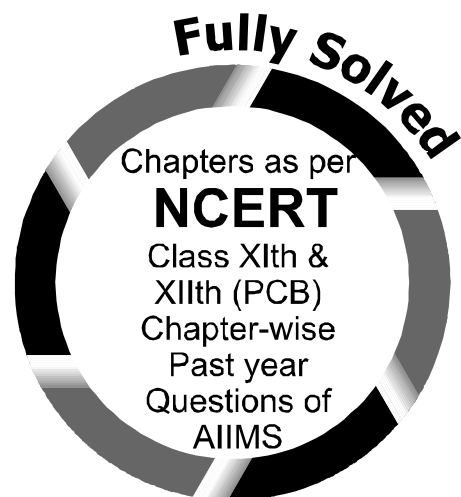


AIIMS

Topic-wise Solved Papers

with 1 Mock Test



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Mock Test with Detailed Solutions

1 - 30

Units and Measurements

TYPE A : MULTIPLE CHOICE QUESTIONS

1. The dimensions of Planck's constant are [1997]
 - (a) $[ML^{-3}T^{-1}]$ (b) $[ML^{-2}T^{-1}]$
 - (c) $[M^0L^{-1}T^{-3}]$ (d) $[ML^2T^{-1}]$
2. The dimensional formula of magnetic flux is [1998]
 - (a) $[ML^0T^{-2}A^{-1}]$ (b) $[ML^2T^{-2}A^{-1}]$
 - (c) $[ML^2T^{-1}A^3]$ (d) $[M^0L^{-2}T^{-2}A^{-2}]$
3. The dimensional formula of the constant a in Vander Waal's gas equation $\left(P + \frac{a}{V^2}\right)(V - b) = RT$ is: [1999]
 - (a) $[ML^4T^{-1}]$ (b) $[ML^2T^{-2}]$
 - (c) $[ML^5T^{-3}]$ (d) $[ML^5T^{-2}]$
4. What is the dimensional formula of gravitational constant? [2000]
 - (a) $[ML^2T^{-2}]$ (b) $[ML^{-1}T^{-1}]$
 - (c) $[M^{-1}L^3T^{-2}]$ (d) none of these
5. Which of the following pairs does not have similar dimensions? [2001]
 - (a) tension and surface tension
 - (b) stress and pressure
 - (c) Planck's constant and angular momentum
 - (d) angle and strain
6. The length and breadth of a metal sheet are 3.124 m and 3.002 m respectively. The area of this sheet upto four correct significant figure is: [2001]
 - (a) $9.378 m^2$ (b) $9.37 m^2$
 - (c) $9.378248 m^2$ (d) $9.3782 m^2$
7. The dimensions of energy are [2002]
 - (a) $[ML^3T^{-3}]$ (b) $[ML^{-1}T^{-1}]$
 - (c) $[ML^2T^{-2}]$ (d) $[MT^{-2}]$
8. Velocity of light is equal to [2002]
 - (a) $\sqrt{\frac{1}{\epsilon_0\mu_0}}$ (b) $\sqrt{\epsilon_0/\mu_0}$
 - (c) ϵ_0/μ_0 (d) $\epsilon_0\mu$
9. Using mass (M), length (L), time (T) and current (A) as fundamental quantities, the dimensions of permeability are: [2003]
 - (a) $[M^{-1}LT^{-2}A]$ (b) $[ML^{-2}T^{-2}A^{-1}]$
 - (c) $[MLT^{-2}A^{-2}]$ (d) $[MLT^{-1}A^{-1}]$
10. Using mass (M), length (L), time (T) and current (A) as fundamental quantities, the dimensional formula of permittivity is: [2004]
 - (a) $[ML^{-2}T^2A]$ (b) $[M^{-1}L^{-3}T^4A^2]$
 - (c) $[MLT^{-2}A]$ (d) $[ML^2T^{-1}A^2]$
11. "Parsec" is the unit of: [2005]
 - (a) time
 - (b) distance
 - (c) frequency
 - (d) angular acceleration
12. Dimensions of electrical resistance are: [2005]
 - (a) $[ML^2T^{-3}A^{-1}]$ (b) $[ML^2T^{-3}A^{-2}]$
 - (c) $[ML^3T^{-3}A^{-2}]$ (d) $[ML^{-1}L^3T^3A^2]$
13. The magnetic moment has dimensions of: [2006]
 - (a) $[LA]$ (b) $[L^2A]$
 - (c) $[LT^{-1}A]$ (d) $[L^2T^{-1}A]$
14. Which of the following physical quantities do not have same dimensions? [2007]
 - (a) pressure and stress
 - (b) tension and surface tension
 - (c) strain and angle
 - (d) energy and work.
15. What is the dimensions of impedance? [2007]
 - (a) $ML^2T^{-3}I^{-2}$ (b) $M^{-1}L^{-2}T^3I^2$
 - (c) $ML^3T^{-3}I^{-2}$ (d) $M^{-1}L^{-3}T^3I^2$

P-2

Topicwise AIIMS Solved Papers – PHYSICS

16. The speed of light (c), gravitational constant (G) and planck's constant (h) are taken as fundamental units in a system. The dimensions of time in this new system should be [2008]
 (a) $G^{1/2} h^{1/2} c^{-5/2}$ (b) $G^{-1/2} h^{1/2} c^{1/2}$
 (c) $G^{1/2} h^{1/2} c^{-3/2}$ (d) $G^{1/2} h^{1/2} c^{1/2}$
17. Dimensions of coefficient of viscosity is [2010]
 (a) $[MT^2]$ (b) $[ML^{-3}T^{-4}]$
 (c) $[ML^{-1}T^{-2}]$ (d) $[ML^{-1}T^{-1}]$
18. Which of the following pair of quantities do not have the same dimensions : [2011]
 (a) Potential gradient, electric field
 (b) Torque, kinetic energy
 (c) Light year, time period
 (d) Impedance, reactance
19. The dimensional formula for torque is : [2011]
 (a) ML^2T^{-2} (b) $ML^{-1}T^{-1}$
 (c) L^2T^{-1} (d) $M^2T^{-2}K^{-1}$
20. What is the fractional error in g calculated from $T = 2\pi\sqrt{\ell/g}$? Given fraction errors in T and ℓ are $\pm x$ and $\pm y$ respectively? [2012]
 (a) $x + y$ (b) $x - y$
 (c) $2x + y$ (d) $2x - y$
21. The dimensional formula of farad is [2012]
 (a) $[M^{-1}L^{-2}TQ]$ (b) $[M^{-1}L^{-2}T^2Q^2]$
 (c) $[M^{-1}L^{-2}TQ^2]$ (d) $[M^{-1}L^{-2}T^2Q]$
22. The density of a cube is measured by measuring its mass and length of its sides. If the maximum error in the measurement of mass and length are 4% and 3% respectively, the maximum error in the measurement of density will be [2013]
 (a) 7% (b) 9%
 (c) 12% (d) 13%
23. The dimensions of $\left(\frac{1}{2}\right)\epsilon_0 E^2$ (ϵ_0 : permittivity of free space, E electric field) are [2014]
 (a) $[MLT^{-1}]$ (b) $[ML^2T^{-2}]$
 (c) $[ML^{-1}T^{-2}]$ (d) $[ML^2T^{-1}]$
24. The least count of a stop watch is 0.2 second. The time of 20 oscillations of a pendulum is measured to be 25 second. The percentage error in the measurement of time will be [2015]
 (a) 8% (b) 1.8%
 (c) 0.8% (d) 0.1%
25. If e is the charge, V the potential difference, T the temperature, then the units of $\frac{eV}{T}$ are the same as that of [2016]
 (a) Planck's constant
 (b) Stefan's constant
 (c) Boltzmann constant
 (d) Gravitational constant
26. If the capacitance of a nanocapacitor is measured in terms of a unit ' u ' made by combining the electric charge ' e ', Bohr radius ' a_0 ', Planck's constant ' h ' and speed of light ' c ' then [2016]
 (a) $u = \frac{e^2 h}{a_0}$ (b) $u = \frac{hc}{e^2 a_0}$
 (c) $u = \frac{e^2 c}{ha_0}$ (d) $u = \frac{e^2 a_0}{hc}$
27. A force F is applied onto a square plate of side L . If the percentage error in determining L is 2% and that in F is 4%, the permissible percentage error in determining the pressure is [2017]
 (a) 2% (b) 4%
 (c) 6% (d) 8%

TYPE B : ASSERTION REASON QUESTIONS

Directions for (Qs. 28-30) : These questions consist of two statements, each printed as Assertion and Reason. While answering these questions, you are required to choose any one of the following five responses.

- (a) If both Assertion and Reason are correct and the Reason is a correct explanation of the Assertion.
 (b) If both Assertion and Reason are correct but Reason is not a correct explanation of the Assertion.
 (c) If the Assertion is correct but Reason is incorrect.
 (d) If both the Assertion and Reason are incorrect.
 (e) If the Assertion is incorrect but the Reason is correct.

28. **Assertion :** The dimensional formula for relative velocity is same as that of the change in velocity.

Reason : Relative velocity of P w.r.t. Q is the ratio of velocity of P and that of Q. [2002]

29. **Assertion :** Specific gravity of a fluid is a dimensionless quantity.

Reason : It is the ratio of density of fluid to the density of water. [2005]

30. **Assertion :** The error in the measurement of radius of the sphere is 0.3%. The permissible error in its surface area is 0.6%

Reason : The permissible error is calculated by

the formula $\frac{\Delta A}{A} = \frac{4\Delta r}{r}$ [2008]

Directions for (Qs.31-33) : Each of these questions contains an Assertion followed by Reason. Read them carefully and answer the question on the basis of following options. You have to select the one that best describes the two statements.

(a) If both Assertion and Reason are correct and Reason is the correct explanation of Assertion.

(b) If both Assertion and Reason are correct, but Reason is not the correct explanation of Assertion.

(c) If Assertion is correct but Reason is incorrect.

(d) If both the Assertion and Reason are incorrect.

31. **Assertion :** When percentage errors in the measurement of mass and velocity are 1% and 2% respectively, the percentage error in K.E. is 5%.

Reason : $\frac{\Delta E}{E} = \frac{\Delta m}{m} + \frac{2\Delta v}{v}$ [2010]

32. **Assertion :** The number of significant figures depends on the least count of measuring instrument.

Reason : Significant figures define the accuracy of measuring instrument. [2016]

33. **Assertion:** In the measurement of physical quantities direct and indirect methods are used.

Reason : The accuracy and precision of measuring instruments along with errors in measurements should be taken into account, while expressing the result. [2017]

HINTS & SOLUTIONS

Type A : Multiple Choice Questions

1. (d) $E = hv$, h is Planck's constant

$$[h] = \frac{[E]}{[v]} = \frac{ML^2T^{-2}}{T^{-1}} = ML^2T^{-1}$$

2. (b) $F = Bqv \Rightarrow F = \frac{\phi}{A}qv$

$$\phi = \frac{FA}{qv} = \frac{MLT^{-2}L^2}{ATLT^{-1}} = ML^{+2}A^{-1}T^{-2}$$

3. (d) Here the dimension of $\frac{a}{V^2}$ will be equal to

$$\text{pressure so } \frac{a}{(L^3)^2} = ML^{-1}T^{-2}$$

$$a = ML^5T^{-2}$$

4. (c) $F = \frac{G.M.M}{L^2} = MLT^{-2}$

$$G = \frac{MLT^{-2}L^2}{M^2} = M^{-1}L^3T^{-2}$$

5. (a) Tension will have dimension of force and surface tension will have dimension of force per unit length so they have different dimensions.

6. (a) Area of metal sheet = 3.124×3.002
= 9.378248

Now, the result must have significant figures equal to the least of figure being multiplied, so, Area of metal sheet = 9.378 m²

7. (c) Torque = Force $\times$ distance = Energy

$$= MLT^{-2}L = ML^2T^{-2}$$

8. (a) Velocity of light, $c = \sqrt{\frac{1}{\epsilon_0\mu_0}}$

9. (c) $B = \mu ni$; $F = Bqv$

$$F = \mu niqv \Rightarrow \mu = \frac{F}{niqv}$$

$$\mu = \frac{MLT^{-2}}{\frac{1}{L}A.AT.LT^{-1}}$$

[n is no. of turns per unit length]

$$= MLA^{-2}T^{-2}$$

10. (b) $F = \frac{1}{4\pi\epsilon_0} \cdot \frac{q_1q_2}{r^2} \Rightarrow \epsilon_0 = \frac{q_1q_2}{4\pi Fr^2}$

$$\frac{AT.AT}{MLT^{-2}L^2} = \frac{A^2T^2}{ML^3T^{-2}} = M^{-1}L^{-3}A^2T^4$$

11. (b) Parsec is a unit of length on the astronomical scale. It is the distance of an object that will show a parallax of 1" of arc from opposite side of a baseline (radius) equal to the distance between sun and earth.

$$1 \text{ parsec} = 3.1 \times 10^{16} \text{ m}$$

12. (b) $R = \frac{V}{I} = \frac{W}{qI}$ (Work = $V \times q \Rightarrow V = \frac{W}{q}$)

$$R = \frac{ML^2T^{-2}}{AT.A} = ML^2A^{-2}T^{-3}$$

13. (b) Magnetic moment of a coil carrying current is,

$$M = I.A$$

[A is area of cross section and i is current]

$$\text{Dimension of } M = AL^2$$

14. (b) Tension is a force and surface tension is force per unit area hence their dimensions are not same.

15. (a) Impedance is same as resistance but in ac circuit

$\therefore$ Dimension of impedance

$$= \frac{\text{dimension of voltage}}{\text{dimension of current}}$$

$$= \frac{[V]}{[I]} = \frac{[ML^2T^{-3}I^{-1}]}{I} = [ML^2T^{-3}I^{-2}]$$

16. (a) Let time, $T \propto c^x G^y h^z$

$$\Rightarrow T = kc^x G^y h^z$$

Taking dimensions on both sides

$$[M^0 L^0 T^1] = [L T^{-1}]^x [M^{-1} L^3 T^{-2}]^y [M L^2 T^{-1}]^z$$

i.e.,

$$[M^0 L^0 T^1] = [M^{-y+z} L^{x+3y+2z} T^{-x-2y-z}]$$

Equating power of M, L, T on both sides, we get

$$-y + z = 0 \quad \dots (1)$$

$$x + 3y + 2z = 0 \quad \dots (2)$$

$$-x - 2y - z = 1 \quad \dots (3)$$

$$\text{From (1)} \Rightarrow z = y$$

$$\text{Adding (2) and (3)} \Rightarrow y + z = 1$$

$$\text{or } 2y = 1 \quad [\text{From (1)}]$$

$$\text{i.e., } y = \frac{1}{2}$$

$$\therefore z = y = \frac{1}{2}$$

Putting these values in (2) we get

$$x + \frac{3}{2} + 1 = 0 \quad \text{or} \quad x = -\frac{5}{2}$$

$$\text{Hence, } [T] = [G^{1/2} h^{1/2} c^{-5/2}]$$

$$17. \quad (d) \quad \text{Coefficient of viscosity, } \eta = \frac{F}{A \frac{dv}{dx}}$$

$$[F] = [\text{Force}] = MLT^{-2}$$

$$[A] = [\text{Area}] = L^2$$

$$\left[\frac{dv}{dx} \right] = [\text{Velocity gradient}] = \frac{LT^{-1}}{L} = T^{-1}$$

$$\therefore [\eta] = \frac{MLT^{-2}}{L^2 T^{-1}} = [ML^{-1} T^{-1}]$$

$$18. \quad (c) \quad \text{Light year has the dimensions of distance and time period is time.}$$

$$19. \quad (a) \quad \tau = Fr = MLT^{-2} L = ML^2 T^{-2}$$

$$20. \quad (c) \quad \text{From } T = 2\pi \sqrt{\frac{\ell}{g}}; \quad g = 4\pi^2 \frac{\ell}{T^2}$$

$$\frac{\Delta g}{g} = \frac{\Delta \ell}{\ell} + \frac{2\Delta T}{T} = (y + 2x)$$

$$21. \quad (b) \quad [C] = \left[\frac{Q}{V} \right] = \left[\frac{Q^2}{W} \right] = [M^{-1} L^{-2} T^2 Q^2]$$

$$22. \quad (d) \quad \text{Density} = \frac{\text{Mass}}{\text{Volume}}$$

$$\rho = \frac{M}{L^3}, \quad \frac{\Delta \rho}{\rho} = \frac{\Delta M}{M} + 3 \frac{\Delta L}{L}$$

$$\% \text{ error in density} = \% \text{ error in Mass} + 3 (\% \text{ error in length}) = 4 + 3(3) = 13\%$$

$$23. \quad (c) \quad \text{Here } \left(\frac{1}{2} \right) \epsilon_0 E^2 \text{ represents energy per unit volume}$$

$$[\epsilon_0] [E^2] = \frac{\text{Energy}}{\text{volume}} = \frac{[ML^2 T^{-2}]}{[L^3]} = ML^{-1} T^{-2}$$

$$24. \quad (c) \quad \frac{0.2}{25} \times 100 = 0.8$$

$$25. \quad (c) \quad \frac{eV}{T} = \frac{W}{T} = \frac{PV}{T} = R$$

$$\text{and } \frac{R}{N} = \text{Boltzmann constant.}$$

$$26. \quad (d) \quad \text{Let unit 'u' related with } e, a_0, h \text{ and } c \text{ as follows :}$$

$$[u] = [e]^a [a_0]^b [h]^c [C]^d$$

Using dimensional method,

$$[M^{-1} L^{-2} T^{+4} A^{+2}]$$

$$= [A^1 T^1]^a [L]^b [ML^2 T^{-1}]^c [LT^{-1}]^d$$

$$[M^{-1} L^{-2} T^{+4} A^{+2}] = [M^c L^{b+2c+d} T^{a-c-d} A^a]$$

$$a = 2, b = 1, c = -1, d = -1$$

$$\therefore u = \frac{e^2 a_0}{hc}$$

$$27. \quad (d) \quad \text{As, pressure } P = \frac{F}{A} = \frac{F}{L^2}$$

$$\% \text{ Error} = \frac{\Delta F}{F} \times 100 + 2 \frac{\Delta L}{L} \times 100 = 4 + 2 \times 2 = 8\%$$

Type B : Assertion Reason Questions

28. (e) Relative velocity which is vector subtraction of two velocities will also be a vector of the form of velocity so, its dimensional formula will remain unchanged. Relative velocity is measured not by calculating ratio but by calculating difference.

29. (a) Specific gravity of fluid

$$= \frac{\text{density of fluid}}{\text{density of water}}$$

It is a ratio.

30. (c) Area of the sphere, $A = 4\pi r^2$
% error in area = $2 \times$ % error in radius

$$\text{i.e., } \frac{\Delta A}{A} \times 100 = 2 \times \frac{\Delta r}{r} \times 100$$

$$= 2 \times 0.3\% = 0.6\%$$

But $\frac{\Delta A}{A} = 4 \frac{\Delta r}{r}$ is false.

31. (a) Both Assertion and Reason are correct and Reason is the correct explanation of Assertion.

$$\text{Kinetic energy, } E = \frac{1}{2}mv^2.$$

Differentiating both side

$$\frac{\Delta E}{E} = \frac{\Delta m}{m} + 2 \frac{\Delta v}{v}$$

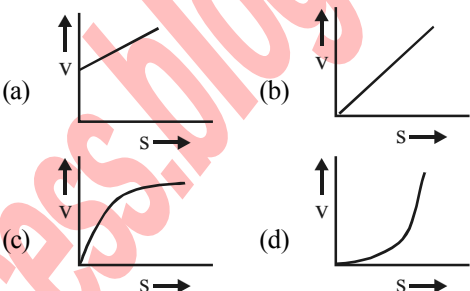
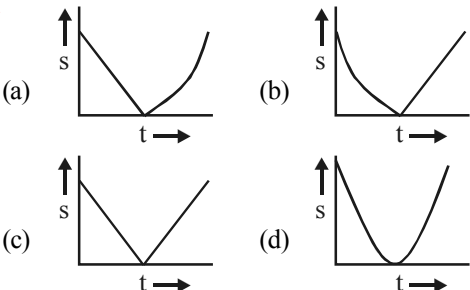
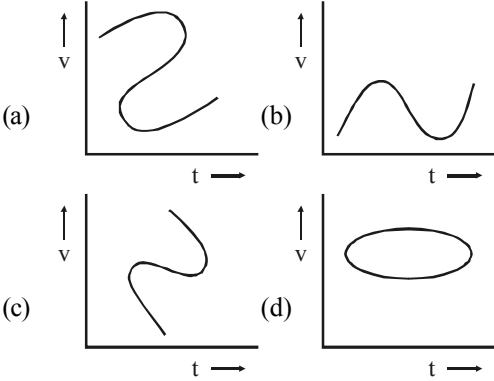
$$\frac{\Delta E}{E} = \frac{1}{100} + 2 \times \frac{2}{100} = \frac{5}{100} = 5\%$$

32. (b) Significant figure refers to the accuracy of measurement and accuracy of measurement also depends upon the least count of measuring instrument.

33. (a)

Motion in a Straight Line

TYPE A : MULTIPLE CHOICE QUESTIONS

- If a car at rest accelerated uniformly to a speed of 144 km/hour in 20 second it covers a distance :
(a) 400m (b) 1440m [1997]
(c) 2880m (d) 25m
- A ball is dropped from a bridge 122.5 m high. After the first ball has fallen for 2 second, a second ball is thrown straight down after it, what must be the initial velocity of the second ball be, so that both the balls hit the surface of water at the same time? [1997]
(a) 26.1 m/s (b) 9.8 m/s
(c) 55.5 m/s (d) 49 m/s
- A particle is thrown vertically upwards. Its velocity at half of the height is 10 m/s, then the maximum height attained by it will be : ($g = 10 \text{ m/s}^2$)
(a) 10m (b) 20m [1999]
(c) 15m (d) 25m
- A body is released from the top of the tower H metre high. It takes t second to reach the ground. Where is the body after $t/2$ second of release ? [2000]
(a) at $3H/4$ metre from the ground
(b) at $H/2$ metre from the ground
(c) at $H/6$ metre from the ground
(d) at $H/4$ metre from the ground
- A body starts from rest with an acceleration a_1 . After two seconds another body B starts from rest with an acceleration a_2 . If they travel equal distances in fifth second after the starts of A, the ratio $a_1 : a_2$ will be equal to : [2001]
(a) 9 : 5 (b) 5 : 7
(c) 5 : 9 (d) 7 : 9
- Three different objects m_1 , m_2 and m_3 are allowed to fall from rest and from the same point O along three different frictionless paths. The speeds of the three objects, on reaching the ground, will be in the ratio of [2002]
(a) $m_1 : m_2 : m_3$ (b) 1 : 1 : 1
(c) $m_1 : 2m_2 : 3m_3$ (d) $\frac{1}{m_1} : \frac{1}{m_2} : \frac{1}{m_3}$
- A body starting from rest moves along straight line with a constant acceleration. The variation of speed (v) with distance (s) is represented by the graph : [2003]

- A ball is thrown vertically upwards. Which of the following plots represents the speed-time graph of the ball during its flight if the air resistance is not ignored? [2003]

- Which of the following velocity-time graphs shows a realistic situation for a body in motion? [2004, 2007]


10. Two spheres of same size one of mass 2 kg and another of mass 4 kg are dropped simultaneously from the top of Qutab Minar (height = 72m). When they are 1m above the ground, the two spheres have the same: [2006]

(a) momentum (b) kinetic energy
(c) potential energy (d) acceleration

11. A particle is thrown vertically upwards with a velocity of 4ms^{-1} . The ratio of its accelerations after 1s and 2s of its motion is [2009]

(a) 2 (b) 9.8
(c) 1 (d) 4.9

12. A body is thrown vertically upwards with a velocity of 19.6ms^{-1} . The position of the body after 4 s will be [2009]

(a) at the highest point
(b) at the mid-point of the line joining the starting point and the highest point
(c) at the starting point
(d) none of the above

13. The position(x) of a particle at any time(t) is given by [2009]

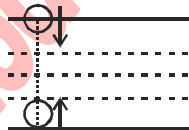
$$x(t) = 4t^3 - 3t^2 + 2$$

The acceleration and velocity of the particle at any time $t = 2$ sec are respectively

(a) 16ms^{-2} and 22ms^{-1}
(b) 42ms^{-2} and 36ms^{-1}
(c) 48ms^{-2} and 36ms^{-1}
(d) 12ms^{-2} and 25ms^{-1}

14. A stone is projected vertically up from the bottom of a water tank. Assuming no water resistance it will go up & come down in same time but if water drag is present then the time it takes to go up, t_{up} and the time it takes to come down, t_{down} are related as [2009]

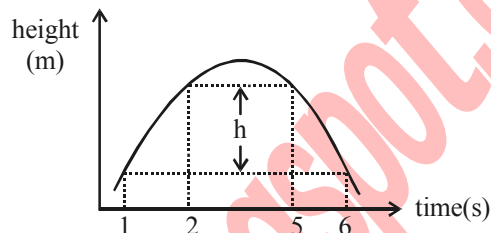
(a) $t_{\text{up}} > t_{\text{down}}$
(b) $t_{\text{up}} = t_{\text{down}}$
(c) $t_{\text{up}} < t_{\text{down}}$
(d) can not say



15. A student is standing at a distance of 50 metre from the bus. As soon as the bus begins its motion with an acceleration of 1ms^{-2} , the student starts running towards the bus with a uniform velocity u . Assuming the motion to be along a straight road, the minimum value of u , so that the student is able to catch the bus is

(a) 8ms^{-1} (b) 5ms^{-1} [2010]
(c) 12ms^{-1} (d) 10ms^{-1}

16. A ball is thrown upwards. Its height varies with time as follows :



If the acceleration due to gravity is 7.5m/s^2 , then the height h is : [2011]

(a) 10m (b) 15m
(c) 20m (d) 25m

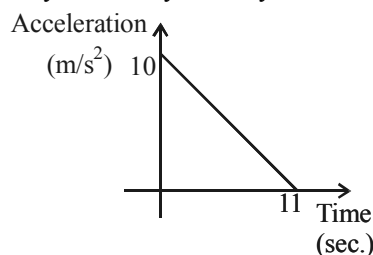
17. The coordinates of a moving particle at any time t are given by $x = at^2$ and $y = bt^2$. The speed of the particle is [2012]

(a) $2t(a+b)$ (b) $2t\sqrt{a^2+b^2}$
(c) $2t\sqrt{a^2-b^2}$ (d) $\sqrt{a^2+b^2}$

18. A ball is released from the top of a tower of height h meters. It takes T seconds to reach the ground. What is the position of the ball at $\frac{T}{3}$ second

(a) $\frac{8h}{9}$ meters from the ground [2012]
(b) $\frac{7h}{9}$ meters from the ground
(c) $\frac{h}{9}$ meters from the ground
(d) $\frac{17h}{18}$ meters from the ground

19. A body starts from rest at time $t=0$, the acceleration time graph is shown in the figure. The maximum velocity attained by the body will be [2014]



(a) 110 m/s (b) 55 m/s
(c) 650 m/s (d) 550 m/s

20. Two bodies begin a free fall from the same height at a time interval of N s. If vertical separation between the two bodies is l after n second from the start of the first body, then n is equal to

[2016]

- (a) $\sqrt{nN}$ (b) $\frac{1}{gN}$
 (c) $\frac{1}{gN} + \frac{N}{2}$ (d) $\frac{1}{gN} - \frac{N}{4}$

21. From a balloon moving upwards with a velocity of 12 ms^{-1} , a packet is released when it is at a height of 65 m from the ground. The time taken by it to reach the ground is ($g = 10 \text{ ms}^{-2}$)

[2017]

- (a) 5 s (b) 8 s
 (c) 4 s (d) 7 s

TYPE B : ASSERTION REASON QUESTIONS

Directions for (Qs. 22-24) : These questions consist of two statements, each printed as Assertion and Reason. While answering these questions, you are required to choose any one of the following five responses.

- (a) If both Assertion and Reason are correct and the Reason is a correct explanation of the Assertion.
 (b) If both Assertion and Reason are correct but Reason is not a correct explanation of the Assertion.
 (c) If the Assertion is correct but Reason is incorrect.
 (d) If both the Assertion and Reason are incorrect.
 (e) If the Assertion is incorrect but the Reason is correct.

22. **Assertion :** A body can have acceleration even if its velocity is zero at a given instant of time.

Reason : A body is numerically at rest when it reverses its direction. [1998]

23. **Assertion :** A body with constant acceleration always moves along a straight line.

Reason : A body with constant acceleration may not speed up. [1998]

24. **Assertion :** Retardation is directly opposite to the velocity.

Reason : Retardation is equal to the time rate of decrease of speed. [2002]

Directions for (Qs.25-28) : Each of these questions contains an Assertion followed by Reason. Read them carefully and answer the question on the basis of following options. You have to select the one that best describes the two statements.

- (a) If both Assertion and Reason are correct and Reason is the correct explanation of Assertion.
 (b) If both Assertion and Reason are correct, but Reason is not the correct explanation of Assertion.
 (c) If Assertion is correct but Reason is incorrect.
 (d) If both the Assertion and Reason are incorrect.

25. **Assertion :** Two balls of different masses are thrown vertically upward with same speed. They will pass through their point of projection in the downward direction with the same speed.

Reason : The maximum height and downward velocity attained at the point of projection are independent of the mass of the ball. [2013]

26. **Assertion :** The two bodies of masses M and m ($M > m$) are allowed to fall from the same height if the air resistance for each be the same then both the bodies will reach the earth simultaneously.

Reason : For same air resistance, acceleration of both the bodies will be same. [2014]

27. **Assertion :** In a free fall, weight of a body becomes effectively zero.

Reason : Acceleration due to gravity acting on a body having free fall is zero. [2014]

28. **Assertion :** Velocity-time graph for an object in uniform motion along a straight path is a straight line parallel to the time axis.

Reason : In uniform motion of an object velocity increases as the square of time elapsed. [2015]

HINTS & SOLUTIONS

Type A : Multiple Choice Questions

1. (a) $u = 0, v = 144 \text{ km/hour} = 144 \times \frac{5}{18} \text{ m/sec}$

$$= 40 \text{ m/sec}$$

$$v = u + at$$

$$\Rightarrow a = \frac{v - u}{t} = \frac{40 - 0}{20} = 2 \text{ m/sec}^2$$

$$\therefore s = ut + \frac{1}{2}at^2$$

$$= \frac{1}{2} \times 2 \times (20)^2 = 400 \text{ m}$$

2. (a) Time taken by the first object to reach the ground = t , so

$$122.5 = ut + \frac{1}{2}gt^2$$

$$122.5 = \frac{1}{2} \times 10 \times t^2$$

$$\Rightarrow t = 5 \text{ sec (approx)}$$

Time to be taken by the second ball to reach the ground = $5 - 2 = 3 \text{ sec}$.

If u be its initial velocity then,

$$122.5 = u \times 3 + \frac{1}{2}gt^2 = 3u + \frac{1}{2} \times 10 \times 9$$

$$3u = 122.5 - 45 = 77.5$$

$$u = 26 \text{ (approx.)}$$

3. (a) Let maximum height be H

From the formula, $v^2 = u^2 - 2gs$

$$(10)^2 = u^2 - 2gH/2 = u^2 - gH \quad \dots\dots(1)$$

For attaining maximum height, $v = 0$

$$0 = u^2 - 2gH \Rightarrow u^2 = 2gH$$

Putting the value of u^2 in (1),

$$100 = 2gH - gH = gH$$

$$H = \frac{100}{g} = \frac{100}{10} = 10 \text{ metre}$$

4. (a) Applying $S = ut + \frac{1}{2}gt^2$ for the 1st case

$$H = \frac{1}{2}gt^2 \quad \dots\dots(i)$$

Let H_1 be the height after $t/2$ secs. So

distance of fall = $H - H_1$

$$H - H_1 = \frac{1}{2}g\left(\frac{t}{2}\right)^2$$

$$\Rightarrow H - H_1 = \frac{1}{8}gt^2 \quad \dots\dots(ii)$$

Dividing (i) and (ii),

$$\frac{H - H_1}{H} = \frac{1}{8} \times \frac{2}{1} = \frac{1}{4}$$

$$\Rightarrow 4H - 4H_1 = H \Rightarrow H_1 = \frac{3}{4}H$$

5. (c) Distance travelled in fifth second for first body = distance travelled in 3rd second for second body,

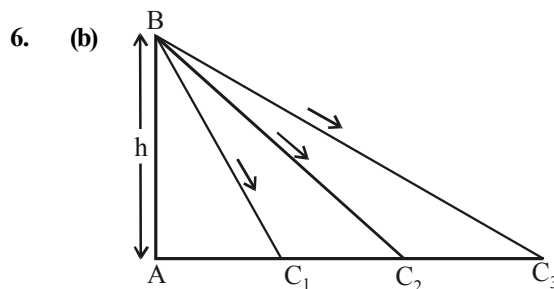
$$S_5 = S_3$$

$$S_t = u + \frac{(2t-1)a}{2}$$

$$S_5 = 0 + \frac{9}{2}a_1$$

$$S_3 = 0 + \frac{5}{2}a_2$$

$$\frac{9}{2}a_1 = \frac{5}{2}a_2 \Rightarrow \frac{a_1}{a_2} = \frac{5}{9}$$



For paths BC_1 , BC_2 & BC_3 the height is same that is h . The terminal velocity be v

then for all cases, $v = \sqrt{2gh}$

So, all will have same value of terminal velocity.

7. (d) $v^2 = u^2 + 2as$

$$v^2 = 2as \text{ as } u = 0$$

The graph between v and s will be of the form of parabola which will be symmetric with respect to v -axis. So curve (d) is the right answer.

8. (d) For a body going in upward direction

$$v = u - gt$$

The slope of the graph, $\frac{dv}{dt} = -g$ (constant)

But when we take into account the effect of resistance it will have sharper slope. Curve (d) fits into this result.

9. (b) Time cannot reverse itself or it can only go forward. In graph (a), (c) & (d) some portion of graph has shown time changing in such a way or time is going from high value to low value which is not practical.

Graph (b) is the answer.

10. (d) Since their masses are different they will have different momentum, kinetic energy and potential energy. But their acceleration will be same which will be equal to g .

11. (c) We know that the acceleration in a motion under gravity is constant which is 9.8 ms^{-2} .

Hence, the required ratio will be $\frac{9.8}{9.8} = 1$

12. (c) Clearly the time taken by the particle to reach the highest point is given by

$$v = u - gt$$

$$\text{or, } t = \frac{u - v}{g} = \frac{19.6 - 0}{9.8}$$

$$\text{or, } t = 2 \text{ s.}$$

Therefore, the particle will reach at the starting point itself after 4 s.

13. (c) We have $x(t) = 4t^3 - 3t^2 + 2$

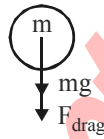
$$\Rightarrow v = \frac{dx}{dt} = 12t^2 - 6t$$

$$\text{and } a = \frac{dv}{dt} = 24t$$

$$\therefore v \text{ at } t = 2 \text{ s is } 12(2)^2 - 6(2) \text{ i.e., } 36 \text{ ms}^{-1}$$

$$\text{and } a \text{ at } t = 2 \text{ s is } 24 \times 2 \text{ i.e., } 48 \text{ ms}^{-2}$$

14. (c) While moving up



& while



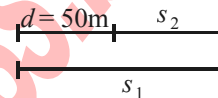
$$\therefore a_{\text{up}} > a_{\text{down}}$$

Hence to cover same distance $t_{\text{up}} < t_{\text{down}}$.

15. (d) Let the student travels distance s_1 in time t and catches the bus.

$$s_1 = ut$$

$$\dots(1)$$



Distance travelled by the bus in time t

$$s_2 = 0 + \frac{1}{2} at^2$$

$$\dots(2)$$

The student is able to catch the bus if,

$$s_1 = d + s_2$$

$$ut = d + \frac{1}{2} 1 \times t^2$$

$$\text{or, } 2ut = 2d + t^2$$

$$\text{or, } t^2 - 2ut + 2d = 0$$

Solving the quadratic equation

$$t = -2 \pm \sqrt{4u^2 - 8d}$$

$$= -2 \pm 2\sqrt{u^2 - 2d}$$

For t to be real

$$u \geq \sqrt{2d}$$

$$\geq \sqrt{2 \times 50} = 10 \text{ m/s.}$$

16. (b) Velocity at highest point becomes zero

$$\therefore 0 = u - at$$

$$\text{or } u = at$$

$$= 7.5 \times 3.5 = 62.25 \text{ m/s}$$

$$y_1 = u \times 1 - \frac{1}{2} \times 7.5 \times 1^2$$

$$y_2 = u \times 2 - \frac{1}{2} \times 7.5 \times 2^2$$

$$h = y_2 - y_1 = 15$$

P-12

Topicwise AIIMS Solved Papers – PHYSICS

17. (b) $\mathbf{r} = \mathbf{i} a t^2 + \mathbf{j} b t^2$, $\mathbf{v} = \frac{d\mathbf{r}}{dt} = \mathbf{i} 2 a t + \mathbf{j} 2 b t$

$$\therefore \text{Magnitude of } \mathbf{v} = \sqrt{(4a^2 t^2 + 4b^2 t^2)}$$

$$= 2t\sqrt{a^2 + b^2}$$

18. (a) $h = \frac{1}{2} g T^2$

now for $t = T/3$ second vertical distance moved is given by

$$h' = \frac{1}{2} g \left(\frac{T}{3} \right)^2 \Rightarrow h' = \frac{1}{2} \times \frac{g T^2}{9} = \frac{h}{9}$$

$$\therefore \text{position of ball from ground} = h - \frac{h}{9}$$

$$= \frac{8h}{9}$$

19. (b) $V_i = 0, V_f = V_{\max}$

$$\Delta V = \text{area under the curve} = 10 \times \frac{11}{2} = 55$$

$$\text{or } V_f - V_i = 55 \text{ m/s} \quad \text{since } V_i = 0$$

$$V_f = 55 \text{ m/s}$$

$$V_f = V_{\max} = 55 \text{ m/s}$$

20. (c) $y_1 = \frac{1}{2} g n^2$, $y_2 = \frac{1}{2} g (n - N)^2$

$$\therefore y_1 - y_2 = \frac{1}{2} g [n^2 - (n - N)^2]$$

$$\Rightarrow 1 = \frac{g}{2} (2n - N) N$$

$$[\because y_1 - y_2 = 1]$$

$$\Rightarrow n = \frac{1}{gN} + \frac{N}{2}$$

21. (a) $s = ut + \frac{1}{2} at^2$

$$-65 = 12t - 5t^2 \text{ on solving we get, } t = 5\text{s}$$

Type B : Assertion Reason Questions

22. (a) When a body is thrown upwards vertically, at the highest point its velocity becomes zero but gravitational force continues to act on it so it has acceleration in downward direction even at the highest point. So assertion is true.

A body is numerically at rest but it reverses its direction due to acceleration present in it. Reason is true & it supports assertion.

23. (e) In case of circular motion, constant acceleration creates circular motion. In circular motion (uniform) the body in motion does not speed up inspite of acceleration.

24. (a) Retardation = $\frac{\text{decrease in velocity}}{\text{time}}$

It acts opposite to velocity.

25. (a) $h = ut - \frac{1}{2} g t^2$ and $v^2 = u^2 - 2gh$;

These equations are independent of mass.

26. (d) The force acting on the body of mass M are its weight Mg acting vertically downward and air resistance F acting vertically upward.

$$\therefore \text{Acceleration of the body, } a = g - \frac{F}{M}$$

Now $M > m$, therefore, the body with larger mass will have great acceleration and it will reach the ground first.

27. (d)

28. (c) In uniform motion the object moves with uniform velocity, the magnitude of its velocity at different instance i.e., at $t = 0$, $t = 1$ sec, $t = 2$ sec will always be constant. Thus velocity-time graph for an object in uniform motion along a straight path is a straight line parallel to time axis.

Motion in a Plane

TYPE A : MULTIPLE CHOICE QUESTIONS

- Rain is falling vertically downwards with a velocity of 3 km/hr. A man walks in the rain with a velocity of 4 km/hr. The rain drop will fall on the man with a velocity of [1997]
 (a) 5 km/hr (b) 4 km/hr
 (c) 1 km/hr (d) 3 km/hr
- A body of mass 5 kg is moving in a circle of radius 1 m with an angular velocity of 2 rad/sec. Then the centripetal acceleration (in m/s^2) will be [1998]
 (a) 80 N (b) 30 N
 (c) 10 N (d) 20 N
- A body is projected at such angle that the horizontal range is three times the greatest height. The angle of projection is [1998]
 (a) $42^\circ 8'$ (b) $53^\circ 7'$
 (c) $33^\circ 7'$ (d) $25^\circ 8'$
- An aeroplane moves 400 m towards the north, 300 m towards west and then 1200 m vertically upwards, then its displacement from the initial position is [1998]
 (a) 1600 m (b) 1800 m
 (c) 1500 m (d) 1300 m
- The angle between $(\vec{P} + \vec{Q})$ and $(\vec{P} - \vec{Q})$ will be [1999]
 (a) 90° only
 (b) between 0° and 180°
 (c) 180° only
 (d) none of these
- Two equal vectors have a resultant equal to either of them, then the angle between them will be [2000]
 (a) 110° (b) 120°
 (c) 60° (d) 150°
- A stone tied to the end of a string of 80 cm long, is whirled in a horizontal circle with a constant speed. If the stone makes 14 revolutions in 25 sec, then magnitude of acceleration of the same will be [2001]
 (a) 990 cm/sec^2 (b) 680 cm/sec^2
 (c) 750 cm/sec^2 (d) 650 cm/sec^2
- Two projectiles are projected with the same velocity. If one is projected at an angle of 30° and the other at 60° to the horizontal, the ratio of maximum heights reached, is [2001]
 (a) 1 : 3 (b) 2 : 1
 (c) 3 : 1 (d) 1 : 4
- A stone tied to a string is rotated with a uniform speed in a vertical plane. If mass of the stone is m , the length of the string is r and the linear speed of the stone is v , when the stone is at its lowest point, then the tension in the string will be (g = acceleration due to gravity) [2001]
 (a) $\frac{mv^2}{r} + mg$ (b) $\frac{mv^2}{r} - mg$
 (c) $\frac{mv}{r}$ (d) mg
- At the uppermost point of a projectile, its velocity and acceleration are at an angle of [2002]
 (a) 180° (b) 90°
 (c) 60° (d) 45°
- If vectors $\vec{P} = a\hat{i} + a\hat{j} + 3\hat{k}$ and $\vec{Q} = a\hat{i} - 2\hat{j} - \hat{k}$ are perpendicular to each other, then the positive value of a is [2002]
 (a) zero (b) 1
 (c) 2 (d) 3
- The maximum range of a gun horizontal terrain is 10 km. If $g = 10 \text{ m/s}^2$ what must be the muzzle velocity of the shell [2004]
 (a) 400 m/s (b) 200 m/s
 (c) 100 m/s (d) 50 m/s
- A projectile can have the same range R for two angles of projection. If t_1 and t_2 be the times of flights in the two cases, then the product of the two time of flights is proportional to [2006]
 (a) $\frac{1}{R^2}$ (b) R^2
 (c) R (d) $\frac{1}{R}$

P-14

Topicwise AIIMS Solved Papers – PHYSICS

14. A car travels 6 km towards north at an angle of 45° to the east and then travels distance of 4 km towards north at an angle 135° to east. How far is the point from the starting point? What angle does the straight line joining its initial and final position makes with the east? [2008]
- (a) $\sqrt{50}$ km and $\tan^{-1}(5)$
 (b) 10 km and $\tan^{-1}(\sqrt{5})$
 (c) $\sqrt{52}$ km and $\tan^{-1}(5)$
 (d) $\sqrt{52}$ km and $\tan^{-1}(\sqrt{5})$
15. If two forces of equal magnitudes act simultaneously on a body in the east and the north directions then [2009]
- (a) the body will displace in the north direction
 (b) the body will displace in the east direction
 (c) the body will displace in the north-east direction
 (d) the body will remain at the rest.
16. Two vectors having equal magnitudes of x units acting at an angle of 45° have resultant $\sqrt{(2 + \sqrt{2})}$ units. The value of x is [2009]
- (a) 0 (b) 1
 (c) $\sqrt{2}$ (d) $2\sqrt{2}$
17. If R and H represent the horizontal range and the maximum height achieved by a projectile then which of the relation exists? [2009]
- (a) $\frac{H}{R} = 4 \cot \theta$ (b) $\frac{R}{H} = 4 \cot \theta$
 (c) $\frac{H}{R} = 4 \tan \theta$ (d) $\frac{R}{H} = 4 \tan \theta$
18. The acceleration of a body in a non-uniform circular motion is 5 ms^{-2} . Which one of the following is correct? [2009]
- (a) The radial acceleration and the tangential accelerations are 3 ms^{-2} and 4 ms^{-2} respectively.
 (b) The radial and the tangential accelerations are 2 ms^{-2} and 3 ms^{-2} respectively.
 (c) The radial and the tangential accelerations are both 5 ms^{-2} .
 (d) The radial and the tangential acceleration are 5 ms^{-2} and 3 ms^{-2} respectively.
19. An aircraft executes a horizontal loop with a speed of 150 m/s with its wings banked at an angle of 12° . The radius of the loop is ($g = 10 \text{ m/s}^2$) [2010]
- (a) 10.6 km (b) 9.6 km
 (c) 7.4 km (d) 5.8 km
20. For ordinary terrestrial experiments, the observer in an inertial frame in the following cases is [2010]
- (a) a child revolving in a giant wheel
 (b) a driver in a sports car moving with a constant high speed of 200 kmh^{-1} on a straight road
 (c) the pilot of an aeroplane which is taking off
 (d) a cyclist negotiating a sharp curve
21. For a particle in a uniformly accelerated circular motion [2011]
- (a) velocity is radial and acceleration has both radial and transverse components
 (b) velocity is transverse and acceleration has both radial and transverse components
 (c) velocity is radial and acceleration is transverse only
 (d) velocity is transverse and acceleration is radial only
22. For a given angle of the projectile if the initial velocity is doubled the range of the projectile becomes [2011]
- (a) Half (b) One-fourth
 (c) Two times (d) Four times
23. If we can throw a ball upto a maximum height H , the maximum horizontal distance to which we can throw it is [2011]
- (a) $2H$ (b) $\sqrt{2}H$
 (c) H (d) $\frac{H}{2}$
24. The vector sum of two forces is perpendicular to their vector differences. In that case, the forces [2012]
- (a) cannot be predicted
 (b) are equal to each other
 (c) are equal to each other in magnitude
 (d) are not equal to each other in magnitude
25. A projectile can have the same range for two angles of projection. If h_1 and h_2 are maximum heights when the range in the two cases is R , then the relation between R , h_1 and h_2 is [2013]
- (a) $R = 4\sqrt{h_1 h_2}$ (b) $R = 2\sqrt{h_1 h_2}$
 (c) $R = \sqrt{h_1 h_2}$ (d) None of these

26. A projectile thrown with velocity v making angle θ with vertical gains maximum height H in the time for which the projectile remains in air, the time period is [2013]

(a) $\sqrt{H \cos \theta / g}$ (b) $\sqrt{2H \cos \theta / g}$
(c) $\sqrt{4H / g}$ (d) $\sqrt{8H / g}$

27. A bomb is released from a horizontal flying aeroplane. The trajectory of bomb is [2013]

(a) a parabola (b) a straight line
(c) a circle (d) a hyperbola

28. A stone tied to the end of a string of 1 m long is whirled in a horizontal circle with a constant speed. If the stone makes 22 revolution in 44 seconds, what is the magnitude and direction of acceleration of the stone? [2014]

(a) $\pi^2 \text{ m s}^{-2}$ and direction along the radius towards the centre.
(b) $\pi^2 \text{ m s}^{-2}$ and direction along the radius away from the centre.
(c) $\pi^2 \text{ m s}^{-2}$ and direction along the tangent to the circle.
(d) $\pi^2/4 \text{ m s}^{-2}$ and direction along the radius towards the centre.

29. Two projectiles are fired from the same point with the same speed at angles of projection 60° and 30° respectively. Which one of the following is true? [2014]

(a) Their maximum height will be same
(b) Their range will be same
(c) Their landing velocity will be same
(d) Their time of flight will be same

30. A ball is thrown from a point with a speed ' v_0 ' at an elevation angle of θ . From the same point and at the same instant, a person starts running

with a constant speed $\frac{v_0}{2}$ to catch the ball. Will the person be able to catch the ball? If yes, what should be the angle of projection θ ?

[2016]

(a) No (b) Yes, 30°
(c) Yes, 60° (d) Yes, 45°

31. A boy playing on the roof of a 10 m high building throws a ball with a speed of 10 m/s at an angle of 30° with the horizontal. How far from the throwing point will the ball be at the height of 10 m from the ground? [2017]

$$[g = 10 \text{ m/s}^2, \sin 30^\circ = \frac{1}{2}, \cos 30^\circ = \frac{\sqrt{3}}{2}]$$

(a) $5\sqrt{5}$ (b) 6
(c) 3 (d) $5\sqrt{3}$

TYPE B : ASSERTION REASON QUESTIONS

Directions for (Q. 32) : These questions consist of two statements, each printed as Assertion and Reason. While answering these questions, you are required to choose any one of the following five responses.

- (a) If both Assertion and Reason are correct and the Reason is a correct explanation of the Assertion.
(b) If both Assertion and Reason are correct but Reason is not a correct explanation of the Assertion.
(c) If the Assertion is correct but Reason is incorrect.
(d) If both the Assertion and Reason are incorrect.
(e) If the Assertion is incorrect but the Reason is correct.

32. **Assertion :** If a body is thrown upwards, the distance covered by it in the last second of upward motion is about 5 m irrespective of its initial speed

Reason : The distance covered in the last second of upward motion is equal to that covered in the first second of downward motion when the particle is dropped. [2000]

Directions for (Qs.33-37) : Each of these questions contains an Assertion followed by Reason. Read them carefully and answer the question on the basis of following options. You have to select the one that best describes the two statements.

- (a) If both Assertion and Reason are correct and Reason is the correct explanation of Assertion.
(b) If both Assertion and Reason are correct, but Reason is not the correct explanation of Assertion.
(c) If Assertion is correct but Reason is incorrect.
(d) If both the Assertion and Reason are incorrect.

33. **Assertion :** The driver in a vehicle moving with a constant speed on a straight road is an inertial frame of reference.

Reason : A reference frame in which Newton's laws of motion are applicable is non-inertial.

[2009]

34. **Assertion :** A tennis ball bounces higher on hills than in plains.

Reason : Acceleration due to gravity on the hill is greater than that on the surface of earth. [2009]

35. **Assertion :** When a particle moves in a circle with a uniform speed, its velocity and acceleration both changes.

Reason : The centripetal acceleration in circular motion is dependent on angular velocity of the body. [2010]

36. **Assertion :** Centripetal and centrifugal forces cancel each other.

Reason : Centrifugal force is a reaction of centripetal force. [2011]

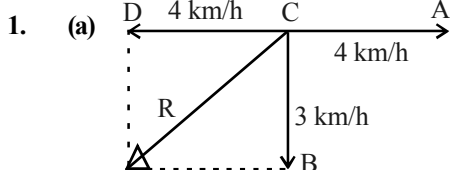
37. **Assertion :** The magnitude of velocity of two boats relative to river is same. Both boats start simultaneously from same point on one bank may reach opposite bank simultaneously moving along different paths.

Reason : For boats to cross the river in same time. The component of their velocity relative to river in direction normal to flow should be same.

[2015]

HINTS & SOLUTIONS

Type A : Multiple Choice Questions



In the figure, CB represents velocity of rain, CA represents velocity of the man. To find relative velocity of the rain with respect to man we add a velocity equal to that of man in opposite direction to the velocity of rain. It has been depicted by line CD. Now rain has two velocities simultaneously. Their resultant,

$$R^2 = 4^2 + 3^2 \Rightarrow R = 5$$

which gives us the value of relative velocity of rain.

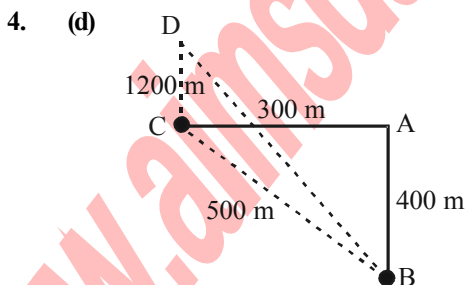
2. (d) Centripetal acceleration = $\omega^2 r = 2 \times 2 \times 1 = 4 \text{ m/s}^2$

3. (b) $R = 3H$; $R = \frac{u^2 \sin^2 \theta}{g}$; $H = \frac{u^2 \sin^2 \theta}{2g}$

$$\frac{u^2 \sin^2 \theta}{g} = \frac{3u^2 \sin^2 \theta}{2g}$$

$$2 \sin \theta \cos \theta = \frac{3 \sin^2 \theta}{2}$$

$$\tan \theta = \frac{4}{3} \Rightarrow \theta = 53^\circ 7'$$

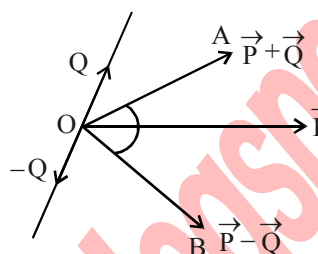


Here CD is perpendicular to the plane of paper. Required distance = BD

$$BD^2 = CB^2 + CD^2 = 500^2 + 1200^2$$

$$BD = \sqrt{500^2 + 1200^2} = 1300 \text{ m}$$

5. (b)



In the figure $\vec{OA}$ represents $(\vec{P} + \vec{Q})$, $\vec{OB}$ represents $(\vec{P} - \vec{Q})$. It is clear from the figure that angle between $\vec{OA}$ and $\vec{OB}$ may be between 0° and 180° .

6. (b) Applying the formula,

$$R^2 = P^2 + Q^2 + 2PQ \cos \alpha$$

$$P^2 = P^2 + P^2 + 2PP \cos \alpha$$

$$= 2P^2 + 2P^2 \cos \alpha = 2P^2(1 + \cos \alpha)$$

$$1 + \cos \alpha = \frac{1}{2} \Rightarrow 2 \cos^2 \frac{\alpha}{2} = \frac{1}{2}$$

$$\cos^2 \frac{\alpha}{2} = \frac{1}{4} \Rightarrow \cos \frac{\alpha}{2} = \frac{1}{2} = \cos 60^\circ$$

$$\frac{\alpha}{2} = 60^\circ \Rightarrow \alpha = 120^\circ$$

7. (a) Centripetal accⁿ = $\omega^2 r = (2\pi n)^2 \times r$

where frequency, $n = \frac{14}{25}$

$$\therefore \text{acc}^n = 4 \times \frac{22}{7} \times \frac{22}{7} \times \frac{14}{25} \times \frac{14}{25} \times 80$$

$$= 990 \text{ cm/sec}^2$$

8. (a) For maximum height

$$H = \frac{u^2 \sin^2 \alpha}{2g}$$

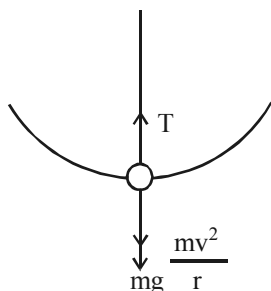
$$H_1 = \frac{u^2 \sin^2 30^\circ}{2g}; H_2 = \frac{u^2 \sin^2 60^\circ}{2g}$$

$$H_1 : H_2 = \sin^2 30^\circ : \sin^2 60^\circ = \frac{1/4}{3/4} = 1 : 3$$

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Topicwise AIIMS Solved Papers – PHYSICS

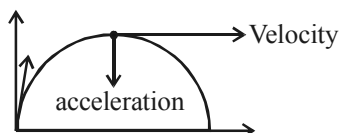
9. (a)



At the lowest point, as shown in the figure both mg and centrifugal force $\frac{mv^2}{r}$ will act in the same direction so,

$$T = mg + \frac{mv^2}{r}$$

10. (b)



As the figure implies, velocity acts in horizontal direction and acceleration due to gravity acts in vertical direction. So, angle between them is 90° .

11. (d) If $\vec{P}$ and $\vec{Q}$ are perpendicular to each other then $\vec{P} \cdot \vec{Q} = 0$

(where vector $\vec{P} = a\hat{i} + a\hat{j} + 3\hat{k}$ and

$\vec{Q} = a\hat{i} - 2\hat{j} - \hat{k}$)

$$(a\hat{i} + a\hat{j} + 3\hat{k})(a\hat{i} - 2\hat{j} - \hat{k}) = 0$$

$$a^2 - 2a - 3 = 0 \Rightarrow (a - 3)(a + 1) = 0$$

$$a - 3 = 0 \Rightarrow a = 3 \text{ and } a = -1$$

12. (a) For maximum range

$$R = \frac{u^2}{g} \Rightarrow u^2 = gR$$

$$u^2 = 16,000 \times 10 \Rightarrow u = 4 \times 100$$

$$u = 400 \text{ m/sec}$$

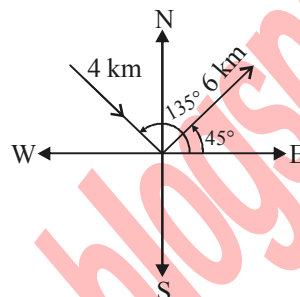
13. (c) $t_1 t_2 = \frac{2R}{g}$ (It is a formula)

$$t_1 t_2 \propto R$$

14. (c) Net distance travelled along x-direction,

$$S_x = 6 \cos 45^\circ \hat{i} - 4 \cos 45^\circ \hat{i}$$

$$= 2 \times \frac{1}{\sqrt{2}} = \sqrt{2} \text{ km}$$



Net distance travelled along y-direction

$$S_y = 6 \sin 45^\circ \hat{j} + 4 \sin 45^\circ \hat{j}$$

$$= 10 \times \frac{1}{\sqrt{2}} = 5\sqrt{2} \text{ km}$$

$\therefore$ Net distance travelled from the starting point,

$$S = \sqrt{S_x^2 + S_y^2} = \sqrt{(\sqrt{2})^2 + (5\sqrt{2})^2}$$

$$= \sqrt{2 + 25 \times 2} = \sqrt{52} \text{ km}$$

Angle which the resultant makes with the east direction

$$\tan \theta = \frac{y}{x} = \frac{5\sqrt{2}}{\sqrt{2}} \quad \text{or } \theta = \tan^{-1}(5)$$

15. (c) The resultant $\vec{F}$ of two forces $\vec{F}_1$ and $\vec{F}_2$ acting in the east and the north direction respectively will act in the north-east direction as per the parallelogram law of vector addition.

16. (b) Here, $P = x$ units, $Q = x$ units, $\theta = 45^\circ$

$$R = \sqrt{(2 + \sqrt{2})} \text{ units}$$

$$\text{We have, } R = \sqrt{P^2 + Q^2 + 2PQ \cos \theta}$$

$$\text{or, } R = \sqrt{x^2 + x^2 + 2 \cdot x \cdot x \cos 45^\circ}$$

$$\text{or, } \sqrt{(2 + \sqrt{2})} = \sqrt{2x^2 + 2x^2 \frac{1}{\sqrt{2}}}$$

$$= \sqrt{2x^2 + \sqrt{2}x^2}$$

$$\text{or, } \sqrt{(2 + \sqrt{2})} = \sqrt{x^2(2 + \sqrt{2})}$$

$$\text{or, } \sqrt{(2 + \sqrt{2})} = x\sqrt{(2 + \sqrt{2})} \Rightarrow x = 1$$

$$17. \text{ (b) } R = \frac{u^2 \sin 2\theta}{g} = \frac{2u^2 \sin \theta \cos \theta}{g}$$

$$H = \frac{u^2 \sin^2 \theta}{2g}$$

$$\therefore \frac{H}{R} = \frac{u^2 \sin^2 \theta}{2g} \times \frac{g}{2u^2 \sin \theta \cos \theta}$$

$$= \frac{\sin \theta}{4 \cos \theta}$$

$$\Rightarrow \frac{R}{H} = \frac{4 \cos \theta}{\sin \theta} \text{ or, } \frac{R}{H} = 4 \cot \theta$$

18. (a) The acceleration of a body in a non-uniform circular motion is the resultant of the radial and the tangential accelerations. If $a_r = 3 \text{ ms}^{-2}$ and $a_t = 4 \text{ ms}^{-2}$ then, $a = \sqrt{a_r^2 + a_t^2} = \sqrt{(3)^2 + (4)^2}$
- $$= \sqrt{9 + 16} = \sqrt{25} = 5 \text{ ms}^{-2}$$

19. (a) Using the relation for the radius (r) of loop

$$\tan \theta = \frac{v^2}{rg}$$

$$\text{or } \tan 12^\circ = \frac{(150)^2}{r \times 10}$$

$$\text{or } r = \frac{2250}{0.2125} = 10.6 \times 10^3 \text{ m} = 10.6 \text{ km.}$$

20. (b) The car moving with a constant velocity has no acceleration. Hence, it is an inertial frame.

21. (b) For a uniformly accelerated motion there are two acceleration, one along the radius called radial acceleration and another along tangent called tangential acceleration. Velocity is directed along the tangent.

$$22. \text{ (d) } R = \frac{u^2 \sin 2\theta}{g}$$

$$R' = \frac{(2u)^2 \sin 2\theta}{g} = 4R.$$

$$23. \text{ (a) } H = \frac{u^2}{2g} \Rightarrow u^2 = 2gH$$

For maximum horizontal distance

$$x_{\max} = \frac{u^2}{g} = \frac{2gH}{g} = 2H$$

24. (c) $\vec{P}$ = vector sum = $\vec{A} + \vec{B}$

$$\vec{Q} = \text{vector differences} = \vec{A} - \vec{B}$$

Since $\vec{P}$ and $\vec{Q}$ are perpendicular

$$\therefore \vec{P} \cdot \vec{Q} = 0$$

$$\Rightarrow (\vec{A} + \vec{B}) \cdot (\vec{A} - \vec{B}) = 0 \Rightarrow A^2 = B^2$$

$$\Rightarrow |\vec{A}| = |\vec{B}|$$

$$25. \text{ (a) } h_1 = \frac{u^2 \sin^2 \theta}{2g}$$

$$h_2 = \frac{u^2 \sin^2 (90^\circ - \theta)}{2g}, \quad R = \frac{u^2 \sin 2\theta}{g}$$

Range R is same for angle θ and $(90^\circ - \theta)$

$$\therefore h_1 h_2 = \frac{u^2 \sin^2 \theta}{2g} \times \frac{u^2 \sin^2 (90^\circ - \theta)}{2g}$$

$$= \frac{u^4 (\sin^2 \theta) \times \sin^2 (90^\circ - \theta)}{4g^2} \quad [\because \sin(90^\circ - \theta) = \cos \theta]$$

$$= \frac{u^4 (\sin^2 \theta) \times \cos^2 \theta}{4g^2}$$

$$[\because \sin 2\theta = 2 \sin \theta \cos \theta]$$

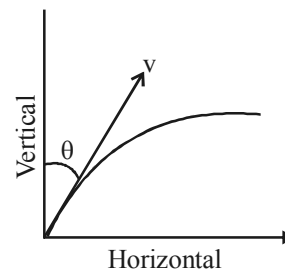
$$= \frac{u^4 (\sin \theta \cos \theta)^2}{4g^2} = \frac{u^4 (\sin 2\theta)^2}{16g^2}$$

$$= \frac{(u^2 \sin 2\theta)^2}{16g^2} = \frac{R^2}{16}$$

$$\text{or, } R^2 = 16 h_1 h_2 \text{ or } R = 4 \sqrt{h_1 h_2}$$

$$26. \text{ (d) } \text{Max. height} = H = \frac{v^2 \sin^2 (90^\circ - \theta)}{2g} \quad \dots (i)$$

$$\text{Time of flight, } T = \frac{2 v \sin (90^\circ - \theta)}{g} \quad \dots (ii)$$



From (i), $\frac{v \cos \theta}{g} = \sqrt{\frac{2H}{g}}$, From (ii),

$$T = 2\sqrt{\frac{2H}{g}} = \sqrt{\frac{8H}{g}}$$

27. (a) A parabola

28. (a) $a_r = \omega^2 R$

$$a_r = (2\pi)^2 R$$

$$= 4\pi^2 2^2 R = 4\pi^2 \left(\frac{22}{44}\right)^2 (1) \left[\because v = \frac{22}{44}\right]$$

$$a_t = \frac{dv}{dt} = 0$$

$a_{\text{net}} = a_r = \pi^2 \text{ ms}^{-2}$ and direction along the radius towards the centre.

29. (b) Given, $u_1 = u_2 = u$, $\theta_1 = 60^\circ$, $\theta_2 = 30^\circ$
In Ist case, we know that range

$$R_1 = \frac{u^2 \sin 2(60^\circ)}{g} = \frac{u^2 \sin 120^\circ}{g} = \frac{u^2 \sin(90^\circ + 30^\circ)}{g}$$

$$= \frac{u^2 (\cos 30^\circ)}{g} = \frac{\sqrt{3} u^2}{2g}$$

In IInd case when $\theta_2 = 30^\circ$, then

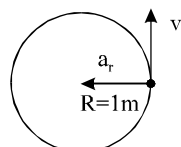
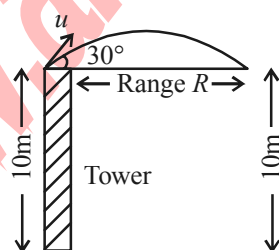
$$R_2 = \frac{u^2 \sin 60^\circ}{g} = \frac{u^2 \sqrt{3}}{2g} \Rightarrow R_1 = R_2$$

(we get same value of ranges).

30. (c) Yes, the person can catch the ball when horizontal velocity is equal to the horizontal component of ball's velocity, the motion of ball will be only in vertical direction w.r.t person for that $\frac{v_0}{2} = v_0 \cos \theta$ or $\theta = 60^\circ$

31. (d) From the figure it is clear that range is required

$$R = \frac{u^2 \sin 2\theta}{g} = \frac{(10)^2 \sin(2 \times 30^\circ)}{10} = 5\sqrt{3}$$



Type B : Assertion Reason Questions

32. (a) For the distance covered in the last second, final velocity becomes zero. So if we drop an object with zero velocity it will cover the same distance in one second while going downwards.

Now distance travelled in the later case

$$s = ut + \frac{1}{2}gt^2 = 0 + \frac{1}{2} \times 10 \times 1$$

$$s = 5\text{m}$$

33. (c) A vehicle moving with constant speed on a straight road is an inertial frame. Newton's laws of motion is applicable only in inertial frame.

34. (c) Suppose that the tennis ball bounces with a velocity u . It will go up, till its velocity becomes zero. If h is the height up to which it rises on the hill, then

$$(0)^2 - u^2 = 2(-g')h$$

where g' is acceleration due to gravity on the hill.

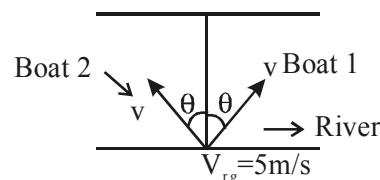
$$\therefore h = \frac{u^2}{2g'}$$

Since, the acceleration due to gravity on the hill (g') is less than that on earth (effect of height), it follows that tennis ball will bounce higher on hills than in plains.

35. (b) In uniform circular motion, the magnitude of velocity and acceleration remains same, but due to change in direction of motion, the direction of velocity and acceleration changes. Also the centripetal acceleration is given by $a = \omega^2 r$.

36. (d)

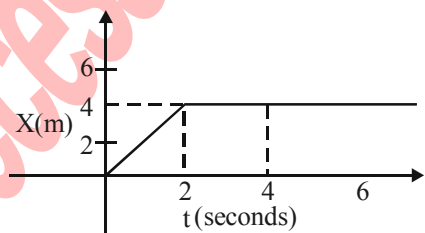
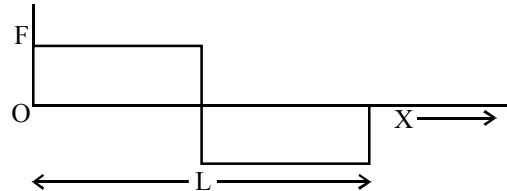
37. (a)



If component of velocities of boat relative to river is same normal to river flow (as shown in figure) both boats reach other bank simultaneously.

Laws of Motion

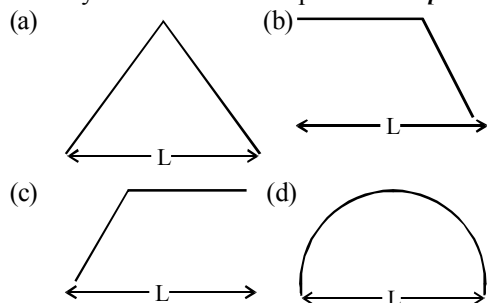
TYPE A : MULTIPLE CHOICE QUESTIONS

- A molecule of mass m of an ideal gas collides with the wall of the vessel with the velocity v and returns back with the same velocity. The change in the linear momentum of the molecule will be : [1997]
 - $4mv$
 - $8mv$
 - $2mv$
 - $-2mv$
- If the force on a rocket, moving with a velocity 500 m/s is 400 N , then the rate of combustion of the fuel will be : [1997]
 - 0.8 kg/sec
 - 10.8 kg/sec
 - 8 kg/sec
 - 1.6 kg/sec
- The rocket engine lift a rocket from the earth, because hot gases : [1998]
 - push it against the air with very high velocity
 - push it against the earth with very high velocity
 - heat up the air which lifts the rocket with very high velocity
 - react against rocket and push it up with very high velocity
- A 1 kg particle strikes a wall with a velocity 1 m/s at an angle 30° and reflects at the same wall in 0.1 second then the force will be: [1999]
 - $30\sqrt{3}\text{ N}$
 - 0
 - $40\sqrt{3}\text{ N}$
 - $10\sqrt{3}\text{ N}$
- A gun fires a bullet of mass 50 g with a velocity of 30 m/s . Due to this, the gun is pushed back with a velocity of 1 m/s , then the mass of the gun is : [2001]
 - 1.5 kg
 - 5.5 kg
 - 0.5 kg
 - 3.5 kg
- When the two surfaces are coated with the lubricant, then they will : [2001]
 - slide upon each other
 - stick to each other
 - roll upon each other
 - none of these
- The velocity of a bullet is reduced from 200 m/s to 100 m/s while travelling through a wooden block of thickness 10 cm . Assuming it to be uniform, the retardation will be : [2001]
 - $15 \times 10^4\text{ m/s}^2$
 - $10 \times 10^4\text{ m/s}^2$
 - $12 \times 10^4\text{ m/s}^2$
 - 14.5 m/s^2
- In the given figure, the position-time graph of a particle of mass 0.1 kg is shown. The impulse at $t = 2\text{ sec}$ is : [2005]
 
 - 0.2 kg m sec^{-1}
 - $-0.2\text{ kg m sec}^{-1}$
 - 0.1 kg m sec^{-1}
 - $-0.4\text{ kg m sec}^{-1}$
- A person is standing in an elevator. In which situation he finds his weight less ? [2005]
 - When the elevator moves upward with constant acceleration
 - When the elevator moves downward with constant acceleration
 - When the elevator moves upward with uniform velocity
 - When the elevator moves downward with uniform velocity
- A person used force (F), shown in the figure to move a load with a constant velocity on a given surface.
 

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Topicwise AIIMS Solved Papers – PHYSICS

Identify the correct surface profile: [2006]



11. A man of mass 60 kg records his wt. on a weighing machine placed inside a lift. The ratio of wts. of man recorded when lift ascending up with a uniform speed of 2 m/s to when it is descending down with a uniform speed of 4 m/s will be [2007]

(a) 0.5 (b) 1
(c) 2 (d) None of these

12. A smooth block is released at rest on a 45° incline and then slides a distance 'd'. The time taken to slide is 'n' times as much to slide on rough incline than on a smooth incline. The coefficient of friction is [2008]

(a) $\mu_k = \sqrt{1 - \frac{1}{n^2}}$ (b) $\mu_k = 1 - \frac{1}{n^2}$
(c) $\mu_s = \sqrt{1 - \frac{1}{n^2}}$ (d) $\mu_s = 1 - \frac{1}{n^2}$

13. A parachutist after bailing out falls 50 m without friction. When parachute opens, it decelerates at 2 m/s^2 . He reaches the ground with a speed of 3 m/s. At what height, did he bail out? [2008]

(a) 182m (b) 91m
(c) 111m (d) 293m

14. An 80 kg person is parachuting and is experiencing a downward acceleration of 2.8 m/s^2 . The mass of the parachute is 5 kg. The upward force on the open parachute is (Take $g = 9.8 \text{ m/s}^2$) [2009]

(a) 595 N (b) 675 N
(c) 456 N (d) 925 N

15. When a horse pulls a wagon, the force that causes the horse to move forward is the force [2010]

(a) the ground exerts on it
(b) it exerts on the ground
(c) the wagon exerts on it
(d) it exerts on the wagon

16. A gardener holds a hosepipe through which water is gushing out at a rate of 4 kg s^{-1} with speed 2 ms^{-1} . The moment the speed of water is increased to 3 ms^{-1} , the gardener will experience a jerk of: [2011]

(a) 20 Ns in backward direction
(b) 18 Ns in forward direction
(c) 10 Ns in backward direction
(d) 10 Ns in forward direction

17. A 150 g tennis ball coming at a speed of 40 m/s is hit straight back by a bat to a speed of 60 m/s. The magnitude of the average force F on the ball, when it is in contact for 5 ms, is: [2011]

(a) 2500 N (b) 3000 N
(c) 3500 N (d) 4000 N

18. A particle moves in a circle of radius 25 cm at two revolutions per second. The acceleration of the particle in meter per second² is [2012]

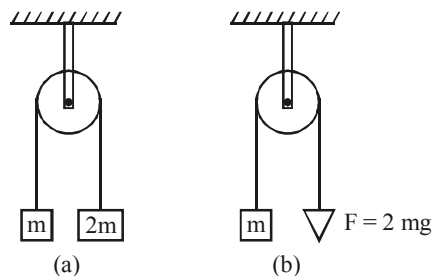
(a) π^2 (b) $8\pi^2$
(c) $4\pi^2$ (d) $2\pi^2$

19. On a smooth plane surface (figure) two block A and B are accelerated up by applying a force 15 N on A. If mass of B is twice that of A, the force on B is [2012]



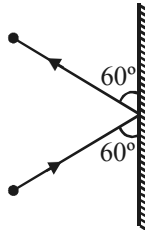
(a) 30 N (b) 15 N
(c) 10 N (d) 5 N

20. Two pulley arrangements of figure given are identical. The mass of the rope is negligible. In fig (a), the mass m is lifted by attaching a mass 2m to the other end of the rope. In fig (b), m is lifted up by pulling the other end of the rope with a constant downward force $F = 2mg$. The acceleration of m in the two cases are respectively [2013]

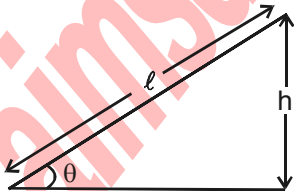


(a) 3g, g (b) g/3, g
(c) g/3, 2g (d) g, g/3

21. A 3 kg ball strikes a heavy rigid wall with a speed of 10 m/s at an angle of 60° . It gets reflected with the same speed and angle as shown here. If the ball is in contact with the wall for 0.20s, what is the average force exerted on the ball by the wall? [2013]



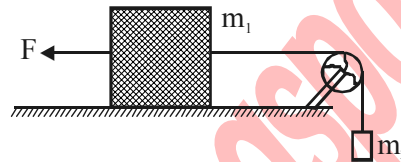
- (a) 150 N (b) Zero
(c) $150\sqrt{3}$ N (d) 300 N
22. A mass is hanging on a spring balance which is kept in a lift. The lift ascends. The spring balance will show in its readings [2014]
(a) an increase
(b) a decrease
(c) no change
(d) a change depending on its velocity
23. A ball of mass 0.5 kg moving with a velocity of 2 m/sec strikes a wall normally and bounces back with the same speed. If the time of contact between the ball and the wall is one millisecond, the average force exerted by the wall on the ball is: [2015]
(a) 2000 newton (b) 1000 newton
(c) 5000 newton (d) 125 newton
24. A smooth inclined plane is inclined at an angle θ with horizontal. A body starts from rest and slides down the inclined surface. [2015]



Then the time taken by it to reach the bottom is

- (a) $\sqrt{\left(\frac{2h}{g}\right)}$ (b) $\sqrt{\left(\frac{2\ell}{g}\right)}$
(c) $\frac{1}{\sin \theta} \sqrt{\frac{2h}{g}}$ (d) $\sin \theta \sqrt{\frac{2h}{g}}$

25. A constant force $F = m_2g/2$ is applied on the block of mass m_1 as shown in fig. The string and the pulley are light and the surface of the table is smooth. The acceleration of m_1 is [2015]



- (a) $\frac{m_2g}{2(m_1 + m_2)}$ towards right
(b) $\frac{m_2g}{2(m_1 - m_2)}$ towards left
(c) $\frac{m_2g}{2(m_2 + m_1)}$ towards right
(d) $\frac{m_2g}{2(m_2 - m_1)}$ towards left
26. A smooth block is released at rest on a 45° incline and then slides a distance 'd'. The time taken to slide is 'n' times as much to slide on rough incline than on a smooth incline. The coefficient of friction is [2016]
(a) $\mu_k = \sqrt{1 - \frac{1}{n^2}}$ (b) $\mu_k = 1 - \frac{1}{n^2}$
(c) $\mu_s = \sqrt{1 - \frac{1}{n^2}}$ (d) $\mu_s = 1 - \frac{1}{n^2}$
27. A hockey player is moving northward and suddenly turns westward with the same speed to avoid an opponent. The force that acts on the player is [2017]
(a) frictional force along westward
(b) muscles force along southward
(c) frictional force along south-west
(d) muscle force along south-west
28. The retarding acceleration of 7.35 ms^{-2} due to frictional force stops the car of mass 400 kg travelling on a road. The coefficient of friction between the tyre of the car and the road is [2017]
(a) 0.55 (b) 0.75
(c) 0.70 (d) 0.65

TYPE B : ASSERTION REASON QUESTIONS

Directions for (Qs. 29-33) : These questions consist of two statements, each printed as Assertion and Reason. While answering these questions, you are required to choose any one of the following five responses.

- (a) If both Assertion and Reason are correct and the Reason is a correct explanation of the Assertion.
- (b) If both Assertion and Reason are correct but Reason is not a correct explanation of the Assertion.
- (c) If the Assertion is correct but Reason is incorrect.
- (d) If both the Assertion and Reason are incorrect.
- (e) If the Assertion is incorrect but the Reason is correct.

29. Assertion : On a rainy day it is difficult to drive a car or bus at high speed.

Reason : The value of coefficient of friction is lowered due to wetting of the surface. [1999]

30. Assertion : A rocket moves forward by pushing the surrounding air backwards.

Reason : It derives the necessary thrust to move forward according to Newton's third law of motion. [2001]

31. Assertion : The driver in a vehicle moving with a constant speed on a straight road is in a non-inertial frame of reference.

Reason : A reference frame in which Newton's laws of motion are applicable is non-inertial. [2004]

32. Assertion : Use of ball bearings between two moving parts of a machine is a common practice.

Reason : Ball bearings reduce vibrations and provide good stability. [2006]

33. Assertion : Angle of repose is equal to the angle of limiting friction.

Reason : When the body is just at the point of motion, the force of friction in this stage is called limiting friction. [2008]

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Directions for (Qs. 34-36) : Each of these questions contains an Assertion followed by Reason. Read them carefully and answer the question on the basis of following options. You have to select the one that best describes the two statements.

- (a) If both Assertion and Reason are correct and Reason is the correct explanation of Assertion.
- (b) If both Assertion and Reason are correct, but Reason is not the correct explanation of Assertion.
- (c) If Assertion is correct but Reason is incorrect.
- (d) If both the Assertion and Reason are incorrect.

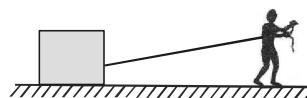
34. Assertion : There is a stage when frictional force is not needed at all to provide the necessary centripetal force on a banked road.

Reason : On a banked road, due to its inclination the vehicle tends to remain inwards without any chances of skidding. [2016]

35. Assertion : Mountain roads rarely go straight up the slope.

Reason : Slope of mountains are large, therefore more chances of vehicle to slip from roads. [2016]

36. Assertion : A man and a block rest on smooth horizontal surface. The man holds a rope which is connected to block. The man cannot move on the horizontal surface.



Reason : A man standing at rest on smooth horizontal surface cannot start walking due to absence of friction (The man is only in contact with floor as shown). [2017]



HINTS & SOLUTIONS

Type A : Multiple Choice Questions

1. (c) Initial momentum = mv
Final momentum = $-mv$
Change in momentum = $mv - (-mv) = 2mv$

2. (a) We know that

$$\text{Force} = \frac{dp}{dt} = \frac{d(mv)}{dt} = v \frac{dm}{dt}$$

[when v is constant]

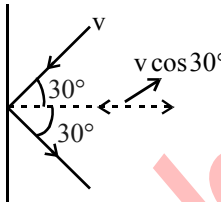
In the given case force = 400 N;
 $v = 500$ m/sec.

We are required to calculate $\frac{dm}{dt}$ or rate of change of mass of the rocket.

In normal cases, force creates change in momentum. Here force is created due to change in momentum of the rocket by emission of fuel (a part of rocket).

$$\text{So, } \frac{dm}{dt} = \frac{\text{force}}{v} = \frac{400}{500} = 0.8 \text{ kg/sec}$$

3. (b) When the rocket gas pushes it against the earth with high velocity, there is production of reaction force which creates lift for the rocket.

4. (d) 

Change in momentum of the ball perpendicular to the wall

$$\begin{aligned} &= m[v \cos \theta - (-v \cos \theta)] \\ &= 2mv \cos \theta \\ &= 2 \times 1 \times 1 \times \cos 30^\circ = 2 \times \frac{\sqrt{3}}{2} = \sqrt{3}, \end{aligned}$$

Rate of change of momentum

$$= \frac{\text{Change of momentum}}{\text{time}} = \frac{\sqrt{3}}{0.1} = 10\sqrt{3}$$

This will be equal to force, so force = $10\sqrt{3}$ N

5. (a) Applying conservation of momentum
 $MV = mv$

$$\begin{aligned} M \times 1 &= \frac{50}{1000} \times 30 = \frac{3}{2} \\ M &= 1.5 \text{ kg} \end{aligned}$$

6. (a) If two surfaces are coated with lubricant then friction will be reduced so they can slide over each other if one is pushed on the other. It is friction which prevents relative motion between two surfaces.

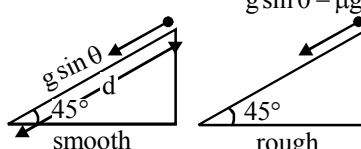
7. (a) Using the formula, $v^2 = u^2 + 2as$
 $(100)^2 = (200)^2 - 2a \times \frac{10}{100}$
 $2a \times \frac{10}{100} = (200)^2 - (100)^2 = 300 \times 100$
 $a = \frac{3 \times 10^5}{2} = 15 \times 10^4 \text{ m/sec}^2$

8. (a) Impulse = $mu - mv$
 $= 0.1 \times \frac{4}{2} - m \times 0$ [$v = 0$ after two seconds]
 $= 0.2 \text{ kg m sec}^{-1}$

9. (b) Person will feel his weight less when the lift goes down with some acceleration.

10. (a) In figure no. (a) and (c), a constant force equal to $mg \sin \theta$ is required. After reaching the highest point, in case of figure (c), no force is required but in case of figure (a), body travels on its own. So a $-ve$ force is acting on the body. In this way, figure (a) represents the given $F - x$ curve.

11. (b) Net force of reaction acts on a body in a lift when it is accelerating. If lift moves up or down with uniform speed then acceleration $a = 0$, $\therefore$ weight of man = mg is same in ascending or descending hence ratio = 1.

12. (b) 

$$d = \frac{1}{2} (g \sin \theta) t_1,$$

$$d = \frac{1}{2} (g \sin \theta - \mu g \cos \theta) t_2$$

$$t_1 = \sqrt{\frac{2d}{g \sin \theta}}$$

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$$t_2 = \sqrt{\frac{2d}{g \sin \theta - \mu g \cos \theta}}$$

According to question, $t_2 = nt_1$

$$n\sqrt{\frac{2d}{g \sin \theta}} = \sqrt{\frac{2d}{g \sin \theta - \mu g \cos \theta}}$$

μ , applicable here, is kinetic friction as the block moves over the inclined plane.

$$n = \frac{1}{\sqrt{1 - \mu_k}} \left(\because \cos 45^\circ = \sin 45^\circ = \frac{1}{\sqrt{2}} \right)$$

$$n^2 = \frac{1}{1 - \mu_k} \quad \text{or} \quad 1 - \mu_k = \frac{1}{n^2}$$

$$\text{or} \quad \mu_k = 1 - \frac{1}{n^2}$$

13. (d) $v = \sqrt{2gh} = \sqrt{2 \times 9.8 \times 50} = 14\sqrt{5}$

$$S = \frac{v^2 - u^2}{2 \times 2} = \frac{3^2 - 980}{4} \approx 243 \text{ m}$$

Initially he has fallen 50 m.

$\therefore$ Total height from where he bailed out = $244 + 50 = 293 \text{ m}$

14. (a) The net upward acceleration is $(9.8 - 2.8) = 7 \text{ m/sec}^2$

Total mass = $80 + 5 = 85 \text{ kg}$

So, net upward force is

$$F = 85 \times 7 = 595 \text{ N}$$

15. (a) As per Newton's third law of motion, when a horse pulls a wagon, the force that causes the horse to move forward is the force the ground exerts on it.

16. (a) $F = \frac{dm}{dt}(\Delta v) = 4(2 + 3) = 20 \text{ N}$

17. (b) The change in momentum

$$\Delta p = m(v_f - v_i)$$

$$= 0.150 (60 - (-40))$$

$$= 0.150 \times 100 = 15 \text{ Ns}$$

$$\text{Thus, } F = \frac{\Delta p}{\Delta t} = \frac{15}{5 \times 10^{-3}} = 3 \times 10^3 \text{ N}$$

18. (c) Here $T = \frac{1}{2}$ sec the required centripetal acceleration for moving in a circle is

$$a_c = \frac{v^2}{r} = \frac{(r\omega)^2}{r} = r\omega^2 = r \times (2\pi/T)^2$$

$$\text{so } a_c = 0.25 \times (2\pi/0.5)^2$$

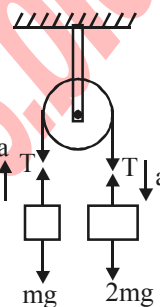
$$= 16\pi^2 \times .25 = 4.0\pi^2$$

19. (c) The acceleration of both the blocks =

$$\frac{15}{3x} = \frac{5}{x}$$

$$\therefore \text{ Force on B} = \frac{5}{x} \times 2x = 10 \text{ N}$$

20. (b) Let a and a' be the accelerations in both cases respectively. Then for fig (a),



(a)

$$T - mg = ma \quad \dots (i)$$

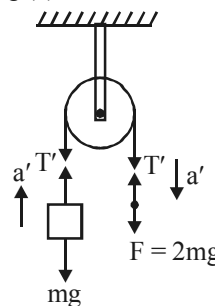
$$\text{and } 2mg - T = 2ma \quad \dots (ii)$$

Adding (i) and (ii), we get

$$mg = 3ma$$

$$\therefore a = \frac{g}{3}$$

For fig (b),



(b)

$$T' - mg = ma' \quad \dots (iii)$$

$$\text{and } 2mg - T' = 0 \quad \dots (iv)$$

Solving (iii) and (iv)

$$a' = g$$

$$\therefore a = \frac{g}{3} \text{ and } a' = g$$

21. (c) Change in momentum along the wall
 $= mv \cos 60^\circ - mv \cos 60^\circ = 0$
 Change in momentum perpendicular to the wall
 $= mv \sin 60^\circ - (-mv \sin 60^\circ)$
 $= 2mv \sin 60^\circ$
 $\therefore$ Applied force

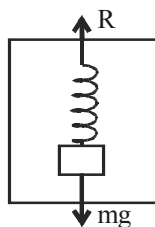
$$= \frac{\text{Change in momentum}}{\text{Time}}$$

$$= \frac{2mv \sin 60^\circ}{0.20}$$

$$= \frac{2 \times 3 \times 10 \times \sqrt{3}}{2 \times 0.20} = 50 \times 3\sqrt{3}$$

$$= 150\sqrt{3} \text{ newton}$$

22. (a) Let acceleration of lift = a and
 let reaction at spring balance = R



Applying Newton's law

$$R - mg = ma \Rightarrow R = m(g + a)$$

thus net weight increases, so reading of spring balance increases.

23. (a) $F = \frac{mv - (-mv)}{t} = \frac{2mv}{t} = \frac{2 \times 0.5 \times 2}{10^{-3}} = 2 \times 10^3 \text{ N}$

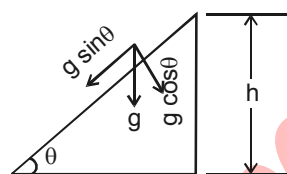
24. (c) So by second equation of motion, we get

$$S = ut + \frac{1}{2}at^2$$

here $S = \ell$, $u = 0$, $a = g \sin \theta$

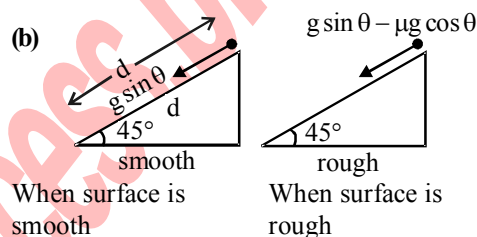
$$t = \sqrt{\frac{2\ell}{a}} = \sqrt{\frac{2h}{g \sin^2 \theta}} = \frac{1}{\sin \theta} \sqrt{\frac{2h}{g}}$$

$$\left(\because \sin \theta = \frac{h}{\ell} \right)$$



25. (a) Let a be the acceleration of mass m_2 in the downward direction. Then
 $T - m_2(g/2) = m_1 a \dots (i)$
 and $m_2 g - T = m_2 a \dots (ii)$
 Adding eqs. (1) and (2), we get
 $(m_1 + m_2) a = m_2 g - m_2(g/2) = m_2 g/2$
 $\therefore a = \frac{m_2 g}{2(m_1 + m_2)}$

26. (b)



When surface is smooth

$$d = \frac{1}{2}(g \sin \theta) t_1^2$$

$$d = \frac{1}{2}(g \sin \theta - \mu g \cos \theta) t_2^2$$

$$t_1 = \sqrt{\frac{2d}{g \sin \theta}}$$

$$t_2 = \sqrt{\frac{2d}{g \sin \theta - \mu g \cos \theta}}$$

According to question, $t_2 = n t_1$

$$n \sqrt{\frac{2d}{g \sin \theta}} = \sqrt{\frac{2d}{g \sin \theta - \mu g \cos \theta}}$$

μ , applicable here, is coefficient of kinetic friction as the block moves over the inclined plane.

$$n = \frac{1}{\sqrt{1 - \mu_k}}$$

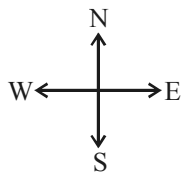
$$\left(\because \cos 45^\circ = \sin 45^\circ = \frac{1}{\sqrt{2}} \right)$$

$$n^2 = \frac{1}{1 - \mu_k} \quad \text{or} \quad 1 - \mu_k = \frac{1}{n^2}$$

$$\text{or } \mu_k = 1 - \frac{1}{n^2}$$

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27. (c) Frictional force is always opposite to the direction of motion



28. (b) As we know, coefficient of friction $\mu = \frac{F}{N}$

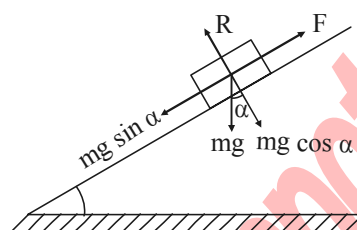
$$\Rightarrow \mu = \frac{ma}{mg} = \frac{a}{g} \quad (a = 7.35 \text{ m s}^{-2} \text{ given})$$

$$\therefore \mu = \frac{7.35}{9.8} = 0.75$$

Type B : Assertion Reason Questions

29. (a) On a rainy day, the roads are wet. Wetting of roads lowers the coefficient of friction between the tyres and the road. Therefore, grip on a road of car reduces and thus chances of skidding increases.
30. (a) A rocket moves forward taking the help of reaction force. For that it has to exert a force on the surrounding air so that it receives reaction force as per Newton's third law.
31. (d) A vehicle moving with constant speed on a straight road is an inertial frame. Newton's laws of motion is applicable only in inertial frame.
32. (c) Ball bearing are used to convert sliding friction to rolling friction. Sliding friction is less than rolling friction.
33. (b) The maximum value of static friction up to which body does not move is called limiting friction.

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Angle of repose is defined as the angle of the inclined plane with horizontal such that a body placed on it is just begins to slide. In limiting condition,
 $F = mg \sin \alpha$ and $R = mg \cos \alpha$
 where α —angle of repose.

$$\text{So } \frac{F}{R} = \tan \alpha$$

$$\therefore \frac{F}{R} = \mu_s = \tan \theta = \tan \alpha \quad (\because \tan \theta = \mu_s)$$

$$\text{or } \theta = \alpha$$

i.e., angle of friction = angle of repose.

34. (c) The assertion is true for a reason that when the car is driven at optimum speed. Then the normal reaction component is enough to provide the centripetal force.
35. (a) Both Assertion and Reason are true and Reason is the correct explanation of Assertion.
 If roads of the mountain were to go straight up, the slope (θ) would have been large, the frictional force ($\mu mg \cos \theta$) would be small. Due to small friction, wheels of vehicle would slip. Also for going up a large slope, a greater power shall be required.
36. (d) The man can exert force on block by pulling the rope. The tension in rope will make the man move. Hence Assertion is incorrect.

Work, Energy and Power

TYPE A : MULTIPLE CHOICE QUESTIONS

- If a spring extends by x on loading, then energy stored by the spring is (if T is the tension in spring and k is spring constant) [1997]
 - $\frac{T^2}{2k}$
 - $\frac{2T^2}{k}$
 - $\frac{T^2}{k}$
 - $\frac{T^2}{2k}$
- A bullet is fired from a rifle. If the rifle recoils freely, then the kinetic energy of the rifle will be : [1998]
 - same as that of bullet
 - more than that of bullet
 - less than that of bullet
 - none of these
- A spring 40 mm long is stretched by applying a force. If 10 N force is required to stretch the spring through one mm, then work done in stretching the spring through 40 mm is : [1998]
 - 24 J
 - 8 J
 - 56 J
 - 64 J
- If the kinetic energy of the body becomes four times of its initial value, then the new momentum will : [1998]
 - become twice its initial value
 - remain constant
 - become four times its initial value
 - become three times its initial value
- If the water falls from a dam into a turbine wheel 19.6 m below (which have both KE + PE), then the velocity of water at the turbine is : (take $g = 9.8 \text{ m/sec}^2$) [1998]
 - 19.6 m/s
 - 39.0 m/s
 - 98.8 m/s
 - 9.8 m/s
- If the force applied is F and the velocity gained is v , then the power developed is : [1998]
 - $\frac{v}{F}$
 - Fv
 - Fv^2
 - $\frac{F}{v}$
- Two bodies of masses m and $4m$ are moving with equal kinetic energy. Then the ratio of their linear momentum will be : [1999]
 - 1 : 1
 - 2 : 1
 - 4 : 1
 - 1 : 2
- A particle of mass m moving with velocity v collides with a stationary particle of mass $2m$. Then the speed of the system after collision is : [1999]
 - $2v$
 - $\frac{v}{2}$
 - $3v$
 - $\frac{v}{3}$
- Which one of the following is true ? [2000]
 - momentum is conserved in all collisions but kinetic energy is conserved in elastic collisions
 - momentum is conserved in all collisions but not kinetic energy
 - both momentum and kinetic energy are conserved in all collisions
 - neither momentum nor kinetic energy is conserved in elastic collisions
- A ball of mass 10 kg is moving with a velocity of 10 m/s. It strikes another ball of mass 5 kg, which is moving in the same direction with a velocity of 4 m/s. If the collision is elastic their velocities after collision will be respectively : [2000]
 - 12 m/s, 6 m/s
 - 12 m/s, 25 m/s
 - 6 m/s, 12 m/s
 - 8 m/s, 20 m/s
- A bullet of mass 10g leaves a rifle at an initial velocity of 1000 m/sec and strikes the earth at the same level with a velocity of 500 m/sec. The work in overcoming the resistance of air will be : [2000]
 - 500 J
 - 5000 J
 - 3750 J
 - 475 J
- A body of mass 5 kg has momentum of 10 kg m/sec. When a force of 0.2 N is applied on it for 10 sec, the change in its kinetic energy is [2000]
 - 4.4 J
 - 3.3 J
 - 5.5 J
 - 1.1 J

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13. A metal ball of mass 2 kg moving with speed of 36 km/hr is having a collision with a stationary ball of mass 3 kg. If after collision, both the balls move together, the loss in kinetic energy due to collision is : [2001]
 (a) 80 J (b) 40 J
 (c) 60 J (d) 160 J
14. A force $(3\hat{i} + 4\hat{j})$ newton acts on a body and displaced it by $(3\hat{i} + 4\hat{j})$ metre. The work done by the force is : [2001]
 (a) 5 J (b) 25 J
 (c) 10 J (d) 30 J
15. The kinetic energy of a body becomes four times its initial value. The new linear momentum will be [2002]
 (a) eight times of the initial value
 (b) four times of the initial value
 (c) twice of the initial value
 (d) remain as the initial value
16. A block of mass 10 kg is moving in x-direction with a constant speed of 10 m/sec. It is subjected to a retarding force $F = -0.1x$ joule/metre during its travel from $x = 20$ metre to $x = 30$ metre. Its final kinetic energy will be [2005]
 (a) 475 joule (b) 450 joule
 (c) 275 joule (d) 250 joule
17. When a ball is thrown up vertically with velocity v_0 it reaches a maximum height of h . If one wishes to triple the maximum height then the ball should be thrown with velocity : [2005]
 (a) $\sqrt{3} v_0$ (b) $3v_0$
 (c) $9v_0$ (d) $3/2v_0$
18. For inelastic collision between two spherical rigid bodies: [2006]
 (a) the total kinetic energy is conserved
 (b) the total potential energy is conserved
 (c) the linear momentum is not conserved
 (d) the linear momentum is conserved
19. If the water falls from a dam into a turbine wheel 19.6 m below, then the velocity of water at the turbines, is (take $g = 9.8 \text{ m/s}^2$) [2007]
 (a) 9.8 m/s (b) 19.6 m/s
 (c) 39.2 m/s (d) 98.0 m/s
20. A particle of mass 10 g is kept on the surface of a uniform sphere of mass 100 kg and radius 10 cm. Find the work to be done against the gravitational force between them to take the particle far away from the sphere (you may take $G = 6.67 \times 10^{-11} \text{ Nm}^2/\text{kg}^2$) [2008]
 (a) $3.33 \times 10^{-10} \text{ J}$
 (b) $13.34 \times 10^{-10} \text{ J}$
 (c) $6.67 \times 10^{-10} \text{ J}$
 (d) $6.67 \times 10^{-9} \text{ J}$
21. A vertical spring with force constant k is fixed on a table. A ball of mass m at a height h above the free upper end of the spring falls vertically on the spring so that the spring is compressed by a distance d . The net work done in the process is [2008]
 (a) $mg(h+d) - \frac{1}{2}kd^2$
 (b) $mg(h-d) - \frac{1}{2}kd^2$
 (c) $mg(h-d) + \frac{1}{2}kd^2$
 (d) $mg(h+d) + \frac{1}{2}kd^2$
22. A shell of mass m moving with velocity v suddenly breaks into 2 pieces. The part having mass $m/3$ remains stationary. The velocity of other part will be [2009]
 (a) $\frac{2}{3}v$ (b) $\frac{7}{5}v$
 (c) $\frac{3}{2}v$ (d) none of these
23. A mass of 1 kg is hanging from a spring of spring constant 1 N/m. If Saroj pulls the mass down by 2m. The work done by Saroj is [2009]
 (a) 1 J (b) 2 J
 (c) 3 J (d) 4 J
24. A ball loses 15.0% of its kinetic energy when it bounces back from a concrete wall. With what speed you must throw it vertically down from a height of 12.4 m to have it bounce back to the same height (ignore air resistance)? [2010]
 (a) 6.55 m/s (b) 12.0 m/s
 (c) 8.6 m/s (d) 4.55 m/s

25. Two bodies of masses 0.1 kg and 0.4 kg move towards each other with the velocities 1 m/s and 0.1 m/s respectively. After collision they stick together. In 10 sec the combined mass travels
- (a) 120m (b) 0.12m [2010]
(c) 12m (d) 1.2m

26. The potential energy of a certain particle is given

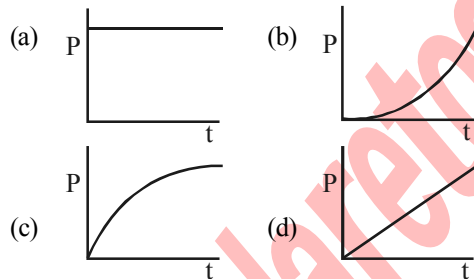
by $U = \frac{1}{2}(x^2 - z^2)$. The force on it is : [2011]

- (a) $-x\hat{i} + z\hat{k}$ (b) $x\hat{i} + z\hat{k}$
(c) $\frac{1}{2}(x\hat{i} + z\hat{k})$ (d) $\frac{1}{2}(x\hat{i} - z\hat{k})$

27. From a building two balls A and B are thrown such that A is thrown upwards and B downwards (both vertically). If v_A and v_B are their respective velocities on reaching the ground, then [2012]

- (a) $v_A > v_B$
(b) $v_A = v_B$
(c) $v_A < v_B$
(d) their velocities depend on their masses.

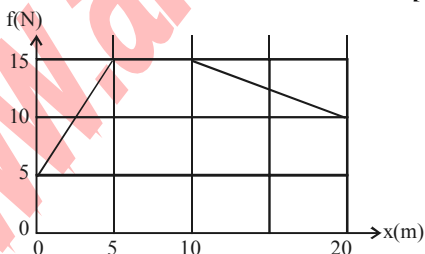
28. A motor drives a body along a straight line with a constant force. The power P developed by the motor must vary with time t according to [2012]



29. If the linear momentum is increased by 5%, the kinetic energy will increase by [2013, 2014]

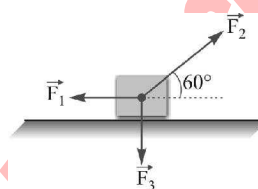
- (a) 50% (b) 100%
(c) 125% (d) 10%

30. Figure here shows the frictional force versus displacement for a particle in motion. The loss of kinetic energy in travelling over $s = 0$ to 20 m will be [2015]



- (a) 250J (b) 200J
(c) 150J (d) 10J

31. Figure shows three forces applied to a trunk that moves leftward by 3 m over a smooth floor. The force magnitudes are $F_1 = 5\text{N}$, $F_2 = 9\text{N}$, and $F_3 = 3\text{N}$. The net work done on the trunk by the three forces [2017]



- (a) 1.50J (b) 2.40J
(c) 3.00J (d) 6.00J

TYPE B : ASSERTION REASON QUESTIONS

Directions for (Qs. 32-34) : These questions consist of two statements, each printed as Assertion and Reason. While answering these questions, you are required to choose any one of the following five responses.

- (a) If both Assertion and Reason are correct and the Reason is a correct explanation of the Assertion.
(b) If both Assertion and Reason are correct but Reason is not a correct explanation of the Assertion.
(c) If the Assertion is correct but Reason is incorrect.
(d) If both the Assertion and Reason are incorrect.
(e) If the Assertion is incorrect but the Reason is correct.

32. **Assertion :** In an elastic collision of two billiard balls, the total kinetic energy is conserved during the short time of oscillation of the balls (i.e., when they are in contact).

Reason : Energy spent against friction does not follow the law of conservation of energy. [2002]

33. **Assertion :** Frictional forces are conservative forces.

Reason : Potential energy can be associated with frictional forces. [2005]

34. **Assertion :** A quick collision between two bodies is more violent than a slow collision; even when the initial and final velocities are identical.

Reason : The momentum is greater in first case. [2008]

Directions for (Qs. 35-40) : Each of these questions contains an Assertion followed by Reason. Read them carefully and answer the question on the basis of following options. You have to select the one that best describes the two statements.

- (a) If both Assertion and Reason are correct and Reason is the correct explanation of Assertion.
- (b) If both Assertion and Reason are correct, but Reason is not the correct explanation of Assertion.
- (c) If Assertion is correct but Reason is incorrect.
- (d) If both the Assertion and Reason are incorrect.

35. Assertion : n small balls each of mass m colliding elastically each second on surface with velocity u . The force experienced by the surface is $2mnu$.

Reason : On elastic collision, the ball rebounds with the same velocity. [2010]

36. Assertion : A helicopter must necessarily have two propellers.

Reason : Two propellers are provided in helicopter in order to conserve linear momentum. [2010]

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37. Assertion : If collision occurs between two elastic bodies their kinetic energy decreases during the time of collision.

Reason : During collision intermolecular space decreases and hence elastic potential energy increases. [2011]

38. Assertion : The total translational kinetic energy of all the molecules of a given mass of an ideal gas is 1.5 times the product of its pressure and its volume.

Reason : The molecules of a gas collide with each other and the velocities of the molecules change due to the collision. [2015]

39. Assertion : If collision occurs between two elastic bodies their kinetic energy decreases during the time of collision.

Reason : During collision intermolecular space decreases and hence elastic potential energy increases. [2015]

40. Assertion : Graph between potential energy of a spring versus the extension or compression of the spring is a straight line.

Reason : Potential energy of a stretched or compressed spring, proportional to square of extension or compression. [2017]

HINTS & SOLUTIONS

Type A : Multiple Choice Questions

1. (c) Energy of spring = $\frac{1}{2} kx^2$

$$T = kx \Rightarrow x = \frac{T}{k}$$

$$E = \frac{1}{2} k \left(\frac{T}{k} \right)^2 = \frac{1}{2} \frac{T^2}{k}$$

2. (c) For recoil of rifle, momentum will be conserved

$$MV = mv$$

$$\frac{\text{K.E of rifle}}{\text{K.E of bullet}} = \frac{\frac{1}{2} MV^2}{\frac{1}{2} mv^2}$$

$$= \frac{M}{m} \times \left(\frac{m}{M} \right)^2 = \frac{m}{M}$$

As $m < M$, kinetic energy of rifle < kinetic energy of bullet.

3. (b) Force constant,

$$k = \frac{F}{x} = \frac{10}{0.001} = 10^4 \text{ N/m}$$

$$\begin{aligned} \text{Work done} &= \frac{1}{2} kx^2 = \frac{1}{2} \times 10^4 \times \left(\frac{40}{1000} \right)^2 \\ &= \frac{1}{2} \times 10^4 \times \frac{16}{10^4} = 8 \text{ joule} \end{aligned}$$

4. (a) $E = \frac{p^2}{2m}$; $E \propto p^2$
- $$\frac{E_1}{E_2} = \frac{p_1^2}{p_2^2} \Rightarrow \frac{1}{4} = \left(\frac{p_1}{p_2} \right)^2 \Rightarrow \frac{p_1}{p_2} = \frac{1}{2}$$
- ratio of momentum = 1 : 2

5. (a) $v^2 = \sqrt{2gh} = \sqrt{2 \times 9.8 \times 19.6}$
 $= 19.6 \text{ m/sec}$

6. (b) Power = $\frac{\text{Work}}{\text{Time}} = \frac{F.s}{t} = F \cdot \frac{s}{t} = F.v$

7. (d) Relation between momentum and energy is

$$E = \frac{p^2}{2m}; E = \frac{p_1^2}{2m}; E = \frac{p_2^2}{2 \times 4m};$$

$$\frac{p_1^2}{2m} \times \frac{2 \times 4 \text{ m}}{p_2^2} = \frac{E}{E} = 1$$

$$\frac{p_1^2}{p_2^2} = \frac{1}{4} \Rightarrow \frac{p_1}{p_2} = \frac{1}{2} \Rightarrow p_1 : p_2 = 1 : 2$$

8. (d) Applying conservation of momentum,

$$mv + 0 = (2m + m)v' = 3mv'$$

$$v' = \frac{mv}{3m} = \frac{v}{3}$$

9. (a) Kinetic energy is not conserved in inelastic collision as some energy is stored as deformation at the point of collision in the form of potential energy. Since no deformation occurs in case of elastic collision so, kinetic energy is conserved. But momentum is conserved in both elastic and inelastic collisions as in both the cases, no external force is applied on them so, no change in momentum.

10. (c) Let their velocities after the collision be v_1 and v_2 . As we know for elastic collision.

Relative velocity of approach
 $=$ relative velocity of separation

$$10 - 4 = v_2 - v_1 \Rightarrow 6 = v_2 - v_1$$

$$\Rightarrow v_1 = v_2 - 6$$

Applying conservation of momentum,

$$10 \times 10 + 5 \times 4 = 10v_1 + 5v_2$$

$$120 = 10v_1 + 5v_2$$

$$120 = 10(v_2 - 6) + 5v_2 = 15v_2 - 60$$

$$15v_2 = 180 \Rightarrow v_2 = 12 \text{ cm/sec,}$$

$$v_1 = 6 \text{ cm/sec}$$

11. (c) Loss of kinetic energy of bullet
 $=$ The work done in over coming air resistance.

$$= \frac{1}{2} \times \frac{10}{1000} (1000^2 - 500^2)$$

$$= \frac{1}{2} \times \frac{1}{100} \times 1500 \times 500 = 3750 \text{ J}$$

12. (a) Change in momentum,

$$\Delta p = F.t = 0.2 \times 10 = 2$$

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$$\text{Initial value of velocity} = \frac{10}{5} = 2 \text{ m/sec}$$

$$\text{Initial energy} = \frac{1}{2} \times 5 \times 2 \times 2 = 10 \text{ J}$$

$$\begin{aligned} \text{Total final momentum} &= 10 + 2 \\ &= 12 \text{ kg m/sec} \end{aligned}$$

$$\text{Final velocity} = \frac{12}{5} \text{ m/sec}$$

$$\begin{aligned} \text{Final energy} &= \frac{1}{2} \times 5 \times \frac{12}{5} \times \frac{12}{5} \\ &= \frac{72}{5} = 14.4 \text{ J} \end{aligned}$$

$$\text{Change in energy} = 14.4 - 10 = 4.4 \text{ joule}$$

13. (c) Let v be the common velocity.

Applying conservation of momentum

$$2 \times 10 + 3 \times 0 = (2 + 3)v$$

$$v = \frac{10 \times 2}{5} = 4 \text{ m/sec}$$

$$[36 \text{ km/hour} = 10 \text{ m/sec}]$$

$$\text{Initial Energy} = \frac{1}{2} \times 2 \times (10)^2 + 0 = 100 \text{ J}$$

$$\text{Final Energy} = \frac{1}{2} \times 5 \times 4 \times 4 = 40 \text{ J}$$

$$\text{Loss of energy} = 100 - 40 = 60 \text{ joule}$$

14. (b) Work done = $\vec{F} \cdot \vec{s}$

$$= (3\hat{i} + 4\hat{j}) \cdot (3\hat{i} + 4\hat{j}) = 9 + 16 = 25 \text{ joule}$$

15. (c) The relation between kinetic energy and linear momentum is

$$E = \frac{p^2}{2m} \text{ so } E \propto p^2$$

If energy becomes four times then momentum will become twice as

$$p \propto \sqrt{E}$$

16. (a) We know that,

Change in kinetic energy

$$= \text{work done on the object by force}$$

$$\text{Here, work done} = \int F dx = \int_{20}^{30} 0.1x \, dx$$

$$= 0.1 \left[\frac{x^2}{2} \right]_{20}^{30} = \frac{0.1}{2} [30^2 - 20^2]$$

$$= 0.05 [900 - 400] = 0.05 \times 500 = 25 \text{ joule}$$

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Now, initial kinetic energy

$$= \frac{1}{2} \times 10 \times 100 = 500 \text{ joule}$$

$$\text{Final kinetic energy} = 500 - 25 = 475 \text{ joule}$$

[Direction of force is opposite to direction of motion]

$$17. (a) \frac{1}{2} mv_0^2 = mgh \quad \dots\dots\dots (i)$$

$$\frac{1}{2} mv^2 = mg \times 3h \quad \dots\dots\dots (ii)$$

$$\text{Dividing } \frac{v^2}{v_0^2} = 3; \quad v^2 = 3v_0^2$$

$$\Rightarrow v = \sqrt{3}v_0$$

18. (d) In inelastic collision, linear momentum is conserved.

19. (b) $v^2 - u^2 = 2as \Rightarrow v^2 - 0^2 = 2 \times 9.8 \times 19.6$
(Initial velocity = 0 as water falls from rest)

$$\begin{aligned} \Rightarrow v &= \sqrt{2 \times 9.8 \times 2 \times 9.8} \\ &= 2 \times 9.8 = 19.6 \text{ m/s} \end{aligned}$$

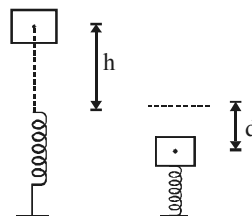
$$20. (c) W = \frac{GMm}{R}$$

$$\begin{aligned} W &= \frac{6.67 \times 10^{-11} \times 100}{0.1} \times \frac{10}{1000} \\ &= 6.67 \times 10^{-10} \text{ J} \end{aligned}$$

21. (a) Gravitational potential energy of ball gets converted into elastic potential energy of the spring.

$$mg(h + d) = \frac{1}{2} kd^2$$

$$\text{Net work done} = mg(h + d) - \frac{1}{2} kd^2 = 0$$



$$22. (c) \begin{array}{ccc} (m) \rightarrow v & \rightarrow & (m/3) \quad (m - m/3 = 2m/3) \\ & & v = 0 \quad v' = ? \end{array}$$

According to momentum conservation.

$$mv = m/3 \times 0 + \frac{2m}{3} v'$$

$$mv = \frac{2m}{3} v' \quad \left[v' = \frac{3}{2} v \right]$$

$$\begin{aligned} 23. \quad (b) \quad \text{Workdone} &= \int_0^2 F \cdot dx = \int_0^2 kx \, dx = \left[\frac{1}{2} kx^2 \right]_0^2 \\ &= \frac{1}{2} \cdot 1 \cdot (4 - 0) = 2 \, \text{J} \end{aligned}$$

24. (a) Given: $h = 12.4$, $v = ?$

$$\therefore v^2 = u^2 + 2gh$$

$$\begin{aligned} \text{i.e., } v^2 &= u^2 + 2 \times 9.8 \times 12.4 \\ &= u^2 + 243.04 \end{aligned}$$

Kinetic energy of the ball when it just hits the wall

$$= \frac{1}{2} mv^2 = \frac{1}{2} m(u^2 + 243.04)$$

The K.E. of ball after the impact

$$= \frac{(100 - 15)}{100} \times \frac{1}{2} m(u^2 + 243.04)$$

$$= \frac{85}{100} \times \frac{1}{2} m(u^2 + 243.04)$$

Let v_2 be the upward velocity just after the collision with the ground.

$$\text{So, } \frac{1}{2} mv_2^2 = \frac{85}{100} \times \frac{1}{2} m(u^2 + 243.04)$$

$$v_2^2 = \frac{85}{100} (u^2 + 243.04)$$

Now, taking upward motion

$$v = 0, u = v_2$$

$$\therefore v^2 = u^2 - 2gh$$

$$0 = \frac{85}{100} (u^2 + 243.04) - 2 \times 9.8 \times 12.4$$

$$\frac{85}{100} u^2 = 36.46$$

$$u^2 = \frac{36.46 \times 100}{85} = 42.89$$

$$u = 6.55 \, \text{m/s}$$

25. (d) According to conservation of momentum

$$m_1 v_1 + m_2 v_2 = (m_1 + m_2) v,$$

where v is common velocity of the two bodies.

$$m_1 = 0.1 \, \text{kg}, m_2 = 0.4 \, \text{kg}$$

$$v_1 = 1 \, \text{m/s}, v_2 = -0.1 \, \text{m/s},$$

$$\therefore 0.1 \times 1 + 0.4 \times (-0.1) = (0.1 + 0.4) v$$

$$\text{or } 0.1 - 0.04 = 0.5 v,$$

$$v = \frac{0.06}{0.5} = 0.12 \, \text{m/s}$$

$$\text{Hence, distance covered} = 0.12 \times 10 = 1.2 \, \text{m}.$$

$$26. \quad (a) \quad F_x = \frac{-dU}{dx} = x \frac{-d}{dx} \left(\frac{x^2 - z^2}{2} \right) = -x$$

$$F_z = \frac{-dU}{dz} = \frac{-d}{dz} \left(\frac{x^2 - z^2}{2} \right) = z$$

$$\therefore \vec{F} = -x\hat{i} + z\hat{k}$$

27. (b) As the ball moves down from height 'h' to ground the P.E. at height 'h' is converted to K.E. at the ground (Applying Law of conservation of Energy).

$$\text{Hence, } \frac{1}{2} m_A v_A^2 = m_A g h_A \text{ or } v_A = \sqrt{2gh};$$

$$\text{Similarly, } v_B = \sqrt{2gh} \text{ or } v_A = v_B$$

28. (d) $P = F \times v \Rightarrow P = F \, a \, t$

$$\therefore P \propto t$$

29. (d) As $E = \frac{p^2}{2m}$

$$\therefore \frac{dE}{E} = 2 \left(\frac{dp}{p} \right) = 2 \times 5\% = 10\%$$

30. (a) Loss in K.E. = Area under the curve

$$31. \quad (a) \quad \vec{F} = -5\hat{i} + 9\cos 60^\circ \hat{i} + 9\sin 60^\circ \hat{j} - 3\hat{j}$$

$$= -5\hat{i} + \frac{9}{2}\hat{i} + \frac{9\sqrt{3}}{2}\hat{j} - 3\hat{j}$$

$$= -\frac{\hat{i}}{2} + \left(\frac{9\sqrt{3}}{2} - 3 \right) \hat{j}$$

$$\vec{s} = -3\hat{i}.$$

$$W = \vec{F} \cdot \vec{s} = \left[-\frac{\hat{i}}{2} + \left(\frac{9\sqrt{3}}{2} - 3 \right) \hat{j} \right] \cdot (-3\hat{i})$$

$$= 1.5 \, \text{J}.$$

Type B : Assertion Reason Questions

32. (d) In an elastic collision, no conversion of energy, so K.E. remains constant during the time of collision. There is no friction acting in this case. In case of friction too

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conservation of energy is followed provided we take into account all the transformations there.

33. (d) Frictional force is non-conservative as work done against frictional force can not be stored as potential energy.
34. (a) In a quick collision, time t is small.
As $F \times t = \text{constant}$, therefore, force involved is large. I.e., collision is more violent in comparison to slow collision.
Momentum, $p = mv$ or $p \propto v$
i.e., momentum is directly proportional to its velocity, so the momentum is greater in a quicker collision.
35. (a) In elastic collision, kinetic energy remains conserved therefore the ball rebounds with the same velocity. According to Newton's second law
 $F \times t = \text{change in linear momentum.}$
 $\therefore F \times 1 = m \times n(u + u) \Rightarrow F = 2mnu.$

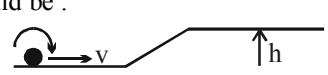
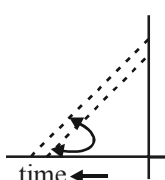
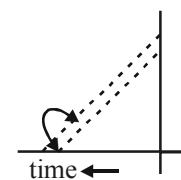
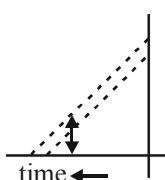
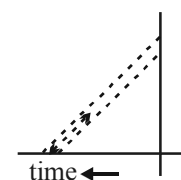
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36. (c) If there were only one propeller in the helicopter, the helicopter itself, would have turned in opposite direction of the direction of propeller due to conservation of angular momentum. Thus two propeller provides helicopter a steady movement.
37. (a)
38. (b) Total translational kinetic energy
$$= \frac{3}{2} nRT = \frac{3}{2} PV$$

In an ideal gas all molecules moving randomly in all direction collide and their velocity changes after collision.
39. (a)
40. (d) Potential energy $U = \frac{1}{2} kx^2$ i.e. $U \propto x^2$
This is a equation of parabola, so graph between U and x is a parabola not a straight line.

System of Particles and Rotational Motion

TYPE A : MULTIPLE CHOICE QUESTIONS

- If there is change of angular momentum from 1 J to 5 J in 5 second. Then the torque is : [1997]
 - $\frac{3J}{5}$
 - $\frac{4J}{5}$
 - $\frac{5J}{4}$
 - none of these
- If the equation for the displacement of a particle moving on a circular path is given as $\theta = 2t^3 + 0.5$, where θ is in radians and t is in second. Then the angular velocity of the particle after two second will be : [1998]
 - 36 rad/sec
 - 8 rad/sec
 - 48 rad/sec
 - 24 rad/sec
- The moment of inertia of a regular circular disc of mass 0.4 kg and radius 100 cm about an axis perpendicular to the plane of the disc and passing through its centre is: [1999]
 - 0.2 kg m^2
 - 0.02 kg m^2
 - 0.002 kg m^2
 - 2 kg m^2
- A constant torque of 31.4 Nm is exerted on a pivoted wheel. If the angular acceleration of the wheel is $4\pi \text{ rad/sec}^2$, then the moment of inertia will be : [2001]
 - 5.8 kg-m^2
 - 4.5 kg-m^2
 - 5.6 kg-m^2
 - 2.5 kg-m^2
- The motion of planets in the solar system is an example of the conservation of : [2003]
 - mass
 - linear momentum
 - angular momentum
 - energy
- The direction of the angular velocity vector along : [2004]
 - the tangent to the circular path
 - the inward radius
 - the outward radius
 - the axis of rotation
- In an orbital motion, the angular momentum vector is : [2004]
 - along the radius vector
 - parallel to the linear momentum
 - in the orbital plane
 - perpendicular to the orbital plane
- A horizontal platform is rotating with uniform angular velocity around the vertical axis passing through its centre. At some instant of time a viscous fluid of mass m is dropped at the centre and is allowed to spread out and finally fall. The angular velocity during this period : [2005]
 - decreases continuously
 - decreases initially and increases again
 - remains unaltered
 - increases continuously
- A solid sphere is rolling on a frictionless surface, shown in figure with a translational velocity v m/s. If it is to climb the inclined surface then v should be : [2005]
 
 - $\geq \sqrt{\frac{10}{7}} gh$
 - $\geq \sqrt{2gh}$
 - $2gh$
 - $\frac{10}{7} gh$
- A ladder is leaned against a smooth wall and it is allowed to slip on a frictionless floor. Which figure represents the track of its centre of mass? [2005]
 - 
 - 
 - 
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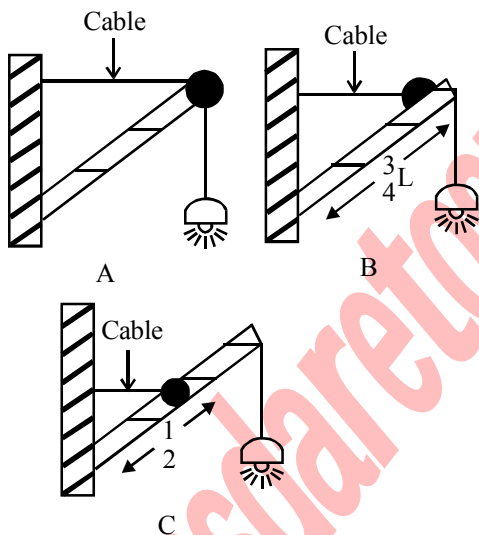
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11. The moment of inertia of a rod about an axis through its centre and perpendicular to it is $\frac{1}{12}ML^2$ (where M is the mass and L, the length of the rod). The rod is bent in the middle so that the two halves make an angle of 60° . The moment of inertia of the bent rod about the same axis would be : [2006]

- (a) $\frac{1}{48}ML^2$ (b) $\frac{1}{12}ML^2$
(c) $\frac{1}{24}ML^2$ (d) $\frac{ML^2}{8\sqrt{3}}$

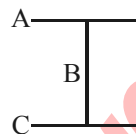
12. If a street light of mass M is suspended from the end of a uniform rod of length L in different possible patterns as shown in figure, then : [2006]



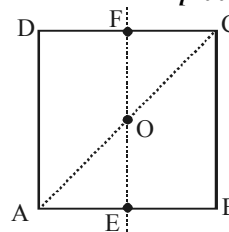
- (a) Pattern A is more sturdy
(b) Pattern B is more sturdy
(c) Pattern C is more sturdy
(d) All will have same sturdiness
13. If a solid sphere of mass 1 kg and radius 0.1 m rolls without slipping at a uniform velocity of 1 m/s along a straight line on a horizontal floor, the kinetic energy is [2007]

- (a) $\frac{7}{5}J$ (b) $\frac{2}{5}J$
(c) $\frac{7}{10}J$ (d) 1 J

14. In the diagram shown below all three rods are of equal length L and equal mass M. The system is rotated such that rod B is the axis. What is the moment of inertia of the system? [2007]



- (a) $\frac{ML^2}{6}$ (b) $\frac{4}{3}ML^2$
(c) $\frac{ML^2}{3}$ (d) $\frac{2}{3}ML^2$
15. The direction of the angular velocity vector is along [2007]
(a) the tangent to the circular path
(b) the inward radius
(c) the outward radius
(d) the axis of rotation
16. Four point masses, each of value m, are placed at the corners of a square ABCD of side ℓ . The moment of inertia of this system about an axis passing through A and parallel to BD is [2008]
(a) $2m\ell^2$ (b) $\sqrt{3}m\ell^2$
(c) $3m\ell^2$ (d) $m\ell^2$
17. For the given uniform square lamina ABCD, whose centre is O, [2008]



- (a) $I_{AC} = \sqrt{2} I_{EF}$
(b) $\sqrt{2} I_{AC} = I_{EF}$
(c) $I_{AD} = 3I_{EF}$
(d) $I_{AC} = I_{EF}$
18. A wheel has angular acceleration of 3.0 rad/s^2 and an initial angular speed of 2.00 rad/s . In a time of 2 s it has rotated through an angle (in radian) of [2008]
(a) 6 (b) 10
(c) 12 (d) 4
19. The angular speed of a body changes from ω_1 to ω_2 without applying a torque but due to changes in moment of inertia. The ratio of radii of gyration in two cases is [2009]
(a) $\omega_2 : \omega_1$ (b) $\sqrt{\omega_2} : \sqrt{\omega_1}$
(c) $\sqrt{\omega_2^2} : \sqrt{\omega_1^2}$ (d) $\sqrt{\omega_2^3} : \sqrt{\omega_1^3}$

20. A disc is rolling without slipping on a straight surface. The ratio of its translational kinetic energy to its total kinetic energy is [2009]

(a) $\frac{2}{3}$ (b) $\frac{1}{3}$
(c) $\frac{2}{5}$ (d) $\frac{3}{5}$

21. Two particles of masses m_1 and m_2 ($m_1 > m_2$), initially at rest, move towards each other under an inverse square law force of attraction. Pick out the correct statement about the centre of mass (CM) of the system [2009]

- (a) The CM moves towards m_1
(b) The CM moves towards m_2
(c) The CM remains at rest
(d) The motion of CM is accelerated

22. A wire of mass m and length l is bent in the form of a circular ring, the moment of inertia of the ring about its axis is [2010]

(a) $\left(\frac{1}{8\pi^2}\right)ml^2$ (b) $\left(\frac{1}{2\pi^2}\right)ml^2$
(c) $\left(\frac{1}{4\pi^2}\right)ml^2$ (d) ml^2

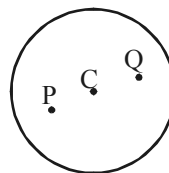
23. Which of the following is true about the angular momentum of a cylinder down a slope without slipping: [2011]

- (a) its magnitude changes but the direction remains same
(b) both magnitude and direction change
(c) only the direction change
(d) neither change

24. A circular disc rotating with frequency $f_0 = 1.3$ rev/sec comes to a stop in 30 seconds. The approximate angular acceleration is: [2011]

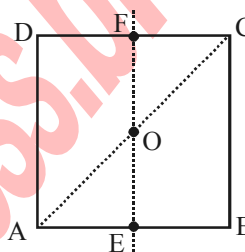
(a) $+0.27 \text{ rad/sec}^2$ (b) -0.27 rad/sec^2
(c) $+0.54 \text{ rad/sec}^2$ (d) $+0.27 \text{ rad/sec}^2$

25. A disc is rolling (without slipping) on a horizontal surface. C is its centre and Q and P are two points equidistant from C. Let V_P , V_Q and V_C be the magnitude of velocities of points P, Q and C respectively, then [2012]



- (a) $V_Q > V_C > V_P$
(b) $V_Q < V_C < V_P$
(c) $V_Q = V_P$, $V_C = \frac{1}{2}V_P$
(d) $V_Q = V_C = V_P$

26. For the given uniform square lamina ABCD, whose centre is O, [2012]



- (a) $I_{AC} = \sqrt{2} I_{EF}$ (b) $\sqrt{2} I_{AC} = I_{EF}$
(c) $I_{AD} = 3I_{EF}$ (d) $I_{AC} = I_{EF}$

27. One quarter sector is cut from a uniform circular disc of radius R . This sector has mass M . It is made to rotate about a line perpendicular to its plane and passing through the centre of the original disc. Its moment of inertia about the axis of rotation is [2013]

(a) $\frac{1}{2}mR^2$ (b) $\frac{1}{4}mR^2$
(c) $\frac{1}{8}mR^2$ (d) $\sqrt{2}mR^2$

28. A particle is confined to rotate in a circular path decreasing linear speed, then which of the following is correct? [2013]

- (a) $\vec{L}$ (angular momentum) is conserved about the centre.
(b) Only direction of angular momentum $\vec{L}$ is conserved.
(c) It spirals towards the centre.
(d) Its acceleration is towards the centre.

29. A flywheel rotates about an axis. Due to friction at the axis, it experiences an angular retardation proportional to its angular velocity. If its angular

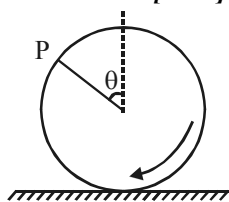
P-40

velocity falls to half while it makes n rotations, how many more rotations will it make before coming to rest? [2013]

- (a) $2n$ (b) n
(c) $n/2$ (d) $n/3$

30. A wheel is rolling straight on ground without slipping. If the axis of the wheel has speed v , the instantaneous velocity of a point P on the rim, defined by angle θ , relative to the ground will be [2014]

- (a) $v \cos\left(\frac{1}{2}\theta\right)$
(b) $2v \cos\left(\frac{1}{2}\theta\right)$
(c) $v(1 + \sin\theta)$
(d) $v(1 + \cos\theta)$

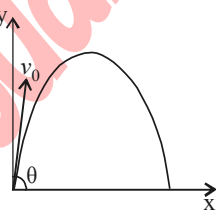


31. Consider a thin uniform square sheet made of a rigid material. If its side is ' a ' mass m and moment of inertia I about one of its diagonals, then [2016]

- (a) $I > \frac{ma^2}{12}$ (b) $\frac{ma^2}{24} < I < \frac{ma^2}{12}$
(c) $I = \frac{ma^2}{24}$ (d) $I = \frac{ma^2}{12}$

32. A small particle of mass m is projected at an angle θ with the x -axis with an initial velocity v_0 in the x - y plane as shown in the figure. At a time $t < \frac{v_0 \sin \theta}{g}$, the angular momentum of the particle is [2016]

- (a) $-mg v_0 t^2 \cos \theta \hat{j}$
(b) $mg v_0 t \cos \theta \hat{k}$
(c) $-\frac{1}{2} mg v_0 t^2 \cos \theta \hat{k}$
(d) $\frac{1}{2} mg v_0 t^2 \cos \theta \hat{i}$



33. A solid sphere rolls down two different inclined planes of same height, but of different inclinations. In both cases [2017]
(a) speed and time of descent will be same
(b) speed will be same, but time of descent will be different
(c) speed will be different, but time of descent will be same
(d) speed and time of descent both are different

Topicwise AIIMS Solved Papers – PHYSICS

TYPE B : ASSERTION REASON QUESTIONS

Directions for (Qs. 34-39) : These questions consist of two statements, each printed as Assertion and Reason. While answering these questions, you are required to choose any one of the following five responses.

- (a) If both Assertion and Reason are correct and the Reason is a correct explanation of the Assertion.
(b) If both Assertion and Reason are correct but Reason is not a correct explanation of the Assertion.
(c) If the Assertion is correct but Reason is incorrect.
(d) If both the Assertion and Reason are incorrect.
(e) If the Assertion is incorrect but the Reason is correct.

34. **Assertion :** Moment of inertia depends on the axis of rotation and the nature of distribution of the mass of the body.

Reason : Moment of inertia is the rotational inertia of the body. [1997]

35. **Assertion :** The earth is slowing down and as a result the moon is coming nearer to it.

Reason : The angular momentum of the earth moon system is not conserved. [2003]

36. **Assertion :** There are very small sporadic changes in the speed of rotation of the earth

Reason : Shifting of large air masses in the earth's atmosphere produce a change in the moment of inertia of the earth causing its speed of rotation to change. [2004]

37. **Assertion :** For a system of particles under central force field, the total angular momentum is conserved.

Reason : The torque acting on such a system is zero. [2005]

38. **Assertion :** A judo fighter in order to throw his opponent on to the mat tries to initially bend his opponent and then rotate him around his hip.

Reason : As the mass of the opponent is brought closer to the fighter's hip, the force required to throw the opponent is reduced. [2006]

39. **Assertion :** The velocity of a body at the bottom of an inclined plane of given height is more when it slides down the plane, compared to, when it rolling down the same plane.

Reason : In rolling down a body acquires both, kinetic energy of translation and rotation. [2008]

Directions for (Qs. 40-45) : Each of these questions contains an Assertion followed by Reason. Read them carefully and answer the question on the basis of following options. You have to select the one that best describes the two statements.

- (a) If both Assertion and Reason are correct and Reason is the correct explanation of Assertion.
- (b) If both Assertion and Reason are correct, but Reason is not the correct explanation of Assertion.
- (c) If Assertion is correct but Reason is incorrect.
- (d) If both the Assertion and Reason are incorrect.

40. Assertion : The position of centre of mass of a body depends upon shape and size of the body.

Reason : Centre of mass of a body lies always at the centre of the body. [2009]

41. Assertion : If polar ice melts, days will be shorter.

Reason : Moment of inertia decreases and thus angular velocity increases. [2010]

42. Assertion : If no external force acts on a system of particles, then the centre of mass will not move in any direction.

Reason : If net external force is zero, then the linear momentum of the system changes. [2011]

43. Assertion : A rigid disc rolls without slipping on a fixed rough horizontal surface with uniform angular velocity. Then the acceleration of lowest point on the disc is zero.

Reason : For a rigid disc rolling without slipping on a fixed rough horizontal surface, the velocity of the lowest point on the disc is always zero. [2013]

44. Assertion : For the planets orbiting around the sun, angular speed, linear speed and K.E. changes with time, but angular momentum remains constant.

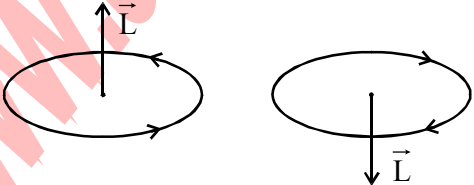
Reason : No torque is acting on the rotating planet. So its angular momentum is constant. [2013]

45. Assertion : Radius of gyration of body is a constant quantity.

Reason : The radius of gyration of a body about an axis of rotation may be defined as the root mean square distance of the particle from the axis of rotation. [2017]

HINTS & SOLUTIONS

Type A : Multiple Choice Questions

1. (b) $\text{Torque} = \frac{dL}{dt} = \frac{\Delta L}{\Delta t}$,
Here $\Delta L = 5J - J = 4J$
 $\Delta t = 5 \text{ sec}$ torque $= \frac{4}{5} J$
2. (d) $\theta = 2t^3 + 0.5$
 $\omega = \frac{d\theta}{dt} = 6t^2 = 6 \times 2^2$
 $= 6 \times 4 = 24 \text{ radian/sec}$
3. (a) Moment of inertia of a circular disc
 $= \frac{1}{2} MR^2 = \frac{1}{2} \times 0.4 \times 1 \times 1 = 0.2 \text{ kg-m}^2$
4. (d) Torque $= I\alpha$
[I is moment of inertia and α is angular acceleration]
 $31.4 = I \times 4\pi$
 $I = \frac{31.4}{4\pi} = 2.50 \text{ kg-m}^2$
5. (c) For any circular motion the angular momentum is conserved as no torque is acting on it because centripetal force acts through the point of axis.
6. (d) 
Angular velocity is a vector whose direction is perpendicular to the plane of circular path or axis of rotation. Its direction has been shown in the figure.
7. (d) Angular momentum is a vector quantity whose direction is perpendicular to plane of revolution. It has been shown in the figure.


8. (b) When the fluid spreads out, the moment of inertia of the system is increased. If we apply conservation of angular momentum.

$$I\omega = I_1\omega_1$$

As I increases due to water spreading out, the angular velocity decrease.

When water level falls, I decreases resulting in increased angular velocity.

9. (a) Applying law of conservation of energy for rotating body,

$$\frac{1}{2}mv^2 + \frac{1}{2}I\omega^2 = mgh$$

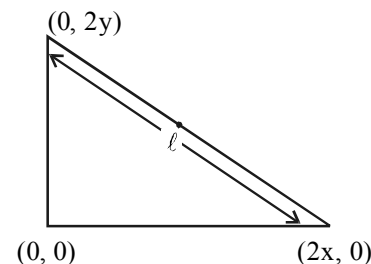
$$\frac{1}{2}mv^2 + \frac{1}{2} \times \frac{2}{5}mr^2 \times \frac{v^2}{r^2} = mgh$$

$$\frac{v^2}{2} + \frac{2v^2}{10} = gh$$

$$\frac{5v^2 + 2v^2}{10} = gh \Rightarrow v^2 = \frac{10}{7}gh$$

$$v \geq \sqrt{\frac{10}{7}gh}$$

10. (a)



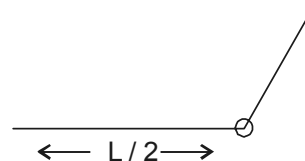
Let ℓ be the length of ladder and (x, y) be its centre of mass which is middle point of the ladder. From the figure it is clear that,

$$(2x)^2 + (2y)^2 = \ell^2 \Rightarrow x^2 + y^2 = \frac{\ell^2}{4}$$

So, locus of (x, y) is a circle with radius $\frac{\ell}{2}$.

As centre of mass will always go downwards. So option (a) is correct.

11. (b)



We know that for a body, moment of inertia

$$M.I = \sum Mr^2$$

Now, bending of rod does not alter the distribution of individual particle, the body is made of, so the value of $\sum Mr^2$ will not change. Hence the changed moment of inertia of the body will be $\frac{1}{12}ML^2$.

12. (a) Torque created due to weight of street light remains same in all the three cases. It is balanced by torque created by tension in the string. So if τ be the torque created by weight of lamp and T be tension in the string and d be perpendicular distance of cable from the axis then,

$$\tau = T.d$$

Tension will be least for largest d . This is in pattern A. So Pattern A is more sturdy.

13. (c) When a body rolls over a smooth surface, it has linear K.E. and rotational K.E.

$$\therefore E = \frac{1}{2}mv^2 + \frac{1}{2}I\omega^2$$

where $\omega = \frac{v}{r}$ and $I = \frac{2}{5}mr^2$ for solid sphere.

$$\begin{aligned}\therefore \text{K.E.} &= \frac{1}{2}mv^2 + \frac{1}{2}\left(\frac{2}{5}mr^2\right) \cdot \frac{v^2}{r^2} \\ &= \frac{1}{2}mv^2 + \frac{1}{5}mv^2 = \frac{7}{10}mv^2 = \frac{7}{10} \times 1 \times 1^2 \\ &= \frac{7}{10} \text{ J}\end{aligned}$$

14. (a) Moment of inertia of system
= M.I of A + M.I. of B + M.I of C
M.I of A = $M \cdot T$ through centre and perpendicular to length = $\frac{1}{12}ML^2$

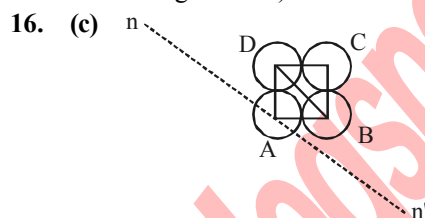
$$\text{M.I of C} = \text{M.I of A} = \frac{1}{12}ML^2$$

$$\text{M.I of B} = 0$$

(moment of mass about an axis passing through its own position is zero)

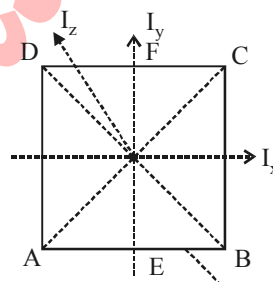
$$\therefore \text{Total M.I} = \frac{1}{12}ML^2 + \frac{1}{12}ML^2 = \frac{1}{6}ML^2$$

15. (d) $\omega = \frac{2\pi}{T} = \frac{\theta}{t}$ in magnitude and direction is axis of rotation (direction in which θ changes with t)



$$\begin{aligned}I_{nn'} &= 2 \times m \left(\frac{\ell}{\sqrt{2}} \right)^2 + m(\sqrt{2}\ell)^2 \\ &= m\ell^2 + 2m\ell^2 = 3m\ell^2\end{aligned}$$

17. (d) By the theorem of perpendicular axes,
 $I_z = I_x + I_y$ or, $I_z = 2 I_y$
($\therefore I_x = I_y$ by symmetry of the figure)



$$\therefore I_{EF} = \frac{I_z}{2} \quad \dots (i)$$

Again, by the same theorem,

$$I_z = I_{AC} + I_{BD} = 2 I_{AC}$$

($\therefore I_{AC} = I_{BD}$ by symmetry of the figure)

$$\therefore I_{AC} = \frac{I_z}{2} \quad \dots (ii)$$

From (i) and (ii), we get $I_{EF} = I_{AC}$.

18. (b) Given : initial angular speed,
 $\omega_0 = 2 \text{ rad/s}$, angular acceleration,
 $\alpha = 3 \text{ rad/s}^2$, time, $t = 2 \text{ s}$
From the equation of the angular displacement,

$$\begin{aligned}\theta &= \omega_0 t + \frac{1}{2} \alpha t^2 = 2 \times 2 + \frac{1}{2} \times 3 \times (2)^2 \\ &= 4 + 6 = 10 \text{ radians}\end{aligned}$$

19. (a) $I_1 \omega_1 = I_2 \omega_2$
 $MK_1^2 \omega_1 = MK_2^2 \omega_2$

$$\left(\frac{K_1}{K_2}\right)^2 = \frac{\omega_2}{\omega_1} \Rightarrow \frac{K_1}{K_2} = \sqrt{\omega_2} : \sqrt{\omega_1}$$

20. (a) $TKE = \frac{1}{2}mv^2$

$$RKE = \frac{1}{2}I\omega^2$$

$$\omega = v/R$$

$$\Rightarrow \frac{TKE}{TKE + RKE} = \frac{2}{3}$$

21. (c) When no external force acts on the system and initially velocity of centre of mass is zero and so the centre mass remain at rest.

22. (c) Length of the wire = l .

Let it is bent in the form of a circular ring of radius r .

Thus, radius of the ring

$$r = \frac{l}{2\pi}$$

The moment of inertia of the ring about its axis,

$$I = mr^2 = m \left(\frac{l}{2\pi} \right)^2 = m \times \frac{l^2}{4\pi^2}$$

$$= \left(\frac{1}{4\pi^2} \right) ml^2.$$

23. (a) As axis of rotation is along the length of the cylinder are remain same, but speed increases continuously.

24. (b) Given, $\omega_0 = 2\pi f = 2\pi \times 13 = 2.6\pi \text{ rad/s}$

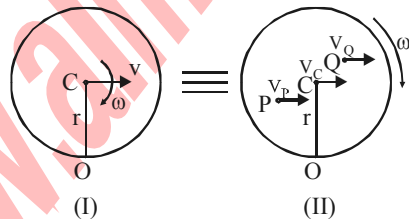
Using I equation of motion

$$\omega = \omega_0 + \alpha t$$

$$0 = 2.6\pi + \alpha \times 30$$

$$\Rightarrow \alpha = \frac{2.6\pi}{30} = -0.27 \text{ rad/s}^2$$

25. (a)



From Fig. (I), we have $OC = r$ (radius)

Therefore, $v = r\omega$

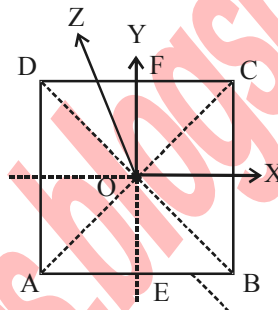
Since, $\omega = \text{constant}$, therefore $v \propto r$

Now, from Fig (II), it is clear that the distance, $OP < OC < OQ \Rightarrow V_P < V_C < V_Q$ or $V_Q > V_C > V_P$.

26. (d) By the theorem of perpendicular axes,

$$I_z = I_x + I_y \quad \text{or,} \quad I_z = 2 I_y$$

($\because I_x = I_y$ by symmetry of the figure)



$$\therefore I_{EF} = \frac{I_z}{2} \quad \dots(i)$$

Again, by the same theorem

$$I_z = I_{AC} + I_{BD} = 2 I_{AC}$$

($\because I_{AC} = I_{BD}$ by symmetry of the figure)

$$\therefore I_{AC} = \frac{I_z}{2} \quad \dots(ii)$$

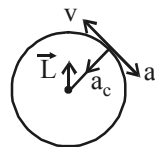
From (i) and (ii), we get

$$I_{EF} = I_{AC}.$$

27. (a) For complete disc with mass '4M', M.I. about given axis = $(4M)(R^2/2) = 2 MR^2$
Hence, by symmetry, for the given quarter of the disc

$$\text{M.I.} = 2 MR^2 / 4 = \frac{1}{2} MR^2$$

28. (b) Since v is changing (decreasing), L is not conserved in magnitude. Since it is given that a particle is confined to rotate in a circular path, it can not have spiral path. Since the particle has two accelerations a_c and a_t therefore the net acceleration is not towards the centre.



The direction of $\vec{L}$ remains same even when the speed decreases.

29. (b)
- α
- is proportional to
- ω

Let $\alpha = k\omega$ ($\because k$ is a constant)

$$\frac{d\omega}{dt} = k\omega \quad \left[\text{also } \frac{d\theta}{dt} = \omega \Rightarrow dt = \frac{d\theta}{\omega} \right]$$

$$\therefore \frac{\omega d\omega}{d\theta} = k\omega \Rightarrow d\omega = k d\theta$$

$$\text{Now } \int_{\omega}^{\omega/2} d\omega = k \int_{\theta}^{\theta/2} d\theta$$

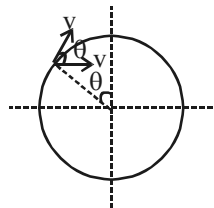
$$\int_{\omega/2}^{\omega} d\omega = k \int_0^{\theta} d\theta \Rightarrow -\frac{\omega}{2} = k\theta \Rightarrow -\frac{\omega}{2} = k\theta_1$$

$$(\because \theta_1 = 2\pi n)$$

$$\therefore \theta = \theta_1 \text{ or } 2\pi n_1 = 2\pi n$$

$$n_1 = n$$

30. (b)

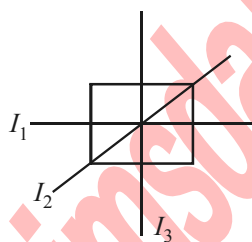


$$v_R = \sqrt{v^2 + v^2 + 2v^2 \cos \theta} = \sqrt{2v^2(1 + \cos \theta)}$$

$$= 2v \cos \frac{\theta}{2}$$

31. (d) For a thin uniform square sheet

$$I_1 = I_2 = I_3 = \frac{ma^2}{12}$$



32. (c)
- $\vec{L} = m(\vec{r} \times \vec{v})$

$$\vec{L} = m \left[v_0 \cos \theta t \hat{i} + \left(v_0 \sin \theta t - \frac{1}{2} g t^2 \right) \hat{j} \right]$$

$$\times \left[v_0 \cos \theta \hat{i} + (v_0 \sin \theta - g t) \hat{j} \right]$$

$$= m v_0 \cos \theta t \left[-\frac{1}{2} g t \right] \hat{k}$$

$$= -\frac{1}{2} m g v_0 t^2 \cos \theta \hat{k}$$

33. (b) In pure rolling, mechanical energy remains conserved. Therefore, when heights of inclines are equal, speed of sphere will be same in both the case. But as acceleration down the plane,
- $a \propto \sin \theta$
- . Therefore, acceleration and time of descent will be different.

Type B : Assertion Reason Questions

34. (b) We know that

$$I = \frac{m_1 r_1^2 + m_2 r_2^2 + m_3 r_3^2 + \dots + m_n r_n^2}{m_1 + m_2 + m_3 + \dots}$$

where r_1, r_2, r_3 are distances of mass m_1, m_2, m_3 etc. from the axis. From the relation it is clear that I depends upon distribution of the masses and position of axis.

So, Assertion is correct.

We know that,

$$\text{angular momentum} = I\omega$$

$$\text{Torque} = I\alpha$$

If we compare these equations with equations like linear momentum = mv , force = ma , we find that I represents mass in angular motion. As mass represents inertia in linear motion, I represents inertia in angular motion.

But assertion and reason are mutually exclusive. So (b) is the answer.

35. (c) The angular momentum of earth-moon system will be conserved because no torque is acting on it.

$$\text{So, } \tau = \frac{dL}{dt}$$

$$\text{If } \tau = 0, \frac{dL}{dt} = 0 \Rightarrow L \text{ is constant.}$$

or angular momentum is constant. So Reason is incorrect.

$$\text{So, } I_1 \omega_1 = I_2 \omega_2$$

where I_1 & I_2 are momentia of inertia of earth and moon & ω_1 & ω_2 are their angular velocities. If earth slows down ω , will be decreased. So, I_2 will be decreased if we take ω_2 to remain constant.

$I_2 = m_2 r_2^2$ where m_2 is mass of moon & r_2 is radius of moon's orbit, r_2 will be reduced to reduce I_2 . Hence moon will come near to the earth. Hence Assertion is correct.

36. (a) Along with earth, particles of atmosphere also revolves around the axis of rotation. Now due to change in the constitution of atmosphere there is small change in the total moment of inertia of the whole system. Applying conservation of angular momentum

$$I\omega = I'\omega'$$

If I' changes, there is corresponding change in the angular velocity of the system.

37. (a) Under central force field, force acts along the line joining the bodies so it does not have rotatory effect i.e., torque is zero. Hence angular momentum is conservative.
38. (a) When mass of the opponent is brought nearby by his moment of inertia gets reduced which makes the operation of rotating him around the hip an easier exercise.
39. (b) In sliding down, the entire potential energy is converted into kinetic energy. While in rolling down, some part of the potential energy is converted into kinetic energy of rotation. Therefore linear velocity acquired is less.
40. (c) The position of centre of mass of a body depends on shape, size and distribution of mass of the body. The centre of mass does not lie necessarily at the centre of the body.

Many objects have a point, a line or a plane of symmetry. The centre of mass of such an object then lies at that point, on that line or in that plane. Also the centre of mass of an object need not lie within the object, like no iron at the centre of mass of a horse shoe.

41. (a)

42. (d)

43. (d) For a disc rolling without slipping on a horizontal rough surface with uniform angular velocity, the acceleration of lowest point of disc is directed vertically upwards and is not zero (Due to translation part of rolling, acceleration of lowest point is zero. Due to rotational part of rolling, the tangential acceleration of lowest point is zero and centripetal acceleration is non-zero and upwards). Hence Assertion is incorrect.

44. (a)

45. (d) Radius of gyration of body is not a constant quantity. Its value changes with the change in location of the axis of rotation. Radius of gyration of a body about a given axis is given as

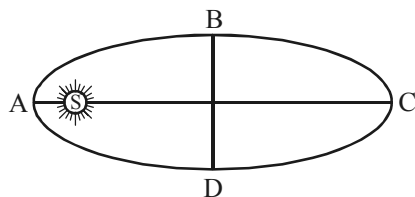
$$K = \sqrt{\frac{r_1^2 + r_2^2 + \dots + r_n^2}{n}}$$

TYPE A : MULTIPLE CHOICE QUESTIONS

1. If a mass of a body is M on the earth surface, the mass of the same body on moon surface will be

(a) M (b) $\frac{M}{6}$ [1997]
(c) zero (d) none of these

2. The earth rotates about the sun in an elliptical orbit as shown in figure. At which point its velocity will be maximum? [1997]



- (a) at C (b) at A
(c) at D (d) at B
3. The ratio of the radii of two planets r_1 and r_2 is k . The ratio of acceleration due to gravity on them is r . Then the ratio of the escape velocities from them, will be : [1997]

(a) $\sqrt{\frac{r}{k}}$ (b) $\sqrt{\frac{k}{r}}$
(c) kr (d) $\sqrt{kr}$

4. The value of acceleration due to gravity, at earth surface is g . Its value at the centre of the earth, which we assume as a sphere of radius R and of uniform mass density, will be : [1997]

(a) $10 R m/s^2$ (b) zero
(c) $5 R m/s$ (d) $20 R m/s^2$

5. Gravitational mass is proportional to the gravitational : [1998]

(a) intensity (b) field
(c) force (d) none of these

6. Escape velocity of a body when projected from the earth's surface is 11.2 km/sec . If it is projected

at an angle of 50° from the horizontal, then escape velocity is: [1999]

(a) 12.8 km/sec (b) 16.2 km/sec
(c) 11.2 km/sec (d) 11.8 km/sec

7. Knowing that the mass of the moon is $1/81$ times that of earth and its radius is $1/4$ the radius of earth. If the escape velocity at the surface of the earth is 11.2 km/sec , then the value of escape velocity at the surface of the moon is [2000]

(a) 2.5 km/sec (b) 0.14 km/sec
(c) 5 km/sec (d) 8 km/sec

8. If the mass of moon is $\frac{M}{81}$, where M is the mass of earth, find the distance of the point from the moon, where gravitational field due to earth and moon cancel each other. Given that distance between earth and moon is $60R$ where R is the radius of earth [2000]

(a) $4R$ (b) $8R$
(c) $2R$ (d) $6R$

9. Potential energy of a satellite having mass m and rotating at a height of $6.4 \times 10^6 \text{ m}$ from the earth centre is [2000]

(a) $-0.2 mg R_e$ (b) $-2 mg R_e$
(c) $-0.5 mg R_e$ (d) $-mg R_e$

10. The escape velocity from the earth is 11.2 km/sec . The escape velocity from a planet having twice the radius and the same mean density as the earth, is : [2001]

(a) 11.2 km/sec (b) 22.4 km/sec
(c) 15.00 km/sec (d) 5.8 km/sec

11. If v_0 be the orbital velocity of a satellite in a circular orbit close to the earth's surface and v_e is the escape velocity from the earth, then relation between the two is [2002]

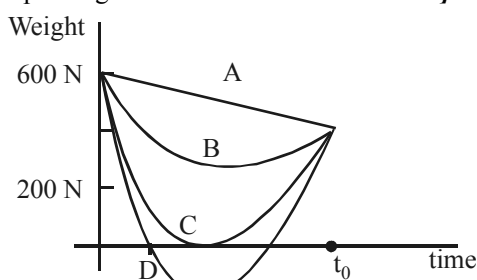
(a) $v_e = 2v_0$ (b) $v_e = \sqrt{3}v_0$
(c) $v_e = v_0\sqrt{2}$ (d) $v_0 = v_e$

12. Hubble's law is related with [2002]
 (a) planetary motion
 (b) speed of galaxy
 (c) black hole
 (d) comet
13. The radius of earth is about 6400 km and that of mass is about 3200 km. The mass of the earth is about 10 times of the mass. The object weighs 200 N on earth surface, then its weight on the surface of mars will be [2002]
 (a) 80 N (b) 40 N
 (c) 20 N (d) 8 N
14. A satellite is launched into a circular orbit of radius R around the earth. While a second satellite launched into an orbit of radius $1.01R$. The period of the second satellite is longer than the first one by approximately : [2002]
 (a) 3.0% (b) 1.5%
 (c) 0.7% (d) 1.0%
15. The velocity with which a projectile must be fired so that it escapes earth's gravitation does not depend on : [2003]
 (a) mass of the earth
 (b) mass of the projectile
 (c) radius of the projectile's orbit
 (d) gravitational constant
16. The difference in the length of a mean solar day and a sidereal day is about : [2003]
 (a) 1 minute (b) 4 minute
 (c) 15 minute (d) 56 minute
17. The condition for a uniform spherical mass m of radius r to be a black hole is : [G = gravitational constant and g = acceleration due to gravity] [2005]
 (a) $\left(\frac{2Gm}{r}\right)^{1/2} \leq c$ (b) $\left(\frac{2gm}{r}\right)^{1/2} = c$
 (c) $\left(\frac{2Gm}{r}\right)^{1/2} \geq c$ (d) $\left(\frac{gm}{r}\right)^{1/2} \geq c$
18. Height of geostationary satellite is [2007]
 (a) 16000 km (b) 22000 km
 (c) 28000 km (d) 36000 km
19. The force of gravitation is [2007]
 (a) repulsive (b) conservative
 (c) electrostatic (d) non-conservative
20. A long straight wire of radius a carries a steady current i . The current is uniformly distributed across its cross section. The ratio of the magnetic field at $a/2$ and $2a$ is [2008]
 (a) $1/2$ (b) $1/4$
 (c) 4 (d) 1
21. Two bodies of masses m_1 and m_2 are initially at rest at infinite distance apart. They are then allowed to move towards each other under mutual gravitational attraction. Their relative velocity of approach at a separation distance r between them is [2008]
 (a) $\left[2G \frac{(m_1 - m_2)}{r}\right]^{1/2}$
 (b) $\left[\frac{2G}{r}(m_1 + m_2)\right]^{1/2}$
 (c) $\left[\frac{r}{2G(m_1 m_2)}\right]^{1/2}$
 (d) $\left[\frac{2G}{r} m_1 m_2\right]^{1/2}$
22. A satellite S is moving in an elliptical orbit around the earth. The mass of the satellite is very small compared to the mass of the earth. Then
 (a) the acceleration of S is always directed towards the centre of the earth
 (b) the angular momentum of S about the centre of the earth changes in direction, but its magnitude remains constant
 (c) the total mechanical energy of S varies periodically with time
 (d) the linear momentum of S remains constant in magnitude [2010]
23. If the earth were to cease rotating about its own axis. The increase in the value of g in C.G.S. system at a place of latitude of 45° will be [2010]
 (a) 2.68 (b) 1.68
 (c) 3.36 (d) 0.34
24. A geostationary satellite is orbiting the earth at a height of $6R$ from the earth's surface (R is the earth's radius). What is the period of rotation of another satellite at a height of $2.5R$ from the earth's surface [2011]
 (a) $6\sqrt{2}$ hours (b) 10 hours
 (c) $\frac{5\sqrt{5}}{\sqrt{3}}$ hours (d) none of the above

25. The angular speed of earth in rad/s, so that bodies on equator may appear weightless is : [Use $g = 10 \text{ m/s}^2$ and the radius of earth $= 6.4 \times 10^3 \text{ km}$] [2011]

(a) 1.25×10^{-3} (b) 1.56×10^{-3}
(c) 1.25×10^{-1} (d) 1.56

26. Suppose, the acceleration due to gravity at the Earth's surface is 10 m/s^2 and at the surface of Mars it is 4.0 m/s^2 . A 60 kg passenger goes from the Earth to the Mars in a spaceship moving with a constant velocity. Neglect all other objects in the sky. Which part of figure best represents the weight (net gravitational force) of the passenger as a function of time? [2012]



- (a) A (b) B
(c) C (d) D
27. Two masses m_1 and m_2 ($m_1 < m_2$) are released from rest from a finite distance. They start under their mutual gravitational attraction – [2012]
- (a) acceleration of m_1 is more than that of m_2 .
(b) acceleration of m_2 is more than that of m_1 .
(c) centre of mass of system will remain at rest in all the reference frame
(d) total energy of system does not remain constant
28. The escape velocity for a body projected vertically upwards from the surface of earth is 11 km/s . If the body is projected at an angle of 45° with the vertical, the escape velocity will be [2013]
- (a) 22 km/s (b) 11 km/s
(c) $\frac{11}{\sqrt{2}} \text{ km/s}$ (d) $11\sqrt{2} \text{ km/s}$
29. The radii of two planets are respectively R_1 and R_2 and their densities are respectively ρ_1 and ρ_2 . The ratio of the accelerations due to gravity at their surfaces is [2013]

(a) $g_1 : g_2 = \frac{\rho_1}{R_1^2} : \frac{\rho_2}{R_2^2}$
(b) $g_1 : g_2 = R_1 R_2 : \rho_1 \rho_2$

(c) $g_1 : g_2 = R_1 \rho_2 : R_2 \rho_1$

(d) $g_1 : g_2 = R_1 \rho_1 : R_2 \rho_2$

30. A body starts from rest from a point distance R_0 from the centre of the earth. The velocity acquired by the body when it reaches the surface of the earth will be (R represents radius of the earth). [2014]

(a) $2GM \left(\frac{1}{R} - \frac{1}{R_0} \right)$

(b) $\sqrt{2GM \left(\frac{1}{R_0} - \frac{1}{R} \right)}$

(c) $GM \left(\frac{1}{R} - \frac{1}{R_0} \right)$

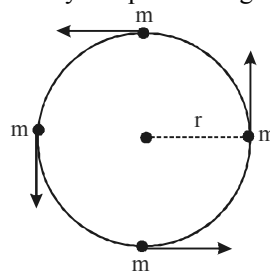
(d) $2GM \sqrt{\left(\frac{1}{R} - \frac{1}{R_0} \right)}$

31. The potential energy of a satellite of mass m and revolving at a height R_e above the surface of earth where R_e = radius of earth, is [2014]

(a) $-mgR_e$ (b) $\frac{-mgR_e}{2}$

(c) $\frac{-mgR_e}{3}$ (d) $\frac{-mgR_e}{4}$

32. Four similar particles of mass m are orbiting in a circle of radius r in the same angular direction because of their mutual gravitational attractive force. Velocity of a particle is given by [2015]



(a) $\left[\frac{GM}{r} \left(\frac{1+2\sqrt{2}}{4} \right) \right]^{1/2}$

(b) $\sqrt[3]{\frac{GM}{r}}$

(c) $\sqrt{\frac{GM}{r} (1+2\sqrt{2})}$

(d) $\left[\frac{1}{2} \frac{GM}{r} \left(\frac{1+\sqrt{2}}{2} \right) \right]^{1/2}$

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33. Taking the gravitational potential at a point infinite distance away as zero, the gravitational potential at a point A is -5 unit. If the gravitational potential at point infinite distance away is taken as $+10$ units, the potential at point A is [2015]
 (a) -5 unit (b) $+5$ unit
 (c) $+10$ unit (d) $+15$ unit
34. A particle of mass M is situated at the centre of a spherical shell of same mass and radius a . The gravitational potential at a point situated at $\frac{a}{2}$ distance from the centre, will be [2016]
 (a) $-\frac{3GM}{a}$ (b) $-\frac{2GM}{a}$
 (c) $-\frac{GM}{a}$ (d) $-\frac{4GM}{a}$
35. The distance of neptune and saturn from the sun is nearly 10^{13} and 10^{12} meter respectively. Assuming that they move in circular orbits, their periodic times will be in the ratio [2016]
 (a) 10 (b) 100
 (c) $10\sqrt{10}$ (d) 1000
36. The change in the value of 'g' at a height 'h' above the surface of the earth is the same as at a depth 'd' below the surface of earth. When both 'd' and 'h' are much smaller than the radius of earth, then which one of the following is correct? [2017]
 (a) $d = \frac{3h}{2}$ (b) $d = \frac{h}{2}$
 (c) $d = h$ (d) $d = 2h$
- (d) If both the Assertion and Reason are incorrect.
 (e) If the Assertion is incorrect but the Reason is correct.
37. **Assertion :** A balloon filled with hydrogen will fall with acceleration $\frac{g}{6}$ of the moon.
Reason : Moon has no atmosphere. [2000]
38. **Assertion :** The length of the day is slowly increasing.
Reason : The dominant effect causing a slowdown in the rotation of the earth is the gravitational pull of other planets in the solar system. [2003]
39. **Assertion :** An astronaut experience weightlessness in a space satellite.
Reason : When a body falls freely it does not experience gravity. [2007]
- Directions for (Qs. 40-43) :** Each of these questions contains an Assertion followed by Reason. Read them carefully and answer the question on the basis of following options. You have to select the one that best describes the two statements.
- (a) If both Assertion and Reason are correct and Reason is the correct explanation of Assertion.
 (b) If both Assertion and Reason are correct, but Reason is not the correct explanation of Assertion.
 (c) If Assertion is correct but Reason is incorrect.
 (d) If both the Assertion and Reason are incorrect.
40. **Assertion :** In a free fall, weight of a body becomes effectively zero.
Reason : Acceleration due to gravity acting on a body having free fall is zero. [2011]
41. **Assertion :** The escape speed does not depend on the direction in which the projectile is fired.
Reason : Attaining the escape speed is easier if a projectile is fired in the direction the launch site is moving as the earth rotates about its axis.
42. **Assertion :** The earth without atmosphere would be inhospitably cold.
Reason : All heat would escape in the absence of atmosphere. [2016]
43. **Assertion :** Space rocket are usually launched in the equatorial line from west to east
Reason : The acceleration due to gravity is minimum at the equator. [2017]

TYPE B : ASSERTION REASON QUESTIONS

Directions for (Qs. 37-39) : These questions consist of two statements, each printed as Assertion and Reason. While answering these questions, you are required to choose any one of the following five responses.

- (a) If both Assertion and Reason are correct and the Reason is a correct explanation of the Assertion.
 (b) If both Assertion and Reason are correct but Reason is not a correct explanation of the Assertion.
 (c) If the Assertion is correct but Reason is incorrect.

HINTS & SOLUTIONS

Type A : Multiple Choice Questions

1. (a) The mass of a body does not change unless we withdraw or add some mass to it. So mass of a body on the surface of moon will remain unchanged.

2. (b) When earth rotates around the Sun, the net torque acting on the body is zero. So, angular momentum will be conserved at all points.

$$I_1 \omega_1 = I_2 \omega_2$$

$$\Rightarrow mv_1 r_1 = mv_2 r_2$$

$$v_1 r_1 = v_2 r_2$$

At 'A' radius is minimum so, velocity of the earth will be maximum.

3. (d) $v_e = \sqrt{2gr}$
 $\frac{v_e'}{v_e''} = \frac{\sqrt{2g_1 r_1}}{\sqrt{2g_2 r_2}} = \sqrt{k.r}$

4. (b) The value of acceleration due to gravity at the centre of earth is zero.

5. (c) Inertial mass is free from gravitational force. It depends upon only mass. Gravitational mass is dependent on gravitational force.

6. (c) Escape velocity does not depend on the direction of throw of object. This is because gravitational field is a conservative field.

7. (a) For escape velocity, $v_e = \sqrt{\frac{2GM}{R}}$

$$v_e' = \sqrt{\frac{2GM/81}{R/4}} = \sqrt{\frac{4 \times 2GM}{81R}} = \frac{2}{9} \sqrt{\frac{GM}{R}}$$

$$v_e' = \frac{2}{9} \times 11.2 = 2.5 \text{ km/sec}$$

8. (d) Let at a distance x from the earth, field equalises each other. So, applying Newton's law of gravitation

$$\frac{GM}{x^2} = \frac{GM/81}{(60R - x)^2}$$

$$\frac{1}{x^2} = \frac{1}{81(60R - x)^2}$$

$$\Rightarrow \frac{1}{x} = \frac{1}{9(60R - x)}$$

$$x = 540R - 9x \Rightarrow 10x = 540R$$

$$x = 54R;$$

$$\text{Distance of the point from moon} = 60R - 54R = 6R$$

9. (d) Potential energy of a satellite = $\frac{-GMm}{R}$

$$= \frac{-GM \times R_e m}{R_e^2} = -mgR_e$$

10. (b) For escape velocity the formula is,

$$v_e = \sqrt{\frac{2GM}{R}} = \sqrt{\frac{2G \frac{4}{3} \pi R^3 \rho}{R}}$$

[ρ is density of the planet, R is radius.]

$$= \sqrt{\frac{8}{3} G \pi R^2 \rho}$$

$$v_e = R \sqrt{\frac{8}{3} G \pi \rho}$$

$$v_e \propto R$$

If radius becomes twice, v_e will also become twice. So new escape velocity

$$= 2 \times 11.2 = 22.4 \text{ km/sec}$$

11. (c) We know that,

$$v_0 = \sqrt{gr} \quad \& \quad v_e = \sqrt{2gr}$$

$$\text{So, } v_e = \sqrt{2} v_0$$

12. (b) Hubble's law states that speed of a star is directly proportional to distance from the star i.e.

$$v \propto r \Rightarrow v = Hr$$

where H is Hubble's constant.

13. (a) We know that $g = \frac{GM}{R^2}$

$$\text{Value of } g \text{ for Mass} = \frac{G.M/10}{(R/2)^2}$$

[Radius of mass is $1/2$ that of earth]

$$= \frac{GM}{10} \times \frac{4}{R^2} = \frac{2}{5} \frac{GM}{R^2}$$

$$\text{So, } g' = \frac{2}{5} g$$

$$\text{If } mg = 200 \text{ N, } mg' = \frac{200 \times 2}{5} = 80 \text{ N.}$$

14. (b) We know that relation between radius of orbit and time period of revolution is $T^2 \propto R^3$

$$\frac{T'}{T} = \left(\frac{1.01}{1} \right)^{3/2} = \left(1 + \frac{1}{100} \right)^{3/2}$$

$$= 1 + \frac{3}{2} \times \frac{1}{100} = 1 + \frac{3}{200}$$

$$\frac{T'}{T} - 1 = 1 + \frac{3}{200} - 1$$

$$\frac{T' - T}{T} = \frac{3}{200} \Rightarrow \frac{\Delta T}{T} = \frac{3}{200}$$

$$\frac{\Delta T}{T} \times 100 = \frac{3 \times 100}{200}$$

$$\% \text{ Change in } T = 1.5\%$$

15. (b) The value of escape velocity for a planet is

$$v_e = \sqrt{2gR}$$

It does not depend upon the mass of the body.

16. (b) Solar day is the time taken by earth to complete one rotation about its axis with respect to sun. Sidereal day is the time taken by earth to complete one rotation about its axis with respect to distant star.

There is a difference of 4 minutes between solar day and sidereal day. Solar day is longer as earth has to rotate greater angle to attain same position with respect to sun due to its own motion (revolution) round the sun. Its position with respect to distant star remains almost fixed.

17. (c) A black hole does not allow light to escape its surface. In other words for a black hole body escape velocity becomes $\geq$ velocity of light

Now for a body of mass m ,

$$\text{Escape velocity} = \left(\frac{2Gm}{r} \right)^{1/2}$$

$$\text{So, } \left(\frac{2Gm}{r} \right)^{1/2} \geq c$$

18. (d) The height of geostationary satellites is

$$\text{given by } h = \left(\frac{T^2 R^2 g}{4\pi^2} \right)^{1/3} - R$$

$T = 24 \text{ hr}$, $R = 6.4 \times 10^6 \text{ m}$, $g = 9.8 \text{ m/s}^2$ and comes out to be 35930 km.

19. (b) The work done by force of gravitation does not depend on path taken hence force of gravitation is conservative.

20. (d) Here, current is uniformly distributed across the cross-section of the wire, therefore, current enclosed in the amperian path formed at a distance

$$r_1 \left(= \frac{a}{2} \right)$$

$$= \left(\frac{\pi r_1^2}{\pi a^2} \right) \times I, \text{ where } I \text{ is total current}$$

$\therefore$ Magnetic field at

$$P_1 (B_1) = \frac{\mu_0 \times \text{current enclosed}}{\text{Path}}$$

$$= \frac{\mu_0 \times \left(\frac{\pi r_1^2}{\pi a^2} \right) \times I}{2\pi r_1} = \frac{\mu_0 \times I r_1}{2\pi a^2}$$

Now, magnetic field at point P_2 ,

$$(B_2) = \frac{\mu_0}{2\pi} \cdot \frac{I}{(2a)} = \frac{\mu_0 I}{4\pi a}$$

$$\therefore \text{Required Ratio} = \frac{B_1}{B_2} = \frac{\mu_0 I r_1}{2\pi a^2} \times \frac{4\pi a}{\mu_0 I}$$

$$= \frac{2r_1}{a} = \frac{2 \times \frac{a}{2}}{a} = 1.$$

21. (b) By applying law of conservation of momentum,

$$m_1 v_1 - m_2 v_2 = 0 \Rightarrow m_1 v_1 = m_2 v_2 \dots (i)$$

Where v_1 and v_2 are the velocities of masses m_1 and m_2 at a distance r from each other.

By conservation of energy,

Change in P.E = change in K.E.

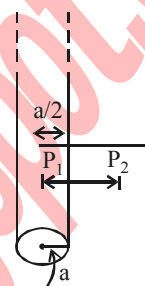
$$\frac{Gm_1 m_2}{r} = \frac{1}{2} m_1 v_1^2 + \frac{1}{2} m_2 v_2^2 \dots (ii)$$

Solving eqn. (i) and (ii) we get

$$v_1 = \sqrt{\frac{2Gm_2^2}{r(m_1 + m_2)}} \text{ and } v_2 = \sqrt{\frac{2Gm_1^2}{r(m_1 + m_2)}}$$

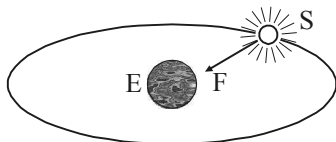
Relative velocity of approach, v_R

$$= |v_1| + |v_2| = \sqrt{\frac{2G}{r} (m_1 + m_2)}$$



22. (a) Force on satellite is always directed towards earth, So, acceleration of satellite S is always directed towards centre of earth. Net torque of this gravitational force F about centre of earth is zero. Therefore, angular momentum (both in magnitude and direction) of S about centre of earth is constant throughout.

Since, the force F is conservative in nature, therefore, mechanical energy of satellite remains constant. Speed of S is maximum when it is nearest to earth and minimum when it is farthest.



23. (b) $\lambda = 45^\circ$; $R = 6400 \times 10^3 \text{ m}$

$$\omega = \frac{2\pi}{24 \times 60 \times 60}$$

The value of acceleration due to gravity with latitude λ due to rotation of earth is,

$$g' = g - R\omega^2 \cos^2 \lambda$$

$$g - g' = R\omega^2 \cos^2 \lambda$$

$$= \frac{6400 \times 10^3}{2} \times \left(\frac{2 \times 3.14}{24 \times 60 \times 60} \right)^2$$

$$= \frac{6400 \times 10^3 \times 4 \times 3.14 \times 3.14}{2 \times 24 \times 60 \times 60 \times 24 \times 60 \times 60}$$

$$= 16.89 \times 10^{-3} \text{ m/sec}^2$$

$$= 16.89 \times 10^{-1} \text{ cm/sec}^2$$

$$= 1.68 \text{ cm/sec}^2$$

24. (a) $T = 2\pi \sqrt{\frac{r^3}{GM}}$

$$\therefore \left(\frac{T_1}{T_2} \right)^2 = \left(\frac{r_1}{r_2} \right)^3 = \left(\frac{6R + R}{2.5R + r} \right)^3 = 8$$

$$T_2 = \frac{T_1}{\sqrt{8}} = \frac{24}{\sqrt{8}} = 6\sqrt{2} \text{ hr}$$

25. (a) $\omega' = \sqrt{g/R} = \sqrt{\frac{281}{6.4 \times 10^6}}$
 $= 1.25 \times 10^{-3} \text{ rad/s}$

26. (c) $g \propto \frac{1}{R^2}$ so we will not get a straight line.

Also $F = 0$ at a point where Force due to Earth = Force due to Mars

27. (a) Same force acts on both masses

$$\text{Hence } a \propto \frac{1}{m} \quad (F = ma)$$

In absence of external force (remember mutual gravitational force is an internal force for the system) total energy remains constant.

28. (b) Since escape velocity ($v_e = \sqrt{2gR_e}$) is independent of angle of projection, so it will not change.

29. (d) $g \propto \rho R$

30. (b) $\text{P.E.} = \int_{R_0}^R \frac{GMm}{r^2} dr = -GMm \left[\frac{1}{R} - \frac{1}{R_0} \right]$

The K.E. acquired by the body at the surface $= \frac{1}{2} m v^2$

$$\therefore \frac{1}{2} m v^2 = -GMm \left[\frac{1}{R} - \frac{1}{R_0} \right]$$

$$v = \sqrt{2GM \left(\frac{1}{R_0} - \frac{1}{R} \right)}$$

31. (b) At a height h above the surface of earth the gravitational potential energy of the particle of mass m is

$$U_h = -\frac{GM_e m}{R_e + h}$$

Where M_e & R_e are the mass & radius of earth respectively.

In this question, since $h = R_e$

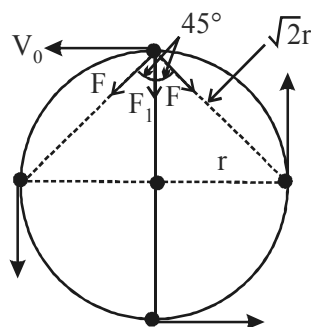
$$\text{So } U_{h=R_e} = -\frac{GM_e m}{2R_e} = \frac{-mgR_e}{2}$$

32. (a) Centripetal force = net gravitational force

$$\frac{mv_0^2}{r} = 2F \cos 45^\circ + F_1$$

$$= \frac{2GM^2}{(\sqrt{2}r)^2} \frac{1}{\sqrt{2}} + \frac{Gm^2}{4r^2}$$

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$$\frac{mv_0^2}{r} = \frac{Gm^2}{4r^2} [2\sqrt{2} + 1]$$

$$\Rightarrow \left(\frac{GM(2\sqrt{2} + 1)}{4r} \right)^{1/2}$$

33. (b) The gravitational potential V at a point distant ' r ' from a body of mass m is equal to the amount of work done in moving a unit mass from infinity to that point.

$$V_r - V_\infty = - \int_\infty^r \vec{E} \cdot d\vec{r} = -GM(1/r - 1/\infty)$$

$$= \frac{-GM}{r} \left(\text{As } \vec{E} = \frac{-dV}{dr} \right)$$

- (i) In the first case

$$\text{when } V_\infty = 0, V_r = \frac{-GM}{r} = -5 \text{ unit}$$

- (ii) In the second case $V^\infty = +10$ unit

$$V_r - 10 = -5$$

$$\text{or } V_r = +5 \text{ unit}$$

34. (a) Potential at the given point = Potential at the point due to the shell + Potential due to the particle

$$= -\frac{GM}{a} - \frac{2GM}{a} = -\frac{3GM}{a}$$

35. (c) $T^2 \propto R^3$ (According to Kepler's law)
 $T_1^2 \propto (10^{13})^3$ and $T_2^2 \propto (10^{12})^3$

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$$\therefore \frac{T_1^2}{T_2^2} = (10)^3 \text{ or } \frac{T_1}{T_2} = 10\sqrt{10}$$

36. (d) Variation of g with altitude is,

$$g_h = g \left[1 - \frac{2h}{R} \right];$$

variation of g with depth is,

$$g_d = g \left[1 - \frac{d}{R} \right]$$

Equating g_h and g_d , we get $d = 2h$

Type B : Assertion Reason Questions

37. (a) A balloon will not experience any buoyant force on the moon because it has no atmosphere, so it will have free fall under gravitational pull of the moon with acceleration equal to $\frac{g}{6}$.
38. (c) The length of the day is slowly increasing not due to gravitational pull of other planets in the solar system but due to viscous force between the earth and the atmosphere around it. So Assertion is correct but Reason is incorrect.
39. (a) When a body falls freely its accelerating force is g thus apparent weight of body $= M(g - g)$ is zero. Hence astronaut falling freely in space experiences weightlessness as its gravitational force is counter balanced by centripetal force of satellite.
40. (c)
41. (b)
42. (b) In the absence of atmosphere, all the heat will escape from earth's surface which will make earth inhospitably cold.
43. (b) Space rocket are usually launched from west to east to take the advantage of rotation of earth.
 Also $g' = g - \omega^2 R \cos^2 \lambda$, at equator $\lambda = 0$, and so $\cos \lambda = 1$, and g' is least.

Mechanical Properties of Solids

TYPE A : MULTIPLE CHOICE QUESTIONS

1. If S is stress and Y is Young's modulus of a material of wire, then energy stored in the wire per unit volume is : [1997]

(a) $2S^2Y$ (b) $\frac{S}{2Y}$
 (c) $\frac{2Y}{S^2}$ (d) $\frac{S^2}{2Y}$

2. Longitudinal strain is possible in : [1998]

- (a) Liquid (b) Gases
 (c) Solid (d) All of these

3. Which one of the following affects the elasticity of a substance ? [1999]

- (a) Change in temperature
 (b) Hammering and annealing
 (c) Impurity in substance
 (d) All of these

4. If in a wire of Young's modulus Y , longitudinal strain X is produced then the potential energy stored in its unit volume will be : [2001]

(a) $0.5 YX^2$ (b) $0.5 Y^2X$
 (c) $2 YX^2$ (d) YX^2

5. According to Hook's law of elasticity, if stress is increased, then the ratio of stress to strain : [2001]

- (a) becomes zero (b) remains constant
 (c) decreases (d) increases

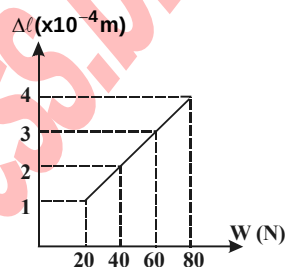
6. The bulk modulus of a metal is 10^{10} N/m^2 and Poisson's ratio 0.20. If average distance between the molecules is $3\text{\AA}$ then the interatomic force constant : [2002]

(a) 5.4 N/m (b) 7.5 N/m
 (c) 7.5 N/m (d) 30 N/m

7. Shear modulus is zero for [2007]

- (a) solids (b) liquids
 (c) gases (d) liquids and gases

8. The adjacent graph shows the extension ($\Delta\ell$) of a wire of length 1 m suspended from the top of a roof at one end and with a load W connected to the other end. If the cross-sectional area of the wire is 10^{-6} m^2 , calculate the Young's modulus of the material of the wire. [2008]

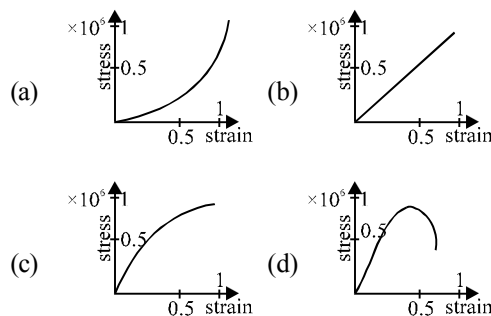


- (a) $2 \times 10^{11} \text{ N/m}^2$ (b) $2 \times 10^{-11} \text{ N/m}^2$
 (c) $3 \times 10^{-12} \text{ N/m}^2$ (d) $2 \times 10^{-13} \text{ N/m}^2$

9. There are two wire of same material and same length while the diameter of second wire is two times the diameter of first wire, then the ratio of extension produced in the wires by applying same load will be [2013]

- (a) 1 : 1 (b) 2 : 1
 (c) 1 : 2 (d) 4 : 1

10. Stress vs strain curve for the elastic tissue of the aorta, the large tube (vessel) carrying blood from the heart, will be : [stress is proportional to square of the strain for the elastic tissue of the aorta] [2015]



11. An iron rod of length 2m and cross-sectional area of 50 mm^2 stretched by 0.5 mm, when a mass of 250 kg is hung from its lower end. Young's modulus of iron rod is [2017]

(a) $19.6 \times 10^{20} \text{ N/m}^2$ (b) $19.6 \times 10^{18} \text{ N/m}^2$
(c) $19.6 \times 10^{10} \text{ N/m}^2$ (d) $19.6 \times 10^{15} \text{ N/m}^2$

TYPE B : ASSERTION REASON QUESTIONS

Directions for (Qs. 12) : These questions consist of two statements, each printed as Assertion and Reason. While answering these questions, you are required to choose any one of the following five responses.

- (a) If both Assertion and Reason are correct and the Reason is a correct explanation of the Assertion.
(b) If both Assertion and Reason are correct but Reason is not a correct explanation of the Assertion.
(c) If the Assertion is correct but Reason is incorrect.
(d) If both the Assertion and Reason are incorrect.
(e) If the Assertion is incorrect but the Reason is correct.

12. **Assertion :** Stress is the internal force per unit area of a body.

Reason : Rubber is more elastic than steel.

[2002]

Directions for (Qs. 13-15) : Each of these questions contains an Assertion followed by Reason. Read them carefully and answer the question on the basis of following options. You have to select the one that best describes the two statements.

- (a) If both Assertion and Reason are correct and Reason is the correct explanation of Assertion.
(b) If both Assertion and Reason are correct, but Reason is not the correct explanation of Assertion.
(c) If Assertion is correct but Reason is incorrect.
(d) If both the Assertion and Reason are incorrect.

13. **Assertion:** Strain causes the stress in an elastic body.

Reason: An elastic rubber is more plastic in nature. [2014]

14. **Assertion:** Hollow shaft is found to be stronger than a solid shaft made of same equal material.

Reason: Torque required to produce a given twist in hollow cylinder is greater than that required to twist a solid cylinder of same length and material. [2016]

15. **Assertion:** Solids are least compressible and gases are most compressible.

Reason: solids have definite shape and volume but gases do not have either definite shape or definite volume. [2017]

HINTS & SOLUTIONS

Type A : Multiple Choice Questions

1. (d) Energy stored in stretched wire per unit

$$\text{volume} = \frac{1}{2} \times \text{stress} \times \text{strain}$$

$$= \frac{1}{2} \times S \times \frac{S}{Y} = \frac{1}{2} \frac{S^2}{Y}$$

2. (c) Longitudinal strain is possible only in solids because only solids can have length which can be stretched by applying force.
3. (d) The elasticity of a material depends upon the temperature of the material. Hammering & annealing reduces elastic property of a substance.
4. (a) Potential energy stored per unit volume of a wire

$$= \frac{1}{2} \times \text{Stress} \times \text{Strain}$$

$$= \frac{1}{2} \times Y \times X \times X \quad [\text{Stress} = Y \times X]$$

$$= 0.5 Y X^2$$

5. (b) The Ratio of stress to strain is always constant. If stress is increased, strain will also increase so that their ratio remains constant.
6. (a) Young's modulus,
 $Y = 3K(1 - 2\sigma) = 3 \times 10^{10}(1 - 2 \times 0.2)$
 $= 1.8 \times 10^{10} \text{ N/m}^2$
 $\therefore$ Interatomic force constant is
 $K = Yr = 1.8 \times 10^{10} \times 3 \times 10^{-10} = 5.4 \text{ N/m}$
7. (d) Shear modulus is applicable to solids where deforming force causes change in shape of body. For fluids it is not possible since they have no fixed shape.

8. (a) $Y = \frac{F}{A} / \frac{\Delta l}{l} = \frac{20 \times 1}{10^{-6} \times 10^{-4}}$
 $= 2 \times 10^{11} \text{ N/m}^2$

9. (d) $\therefore$ Both wires are same materials so both will have same Young's modulus, and let it be Y . $Y = \frac{\text{stress}}{\text{strain}} = \frac{F}{A(\Delta L/L)}$,
 $F = \text{applied force}$

$A = \text{area of cross-section of wire}$

Now,

$$Y_1 = Y_2 \Rightarrow \frac{FL}{(A_1)(\Delta L_1)} = \frac{FL}{(A_2)(\Delta L_2)}$$

Since load and length are same for both

$$\Rightarrow r_1^2 \Delta L_1 = r_2^2 \Delta L_2,$$

$$\left(\frac{\Delta L_1}{\Delta L_2} \right) = \left(\frac{r_2}{r_1} \right)^2 = 4 \quad \Delta L_1 : \Delta L_2 = 4 : 1$$

10. (a) As stress $\propto$ strain² hence graph (a) correctly depicts.

11. (c) $Y = \frac{F/A}{\Delta l/l} = \frac{250 \times 9.8}{50 \times 10^{-6} \times \frac{0.5 \times 10^{-3}}{2}}$

$$= \frac{250 \times 9.8}{50 \times 10^{-6}} \times \frac{2}{0.5 \times 10^{-3}} \Rightarrow 19.6 \times 10^{10} \text{ N/m}^2$$

Type B : Assertion Reason Questions

12. (c) Stress is internal force (restoring force) developed within the body of the object. Since it is easier to stretch rubber so it is less stressful and therefore less elastic.
13. (a)
14. (a) Torque required to produce a given twist in hollow cylinder is greater than solid cylinder thus both are correct.
15. (b) The incompressibility of solids is primarily due to the tight coupling between the neighbouring atoms. Molecules in gases are very poorly coupled to their neighbours.

Chapter

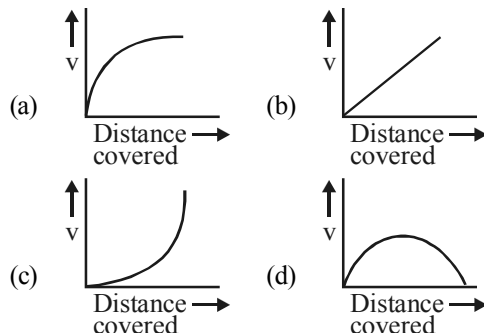
9

Mechanical Properties
of Fluids

TYPE A : MULTIPLE CHOICE QUESTIONS

1. A big drop of radius R is formed by 729 small drops of water of radius r , then the radius of each small drop will be : [1997]
 - (a) $\frac{R}{9}$
 - (b) $\frac{R}{900}$
 - (c) $\frac{R}{1800}$
 - (d) $\frac{R}{9000}$
2. The work done in splitting a drop of water of 1 mm radius into 10^6 droplets is (surface tension of water 72×10^{-3} N/m) : [1998]
 - (a) 5.98×10^{-5} J
 - (b) 10.98×10^{-5} J
 - (c) 16.95×10^{-5} J
 - (d) 8.95×10^{-5} J
3. The excess pressure inside the first soap bubble is three times that inside the second bubble then, the ratio of volume of the first to the second bubble will be : [1998]
 - (a) 1 : 27
 - (b) 3 : 1
 - (c) 1 : 3
 - (d) 1 : 9
4. The rain drops are in spherical shape due to [1998]
 - (a) surface tension
 - (b) viscosity
 - (c) residual pressure
 - (d) thrust on drop
5. If work done in increasing the size of a soap film from $10 \text{ cm} \times 6 \text{ cm}$ to $60 \text{ cm} \times 11 \text{ cm}$ is 2×10^{-4} J. What is the surface tension ? [2000]
 - (a) $2 \times 10^{-8} \text{ Nm}^{-1}$
 - (b) $2 \times 10^{-2} \text{ Nm}^{-1}$
 - (c) $2 \times 10^{-4} \text{ Nm}^{-1}$
 - (d) none of these
6. A hole is made at the bottom of the tank filled with water (density 1000 kg/m^3). If the total pressure at the bottom of the tank is 3 atmosphere (1 atmosphere = 10^5 N/m^2), then the velocity of efflux is [2000]
 - (a) $\sqrt{200} \text{ m/s}$
 - (b) $\sqrt{400} \text{ m/s}$
 - (c) $\sqrt{500} \text{ m/s}$
 - (d) $\sqrt{800} \text{ m/s}$
7. A spherical drop of water has 1 mm radius. If the surface tension of water is $70 \times 10^{-3} \text{ N/m}$. Then the difference of pressures between inside and outside of the spherical drop is : [2001]
 - (a) 140 N/m^2
 - (b) 140 N/m
 - (c) 35 Nm^2
 - (d) none of these
8. Bernoulli's principle is based on the law of conservation of : [2001, 2013]
 - (a) mass
 - (b) energy
 - (c) angular momentum
 - (d) linear momentum
9. Scent sprayer is based on [2002]
 - (a) Bernoulli's theorem
 - (b) Archimedes principle
 - (c) Charle's law
 - (d) Boyle's law
10. A soap bubble in vacuum has a radius 3 cm and another soap bubble in vacuum has radius 4 cm. If two bubbles coalesce under isothermal condition. Then the radius of the new bubble will be : [2002]
 - (a) 7 cm
 - (b) 5 cm
 - (c) 4.5 cm
 - (d) 2.3 cm
11. Two small drops of mercury, each of radius R coalesce to form a single large drop. The ratio of the total surface energies before and after the change is : [2003]
 - (a) $1 : 2^{1/3}$
 - (b) $2^{1/3} : 1$
 - (c) $2 : 1$
 - (d) $1 : 2$

12. A lead shot of 1 mm diameter falls through a long column of glycerine. The variation of its velocity v with distance covered is represented by : [2003]



13. In old age arteries carrying blood in the human body become narrow resulting in an increase in the blood pressure. This follows from : [2004]

- (a) Pascal's law
(b) Stoke's law
(c) Bernoulli's principle
(d) Archimedes principle

14. A sphere of mass M and radius R is falling in a viscous fluid. The terminal velocity attained by the falling object will be proportional to : [2004]

- (a) R^2 (b) R
(c) $1/R$ (d) $1/R^2$

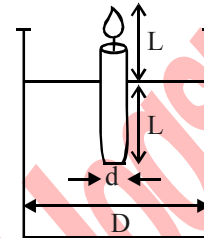
15. For a constant hydraulic stress on an object, the fractional change in the object's volume ($\Delta V/V$) and its bulk modulus (B) are related as : [2005]

- (a) $\frac{\Delta V}{V} \propto B$ (b) $\frac{\Delta V}{V} \propto \frac{1}{B}$
(c) $\frac{\Delta V}{V} \propto B^2$ (d) $\frac{\Delta V}{V} \propto B^{-2}$

16. The apparent depth of water in cylindrical water tank of diameter $2R$ cm is reducing at the rate of x cm/minute when water is being drained out at a constant rate. The amount of water drained in c.c. per minute is : (n_1 = refractive index of air, n_2 = refractive index of water) [2005]

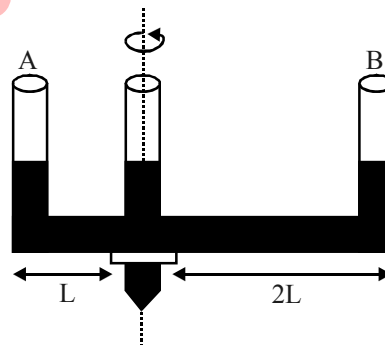
- (a) $\frac{x\pi R^2 n_1}{n_2}$ (b) $\frac{x\pi R^2 n_2}{n_1}$
(c) $\frac{2\pi R n_1}{n_2}$ (d) $\pi R^2 x$

17. A candle of diameter d is floating on a liquid in a cylindrical container of diameter D ($D \gg d$) as shown in figure. If it is burning at the rate of 2 cm/hour then the top of the candle will : [2005]



- (a) remain at the same height
(b) fall at the rate of 1 cm/hour
(c) fall at the rate of 2 cm/hour
(d) go up at the rate of 1 cm/hour

18. A given shaped glass tube having uniform cross-section is filled with water and is mounted on a rotatable shaft as shown in figure. If the tube is rotated with a constant angular velocity ω then [2005]

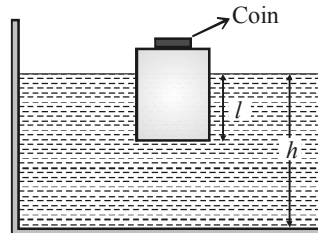


- (a) water levels in both sections A and B go up
(b) water level in section A goes up and that in B comes down
(c) water level in section A comes down and that in B it goes up
(d) water levels remain same in both sections

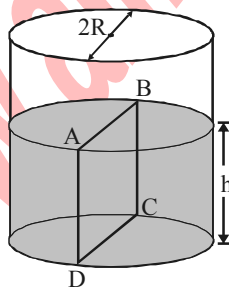
19. By sucking through a straw, a student can reduce the pressure in his lungs to 750 mm of Hg (density = 13.6 gm/cm^3). Using the straw, he can drink water from a glass upto a maximum depth of : [2006]

- (a) 10 cm (b) 75 cm
(c) 13.6 cm (d) 1.36 cm

20. Work of 3.0×10^{-4} joule is required to be done in increasing the size of a soap film from $10 \text{ cm} \times 6 \text{ cm}$ to $10 \text{ cm} \times 11 \text{ cm}$. The surface tension of the film is [2007]
 (a) $5 \times 10^{-2} \text{ N/m}$ (b) $3 \times 10^{-2} \text{ N/m}$
 (c) $1.5 \times 10^{-2} \text{ N/m}$ (d) $1.2 \times 10^{-2} \text{ N/m}$
21. If the terminal speed of a sphere of gold (density = 19.5 kg/m^3) is 0.2 m/s in a viscous liquid (density = 1.5 kg/m^3), find the terminal speed of a sphere of silver (density = 10.5 kg/m^3) of the same size in the same liquid [2008]
 (a) 0.4 m/s (b) 0.133 m/s
 (c) 0.1 m/s (d) 0.2 m/s
22. Water is filled in a container upto height of 3 m . A small hole of area ' A_0 ' is punched in the wall of the container at a height 52.5 cm from the bottom. The cross sectional area of the container is A . If $A_0/A = 0.1$ then v^2 is (where v is the velocity of water coming out of the hole) [2008]
 (a) $50 \text{ m}^2/\text{s}^2$ (b) $50.5 \text{ m}^2/\text{s}^2$
 (c) $51 \text{ m}^2/\text{s}^2$ (d) $52 \text{ m}^2/\text{s}^2$
23. A boy has 60 kg weight. He wants to swim in a river with the help of a wooden log. If relative density of wood is 0.6 , what is the minimum volume of wooden log? [2010]
 (density of river water is 1000 kg/m^3)
 (a) 0.66 m^3 (b) 150 m^3
 (c) $\frac{3}{1} \text{ m}^3$ (d) $\frac{3}{20} \text{ m}^3$
24. The work done in blowing a soap bubble of radius 0.2 m , given that the surface tension of soap solution is $60 \times 10^{-3} \text{ N/m}$ is : [2011]
 (a) $24\pi \times 10^{-4} \text{ J}$ (b) $24\pi \times 10^{-4} \text{ J}$
 (c) $96\pi \times 10^{-4} \text{ J}$ (d) $1.92\pi \times 10^{-4} \text{ J}$
25. Water rises to a height of 10 cm in capillary tube and mercury falls to a depth of 3.1 cm in the same capillary tube. If the density of mercury is 13.6 and the angle of contact for mercury is 135° , the approximate ratio of surface tensions of water and mercury is [2012]
 (a) $1:0.15$ (b) $1:3$
 (c) $1:6$ (d) $1.5:1$
26. The lift of an air plane is based on [2012]
 (a) Torricelli's theorem
 (b) Bernoulli's theorem
 (c) Law of gravitation
 (d) Conservation of linear momentum.
27. A spherical solid ball of volume V is made of a material of density ρ_1 . It is falling through a liquid of density ρ_2 ($\rho_2 < \rho_1$). Assume that the liquid applies a viscous force on the ball that is proportional to the square of its speed v , i.e., $F_{\text{viscous}} = -kv^2$ ($k > 0$). The terminal speed of the ball is [2013]
 (a) $\sqrt{\frac{Vg(\rho_1 - \rho_2)}{k}}$ (b) $\frac{Vg\rho_1}{k}$
 (c) $\sqrt{\frac{Vg\rho_1}{k}}$ (d) $\frac{Vg(\rho_1 - \rho_2)}{k}$
28. A ring is cut from a platinum tube 8.5 cm internal and 8.7 cm external diameter. It is supported horizontally from the pan of a balance, so that it comes in contact with the water in a glass vessel. If an extra 3.97 is required to pull it away from water, the surface tension of water is [2013]
 (a) 72 dyne cm^{-1} (b) $70.80 \text{ dyne cm}^{-1}$
 (c) $63.35 \text{ dyne cm}^{-1}$ (d) 60 dyne cm^{-1}
29. A water tank of height 10 m , completely filled with water is placed on a level ground. It has two holes one at 3 m and the other at 7 m from its base. The water ejecting from [2014]
 (a) both the holes will fall at the same spot
 (b) upper hole will fall farther than that from the lower hole
 (c) upper hole will fall closer than that from the lower hole
 (d) more information is required
30. Which of the following relation is true? [2014]
 (a) $3Y = K(1 - \sigma)$ (b) $K = \frac{9\eta Y}{Y + \eta}$
 (c) $\sigma = (6K + \eta)Y$ (d) $\sigma = \frac{0.5Y - \eta}{\eta}$
31. A wooden block, with a coin placed on its top, floats in water as shown in fig. the distance l and h are shown there. After some time the coin falls into the water. Then [2014]



- (a) ℓ decreases and h increases
 (b) ℓ increases and h decreases
 (c) both ℓ and h increases
 (d) both ℓ and h decreases
32. 1 m^3 water is brought inside the lake upto 200 metres depth from the surface of the lake. What will be change in the volume when the bulk modulus of elasticity of water is 22000 atmosphere? [2015]
 (density of water is $1 \times 10^3 \text{ kg/m}^3$ atmosphere pressure = 10^5 N/m^2 and $g = 10 \text{ m/s}^2$)
 (a) $8.9 \times 10^{-3} \text{ m}^3$ (b) $7.8 \times 10^{-3} \text{ m}^3$
 (c) $9.1 \times 10^{-4} \text{ m}^3$ (d) $8.7 \times 10^{-4} \text{ m}^3$
33. The excess of pressure inside a soap bubble is twice the excess pressure inside a second soap bubble. The volume of the first bubble is n times the volume of the second where n is [2015]
 (a) 0.125 (b) 0.250
 (c) 1 (d) 2
34. A steel wire is suspended vertically from a rigid support. When loaded with a weight in air, it extends by ℓ_a and when the weight is immersed completely in water, the extension is reduced to ℓ_w . Then the relative density of material of the weight is [2016]
 (a) ℓ_a / ℓ_w (b) $\frac{\ell_a}{\ell_a - \ell_w}$
 (c) $\ell_w / (\ell_a - \ell_w)$ (d) ℓ_w / ℓ_a
35. Water is filled up to a height h in a beaker of radius R as shown in the figure. The density of water is ρ , the surface tension of water is T and the atmospheric pressure is P_0 . Consider a vertical section ABCD of the water column through a diameter of the beaker. The force on water on one side of this section by water on the other side of this section has magnitude [2016]

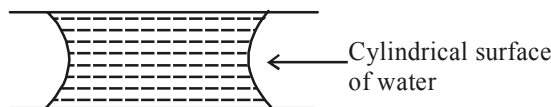


(a) $|2P_0Rh + \pi R^2 \rho gh - 2RT|$

(b) $|2P_0Rh + R\rho gh^2 - 2RT|$

(c) $|P_0\pi R^2 + R\rho gh^2 - 2RT|$

(d) $|P_0\pi R^2 + R\rho gh^2 + 2RT|$



(a) $\frac{2T}{R}$

(b) $\frac{4T}{R}$

(c) $\frac{T}{4R}$

(d) $\frac{T}{R}$

TYPE B : ASSERTION REASON QUESTIONS

Directions for (Qs. 39-44) : These questions consist of two statements, each printed as Assertion and Reason. While answering these questions, you are required to choose any one of the following five responses.

- (a) If both Assertion and Reason are correct and the Reason is a correct explanation of the Assertion.
- (b) If both Assertion and Reason are correct but Reason is not a correct explanation of the Assertion.
- (c) If the Assertion is correct but Reason is incorrect.
- (d) If both the Assertion and Reason are incorrect.
- (e) If the Assertion is incorrect but the Reason is correct.

39. Assertion : In a pressure cooker the water is brought to boil. The cooker is then removed from the stove. Now on removing the lid of the pressure cooker, the water starts boiling again.
Reason : The impurities in water bring down its boiling point [2004]

40. Assertion : Smaller drops of liquid resist deforming forces better than the larger drops.
Reason : Excess pressure inside a drop is directly proportional to its surface area. [2004]

41. Assertion : For Reynold's number $Re > 2000$, the flow of fluid is turbulent.
Reason : Inertial forces are dominant compared to the viscous forces at such high Reynold's numbers. [2005]

42. Assertion : A thin stainless steel needle can lay floating on a still water surface.

Reason : Any object floats when the buoyancy force balances the weight of the object [2006]

43. Assertion : Machine parts are jammed in winter.
Reason : The viscosity of lubricant used in machine parts increases at low temperatures. [2007]

44. Assertion : A bubble comes from the bottom of a lake to the top.

Reason : Its radius increases. [2008]

Directions for (Qs. 45-49) : Each of these questions contains an Assertion followed by Reason. Read them carefully and answer the question on the basis of following options. You have to select the one that best describes the two statements.

- (a) If both Assertion and Reason are correct and Reason is the correct explanation of Assertion.
- (b) If both Assertion and Reason are correct, but Reason is not the correct explanation of Assertion.
- (c) If Assertion is correct but Reason is incorrect.
- (d) If both the Assertion and Reason are incorrect.

45. Assertion : A large force is required to draw apart normally two glass plates enclosing a thin water film.

Reason : Water works as glue and sticks two glass plates. [2010]

46. Assertion : Falling raindrops acquire a terminal velocity.

Reason : A constant force in the direction of motion and a velocity dependent force opposite to the direction of motion, always result in the acquisition of terminal velocity. [2011]

47. Assertion : The velocity of flow of a liquid is smaller when pressure is larger and vice-versa.

Reason : According to Bernoulli's theorem, for the stream line flow of an ideal liquid, the total energy per unit mass remains constant. [2013, 14]

48. Assertion : The buoyant force on a submerged rigid object can be considered to be acting at the centre of mass of the object.

Reason : For a rigid body a force field distributed uniformly through its volume can be considered to be acting at the centre of mass of the body. [2015]

49. Assertion : The pressure of water reduces when it flows from a narrow pipe to a wider pipe.

Reason : Since for wider pipe area is large, so flow of speed is small and pressure also reduces proportionately. [2017]

HINTS & SOLUTIONS

Type A : Multiple Choice Questions

1. (a) Equating volume in both cases,

$$\frac{4}{3}\pi R^3 = 729 \times \frac{4}{3}\pi r^3$$

$$\Rightarrow r^3 = \frac{R^3}{729}$$

$$\Rightarrow r = \frac{R}{9}$$

2. (d) Radius of new droplet if be
- r
- then,

$$10^6 \times \frac{4}{3}\pi r^3 = \frac{4}{3}\pi \times (0.001)^3$$

$$r^3 = 10^{-15} \Rightarrow r = 10^{-5}$$

Increase in surface area

$$= [4\pi \times (10^{-5})^2 \times 10^6] - [4\pi \times (10^{-3})^2]$$

$$= [4\pi \times 10^{-4}] - [4\pi \times 10^{-6}] = 4\pi 10^{-6} [100 - 1]$$

$$= 4\pi \times 10^{-6} \times 99 = 4\pi \times 10^{-6} \times 99$$

Work done

= surface tension $\times$ increase in surface area

$$= 72 \times 4\pi \times 99 \times 10^{-6} \times 10^{-3} = 8.95 \times 10^{-5} \text{ J}$$

3. (a) Excess pressure in first soap bubble,

$$p_1 = \frac{4T}{r_1}$$

 $\therefore$ excess pressure inside second bubble,

$$p_2 = \frac{4T}{r_2}$$

On dividing these, we get

$$\frac{p_1}{p_2} = \frac{r_2}{r_1}$$

$$\text{but } p_1 = 3p_2 \Rightarrow \frac{r_1}{r_2} = \frac{1}{3}$$

$$\Rightarrow \left(\frac{r_1}{r_2}\right)^3 = \frac{1}{27}$$

So, ratio of their volumes is,

$$\frac{\frac{4}{3}\pi r_1^3}{\frac{4}{3}\pi r_2^3} = \frac{v_1}{v_2} \Rightarrow \frac{v_1}{v_2} = \frac{1}{27}$$

4. (a) The surface of water tends to contract which is known as surface tension. In case of water droplets, the surface tension attains minimum value when its shape is spherical. So water droplets are spherical in shape.

5. (d) Work done
-
- = Increase in surface area
- $\times$
- Surface tension

$$2 \times 10^{-4} = \frac{2(60 \times 11 - 10 \times 6) \times T}{100 \times 100}$$

$$T = \frac{2 \times 10^{-4}}{2 \times 6 \times 10^{-2}} = \frac{1}{6} \times 10^{-2} \text{ Nm}^{-1}$$

6. (b) We know that velocity of efflux,
- $v = \sqrt{2gh}$

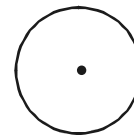
At the bottom of tank pressure is 3 atmosphere. So, total pressure due to water column

$$= h\rho g = 2 \times 10^5 \text{ (two atmosphere)}$$

$$\Rightarrow gh = \frac{2 \times 10^5}{\rho} = \frac{2 \times 10^5}{10^3} = 2 \times 10^2$$

$$\Rightarrow v = \sqrt{2 \times 2 \times 10^2} = \sqrt{400} \text{ m/sec}$$

7. (a)



$$\text{Excess pressure, } \Delta p = \frac{2T}{r}$$

$$= \frac{2 \times 70 \times 10^{-3}}{1 \times 10^{-3}} = 140 \text{ newton/m}^2$$

8. (b) Bernoulli's principle is based on the law of conservation of energy. We equate total energy (pressure energy, potential energy and kinetic energy) of a flowing liquid at different points flowing under constant pressure difference.

9. (a) Bernoulli's theorem states that when there is greater speed in liquid, pressure is reduced. When air is pumped inside the pipe, the velocity of air inside increases which creates low pressure there. The liquid in the basic is then travelled in upward direction. This is theory of Scent Sprayer.
10. (b) If r_1, r_2, r be radius of soap bubbles before and after the coalesce & p_1, p_2 and p the pressure then, applying gas laws equation

$$p_1 V_1 + p_2 V_2 = pV$$

$$\frac{4T}{r_1} \times \frac{4}{3} \pi r_1^3 + \frac{4T}{r_2} \times \frac{4}{3} \pi r_2^3 = \frac{4T}{r} \times \frac{4}{3} \pi r^3$$

$$r_1^2 + r_2^2 = r^2$$

$$3^2 + 4^2 = r^2 \Rightarrow r = \sqrt{25} = 5 \text{ cm.}$$
11. (b) Let r be radius of common drop

$$\frac{4}{3} \pi r^3 = 2 \times \frac{4}{3} \pi R^3$$

$$r = (2)^{\frac{1}{3}} R$$
 Surface energy before the coalesce

$$= 2 \times 4\pi R^2 T$$
 Surface energy after the coalesce = $4\pi r^2 T$
 Ratio = $\frac{2 \times 4\pi R^2 T}{4\pi r^2 T} = \frac{2R^2}{2^{\frac{2}{3}} R^2}$

$$= \frac{2^{\frac{1}{3}} \cdot 2^{\frac{2}{3}}}{2^{\frac{2}{3}}} = \frac{2^{\frac{1}{3}}}{2^{\frac{2}{3}}} = \frac{1}{2^{\frac{1}{3}}}$$
12. (a) When a body falls through a viscous liquid, its velocity increases due to gravity but after some time its velocity becomes uniform because of viscous force becoming equal to the gravitational force. Viscous force itself is a variable force which increases as velocity increases, so curve (a) represents the correct alternative.
13. (c) In old age arteries carrying blood when there is narrow arteries pressure is increased. Actually due to narrowness and other obstruction the velocity of the flow of blood gets decreased. This results in increased pressure inside the blood vessel, according to Bernoulli's principle.
14. (a) For a falling body in viscous fluid the terminal velocity is related to radius as follows.

$$V_T = \frac{2}{9\eta} R^2 (\rho - \sigma)g \Rightarrow v_T \propto R^2$$
15. (b) $B = \frac{\text{Stress}}{\text{Volume strain}} = \frac{\text{Stress}}{\Delta V/V}$

$$\frac{\Delta V}{V} = \frac{\text{Stress}}{B}$$
 As stress is constant. So, $\frac{\Delta V}{V} \propto \frac{1}{B}$
16. (b) If apparent depth = d_A and real depth = d_R

$$\frac{d_R}{d_A} = \frac{n_2}{n_1} \Rightarrow d_A = \frac{n_1}{n_2} d_R$$

$$\Delta d_A = \frac{n_1}{n_2} \Delta d_R \quad \dots\dots\dots (i)$$
 Now, $V = \pi R^2 d_R$

$$\Delta V = \pi R^2 \Delta d_R$$

$$\Delta d_R = \frac{\Delta V}{\pi R^2}$$
 Putting it in equation (i),

$$\Delta d_A = \frac{n_1}{n_2} \frac{\Delta V}{\pi R^2} \Rightarrow \Delta V = \frac{n_2}{n_1} \pi R^2 \Delta d_A$$
17. (b) The candle floats on the water with half its length above and below water level. Let its length be 10 cm. with 5 cm. below the surface and 5 cm. above it. If its length is reduced to 8 cm. It will have 4 cm. above water surface. So we see tip going down by 1 cm. So rate of fall of tip = 1 cm/hour.
18. (a) Water level in both A and B will go up. The pressure difference thus created will provide the necessary centripetal force for the water body to rotate around the vertical axis.
19. (c) Pressure difference created = 10 mm of Hg
 This must be equal to the pressure of water column being created in the straw. If height of water column be h

$$h\rho g = \frac{10}{10} \times 13.6 \times g$$

$$h \times 1 = 13.6 \Rightarrow h = 13.6 \text{ cm.}$$

20. (b) Area increased $= (10 \times 11) - (10 \times 6) \text{ cm}^2$
 $= 110 - 60 = 50 \text{ cm}^2$

Since film has 2 sides

$\therefore$ total increased area $= 50 \times 2 = 100 \text{ cm}^2$
 work done $=$ surface tension $\times$ increase in surface area

$\Rightarrow$ Surface tension

$$= \frac{\text{Work done}}{\text{increase in surface area}}$$

$$= \frac{3 \times 10^{-4}}{100 \text{ cm}^2} = \frac{3 \times 10^{-4}}{100 \times 10^{-4} \text{ m}^2}$$

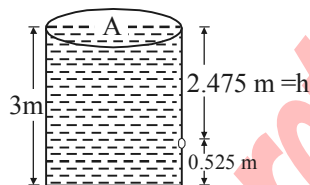
$$= 0.03 \text{ N/m} = 3 \times 10^{-2} \text{ N/m}$$

21. (c) $V_T = \frac{2r^2(d_1 - d_2)g}{9\eta}$

$$\frac{V_{T_2}}{0.2} = \frac{(10.5 - 1.5)}{(19.5 - 1.5)} \Rightarrow V_{T_2} = 0.2 \times \frac{9}{18}$$

$$\therefore V_{T_2} = 0.1 \text{ m/s}$$

22. (a) The square of the velocity of flux



$$v^2 = \frac{2gh}{1 - \left(\frac{A_0}{A}\right)^2}$$

$$= \frac{2 \times 10 \times 2.475}{1 - (0.1)^2} = 50 \text{ m}^2/\text{s}^2$$

23. (d) Archimedes principle states that weight of body displaced by liquid $=$ upthrust.

$$60 \times g + V \times 0.6 \times 10^3 g = V \times 1000 g$$

$$60 + 600 V = 1000 V$$

$$60 = 400 V$$

$$V = \frac{60}{400} = \frac{3}{20} \text{ m}^3$$

where, V is the volume of wooden log.

24. (d) $W = T\Delta A = T \times 2[4\pi R^2]$
 $= 60 \times 10^{-3} \times 8\pi \times (0.2)^2$
 $= 1.92 \pi \times 10^{-4} \text{ J}$

25. (c) $h = \frac{2\sigma \cos \theta}{r\rho g} \Rightarrow \sigma \propto \frac{h\rho}{\cos \theta}$

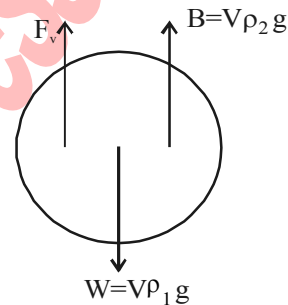
$$\Rightarrow \frac{\sigma_w}{\sigma_m} = \frac{h_w \rho_w}{\cos \theta_w} \times \frac{\cos \theta_m}{h_m \rho_m}$$

$$= \frac{10 \times 1}{\cos 0^\circ} \times \frac{\cos 135^\circ}{-3.1 \times 13.6}$$

$$= \frac{10 \times (-0.707)}{-3.1 \times 13.6} \approx \frac{1}{6}$$

26. (b) Apply Bernoulli's theorem.

27. (a) The condition for terminal speed (v_t) is
 Weight $=$ Buoyant force $+ \text{Viscous force}$



$$\therefore V\rho_1 g = V\rho_2 g + kv_t^2$$

$$\therefore v_t = \sqrt{\frac{Vg(\rho_1 - \rho_2)}{k}}$$

28. (a) $(2\pi r_1 + 2\pi r_2)\sigma = mg$

$$\left[2\pi \times \frac{8.7}{2} + 2\pi \times \frac{8.5}{2} \right] \sigma = 3.97 \times 980$$

$$\Rightarrow \sigma = 72 \text{ dyne cm}^{-1}$$

29. (a) Velocity of water from hole

$$A = v_1 = \sqrt{2gh}$$

Velocity of water from hole B

$$= v_2 = \sqrt{2g(H_0 - h)}$$

Time of reaching the ground from hole B

$$= t_1 = \sqrt{2(H_0 - h)/g}$$

Time of reaching the ground from hole A

$$= t_2 = \sqrt{2h/g}$$

30. (d) $Y = 2\eta(1 + \sigma) \Rightarrow \sigma = \frac{0.5Y - \eta}{\eta}$

31. (d) As the block moves up with the fall of coil, l decreases, similarly h will also decrease because when the coin is in water, it displaces water equal to its own volume only.

32. (c) $K = \frac{P}{\Delta V/V} \quad \therefore \Delta V = \frac{PV}{K}$

$$P = h\rho g = 200 \times 10^3 \times 10 \text{ N/m}^2$$

$$K = 22000 \text{ atm} = 22000 \times 10^5 \text{ N/m}^2$$

$$V = 1 \text{ m}^3$$

$$\Delta V = \frac{200 \times 10^3 \times 10 \times 1}{22000 \times 10^5} = 9.1 \times 10^{-4} \text{ m}^3$$

33. (a) Given, $\frac{4T}{r_1} = 2 \times \frac{4T}{r_2}$ or $r_2 = 2r_1$

$$\frac{4}{3}\pi r_1^3 = n \times \frac{4}{3}\pi r_2^3 = n \times \frac{4}{3}\pi (2r_1)^3$$

$$\text{or } n = \frac{1}{8} = 0.125$$

34. (b) Let V be the volume of the load and ρ its relative density

$$\text{So, } Y = \frac{FL}{A\ell_a} = \frac{V\rho gL}{A\ell_a} \quad \dots (1)$$

When the load is immersed in the liquid, then

$$Y = \frac{F'L}{A\ell_w} = \frac{(V\rho g - V \times 1 \times g)L}{A\ell_w} \quad \dots (2)$$

($\because$ Now net weight = weight – upthrust)
From eqs. (1) and (2), we get

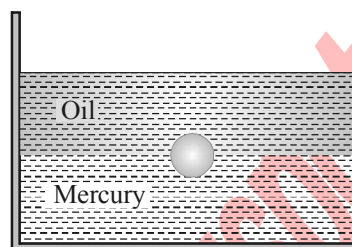
$$\frac{\rho}{\ell_a} = \frac{(\rho - 1)}{\ell_w} \text{ or } \rho = \frac{\ell_a}{(\ell_a - \ell_w)}$$

35. (b) Net force = Average pressure $\times$ Area
 $- T \times 2R$

$$\left(P_0 + \rho g \frac{h}{2} \right) (2Rh) - T \times 2R$$

$$\Rightarrow | 2P_0Rh + R\rho gh^2 - 2RT |$$

36. (c)



As the sphere floats in the liquid. Therefore its weight will be equal to the upthrust force on it

$$\text{Weight of sphere} = \frac{4}{3}\pi R^3 \rho g \quad \dots (i)$$

Upthrust due to oil and mercury

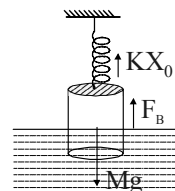
$$= \frac{2}{3}\pi R^3 \times \sigma_{oil} g + \frac{2}{3}\pi R^3 \sigma_{Hg} g \quad \dots (ii)$$

Equating (i) and (ii)

$$\frac{4}{3}\pi R^3 \rho g = \frac{2}{3}\pi R^3 0.8g + \frac{2}{3}\pi R^3 + 13.6g$$

$$\Rightarrow 2\rho = 0.8 + 13.6 = 14.4 \Rightarrow \rho = 7.2$$

37. (c) From figure, $kx_0 + F_B = Mg$



$$kx_0 + \sigma \frac{L}{2} Ag = Mg$$

[$\because$ mass = density $\times$ volume]

$$\Rightarrow kx_0 = Mg - \sigma \frac{L}{2} Ag$$

$$\Rightarrow x_0 = \frac{Mg - \frac{\sigma LA g}{2}}{k} = \frac{Mg}{k} \left(1 - \frac{LA\sigma}{2M} \right)$$

Hence, extension of the spring when it is in

$$\text{equilibrium is, } x_0 = \frac{Mg}{k} \left(1 - \frac{LA\sigma}{2M} \right)$$

38. (d) Here excess pressure, $P_{\text{excess}} = \frac{T}{r_1} + \frac{T}{r_2}$

$$P_{\text{excess}} = \frac{T}{R} \quad \because \begin{pmatrix} r_1 = R \\ r_2 = O \end{pmatrix}$$

$$F = -\eta A \frac{dv}{dx}$$

$\Rightarrow$ force required to move the body or machine increases hence, machines are jammed.

Type B : Assertion Reason Questions

39. (c) The water starts boiling a second time because when pressure cooker cools down pressure inside gets reduced. Reduced pressure brings down the B.P. of water. The reduced B.P. makes the water boil a second time.

40. (b) Smaller drops have larger excess pressure inside. The excess pressure is related to radius as follow

$$p = \frac{4T}{r}$$

That is why smaller droplets resist deforming forces.

41. (a) Reynold number

$$= \frac{\text{Inertial force per unit area}}{\text{Viscous force per unit area}}$$

So for higher value of Reynold's number, inertial force is dominant.

42. (b) Assertion and Reason are correct. But Reason does not explain Assertion. Explanation of Assertion is that it is the surface tension of the water surface which is balancing the weight of the steel needle.

43. (a) Viscosity of a liquid decreases with increase in temperature and vice versa i.e.,

$$\eta = \frac{1}{\sqrt{T}}$$

$\therefore$ at low temperatures viscosity increases
 $\Rightarrow$ Viscous drag increases

44. (b) The pressure will be greater at the bottom than at the top. So the air bubble moves from the bottom to the top i.e., from higher to lower pressure. Further in coming from bottom to top, the pressure decreases and hence volume increases (By Boyle's law, $PV = \text{constant}$), thus radius also increases.

45. (c) In this case, atmospheric pressure does not come into it because it acts in all direction. The force which is effective in case of water between two pieces of glass is adhesive force. As, adhesive forces are considered that between two different bodies; cohesive forces are internal forces of a body, resulting from attraction between the molecules of it. The attractive force between water and glass (the glass contain silicium atoms, negatively charged and water is a polar molecule so that the positive side of water is attached and causes part of the bond) keep them firmly together. Due to the big surface of the glass slide, the resultant force is also big. So we have to apply a large force in order to separate two glass plates enclosed with water film.

46. (c) 47. (d) 48. (c)

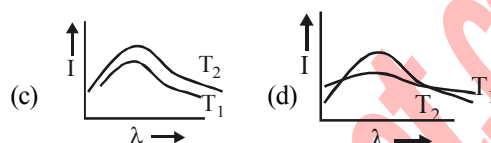
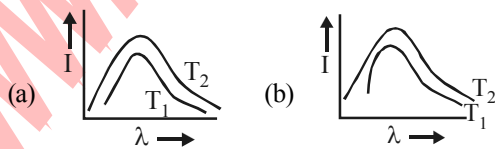
49. (d) Pressure of water reduces when it comes from wide pipe to narrow pipe. According to equation of continuity, $av = \text{constant}$. As the water flows from wider tube to narrow tube, its velocity increases. According to Bernoulli principle, where velocity is large pressure is less.

Thermal Properties of Matter

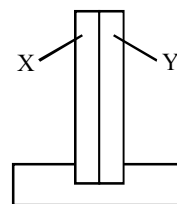
TYPE A : MULTIPLE CHOICE QUESTIONS

- If the temperature of a black body increases from 7°C to 287°C , then the rate of emission of radiation energy is: [1997]
 (a) 8 times (b) 16 times
 (c) 2 times (d) 4 times
- The radiation from the sun, incident normally at the surface of the earth is $20\text{ kcal/m}^2\text{ min}$. What would have the radiant energy, incident normally on the earth if the sun had a temperature, twice of the present one? [1997]
 (a) $80\text{ kcal/m}^2\text{ min}$ (b) $320\text{ kcal/m}^2\text{ min}$
 (c) $160\text{ kcal/m}^2\text{ min}$ (d) $40\text{ kcal/m}^2\text{ min}$
- The thermal conductivity of a rod is 2. What is its thermal resistivity? [1997]
 (a) 0.5 (b) 1
 (c) 0.25 (d) 2
- The instrument used to measure the temperature of the source from its thermal radiation is: [1997]
 (a) hydrometer (b) barometer
 (c) thermopile (d) pyrometer
- The surface temperature of a body is 727°C and that of another body is 327°C . The ratio of total energies radiated by them is: [1997]
 (a) 625 : 81 (b) 125 : 27
 (c) 8 : 27 (d) 9 : 25
- A Centigrade and Fahrenheit thermometers are dipped in boiling water. The water temperature is lowered until the Fahrenheit thermometer registers a temperature of 140°C . The fall of the temperature as registered by the centigrade thermometer is: [1998]
 (a) 40° (b) 80°
 (c) 50° (d) 90°
- On a cold morning, a metal surface on touching is felt colder than a wooden surface, because the metal has: [1998]
 (a) low thermal conductivity
 (b) high thermal conductivity
 (c) high specific heat
 (d) low specific heat
- The relative humidity on a day, when partial pressure of water vapour is $0.012 \times 10^5\text{ pa}$ at 12°C is (take vapour pressure of water at this temperature as $0.016 \times 10^5\text{ pa}$): [1998]
 (a) 70% (b) 40%
 (c) 75% (d) 25%
- The absolute zero is the temperature at which : [1998]
 (a) all substances exist in solid state
 (b) molecular motion ceases
 (c) water freezes
 (d) none of these
- A quantity of heat required to change the unit mass of a solid substance to its liquid state, while the temperature remains constant, is known as [1998]
 (a) latent heat of vaporation
 (b) latent heat of fusion
 (c) heat of condensation
 (d) specific heat
- Woolen clothes keep the body warm because the wool : [1998]
 (a) decreases the temperature of the body
 (b) is a good conductor of heat
 (c) increases the temperature of the body
 (d) is a bad conductor of heat
- Heat travels through vacuum by : [1998]
 (a) convection (b) radiation
 (c) conduction (d) all of these
- A black body has maximum wavelength λ_m at 2000 K. Its corresponding wavelength at 3000 K is: [1999]
 (a) $\frac{16}{81}\lambda_m$ (b) $\frac{3}{2}\lambda_m$
 (c) $\frac{81}{16}\lambda_m$ (d) $\frac{2}{3}\lambda_m$

14. When a solid is converted into a gas, directly by heating then this process is known as: [1999]
 (a) Sublimation (b) Vaporization
 (c) Condensation (d) Boiling
15. The sun emits a light with maximum wave length 510 nm while another star emits a light with maximum wavelength of 350 nm. The ratio of surface temperature of sun and the star will be :
 (a) 0.68 (b) 2.1 [2000]
 (c) 1.45 (d) 0.46
16. The real coefficient of volume expansion of glycerine is $0.000597 \text{ per } ^\circ\text{C}$ and linear coefficient of expansion of glass is $0.000009 \text{ per } ^\circ\text{C}$. Then the apparent volume coefficient of expansion of glycerine is [2000]
 (a) $0.000558 \text{ per } ^\circ\text{C}$ (b) $0.00057 \text{ per } ^\circ\text{C}$
 (c) $0.00027 \text{ per } ^\circ\text{C}$ (d) $0.00066 \text{ per } ^\circ\text{C}$
17. The colour of a star indicates its : [2001]
 (a) velocity (b) temperature
 (c) size (d) length
18. A black body is heated from 27°C to 127°C . The ratio of their energies of radiation emitted will be: [2001]
 (a) 9 : 16 (b) 27 : 64
 (c) 81 : 256 (d) 3 : 4
19. A black body is at a temperature 300 K. It emits energy at a rate, which is proportional to [2002]
 (a) $(300)^4$ (b) $(300)^3$
 (c) $(300)^2$ (d) 300
20. The density of a substance at 0°C is 10 g/cc and at 100°C , its density is 9.7 g/cc . The coefficient of linear expansion of the substance is [2002]
 (a) 10^{-2} (b) 10^{-2}
 (c) 10^{-3} (d) 10^{-4}
21. A black body, at a temperature of 227°C , radiates heat at a rate of $20 \text{ cal m}^{-2}\text{s}^{-1}$. When its temperature is raised to 727°C , the heat radiated by it in $\text{cal m}^{-2}\text{s}^{-1}$ will be closest to : [2003]
 (a) 40 (b) 160
 (c) 320 (d) 640
22. Shown below are the black body radiation curves at temperatures T_1 and T_2 ($T_2 > T_1$). Which of the following plots is correct? [2003]



23. Suppose the sun expands so that its radius becomes 100 times its present radius and its surface temperature becomes half of its present value. The total energy emitted by it then will increase by a factor of : [2004]
 (a) 10^4 (b) 625
 (c) 16 (d) 16
24. Three objects colored black, gray and white can withstand hostile conditions upto 2800°C . These objects are thrown into a furnace where each of them attains a temperature of 2000°C . Which object will glow brightest? [2006]
 (a) the white object
 (b) the black object
 (c) all glow with equal brightness
 (d) gray object
25. A bimetallic strip consists of metals X and Y. It is mounted rigidly at the base as shown. The metal X has a higher coefficient of expansion compared to that for metal Y. When the bimetallic strip is placed in a cold bath: [2006]

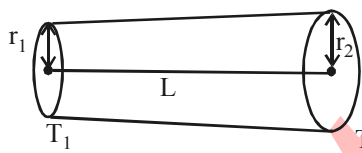


- (a) It will bend towards the right
 (b) It will bend towards the left
 (c) It will not bend but shrink
 (d) It will neither bend nor shrink
26. If the temperature of a black body increases from 7°C to 287°C then the rate of energy radiation increases by [2007]
 (a) $\left(\frac{287}{7}\right)^4$ (b) 16
 (c) 4 (d) 2
27. The wavelength of maximum energy released during an atomic explosion was $2.93 \times 10^{-10} \text{ m}$. The maximum temperature attained must be, (Weins constant = $2.93 \times 10^{-3} \text{ mK}$) [2010]
 (a) $5.86 \times 10^7 \text{ K}$ (b) 10^{-13} K
 (c) 10^{-7} K (d) 10^7 K

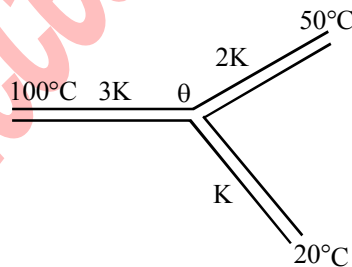
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Topicwise AIIMS Solved Papers – PHYSICS

28. If the temperature of the sun were to increase from T to $2T$ and its radius from R to $2R$, then the ratio of the radiant energy received on earth to what it was previously will be [2014]
 (a) 32 (b) 16
 (c) 4 (d) 64
29. A crystal has a coefficient of expansion 13×10^{-7} in one direction and 231×10^{-7} in every direction at right angles to it. Then the cubical coefficient of expansion is [2014]
 (a) 462×10^{-7} (b) 244×10^{-7}
 (c) 475×10^{-7} (d) 257×10^{-7}
30. Two identical rods of copper and iron are coated with wax uniformly. When one end of each is kept at temperature of boiling water, the length upto which wax melts are 8.4 cm and 4.2 cm, respectively. If thermal conductivity of copper is 0.92, then thermal conductivity of iron is [2015]
 (a) 0.23 (b) 0.46
 (c) 0.115 (d) 0.69
31. The rate of heat flow through the cross-section of the rod shown in figure is ($T_2 > T_1$ and thermal conductivity of the material of the rod is K) [2015]



- (a) $\frac{K\pi r_1 r_2 (T_2 - T_1)}{L}$
 (b) $\frac{K\pi (r_1 + r_2)^2 (T_2 - T_1)}{4L}$
 (c) $\frac{K\pi (r_1 + r_2)^2 (T_2 - T_1)}{L}$
 (d) $\frac{K\pi (r_1 + r_2)^2 (T_2 - T_1)}{2L}$
32. The diagram below shows the change in the length X of a thin uniform wire caused by the application of stress F at two different temperatures T_1 and T_2 . The variation shown suggests that [2015]
- (a) $T_1 > T_2$
 (b) $T_1 < T_2$
 (c) $T_2 > T_1$
 (d) $T_1 \geq T_2$
33. A glass flask of volume 1 litre is fully filled with mercury at 0°C . Both the flask and mercury are now heated to 100°C . If the coefficient of volume expansion of mercury is $1.82 \times 10^{-4}/^\circ\text{C}$, volume coefficient of linear expansion of glass is $10 \times 10^{-6}/^\circ\text{C}$, the amount of mercury which is spilted out is [2015]
 (a) 15.2 ml (b) 17.2 ml
 (c) 19.2 ml (d) 21.2 ml
34. Steam is passed into 22 g of water at 20°C . The mass of water that will be present when the water acquires a temperature of 90°C is (Latent heat of steam is 540 cal/gm) [2016]
 (a) 24.8 gm (b) 24 gm
 (c) 36.6 gm (d) 30 gm
35. Three rods of the same dimensions have thermal conductivities $3K$, $2K$ and K . They are arranged as shown in fig. with their ends at 100°C , 50°C and 20°C . The temperature of their junction is [2017]



- (a) 60° (b) 70°
 (c) 50° (d) 35°
36. A beaker is filled with water at 4°C . At one time the temperature is increased by few degrees above 4°C and at another time it is decreased by a few degrees below 4°C . One shall observe that: [2017]
 (a) the level remains constant in each case
 (b) in first case water flows while in second case its level comes down
 (c) in second case water over flows while in first case its comes down
 (d) water overflows in both the cases

TYPE B : ASSERTION REASON QUESTIONS

Directions for (Qs. 37-50) : These questions consist of two statements, each printed as Assertion and Reason. While answering these questions, you are required to choose any one of the following five responses.

- (a) If both Assertion and Reason are correct and the Reason is a correct explanation of the Assertion.
(b) If both Assertion and Reason are correct but Reason is not a correct explanation of the Assertion.
(c) If the Assertion is correct but Reason is incorrect.
(d) If both the Assertion and Reason are incorrect.
(e) If the Assertion is incorrect but the Reason is correct.
37. **Assertion :** The equivalent thermal conductivity of two plates of same thickness in contact is less than the smaller value of thermal conductivity.
Reason : For two plates of equal thickness in contact the equivalent thermal conductivity is given by :
$$\frac{1}{K} = \frac{1}{K_1} + \frac{1}{K_2}$$

[1997]
38. **Assertion :** Melting of solid causes no change in internal energy.
Reason : Latent heat is the heat required to melt a unit mass of solid.
[1998]
39. **Assertion :** Fahrenheit is the smallest unit measuring temperature.
Reason : Fahrenheit was the first temperature scale used for measuring temperature.
[1999]
40. **Assertion :** Bodies radiate heat at all temperature.
Reason : Rate of radiation of heat is proportional to the fourth power of absolute temperature.
[1999]
41. **Assertion :** Woolen clothes keep the body warm in winter
Reason : Air is a bad conductor of heat.
[2002]
42. **Assertion :** Bodies radiate heat at all temperatures.
Reason : Rate of radiation of heat is proportional to the fourth power of absolute temperature.
[2002]
43. **Assertion :** A tube light emits white light.
Reason : Emission of light in a tube takes place at a very high temperature.
[2003]
44. **Assertion :** It is hotter over the top of a fire than at the same distance of the sides.
Reason : Air surrounding the fire conducts more heat upwards.
[2003]
45. **Assertion :** A body that is good radiator is also a good absorber of radiation at a given wavelength.
Reason : According to Kirchhoff's law the absorptivity of a body is equal to its emissivity at a given wavelength.
[2005]
46. **Assertion :** In pressure-temperature (P-T) phase diagram of water, the slope of the melting curve is found to be negative.
Reason : Ice contracts on melting to water.
[2005]
47. **Assertion :** For higher temperature the peak emission wavelength of a blackbody shifts to lower wavelengths.
Reason : Peak emission wavelengths of a black body is proportional to the fourth-power of temperature.
[2005]
48. **Assertion :** Perspiration from human body helps in cooling the body.
Reason : A thin layer of water on the skin enhances its emissivity.
[2006]
49. **Assertion :** A hollow metallic closed container maintained at a uniform temperature can act as a source of black body radiation.
Reason : All metals act as black bodies.
[2007]
50. **Assertion :** A brass tumbler feels much colder than a wooden tray on a chilly day.
Reason : The thermal conductivity of brass is more than the thermal conductivity of wood.
[2008]
- Directions for (Qs. 51) :** Each of these questions contains an Assertion followed by Reason. Read them carefully and answer the question on the basis of following options. You have to select the one that best describes the two statements.
- (a) If both Assertion and Reason are correct and Reason is the correct explanation of Assertion.
(b) If both Assertion and Reason are correct, but Reason is not the correct explanation of Assertion.
(c) If Assertion is correct but Reason is incorrect.
(d) If both the Assertion and Reason are incorrect.
51. **Assertion :** Two thin blankets put together are warmer than a single blanket of double the thickness.
Reason : Thickness increases because of air layer enclosed between the two blankets.
[2010]

HINTS & SOLUTIONS

Type A : Multiple Choice Questions

1. (b) For black body radiation

$$E = \sigma T^4$$

[E is energy radiated per unit time per unit area, T is temperature of the body]

$$\frac{E_2}{E_1} = \left(\frac{T_2}{T_1}\right)^4 \Rightarrow \frac{E_2}{E_1} = \left(\frac{273+287}{273+7}\right)^4$$

$$= \left(\frac{560}{280}\right)^4 = \frac{16}{1} \Rightarrow E_2 = 16E_1$$

2. (b) We know that, for a source, emitting energy E at temperature T

$$E = \sigma T^4 \Rightarrow E_1 = \sigma(2T)^4$$

$$\frac{E}{E_1} = \frac{\sigma T^4}{16\sigma T^4} = \frac{1}{16}$$

Now radiation falling on the earth will be proportional to radiation being emitted so.

$$\frac{E}{E_1} = \frac{20}{X}$$

Here, X is the radiation falling in the earth in the latter case.

$$\frac{20}{X} = \frac{1}{16}$$

$$\Rightarrow X = 20 \times 16 = 320 \text{ kcal/m}^2 \text{ min}$$

3. (a) Conductivity = $\frac{1}{\text{Resistivity}}$

$$\text{Thermal conductivity} = 2$$

$$\text{Thermal resistivity} = \frac{1}{2} = 0.5$$

4. (c) Thermopile is a combination of thermocouple which generates electrical energy when one end is kept at higher temperature with respect to the other end. It is helpful in measuring the temperature of a hot and radiating body.

5. (a) We know that

$$E = \sigma T^4$$

$$\frac{E_1}{E_2} = \left(\frac{T_1}{T_2}\right)^4 = \left(\frac{727+273}{327+273}\right)^4$$

$$= \left(\frac{1000}{600}\right)^4 = \frac{625}{81}$$

6. (a) From the formula,

$$\frac{C}{5} = \frac{F-32}{9}$$

$$\Rightarrow \frac{C}{5} = \frac{140-32}{9} = \frac{108}{9}$$

So, fall of temperature in °C is $100-60=40^\circ\text{C}$

7. (b) Metal appears cool on touching because heat flows from body (at higher temperature) to iron (at lower temperature). This can happen only when metal conducts heat. Wooden surface does not feel cool as it is non-conductor of heat.

8. (c) Relative Humidity

$$= \frac{\text{Partial pressure of water vapour}}{\text{Vapour pressure of water}}$$

$$= \frac{0.012 \times 10^5 \times 100}{0.016 \times 10^5} = \frac{12}{16} \times 100 = 75\%$$

9. (b) Absolute zero is the temperature at which molecular motion ceases when vibrational energy exists.

10. (b) During fusion of solid into liquid some energy is used up to transform the state of matter from solid to liquid. Since it does not increase the kinetic energy of particles, there is no increase in the temperature of the material. So, phase transformation takes place at constant temperature.

11. (d) Wool is a bad conductor of heat. It does not allow heat to pass on from body to surrounding. So, body is kept warm.

12. (b) The process of convection and conduction requires some medium made of material particle for transmission of heat. In vacuum there is no material. So, heat travels in vacuum by radiation.

13. (d) Applying Wein's displacement law,

$$\lambda_m T = \text{constant}$$

$$\lambda_{1m} T_1 = \lambda_{2m} T_2$$

$$\lambda_m \times 2000 = \lambda \times 3000$$

$$\lambda = \frac{2}{3} \lambda_m$$

14. (a) Sublimation is conversion of a solid directly into gas by heat.

15. (a) Applying Wein's displacement law,

$$\lambda_m T = \text{constant}$$

$$\frac{\lambda'_m}{\lambda''_m} = \frac{T_2}{T_1} \Rightarrow \frac{510}{350} = \frac{T_2}{T_1}$$

$$\frac{T_2}{T_1} = \frac{51}{35} \Rightarrow \frac{T_1}{T_2} = \frac{35}{51} = 0.68$$

16. (b) Coefficient of volume expansion of glycerine

$$= 0.000597 \text{ per } ^\circ\text{C}$$

Coefficient of volume expansion of glass

$$= 3 \times 0.000009 = 0.000027 \text{ per } ^\circ\text{C}$$

Apparent coefficient of volume expansion

$$= 0.000597 - 0.000027$$

$$= 0.00057 \text{ per } ^\circ\text{C}$$

17. (b) The colour of the star indicates its temperature. Higher the wavelength emitted lower will be its temperature. This is from Wein's displacement Law, $\lambda_m T = \text{constant}$.

A blue coloured star will have high temperature than red coloured star.

18. (c) We know that

$$E = \sigma T^4$$

Where E is rate of emission of radiation of a body at temperature T.

$$E_1 = \sigma(27 + 273)^2$$

$$E_2 = \sigma(127 + 273)^2$$

$$\frac{E_1}{E_2} = \frac{(300)^4}{(400)^4} = \frac{81}{256}$$

19. (a) For black body radiation

$$E = \sigma T^4 \text{ or } E \propto T^4$$

Rate of emission of energy $\propto (300)^4$

20. (a) The coefficient of volume expansion,

$$\gamma = \frac{\Delta \rho}{\rho_1 \times \Delta t}$$

$$= \frac{\rho_1 - \rho_2}{\rho_1(T_2 - T_1)} = \frac{10 - 9.7}{10(100 - 0)} = 3 \times 10^{-4}$$

Coefficient of linear expansion

$$\alpha = \frac{\gamma}{3} = \frac{3 \times 10^{-4}}{3} = 10^{-4}$$

21. (c) We know that

$$E = \sigma T^4 \Rightarrow \frac{E_1}{E_2} = \frac{T_1^4}{T_2^4}$$

$$\Rightarrow \frac{E}{20} = \frac{(727 + 273)^4}{(227 + 273)^4} = \frac{(1000)^4}{(500)^4}$$

$$\frac{E_1}{20} = \left(\frac{2}{1}\right)^4 = \frac{16}{1}$$

$$\Rightarrow E_1 = 20 \times 16 = 320 \text{ cal m}^{-2} \text{ s}^{-1}$$

22. (a) From Wein's displacement law,

$$\lambda_m T = \text{constant i.e.}$$

at greater temperature λ_m will be small λ_m is the wavelength of the radiation having highest intensity. In figure (a) curve representing T_2 has λ_m smaller than that for T_1 so, (a) is the right answer.

23. (b) $E = \sigma T^4$, here, E is energy radiated per unit area. Total energy emitted = $\sigma T^4 \times A$
Total energy emitted by sun after expansion

$$= \sigma \times \left(\frac{T}{2}\right)^4 \times 100 \times 100 \text{ A}$$

[When radius becomes 100 times, area becomes 100^2 times]

$$= A \sigma T^4 \times \frac{1}{16} \times 100 \times 100 = 625 \times \sigma T^4 \text{ A}$$

So, total energy emitted is 625 times.

24. (b) Black has greatest emissivity and greatest absorptivity as compared with other colours. At 2000°C it will have greatest emissivity so it will glow brightest.

25. (b) As coefficient of thermal expansion of X is more. On cooling, it will shrink more. So the strip will bend towards the left.

26. (b) By Stefan's law, energy radiated per sec by a black body is given by $E = A \sigma T^4$ where A = area of black body, σ = Stefan's constant. For a black body at temperature T_1 , $E_1 = A \sigma T_1^4$, at T_2 , $E_2 = A \sigma T_2^4$ (Since A, σ all same)

$$\therefore \frac{E_2}{E_1} = \frac{T_2^4}{T_1^4}$$

$$\Rightarrow E_2 = \left(\frac{T_2}{T_1} \right)^4 E_1$$

$$T_2 = 287^\circ\text{C} = 287 + 273 = 560 \text{ K},$$

$$T_1 = 7^\circ\text{C} = 7 + 273 = 280 \text{ K},$$

$$\therefore E_2 = \left(\frac{560}{280} \right)^4 E_1 = 2^4 E_1 = 16 E_1$$

$\therefore$ Rate of energy radiated increases by 16 times.

27. (d) $\lambda_m \times T = b$ (Wein's displacement Law)

$$T = \frac{2.93 \times 10^{-3}}{2.93 \times 10^{-10}} = 10^7 \text{ K}$$

28. (d) $E = \sigma A T^4$

$$A \propto R^2 \therefore E \propto R^2 T^4$$

$$\therefore \frac{E_2}{E_1} = \frac{R_2^2 T_2^4}{R_1^2 T_1^4}$$

$$\text{put } R_2 = 2R, R_1 = R$$

$$T_2 = 2T, T_1 = T$$

$$\Rightarrow \frac{E_2}{E_1} = \frac{(2R)^2 (2T)^4}{R^2 T^4} = 64$$

29. (a) $\gamma = \alpha_1 + \alpha_2 + \alpha_3$

$$= 13 \times 10^{-7} + 231 \times 10^{-7} + 231 \times 10^{-7}$$

$$= 475 \times 10^{-7}$$

30. (a) Use $\frac{K_1}{K_2} = \frac{\ell_1^2}{\ell_2^2}$

31. (a) $r_{\text{eff}} = \sqrt{r_1 r_2}$

$$\frac{dQ}{dt} = \frac{KA(T_2 - T_1)}{L} = \frac{K\pi r_1 r_2 (T_2 - T_1)}{L}$$

32. (a) When same stress is applied at two different temperatures, the increase in length is more at higher temperature. Thus $T_1 > T_2$.

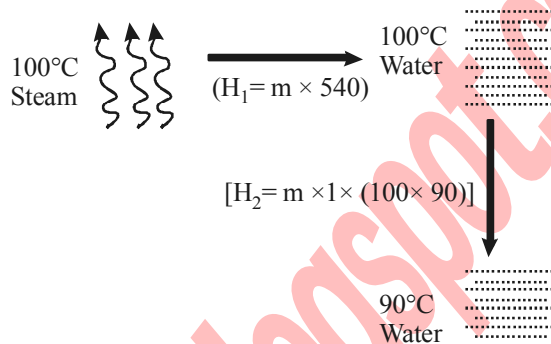
33. (a) $\Delta V = V_0(\gamma_m - \gamma_g)\Delta T$

$$= 1[1.82 \times 10^{-4} - 3 \times (10 \times 10^{-6})] 100$$

$$= 1[1.82 \times 10^{-4} - 0.3 \times 10^{-4}] 100$$

$$= 15.2 \text{ ml}$$

34. (a) Let m g of steam get condensed into water (By heat loss). This happens in following two steps.



Heat gained by water (20°C) to raise its temperature upto $90^\circ\text{C} = 22 \times 1 \times (90 - 20)$

Hence, in equilibrium, heat lost = Heat gain

$$\Rightarrow m \times 540 + m \times 1 \times (100 - 90)$$

$$= 22 \times 1 \times (90 - 20)$$

$$\Rightarrow m = 2.8 \text{ gm}$$

The net mass of the water present in the mixture = $22 + 2.8 = 24.8 \text{ gm}$.

35. (b) $\frac{dQ}{dt} = KA \frac{\Delta T}{L}$

$$\text{For the first rod, } \left(\frac{dQ}{dt} \right)_1 = \frac{3KA}{L} (100 - \theta)$$

$$\text{Similarly, } \left(\frac{dQ}{dt} \right)_2 = 2K \frac{A}{L} (\theta - 50)$$

$$\left(\frac{dQ}{dt} \right)_3 = K \frac{A}{L} (\theta - 20)$$

$$\text{Now, } \left(\frac{dQ}{dt} \right)_1 = \left(\frac{dQ}{dt} \right)_2 + \left(\frac{dQ}{dt} \right)_3$$

$$\Rightarrow 3(100 - \theta) = 2(\theta - 50) + (\theta - 20)$$

$$\Rightarrow \theta = 70^\circ$$

36. (d) water expands on both sides of 4°C .

Type B : Assertion Reason Questions

37. (a) For equivalent thermal conductivity, the relation is

$$\frac{1}{K_R} = \frac{1}{K_1} + \frac{1}{K_2}; \text{ If } K_1 = K_2 = K$$

$$\frac{1}{K_R} = \frac{1}{K} + \frac{1}{K} = \frac{2}{K} \Rightarrow K_R = \frac{K}{2}$$

Which is less than K .

If $K_1 > K_2$ suppose $K_1 = K_2 + x$

$$\frac{1}{K} = \frac{1}{K_1} + \frac{1}{K_2} = \frac{K_2 + K_1}{K_1 K_2}$$

$$\Rightarrow \frac{1}{K} = \frac{K_2 + K_2 + x}{(K_2 + x)K_2} \Rightarrow K = \frac{K_2^2 + K_2 x}{2K_2 + x}$$

$$\begin{aligned}
 \text{Now, } K_2 - K &= K_2 - \frac{K_2^2 + K_2x}{2K_2 + x} \\
 &= \frac{2K_2^2 + K_2x - K_2^2 - K_2x}{(2K_2 + x)} \\
 &= \frac{K_2^2}{2K_2 + x} = \text{positive}
 \end{aligned}$$

So, $K_2 > K$, so the value of K is smaller than K_2 and K_1 .

38. (e) Melting of solid causes change in its internal energy.
Latent heat is the heat required to melt one unit mass of solid. Option (e) is correct.
39. (e) Here, Assertion is incorrect & Reason is correct. The temperature difference between boiling point of water and freezing point of water has been divided into 100 parts in °C scale, 180 parts in Fahrenheit scale, 80 parts in Reaumer scale and 212 parts in Rankine scale. So, Rankine scale is the smallest unit. Assertion is incorrect. Fahrenheit was the first temperature scale used for measuring temperature. So, the Reason is correct.
40. (a) Bodies radiate heat at all temperatures. It is true.
We also know that, $E \propto T^4$.
So, Reason is also correct and it explains Assertion.
41. (a) Woolen clothes keep the body warm. The air trapped in clothes are bad conductor of heat.
42. (e) Bodies radiate heat at all temperature. The rate of radiation of heat is proportional to the fourth power of absolute temperature is
 $E = \sigma T^4$ which is Stefan's Boltzmann's law
43. (c) In tube light, the gas contains vapour of metals. In metallic atoms, electronic transition occurs due to which light of a particular wavelength is emitted. So emission of white light is due to electronic transition and not due to vibration of atoms as in hot substances. So, Assertion is correct but Reason is incorrect.
44. (c) It is hotter over the top of a fire. It is because of convection current established over the fire. As air warms up, its density decreases as a result of which it goes up and makes upper layer of air hot.
The Reason is incorrect.

45. (c) According to Kirchhoff's law

$$\frac{e_\lambda}{a_\lambda} = E_\lambda$$

Here, E_λ is emissivity of black body which is constant, so, $e_\lambda \propto a_\lambda$. It means good emitter are good absorber of radiation.

46. (a) The slope of melting curve in phase diagram is negative for water as due to increase in temperature vapour, pressure of ice decreases. The Reason is that ice contracts on melting.
47. (c) According to Wein's displacement law,
 $\lambda_m T = \text{constant}$
Naturally, when T increases λ_m decreases.
 λ_m is peak emission wavelength
and $E = \sigma T^4$
Here, E is energy being radiated per unit area per unit time.
48. (c) Perspiration involves exchange of heat from body to surrounding. Water takes heat from the body and gets converted into vapour. Hence, body cools down.
A thin layer of water on the skin will reduce rather than increase its emissivity. So, Assertion is correct but Reason is incorrect.
49. (d) A perfect black body is one which absorbs all heat radiations (whatever be the wavelength) incident on it. No natural object is a perfect black body. Best approximations are lamp black and platinum black. Fery's black body is a double walled metallic sphere coated with lamp black on the inside and nickel on outside. It has a narrow opening opposite a conical projection inside.
 $\therefore$ Both Assertion and Reason are incorrect.
50. (a) Brass is a metal and good conductor. On a cold day, when brass tumbler is touched heat transfers from our body to brass, since our body loses heat so the tumbler feels cold. On the other hand, transfer of heat from our body to wood is slow and less, hence wooden tray appears warm.
51. (c) Two thin blankets put together are more warm because an insulating layer of air (as air is good insulator of heat) is enclosed between two blankets due to which it gives more warmth.

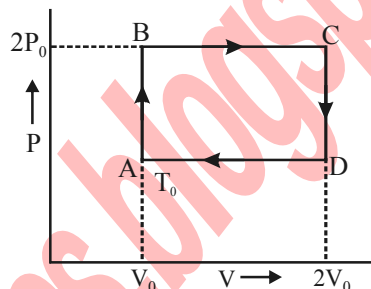
Chapter

11

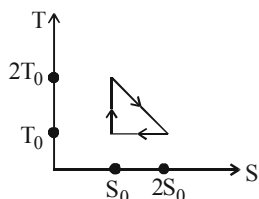
Thermodynamics

TYPE A : MULTIPLE CHOICE QUESTIONS

- A sample of gas expands from volume V_1 to V_2 . The amount of work done by the gas is greatest, when the expansion is : **[1998]**
 - isothermal
 - adiabatic
 - isobaric
 - all of these
- In an adiabatic process the quantity which remains constant is: **[1999]**
 - total heat of system
 - temperature
 - volume
 - pressure
- During the adiabatic expansion of two moles of a gas the internal energy of a gas is found to decrease by 2 joule. The work done on gas during the process will be equal to **[2000]**
 - 2 J
 - 3 J
 - 1 J
 - 2 J
- Which one of the following is not a thermodynamical co-ordinate ? **[2001]**
 - V
 - R
 - T
 - P
- The latent heat of vaporization of water is 2240 J. If the work done in the process of vaporization of 1g is 168 J, then increase in internal energy is **[2002]**
 - 1940 J
 - 2072 J
 - 2240 J
 - 2408 J
- The volume of a gas is reduced adiabatically to $(1/4)$ of its volume at 27°C . If $\gamma = 1.4$. The new temperature will be : **[2002]**
 - $300 \times (4)^{0.4} \text{ K}$
 - $150 \times (4)^{0.4} \text{ K}$
 - $250 \times (4)^{0.4} \text{ K}$
 - none of these
- N moles of a monoatomic gas is carried round the reversible rectangular cycle ABCDA as shown in the diagram. The temperature at A is T_0 . The thermodynamic efficiency of the cycle is : **[2004]**
 - 15%
 - 50%
 - 20%
 - 25%
- When you make ice cubes, the entropy of water **[2006]**
 - does not change
 - increases
 - decreases
 - may either increase or decrease depending on the process if used
- In an adiabatic change, the pressure and temperature of a monoatomic gas are related as $P \propto T^C$, where C equals **[2007]**
 - $\frac{2}{5}$
 - $\frac{5}{2}$
 - $\frac{3}{5}$
 - $\frac{5}{3}$
- Two rigid boxes containing different ideal gases are placed on a table. Box A contains one mole of nitrogen at temperature T_0 , while box B contains one mole of helium at temperature $\left(\frac{7}{3}\right)T_0$. The boxes are then put into thermal contact with each other, and heat flows between them until the gases reach a common final temperature (ignore the heat capacity of boxes). Then, the final temperature of the gases, T_f in terms of T_0 is **[2008]**
 - $T_f = \frac{3}{7}T_0$
 - $T_f = \frac{7}{3}T_0$
 - $T_f = \frac{3}{2}T_0$
 - $T_f = \frac{5}{2}T_0$

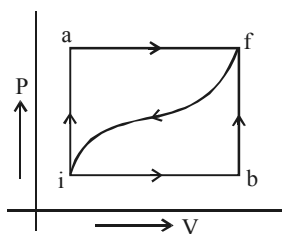


11. The temperature-entropy diagram of a reversible engine cycle is given in the figure. Its efficiency is [2008]



- (a) $\frac{1}{4}$ (b) $\frac{1}{2}$
(c) $\frac{2}{3}$ (d) $\frac{1}{3}$

12. When a system is taken from a state i to f along the path iaf (as shown in the figure). $Q = 50$ cal and $W = 20$ cal; along path ibf, $Q = 36$ cal. [2009]



- (i) What is W along path ibf?
(ii) If $W = 13$ cal for path fi, what is Q for the path f_i ?
(iii) Take $E_{\text{int}, i} = 10$ cal then what is $E_{\text{int}, f}$?
(a) 30, 20, 40 cal (b) 6, -43, 40 cal
(c) 10, -20, 30, cal (d) 15, 35, 25 cal
13. The change in the entropy of a 1 mole of an ideal gas which went through an isothermal process from an initial state (P_1, V_1, T) to the final state (P_2, V_2, T) is equal to [2010]
(a) zero (b) $R \ln T$
(c) $R \ln \frac{V_1}{V_2}$ (d) $R \ln \frac{V_2}{V_1}$
14. An ideal gas is subjected to an isothermal expansion such that its volume changes from V_i to V_f and pressure from P_i to P_f . The work done on the gas is : [2011]

- (a) $W = +nRT \log \frac{V_f}{V_i}$
(b) $W = -nRT \log \frac{V_f}{V_i}$
(c) $W = nRT \log \frac{P_f}{P_i}$

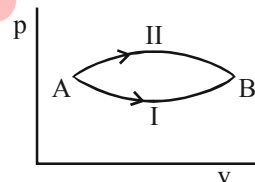
(d) $W = -nRT \log \frac{P_f}{P_i}$

15. Two moles of a monoatomic ideal gas is confined in a container and is heated such that its temperature increases by 10°C . The approximate change in its internal energy is [2011]
($R = 8.31$ J/mole-K)
(a) + 250 joules (b) + 350 joules
(c) - 250 joules (d) + 450 joules

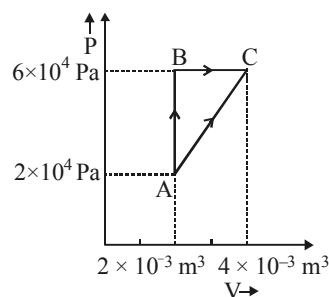
16. If ΔQ and ΔW represent the heat supplied to the system and the work done on the system respectively, then the first law of thermodynamics can be written as [2013]

- (a) $\Delta Q = \Delta U + \Delta W$
(b) $\Delta Q = \Delta U - \Delta W$
(c) $\Delta Q = \Delta W - \Delta U$
(d) $\Delta Q = -\Delta W - \Delta U$

17. A system goes from A to B via two processes I and II as shown in figure. If ΔU_1 and ΔU_2 are the changes in internal energies in the processes I and II respectively, then [2013, 2014]



- (a) relation between ΔU_1 and ΔU_2 can not be determined
(b) $\Delta U_1 = \Delta U_2$
(c) $\Delta U_1 < \Delta U_2$
(d) $\Delta U_1 > \Delta U_2$
18. Figure below shows two paths that may be taken by a gas to go from a state A to a state C.



In process AB, 400 J of heat is added to the system and in process BC, 100 J of heat is added to the system. The heat absorbed by the system in the process AC will be [2016]

- (a) 500 J (b) 460 J
(c) 300 J (d) 380 J

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19. The internal energy change in a system that has absorbed 2 kcal of heat and done 500 J of work is [2017]
 (a) 6400 J (b) 5400 J
 (c) 7900 J (d) 8900 J
20. In a heat engine, the temperature of the source and sink are 500 K and 375 K. If the engine consumes 25×10^5 J per cycle, the work done per cycle is [2017]
 (a) 6.25×10^5 J (b) 3×10^5 J
 (c) 2.19×10^5 J (d) 4×10^4 J

TYPE B : ASSERTION REASON QUESTIONS

Directions for (Qs. 29-32) : These questions consist of two statements, each printed as Assertion and Reason. While answering these questions, you are required to choose any one of the following five responses.

- (a) If both Assertion and Reason are correct and the Reason is a correct explanation of the Assertion.
 (b) If both Assertion and Reason are correct but Reason is not a correct explanation of the Assertion.
 (c) If the Assertion is correct but Reason is incorrect.
 (d) If both the Assertion and Reason are incorrect.
 (e) If the Assertion is incorrect but the Reason is correct.
21. **Assertion :** In isothermal process whole of the heat supplied to the body is converted into internal energy.
Reason : According to the first law of thermodynamics :
 $\Delta Q = \Delta U + p\Delta V$ [1997]
22. **Assertion :** In adiabatic compression, the internal energy and temperature of the system get decreased.
Reason : The adiabatic compression is a slow process. [2001]
23. **Assertion :** The isothermal curves intersect each other at a certain point.
Reason : The isothermal change takes place slowly, so, the isothermal curves have very little slope. [2001]
24. **Assertion :** When a bottle of cold carbonated drink is opened, a slight fog forms around the opening.
Reason : Adiabatic expansion of the gas causes lowering of temperature and condensation of water vapours. [2003]
25. **Assertion :** Thermodynamic process in nature are irreversible.
Reason : Dissipative effects cannot be eliminated. [2004]

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26. **Assertion :** Reversible systems are difficult to find in real world. [2005]
Reason : Most processes are dissipative in nature.
27. **Assertion :** Air quickly leaking out of a balloon becomes cooler.
Reason : The leaking air undergoes adiabatic expansion. [2005]
28. **Assertion :** In an isolated system the entropy increases.
Reason : The processes in an isolated system are adiabatic. [2006]
29. **Assertion :** The Carnot cycle is useful in understanding the performance of heat engines.
Reason : The Carnot cycle provides a way of determining the maximum possible efficiency achievable with reservoirs of given temperatures. [2006]
30. **Assertion :** When a glass of hot milk is placed in a room and allowed to cool, its entropy decreases.
Reason : Allowing hot object to cool does not violate the second law of thermodynamics. [2006]
31. **Assertion :** In free expansion of an ideal gas, the entropy increases.
Reason : Entropy increases in all natural processes. [2007]
32. **Assertion :** The isothermal curves intersect each other at a certain point.
Reason : The isothermal changes takes place rapidly, so the isothermal curves have very little slope. [2008]
- Directions for (Qs. 33-34) :** Each of these questions contains an Assertion followed by Reason. Read them carefully and answer the question on the basis of following options. You have to select the one that best describes the two statements.
- (a) If both Assertion and Reason are correct and Reason is the correct explanation of Assertion.
 (b) If both Assertion and Reason are correct, but Reason is not the correct explanation of Assertion.
 (c) If Assertion is correct but Reason is incorrect.
 (d) If both the Assertion and Reason are incorrect.
33. **Assertion :** Adiabatic expansion is always accompanied by fall in temperature.
Reason : In adiabatic process, volume is inversely proportional to temperature. [2011, 2013, 2014]
34. **Assertion :** The heat supplied to a system is always equal to the increase in its internal energy.
Reason : When a system changes from one thermal equilibrium to another, some heat is absorbed by it. [2017]

HINTS & SOLUTIONS

Type A : Multiple Choice Questions

1. (a) We know that
 $Q = \Delta E + \text{work done by gas}$
 $\text{Work done by gas} = Q - \Delta E$
 $\text{Work done by gas is maximum when } \Delta E \text{ is minimum. For Isothermal Change, } \Delta E = 0.$
 $\text{So, for isothermal expansion work done is maximum.}$
2. (a) In adiabatic process there is no exchange of heat with the surroundings, so total heat of the system remains constant.
3. (a) Gas is expanding at the cost of internal energy of the gas. Work done by the gas is 2 joule. So, work done on the gas = -2 joule.
4. (b) R is a constant term. To define a thermodynamic state of a gas we use any two of three physical quantities P, V & T. Following ratio is always constant

$$\frac{PV}{T} = R \quad (\text{constant})$$
 $\text{So, if we change P \& V, T will automatically change itself to make the ratio constant.}$
5. (b) We know that for first law of thermodynamics, equation is
 $Q = \Delta E + \Delta W$
 $\text{Here, } Q = 2240; \Delta E = ? \Delta W = 168$
 $\Delta E = Q - \Delta W = 2240 - 168 = 2072 \text{ J}$
6. (a) For adiabatic change, the equation is
 $TV^{\gamma-1} = \text{constant}$
 $T_1 V_1^{\gamma-1} = T_2 V_2^{\gamma-1}$
 $(27 + 273) V_1^{\gamma-1} = T_2 \left(\frac{V_1}{4} \right)^{\gamma-1}$
 $300 \times V_1^{\gamma-1} = \frac{T_2 \times V_1^{\gamma-1}}{4^{\gamma-1}} \Rightarrow T_2 = 300 \times 4^{\gamma-1}$
 $T_2 = 300 \times 4^{1.4-1} = 300 \times 4^{0.4} \text{ K}$
7. (b) Heat absorbed = Work done by gas at constant pressure
 $= 2P_0(2V_0 - V_0) = 2P_0 V_0$
 $\text{Net work done by the gas}$
 $= \text{Workdone by the gas}$
 $\quad - \text{Workdone on the gas}$

$$= 2P_0 V_0 - P_0 V_0 \quad [\text{Net work done in a cyclic process is area of the loop}]$$

$$= P_0 V_0$$

$$\text{So, efficiency} = \frac{P_0 V_0}{2P_0 V_0} \times 100 = 50\%$$

8. (c) $dS = \frac{dQ}{T}$
 $\text{In freezing process } dQ \text{ is negative so entropy decreases.}$

9. (b) In adiabatic process, $P^{\gamma-1} \propto T^{\gamma}$ where $\gamma = \frac{5}{3}$
 $\text{for monoatomic gas } \therefore P \propto T^{\gamma/(\gamma-1)}$

$$\therefore C = \frac{\gamma}{\gamma-1} = \frac{5/3}{5/3-1} = \frac{5/3}{2/3} = \frac{5}{2}$$

10. (c) Heat lost by He = Heat gained by N_2

$$n_1 C_{v1} \Delta T_1 = n_2 C_{v2} \Delta T_2$$

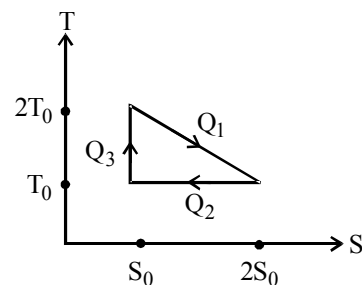
$$\frac{3}{2} R \left[\frac{7}{3} T_0 - T_f \right] = \frac{5}{2} R [T_f - T_0]$$

$$7T_0 - 3T_f = 5T_f - 5T_0$$

$$\Rightarrow 12T_0 = 8T_f \Rightarrow T_f = \frac{12}{8} T_0$$

$$\Rightarrow T_f = \frac{3}{2} T_0$$

11. (d)



$$Q_1 = T_0 S_0 + \frac{1}{2} T_0 S_0 = \frac{3}{2} T_0 S_0$$

$$Q_2 = T_0 (2S_0 - S_0) = T_0 S_0 \text{ and } Q_3 = 0$$

$$\eta = \frac{W}{Q_1} = \frac{Q_1 - Q_2}{Q_1}$$

$$= 1 - \frac{Q_2}{Q_1} = 1 - \frac{T_0 S_0}{\frac{3}{2} T_0 S_0} = \frac{1}{3}$$

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12. (b) For path iaf
 $Q = 50 \text{ cal.}$
 $W = 20 \text{ cal.}$
 According to I law of thermodynamics,
 $dQ = dU + dW$
 or $dU = dQ - dW = 50 - 20 = 30 \text{ cal.}$
- (i) For path iaf
 $Q = 36 \text{ cal.}$
 $W = ?$
 $dU = 30 \text{ cal}$ (since internal energy depends only on the initial and final positions of the system).
 $\therefore W = Q - dU = 36 - 30 = 6 \text{ cal.}$
- (ii) $W = -13 \text{ cal.}$
 $dU = -30 \text{ cal.}$
 $Q = ?$
 $\therefore Q = dU + W = -43 \text{ cal.}$
- (iii) $E_{\text{int, f}} = E_{\text{int, i}} + \Delta U = 10 \text{ cal} + 30 \text{ cal.} = 40 \text{ cal.}$
13. (d) Workdone by n moles of a gas when its volume changes from V_1 to V_2 is,
 $W = nRT \log_e \frac{V_2}{V_1}$
 For, $n = 1$
 $W = RT \ln \frac{V_2}{V_1}$
 For an isothermal process, $\Delta U = 0$
 $\therefore \Delta Q = \Delta U + W = 0 + RT \ln \frac{V_2}{V_1}$
 $\therefore \text{Entropy} = \frac{\Delta Q}{T} = R \ln \frac{V_2}{V_1}$
14. (d) The work done in expansion of gas
 $W = nRT \ln \frac{V_f}{V_i} = nRT \ln \frac{P_i}{P_f}$
 The work done on the gas
 $= -nRT \ln \left(\frac{P_f}{P_i} \right)$
15. (a) $\Delta E = n \frac{3}{2} R \Delta T$
 $= 2 \times \frac{3}{2} \times 8.31 \times 10 = 250 \text{ J}$
16. (b) From FLOT $\Delta Q = \Delta U + \Delta W$
 $\therefore$ Heat supplied to the system so
 $\Delta Q \rightarrow \text{Positive}$
 and work is done on the system so
 $\Delta W \rightarrow \text{Negative}$
 Hence $+\Delta Q = \Delta U - \Delta W$
17. (b) Change in internal energy do not depend upon the path followed by the process. It only depends on initial and final states i.e.,
 $\Delta U_1 = \Delta U_2$
18. (b) In cyclic process ABCA
 $Q_{\text{cycle}} = W_{\text{cycle}}$
 $Q_{AB} + Q_{BC} + Q_{CA} = \text{ar. of } \Delta ABC$
 $+ 400 + 100 + Q_{C \rightarrow A} = \frac{1}{2} (2 \times 10^{-3}) (4 \times 10^4)$
 $\Rightarrow Q_{C \rightarrow A} = -460 \text{ J}$
 $\Rightarrow Q_{A \rightarrow C} = +460 \text{ J}$
19. (c) According to first law of thermodynamics
 $Q = \Delta U + W$
 $\Delta U = Q - W$
 $= 2 \times 4.2 \times 1000 - 500$
 $= 8400 - 500$
 $= 7900 \text{ J}$
20. (a) Here, $T_1 = 500 \text{ K}$, $T_2 = 375 \text{ K}$
 $Q_1 = 25 \times 10^5 \text{ J}$
 $\therefore \eta = 1 - \frac{T_2}{T_1} = 1 - \frac{375}{500} = 0.25$
 $W = \eta Q = 0.25 \times 25 \times 10^5 = 6.25 \times 10^5 \text{ J}$

Type B : Assertion Reason Questions

21. (a) $\Delta Q = \Delta U + P \Delta V$ [PV = nRT]
 $\Delta Q = \Delta U + nR \Delta T$ $P \Delta V = nR \Delta T$
 For isothermal change $\Delta T = 0$
 $\therefore \Delta Q = \Delta U$
 In other words whole of heat supplied is converted into internal energy.
22. (d) Adiabatic compression is a fast process. There is rise in temperature and also increase in internal energy.
 So, both are false.
23. (e) Isothermal curves have slope which is equal to $\frac{P}{V}$. It can be calculated as follows
 $PV = RT$
 Differentiating,
 $PdV + VdP = 0$
 $-\frac{dP}{dV} = \frac{P}{V}$

Now, if they cut each other at certain point, they will have different slope at the same point (for same value of P & V). So, they can not cut each other at some point.

Reason is true, slope is $\frac{P}{V}$.

For adiabatic curve slope is γ times $\frac{P}{V}$.

24. (a) In cold carbonated drink, gas is dissolved under pressure, when pressure is released expansion of gas occurs due to which gas cools down and temperature falls. Condensation of water vapour occurs.
25. (a) Most of the phenomenon in nature is irreversible. A process becomes irreversible in case some energy is converted into heat energy. This is known as dissipative effect. When there is dissipative effect, process becomes irreversible.
26. (a) In any process some energy is found to be converted into heat (dissipative in nature) due to which process becomes irreversible.
27. (a) Air cools down due to adiabatic expansion as air has to do work against external pressure at the cost of its internal energy.
28. (b) In an unisolated system, heat may enter into or escape from the system due to which entropy may increase or decrease but for isolated system we do not consider exchange of heat, so, in this case entropy will always increase as the process is spontaneous. An adiabatic process involves no exchange of heat. We also define isolated system as having no exchange of heat with the surrounding so its process in an isolated system are adiabatic. The two statements are independently correct but not co-related.

29. (a) Carnot cycle represents process of an ideal heat engine which has maximum efficiency of conversion of heat energy into mechanical energy. So, A is right. The efficiency of a Carnot cycle depends only on the temperature of heat reservoirs is source and sink. So, reason is right and reason explains assertion.

30. (b) A body cools, its entropy decreases as

$$dS = \frac{dQ}{T} \text{ and } dQ \text{ is } -ve, dS \text{ is also } -ve.$$

R is also true. Second law states that entropy of the universe increases. Universe includes both system and surroundings. R does not explain A.

31. (c) In free expansion of an ideal gas, work done comes from internal energy of the gas and since randomness increases or Gibbs free energy increases so we can say entropy increases.

32. (d) As isothermal processes are very slow and so the different isothermal curves have different slopes, they cannot intersect each other.

33. (c)

34. (d) According to first law of thermodynamics, $\Delta Q = \Delta U + \Delta W = \Delta U + P\Delta V$. If heat is supplied in such a manner that volume does not change $\Delta V = 0$, i.e., isochoric process, then whole of the heat energy supplied to the system will increase internal energy only. But, in any other process it is not possible.

Also heat may be adsorbed or evolved when state of thermal equilibrium changes.

Chapter

12

Kinetic Theory

TYPE A : MULTIPLE CHOICE QUESTIONS

- The average kinetic energy of a gas molecule at 27°C is $6.21 \times 10^{-21} \text{ J}$, then its average kinetic energy at 227°C is : [1999]
 (a) $10.35 \times 10^{-21} \text{ J}$ (b) $11.35 \times 10^{-21} \text{ J}$
 (c) $52.2 \times 10^{-21} \text{ J}$ (d) $5.22 \times 10^{-21} \text{ J}$
- An ideal gas at 27°C is compressed adiabatically to $\frac{8}{27}$ its original volume [$TV^{\gamma-1} = \text{constant}$] and $\gamma = \frac{5}{3}$, then the rise in temperature will be: [1999]
 (a) 480°C (b) 450°C
 (c) 375°C (d) 225°C
- v_{rms} , v_{av} and v_{mp} are root mean square, average and most probable speeds of molecules of a gas obeying Maxwellian velocity distribution. Which of the following statements is correct ? [2005]
 (a) $v_{\text{rms}} < v_{\text{av}} < v_{\text{mp}}$ (b) $v_{\text{rms}} > v_{\text{av}} > v_{\text{mp}}$
 (c) $v_{\text{mp}} < v_{\text{rms}} < v_{\text{av}}$ (d) $v_{\text{mp}} > v_{\text{rms}} < v_{\text{av}}$
- Let $\bar{v}$, $\bar{v}_{\text{rms}}$ and v_p respectively denote the mean speed, root mean square speed and most probable speed of the molecules in an ideal monoatomic gas at absolute temperature T . The mass of the molecule is m . Then [2010]
 (a) no molecule can have a speed greater than $(\sqrt{2}v_{\text{rms}})$
 (b) no molecule can have a speed less than $\frac{v_p}{(\sqrt{2})}$
 (c) $\bar{v} < v_p < v_{\text{rms}}$
 (d) the average kinetic energy of the molecules is $\frac{3}{4}(mv_p^2)$
- Two identical containers A and B with frictionless pistons contain the ideal gas at the same temperature and the same volume V . The mass of the gas in A is m_A and in B is m_B . The gas in each cylinder is now allowed to expand isothermally to the same final volume $2V$. The changes in pressure in A and B are found to be Δp and $1.5\Delta p$ respectively. Then [2010]
 (a) $4m_A = 9m_B$ (b) $2m_A = 3m_B$
 (c) $3m_A = 2m_B$ (d) $9m_A = 4m_B$
- N_1 molecules of a gas at temperature T_1 are mixed with N_2 molecules at temperature T_2 . The resulting temperature of the mixture gas is [2010]
 (a) $\frac{(T_1 - T_2)}{2}$
 (b) $\frac{(N_1T_1 - N_2T_2)}{(N_1 + N_2)}$
 (c) $\frac{(N_1T_1 + N_2T_2)}{(N_1 + N_2)}$
 (d) $\left\{ \frac{(N_1 + N_2)}{2} \right\} \left\{ \frac{T_1 + T_2}{2} \right\}$
- At what temperature the molecules of nitrogen will have the same rms velocity as the molecules of oxygen at 127°C [2011]
 (a) 457°C (b) 273°C
 (c) 350°C (d) 77°C
- If liquefied oxygen at 1 atmospheric pressure is heated from 50 K to 300 K by supplying heat at constant rate. The graph of temperature vs time will be [2012]
- The figure shows the volume V versus temperature T graphs for a certain mass of a perfect gas at two constant pressures of P_1 and P_2 . What inference can you draw from the graphs? [2014]

 (a) $P_1 > P_2$
 (b) $P_1 < P_2$
 (c) $P_1 = P_2$
 (d) No inference can be drawn due to insufficient information.

10. A gas mixture consists of molecules of type 1, 2 and 3, with molar masses $m_1 > m_2 > m_3$. v_{rms} and $\bar{K}$ are the r.m.s. speed and average kinetic energy of the gases. Which of the following is true? [2015]
- (a) $(v_{rms})_1 < (v_{rms})_2 < (v_{rms})_3$ and $(\bar{K})_1 = (\bar{K})_2 = (\bar{K})_3$
- (b) $(v_{rms})_1 = (v_{rms})_2 = (v_{rms})_3$ and $(\bar{K})_1 = (\bar{K})_2 > (\bar{K})_3$
- (c) $(v_{rms})_1 > (v_{rms})_2 > (v_{rms})_3$ and $(\bar{K})_1 < (\bar{K})_2 > (\bar{K})_3$
- (d) $(v_{rms})_1 > (v_{rms})_2 > (v_{rms})_3$ and $(\bar{K})_1 < (\bar{K})_2 < (\bar{K})_3$
11. A thermally insulated vessel contains an ideal gas of molecular mass M and ratio of specific heats γ . It is moving with speed v and is suddenly brought to rest. Assuming no heat is lost to the surroundings, its temperature increases by
- (a) $\frac{(\gamma-1)}{2\gamma R} Mv^2 K$ (b) $\frac{\gamma Mv^2}{2R} K$ [2016]
- (c) $\frac{(\gamma-1)}{2R} Mv^2 K$ (d) $\frac{(\gamma-1)}{2(\gamma+1)R} Mv^2 K$
12. If the root mean square velocity of the molecules of hydrogen at NTP is 1.84 km/s. Calculate the root mean square velocity of oxygen molecule at NTP, molecular weight of hydrogen and oxygen are 2 and 32 respectively [2017]
- (a) 1.47 km/sec (b) 0.94 km/s
- (c) 1.84 km/s (d) 0.47 km/sec

TYPE B : ASSERTION REASON QUESTIONS

Directions for (Qs. 13-14) : These questions consist of two statements, each printed as Assertion and Reason. While answering these questions, you are required to choose any one of the following five responses.

- (a) If both Assertion and Reason are correct and the Reason is a correct explanation of the Assertion.
- (b) If both Assertion and Reason are correct but Reason is not a correct explanation of the Assertion.
- (c) If the Assertion is correct but Reason is incorrect.
- (d) If both the Assertion and Reason are incorrect.
- (e) If the Assertion is incorrect but the Reason is correct.
13. **Assertion :** For a gas atom the number of degrees of freedom is 3.

Reason : $\frac{C_p}{C_v} = \gamma$ [2000]

14. **Assertion :** The root mean square and most probable speeds of the molecules in a gas are the same.

Reason : The Maxwell distribution for the speed of molecules in a gas is symmetrical. [2006]

Directions for (Qs. 15-20) : Each of these questions contains an Assertion followed by Reason. Read them carefully and answer the question on the basis of following options. You have to select the one that best describes the two statements.

- (a) If both Assertion and Reason are correct and Reason is the correct explanation of Assertion.
- (b) If both Assertion and Reason are correct, but Reason is not the correct explanation of Assertion.
- (c) If Assertion is correct but Reason is incorrect.
- (d) If both the Assertion and Reason are incorrect.

15. **Assertion :** The ratio of $\frac{C_p}{C_v}$ for an ideal diatomic gas is less than that for an ideal monoatomic gas (where C_p and C_v have usual meaning).

Reason : The atoms of a monoatomic gas have less degrees of freedom as compared to molecules of the diatomic gas. [2009]

16. **Assertion :** The total translational kinetic energy of all the molecules of a given mass of an ideal gas is 1.5 times the product of its pressure and its volume.

Reason : The molecules of a gas collide with each other and the velocities of the molecules change due to the collision. [2013]

17. **Assertion :** Mean free path of a gas molecules varies inversely as density of the gas.

Reason : Mean free path varies inversely as pressure of the gas. [2014]

18. **Assertion :** At a given temperature the specific heat of a gas at constant volume is always greater than its specific heat at constant pressure.

Reason : When a gas is heated at constant volume some extra heat is needed compared to that at constant pressure for doing work in expansion. [2015]

19. **Assertion :** One mole of any substance at any temperature or volume always contains 6.02×10^{23} molecules.

Reason : One mole of a substance always refers to S.T.P. conditions. [2016]

20. **Assertion :** Air pressure in a car tyre increases during driving.

Reason : Absolute zero temperature is not zero energy temperature. [2017]

HINTS & SOLUTIONS

Type A : Multiple Choice Questions

1. (a) Average kinetic energy of gas molecules
 $\propto$ Temperature (Absolute)

$$\frac{\text{K.E. (at } 227^\circ\text{C)}}{\text{K.E. (at } 27^\circ\text{C)}} = \frac{273 + 227}{273 + 27} = \frac{500}{300} = \frac{5}{3}$$

$$\text{K.E. (227}^\circ) = \frac{5}{3} \times 6.21 \times 10^{-21} \text{ J}$$

$$= 10.35 \times 10^{-21} \text{ J}$$

2. (c) Applying the formula

$$T_1 V_1^{\gamma-1} = T_2 V_2^{\gamma-1}$$

$$\frac{T_1}{T_2} = \left(\frac{V_2}{V_1} \right)^{\gamma-1}$$

$$\left(\Rightarrow \frac{27 + 273}{T_2} \right) = \left(\frac{8}{27} \right)^{\gamma-1} = \left(\frac{8}{27} \right)^{5/3-1}$$

$$\text{or, } \frac{300}{T_2} = \left(\frac{2}{3} \right)^{\frac{2}{3} \times 3} = \frac{4}{9}$$

$$T_2 = \frac{9 \times 300}{4} = 675^\circ\text{K}$$

$$t^\circ\text{C} = 675 - 273 = 402^\circ\text{C}$$

$$\text{Rise in temperature} = 402 - 27 = 375^\circ\text{C}$$

3. (b) $v_{\text{rms}} = \sqrt{\frac{3kT}{m}}$; $v_{\text{mp}} = \sqrt{\frac{2kT}{m}}$

$$v_{\text{av}} = \sqrt{\frac{8kT}{\pi m}}$$

$$\text{So, } v_{\text{rms}} > v_{\text{av}} > v_{\text{mp}}$$

4. (d) $v_{\text{rms}} = \sqrt{\frac{3RT}{m}}$

$$\bar{v} = \sqrt{\frac{8RT}{\pi m}} = \sqrt{\frac{2.5RT}{m}}$$

$$\text{and } v_p = \sqrt{\frac{2RT}{m}}$$

From these expressions, we can see that

$$v_p < \bar{v} < v_{\text{rms}}$$

$$\text{Again, } v_{\text{rms}} = v_p \frac{\sqrt{3}}{2}$$

and average kinetic energy of a gas molecule

$$E_k = \frac{1}{2} m v_{\text{rms}}^2$$

$$E_k = \frac{1}{2} m \left(\sqrt{\frac{3}{2}} v_p \right)^2 = \frac{1}{2} m \times \frac{3}{2} v_p^2 = \frac{3}{4} m v_p^2$$

5. (c) The initial pressure in the two containers will be

$$P_A = \frac{n_A R T}{V} = m_A \left(\frac{RT}{MV} \right)$$

$$P_B = \frac{n_B R T}{V} = m_B \left(\frac{RT}{MV} \right)$$

After isothermal expansion, pressure will be

$$P'_A = \frac{n_A R T}{2V} = m_A \left(\frac{RT}{2MV} \right)$$

$$P'_B = \frac{n_B R T}{2V} = m_B \left(\frac{RT}{2MV} \right)$$

$$\therefore -\Delta P_A = P_A - P'_A = m_A \left(\frac{RT}{2MV} \right)$$

$$\therefore -\Delta P_B = P_B - P'_B = m_B \left(\frac{RT}{2MV} \right)$$

$$\text{But } \Delta P_A = \Delta P \text{ and } -\Delta P_B = 1.5 \Delta P$$

$$\text{So, } \frac{-\Delta P_A}{-\Delta P_B} = \frac{1}{1.5} \Rightarrow -\Delta P_A = \frac{-\Delta P_B}{1.5}$$

$$m_A \left(\frac{RT}{2MV} \right) = \frac{m_B}{1.5} \left(\frac{RT}{2MV} \right)$$

$$\text{or } m_A = \frac{10m_B}{15}$$

$$\therefore 3m_A = 2m_B$$

6. (c) $\left(\frac{3}{2} k T_1 \right) \times N_1 + \left(\frac{3}{2} k T_2 \right) \times N_2$

$$= (N_1 + N_2) \times \frac{3}{2} k T$$

$$T_1 N_1 + T_2 N_2 = (N_1 + N_2) T$$

$$\therefore T = \frac{N_1 T_1 + N_2 T_2}{N_1 + N_2}$$

7. (d) Rms velocity of gas is

$$v_{rms} = 1.73 \left(\frac{RT}{M} \right)^{\frac{1}{2}};$$

M = molecular mass

For oxygen, $M = 16 \times 2$,

$T = 127^\circ\text{C} = 127 + 273 = 400\text{ K}$

For nitrogen, $M = 17 \times 2$, $T = ?$

$$\Rightarrow 1.73 \left(\frac{RT}{M} \right)^{\frac{1}{2}}_{\text{O}_2} = 1.73 \left(\frac{RT}{M} \right)^{\frac{1}{2}}_{\text{N}_2}$$

$$\Rightarrow \left(\frac{T}{M} \right)^{\frac{1}{2}}_{\text{O}_2} = \left(\frac{T}{M} \right)^{\frac{1}{2}}_{\text{N}_2}$$

$$\Rightarrow \sqrt{T_{\text{N}_2}} = \sqrt{\frac{M_{\text{N}_2}}{M_{\text{O}_2}} T_{\text{O}_2}} = \sqrt{\frac{28}{32} \times 400}$$

$$= \sqrt{\frac{7}{8} \times 400}$$

$$\Rightarrow T_{\text{N}_2} = \frac{7}{8} \times 400 = 350\text{ K}$$

$$T_{\text{N}_2} = 350\text{ K} - 273\text{ K} = 77^\circ\text{C}$$

8. (c) $Q = mc\Delta T$
 $Q = mc(T - T_0)$ (i)
 $Q = Kt$ whereas K is heating rate
 $\therefore$ from 50 to boiling temperature, T increases linearly.
 At vaporization, equation is $Q = mL$
 so, temperature remains constant till vaporisation is complete
 After that, again Eqn (i) is followed and temperature increases linearly

9. (b) $\therefore \theta_1 < \theta_2 \Rightarrow \tan \theta_1 < \tan \theta_2$

$$\Rightarrow \left(\frac{V}{T} \right)_1 < \left(\frac{V}{T} \right)_2$$

$$\text{from } PV = \mu RT; \frac{V}{T} \propto \frac{1}{P}$$

$$\text{Hence } \left(\frac{1}{P} \right)_1 < \left(\frac{1}{P} \right)_2 \Rightarrow P_1 > P_2.$$

10. (a) $v_{rms} \propto \frac{1}{\sqrt{M}} \Rightarrow (v_{rms})_1 < (v_{rms})_2 < (v_{rms})_3$
 also in mixture temperature of each gas will be same, hence kinetic energy also remains same.

11. (c) As no heat is lost,
 Loss of kinetic energy = gain of internal energy of gas

$$\frac{1}{2}mv^2 = nC_V\Delta T$$

$$\Rightarrow \frac{1}{2}mv^2 = \frac{m}{M} \cdot \frac{R}{\gamma - 1} \Delta T$$

$$\Rightarrow \Delta T = \frac{mv^2(\gamma - 1)}{2R} K$$

12. (d) $(c_{rms})_{\text{H}_2} = 1.84\text{ km/s}$, $(c_{rms})_{\text{O}_2} = ?$

$$M_{\text{H}_2} = 2, M_{\text{O}_2} = 32$$

$\Rightarrow$ Rms velocity,

$$c_{rms} = \sqrt{\frac{3RT}{M}}$$

$$\therefore \frac{c_{\text{H}_2}}{c_{\text{O}_2}} = \sqrt{\frac{M_{\text{O}_2}}{M_{\text{H}_2}}}$$

$$\Rightarrow \frac{1.84}{C_{\text{O}_2}} = \sqrt{\frac{32}{2}} = 4$$

$$\Rightarrow C_{\text{O}_2} = \frac{1.84}{4} = 0.46\text{ km/s}$$

Type B : Assertion Reason Questions

13. (b) For a gas atom no. of degree of freedom is 3 because it can have translatory motion in three directions, along X-axis, Y-axis, and Z-axis.

$$\frac{C_p}{C_v} = \gamma \text{ is also correct but it is not the}$$

Reason for Assertion given.

14. (d) Both Assertion and Reason are incorrect.

15. (a) If f be the degree of freedom, then the ratio

$$\frac{C_p}{C_v} (= \gamma) \text{ is given by } \gamma = 1 + \frac{2}{f}.$$

For monoatomic gas, $f = 3$;

$$\therefore \gamma = 1 + \frac{2}{3} = \frac{5}{3} = 1.67$$

For diatomic gas, $f = 5$

$$\therefore \gamma = 1 + \frac{2}{5} = \frac{7}{5} = 1.4.$$

$$\therefore \gamma_{\text{diatomic}} < \gamma_{\text{monoatomic}}$$

16. (b) Total translational kinetic energy

$$= \frac{3}{2} nRT = \frac{3}{2} PV$$

In an ideal gas all molecules moving randomly in all direction collide and their velocity changes after collision.

17. (a) The mean free path of a gas molecule is the average distance between two successive collisions. It is represented by λ .

$$\lambda = \frac{1}{\sqrt{2}} \frac{kT}{\pi \sigma^2 P} \text{ and } \lambda = \frac{m}{\sqrt{2} \cdot \pi \sigma^2 d}$$

Here, σ = diameter of molecule and

k = Boltzmann's constant.

$\Rightarrow \lambda \propto 1/d$, $\lambda \propto T$ and $\lambda \propto 1/P$.

Hence, mean free path varies inversely as density of the gas. It can easily be proved that the mean free path varies directly as the temperature and inversely as the pressure of the gas.

18. (a)

19. (c) The number 6.02×10^{23} is Avogadro's number and one mole of a substance contains Avogadro's number of molecules.

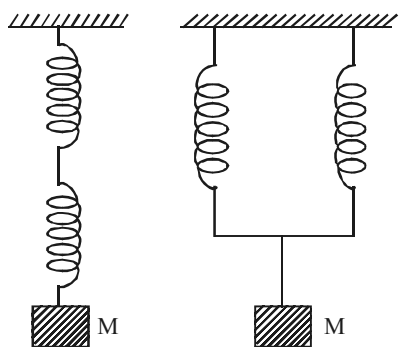
20. (b) When a person is driving a car then the temperature of air inside the tyre is increased because of motion. From the Gay Lussac's law,

$$P \propto T$$

Hence, when temperature increases the pressure also increases.

TYPE A : MULTIPLE CHOICE QUESTIONS

1. Two identical springs of spring constant k are connected in series and parallel as shown in figure. A mass M is suspended from them.



The ratio of their frequencies of vertical oscillation will be : [1997]

- (a) 1 : 2 (b) 2 : 1
(c) 4 : 1 (d) 1 : 4
2. If the metal bob of a simple pendulum is replaced by a wooden bob, then its time period will be :
(a) decreased (b) the same [1998]
(c) increased (d) first (c) then (a)
3. If the time period of oscillation of mass m suspended from a spring is 2 sec, the time period of mass $4m$ will be : [1998]
(a) 2 sec (b) 3 sec
(c) 4 sec (d) T sec
4. If a simple pendulum oscillates with an amplitude of 50 mm and time period of 2 sec then its maximum velocity is [1998]
(a) 0.6 m/s (b) 0.16 m/s
(c) 0.8 m/s (d) 0.32 m/s
5. A horizontal platform with an object placed on it is executing simple harmonic motion in the vertical direction. The amplitude of oscillation is 3.92×10^{-3} m. What should be the least period of these oscillations, so that the object is not detached from the platform ? [1999]
(a) 0.145 sec (b) 0.1556 sec
(c) 0.1256 sec (d) 0.1356 sec

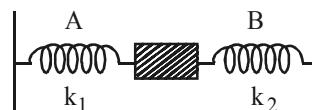
6. Which one of the following statement is not correct for a particle executing S.H.M.? [1999]

- (a) Acceleration of the particle is minimum at the mean position
(b) Restoring force is always directed towards a fixed point
(c) Total energy of the particle always remains the same
(d) Restoring force is maximum at the extreme position

7. A particle execute simple harmonic motion with an angular velocity of 3.5 rad/sec and maximum acceleration 7.5 m/s^2 . The amplitude of oscillation will be: [1999]

- (a) 0.53 cm (b) 0.28 m
(c) 0.61 m (d) 0.36 m

8. In arrangement given in figure if the block of mass m is displaced, the frequency is given by: [1999]



- (a) $n = \frac{1}{2\pi} \sqrt{\frac{k_1 + k_2}{m}}$
(b) $n = \frac{1}{2\pi} \sqrt{\frac{m}{k_1 + k_2}}$
(c) $n = \frac{1}{2\pi} \sqrt{\frac{m}{k_1 - k_2}}$
(d) $n = \frac{1}{2\pi} \sqrt{\frac{k_1 - k_2}{m}}$
9. A spring is vibrating with frequency under same mass. If it is cut into two equal pieces and same mass is suspended then the new frequency will be: [1999]
(a) $n\sqrt{2}$ (b) $\frac{n}{\sqrt{2}}$
(c) $\frac{n}{2}$ (d) n

10. Simple pendulum is executing simple harmonic motion with time period T . If the length of the pendulum is increased by 21 %, then the increase in the time period of the pendulum of the increased length is : [2001]

(a) 22 % (b) 13 %
(c) 50 % (d) 10 %

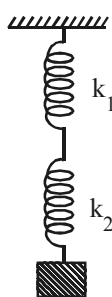
11. The frequency of oscillator of the springs as shown in figure will be : [2001]

(a) $\frac{1}{2\pi} \sqrt{\frac{(k_1 + k_2)m}{k_1 k_2}}$

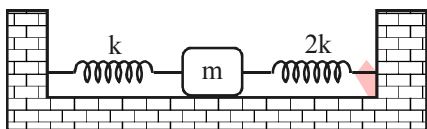
(b) $\frac{1}{2\pi} \sqrt{\frac{k_1 k_2}{(k_1 + k_2)m}}$

(c) $\frac{1}{2\pi} \sqrt{\frac{k}{m}}$

(d) $2\pi \sqrt{\frac{k}{m}}$



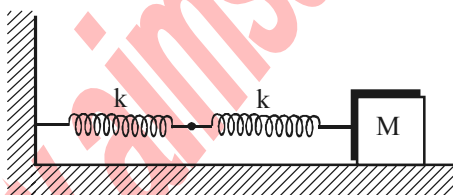
12. Two springs of force constant k and $2k$ are connected to a mass as shown below : The frequency of oscillation of the mass is : [2003]



(a) $(1/2\pi)\sqrt{(k/m)}$ (b) $(1/2\pi)\sqrt{(2k/m)}$

(c) $(1/2\pi)\sqrt{(3k/m)}$ (d) $(1/2\pi)\sqrt{(m/k)}$

13. Two springs are connected to a block of mass M placed on a frictionless surface as shown below. If both the springs have a spring constant k , the frequency of oscillation of block is : [2004]



(a) $\frac{1}{2\pi} \sqrt{\frac{k}{M}}$

(b) $\frac{1}{2\pi} \sqrt{\frac{k}{2M}}$

(c) $\frac{1}{2\pi} \sqrt{\frac{2k}{M}}$

(d) $\frac{1}{2\pi} \sqrt{\frac{M}{k}}$

14. Which of the following functions represents a simple harmonic oscillation ? [2005]

(a) $\sin \omega t - \cos \omega t$ (b) $\sin^2 \omega t$

(c) $\sin \omega t + \sin 2\omega t$ (d) $\sin \omega t - \sin 2\omega t$

15. A large horizontal surface moves up and down in S.H.M. with an amplitude of 1 cm. If a mass of 10 kg (which is placed on the surface) is to remain continuously in contact with it, the maximum frequency of S.H.M. will be [2007]

(a) 5 Hz (b) 0.5 Hz

(c) 1.5 Hz (d) 10 Hz

16. A coin is placed on a horizontal platform which undergoes vertical simple harmonic motion of angular frequency ω . The amplitude of oscillation is gradually increased. The coin will leave contact with the platform for the first time [2008]

(a) at the mean position of the platform

(b) for an amplitude of $\frac{g}{\omega^2}$

(c) for an amplitude of $\frac{g^2}{\omega^2}$

(d) at the highest position of the platform

17. The function $\sin^2(\omega t)$ represents [2008]

(a) a periodic, but not simple harmonic motion with a period $\frac{\pi}{\omega}$

(b) a periodic, but not simple harmonic motion with a period $\frac{2\pi}{\omega}$

(c) a simple harmonic motion with a period $\frac{\pi}{\omega}$

(d) a simple harmonic motion with a period $\frac{2\pi}{\omega}$

18. A particle of mass is executing oscillations about the origin on the x -axis. Its potential energy is $V(x) = k|x|^3$, where k is a positive constant. If the amplitude of oscillation is a , then its time period T is [2008]

(a) proportional to $\frac{1}{\sqrt{a}}$

(b) proportional to $\sqrt{a}$

(c) independent $a^{\frac{3}{2}}$

(d) none of these

19. The average speed of the bob of a simple pendulum oscillating with a small amplitude A and time period T is [2009]
- (a) $\frac{4A}{T}$ (b) $\frac{2\pi A}{T}$
 (c) $\frac{4\pi A}{T}$ (d) $\frac{2A}{T}$
20. A pendulum is swinging in an elevator. Its period will be greatest when the elevator is [2010]
- (a) moving upwards at constant speed
 (b) moving downwards
 (c) moving downwards at constant speed
 (d) accelerating downwards
21. If A is the area of cross-section of a spring L is its length E is the Young's modulus of the material of the spring then time period and force constant of the spring will be respectively: [2010]
- (a) $T = 2\pi\sqrt{\frac{EA}{ML}}, k = \frac{L}{EA}$
 (b) $T = \frac{1}{2\pi}\sqrt{\frac{EA}{ML}}, k = \frac{A}{EL}$
 (c) $T = \frac{1}{2\pi}\sqrt{\frac{EL}{MA}}, k = \sqrt{\frac{EA}{L}}$
 (d) $T = 2\pi\sqrt{\frac{ML}{EA}}, k = \frac{EA}{L}$
22. The time period of a seconds pendulum is 2 sec. The spherical bob which is empty from inside has a mass 50 gram, this now is replaced by another solid of same radius but have different mass of 100 gram. The new time period will be [2010]
- (a) 2 sec (b) 8 sec
 (c) 4 sec (d) 1 sec
23. A particle executes SHM of amplitude 25 cm and time period 3 s. What is the minimum time required for the particle to move between two points 12.5 cm on either side of the mean position? [2010]
- (a) 0.5 s (b) 1.0 s
 (c) 1.5 s (d) 2.0 s
24. The displacement of a particle undergoing SHM of time period T is given by $x(t) = x_m \cos(\omega t + \phi)$. The particle is at $x = -x_m$ at time $t = 0$. The particle is at $x = +x_m$ when: [2011]
- (a) $t = 0.25 T$ (b) $t = 0.50 T$
 (c) $t = 0.75 T$ (d) $t = 1.00 T$
25. The circular motion of a particle with constant speed is [2012]
- (a) periodic but not simple harmonic
 (b) simple harmonic but not periodic
 (c) periodic and simple harmonic
 (d) neither periodic nor simple harmonic
26. A child swinging on a swing in sitting position, stands up, then the time period of the swing will [2012]
- (a) increase
 (b) decrease
 (c) remains same
 (d) increases if the child is long and decreases if the child is short
27. A point particle of mass 0.1 kg is executing S.H.M. of amplitude of 0.1 m. When the particle passes through the mean position, its kinetic energy is 8×10^{-3} Joule. Obtain the equation of motion of this particle if this initial phase of oscillation is 45° . [2013]
- (a) $y = 0.1 \sin\left(\pm 4t + \frac{\pi}{4}\right)$
 (b) $y = 0.2 \sin\left(\pm 4t + \frac{\pi}{4}\right)$
 (c) $y = 0.1 \sin\left(\pm 2t + \frac{\pi}{4}\right)$
 (d) $y = 0.2 \sin\left(\pm 2t + \frac{\pi}{4}\right)$
28. The bob of a simple pendulum is a spherical hollow ball filled with water. A plugged hole near the bottom of the oscillating bob gets suddenly unplugged. During observation, till water is coming out, the time period of oscillation would [2013]
- (a) first decrease and then increase to the original value
 (b) first increase and then decrease to the original value
 (c) increase towards a saturation value
 (d) remain unchanged
29. $y = 2 \text{ (cm)} \sin\left[\frac{\pi t}{2} + \phi\right]$ what is the maximum acceleration of the particle doing the S.H.M. [2014]
- (a) $\frac{\pi}{2} \text{ cm/s}^2$ (b) $\frac{\pi^2}{2} \text{ cm/s}^2$
 (c) $\frac{\pi^2}{4} \text{ cm/s}^2$ (d) $\frac{\pi}{4} \text{ cm/s}^2$
30. Resonance is an example of [2014]
- (a) tuning fork (b) forced vibration
 (c) free vibration (d) damped vibration

31. Two particles are executing S.H.M. of same amplitude and frequency along the same straight line path. They pass each other when going in opposite directions, each time their displacement is half of their amplitude. What is the phase difference between them ? [2015]
 (a) $5\pi/6$ (b) $2\pi/3$
 (c) $\pi/3$ (d) $\pi/6$
32. The period of oscillation of a mass M suspended from a spring of negligible mass is T . If along with it another mass M is also suspended, the period of oscillation will now be [2016]
 (a) T (b) $T/\sqrt{2}$
 (c) $2T$ (d) $\sqrt{2}T$
33. Two, spring P and Q of force constants k_p and k_Q ($k_Q = \frac{k_p}{2}$) are stretched by applying forces of equal magnitude. If the energy stored in Q is E , then the energy stored in P is [2016]
 (a) E (b) $2E$
 (c) $E/2$ (d) $E/4$
34. A particle moves with simple harmonic motion in a straight line. In first τ s, after starting from rest, it travels a distance a , and in next τ s, it travels $2a$ in same direction then [2016]
 (a) amplitude of motion is $3a$
 (b) time period of oscillations is 8τ .
 (c) amplitude of motion is $4a$.
 (d) time period of oscillations is 6τ .
35. The amplitude of a damped oscillator decreases to 0.9 times its original magnitude in 5s. In another 10s it will decrease to α times its original magnitude, where α equals [2017]
 (a) 0.7 (b) 0.81
 (c) 0.729 (d) 0.6
36. **Assertion :** In simple harmonic motion, the motion is to and fro and periodic
Reason : Velocity of the particle $(v) = \omega\sqrt{k^2 - x^2}$ (where x is the displacement). [2002]
37. **Assertion :** The time-period of pendulum, on a satellite orbiting the earth is infinity.
Reason : Time-period of a pendulum is inversely proportional to $\sqrt{g}$. [2002]
38. **Assertion :** The amplitude of an oscillating pendulum decreases gradually with time
Reason : The frequency of the pendulum decreases with time. [2003]
- Directions for (Qs. 39-42) :** Each of these questions contains an Assertion followed by Reason. Read them carefully and answer the question on the basis of following options. You have to select the one that best describes the two statements.
- (a) If both Assertion and Reason are correct and Reason is the correct explanation of Assertion.
 (b) If both Assertion and Reason are correct, but Reason is not the correct explanation of Assertion.
 (c) If Assertion is correct but Reason is incorrect.
 (d) If both the Assertion and Reason are incorrect.
39. **Assertion :** In SHM, acceleration is always directed towards the mean position.
Reason : In SHM, the body has to stop momentarily at the extreme position and move back to mean position. [2009]
40. **Assertion :** For a particle performing SHM, its speed decreases as it goes away from the mean position.
Reason : In SHM, the acceleration is always opposite to the velocity of the particle. [2009]
41. **Assertion :** Resonance is a special case of forced vibration in which the natural frequency of vibration of the body is the same as the impressed frequency of external periodic force and the amplitude of forced vibration is maximum.
Reason : The amplitude of forced vibrations of a body increases with an increase in the frequency of the externally impressed periodic force. [2010]
42. **Assertion :** In simple harmonic motion, the velocity is maximum when the acceleration is minimum.
Reason : Displacement and velocity of S.H.M. differ in phase by $\frac{\pi}{2}$. [2014]

TYPE B : ASSERTION REASON QUESTIONS

Directions for (Qs. 36-38) : These questions consist of two statements, each printed as Assertion and Reason. While answering these questions, you are required to choose any one of the following five responses.

- (a) If both Assertion and Reason are correct and the Reason is a correct explanation of the Assertion.
 (b) If both Assertion and Reason are correct but Reason is not a correct explanation of the Assertion.
 (c) If the Assertion is correct but Reason is incorrect.
 (d) If both the Assertion and Reason are incorrect.
 (e) If the Assertion is incorrect but the Reason is correct.

HINTS & SOLUTIONS

Type A : Multiple Choice Questions

1. (a) We know that

$$T = 2\pi\sqrt{\frac{m}{K}} \Rightarrow n = \frac{1}{2\pi}\sqrt{\frac{K}{m}}$$

For a spring mass system.

In case I if K is the resultant spring constant, then

$$\frac{1}{K} = \frac{1}{k} + \frac{1}{k} = \frac{2}{k} \Rightarrow K = \frac{k}{2}$$

In case II, $K = k + k = 2k$

If n_1 & n_2 be frequencies in two cases, then

$$n_1 = \frac{1}{2\pi}\sqrt{\frac{k}{2m}}; \quad n_2 = \frac{1}{2\pi}\sqrt{\frac{2k}{m}};$$

$$\Rightarrow \frac{n_1}{n_2} = \sqrt{\frac{1}{4}} \Rightarrow \frac{n_1}{n_2} = \frac{1}{2}$$

2. (b) The expression of time period

$$T = 2\pi\sqrt{\frac{\ell}{g}}$$

This formula contains nothing which depends upon the nature of material from which bob is made of. So time period will remain the same.

3. (c)
- $T = 2\pi\sqrt{\frac{m}{K}} \Rightarrow 2 = 2\pi\sqrt{\frac{m}{K}}$

$$T' = 2\pi\sqrt{\frac{4m}{K}} \Rightarrow T' = 2 \times 2\pi\sqrt{\frac{m}{K}}$$

$$T' = 2 \times 2 = 4 \text{ sec}$$

4. (b)
- $v = \omega\sqrt{a^2 - u^2}$
- ; when
- $u = 0$
- ,
- $v = v_{\max}$
- .

$$\text{So, } v_{\max} = \omega a$$

[where ω is angular velocity and a is amplitude]

$$v_{\max} = \frac{2\pi}{T} \times a = \frac{2\pi}{2} \times \frac{50}{1000} = 0.16 \text{ m/sec}$$

5. (c) The possibility of the object to be detached from the platform is at the highest point when the platform starts going down. If it is less than
- g
- then object will not get away from the platform. So, maximum acceleration of platform under SHM is
- g
- . From formula, maximum acceleration under

$$\text{SHM} = \omega^2 a$$

$$\omega^2 a = g \Rightarrow \left(\frac{2\pi}{T}\right)^2 \times 3.92 \times 10^{-3} = 10$$

$$T = 2\pi\sqrt{\frac{3.92 \times 10^{-3}}{10}} = 2\pi\sqrt{3.92 \times 10^{-4}}$$

$$= 0.1256 \text{ secs.}$$

6. (a) For a particle under SHM,

$$\text{acceleration} = \omega^2 x$$

If $x = 0$ (at mean position), acceleration = 0

So, acceleration at the mean position is zero.

7. (c)
- $\omega = 3.5$
- radian/sec

maximum acceleration of a particle under SHM = $\omega^2 a$ where a is amplitude of oscillation.

$$\omega^2 a = 7.5 \Rightarrow (3.5)^2 a = 7.5$$

$$\Rightarrow a = \frac{7.5}{3.5 \times 3.5} \Rightarrow a = \frac{30}{49} = 0.61 \text{ m}$$

8. (a) This is case of spring in series, so

$$K = k_1 + k_2$$

$$T = 2\pi\sqrt{\frac{m}{(k_1 + k_2)}}$$

$$\Rightarrow n(\text{frequency}) = \frac{1}{2\pi}\sqrt{\frac{k_1 + k_2}{m}}$$

9. (a) For a vibrating spring
- $n = \frac{1}{2\pi}\sqrt{\frac{k}{m}}$

Now spring is cut into two pieces, so new spring constant $K' = 2k$

$$n' = \frac{1}{2\pi}\sqrt{\frac{2k}{m}} = n\sqrt{2}$$

10. (d)
- $T = 2\pi\sqrt{\frac{\ell}{g}} \Rightarrow T^2 = 4\pi^2 \frac{\ell}{g}$

Taking log on both sides,

$$2 \log T = \log 4\pi^2 + \log \ell - \log g,$$

Differentiating on both sides,

$$\frac{2}{T} dT = 0 + \frac{1}{\ell} d\ell - 0$$

$$\frac{dT}{T} = \frac{1}{2} \cdot \frac{d\ell}{\ell} \Rightarrow \frac{dT}{T} \times 100 = \frac{1}{2} \cdot \frac{d\ell}{\ell} \times 100$$

Percent increase in time period

$$= \frac{1}{2} \% \text{ increase in length}$$

$$= \frac{1}{2} \times 21 = 10.5\%$$

Percent increase in time period $\cong 10\%$

11. (b) $n = \frac{1}{2\pi} \sqrt{\frac{k}{m}}$

As springs are in parallel, total spring constant k of system of spring

$$\frac{1}{k} = \frac{1}{k_1} + \frac{1}{k_2} = \frac{k_1 + k_2}{k_1 k_2}$$

$$k = \frac{k_1 k_2}{(k_1 + k_2)}$$

$$n = \frac{1}{2\pi} \sqrt{\frac{k_1 k_2}{(k_1 + k_2)m}}$$

12. (c) For any spring-mass system time period of oscillation,

$$T = 2\pi \sqrt{\frac{m}{k}} \Rightarrow n = \frac{1}{2\pi} \sqrt{\frac{k}{m}}$$

In the present case total spring constt. $= k + 2k = 3k$.

$$n = \frac{1}{2\pi} \sqrt{\frac{3k}{m}}$$

13. (b) For spring block system, $n = \frac{1}{2\pi} \sqrt{\frac{k}{m}}$

Here two springs are joined in series so,

$$\text{total spring constant, } k_R = \frac{k_1 k_2}{k_1 + k_2}$$

$$k_R = \frac{k \cdot k}{2k} = \frac{k}{2}$$

$$\text{So, } n = \frac{1}{2\pi} \sqrt{\frac{k}{2m}}$$

14. (a) $\sin \omega t - \cos \omega t = \sqrt{2} \left[\frac{1}{\sqrt{2}} \sin \omega t - \frac{1}{\sqrt{2}} \cos \omega t \right]$

$$= \sqrt{2} \left[\cos \frac{\pi}{4} \cdot \sin \omega t - \sin \frac{\pi}{4} \cos \omega t \right]$$

$$= \sqrt{2} \sin(\omega t - \pi/4)$$

which represents simple harmonic motion.

15. (a) Frequency of SHM,

$$v = \frac{1}{2\pi} \sqrt{\frac{\text{acceleration}}{\text{displacement}}} = \frac{1}{2\pi} \sqrt{\frac{a}{x}}$$

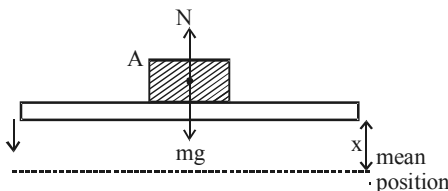
$$\Rightarrow v = \frac{1}{2\pi} \sqrt{\frac{k}{m}}$$

$$\Rightarrow \frac{k}{m} = \frac{a}{x} \Rightarrow \frac{k}{a} = \frac{m}{x} \Rightarrow v = \frac{1}{2\pi} \sqrt{\frac{m}{x}}$$

$$v = \frac{1}{2\pi} \sqrt{\frac{10}{10^{-2}}} = \sqrt{\frac{10^3}{2\pi}} = \frac{10\sqrt{10}}{2\pi}$$

$$= \frac{10 \times 3.16}{2 \times 3.14} = 5 \text{ Hz}$$

16. (b) For block A to move in SHM.



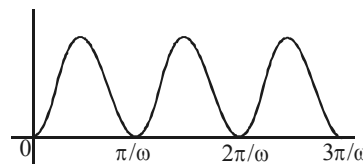
$$mg - N = m\omega^2 x$$

where x is the distance from mean position

For block to leave contact $N = 0$

$$\Rightarrow mg = m\omega^2 x \Rightarrow x = \frac{g}{\omega^2}$$

17. (a) Clearly $\sin^2 \omega t$ is a periodic function as $\sin \omega t$ is periodic with period π / ω



For SHM $\frac{d^2y}{dt^2} \propto -y$

$$\frac{dy}{dt} = 2\omega \sin \omega t \cos \omega t = \omega \sin 2\omega t$$

$$\frac{d^2y}{dt^2} = 2\omega^2 \cos 2\omega t \text{ which is not proportional to } -y. \text{ Hence it is not in SHM.}$$

18. (a) $V(x) = k|x|^3$

$$\text{since, } F = -\frac{dV(x)}{dx} = -3k|x|^2 \quad \dots(1)$$

$$x = a \sin(\omega t)$$

This equation always fits to the differential equation

$$\frac{d^2x}{dt^2} = -\omega^2 x \text{ or } m \frac{d^2x}{dt^2} = -m\omega^2 x$$

$$\Rightarrow F = -m\omega^2 x \quad \dots(2)$$

Equation (1) and (2) give

$$-3k|x|^2 = -m\omega^2 x$$

$$\Rightarrow \omega = \sqrt{\frac{3kx}{m}} = \sqrt{\frac{3ka}{m}} [\sin(\omega t)]^{1/2}$$

$$\Rightarrow \omega \propto \sqrt{a} \Rightarrow T \propto \frac{1}{\sqrt{a}}$$

19. (a) $x = A \sin\left(\frac{2\pi}{T}t\right)$

$$\Rightarrow \text{distance covered in time } t = \frac{T}{4} = A$$

$$\Rightarrow \text{average speed} = \frac{A}{T/4} = \frac{4A}{T}$$

20. (d) Time period of a simple pendulum is given by

$$T = 2\pi\sqrt{\frac{l}{g}} \text{ or } T \propto \sqrt{\frac{l}{g}}$$

when the elevator is accelerating downwards, the net gravitational acceleration is $(g - a)$, so, the time period when elevation is accelerating downwards, is greatest.

21. (d) According to the formula of Young's Modulus

$$E = \frac{FL}{A\Delta L}$$

where ΔL is the extension in the spring.

$$F = \frac{EA\Delta L}{L} \quad \dots(1)$$

Now, according to Hooke's law

$$F = k\Delta L \quad \dots(2)$$

where k is the spring constant

By comparing (1) and (2)

$$k\Delta L = \frac{EA\Delta L}{L}$$

$$k = \frac{EA}{L}$$

$$\text{Time period, } T = 2\pi\sqrt{\frac{M}{k}}$$

$$T = 2\pi\sqrt{\frac{ML}{EA}}$$

22. (a) $T = 2\pi\sqrt{\frac{L}{g}}$

i.e., time period of a simple pendulum depends upon effective length and acceleration due to gravity, not on mass.

So, $T = 2$ sec.

23. (a) $y = r \sin \omega t$

$$12.5 = 25 \sin \frac{2\pi}{3} \times t \quad \left(\because \omega = \frac{2\pi}{T} \right)$$

$$\frac{\pi}{6} = \frac{2\pi}{3} t$$

$$t = \frac{1}{4} \text{ sec} = 0.25 \text{ sec}$$

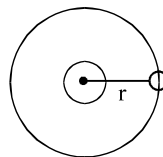
$$t' = 2t$$

$$= 2 \times 0.25 = 0.5 \text{ sec}$$

for either side

24. (b) The time taken by particle from left extreme to right extreme = $0.5 T$.

25. (a) In circular motion of a particle with constant speed, particle repeats its motion after a regular interval of time but does not oscillate about a fixed point. So, motion of particle is periodic but not simple harmonic.



26. (b) $T = 2\pi\sqrt{l_{\text{eff}}/g}$; l_{eff} decreases when the child stands up.

27. (a) The displacement of a particle in S.H.M. is given by
 $y = a \sin(\omega t + \phi)$

$$\text{velocity} = \frac{dy}{dt} = \omega a \cos(\omega t + \phi)$$

The velocity is maximum when the particle passes through the mean position i.e.,

$$\left(\frac{dy}{dt}\right)_{\text{max}} = \omega a$$

The kinetic energy at this instant is given by

$$\frac{1}{2} m \left(\frac{dy}{dt}\right)_{\text{max}}^2 = \frac{1}{2} m \omega^2 a^2 = 8 \times 10^{-3} \text{ joule}$$

$$\text{or} \quad \frac{1}{2} \times (0.1) \omega^2 \times (0.1)^2 = 8 \times 10^{-3}$$

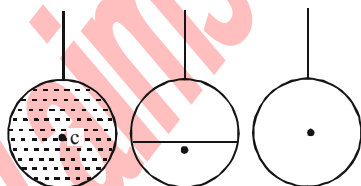
Solving we get $\omega = \pm 4$

Substituting the values of a , ω and ϕ in the equation of S.H.M., we get
 $y = 0.1 \sin(\pm 4t + \pi/4)$ metre.

28. (b) Centre of mass of combination of liquid and hollow portion (at position ℓ), first goes down (to $\ell + \Delta\ell$) and when total water is drained out, centre of mass regain its original position (to ℓ),

$$T = 2\pi\sqrt{\frac{\ell}{g}}$$

$\therefore$ 'T' first increases and then decreases to original value.



29. (b) $y = 2 \sin\left(\frac{\pi t}{2} + \phi\right)$

$$\text{velocity of particle} \frac{dy}{dt} = 2 \times \frac{\pi}{2} \cos\left(\frac{\pi t}{2} + \phi\right)$$

$$\text{acceleration} \frac{d^2y}{dt^2} = -\frac{\pi^2}{2} \sin\left(\frac{\pi t}{2} + \phi\right)$$

$$\text{Thus } a_{\text{max}} = \frac{\pi^2}{2}$$

30. (b)

31. (b) $y = a \sin(\omega t + \phi)$; when $y = a/2$,

$$\text{then } \frac{a}{2} = a \sin(\omega t + \phi)$$

$$\text{or } \sin(\omega t + \phi) = \frac{1}{2} = \sin \frac{\pi}{6} \text{ or } \sin \frac{5\pi}{6}$$

So phase of two particles is $\pi/6$ and $5\pi/6$ radians

$$\text{Hence phase difference} = (5\pi/6) - \pi/6 = 2\pi/3$$

$$32. (d) T = 2\pi\sqrt{\frac{m}{K}} \quad \therefore \frac{T_1}{T_2} = \sqrt{\frac{M_1}{M_2}}$$

$$T_2 = T_1 \sqrt{\frac{M_2}{M_1}} = T_1 \sqrt{\frac{2M}{M}}$$

$$T_2 = T_1 \sqrt{2} = \sqrt{2} T \text{ (where } T_1 = T)$$

33. (c) Here, $k_Q = \frac{k_p}{2}$

According to Hooke's law

$$\therefore F_p = -k_p x_p$$

$$F_Q = -k_Q x_Q \Rightarrow \frac{F_p}{F_Q} = \frac{k_p x_p}{k_Q x_Q}$$

$$F_p = F_Q \text{ [Given]}$$

$$\therefore \frac{x_p}{x_Q} = \frac{k_Q}{k_p} \quad \dots(i)$$

$$\text{Energy stored in a spring is } U = \frac{1}{2} kx^2$$

$$\therefore \frac{U_p}{U_Q} = \frac{k_p x_p^2}{k_Q x_Q^2} = \frac{k_p}{k_Q} \times \frac{k_Q^2}{k_p^2} = \frac{1}{2} \left[\because k_Q = \frac{k_p}{2} \right]$$

$$\Rightarrow U_p = \frac{U_Q}{2} = \frac{E}{2} \quad [\because U_Q = E]$$

34. (d) As it starts from rest, we have,

$$x = A \cos \omega t. \text{ At } t = 0, x = A$$

$$\text{When } t = \tau, x = A - a \text{ and}$$

$$\text{when } t = 2\tau, x = A - 3a$$

$$\Rightarrow A - a = A \times \cos \times \omega \tau \text{ and} \quad \dots(i)$$

$$A - 3a = A \times \cos \times 2\omega \tau \quad \dots(ii)$$

- As, $\cos 2\omega\tau = 2\cos^2\omega\tau - 1$,
- $$\Rightarrow \frac{A-3a}{A} = 2\left(\frac{A-a}{A}\right)^2 - 1$$
- $$\therefore \frac{A-3a}{A} = \frac{2A^2 + 2a^2 - 4Aa - A^2}{A^2}$$
- $$\therefore A^2 - 3aA = A^2 + 2a^2 - 4Aa$$
- $$\therefore a^2 = 2aA \Rightarrow A = 2a$$
- Now, $A - a = A \times \cos \times \omega\tau$ [From (i)]
- $$\Rightarrow \cos \times \omega\tau = \frac{1}{2}$$
- $$\therefore \frac{2\pi}{T} \tau = \frac{\pi}{3} \Rightarrow T = 6\tau$$
35. (c) $\therefore A = A_0 e^{-\frac{bt}{2m}}$ (where, A_0 = maximum amplitude)
According to the questions, after 5 seconds,
- $$0.9A_0 = A_0 e^{-\frac{b(5)}{2m}} \quad \dots (i)$$
- After 10 more seconds,
- $$A = A_0 e^{-\frac{b(15)}{2m}} \quad \dots (ii)$$
- From equations (i) and (ii)
 $A = 0.729 A_0$
 $\therefore \alpha = 0.729$

Type B : Assertion Reason Questions

36. (b) SHM is to and fro motion of an object and it is periodic.
 $v = \omega\sqrt{k^2 - x^2}$
 If $x = 0$, v has maximum value. At $x = k$, v has minimum velocity. Similarly, when $x = -k$, v has zero value, all these indicate to & fro movement.
37. (a) Time period of pendulum in a satellite is infinity. It means it may not oscillate as apparent value of g is zero. So, time period being $\propto \frac{1}{\sqrt{g}} \propto \sqrt{\infty}$
38. (c) The amplitude of an oscillating pendulum decreases with time due to friction of air. In absence of air, its frequency and amplitude will remain constant.

39. (b) SHM is basically to and fro motion about the mean position. So when the body goes away from mean position an acceleration always try to return the body towards mean position. As the acceleration in SHM is always in opposite phase to that of displacement. The displacement of the particle in SHM at an instant is directed away from the mean position then acceleration at that instant is directed towards the mean position.

40. (c) Speed = $\omega \sqrt{A^2 - x^2}$
 as $|x|$ increases $\Rightarrow$ speed decreases
 Acceleration is in direction of speed as it comes towards mean position.

41. (c) The amplitude become large when the frequency of the driving force (ω) is near the natural frequency of oscillation or when $\omega \approx \omega_0$. This frequency is known as resonance frequency. Amplitude of oscillation for a forced, damped oscillator is

$$A = \frac{F_0 / m}{\sqrt{(\omega^2 - \omega_0^2) + (b\omega / m)^2}}$$

where b is constant related to the strength of the resistive force, $\omega_0 = \sqrt{k/m}$ is natural frequency of undamped oscillator ($b = 0$).

42. (b) At the middle point velocity of the particle under SHM is maximum but acceleration is zero since displacement is zero. So Assertion is true.

We know that $x = a \sin \omega t$...(1)

Where x is displacement and a is amplitude.

$$\text{Velocity} = \frac{dx}{dt} = a\omega \cos \omega t$$

$$= a\omega \cos(-\omega t) = a\omega \sin\left(\frac{\pi}{2} - (-\omega t)\right)$$

$$= a\omega \sin\left(\omega t + \frac{\pi}{2}\right) \quad \dots (2)$$

From equation (i) and (ii) it is clear that

Velocity is ahead of displacement (x) by $\frac{\pi}{2}$ angle.

Chapter

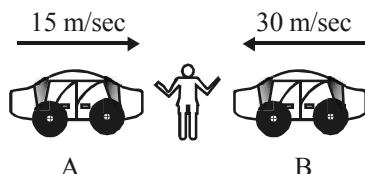
14

Waves

TYPE A : MULTIPLE CHOICE QUESTIONS

- At which temperature velocity of sound (at 27°C) doubles? [1997, 2002]
 (a) 327°C (b) 927°C
 (c) 54°C (d) -123°C
- The wave equation is $y = 0.30 \sin(314t - 1.57x)$ where t , x and y are in second, metre and centimetre respectively. The speed of the wave is [1997]
 (a) 400 m/s (b) 100 m/s
 (c) 200 m/s (d) 50 m/s
- An object producing a pitch of 1200 Hz is moving with a velocity of 50 m/s towards a stationary person. The velocity of sound is 350 m/s. The frequency of sound heard by the stationary person is : [1997]
 (a) 1250 Hz (b) 1050 Hz
 (c) 700 Hz (d) 1400 Hz
- The air column in a pipe which is closed at one end will be in resonance with a vibrating tuning fork at a frequency 260 Hz. The length of the air column is : [1997]
 (a) 12.5 cm (b) 35.75 cm
 (c) 31.92 cm (d) 62.5 cm
- Standing waves are produced in 10 m long stretched string. If the string vibrates in 5 segments and wave velocity is 20 m/s, then its frequency will be : [1998]
 (a) 5 Hz (b) 2 Hz
 (c) 10 Hz (d) 2 Hz
- Newton's formula for the velocity of sound in gas is : [1998]
 (a) $v = \sqrt{\frac{P}{\rho}}$ (b) $v = \frac{2}{3} \sqrt{\frac{P}{\rho}}$
 (c) $v = \sqrt{\frac{\rho}{P}}$ (d) $v = \sqrt{\frac{2P}{\rho}}$
- The equation of a travelling wave is $y = 60 \cos(1800t - 6x)$ where y is in microns, t in second and x in metre. The ratio of maximum particle velocity to the velocity of wave propagation is : [1998]
 (a) 3.6×10^{-4} (b) 3.6×10^{-6}
 (c) 3.6×10^{-8} (d) none of these
- The waves in which the particles of the medium vibrate in a direction perpendicular to the direction of wave motion is known as : [1998]
 (a) longitudinal waves (b) propagated waves
 (c) transverse wave (d) none of these
- Energy is not carried by which of the following wave? [1999]
 (a) Progressive (b) Electromagnetic
 (c) Transverse (d) Stationary
- If the vibrations of a string are to be increased by a factor of two, then tension in the string should be made : [1999]
 (a) Twice (b) Four times
 (c) Eight times (d) Half
- A resonance in air column of length 20 cm resonates with a tuning fork of frequency 450 Hz. Ignoring end correction, the velocity of sound in air is: [1999]
 (a) 1020 m/s (b) 720 m/s
 (c) 620 m/s (d) 820 m/s
- A transverse wave passes through a string with the equation : $y = 10 \sin \pi(0.02x - 2.00t)$ where x is in metre and t in second. The maximum velocity of the particle in wave motion is : [2000]
 (a) 100 m/s (b) 63 m/s
 (c) 120 m/s (d) 161 m/s
- A wave is represented by the equation $y = a \sin(0.01x - 2t)$ where a and x are in cm and t in second. Velocity of propagation of the wave is : [2000]
 (a) 200 cm/sec (b) 10 cm/sec
 (c) 25 cm/sec (d) 50 cm/sec

14. Two cars A and B approach a stationary observer from opposite sides as shown in fig. Observer hears no beats. If the frequency of the horn of the car B is 504 Hz, the frequency of horn of car A will be :

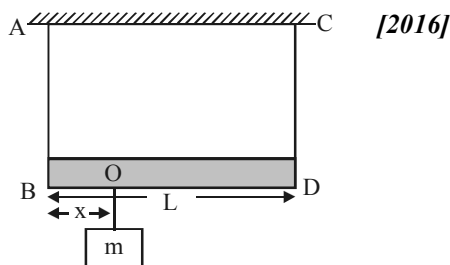


- (a) 529.2 Hz (b) 295.2 Hz [2000]
(c) 440.5 Hz (d) none of these
15. The tension in a piano wire is 10 N. The tension in a piano wire to produce a node of double frequency is : [2001]
(a) 20 N (b) 40 N
(c) 10 N (d) 120 N
16. Two sound waves have phase difference of 60° , then they will have the path difference of :
(a) 3λ (b) $\frac{\lambda}{3}$ [2001]
(c) $\frac{\lambda}{6}$ (d) λ
17. A sings with a frequency (n) and B sings with a frequency $1/8$ that of A. If the energy remains the same and the amplitude of A is a, then amplitude of B will be : [2001]
(a) 2a (b) 8a
(c) 4a (d) a
18. If equation of sound wave is $y = 0.0015 \sin (62.4 x + 316t)$, then its wavelength will be [2002]
(a) 2 unit (b) 0.3 unit
(c) 0.1 unit (d) 0.2 unit
19. A siren emitting sound of frequency 800 Hz is going away from a static listener with a speed of 30 m/s. Frequency of the sound to be heard by the listener is (Take velocity of sound = 300 m/s)
(a) 286.5 Hz (b) 481.2 Hz [2002]
(c) 733.3 Hz (d) 644.8 Hz
20. The velocities of sound at the same temperature in two monoatomic gases of densities ρ_1 and ρ_2 are v_1 and v_2 respectively. If $\rho_1/\rho_2 = 4$, then the value of v_1/v_2 is [2002]
(a) 4 (b) 2
(c) $\frac{1}{2}$ (d) $\frac{1}{4}$
21. A string in a musical instrument is 50 cm long and its fundamental frequency is 800 Hz. If a frequency of 1000 Hz is to be produced, then required length of string is [2002]
(a) 37.5 cm (b) 40 cm
(c) 50 cm (d) 62.5 cm
22. An earthquake generates both transverse (S) and longitudinal (P) sound waves in the earth. The speed of S waves is about 4.5 km/s and that of P waves about 8.0 km/s. A seismograph records P and S waves from an earthquake. The first P wave arrives 4.0 min. before the first S wave. The epicenter of the earthquake is located at a distance of about : [2003]
(a) 25 km (b) 250 km
(c) 2500 km (d) 5000 km
23. An organ pipe closed at one end has fundamental frequency of 1500 Hz. The maximum number of overtones generated by this pipe which a normal person can hear is [2004]
(a) 4 (b) 13
(c) 6 (d) 9
24. The wave produced by a motor boat sailing in water are [2004]
(a) transverse
(b) longitudinal
(c) longitudinal and transverse
(d) stationary
25. A boat at anchor is rocked by waves whose crests are 100 m apart and velocity is 25 m/sec. The boat bounces up once in every: [2006]
(a) 2500 s (b) 75 s
(c) 4s (d) 0.25 s
26. A stone thrown into still water, creates a circular wave pattern moving radially outwards. If r is the distance measured from the centre of the pattern, the amplitude of the wave varies as : [2006]
(a) $r^{-1/2}$ (b) r^{-1}
(c) r^{-2} (d) $r^{-3/2}$
27. When a guitar string is sounded with a 440 Hz tuning fork, a beat frequency of 5 Hz is heard. If the experiment is repeated with a tuning fork of 437 Hz, the beat frequency is 8 Hz. The string frequency (Hz) is : [2006]
(a) 445 (b) 435
(c) 429 (d) 448

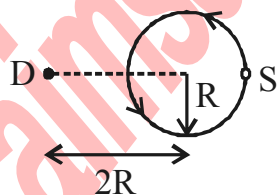
28. For a wave propagating in a medium, identify the property that is independent of the others:
 (a) velocity [2006]
 (b) wavelength
 (c) frequency
 (d) all these depend on each other
29. A string is stretched between fixed points separated by 75.0 cm. It is observed to have resonant frequencies of 420 Hz and 315 Hz. There are no other resonant frequencies between these two. Then, the lowest resonant frequency for this string is [2008]
 (a) 105 Hz (b) 1.05 Hz
 (c) 1050 Hz (d) 10.5 Hz
30. A person speaking normally produces a sound intensity of 40 dB at a distance of 1 m. If the threshold intensity for reasonable audibility is 20 dB, the maximum distance at which he can be heard clearly is [2008]
 (a) 4m (b) 5m
 (c) 10m (d) 20m
31. A wave on a string is travelling and the displacement of particles on it is given by $x = A \sin(2t - 0.1x)$. Then the wavelength of the wave is [2009]
 (a) 10π (b) 20π
 (c) 40π (d) 20
32. A tuning fork of frequency 340 Hz is vibrated just above the tube of 120 cm height. Water is poured slowly in the tube. What is the minimum height of water necessary for the resonance? (speed of sound in air = 340 m/s) [2009]
 (a) 45 cm (b) 30 cm
 (c) 40 cm (d) 25 cm
33. The velocity of sound in a gas at pressure P and density d is [2009]
 (a) $v = \sqrt{\frac{\gamma P}{d}}$ (b) $v = \sqrt{\frac{P}{\gamma d}}$
 (c) $v = \sqrt{\frac{P}{d}}$ (d) $v = \sqrt{\frac{2P}{d}}$
34. The expression $y = a \sin bx \sin \omega t$ represents a stationary wave. The distance between the consecutive nodes is equal to : [2011]
 (a) π/b (b) $2\pi/b$
 (c) $\pi/2b$ (d) $1/b$
35. An open and closed organ pipe have the same length. The ratio of pth mode of frequency of vibration of two pipes is [2012]
 (a) 1 (b) p
 (c) $p(2p+1)$ (d) $\frac{2p}{(2p-1)}$
36. When two tuning forks (fork 1 and fork 2) are sounded simultaneously, 4 beats per second are heard. Now, some tape is attached on the prong of the fork 2. When the tuning forks are sounded again, 6 beats per second are heard. If the frequency of fork 1 is 200 Hz, then what was the original frequency of fork 2? [2012]
 (a) 202 Hz (b) 200 Hz
 (c) 204 Hz (d) 196 Hz
37. A sound absorber attenuates the sound level by 20 dB. The intensity decreases by a factor of [2012]
 (a) 100 (b) 1000
 (c) 10000 (d) 10
38. A fork of frequency 256 Hz resonates with a closed organ pipe of length 25.4 cm. If the length of pipe be increased by 2 mm, the number of beats/sec. will be [2014]
 (a) 4 (b) 1
 (c) 2 (d) 3
39. The equation of a progressive wave is

$$y = 0.02 \sin 2\pi \left[\frac{t}{0.01} - \frac{x}{0.30} \right]$$
 Here x and y are in metre and t is in second. The velocity of propagation of the wave is [2014]
 (a) 300 m s^{-1} (b) 30 m s^{-1}
 (c) 400 m s^{-1} (d) 40 m s^{-1}
40. Two waves of wavelengths 99 cm and 100 cm both travelling with velocity 396 m/s are made to interfere. The number of beats produced by them per second is [2015]
 (a) 1 (b) 2
 (c) 4 (d) 8

41. A massless rod of length L is suspended by two identical strings AB and CD of equal length. A block of mass m is suspended from point O such that BO is equal to ' x '. Further it is observed that the frequency of 1st harmonic in AB is equal to 2nd harmonic frequency in CD. ' x ' is



- (a) $\frac{L}{5}$ (b) $\frac{4L}{5}$
 (c) $\frac{3L}{4}$ (d) $\frac{L}{4}$
42. Two similar open organ pipe of length 50 cm and 50.5 cm produce 3 beats per second when sounded together. The velocity of sound in air is [2016]
 (a) 303 m/s (b) 330 m/s
 (c) 151.5 m/s (d) 603 m/s
43. A whistle S of frequency f revolves in a circle of radius R at a constant speed v . What is the ratio of largest and smallest frequency detected by a detector D at rest at a distance $2R$ from the centre of circle as shown in figure? [2016]
 (take c as speed of sound)



- (a) $\left(\frac{c+v}{c-v}\right)$ (b) $\sqrt{2}\left(\frac{c+v}{c-v}\right)$
 (c) $\sqrt{2}$ (d) $\frac{(c+v)}{c\sqrt{2}}$

44. A train moving at a speed of 220 ms^{-1} towards a stationary object, emits a sound of frequency 1000 Hz. Some of the sound reaching the object gets reflected back to the train as echo. The frequency of the echo as detected by the driver of the train is (speed of sound in air is 330 ms^{-1}) [2017]
 (a) 3500 Hz (b) 4000 Hz
 (c) 5000 Hz (d) 3000 Hz

TYPE B : ASSERTION REASON QUESTIONS

Directions for (Qs. 45-49) : These questions consist of two statements, each printed as Assertion and Reason. While answering these questions, you are required to choose any one of the following five responses.

- (a) If both Assertion and Reason are correct and the Reason is a correct explanation of the Assertion.
 (b) If both Assertion and Reason are correct but Reason is not a correct explanation of the Assertion.
 (c) If the Assertion is correct but Reason is incorrect.
 (d) If both the Assertion and Reason are incorrect.
 (e) If the Assertion is incorrect but the Reason is correct.

45. **Assertion :** Sound travels faster in solids than gases.

Reason : Solids possess greater density than gases. [2000]

46. **Assertion :** Speed of wave = $\frac{\text{wavelength}}{\text{time period}}$

Reason : Wavelength is the distance between two nearest particles in phase. [2002]

47. **Assertion :** When a beetle moves along the sand within a few tens of centimeters of a sand scorpion, the scorpion immediately turns towards the beetle and dashes towards it

Reason : When a beetle disturbs the sand, it sends pulses along the sand's surface. One set of pulses is longitudinal while the other set is transverse. [2003]

48. **Assertion :** Sound waves cannot travel in vacuum but light can travel in vacuum.

Reason : Sound waves are longitudinal waves and they cannot be polarised but electromagnetic waves are transverse and they can be polarised. [2007]

49. **Assertion :** The change in air pressure affects the speed of sound.

Reason : The speed of sound in gases is proportional to the square of pressure. [2008]

Directions for (Qs. 50-56) : Each of these questions contains an Assertion followed by Reason. Read them carefully and answer the question on the basis of following options. You have to select the one that best describes the two statements.

- (a) If both Assertion and Reason are correct and Reason is the correct explanation of Assertion.
- (b) If both Assertion and Reason are correct, but Reason is not the correct explanation of Assertion.
- (c) If Assertion is correct but Reason is incorrect.
- (d) If both the Assertion and Reason are incorrect.

50. **Assertion :** The pitch of wind instruments rises and that of string instruments falls as an orchestra warms up.

Reason : When temperature rises, speed of sound increases but speed of wave in a string fixed at both ends decreases. [2009]

51. **Assertion :** For the formation of stationary waves the medium must be bounded having definite boundaries.

Reason : In the stationary wave, some particles of the medium remain permanently at rest. [2010]

52. **Assertion :** A transverse waves are produced in a very long string fixed at one end. Only progressive wave is observed near the free end.

Reason : Energy of reflected wave does not reach the free end. [2013]

53. **Assertion :** Doppler formula for sound wave is symmetric with respect to the speed of source and speed of observer.

Reason : Motion of source with respect to stationary observer is not equivalent to the motion of an observer with respect to stationary source. [2014]

54. **Assertion :** Two waves moving in a uniform string having uniform tension cannot have different velocities.

Reason : Elastic and inertial properties of string are same for all waves in same string. Moreover speed of wave in a string depends on its elastic and inertial properties only. [2015]

55. **Assertion :** The base of Laplace correction was that exchange of heat between the region of compression and rarefaction in air is negligible.

Reason : Air is bad conductor of heat and velocity of sound in air is quite large. [2016]

56. **Assertion :** The fundamental frequency of an open organ pipe increases as the temperature is increased.

Reason : As the temperature increses, the velocity of sound increases more rapidly than length of the pipe. [2017]

HINTS & SOLUTIONS

Type A : Multiple Choice Questions

1. (b) Velocity of sound $\propto \sqrt{T}$ (where T is temperature of body in absolute scale).

$$\frac{v_1}{v_2} = \sqrt{\frac{T_1}{T_2}} \Rightarrow \frac{2v}{v} = \sqrt{\frac{t+273}{27+273}}$$

$$4 = \frac{t+273}{300} \Rightarrow t+273 = 1200$$

$$\Rightarrow t = 927^\circ \text{C}$$

2. (c) Given equation $y = 0.30 \sin(314t - 1.57x)$
Comparing it with standard equation of wave,

$$y = a \sin(\omega t - kx)$$

$$\omega = 314; k = 1.57$$

$$v = \frac{\omega}{k} \Rightarrow v = \frac{314}{1.57} = 200 \text{ m/sec}$$

3. (d) If n_a be the apparent frequency, then

$$n_a = n \times \frac{v_s}{(v_s - v_0)} = \frac{1200 \times 350}{(350 - 50)}$$

$$= \frac{1200 \times 350}{300} = 1400 \text{ Hz}$$

4. (c) For fundamental frequency

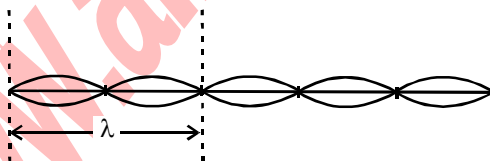
$$n = \frac{v}{\lambda} \text{ \& \ } \frac{\lambda}{4} = \ell \Rightarrow \lambda = 4\ell$$

$$n = \frac{v}{4\ell} \Rightarrow 260 = \frac{330}{4\ell}$$

$$\Rightarrow \ell = \frac{330}{260 \times 4} = 0.3173 \text{ m}$$

$$\ell = 31.73 \text{ cm} \sim 31.92 \text{ cm (given in option)}$$

5. (a)



There are 5 loops in 10 metre.

Length of one loop = 2 m

Length of two loops = $2 \times 2 = 4 \text{ m}$

Now, $\lambda = 4 \text{ m}$; $v = 20 \text{ m/sec}$

From formula

$$v = v\lambda \Rightarrow 20 = v \times 4 \Rightarrow v = 5 \text{ Hz}$$

6. (a) Newton's formula for velocity of sound in gas

$$v = \sqrt{\frac{P}{\rho}} \text{ where } P \text{ is pressure \& } \rho \text{ is density of gas.}$$

7. (a) $y = 60 \cos(1800t - 6x)$, y is in microns.

$$y = 60 \cos(1800t - 6x) \times 10^{-6}$$

$$v = \frac{dy}{dt} = \text{particle velocity}$$

$$= 60 \times 10^{-6} \times 1800 \sin(1800t - 6x)$$

$$v_{\max} = 6 \times 18 \times 10^{-3}$$

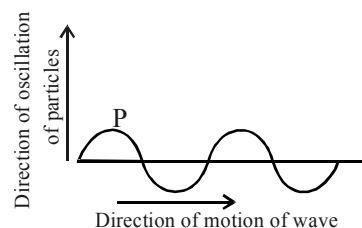
$$v_{\text{wave}} = \frac{\omega}{k}; \omega = 1800; K = 6$$

$$v_{\text{wave}} = \frac{1800}{6} = 300$$

$$\frac{v_{\max}}{v_{\text{wave}}} = \frac{6 \times 18 \times 10^{-3}}{300}$$

$$= 36 \times 10^{-5} = 3.6 \times 10^{-4}$$

8. (c) Transverse waves have particles oscillating perpendicular to the direction of motion of wave. Ripple in the surface of water is transverse in nature.



9. (d) Stationary waves do not carry energy with it as it is stationary or does not change position.

10. (b) We know that, $n = \frac{1}{2} \sqrt{\frac{T}{m}} \Rightarrow n \propto \sqrt{T}$

If tension is increased four times, the frequency will become twice.

11. (b) Let the air column be closed one.
In closed organ pipe for fundamental node of vibration, $\frac{\lambda}{4} = 0.2 \Rightarrow \lambda = 0.8\text{m}$,
 $v = n\lambda$
If we take the frequency of air column to be equal to tuning fork then,
 $v = 450 \times 0.8 = 360 \text{ m/sec}$
If we take the frequency of air column to be twice that of tuning fork then,
 $v = 900 \times 0.8 = 720 \text{ m/sec}$
This matches with alternative (b).
12. (b) The equation of wave
 $y = 10 \sin \pi(0.02x - 2t)$
Particle velocity,
 $\frac{dy}{dt} = 10 \cos \pi(0.02x - 2t) \times \pi \times 0.2$
 $= 0.63 \cos \pi(0.02x - 2t)$
Maximum value of velocity = 63 m/sec.
13. (a) In the wave of the form
 $y = \sin(\omega t - kx)$
Velocity $v = \frac{\omega}{k}$
Here $\omega = 2$; $k = 0.01$
 $v = \frac{\omega}{k} = \frac{2}{0.01} = 200 \text{ cm/sec}$
14. (a) Since, the person hears no beats therefore their apparent frequency are the same.
So, $n \times \frac{330}{330 - 15} = 504 \times \frac{330}{330 - 30}$
 $n = \frac{504 \times 315}{300} = 529.2 \text{ Hz}$
15. (b) For frequency of oscillation of wire.
 $n \propto \sqrt{T}$, Here T is tension in the wire.
In order to increase frequency twice, tension needs to be made 4 times. So, new tension must be $4 \times 10 = 40 \text{ N}$
16. (c) Path diff. $= \frac{\lambda}{2\pi} \times \text{phase difference}$
 $= \frac{\lambda}{2\pi} \times \frac{\pi}{3} = \frac{\lambda}{6}$
17. (b) Energy of sound wave $= 2\pi^2 v^2 a^2 v \rho$
 v is frequency and v is velocity of sound;
 ρ is density of air or any other medium.
Now, $E_1 = 2\pi^2 v^2 a^2 v \rho$
 $E_2 = 2\pi^2 \left(\frac{v}{8}\right)^2 A^2 v \rho$ $E_1 = E_2$
 $2\pi^2 v^2 a^2 v \rho = 2\pi^2 \frac{v^2}{64} A^2 v \rho$
 $A^2 = 64a^2$ $A = 8a$
18. (c) $y = 0.0015 \sin(62.8x + 314t)$
Comparing it with the equation
 $y = a \sin(\omega t + kx)$
 $\omega = 314$, $k = 62.8$
 $k = \frac{2\pi}{\lambda} = 62.8 \Rightarrow \lambda = \frac{2\pi}{62.8} = 0.1 \text{ unit.}$
19. (c) Since, the source is going away from listener
 $n' = n \times \frac{v}{v + u} = 800 \times \frac{330}{(330 + 30)}$
 $n' = 800 \times \frac{330}{360} = 733.33 \text{ Hz}$
20. (c) For velocity of sound in gas
 $v = \sqrt{\frac{\gamma P}{\rho}}$
[P is pressure and ρ is density of gas, γ is C_p/C_v]
Here, $v_1 = \sqrt{\frac{\gamma P}{\rho_1}}$ and $v_2 = \sqrt{\frac{\gamma P}{\rho_2}}$
 $\frac{v_1}{v_2} = \sqrt{\frac{\rho_2}{\rho_1}} = \sqrt{\frac{1}{4}} = \frac{1}{2}$
21. (b) We know that for frequency of sound in string the formula is, $v = \frac{1}{2\ell} \sqrt{\frac{T}{m}}$ or $v = \frac{1}{\ell}$
 $\frac{v_1}{v_2} = \frac{\ell_2}{\ell_1} \Rightarrow \frac{800}{1000} = \frac{\ell_2}{50}$
 $\ell_2 = 50 \times \frac{800}{1000} = 40 \text{ cm}$
22. (c) Let d be the distance of epicenter.
Time taken by S-wave $= \frac{d}{4.5}$

$$\text{Time taken by P-wave} = \frac{d}{8}$$

$$\text{Now } \frac{d}{4.5} - \frac{d}{8} = 4 \times 60$$

$$d \left[\frac{10}{45} - \frac{1}{8} \right] = 4 \times 60$$

$$\Rightarrow d = \frac{4 \times 60 \times 8 \times 45}{35}$$

$$= \frac{240 \times 72}{7} = \frac{17280}{7} = 2468.5 \approx 2500 \text{ km.}$$

23. (c) In an organ pipe only odd harmonics are found. So, frequency equal to odd multiple of 1500 Hz may be found in this case. Maximum audible frequency is 20,000 Hz. So, possible frequency are 1500 Hz, 4500 Hz, 7500 Hz, 10500 Hz, 13500 Hz, 16500 Hz, 19500 Hz. 19500 Hz will be sixth overtone as 4500 will be first overtone.

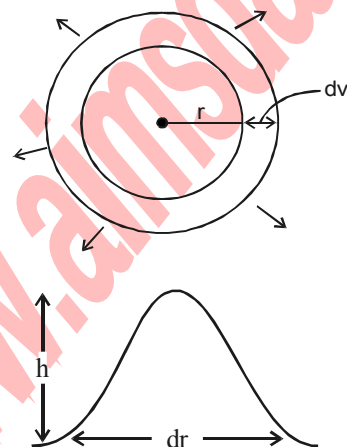
24. (c) The waves produced by a motorboat sailing in water are of both transverse and longitudinal type. Transverse waves are produced on the surface and longitudinal waves are produced deep inside the water.

25. (c) Wavelength is distance between two crest.
 $\lambda = 100 \text{ m}; \quad v = 25$

$$n = \frac{25}{100}$$

$$T = \frac{1}{n} = \frac{100}{25} = 4 \text{ sec}$$

26. (a)



Energy of crest (P.E) = $(2\pi r \cdot dr \times h \times \rho) \times g \times h$
 Now, as crest spread, this energy E remains constant. So,

$$2\pi r dr h^2 \rho g = E$$

$$\Rightarrow h = \sqrt{\frac{E}{2\pi r dr \rho g}} \quad \text{or } h \propto r^{-1/2}$$

27. (a) If we decrease the frequency of tuning fork no. of beat is increased i.e., difference of frequency is increased. It means unknown frequency is more than 440 Hz. So it is $440 + 5 = 445 \text{ Hz}$.

28. (c) In a medium velocity and wavelength are dependent on refractive index of the medium but frequency remains unchanged.

29. (a) Given $\frac{nv}{2\ell} = 315$ and $(n+1)\frac{v}{2\ell} = 420$

$$\Rightarrow \frac{n+1}{n} = \frac{420}{315} \Rightarrow n = 3$$

$$\text{Hence } 3 \times \frac{v}{2\ell} = 315 \Rightarrow \frac{v}{2\ell} = 105 \text{ Hz}$$

The lowest resonant frequency is when $n = 1$

Therefore lowest resonant frequency = 105 Hz.

30. (c) We have, $\beta = 10 \log_{10} \left(\frac{I}{I_0} \right)$

Where I_0 = threshold intensity of sound

$$= 10^{-12} \text{ W/m}^2$$

$$\text{i.e., } 40 = 10 \log_{10} \left(\frac{I_1}{I_0} \right) \quad \dots (i)$$

$$\text{and } 20 = 10 \log_{10} \left(\frac{I_2}{I_0} \right) \quad \dots (ii)$$

$$\frac{(i)}{(ii)} \Rightarrow \frac{40}{20} = \log_{10} \left(\frac{I_1}{I_2} \right)$$

$$2 = \log_{10} \left(\frac{I_1}{I_2} \right) \quad \text{or } \frac{I_1}{I_2} = 10^2$$

$$\therefore \frac{r_2^2}{r_1^2} = 10^2 \quad (\text{since } I \propto \frac{1}{r^2})$$

$$r_2^2 = 10^2 r_1^2 \quad \text{or } r_2 = 10 r_1 = 10 \times 1 = 10 \text{ m}$$

31. (b) $x = A \sin(2t - 0.1x)$

$$\text{also } x = A \sin\left(\frac{2\pi t}{T} - \frac{2\pi}{\lambda}x\right)$$

$$\Rightarrow \frac{2\pi}{\lambda} = 0.1 \Rightarrow \lambda = 20\pi$$

32. (a) We have $v = v\lambda$.

$$\text{or } \lambda = \frac{v}{\nu} = \frac{340\text{m/s}}{340\text{Hz}} = 1\text{m}$$

First resonating length,

$$l_1 = \frac{\lambda}{4} = \frac{1}{4}\text{m} = 25\text{cm}$$

Second resonating length,

$$l_2 = \frac{3\lambda}{4} = \frac{3 \times 1\text{m}}{4} = 75\text{cm}.$$

Third resonating length,

$$l_3 = \frac{5\lambda}{4} = \frac{5 \times 1\text{m}}{4} = 125\text{cm}.$$

So third resonance is not possible since the length of the tube is 120 cm.

$\therefore$ Minimum height of water necessary for resonance = $120 - 75 = 45$ cm.

33. (a) $v = \sqrt{\frac{\gamma RT}{M}}$

$$PV = RT$$

$$P \frac{M}{d} = RT$$

$$\frac{P}{d} = \frac{RT}{M}$$

$$v = \sqrt{\frac{\gamma P}{d}}$$

34. (a) $y = a \sin bx \sin \omega t$
on comparing with standard equation of stationary wave

$$y = R \sin \frac{2\pi x}{\lambda} \cdot \sin \omega t, \text{ we get}$$

$$\frac{2\pi x}{\lambda} = bx,$$

$$\therefore \lambda = \frac{2\pi}{b}$$

The distance between constructive nodes

$$= \frac{\lambda}{2} = \frac{2\pi/b}{2} = \frac{\pi}{b}$$

35. (d) For open pipe, $n = p \frac{v}{2\ell}$

$$\text{For closed pipe } n' = (2p-1) \frac{v}{4\ell}$$

$$\therefore \frac{n}{n'} = \frac{2p}{(2p-1)}$$

36. (d) Frequency of fork 1 = 200 Hz = n_0

No. of beats heard when fork 2 is sounded with fork 1 = $\Delta n = 4$

Now we know that if on loading (attaching tape) an unknown fork, the beat frequency increases (from 4 to 6 in this case) then the frequency of the unknown fork 2 is given

$$\text{by, } n = n_0 - \Delta n = 200 - 4 = 196 \text{ Hz}$$

37. (a) We have, $L_1 = 10 \log \left(\frac{I_1}{I_0} \right)$

$$L_2 = 10 \log \left(\frac{I_2}{I_0} \right)$$

$$\therefore L_1 - L_2 = 10 \log \left(\frac{I_1}{I_0} \right) - 10 \log \left(\frac{I_2}{I_0} \right)$$

$$\text{or, } \Delta L = 10 \log \left(\frac{I_1}{I_0} \times \frac{I_0}{I_2} \right)$$

$$\text{or, } \Delta L = 10 \log \left(\frac{I_1}{I_2} \right)$$

$$\text{or, } 20 = 10 \log \left(\frac{I_1}{I_2} \right)$$

$$\text{or, } 2 = \log \left(\frac{I_1}{I_2} \right)$$

$$\text{or, } \frac{I_1}{I_2} = 10^2$$

$$\text{or, } I_2 = \frac{I_1}{100}.$$

$\Rightarrow$ Intensity decreases by a factor 100.

38. (c) $n_1 = 256 = \frac{v}{4\ell_1} = \frac{v}{4 \times 25.4}$

$$\therefore v = 256 \times 101.6 \text{ cm/s}$$

$$n_2 = \frac{v}{4\ell_2} = \frac{256 \times 101.6}{4 \times 25.6} = 254 \text{ Hz}$$

$$\text{No. of beats/sec} = n_1 - n_2 = 256 - 254 = 2$$

39. (b) $\omega = \frac{2\pi}{0.01}$ and $k = \frac{2\pi}{0.30}$

$$v = \frac{\omega}{k} = \frac{2\pi}{0.01} \times \frac{0.30}{2\pi} = 30 \text{ m s}^{-1}$$

40. (c) Velocity of wave $v = n\lambda$

where n = frequency of wave $\Rightarrow n = \frac{v}{\lambda}$

$$n_2 = \frac{v_2}{\lambda_2} = \frac{396}{100 \times 10^{-2}} = 396 \text{ Hz}$$

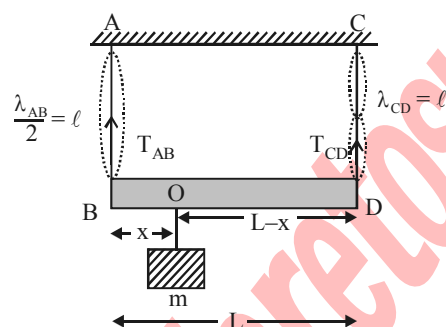
no. of beats = $n_1 - n_2 = 4$

41. (a) Frequency of 1st harmonic of AB

$$= \frac{1}{2\ell} \sqrt{\frac{T_{AB}}{m}}$$

Frequency of 2nd harmonic of CD

$$= \frac{1}{\ell} \sqrt{\frac{T_{CD}}{m}}$$



Given that the two frequencies are equal.

$$\therefore \frac{1}{2\ell} \sqrt{\frac{T_{AB}}{m}} = \frac{1}{\ell} \sqrt{\frac{T_{CD}}{m}}$$

$$\Rightarrow \frac{T_{AB}}{4} = T_{CD} \Rightarrow T_{AB} = 4T_{CD} \quad \dots(i)$$

For rotational equilibrium of massless rod, taking torque about point O,

$$T_{AB} \times x = T_{CD} (L - x) \quad \dots(ii)$$

For translational equilibrium,

$$T_{AB} + T_{CD} = mg \quad \dots(iii)$$

On solving, (i) & (iii) we get, $T_{CD} = \frac{mg}{5}$;

$$\therefore T_{AB} = \frac{4mg}{5}$$

Substituting these values in (ii) we get

$$\frac{4mg}{5} \times x = \frac{mg}{5} (L - x)$$

$$\Rightarrow 4x = L - x \Rightarrow x = \frac{L}{5}$$

42. (a) $L_1 = 50 \text{ cm}$, $L_2 = 50.5 \text{ cm}$
as $L_2 > L_1$, so $n_2 < n_1$
For open pipe,

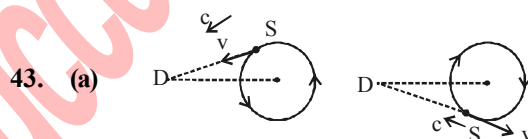
$$n = \frac{v}{2L}$$

$$n_1 - n_2 = 3 \text{ beats/s}$$

$$\therefore \frac{v}{2} \left(\frac{1}{L_1} - \frac{1}{L_2} \right) = 3$$

$$\therefore \frac{v}{10^{-2}} \left(\frac{1}{50} - \frac{1}{50.5} \right) = 6$$

$$\therefore v = \frac{6 \times 50 \times 50.5 \times 10^{-2}}{0.5} = 303 \text{ m/s}$$



Largest frequency (f_1) Lowest frequency (f_2)

Largest frequency will be detected when the source approaches detector along the line joining and the smallest frequency will be detected when the source recedes the detector along the line joining them

$$\frac{f_1}{f_2} = \frac{\left(\frac{c}{c-v} \right) f}{\left(\frac{c}{c+v} \right) f} = \frac{c+v}{c-v}$$

44. (c) Frequency of the echo detected by the driver of the train is
(According to Doppler effect in sound)

$$f' = \left(\frac{v+u}{v-u} \right) f$$

where f = original frequency of source of sound

f' = Apparent frequency of source because of the relative motion between source and observer.

$$f' = \left(\frac{330 + 220}{330 - 220} \right) 1000 = 5000 \text{ Hz}$$

Type B : Assertion Reason Questions

45. (b) Sound travels faster in solids than gases. It is because the elasticity of solid is more than that of gases. Solids possess greater density than gases. Though density has effect on the velocity of sound in the medium as follows

$$v \propto \frac{1}{\sqrt{\rho}}$$

In case of solid, its elasticity far exceeds that of gas so its effect far exceeds the effect of density.

46. (a) Since wavelength is distance between two nearest particles in phase and time period is time required by a wave to cover this distance.

$$\text{So speed of wave} = \frac{\text{wavelength}}{\text{time period}}$$

47. (a) When beetle moves along the sand it sends two sets of pulses, one longitudinal and the other transverse. Scorpion has the capacity to intercept the waves. By getting a sense of time interval between receipt of these two waves, it can determine the distance of beetle also.

48. (b) Longitudinal waves travel or propagate by compression and rarefaction of the medium particles hence in absence of a medium they cannot propagate. Light waves are made of perpendicular electric and magnetic field vectors normal to direction of motion. Hence, they are transverse waves and if plane of vibration is same for a wave then it is polarised but this is not so for sound waves.

49. (d) Speed of sound in gases is independent of pressure because $v = \sqrt{\frac{\gamma P}{\rho}}$. At constant temperature, if P changes then ρ also changes in such a way that the ratio

$\frac{P}{\rho}$ remains constant. Hence there is no effect of the pressure change on the speed of sound.

50. (a) Pitch is related to frequency and $f = \frac{v}{\lambda}$.

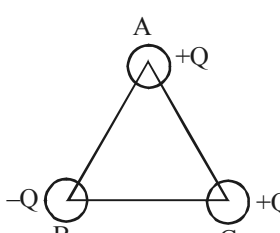
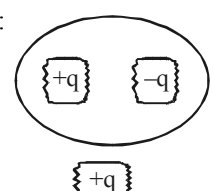
51. (b) For the formation of stationary waves, it is necessary that the medium should not be unlimited but it should have a boundary. The wave propagating in such a medium will reflect at the boundary and produce a wave of the same kind travelling in the opposite direction. The position of two waves will give rise to a stationary wave. At free end, transverse wave is reflected without change of phase. Hence an essential requirement for the formation of stationary wave is that the medium must be bounded having definite boundaries. In stationary waves, there are certain points of the medium, which are permanently at rest *i.e.*, their displacement is zero throughout. These points are called nodes. Similarly, there are some other points which vibrate about their mean position with largest amplitude. These points are called antinodes.

52. (a) Reason is correct, Assertion is incorrect. In Doppler effect for sound wave effect due to observer and source motion are different.
54. (d) Two waves moving in uniform string with uniform tension shall have same speed and may be moving in opposite directions. Hence both waves may have velocities in opposite direction. Hence Assertion is incorrect.
55. (c) Laplace assumed adiabatic process during sound propagation.
56. (a) As $f = \frac{v}{2l}$; and so with increase in temperature v increases more than l .

$$\text{Also } v = \sqrt{\frac{\gamma RT}{M}}$$

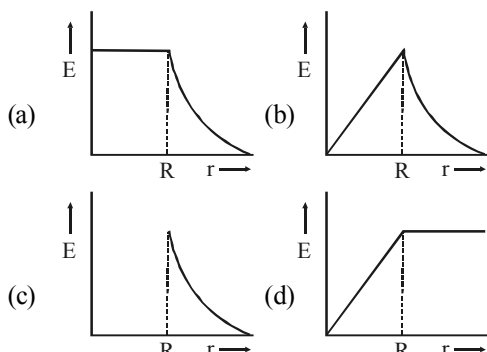
Electric Charges and Fields

TYPE A : MULTIPLE CHOICE QUESTIONS

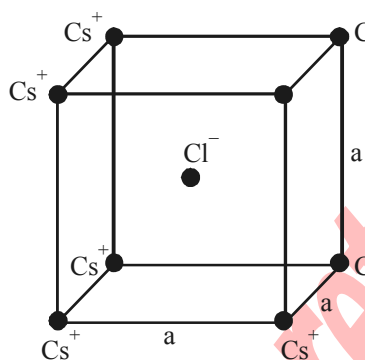
- A body can be negatively charged by : [1998]
 - removing some neutrons from it
 - giving excess electrons to it
 - removing some protons from it
 - removing some electrons from it
- The number of electrons for one coulomb of charge are: [1999]
 - 6.25×10^{23}
 - 6.25×10^{21}
 - 6.25×10^{18}
 - 6.25×10^{19}
- Let E_a be the electric field due to a dipole in its axial plane distant ℓ and E_q be the field in the equatorial plane distant ℓ' , then the relation between E_a and E_q will be : [2000]
 - $E_a = 4E_q$
 - $E_q = 2E_a$
 - $E_a = 2E_q$
 - $E_q = 3E_a$
- A particle of mass 2g and charge $1\mu\text{C}$ is held at a distance of 1m from a fixed charge 1mC . If the particle is released it will be repelled. The speed of particle when it is at a distance of 10 metre from the fixed charge is [2000]
 - 90 m/s
 - 100 m/s
 - 45 m/s
 - 55 m/s
- What is the electric flux associated with one of faces of a cube, when a charge (q) is enclosed in the cube ? [2001]
 - $\frac{6q}{\epsilon_0}$
 - $\frac{q}{6\epsilon_0}$
 - $\frac{q}{3\epsilon_0}$
 - $\frac{3q}{\epsilon_0}$
- The point charges Q and $-2Q$ are placed at some distance apart. If the electric field at the location of Q is E . The electric field at the location of Q is E . The electric field at the location of $-2Q$ will be [2001]
 - $-\frac{3E}{2}$
 - $-E$
 - $-\frac{E}{2}$
 - $-2E$
- How many electrons make up a charge of $20\mu\text{C}$. [2002]
 - 1.25×10^{14}
 - 2.23×10^{14}
 - 3.25×10^{14}
 - 5.25×10^{14}
- A conducting sphere of radius 10 cm is charged with $10\mu\text{C}$. Another uncharged sphere of radius 20 cm is allowed to touch it for some time. After that if the spheres are separated, then surface density of charges on the spheres will be in the ratio of [2002]
 - 1 : 1
 - 2 : 1
 - 1 : 3
 - 4 : 1
- An electric dipole placed in a non-uniform electric field experiences : [2003]
 - both, a torque and a net force
 - only a force but no torque
 - only a torque but no net force
 - no torque and no net force
- Three charges are placed at the vertices of an equilateral triangle of side 'a' as shown in the following figure. The force experienced by the charge placed at the vertex A in a direction normal to BC is : [2003]
 
 - $Q^2/(4\pi\epsilon_0 a^2)$
 - $-Q^2/(4\pi\epsilon_0 a^2)$
 - zero
 - $Q^2/(2\pi\epsilon_0 a^2)$
- Shown below is a distribution of charges. The flux of electric field due to these charges through the surfaces S is : [2003]
 
 - $3q/\epsilon_0$
 - $2q/\epsilon_0$
 - q/ϵ_0
 - zero

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12. The electric field due to a uniformly charged non-conducting sphere of radius R as a function of the distance from its centre is represented graphically by [2004]



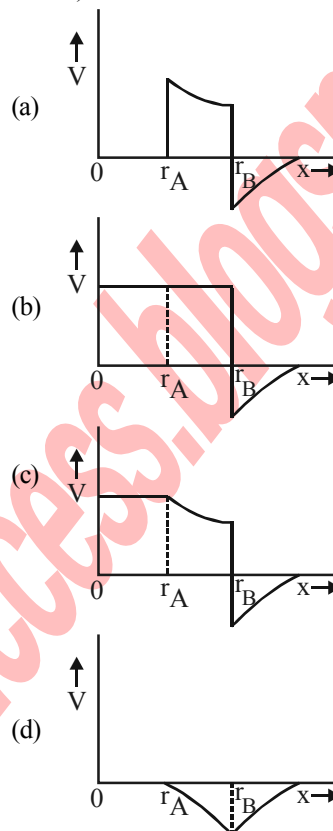
13. In the basic CsCl crystal structure, Cs^+ and Cl^- ions are arranged in a bcc configuration as shown in the figure. The net electrostatic force exerted by the eight Cs^+ ions on the Cl^- ion is : [2004]



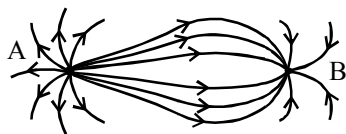
- (a) $\frac{1}{4\pi\epsilon_0} \frac{4e^2}{3a^2}$ (b) $\frac{1}{4\pi\epsilon_0} \frac{16e^2}{3a^2}$
 (c) $\frac{1}{4\pi\epsilon_0} \frac{32e^2}{3a^2}$ (d) zero
14. Two infinitely long parallel conducting plates having surface charge densities $+\sigma$ and $-\sigma$ respectively, are separated by a small distance. The medium between the plates is vacuum. If ϵ_0 is the dielectric permittivity of vacuum then the electric field in the region between the plates is : [2005]
- (a) 0 volt/m (b) $\sigma/2\epsilon_0$ volt/m
 (c) σ/ϵ_0 volt/m (d) $2\sigma/\epsilon_0$ volt/m
15. Two concentric conducting thin spherical shells A and B having radii r_A and r_B ($r_B > r_A$) are

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charged to Q_A and $-Q_B$ ($|Q_B| > |Q_A|$). The electrical field along a line, (passing through the centre) is: [2005]



16. A particle having charge q and mass m is projected with velocity $\vec{v} = 2\hat{i} - 3\hat{j}$ in a uniform electric field $\vec{E} = E_0\hat{j}$. Change in momentum $|\Delta\vec{p}|$ during any time interval t is given by : [2005]
- (a) $\sqrt{qE_0t}$ (b) qE_0t
 (c) $\frac{qE_0t}{m}$ (d) zero
17. Two parallel large thin metal sheets have equal surface charge densities ($\sigma = 26.4 \times 10^{-12} \text{ C/m}^2$) of opposite signs. The electric field between these sheets is : [2006]
- (a) 1.5 N/C (b) $1.5 \times 10^{-10} \text{ N/C}$
 (c) 3 N/C (d) $3 \times 10^{-10} \text{ N/C}$
18. The spatial distribution of the electric field due to two charges (A, B) is shown in figure. Which one of the following statements is correct ? [2006]



- (a) A is +ve and B -ve; $|A| > |B|$
 (b) A is -ve and B +ve; $|A| = |B|$
 (c) Both are +ve but $A > B$
 (d) Both are -ve but $A > B$
19. Three point charges $+q$, $-2q$ and $+q$ are placed at point $(x=0, y=a, z=0)$, $(x=0, y=0, z=0)$ and $(x=a, y=0, z=0)$ respectively. The magnitude and direction of the electric dipole moment vector of this charge assembly are [2008]
- (a) $\sqrt{2}qa$ along $+y$ direction
 (b) $\sqrt{2}qa$ along the line joining points $(x=0, y=0, z=0)$ and $(x=a, y=a, z=0)$
 (c) qa along the line joining points $(x=0, y=0, z=0)$ and $(x=a, y=a, z=0)$
 (d) $\sqrt{2}qa$ along $+x$ direction
20. A hollow cylinder has charge q C within it. If ϕ is the electric flux in unit of voltmeter associated with the curved surface B, the flux linked with the plane surface A in unit of voltmeter will be [2008]



- (a) $\frac{1}{2} \left(\frac{q}{\epsilon_0} - \phi \right)$ (b) $\frac{q}{2\epsilon_0}$
 (c) $\frac{q}{\epsilon_0}$ (d) $\frac{q}{\epsilon_0} - \phi$
21. Charge q is uniformly distributed over a thin half ring of radius R . The electric field at the centre of the ring is [2008]

- (a) $\frac{q}{2\pi^2 \epsilon_0 R^2}$ (b) $\frac{q}{4\pi^2 \epsilon_0 R^2}$
 (c) $\frac{q}{4\pi \epsilon_0 R^2}$ (d) $\frac{q}{2\pi \epsilon_0 R^2}$

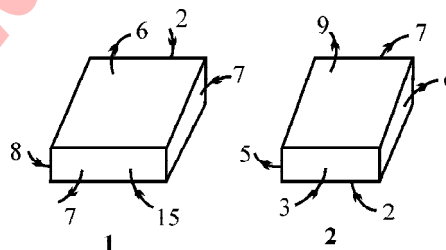
22. The electric field at a distance r from the centre in the space between two concentric metallic spherical shells of radii r_1 and r_2 carrying charge Q_1 and Q_2 is ($r_1 < r < r_2$) [2009]

- (a) $\frac{Q_1 + Q_2}{4\pi \epsilon_0 (r_1 + r_2)^2}$ (b) $\frac{Q_1 + Q_2}{4\pi \epsilon_0 r^2}$
 (c) $\frac{Q_1}{4\pi \epsilon_0 r^2}$ (d) $\frac{Q_2}{4\pi \epsilon_0 r^2}$

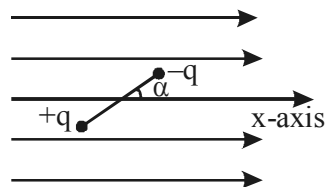
23. The potential at a point P due to an electric dipole is 1.8×10^5 V. If P is at a distance of 50 cm apart from the centre O of the dipole and if CP makes an angle 60° with the positive side of the axial line of the dipole, what is the moment of the dipole? [2010]

- (a) 10 C-m (b) 10^{-3} C-m
 (c) 10^{-4} C-m (d) 10^{-5} C-m

24. The figure shows two situations in which a Gaussian cube sits in an electric field. The arrows and values indicate the directions and magnitudes (in $\text{N-m}^2/\text{C}$) of the electric fields. What is the net charge (in the two situations) inside the cube? [2011]



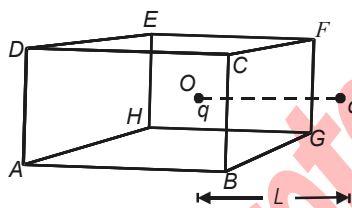
- (a) (1) negative (2) positive
 (b) (1) negative (2) zero
 (c) (1) positive (2) positive
 (d) (1) positive (2) zero
25. There exists a non-uniform electric field along x -axis as shown in the figure below. The field increases at a uniform rate along $+x$ -axis. A dipole is placed inside the field as shown. Which one of the following is correct for the dipole? [2012]



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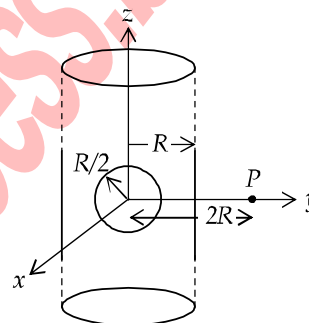
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- (a) Dipole moves along positive x-axis and undergoes a clockwise rotation
 (b) Dipole moves along negative x-axis and undergoes a clockwise rotation
 (c) Dipole moves along positive x-axis and undergoes an anticlockwise rotation
 (d) Dipole moves along negative x-axis and undergoes an anticlockwise rotation
26. Two point charges $+q$ and $-q$ are held fixed at $(-d, 0)$ and $(d, 0)$ respectively of a $x - y$ coordinate system. Then [2013]
 (a) the electric field E at all points on the axis has the same direction
 (b) work has to be done in bringing a test charge from ∞ to the origin
 (c) electric field at all points on y -axis is along x -axis
 (d) the dipole moment is $2qd$ along the x -axis
27. A charged particle q is placed at the centre O of cube of length L ($A B C D E F G H$). Another same charge q is placed at a distance L from O . Then the electric flux through $ABCD$ is [2013]



- (a) $q/4\pi\epsilon_0 L$ (b) zero
 (c) $q/2\pi\epsilon_0 L$ (d) $q/3\pi\epsilon_0 L$
28. In a medium of dielectric constant K , the electric field is $\vec{E}$. If ϵ_0 is permittivity of the free space, the electric displacement vector is [2014]
 (a) $\frac{K\vec{E}}{\epsilon_0}$ (b) $\frac{\vec{E}}{K\epsilon_0}$
 (c) $\frac{\epsilon_0 \vec{E}}{K}$ (d) $K\epsilon_0 \vec{E}$
29. Three charge q , Q and $4q$ are placed in a straight line of length l at points distant 0 , $\frac{1}{2}l$ and l respectively from one end. In order to make the net force on q zero, the charge Q must be equal to [2015]
 (a) $-q$ (b) $-2q$
 (c) $\frac{-q}{2}$ (d) q

30. The electrostatic potential inside a charged spherical ball is given by $\phi = ar^2 + b$ where r is the distance from the centre a, b are constants. Then the charge density inside the ball is [2015]
 (a) $-6a\epsilon_0 r$ (b) $-24\pi a\epsilon_0$
 (c) $-6a\epsilon_0$ (d) $-24\pi a\epsilon_0 r$
31. An infinitely long solid cylinder of radius R has a uniform volume charge density ρ . It has a spherical cavity of radius $R/2$ with its centre on the axis of the cylinder, as shown in the figure. The magnitude of the electric field at the point P , which is at a distance $2R$ from the axis of the cylinder, is given by the expression $\frac{23\rho R}{16K\epsilon_0}$. The value of k is [2016]



- (a) 6 (b) 5
 (c) 7 (d) 4
32. An electric dipole of moment $\vec{P}$ is placed in a uniform electric field $\vec{E}$ such that $\vec{P}$ points along $\vec{E}$. If the dipole is slightly rotated about an axis perpendicular to the plane containing $\vec{E}$ and $\vec{P}$ and passing through the centre of the dipole, the dipole executes simple harmonic motion. Consider I to be the moment of inertia of the dipole about the axis of rotation. What is the time period of such oscillation? [2016]
 (a) $\sqrt{(pE/I)}$ (b) $2\pi\sqrt{(I/pE)}$
 (c) $2\pi\sqrt{(I/2pE)}$ (d) None of these
33. A hollow insulated conduction sphere is given a positive charge of $10 \mu\text{C}$. What will be the electric field at the centre of the sphere if its radius is 2 m ? [2017]
 (a) Zero (b) $5 \mu\text{Cm}^{-2}$
 (c) $20 \mu\text{Cm}^{-2}$ (d) $8 \mu\text{Cm}^{-2}$

TYPE B : ASSERTION REASON QUESTIONS

Directions for (Qs. 34-38) : These questions consist of two statements, each printed as Assertion and Reason. While answering these questions, you are required to choose any one of the following five responses.

- (a) If both Assertion and Reason are correct and the Reason is a correct explanation of the Assertion.
- (b) If both Assertion and Reason are correct but Reason is not a correct explanation of the Assertion.
- (c) If the Assertion is correct but Reason is incorrect.
- (d) If both the Assertion and Reason are incorrect.
- (e) If the Assertion is incorrect but the Reason is correct.

34. Assertion : Electron move away from a region of higher potential to a region of lower potential.
Reason : An electron has a negative charge.

[1999]

35. Assertion : A metallic shield in form of a hollow shell may be built to block an electric field.

Reason : In a hollow spherical shield, the electric field inside it is zero at every point.

[2001]

36. Assertion : Electric lines of force never cross each other.

Reason : Electric field at a point superimpose to give one resultant electric field.

[2002]

37. Assertion : The Coulomb force is the dominating force in the universe.

Reason : The Coulomb force is weaker than the gravitational force.

[2003]

38. Assertion : In a cavity within a conductor, the electric field is zero.

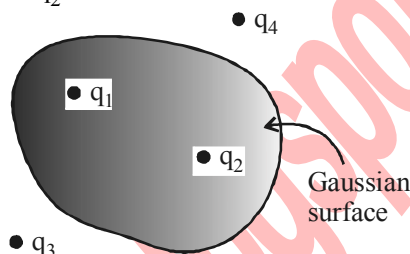
Reason : Charges in a conductor reside only at its surface.

[2007]

Directions for (Qs. 39-43) : Each of these questions contains an Assertion followed by Reason. Read them carefully and answer the question on the basis of following options. You have to select the one that best describes the two statements.

- (a) If both Assertion and Reason are correct and Reason is the correct explanation of Assertion.
- (b) If both Assertion and Reason are correct, but Reason is not the correct explanation of Assertion.
- (c) If Assertion is correct but Reason is incorrect.
- (d) If both the Assertion and Reason are incorrect.

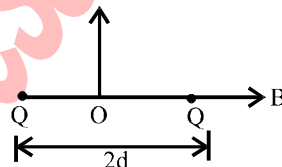
39. Assertion : Four point charges q_1 , q_2 , q_3 and q_4 are as shown in figure. The flux over the shown Gaussian surface depends only on charges q_1 and q_2 .



Reason : Electric field at all points on Gaussian surface depends only on charges q_1 and q_2 .

[2012]

40. Assertion : Consider two identical charges placed distance $2d$ apart, along x-axis.



The equilibrium of a positive test charge placed at the point O midway between them is stable for displacements along the x-axis.

Reason : Force on test charge is zero.

[2013]

41. Assertion : A deuteron and an α -particle are placed in an electric field. If F_1 and F_2 be the forces acting on them and a_1 and a_2 be their accelerations respectively then, $a_1 = a_2$.

Reason : Forces will be same in electric field.

[2015]

42. Assertion : In the absence of an external electric field, the dipole moment per unit volume of a polar dielectric is zero.

Reason : The dipoles of a polar dielectric are randomly oriented.

[2016]

43. Assertion : The positive charge particle is placed in front of a spherical uncharged conductor. The number of lines of forces terminating on the sphere will be more than those emerging from it.

Reason : The surface charge density at a point on the sphere nearest to the point charge will be negative and maximum in magnitude compared to other points on the sphere.

[2017]

HINTS & SOLUTIONS

Type A : Multiple Choice Questions

1. (b) A body can be negatively charged by adding some excess electron to it.

2. (c) 1 electron carries a charge of 1.6×10^{-19} coulomb.

No. of electron in one coulomb

$$= \frac{1}{1.6 \times 10^{-19}}$$

$$= \frac{10^{19}}{1.6} = \frac{10}{1.6} \times 10^{18} = 6.25 \times 10^{18}.$$

3. (c) We know that for short dipole,

field at axial point, $E_a = \frac{2p}{d^3}$

and field at equatorial point, $E_q = \frac{p}{d^3}$

So, $E_a = 2E_q$

4. (a) Potential at 1 m from the charge

$$V_A = \frac{K \cdot 10^{-6}}{1} = K \times 10^{-6}$$

Potential at 10 m from the charge

$$V_B = \frac{K \cdot 10^{-6}}{10} = K \times 10^{-7}$$

Potential diff. = $V_A - V_B = K(10^{-6} - 10^{-7})$

Its velocity at 10 m is V, then

$$\frac{1}{2} \times mv^2 = (V_A - V_B) \times q$$

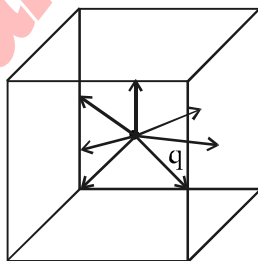
$$\frac{1}{2} \times 2 \times 10^{-3} \times v^2 = K \times 10^{-6} \left(1 - \frac{1}{10}\right) \times 10^{-3}$$

$$v^2 = \frac{K \times 10^{-9} \times 9}{10^{-3} \times 10} = K \times \frac{9}{10} \times 10^{-6}$$

$$= 9 \times 10^9 \times \frac{9}{10} \times 10^{-6} = 81 \times 100$$

$$v = 90 \text{ m/sec}$$

5. (b)



Charge q is lying inside the cube. Flux

coming out of it = $\frac{q}{\epsilon_0}$. It is now distributed evenly over six faces. So, flux passing through one face

$$= \frac{q}{\epsilon_0} \times \frac{1}{6} = \frac{q}{6\epsilon_0}$$

6. (c) Field at Q is E. So, force on Q = QE
This force will be applied on -2Q. Also according to Coulomb's law. So, field at -2Q is $\frac{QE}{-2Q} = \frac{E}{2}$.

7. (a) Charge on an electron
 $= 1.6 \times 10^{-19}$ coulomb

No. of electrons required = $\frac{20 \times 10^{-6}}{1.6 \times 10^{-19}}$

$$= \frac{20}{1.6} \times 10^{13} = 1.25 \times 10^{14}$$

8. (b) Let the common potential after the touch is V. So, applying conservation of charge
 $10 \times 10^{-6} = V \times C_1 + V \times C_2$

$$V = \frac{10 \times 10^{-6}}{(C_1 + C_2)}$$

Charge on first sphere

$$= C_1 V = \frac{10 \times 10^{-6}}{(C_1 + C_2)} \times C_1$$

Charge on second sphere

$$= C_2 V = \frac{10 \times 10^{-6}}{(C_1 + C_2)} \times C_2$$

Charge densities are,

$$= \frac{10 \times 10^{-6} \times C_1}{(C_1 + C_2) 4\pi r_1^2} \text{ \& } \frac{10 \times 10^{-6} \times C_2}{(C_1 + C_2) 4\pi r_2^2}$$

and their ratio = $\frac{C_1}{C_2} \times \frac{r_2^2}{r_1^2}$

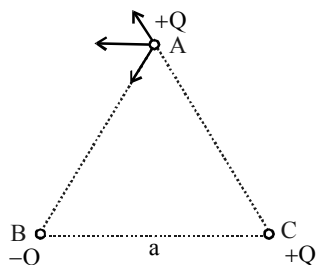
$$= \frac{4\pi \epsilon_0 r_1}{4\pi \epsilon_0 r_2} \times \frac{r_2^2}{r_1^2}$$

$$= \frac{r_2}{r_1} = \frac{20}{10} = 2 : 1$$

[Capacity of spherical capacitor = $4\pi\epsilon_0 R$]

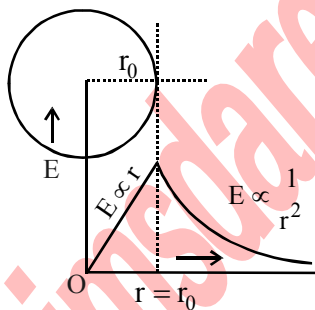
9. (a) An electric dipole placed in a non-uniform electric field experiences a torque and a net force. In a uniform field it experiences only torque.

10. (c)



From the figure it is clear that force on Q due to charges on B and C will be as shown in the figure. Their resultant will be parallel to BC. So, their component perpendicular to BC will be zero.

11. (d) Net charge inside the surface is zero. So, flux through the surface is zero.
12. (b) Inside a uniformly charged non-conducting sphere, charge is uniformly distributed. So, field is there. In such cases electric field is directly proportional to the distance from the centre. Outside the sphere, field is inversely proportional to (distance)². So, graph is as follows



13. (d) All Cs ions are symmetrically distributed around Cl⁻ so, resultant of all the forces acting on Cl⁻ will be zero.

14. (c)

σ	$-\sigma$
+	-
+	-
+	-
+	-
A	B

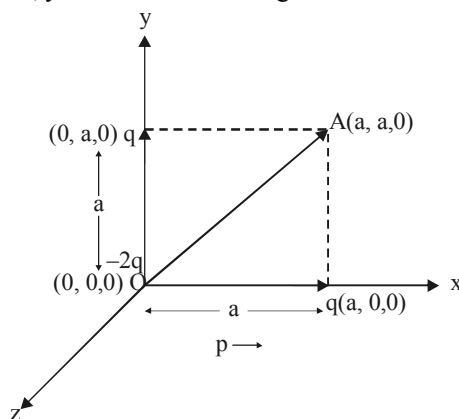
$$\text{Field at P due to plate, } A = \frac{\sigma}{2\epsilon_0}$$

$$\text{Field at P due to plate, } B = \frac{\sigma}{2\epsilon_0}$$

Both are acting in the same direction so,

$$\text{Total field} = \frac{2\sigma}{2\epsilon_0} = \frac{\sigma}{\epsilon_0}$$

15. (c) Electric field inside sphere A is zero. Potential inside is uniform. If we move out of the sphere starting from centre, we find potential dropping to -ve value at the surface of B. After that it becomes zero at infinity as we take potential at infinity to be zero.
16. (b) Impulse = $mv - mu$ = Change in momentum
 $= \text{force} \times \text{time} = qE_0 \times t = qE_0 t$
 $= \text{Change in momentum}$
17. (c) Field between two parallel sheet
 $= \frac{\sigma}{\epsilon_0} = \frac{26.4 \times 10^{-12}}{8.85 \times 10^{-12}} = 3 \text{ N/C}$
18. (a) A is positive as electric lines are coming out of it. B is negative as electric lines are entering into it.
19. (b) The given charge assembly can be represented using the three co-ordinate axes x, y and z as shown in figure.



The charge $-2q$ is placed at the origin O. One $+q$ charge is placed at $(a, 0, 0)$ and the other $+q$ charge is placed at $(0, a, 0)$. Thus the system has two dipoles along x-axis and y-axis respectively.

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As the electric dipole moment is directed from the negative to the positive charge hence the resultant dipole moment will be along $\overline{OA}$ where co-ordinates of point A are (a, a, 0). The magnitude of each dipole moment,

$$p = qa$$

So, the magnitude of resultant dipole moment is

$$P_R = \sqrt{p^2 + p^2} = \sqrt{(qa)^2 + (qa)^2} = \sqrt{2} qa$$

20. (a) Let electric flux linked with surfaces A, B, and C are ϕ_A , ϕ_B and ϕ_C respectively.

$$\text{Thus } \phi_{\text{total}} = \phi_A + \phi_B + \phi_C$$

$$\therefore \phi_A = \phi_C$$

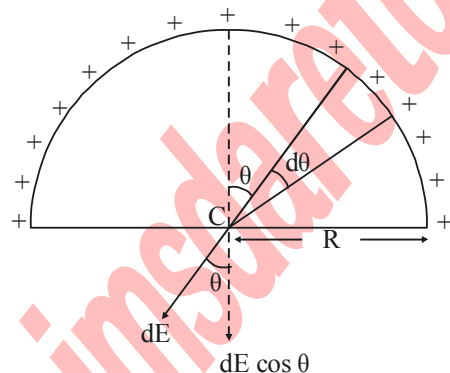
$$\text{and } \phi_{\text{total}} = \frac{q}{\epsilon_0} \text{ (From Gauss's Law)}$$

$$\therefore \frac{q}{\epsilon_0} = 2\phi_A + \phi_B \quad \text{But } \phi_B = \phi \text{ (given)}$$

$$\text{Hence, } \frac{q}{\epsilon_0} = 2\phi_A + \phi$$

$$\text{or } \frac{q}{\epsilon_0} - \phi = 2\phi_A \quad \text{or } \phi_A = \frac{1}{2} \left(\frac{q}{\epsilon_0} - \phi \right)$$

21. (a)



From figure, $d\ell = R d\theta$

Charge on $d\ell = \lambda R d\theta$,
where λ = linear charge density.

Electric field at centre due to $d\ell$

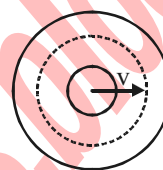
$$dE = k \cdot \frac{\lambda R d\theta}{R^2}$$

We need to consider only the component $dE \cos \theta$, as the component $dE \sin \theta$ will cancel out.

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$$\begin{aligned} \therefore \text{Total field at centre} &= 2 \int_0^{\pi/2} dE \cos \theta \\ &= 2 \int_0^{\pi/2} \frac{k\lambda R \cos \theta}{R^2} d\theta = \frac{2k\lambda}{R} \int_0^{\pi/2} \cos \theta d\theta \\ &= \frac{q}{2\pi^2 \epsilon_0 R^2} \quad \left(\text{since } \lambda = \frac{q}{\pi R} \right) \end{aligned}$$

22. (c) $\int E \cdot dx = \frac{Q_1}{\epsilon_0} \Rightarrow E = \frac{Q_1}{4\pi r^2 \epsilon_0}$



23. (d) $V = \frac{1}{4\pi\epsilon_0} \frac{p \cos \theta}{r^2}$

$$\text{Here, } V = 1.8 \times 10^5 \text{ V, } \theta = 60^\circ,$$

$$r = 50 \times 10^{-2} = 0.5 \text{ m}$$

$$\therefore 1.8 \times 10^5 = 9 \times 10^9 \times \frac{p \cos 60^\circ}{(0.5)^2}$$

$$\text{or } p = \frac{1.8 \times 10^5 \times 0.25 \times 2}{9 \times 10^9} = 10^{-5} \text{ C-m}$$

24. (a) The field lines in 1 are :
(6 + 7) out – (2 + 7 + 15 + 8) in = 19 (in)

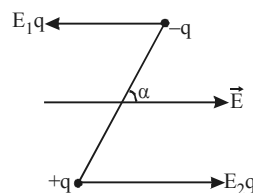
It represents negative charge.

The field lines in 2 are :

$$(9 + 5 + 6) \text{ out} - (7 + 3 + 2) \text{ in} = 8 \text{ (out)}$$

It represents positive charge.

25. (d) The dipole is placed in a non-uniform field, therefore a force as well as a couple acts on it. The force on the negative charge is more ($F \propto E$) and is directed along negative x-axis. Thus the dipole moves along negative x-axis and rotates in an anticlockwise direction.



26. (c) If we take a point M on the X-axis as shown in the figure, then the net electric field is in X-direction.

∴ Option (a) is incorrect.

If we take a point N on Y-axis, we find net electric field along +X direction. The same will be true for any point on Y-axis. (c) is a correct option.

$$W_{\infty 0} = q(V_{\infty} - V_0) = q(0 - 0) = 0$$

∴ (b) is incorrect. The direction of dipole moment is from -ve to +ve. Therefore (d) is incorrect.

27. (b) The flux for both the charges exactly cancels the effect of each other.

28. (d) Electric displacement vector, $\vec{D} = \epsilon \vec{E}$

$$\text{As, } \epsilon = \epsilon_0 K \quad \therefore \vec{D} = \epsilon_0 K \vec{E}$$

29. (a) $(F_{\text{net}})_q = 0$

$$\Rightarrow k \frac{Qq}{\left(\frac{\ell}{2}\right)^2} + k \frac{4q^2}{\ell^2} = 0$$



$$\text{where } k = \frac{1}{4\pi\epsilon_0}$$

$$\Rightarrow 4Qq + 4q^2 = 0$$

$$\Rightarrow Q = -q$$

30. (c) Electric field, $E = -\frac{d\phi}{dt} = -2ar$

$$\text{By Gauss's theorem } E(4\pi r^2) = \frac{q}{\epsilon_0}$$

$$\Rightarrow q = -8\pi\epsilon_0 ar^3$$

$$\rho = \frac{dq}{dV} = \frac{dq}{dr} \times \frac{dr}{dV}$$

$$= (-24\pi\epsilon_0 ar^2) \left(\frac{1}{4\pi r^2} \right) = -6\epsilon_0 a$$

31. (a) We suppose that the cavity is filled up by a positive as well as negative volume charge of ρ . So the electric field now produced at P is the superposition of two electric fields.

- (i) The electric field created due to the infinitely long solid cylinder is

$$E_1 = \frac{\rho R}{4\epsilon_0} \text{ directed towards the } +Y \text{ direction}$$

- (ii) The electric field created due to the spherical negative charge density

$$E_2 = \frac{\rho R}{96\epsilon_0} \text{ directed towards the } -Y \text{ direction.}$$

∴ The net electric field is

$$E = E_1 - E_2 = \frac{1}{6} \left[\frac{23\rho R}{16\epsilon_0} \right]$$

32. (b) The dipole experiences a torque $pE \sin \theta$ tending to bring itself back in the direction of field.

Therefore, on being released (i.e. rotated) the dipole oscillates about an axis through its centre of mass and perpendicular to the field. If I is the moment of inertia of the dipole about the axis of rotation, then the equation of motion is

$$I \cdot d^2\theta/dt^2 = -pE \sin \theta$$

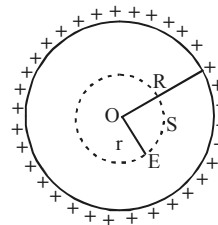
For small amplitude $\sin \theta \approx \theta$

$$\text{Thus } d^2\theta/dt^2 = -(pE/I) \cdot \theta = -\omega^2 \theta$$

$$\text{where } \omega = \sqrt{(pE/I)}.$$

This is a S.H.M., whose period of oscillation is $T = 2\pi/\omega = 2\pi\sqrt{(I/pE)}$.

33. (a) Charge resides on the outer surface of a conducting hollow sphere of radius R. We consider a spherical surface of radius $r < R$. By Gauss theorem



$$\int_s \vec{E} \cdot d\vec{s} = \frac{1}{\epsilon_0} \times \text{charge enclosed or}$$

$$E \times 4\pi r^2 = \frac{1}{\epsilon_0} \times 0 \Rightarrow E = 0$$

i.e., electric field inside a hollow sphere is zero.

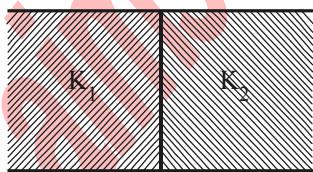
Type B : Assertion Reason Questions

34. (e) Direction of electric field is from region of high potential to low potential & electron or any -ve charged particle will move against the field or lower potential to higher potential.
35. (a) A metallic shield may be used to block an electric field because field inside a metallic shield is zero.
36. (b) Electric lines of force never cross each other. Electric field at a point add up vectorally to give one resultant electric field. So, they do not have independent existence at the point of superposition so, electric lines of force do not cross each other (crossing of electric lines of force at a point means at a point two fields are having independent existence).
37. (d) Gravitational force is the dominating force in the universe so Assertion is incorrect. Gravitational force is weaker than Coulombic force so, Reason is incorrect.
38. (a) Net field inside the conductor is zero because by virtue of induced charges, applied and induced electric fields are equal and opposite thus the net charge resides on surface only. If any cavity is there inside the conductor, electric field will be zero in it.
39. (d) Electric field at any point depends on presence of all charges.
40. (b) If +ve charge is displaced along x-axis, then net force will always act in a direction opposite to that of displacement and the test charge will always come back to its original position.
41. (c) $q_d = e, m_d = 2m_p = 2m$
 $q_\alpha = 2e, m_\alpha = 4m_p = 4m$
 $F_1 = F_\alpha = eE, F_2 = F_\alpha = 2eE \neq F_1$
 Further, $a_1 = \frac{F_1}{2m} = \frac{eE}{2m}$
 and $a_2 = \frac{F_2}{4m} = \frac{2eE}{4m} = \frac{eE}{2m} = a_1$
42. (a)
43. (d) No. of lines entering the surface = No. of lines leaving the surface.

Electrostatic Potential and Capacitance

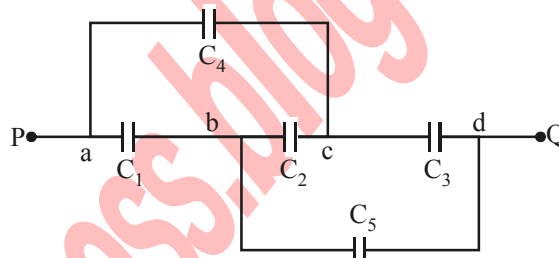
TYPE A : MULTIPLE CHOICE QUESTIONS

1. A condenser of capacitor $50\mu\text{F}$ is charged to 10 volt, the energy stored is : [1997]
 (a) $5 \times 10^{-3} \text{ J}$ (b) $2.5 \times 10^{-3} \text{ J}$
 (c) $3.75 \times 10^{-3} \text{ J}$ (d) $1.25 \times 10^{-3} \text{ J}$
2. If the separation between the plates of a capacitor is 5 mm, then the area of the plate of a 3F parallel plate capacitor is : [1998]
 (a) $4.259 \times 10^9 \text{ m}^2$ (b) $1.964 \times 10^9 \text{ m}^2$
 (c) $12.81 \times 10^9 \text{ m}^2$ (d) $1.964 \times 10^9 \text{ m}^2$
3. Minimum numbers of $8\mu\text{F}$ and 250 V capacitors are used to make a combination of $16\mu\text{F}$ and 1000V are: [2000]
 (a) 4 (b) 32
 (c) 8 (d) 3
4. An insulated charged sphere of radius 5 cm has a potential of 10 V at the surface. The potential at the centre will be [2000]
 (a) same as that at 5 cm from the surface
 (b) same as that at 25 cm from the surface
 (c) 10V
 (d) zero
5. Two materials having the dielectric constants K_1 and K_2 are filled between two parallel plates of a capacitor, which is shown in figure. The capacity of the capacitor is : [2001]

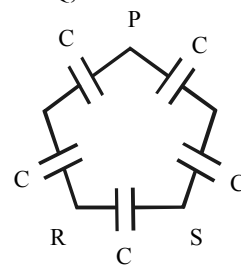


- (a) $\frac{A\epsilon_0(K_1 \times K_2)}{d(K_1 + K_2)}$ (b) $\frac{A\epsilon_0(K_1 - K_2)}{d}$
 (c) $\frac{A\epsilon_0 K_1 K_2}{(K_1 + K_2)}$ (d) $\frac{A\epsilon_0(K_1 + K_2)}{d}$

6. The capacitors C_1, C_3, C_4, C_5 have a capacitance $4\mu\text{F}$ each and C_2 has capacitance $10\mu\text{F}$. The effective capacitance between P and Q will be :



- (a) $8\mu\text{F}$ (b) $6\mu\text{F}$ [2002]
 (c) $4\mu\text{F}$ (d) $2\mu\text{F}$
7. A $40\mu\text{F}$ capacitor in a defibrillator is charged to 3000 V. The energy stored in the capacitor is set through the patient during a pulse of duration 2 ms. The power delivered to the patient is : [2004]
 (a) 45 kW (b) 90 kW
 (c) 180 kW (d) 360 kW
 8. Equipotential surfaces associated with an electric field which is increasing in magnitude along the x-direction are : [2004]
 (a) planes parallel to yz-plane
 (b) planes parallel to xy-plane
 (c) planes parallel to xz-plane
 (d) coaxial cylinders of increasing radii around the x-axis
 9. Five capacitors, each of capacitance value C are connected as shown in the figure. The ratio of capacitance between P & R, and the capacitance between P & Q, is : [2006]

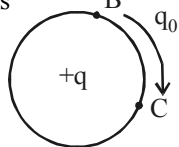


- (a) 3 : 1 (b) 5 : 2
 (c) 2 : 3 (d) 1 : 1

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10. A circle of radius R is drawn with charge $+q$ at the centre. A charge q_0 is brought from point B to C, then work done is [2009]

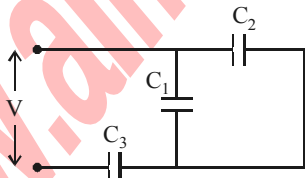


- (a) positive
(b) negative
(c) zero
(d) infinite
11. A parallel plate air capacitor has a capacitance C . When it is half filled with a dielectric of dielectric constant 5, the percentage increase in the capacitance will be [2009]
- (a) 400% (b) 66.6%
(c) 33.3% (d) 200%

12. A capacitor is charged by using a battery which is then disconnected. A dielectric slab is introduced between the plates which results in
- (a) increase in the potential difference across the plates and reduction in stored energy but no change in the charge on the plates
(b) decrease in the potential difference across the plates and reduction in the stored energy but no change in the charge on the plates
(c) reduction of charge on the plates and increase of potential difference across the plates
(d) increase in stored energy but no change in potential difference across the plates [2010]

13. The maximum electric field that can be held in air without producing ionisation of air is 10^7 V/m. The maximum potential therefore, to which a conducting sphere of radius 0.10 m can be charged in air is [2010]
- (a) 10^9 V (b) 10^8 V
(c) 10^7 V (d) 10^6 V

14. Three capacitors C_1 , C_2 and C_3 are connected as shown in the figure to a battery of V volt. If the capacitor C_3 breaks down electrically the change in total charge on the combination of capacitors is [2010]



- (a) $(C_1 + C_2) V [1 - C_3 / (C_1 + C_2 + C_3)]$
(b) $(C_1 + C_2) V [1 - (C_1 + C_2) / (C_1 + C_2 + C_3)]$
(c) $(C_1 + C_2) V [1 + C_3 / (C_1 + C_2 + C_3)]$
(d) $(C_1 + C_2) V [1 - C_2 / (C_1 + C_2 + C_3)]$

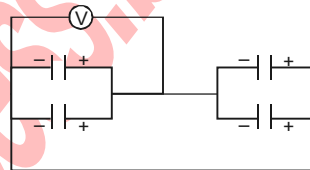
15. Two charges of magnitude $+q$ and $-3q$ are placed 100 cm apart. The distance from $+q$ between the charges where the electrostatic potential is zero is : [2011]

- (a) 25 cm (b) 50 cm
(c) 75 cm (d) 80 cm

16. If a dipole of dipole moment $\vec{p}$ is placed in a uniform electric field $\vec{E}$, then torque acting on it is given by [2012]

- (a) $\vec{\tau} = \vec{p} \cdot \vec{E}$ (b) $\vec{\tau} = \vec{p} \times \vec{E}$
(c) $\vec{\tau} = \vec{p} + \vec{E}$ (d) $\vec{\tau} = \vec{p} - \vec{E}$

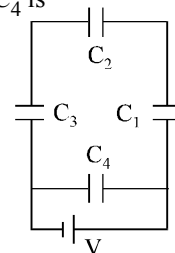
17. The four capacitors, each of $25 \mu\text{F}$ are connected as shown in Fig. The dc voltmeter reads 200 V. The charge on each plate of capacitor is [2012]



- (a) $\pm 2 \times 10^{-3} \text{ C}$ (b) $\pm 5 \times 10^{-3} \text{ C}$
(c) $\pm 2 \times 10^{-2} \text{ C}$ (d) $\pm 5 \times 10^{-2} \text{ C}$

18. A network of four capacitors of capacity equal to $C_1 = C$, $C_2 = 2C$, $C_3 = 3C$ and $C_4 = 4C$ are connected to a battery as shown in the figure. The ratio of the charges on C_2 and C_4 is [2012]

- (a) 4/7
(b) 3/22
(c) 7/4
(d) 22/3

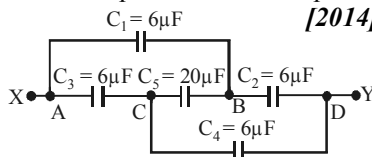


19. In a hollow spherical shell, potential (V) changes with respect to distance (s) from centre as [2013]

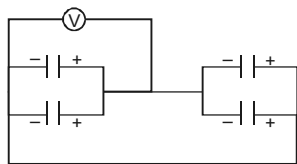
- (a) (b)
(c) (d)

20. What is the effective capacitance between points X and Y? [2014]

- (a) $24 \mu\text{F}$
 (b) $18 \mu\text{F}$
 (c) $12 \mu\text{F}$
 (d) $6 \mu\text{F}$



21. The four capacitors, each of 25 mF are connected as shown in fig. The dc voltmeter reads 200 V . The charge on each plate of capacitor is [2015]



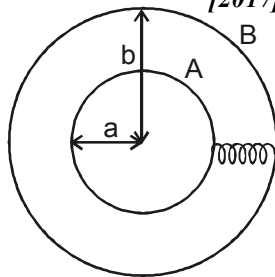
- (a) $\pm 2 \times 10^{-3} \text{ C}$ (b) $\pm 5 \times 10^{-3} \text{ C}$
 (c) $\pm 2 \times 10^{-2} \text{ C}$ (d) $\pm 5 \times 10^{-2} \text{ C}$
22. A charge $+q$ is fixed at each of the points $x = x_0, x = 3x_0, x = 5x_0, \dots$ upto ∞ on X-axis and charge $-q$ is fixed on each of the points $x = 2x_0, x = 4x_0, x = 6x_0, \dots$ upto ∞ . Here x_0 is a positive constant. Take the potential at a point due to a charge Q at

a distance r from it to be $\frac{Q}{4\pi\epsilon_0 r}$. Then the

potential at the origin due to above system of charges will be [2016]

- (a) zero (b) $\frac{q}{8\pi\epsilon_0 x_0 \log_e 2}$
 (c) infinity (d) $\frac{q \log_e 2}{4\pi\epsilon_0 x_0}$
23. Two spherical conductors A and B of radii a and b ($b > a$) are placed concentrically in air. The two are connected by a copper wire as shown in figure. Then the equivalent capacitance of the system is [2017]

- (a) $4\pi\epsilon_0 \frac{ab}{b-a}$
 (b) $4\pi\epsilon_0 (a+b)$
 (c) $4\pi\epsilon_0 b$
 (d) $4\pi\epsilon_0 a$



TYPE B : ASSERTION REASON QUESTIONS

Directions for (Qs. 24-26) : These questions consist of two statements, each printed as Assertion and Reason. While answering these questions, you are required to choose any one of the following five responses.

- (a) If both Assertion and Reason are correct and the Reason is a correct explanation of the Assertion.
 (b) If both Assertion and Reason are correct but Reason is not a correct explanation of the Assertion.
 (c) If the Assertion is correct but Reason is incorrect.
 (d) If both the Assertion and Reason are incorrect.
 (e) If the Assertion is incorrect but the Reason is correct.

24. **Assertion :** If the distance between parallel plates of a capacitor is halved and dielectric constant is three times, then the capacitance becomes 6 times.

Reason : Capacity of the capacitor does not depend upon the nature of the material. [1997]

25. **Assertion :** If three capacitors of capacitances $C_1 < C_2 < C_3$ are connected in parallel then their equivalent capacitance $C_p > C_s$.

Reason : $\frac{1}{C_p} = \frac{1}{C_1} + \frac{1}{C_2} + \frac{1}{C_3}$ [2002]

26. **Assertion :** A parallel plate capacitor is connected across battery through a key. A dielectric slab of dielectric constant K is introduced between the plates. The energy which is stored becomes K times. [2008]

Reason : The surface density of charge on the plate remains constant or unchanged.

Directions for (Qs. 27-33) : Each of these questions contains an Assertion followed by Reason. Read them carefully and answer the question on the basis of following options. You have to select the one that best describes the two statements.

- (a) If both Assertion and Reason are correct and Reason is the correct explanation of Assertion.
 (b) If both Assertion and Reason are correct, but Reason is not the correct explanation of Assertion.
 (c) If Assertion is correct but Reason is incorrect.
 (d) If both the Assertion and Reason are incorrect.

27. **Assertion :** The total charge stored in a capacitor is zero.

Reason : The field just outside the capacitor is

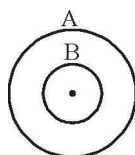
$$\frac{\sigma}{\epsilon_0} \quad (\sigma \text{ is the charge density}). \quad [2009]$$

28. **Assertion :** The electrostatic force between the plates of a charged isolated capacitor decreases when dielectric fills whole space between plates.

Reason : The electric field between the plates of a charged isolated capacitance increases when dielectric fills whole space between plates.

[2009]

29. **Assertion :** Two concentric charged shells are given. The potential difference between the shells depends on charge of inner shell.



Reason : Potential due to charge of outer shell remains same at every point inside the sphere.

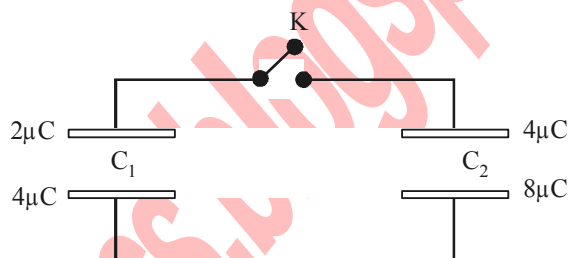
[2010]

30. **Assertion :** Two equipotential surfaces cannot cut each other.

Reason : Two equipotential surfaces are parallel to each other.

[2011]

31. **Assertion :** Charges are given to plates of two plane parallel plate capacitors C_1 and C_2 (such that $C_2 = 2C_1$) as shown in figure. Then the key K is pressed to complete the circuit. Finally the net charge on upper plate and net charge on lower plate of capacitor C_1 is positive.



Reason : In a parallel plate capacitor both plates always carry equal and opposite charge. [2012]

32. **Assertion :** For a non-uniformly charged thin circular ring with net charge is zero, the electric field at any point on axis of the ring is zero.

Reason : For a non-uniformly charged thin circular ring with net charge zero, the electric potential at each point on axis of the ring is zero.

[2015]

33. **Assertion :** Electric potential and electric potential energy are different quantities.

Reason : For a system of positive test charge and point charge electric potential energy = electric potential.

[2017]

HINTS & SOLUTIONS

Type A : Multiple Choice Questions

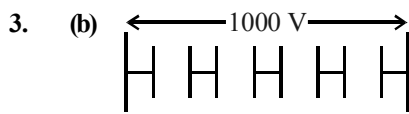
1. (b) Energy of condenser = $\frac{1}{2} \frac{Q^2}{C} = \frac{1}{2} \times CV^2$

$$= \frac{1}{2} \times 50 \times 10^{-6} \times 10 \times 10 = 2.5 \times 10^{-3} \text{ joule}$$

2. (d) $C = \frac{A\epsilon_0}{d} \Rightarrow 3 = \frac{A \times 8.85 \times 10^{-12}}{0.005}$

$$A = \frac{0.015}{8.85 \times 10^{-12}} = \frac{15 \times 10^{-3} \times 10^{12}}{8.85}$$

$$= 1.694 \times 10^9 \text{ m}^2$$



To create 1000 V, we need to combine 4 capacitors in series. Total capacity

becomes = $\frac{8\mu\text{F}}{4} = 2\mu\text{F}$. In order to obtain capacity of $16\mu\text{F}$, 8 rows of this combination will be needed in parallel.

$$\text{Total capacity} = 2\mu\text{F} \times 8 = 16\mu\text{F}$$

$$\text{Total number of capacitor} = 4 \times 8 = 32$$

4. (c) We know that in case of hollow sphere potential at the surface is equal to potential at the centre. So potential at the centre will be 10 V.

5. (d) Capacity of 1st capacitor, $C_1 = \frac{\epsilon_0 AK_1}{d}$

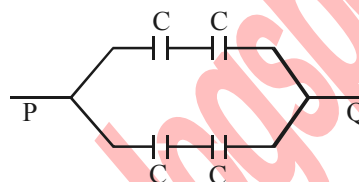
$$\text{Capacity of 2nd capacitor, } C_2 = \frac{\epsilon_0 AK_2}{d}$$

Both of these capacitors are parallel so, total capacity, $C = C_1 + C_2 = \frac{\epsilon_0 A}{d} (K_1 + K_2)$

6. (c) The combination forms Wheatstone bridge

$$\text{as } \frac{C_1}{C_4} = \frac{C_5}{C_3}$$

So, central capacitor, that is C_2 becomes ineffective. Now equivalent circuit will become as follows.



Now, two C are in series, their equivalent capacity

$= \frac{C^2}{2C} = \frac{C}{2}$ and then two $\frac{C}{2}$ are in parallel so their equivalent capacity will be

$$= \frac{C}{2} + \frac{C}{2} = C$$

So, total capacity = $C = 4\mu\text{F}$

7. (b) Energy given during this time period

$$= \frac{1}{2} CV^2 = \frac{1}{2} \times 40 \times 10^{-6} \times 3000 \times 3000$$

$$= 2 \times 9 \times 10 \text{ joule}$$

$$\text{Power} = \frac{\text{Work}}{\text{Time}} = \frac{90 \times 2}{2 \times 10^{-3}} = 90 \times 10^3 \text{ W}$$

$$= 90 \text{ kW}$$

8. (a) Equipotential surface is always perpendicular to the direction of electric field. As the field is along x-direction, equipotential surface must be parallel to yz-plane.

9. (c) In the first case, $3C$ and $2C$ are parallel. Equivalent capacitance is,

$$\frac{C}{3} + \frac{C}{2} = \frac{5C}{6}$$

In the second case $1C$ & $4C$ are parallel.

$$\text{Equivalent capacitance} = \frac{C}{1} + \frac{C}{4} = \frac{5C}{4}$$

$$\text{Ratio} = \frac{5C}{6} \times \frac{4}{5C} = 2:3$$

10. (c) Circle represents equipotential surface $\therefore$ work done around it = 0

11. (b) Initial capacitance = $\frac{\epsilon_0 A}{d}$

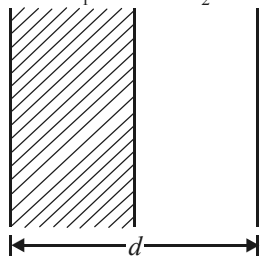
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When it is half filled by a dielectric of dielectric constant K , then

$$C_1 = \frac{K\epsilon_0 A}{d/2} = 2K \frac{\epsilon_0 A}{d}$$

$$\text{and } C_2 = \frac{\epsilon_0 A}{d/2} = \frac{2\epsilon_0 A}{d}$$



$$\therefore \frac{1}{C'} = \frac{1}{C_1} + \frac{1}{C_2} = \frac{d}{2\epsilon_0 A} \left(\frac{1}{K} + 1 \right)$$

$$= \frac{d}{2\epsilon_0 A} \left(\frac{1}{5} + 1 \right) = \frac{6}{10} \frac{d}{\epsilon_0 A}$$

$$C' = \frac{5\epsilon_0 A}{3d}$$

Hence, % increase in capacitance

$$= \left(\frac{\frac{5\epsilon_0 A}{3d} - \frac{\epsilon_0 A}{d}}{\frac{\epsilon_0 A}{d}} \right) \times 100$$

$$= \left(\frac{5}{3} - 1 \right) \times 100 = \frac{2}{3} \times 100 = 66.6\%$$

12. (b) If a dielectric slab of dielectric constant K is filled in between the plates of a capacitor after charging the capacitor (i.e., after removing the connection of battery with the plates of capacitor) the potential difference between the plates reduces to $\frac{1}{K}$ times and the potential energy of

capacitor reduces to $\frac{1}{K}$ times but there is no change in the charge on the plates.

13. (d) $E = 10^7 \text{ V/m}$
 $r = 0.10 \text{ m}$

$$E = \frac{V}{r}$$

$$V = Er = 10^7 \times \frac{10}{100}$$

$$V = 10^6 \text{ V}$$

14. (a) Equivalent capacitance of circuit,

$$\frac{1}{C_{\text{eq}}} = \frac{1}{C_3} + \frac{1}{C_1 + C_2}$$

(Since C_1 and C_2 are in parallel and which is in series with C_3).

$$\text{ie, } \frac{1}{C_{\text{eq}}} = \frac{C_1 + C_2 + C_3}{C_3(C_1 + C_2)}$$

$$\therefore C_{\text{eq}} = \frac{C_3(C_1 + C_2)}{C_1 + C_2 + C_3}$$

Since V is the voltage of battery, charge, $q = C_{\text{eq}} V$

$$= \frac{C_3(C_1 + C_2)V}{C_1 + C_2 + C_3}$$

If the capacitor C_3 breaks down, then effective capacitance,

$$C'_{\text{eq}} = C_1 + C_2$$

$\therefore$ New charge $q' =$

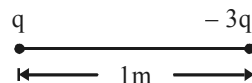
$$C'_{\text{eq}} V = (C_1 + C_2)V$$

Change in total charge = $q' - q$

$$= (C_1 + C_2)V - \frac{C_3(C_1 + C_2)V}{C_1 + C_2 + C_3}$$

$$= (C_1 + C_2)V \left[1 - \frac{C_3}{C_1 + C_2 + C_3} \right]$$

15. (a)



Suppose x is the required distance from q , then

$$\frac{1}{4\pi\epsilon_0} \left[\frac{9}{x} + \frac{(-3q)}{1-x} \right] = 0$$

After solving for x , we get $x = \frac{1}{4} \text{ m}$

16. (b) Given : Dipole moment of the dipole = $\vec{p}$

and uniform electric field = $\vec{E}$. We know that dipole moment (p) = $q \cdot a$ (where q is the charge and a is dipole length). And when a dipole of dipole moment $\vec{p}$ is placed in

uniform electric field $\vec{E}$, then Torque (τ) = Either force $\times$ perpendicular distance between the two forces = $q a E \sin \theta$ or

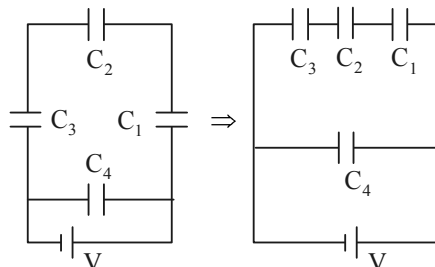
$$\tau = p E \sin \theta \text{ or } \vec{\tau} = \vec{p} \times \vec{E} \text{ (vector form)}$$

17. (b) Charge on each plate of each capacitor

$$Q = \pm CV = \pm 25 \times 10^6 \times 200$$

$$= \pm 5 \times 10^{-3} \text{ C}$$

18. (b)



Equivalent capacitance for three capacitors (C_1 , C_2 & C_3) in series is given by

$$\frac{1}{C_{eq.}} = \frac{1}{C_1} + \frac{1}{C_2} + \frac{1}{C_3} = \frac{C_2 C_3 + C_3 C_1 + C_1 C_2}{C_1 C_2 C_3}$$

$$\Rightarrow$$

$$C_{eq.} = \frac{C_1 C_2 C_3}{C_1 C_2 + C_2 C_3 + C_3 C_1}$$

$$\Rightarrow C_{eq.} = \frac{C(2C)(3C)}{C(2C) + (2C)(3C) + (3C)C} = \frac{6}{11} C$$

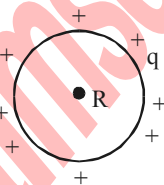
$$\Rightarrow \text{Charge on capacitors } (C_1, C_2 \text{ \& } C_3)$$

$$\text{in series} = C_{eq} V = \frac{6C}{11} V$$

$$\text{Charge on capacitor } C_4 = C_4 V = 4C V$$

$$\frac{\text{Charge on } C_2}{\text{Charge on } C_4} = \frac{\frac{6C}{11} V}{4C V} = \frac{6}{11} \times \frac{1}{4} = \frac{3}{22}$$

19. (b) In shell,
- q
- charge is uniformly distributed over its surface, it behaves as a conductor.

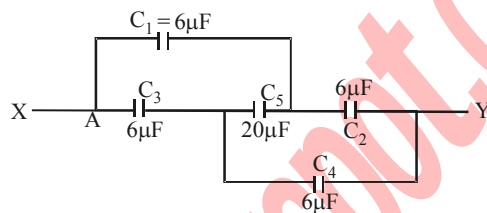


$$V = \text{potential at surface} = \frac{q}{4\pi\epsilon_0 R} \text{ and}$$

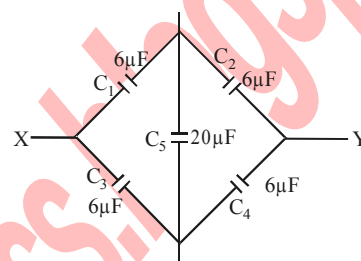
$$\text{inside } V = \frac{q}{4\pi\epsilon_0 R}$$

Because of this it behaves as an equipotential surface.

20. (d)

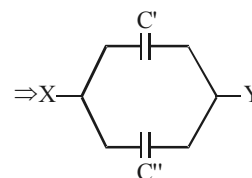
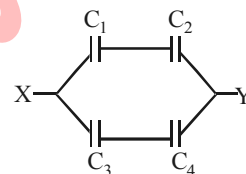


Equivalent circuit



$$\text{As } \frac{C_1}{C_3} = \frac{C_2}{C_4}$$

Hence no charge will flow through $20\mu\text{F}$



C_1 and C_2 are in series, also C_3 and C_4 are in series.

$$\text{Hence } C' = 3\mu\text{F}, C'' = 3\mu\text{F}$$

C' and C'' are in parallel hence net capacitance

$$= C' + C'' = 3 + 3 = 6\mu\text{F}$$

21. (b) Charge on each plate of each capacitor

$$Q = \pm CV = \pm 25 \times 10^6 \times 200$$

$$= \pm 5 \times 10^{-3} \text{ C}$$

22. (d) Potential at origin

$$= (V_1 + V_3 + V_5 + \dots) - (V_2 + V_4 + V_6 + \dots)$$

$$\Rightarrow \frac{q}{4\pi\epsilon_0} \left[\frac{1}{x_0} - \frac{1}{2x_0} + \frac{1}{3x_0} \dots \infty \right]$$

$$\Rightarrow \frac{q}{4\pi\epsilon_0 x_0} \left[1 - \frac{1}{2} + \frac{1}{3} - \frac{1}{4} + \dots \infty \right]$$

$$\Rightarrow \frac{q}{4\pi\epsilon_0 x_0} \log_e(1+1) \Rightarrow \frac{q}{4\pi\epsilon_0 x_0} \log_e 2$$

23. (c) All the charge given to inner sphere will pass on to the outer one. So capacitance that of outer one is $4\pi\epsilon_0 b$.

Type B : Assertion Reason Questions

24. (c) We know that capacity of capacitor is directly proportional to dielectric constant and inversely proportional to distance. So, the net effect of making distance halved & making dielectric constant three times will be capacity becoming six times.

As nature of the material (dielectric constant) is a factor influencing the capacity, therefore, Reason is incorrect.

25. (c) If three capacitors are joined in parallel then their equivalent capacitor will be less than the least value of capacitor so

$$C_p > C_s$$

$$\frac{1}{C_p} = \frac{1}{C_1} + \frac{1}{C_2} + \frac{1}{C_3} \text{ is incorrect.}$$

26. (c) In the given cases, $V = V_0$ (remains constant).

$$\text{Energy stored in the capacitor } U = \frac{1}{2} CV^2$$

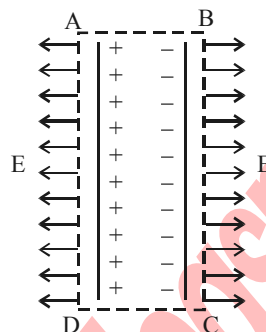
When a dielectric slab of dielectric constant K is introduced between the plates of the condenser, then $C \rightarrow KC$

So energy stored will become K times.

Since $Q = CV$, So Q will become K times
 $\therefore$ Surface charge density

$$\sigma' = \frac{KQ}{A} = K\sigma_0$$

27. (c) Charge stored on the two plates are $+Q$ and $-Q \Rightarrow Q + (-Q) = 0$ and hence Assertion is correct. The field however, outside the plates is zero.



Draw a Gaussian surface ABCD as shown.

The field $\vec{E}$ is uniform on faces AD and BC

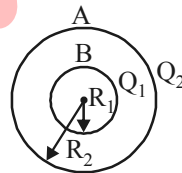
$$\Rightarrow \oint \vec{E} \cdot d\vec{s} = 0 \text{ yields } \vec{E} = 0.$$

28. (d) For isolated capacitor $Q = \text{constant}$,
 $F = \text{constant}$.

$$\text{But } E = \frac{\sigma}{K\epsilon_0}, \text{ hence } E \text{ decreases.}$$

$\therefore$ Assertion is incorrect and Reason is correct.

29. (a)



$$V_A = \frac{1}{4\pi\epsilon_0} \frac{Q_1 + Q_2}{R_2}$$

$$V_B = \frac{1}{4\pi\epsilon_0} \left(\frac{Q_1}{R_1} + \frac{Q_2}{R_2} \right)$$

$$V_B - V_A = \frac{1}{4\pi\epsilon_0} Q_1 \left(\frac{1}{R_1} - \frac{1}{R_2} \right)$$

30. (c) Two equipotential surfaces are not necessarily parallel to each other.
31. (d) Charge distribution on each surface makes both capacitor of same potential difference hence charge will not flow.
32. (d) For a non-uniformly charged thin circular ring with net zero charge, electric potential at each point on its axis is zero. Hence electric field at each point on its axis must be perpendicular to the axis. Therefore Assertion is incorrect and Reason is correct.
33. (c) Potential and potential energy are different quantities and cannot be equated.

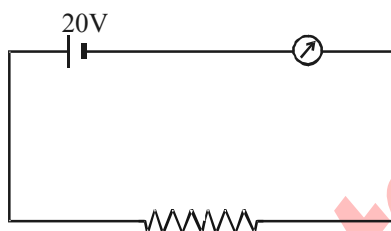
TYPE A : MULTIPLE CHOICE QUESTIONS

1. A wire of radius r has resistance R . If it is stretched to a radius $\frac{r}{2}$, its resistance will be :

[1997]

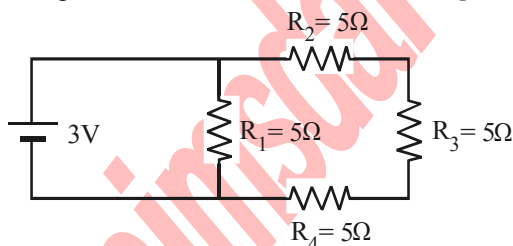
- (a) $16R$ (b) $2R$
(c) $4R$ (d) zero
2. A battery of e.m.f. 20 V and internal resistance 6Ω is connected to a resistor as shown in figure. If the current in the circuit is 1 amp , the resistance of the resistor will be :

[1997]

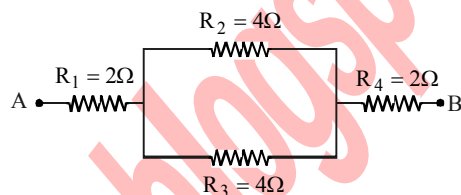


- (a) 14Ω (b) 16Ω
(c) 28Ω (d) 7Ω
3. The value of current i in the circuit as shown in figure is :

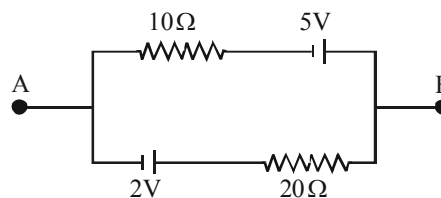
[1998]



- (a) 1.8 A (b) 0.8 A
(c) 0.2 A (d) 1.6 A
4. Electroplating is not provided to be used for
- (a) shining appearance [1998]
(b) protection of metal against corrosion
(c) fine finishing to the surface
(d) hardening the metals
5. In the given figure, the equivalent resistance between two points A and B will be: [1999]



- (a) 4Ω (b) 2Ω
(c) 8Ω (d) 6Ω
6. Two filaments of same length are connected first in series then in parallel. For the same amount of main current flowing, the ratio of the heat produced is: [1999]
- (a) $1:2$ (b) $4:1$
(c) $1:4$ (d) $2:1$
7. Given a current carrying wire of non-uniform cross-section. Which one of the following is constant throughout the length of wire? [2000]
- (a) current only
(b) current and drift speed
(c) drift speed only
(d) current, electric field and drift speed
8. The current in the given circuit is : [2000]



- (a) 0.3 amp (b) 0.4 amp
(c) 0.1 amp (d) 0.2 amp
9. Same length of two identical wires are first connected in series and then in parallel, then the amount of heat produced in both the conditions are in the ratio : [2000]
- (a) $1:4$ (b) $4:1$
(c) $3:1$ (d) $1:2$
10. The temperature of the cold junction of a thermocouple is 0°C and the temperature of the hot junction is $T^\circ\text{C}$. The relation for the thermo

emf is given by; $E = AT - \frac{1}{2}BT^2$

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(when $A = 16$ and $B = 0.08$). The temperature of inversion will be : [2001]

- (a) 500°C (b) 460°C
(c) 600°C (d) 400°C

11. The cell has an emf of 2V and the internal resistance of this cell is 0.1Ω , it is connected to a resistance of 3.9Ω . The voltage across the cell will be : [2001]

- (a) 1.95 V (b) 1.5 V
(c) 2 V (d) 1.8 V

12. The internal resistance of a cell is the resistance of:

- (a) electrolyte used in the cell [2001]
(b) electrodes of the cell
(c) vessel of the cell
(d) none of these

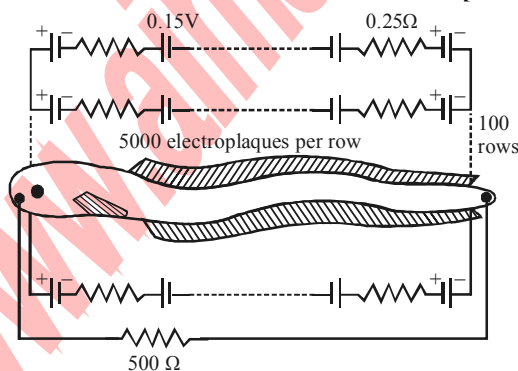
13. An electric bulb marked 40 W and 200V, is used in a circuit of supply voltage 100V. Now its power is [2002]

- (a) 10 W (b) 20 W
(c) 40 W (d) 100 W

14. A wire of length L is drawn such that its diameter is reduced to half of its original diameter. If the initial resistance of the wire were 10Ω , its new resistance would be : [2003]

- (a) 40Ω (b) 80Ω
(c) 120Ω (d) 160Ω

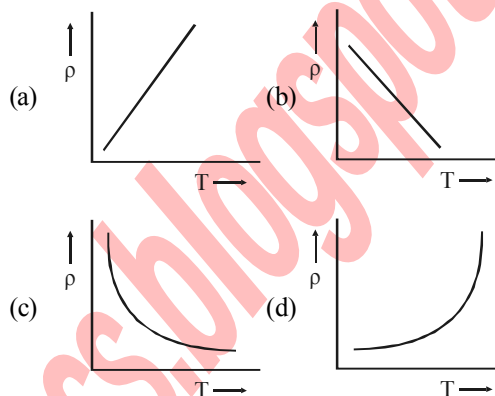
15. Eels are able to generate current with biological cells called electroplaques. The electroplaques in an eel are arranged in 100 rows, each row stretching horizontally along the body of the fish containing 5000 electroplaques. The arrangement is suggestively shown below. Each electroplaque has an emf of 0.15 V and internal resistance of 0.25Ω . The water surrounding the eel completes a circuit between the head and its tail. If the water surrounding it has a resistance of 500Ω , the current an eel can produce in water is about : [2004]



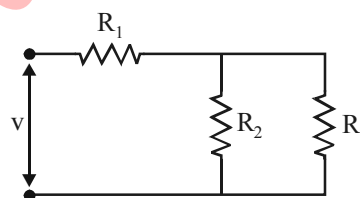
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- (a) 1.5 A (b) 3.0 A
(c) 15 A (d) 300 A

16. The temperature (T) dependence of resistivity (ρ) of a semi-conductor is represented by : [2004]



17. For ensuring dissipation of same energy in all three resistors (R_1, R_2, R_3) connected as shown in figure, their values must be related as [2005]



- (a) $R_1 = R_2 = R_3$
(b) $R_2 = R_3$ and $R_1 = 4R_2$
(c) $R_2 = R_3$ and $R_1 = (1/4)R_2$
(d) $R_1 = R_2 + R_3$

18. The voltage of clouds is 4×10^6 volt with respect to ground. In a lightning strike lasting 100 m sec, a charge of 4 coulombs is delivered to the ground. The power of lightning strike is : [2006]

- (a) 160 MW (b) 80 MW
(c) 20 MW (d) 500 KW

19. Faraday law of electrolysis indirectly shows [2007]

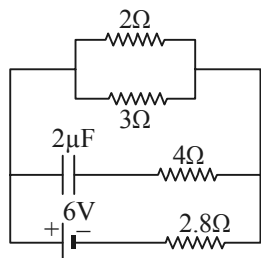
- (a) quantisation of charge
(b) quantisation of angular momentum
(c) quantisation of current
(d) quantisation of viscosity

20. Two sources of equal emf are connected to an external resistance R . The internal resistance of the two sources are R_1 and R_2 ($R_2 > R_1$). If the

potential difference across the source having internal resistance R_2 is zero, then [2008]

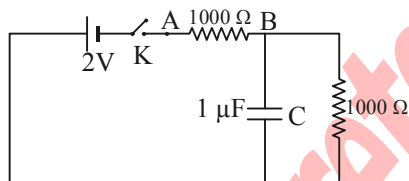
- (a) $R = R_2 - R_1$
 (b) $R = R_2 \times (R_1 + R_2) / (R_2 - R_1)$
 (c) $R = R_1 R_2 / (R_2 - R_1)$
 (d) $R = R_1 R_2 / (R_1 - R_2)$

21. In the figure shown, the capacity of the condenser C is $2\mu\text{F}$. The current in 2Ω resistance is [2008]



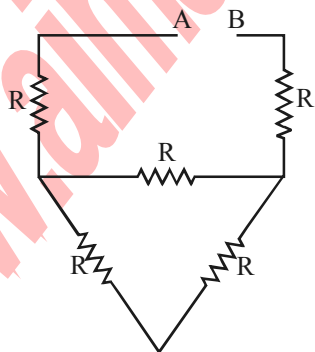
- (a) 9A (b) 0.9A
 (c) $\frac{1}{9}$ A (d) $\frac{1}{0.9}$ A

22. When the key K is passed at $t = 0$, which of the following statements about the current I in the resistor AB of the given circuit is true? [2008]



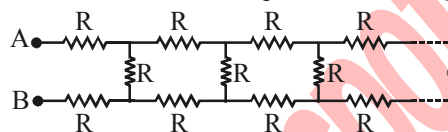
- (a) $I = 2\text{ mA}$ at all t
 (b) I oscillates between 1 mA and 2 mA
 (c) $I = 1\text{ mA}$ at all t
 (d) At $t = 0$, $I = 2\text{ mA}$ and with time it goes to 1 mA

23. What is the equivalent resistance across A and B in the figure shown, if $R = 3\Omega$? [2009]



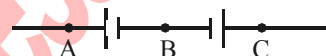
- (a) 9Ω (b) 12Ω
 (c) 15Ω (d) 8Ω

24. The resistance between points A and B is [2009]



- (a) $(\sqrt{3} + 1)R$ (b) $(\sqrt{3} - 1)R$
 (c) $4R$ (d) $(\sqrt{3} + 2)R$

25. A potentiometer is connected between A and B and the balance point is obtained at 203.6 cm. When the end of the potentiometer connected to B is shifted to C, then the balance point is obtained at 24.6 cm. If now the potentiometer be connected between B and C, the balance point will be at



- (a) 179.0 cm (b) 197.2 cm [2010]
 (c) 212.0 cm (d) 228.0 cm

26. Four wires of the same diameter are connected in turn between two points, maintained at a constant potential difference. Their resistivities are; ρ and L (wire 1), 1.2ρ and $1.2L$ (wire 2), 0.9ρ and $0.9L$ (wire 3) and ρ and $1.5L$ (wire 4). Rank the wires according to the rates at which energy is dissipated as heat, greatest first [2010]

- (a) $4 > 3 > 1 > 2$ (b) $4 > 2 > 1 > 3$
 (c) $1 > 2 > 3 > 4$ (d) $3 > 1 > 2 > 4$

27. The resistance of a galvanometer is 50Ω and current required to give full scale deflection is $100\mu\text{A}$ in order to convert it into an ammeter for reading upto 10 A. It is necessary to put a resistance of [2010]

- (a) $3.5 \times 10^{-4}\Omega$ (b) $10 \times 10^{-4}\Omega$
 (c) $2.5 \times 10^{-4}\Omega$ (d) $5 \times 10^{-4}\Omega$

28. Two resistances equal at 0°C with temperature coefficient of resistance α_1 and α_2 joined in series act as a single resistance in a circuit. The temperature coefficient of their single resistance will be: [2011]

- (a) $\alpha_1 + \alpha_2$ (b) $\frac{\alpha_1 \alpha_2}{\alpha_1 + \alpha_2}$
 (c) $\frac{\alpha_1 - \alpha_2}{2}$ (d) $\frac{\alpha_1 + \alpha_2}{2}$

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29. When the power delivered by a 100 volt battery is 40 watts the equivalent resistance of the circuit is : [2011]

(a) 100 ohms (b) 250 ohms
(c) 300 ohms (d) 350 ohms

30. The electro-chemical equivalent of a substance is numerically equal to the mass of the substance deposited if a current I flows through the electrolyte for 0.25 seconds. The value of I is : [2011]

(a) 1 A (b) 2 A
(c) 3 A (d) 4 A

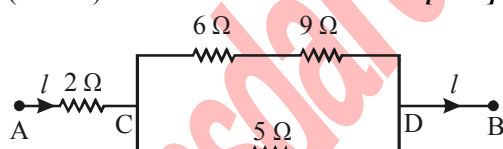
31. Two wires of same metal have the same length but their cross sections are in the ratio 3 : 1. They are joined in series. The resistance of the thicker wire is $10\ \Omega$. The total resistance of the combination is [2012]

(a) $5/2\ \Omega$ (b) $40/3\ \Omega$
(c) $40\ \Omega$ (d) $100\ \Omega$

32. A constant voltage is applied between the two ends of a uniform metallic wire. Some heat is developed in it. The heat developed is double if [2012]

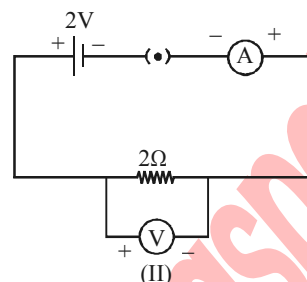
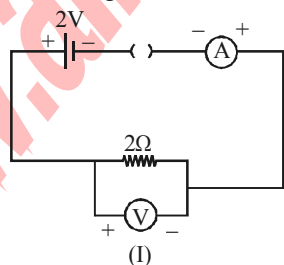
(a) both the length and radius of wire are halved
(b) both length and radius of wire are doubled
(c) the radius of wire is doubled
(d) the length of the wire is doubled

33. In the circuit shown in figure, the $5\ \Omega$ resistance develops 20.00 cal/s due to the current flowing through it. The heat developed in $2\ \Omega$ resistance (in cal/s) is [2012]



(a) 23.8 (b) 14.2
(c) 11.9 (d) 7.1

34. For the circuits shown in figures I and II, the voltmeter reading would be [2012]



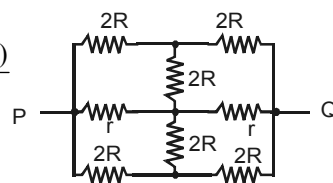
(a) 2 V in circuit I and 0 V in circuit II
(b) 0 V in both circuits
(c) 2 V in both circuits
(d) 0 V in circuit I and 2 V in circuit II

35. Three copper wires of lengths and cross sectional areas are (ℓ, A) , $(2\ell, A/2)$ and $(\ell/2, 2A)$. Resistance is minimum in [2013, 2017]

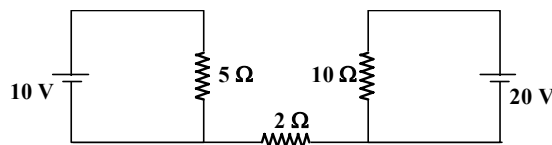
(a) wire of cross-sectional area $A/2$
(b) wire of cross-sectional area A
(c) wire of cross-sectional area $2A$
(d) same in all the three cases

36. The effective resistance between points P and Q of the electrical circuit shown in the figure is [2013]

(a) $\frac{2Rr}{R+r}$
(b) $\frac{8R(R+r)}{3R+r}$
(c) $2r+4R$
(d) $\frac{5R}{2}+2r$



37. Find out the value of current through $2\ \Omega$ resistance for the given circuit [2014]

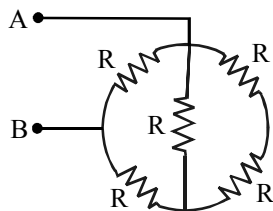


(a) zero (b) 2 A
(c) 5 A (d) 4 A

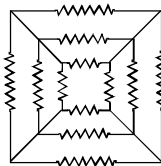
38. The cold junction of a thermocouple is maintained at 10°C . No thermo e.m.f. is developed when the hot junction is maintained at 530°C . The neutral temperature is [2014]

(a) 260°C (b) 265°C
(c) 270°C (d) 520°C

39. The equivalent resistance between A and B is [2015]

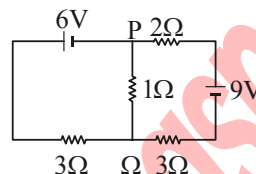


- (a) $\frac{8R}{5}$ (b) $\frac{5R}{8}$
 (c) $\frac{3R}{8}$ (d) $\frac{7R}{8}$
40. A potentiometer wire, 10 m long, has a resistance of 40Ω . It is connected in series with a resistance box and a 2 V storage cell. If the potential gradient along the wire is 0.1 m V/cm, the resistance unplugged in the box is [2015]
 (a) 260Ω (b) 760Ω
 (c) 960Ω (d) 1060Ω
41. A current source drives a current in a coil of resistance R_1 for a time t . The same source drives current in another coil of resistance R_2 for same time. If heat generated is same, find internal resistance of source. [2016]
 (a) $\frac{R_1 R_2}{R_1 + R_2}$ (b) $R_1 + R_2$
 (c) zero (d) $\sqrt{R_1 R_2}$
42. Two long conductors, separated by a distance d carry current I_1 and I_2 in the same direction. They exert a force F on each other. Now the current in one of them is increased to two times and its direction is reversed. The distance is also increased to $3d$. The new value of the force between them is [2016]
 (a) $-\frac{2F}{3}$ (b) $\frac{F}{3}$
 (c) $-2F$ (d) $-\frac{F}{3}$
43. Twelve resistors each of resistance 16Ω are connected in the circuit as shown. The net resistance between AB is [2016]



- (a) 1Ω (b) 2Ω
 (c) 3Ω (d) 4Ω

44. In the circuit shown, the current in the 1Ω resistor is : [2017]



- (a) 0.13 A, from Q to P
 (b) 0.13 A, from P to Q
 (c) 1.3 A from P to Q
 (d) 0A

TYPE B : ASSERTION REASON QUESTIONS

Directions for (Qs. 45-50) : These questions consist of two statements, each printed as Assertion and Reason. While answering these questions, you are required to choose any one of the following five responses.

- (a) If both Assertion and Reason are correct and the Reason is a correct explanation of the Assertion.
 (b) If both Assertion and Reason are correct but Reason is not a correct explanation of the Assertion.
 (c) If the Assertion is correct but Reason is incorrect.
 (d) If both the Assertion and Reason are incorrect.
 (e) If the Assertion is incorrect but the Reason is correct.

45. **Assertion :** In a simple battery circuit, the point of the lowest potential is positive terminal of the battery.

Reason : The current flows towards the point of the higher potential, as it does in such a circuit from the negative to the positive terminal. [2002]

46. **Assertion :** A larger dry cell has higher emf.

Reason : The emf of a dry cell is proportional to its size. [2004]

47. **Assertion :** A current continues to flow in superconducting coil even after switch is off.

Reason : Superconducting coils show Meissner effect. [2007]

48. **Assertion :** Voltmeter is connected in parallel with the circuit.

Reason : Resistance of a voltmeter is very large. [2007]

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49. **Assertion :** Ohm's law is applicable for all conducting elements.

Reason : Ohm's law is a fundamental law. [2007]

50. **Assertion :** An electric bulb becomes dim, when the electric heater in parallel circuit is switched on.

Reason : Dimness decreases after sometime.

[2008]

Directions for (Qs. 51-59) : Each of these questions contains an Assertion followed by Reason. Read them carefully and answer the question on the basis of following options. You have to select the one that best describes the two statements.

- (a) If both Assertion and Reason are correct and Reason is the correct explanation of Assertion.
- (b) If both Assertion and Reason are correct, but Reason is not the correct explanation of Assertion.
- (c) If Assertion is correct but Reason is incorrect.
- (d) If both the Assertion and Reason are incorrect.

51. **Assertion :** The electric bulbs glow immediately when switch is on.

Reason : The drift velocity of electrons in a metallic wire is very high. [2009]

52. **Assertion :** In a simple battery circuit, the point of the lowest potential is negative terminal of the battery.

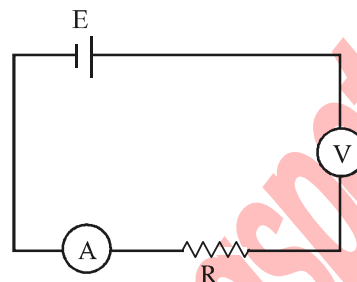
Reason : The current flows towards the point of the higher potential, as it does in such a circuit from the negative to the positive terminal.

[2010]

53. **Assertion :** Free electrons always keep on moving in a conductor even then no magnetic force act on them in magnetic field unless a current is passed through it.

Reason : The average velocity of free electron is zero. [2011]

54. **Assertion :** All electric devices shown in the circuit are ideal. The reading of each of ammeter (a) and voltmeter (V) is zero.



Reason : An ideal voltmeter draws almost no current due to very large resistance, and hence (V) and (a) will read zero. [2012]

55. **Assertion :** Long distance power transmission is done at high voltage.

Reason : At high voltage supply power losses are less. [2014]

56. **Assertion :** When current through a bulb decreases by 0.5%, the glow of bulb decreases by 1%.

Reason : Glow (Power) which is directly proportional to square of current. [2015]

57. **Assertion :** The current density $\vec{j}$ at any point in ohmic resistor is in direction of electric field $\vec{E}$ at that point.

Reason : A point charge when released from rest in a region having only electrostatic field always moves along electric lines of force.

[2016]

58. **Assertion :** Bending a wire does not effect electrical resistance.

Reason : Resistance of wire is proportional to resistivity of material. [2016]

59. **Assertion :** Kirchhoff's junction rule follows from conservation of charge.

Reason : Kirchhoff's loop rule follows from conservation of momentum. [2017]

HINTS & SOLUTIONS

Type A : Multiple Choice Questions

1. (a) Let length & cross sectional area of wire be ℓ & a respectively. ρ be the specific resistance, then

$$R = \rho \frac{\ell}{a}$$

If radius becomes half, area becomes $\frac{1}{4}$ th or cross sectional area after the stretch $= \frac{a}{4}$. Let its length increases to ℓ' . Since volume remains the same in the process,

$$\ell a = \ell' \times \frac{a}{4} \Rightarrow \ell' = 4\ell$$

Let R' be the resistance of stretched wire,

$$R' = \rho \frac{4\ell}{a/4} = 16 \times \rho \frac{\ell}{a} = 16R$$

2. (a) $\frac{20}{R+6} = 1 \Rightarrow 20 = R+6 \Rightarrow R = 14 \Omega$
 3. (b) Three 5Ω resistors are in series. Their total resistance = 15Ω . Now it is in parallel with 5Ω resistor, so total resistance,

$$\frac{1}{R} = \frac{1}{5} + \frac{1}{15} = \frac{3+1}{15} = \frac{4}{15}$$

$$R = \frac{15}{4}$$

$$\therefore I = \frac{V}{R} = \frac{3}{15/4} = \frac{3 \times 4}{15} = 0.8A$$

4. (d) Electroplating is a process which uses the process of electrolysis to form a thin layer of a metal on any other metal. It is not used for hardening purpose.
 6. (d) Two 4Ω resistors are in parallel so, their total resistance = 2Ω . Now three 2Ω resistors are in series. Their total resistance will be 6Ω .
 7. (b) Let main current be I & let the resistance of each wire be R .

In the first case heat produced $= I^2 R t + I^2 R t = 2I^2 R t$

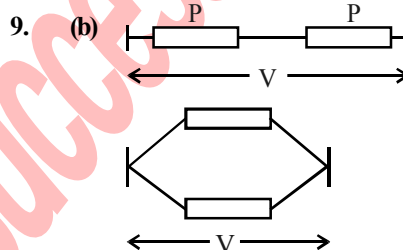
In the second case heat produced

$$= \left(\frac{I}{2}\right)^2 R t \times 2 = \frac{I^2 R t}{2}$$

$$\text{Ratio} = \frac{2I^2 R t}{\frac{I^2 R t}{2}} = 4:1$$

7. (a) Current is uniform throughout the wire even if it is of non-uniform thickness. This is because charge passing through every cross sectional area per unit time remains the same throughout the wire. So, current remains the same.
 8. (c) Two batteries are joined with opposite polarity so, total e.m.f. = $5 - 2 = 3V$
 Total resistance = $10 + 20 = 30\Omega$

$$\text{Current} = \frac{3}{30} = 0.1A$$



Let the resistances be r for each wire.

$$\text{Heat generated} = I^2 (2r) = 2I^2 r,$$

where I is current through both of them. When they are connected in parallel each

$$\text{will have current} = \frac{I}{2}.$$

$$\text{Heat generated} = \left(\frac{I}{2}\right)^2 r t \times 2 = \frac{I^2 r t}{2}$$

Ratio of heat generated in two cases

$$= \frac{2I^2 r t}{\frac{I^2 r t}{2}} = \frac{4 \times I^2 r t}{I^2 r t} = 4:1$$

10. (d) Since, $E = AT - \frac{1}{2} BT^2$

$$E = 16T - \frac{1}{2} 0.08T^2 = 16T - 0.04T^2$$

At temperature of inversion, $E = 0$

$$\text{So, } 16T - 0.04T^2 = 0 \Rightarrow T = 0$$

$$\text{or } 16 - 0.04T = 0$$

$$T = \frac{16}{0.04} = 400^\circ C$$

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11. (a) Current = $\frac{2}{3.9 + 0.1} = \frac{2}{4} = 0.5$

Voltage across the cell

$$= 2 - 0.5 \times 0.1 = 2 - 0.05 = 1.95 \text{ V}$$

12. (a) Internal resistance of a cell is the resistance of electrolyte used in the cell. That is why when it is heated its conductivity is increased due to mobility of ions.

13. (a) Resistance of bulb

$$= \frac{V^2}{P} = \frac{200 \times 200}{40} = 1000 \Omega$$

$$\text{New power} = \frac{V^2}{R} = \frac{100 \times 100}{1000} = 10 \text{ W}$$

14. (d) Let the new length be ℓ_1 , keeping volume constant,

$$\pi r^2 L = \pi \left(\frac{r}{2} \right)^2 \ell_1$$

$$\Rightarrow \ell_1 = 4L$$

$$\text{Now, } 10 = \frac{\rho L}{\pi r^2}; R = \frac{\rho \ell_1}{\pi \left(\frac{r}{2} \right)^2}$$

$$\frac{R}{10} = \frac{\rho \ell_1 \times 4}{\pi r^2} \times \frac{\pi r^2}{\rho L} = \frac{4L \times 4 \times r^2}{r^2 \times L} = \frac{16}{1}$$

$$R = 160$$

15. (a) It is an example of mixed arrangement.

$$\text{Total potential} = 0.15 \times 5000 = 750 \text{ V}$$

$$\text{Resistance per row} = 0.25 \times 5000 = 1250 \Omega$$

There are 100 rows, so

$$\text{Total resistance} = \frac{1250}{100} = 12.5 \Omega$$

It is connected with external resistance of 500Ω , so

$$\text{Total resistance} = 500 + 12.5 = 512.5 \Omega$$

$$\text{Current} = \frac{750}{512.5} = 1.5 \text{ A}$$

16. (c) In a semiconductor when temperature increases conductivity increases so resistivity decreases i.e.

$$T \propto \frac{1}{\rho}$$

$$\rho T = \text{constant} \Rightarrow \rho = K \frac{1}{T}$$

$$d\rho = -K \frac{1}{T^2} dT \Rightarrow \frac{d\rho}{dT} = -\frac{K}{T^2}$$

So, slope of $\rho - T$ curve is negative & it is dependent upon T i.e. it is not constant.

So, alternative (c) is right choice.

17. (c) Let i_1, i_2 & i_3 be current in R_1, R_2 & R_3 .

Now, power consumed are same so,

$$i_1^2 R_1 = i_2^2 R_2 = i_3^2 R_3 \quad \dots (i)$$

$$i_1 R_2 = i_3 R_3 \quad [\text{volt over them are same}]$$

$$\dots (ii)$$

Dividing (i) with (ii), $i_2 = i_3 \Rightarrow R_2 = R_3$

$$i_1 = 2i_2 \quad [i_1 \text{ is equally being divided}]$$

$$i_1^2 R_1 = i_2^2 R_2 = \frac{i_1^2}{4} R_2$$

$$R_2 = 4R_1$$

18. (a) Energy delivered to the ground = $V.Q.$

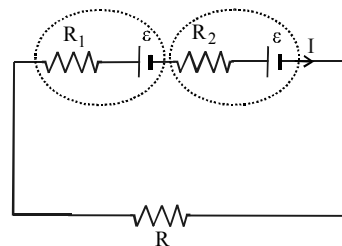
$$= 4 \times 10^6 \times 4 = 16 \times 10^6 \text{ joule}$$

$$\text{Power} = \frac{16 \times 10^6}{\text{time}} = \frac{16 \times 10^6}{100 \times 10^{-3}} = 16 \times 10^7$$

$$= 160 \text{ MW}$$

19. (a) Faraday's law says that amount of substance liberated or deposited at an electrode is proportional to quantity of charge passed through it. Thus, mass $\propto$ charge. Since mass is quantised hence indirectly charge is quantised.

20. (a) $I = \frac{2\varepsilon}{R + R_1 + R_2}$



Pot. difference across second cell

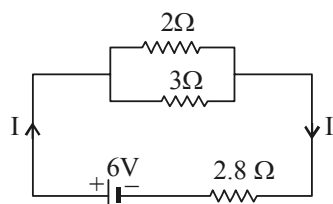
$$= V = \varepsilon - IR_2 = 0$$

$$\varepsilon = \frac{2\varepsilon}{R + R_1 + R_2} \cdot R_2 = 0$$

$$R + R_1 + R_2 - 2R_2 = 0$$

$$R + R_1 - R_2 = 0 \quad \therefore R = R_2 - R_1$$

21. (b) At the steady state, the branch containing capacitor will be ineffective as no current will be flowing through it



Since 2Ω and 3Ω resistors are in parallel, equivalent resistance,

$$R' = \frac{2 \times 3}{2 + 3} = 1.2\Omega$$

Total current through the battery,

$$I = \frac{6}{1.2 + 2.8} = 1.5\text{A}$$

$\therefore$ Current flowing through 2Ω resistor

$$I_{(2\Omega)} = \frac{3}{5} \times 1.5 = 0.9\text{A}$$

22. (d) At time $t = 0$ i.e., when the capacitor is charging, then current through the circuit,

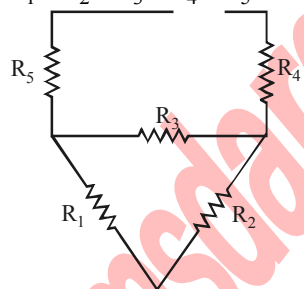
$$I = \frac{2}{1000} = 2\text{mA}$$

When capacitor is fully charged, no current will pass through it.

Hence current through the circuit

$$I = \frac{2}{2000} = 1\text{mA}$$

23. (d) $R_1 = R_2 = R_3 = R_4 = R_5 = R$



R_1 & R_2 are in series

Their equivalent resistance,

$$R' = R_1 + R_2 = 2R$$

Now R' & R_3 are in parallel

Their equivalent resistance R'' is given by

$$\frac{1}{R''} = \frac{1}{R'} + \frac{1}{R_3} = \frac{1}{2R} + \frac{1}{R}$$

$$\frac{1}{R''} = \frac{1 + 2}{2R}$$

$$R'' = \frac{2R}{3}$$

R'' , R_5 & R_4 are in series

$$\therefore R_f = R'' + R_5 + R_4 = R + R + 2R/3 = 8R/3,$$

Since $R = 3\Omega$

$$\therefore R_f = 8 \times \frac{3}{3} = 8\Omega.$$

24. (a) Let resistance between A and B be r .

$$\therefore r = 2R + \frac{R \times r}{r + R}$$



$$\Rightarrow r = (\sqrt{3} + 1)R$$

25. (a) $e_1 = 203.6$ (i)
 $e_1 - e_2 = 24.6$ (ii)
 (i) - (ii) gives $e_2 = 179.0\text{ cm}$

26. (d) $R_1 = \frac{\rho L}{A}$,
 $R_2 = \frac{(1.2\rho)(1.2L)}{A} = \frac{1.44\rho L}{A}$,
 $R_3 = \frac{(0.9\rho)(0.9L)}{A} = \frac{0.81\rho L}{A}$,
 $R_4 = \frac{\rho(1.5L)}{A} = \frac{1.5\rho L}{A}$
 $\therefore R_3 < R_1 < R_2 < R_4$

For constant potential, $P \propto \frac{1}{R}$,

$$\therefore P_3 < P_1 < P_2 < P_4$$

27. (d) $G = 50\Omega$, $I_G = 100\mu\text{A}$, $I = 10\text{A}$

$$\text{Shunt, } S = \left(\frac{I_G}{I - I_G} \right) G$$

$$\Rightarrow S = \left(\frac{100 \times 10^{-6}}{10 - 100 \times 10^{-6}} \right) \times 50$$

$$= \frac{10^{-4}}{10} \times 50 = 5 \times 10^{-4} \Omega$$

28. (d) $R_1 = R_0(1 + \alpha_1 t) + R_0(1 + \alpha_2 t)$

$$= 2R_0 \left(1 + \frac{\alpha_1 + \alpha_2}{2} t \right)$$

$$= R'_0 \left(1 + \frac{\alpha_1 + \alpha_2}{2} t \right)$$

Comparing with $R = R_0(1 + \alpha t)$

$$\alpha = \frac{\alpha_1 + \alpha_2}{2}$$

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29. (b) $P = \frac{V^2}{R} \Rightarrow R = \frac{V^2}{P}$

30. (d) We have, $m = Zq$

or $Z = \frac{m}{q}$

For $q = 1C$, $Z = m$

So, for 1 coulomb of charge, $q = i t$

or $1 = i \times 0.25$ or $i = 4 A$

31. (c) Resistance of a wire $= \rho l / A$.

For the same length and same material,

$$\frac{R_2}{R_1} = \frac{A_1}{A_2} = \frac{3}{1} \text{ or, } R_2 = 3R_1$$

The resistance of thick wire, $R_1 = 10 \Omega$

The resistance of thin wire $= 3R_1 = 3 \times 10 = 30 \Omega$.

Total resistance $= 10 + 30 = 40 \Omega$.

32. (b) $R = \frac{\rho \ell}{\pi r^2}$

When ℓ is $\frac{\ell}{2}$ and radius is $\frac{r}{2}$,

$$\therefore R' = \frac{\rho \ell 4}{\pi 2r^2} = \frac{2\rho \ell}{\pi r^2}$$

So, $R' = 2R$. So, heat is doubled according to $H = I^2 RT$.

33. (b) Let I_1 be the current through 5Ω resistance, I_2 through $(6 + 9) \Omega$ resistance. Then as per question,

$$I_1^2 \times 5 = 20 \text{ or, } I_1 = 2A.$$

Potential difference across C and D $= 2 \times 5 = 10V$

$$\text{Current } I_2 = \frac{10}{6+9} = \frac{2}{3} A.$$

Heat produced per second in 2Ω

$$= I^2 R \left(\frac{8}{3} \right)^2 \times 2 = 14.2 \text{ cal/s.}$$

34. (d) In the circuit I, the key is open so current in the circuit is zero. Therefore the voltmeter gives 0V reading. In the circuit II, the reading of the voltmeter is 2V.

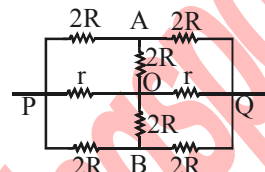
35. (c) $R \propto \frac{\ell}{A}$;

So, the resistance of the wire will be minimum when the area of cross-section is maximum and length is minimum.

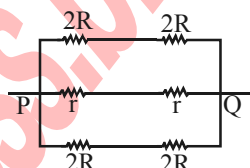
36. (a) The circuit is symmetrical about axis POQ. Therefore the equivalent circuit is drawn

$$\therefore \frac{1}{R_{PQ}} = \frac{1}{4R} + \frac{1}{4R} + \frac{1}{2r} = \frac{1}{2R} + \frac{1}{2r} = \frac{R+r}{2Rr}$$

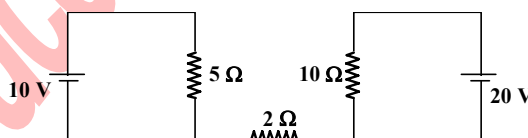
$$\Rightarrow R_{PQ} = \frac{2Rr}{R+r}$$



If a potential difference is applied across P and Q, there will be no currents in arms AO and OB. So these resistance will be ineffective.



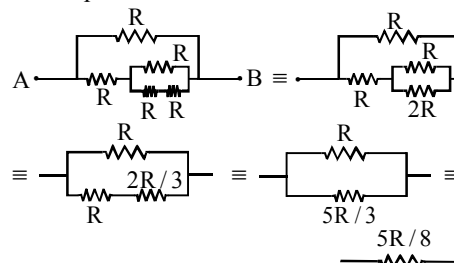
37. (a) The current in 2Ω resistor will be zero because it is not a part of any closed loop.



38. (c) Neutral temperature,

$$\theta_n = \frac{\theta_i + \theta_0}{2} = \frac{530 + 10}{2} = 270^\circ C.$$

39. (b) The equivalent circuit can be redrawn as



40. (b) Potential gradient along wire $= \frac{\text{potential difference along wire}}{\text{length of wire}}$

$$\text{or, } 0.1 \times 10^{-3} = \frac{I \times 40}{1000} \text{ V/cm}$$

$$\text{or, Current in wire, } I = \frac{1}{400} A$$

$$\text{or, } \frac{2}{40+R} = \frac{1}{400} \text{ or } R = 800 - 40 = 760 \Omega$$

41. (d) Let internal resistance of source = R
Current in coil of resistance

$$R_1 = I_1 = \frac{V}{R + R_1}$$

Current in coil of resistance

$$R_2 = I_2 = \frac{V}{R + R_2}$$

Further, as heat generated is same, so

$$I_1^2 R_1 t = I_2^2 R_2 t$$

$$\text{or } \left(\frac{V}{R + R_1} \right)^2 R_1 = \left(\frac{V}{R + R_2} \right)^2 R_2$$

$$\Rightarrow R_1(R + R_2)^2 = R_2(R + R_1)^2$$

$$\Rightarrow R^2 R_1 + R_1 R_2^2 + 2 R R_1 R_2$$

$$= R^2 R_2 + R_1^2 R_2 + 2 R R_1 R_2$$

$$\Rightarrow R^2(R_1 - R_2) = R_1 R_2(R_1 - R_2)$$

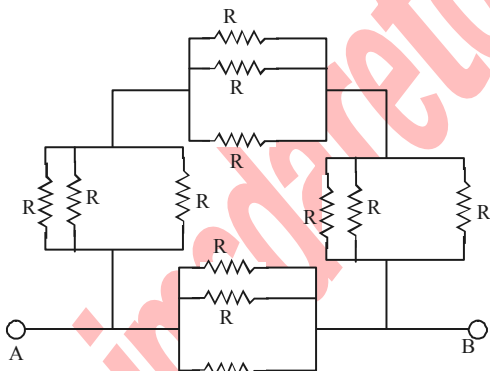
$$\Rightarrow R = \sqrt{R_1 R_2}$$

42. (a) $F = \left(\frac{\mu_0 I_1}{2\pi r} \right) \ell I_2$ When $I_1 = -2I_2$, and $r = 3r$,

$$\text{then } F' = - \frac{\mu_0 - 2I_1 \ell I_2}{2\pi \cdot 3r}$$

$$= \left(\frac{\mu_0 I_1 I_2 \ell}{2\pi r} \right) \left(-\frac{2}{3} \right) = -\frac{2}{3} F$$

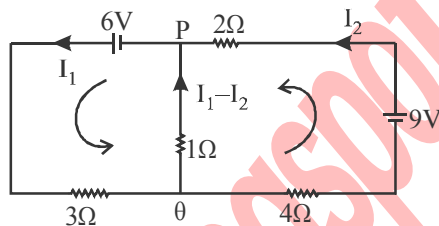
43. (d)



$$R_{\text{net}} \text{ between AB} = \frac{\frac{3R}{3} \times \frac{R}{3}}{\frac{3R}{3} + \frac{R}{3}} = \frac{R^2}{4R} = 4\Omega$$

44. (a) From KVL

$$-6 + 3I_1 + 1(I_1 - I_2) = 0$$



$$6 = 3I_1 + I_1 - I_2$$

$$4I_1 - I_2 = 6 \quad \dots(1)$$

$$-9 + 2I_2 - (I_1 - I_2) + 3I_2 = 0$$

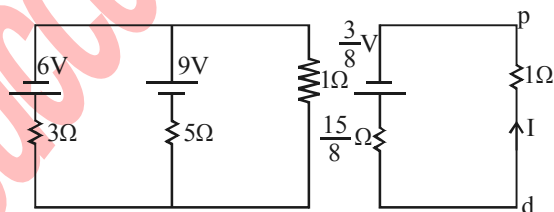
$$-I_1 + 6I_2 = 9 \quad \dots(2)$$

On solving (1) and (2)

$$I_1 = 0.13A$$

Direction Q to P, since $I_1 > I_2$.

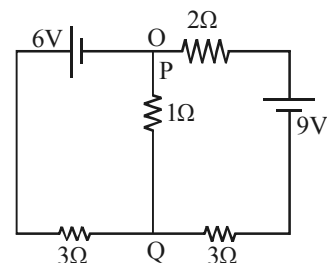
Alternatively



$$E_{\text{eq}} = \frac{\frac{E_1}{r_1} + \frac{E_2}{r_2}}{\frac{1}{r_1} + \frac{1}{r_2}} = \frac{\frac{6}{3} + \frac{9}{5}}{\frac{1}{3} + \frac{1}{5}} = \frac{3}{8V}$$

$$\therefore I = \frac{\frac{3}{8}}{\frac{15}{8} + 1} = \frac{3}{23} = 0.13A$$

Considering potential at P as 0V and at Q as x volt, then



$$\frac{x-6}{3} + \frac{x-0}{1} + \frac{x+9}{5} = 0$$

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$$\therefore x = \frac{2}{23}$$

$$\therefore i = \frac{x-0}{1} = \frac{2}{23} = 0.13\text{A}$$

From Q to P

Type B : Assertion Reason Questions

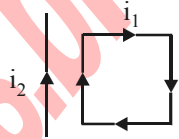
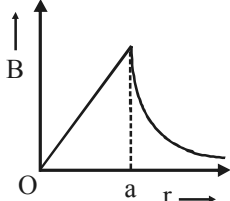
45. (d) Positive terminal of a battery is point of highest potential and current flows from highest to lowest potential i.e. from +ve to -ve potential.
46. (d) The e.m.f. of a dry cell is dependent upon the electrode potential of cathode and anode which in turn is dependent upon the reaction involved as well as concentration of the electrolyte. It has nothing to do with size of the cell.
So, both assertion & reason are wrong.
47. (b) Current continues to flow in a super conducting coil even after switch off because at critical temperature, its resistance is zero so there is no hinderance to current flow.
Meissner effect says that at critical temperature magnetic field inside the conductor is zero i.e., $B = 0$ but this does not explain assertion.
48. (b) Voltmeter is a galvanometer with high resistance. It measures potential drop across any part of an electrical circuit. It is connected in parallel so that it does not draw any current itself (due to high resistance) and does not affect net resistance of the circuit.
49. (c) A conducting device obeys ohm's law when the resistance of device is independent of the magnitude and polarity of the applied potential difference which happens in metallic conductors. Reason is false as ohm's law is not true for non-ohmic conductors such as junction diodes etc.
50. (b) The electric power of a heater is more than that of a bulb. As $P \propto \frac{1}{R}$, the resistance of heater is less than that of the electric bulb. When a heater connected in parallel to the bulb is switched on, it draws more current due to its lesser resistance, consequently, the current through the bulb decreases and so it becomes dim.
When the heater coil becomes sufficient hot, its resistance becomes more and hence

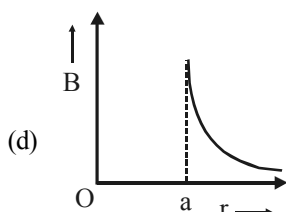
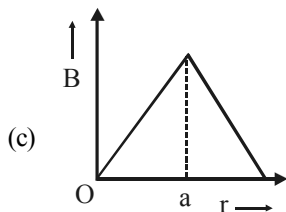
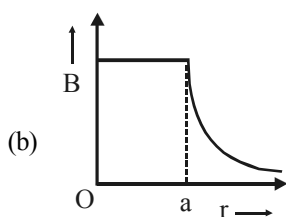
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- it draws a little lesser current. Consequently, the current through the electric bulb recovers.
51. (c) In a conductor there are large number of free electrons. When we close the circuit, the electric field is established instantly with the speed of electromagnetic wave which cause electron drift at every portion of the circuit. Due to which the current is set up in the entire circuit instantly. The current which is set up does not wait for the electrons flow from one end of the conductor to the another end. It is due to this reason, the electric bulb glows immediately when switch is on.
52. (c) Positive terminal of a battery is point of highest potential and current flows from highest to lowest potential i.e. from +ve to -ve potential.
53. (a) In the absence of the electric current, the free electrons in a conductor are in a state of random motion, like molecule in a gas. Their average velocity is zero. i.e. they do not have any net velocity in a direction. As a result, there is no net magnetic force on the free electrons in the magnetic field. On passing the current, the free electrons acquire drift velocity in a definite direction, hence magnetic force acts on them, unless the field has no perpendicular component.
54. (a)
55. (a) Power loss $= i^2 R = \left(\frac{P}{V}\right)^2 R$
[P = Transmitted power]
56. (a) Glow = Power (P) = $I^2 R$
 $\therefore \frac{dP}{P} = 2 \left(\frac{dI}{I}\right) = 2 \times 0.5 = 1\%$
57. (c) From relation $\vec{J} = \sigma \vec{E}$, the current density $\vec{J}$ at any point in ohmic resistor is in direction of electric field $\vec{E}$ at that point. In space having non-uniform electric field, charges released from rest may not move along ELOF. Hence Assertion is correct while Reason is incorrect.
58. (a) Resistance wire $R = \rho \frac{l}{A}$, where ρ is resistivity of material which does not depend on the geometry of wire. Since when wire is bent resistivity, length and area of cross-section do not change, therefore resistance of wire also remain same.
59. (c) Kirchoff's loop rule follows from conservation of energy.

Moving Charges and Magnetism

TYPE A : MULTIPLE CHOICE QUESTIONS

- An electron moving with kinetic energy $6.6 \times 10^{-14} \text{ J}$ enters in a magnetic field of $4 \times 10^{-3} \text{ T}$ at right angles to it. The radius of its circular path will be nearest to : [1997]
 (a) 100 cm (b) 75 cm
 (c) 25 cm (d) 50 cm
- A charged particle enters a magnetic field H with its initial velocity making an angle of 45° with H . Then the path of the particle will be: [1999]
 (a) circle (b) helical
 (c) a straight line (d) a circle
- What should be amount of current through the ring of radius of 5 cm so that field at the centre equal to the magnetic field of $7 \times 10^{-5} \text{ Wb/m}^2$, is
 (a) 0.28 amp (b) 5.57 amp [2000]
 (c) 2.8 amp (d) none of these
- A closely wound flat circular coil of 25 turns of wire has diameter of 10 cm which carries current of 4 amperes, the magnetic field at the centre of a coil will be : [2001]
 (a) 1.256×10^{-3} tesla
 (b) 1.679×10^{-5} tesla
 (c) 1.512×10^{-5} tesla
 (d) 2.28×10^{-4} tesla
- Cyclotron is used to accelerate : [2001]
 (a) positive ion (b) negative ion
 (c) electron (d) none of these
- The magnetic field at a given point is $0.5 \times 10^{-5} \text{ Wb m}^{-2}$. This field is to be annulled by magnetic induction at the centre of a circular conducting loop of radius 5.0 cm. The current required to be flown in the loop is nearly [2002]
 (a) 0.2 A (b) 0.4 A
 (c) 4 A (d) 40 A
- An electron is travelling along the x-direction. It encounters a magnetic field in the y-direction. Its subsequent motion will be : [2002]
 (a) straight line along the x-direction
 (b) a circle in the xz-plane
 (c) a circle in the yz-plane
 (d) a circle in the xy-plane
- A rectangular loop carrying a current i_1 , is situated near a long straight wire carrying a steady current i_2 . The wire is parallel to one of the sides of the loop and is in the plane of the loop as shown in the figure. Then the current loop will : [2003]

 (a) move away from the wire
 (b) move towards the wire
 (c) remain stationary
 (d) rotate about an axis parallel to the wire
- The cyclotron frequency of an electrons gyrating in a magnetic field of 1 T is approximately:
 (a) 28 MHz (b) 280 MHz [2003]
 (c) 2.8 MHz (d) 28 GHz
- The magnetic moment of current (I) carrying circular coil of radius (r) and number of turns (n) varies as : [2004]
 (a) $1/r^2$ (b) $1/r$
 (c) r (d) r^2
- A circular coil of radius R carries an electric current. The magnetic field due to the coil at a point on the axis of the coil located at a distance r from the centre of the coil, such that $r \gg R$, varies as [2004]
 (a) $1/r$ (b) $1/r^{3/2}$
 (c) $1/r^2$ (d) $1/r^3$
- The magnetic field due to a straight conductor of uniform cross-section of radius a and carrying a steady current is represented by : [2004]

 (a)



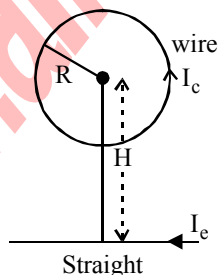
13. Two parallel beams of positrons moving in the same direction will : [2004]

(a) repel each other
 (b) will not interact with each other
 (c) attract each other
 (d) be deflected normal to the plane containing the two beams

14. A proton and an α -particle, moving with the same velocity, enter a uniform magnetic field, acting normal to the plane of their motion. The ratio of the radii of the circular paths described by the proton and α -particle is : [2004]

(a) 1 : 2 (b) 1 : 4
 (c) 4 : 1 (d) 1 : 16

15. Circular loop of a wire and a long straight wire carry currents I_c and I_e , respectively as shown in figure. Assuming that these are placed in the same plane, the magnetic fields will be zero at the centre of the loop when the separation H is : [2006]



(a) $\frac{I_e R}{I_c \pi}$

(b) $\frac{I_c R}{I_e \pi}$

(c) $\frac{\pi I_c}{I_e R}$

(d) $\frac{I_e \pi}{I_c R}$

16. What is the magnetic field at a distance R from a coil of radius r carrying current I ? [2007]

(a) $\frac{\mu_0 I R^2}{2(R^2 + r^2)^{\frac{3}{2}}}$

(b) $\frac{\mu_0 I r^2}{2(R^2 + r^2)^{\frac{3}{2}}}$

(c) $\frac{\mu_0 I}{2r}$

(d) $\frac{\mu_0 I}{2R}$

17. A long straight wire of radius a carries a steady current i . The current is uniformly distributed across its cross section. The ratio of the magnetic field at $a/2$ and $2a$ is [2007]

(a) $1/2$ (b) $1/4$
 (c) 4 (d) 1

18. In a mass spectrometer used for measuring the masses of ions, the ions are initially accelerated by an electric potential V and then made to describe semicircular paths of radius R using a magnetic field B . If V and B are kept constant,

the ratio $\left(\frac{\text{charge on the ion}}{\text{mass of the ion}} \right)$ will be proportional to [2008]

(a) $\frac{1}{R}$ (b) $\frac{1}{R^2}$

(c) R^2 (d) R

19. Two concentric coils each of radius equal to 2π cm are placed at right angles to each other. 3 ampere and 4 ampere are the currents flowing in each coil respectively. The magnetic induction in Weber / m^2 at the centre of the coils will be

$(\mu_0 = 4\pi \times 10^{-7} \text{ Wb / A.m})$ [2008]

(a) 10^{-5} (b) 12×10^{-5}

(c) 7×10^{-5} (d) 5×10^{-5}

20. The magnetic field due to a square loop of side a carrying a current I at its centre is [2009]

(a) $\frac{\mu_0 i}{2a}$ (b) $\frac{\mu_0 i}{\sqrt{2}\pi a}$

(c) $\frac{\mu_0 i}{2\pi a}$ (d) $\sqrt{2} \frac{\mu_0 i}{\pi a}$

21. Electron of mass m and charge q is travelling with a speed along a circular path of radius r at right angles to a uniform magnetic field of intensity B . If the speed of the electron is doubled and the magnetic field is halved the resulting path would have a radius [2009]

(a) $2r$ (b) $4r$

(c) $\frac{r}{4}$ (d) $\frac{r}{2}$

22. Electron moves at right angles to a magnetic field of 1.5×10^{-2} tesla with speed of 6×10^7 m/s. If the specific charge of the electron is 1.7×10^{11} C/kg. The radius of circular path will be [2010]

(a) 3.31 cm (b) 4.31 cm

(c) 1.31 cm (d) 2.35 cm

23. An electron beam passes through a magnetic field of 2×10^{-3} Wb/m² and an electric field of 1.0×10^4 V/m both acting simultaneously. The path of electron remains undeviated. The speed of electron if the electric field is removed, and the radius of electron path will be respectively [2011]

(a) 10×10^6 m/s, 2.43 cm

(b) 2.5×10^6 m/s, 0.43 cm

(c) 5×10^6 m/s, 1.43 cm

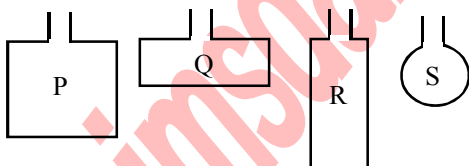
(d) none of these

24. A charged particle is released from rest in a region of uniform electric and magnetic fields which are parallel to each other. The particle will move on a: [2011]

(a) straight line (b) circle

(c) helix (d) cycloid

25. Four wires, each of length 2.0 m, are bent into four loops P, Q, R and S and then suspended in a uniform magnetic field. If the same current is passed in each, then the torque will be maximum on the loop [2012]



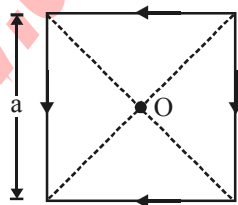
(a) P

(b) Q

(c) R

(d) S

26. A square coil of side a carries a current I . The magnetic field at the centre of the coil is [2012]



(a) $\frac{\mu_0 I}{a\pi}$ (b) $\frac{\sqrt{2}\mu_0 I}{a\pi}$

(c) $\frac{\mu_0 I}{\sqrt{2}a\pi}$ (d) $\frac{2\sqrt{2}\mu_0 I}{a\pi}$

27. A charged particle moves through a magnetic field in a direction perpendicular to it. Then the

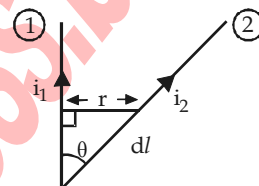
(a) velocity remains unchanged [2013]

(b) speed of the particle remains unchanged

(c) direction of the particle remains unchanged

(d) acceleration remains unchanged

28. Wires 1 and 2 carrying currents i_1 and i_2 respectively are inclined at an angle θ to each other. What is the force on a small element dl of wire 2 at a distance of r from wire 1 (as shown in figure) due to the magnetic field of wire 1? [2013]



(a) $\frac{\mu_0}{2\pi r} i_1 i_2 dl \tan \theta$ (b) $\frac{\mu_0}{2\pi r} i_1 i_2 dl \sin \theta$

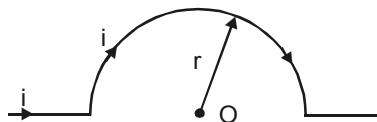
(c) $\frac{\mu_0}{2\pi r} i_1 i_2 dl \cos \theta$ (d) $\frac{\mu_0}{4\pi r} i_1 i_2 dl \sin \theta$

29. If we double the radius of a coil keeping the current through it unchanged, then the magnetic field at any point at a large distance from the centre becomes approximately [2014]

(a) double (b) three times

(c) four times (d) one-fourth

30. A portion of a conductive wire is bent in the form of a semicircle of radius r as shown below in fig. At the centre of semicircle, the magnetic induction will be [2015]



(a) zero

(b) infinite

(c) $\frac{\mu_0}{4\pi} \cdot \frac{\pi i}{r}$ gauss (d) $\frac{\mu_0}{4\pi} \cdot \frac{\pi i}{r}$ tesla

31. A coil of circular cross-section having 1000 turns and 4 cm^2 face area is placed with its axis parallel to a magnetic field which decreases by 10^{-2} Wb/m² in 0.01 s. The e.m.f. induced in the coil is: [2017]

(a) 400mV

(b) 200mV

(c) 4mV

(d) 0.4mV

TYPE B : ASSERTION REASON QUESTIONS

Directions for (Qs. 32-35) : These questions consist of two statements, each printed as Assertion and Reason. While answering these questions, you are required to choose any one of the following five responses.

- If both Assertion and Reason are correct and the Reason is a correct explanation of the Assertion.
- If both Assertion and Reason are correct but Reason is not a correct explanation of the Assertion.
- If the Assertion is correct but Reason is incorrect.
- If both the Assertion and Reason are incorrect.
- If the Assertion is incorrect but the Reason is correct.

32. Assertion : Cyclotron is a device which is used to accelerate the positive ion.

Reason : Cyclotron frequency depends upon the velocity. [1997]

33. Assertion : Cyclotron does not accelerate electron.

Reason : Mass of the electrons is very small. [2000]

34. Assertion : In electric circuits, wires carrying currents in opposite directions are often twisted together

Reason : If the wires are not twisted together, the combination of the wires forms a current loop, the magnetic field generated by the loop might affect adjacent circuits or components. [2008]

35. Assertion : The magnetic field produced by a current carrying solenoid is independent of its length and cross-sectional area.

Reason : The magnetic field inside the solenoid is uniform. [2008]

Directions for (Qs. 36-42) : Each of these questions contains an Assertion followed by Reason. Read them carefully and answer the question on the basis of following options. You have to select the one that best describes the two statements.

- If both Assertion and Reason are correct and Reason is the correct explanation of Assertion.
- If both Assertion and Reason are correct, but Reason is not the correct explanation of Assertion.
- If Assertion is correct but Reason is incorrect.
- If both the Assertion and Reason are incorrect.

36. Assertion : A charge, whether stationary or in motion produces a magnetic field around it.

Reason : Moving charges produce only electric field in the surrounding space. [2009]

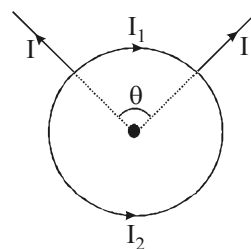
37. Assertion : A proton and an alpha particle having the same kinetic energy are moving in circular paths in a uniform magnetic field. The radii of their circular paths will be equal.

Reason : Any two charged particles having equal kinetic energies and entering a region of uniform magnetic field $\vec{B}$ in a direction perpendicular to $\vec{B}$, will describe circular trajectories of equal radii. [2009]

38. Assertion : If the current in a solenoid is reversed in direction while keeping the same magnitude, the magnetic field energy stored in the solenoid remains unchanged.

Reason : Magnetic field energy density is proportional to the magnetic field. [2010, 2017]

39. Assertion : The magnetic field at the centre of the circular coil in the following figure due to the currents I_1 and I_2 is zero.



Reason : $I_1 = I_2$ implies that the fields due to the current I_1 and I_2 will be balanced. [2013]

40. Assertion : If the current in a solenoid is reversed in direction while keeping the same magnitude, the magnetic field energy stored in the solenoid decreases.

Reason : Magnetic field energy density is proportional to square of current. [2015]

41. Assertion : Free electrons always keep on moving in a conductor even then no magnetic force act on them in magnetic field unless a current is passed through it.

Reason : The average velocity of free electron is zero. [2016]

42. Assertion : To convert a galvanometer into an ammeter a small resistance is connected in parallel with it.

Reason : The small resistance increases the combined resistance of the combination. [2016]

HINTS & SOLUTIONS

Type A : Multiple Choice Questions

1. (d) When a charged particle enters a magnetic field, its path becomes circular whose radius can be found out from the relation.

$$\frac{mv^2}{r} = Bqv \Rightarrow r = \frac{mv}{Bq}$$

$$E = \frac{1}{2}mv^2 = 6.6 \times 10^{-14}$$

$$\frac{1}{2} \frac{m^2 v^2}{m} = 6.6 \times 10^{-14}$$

$$\Rightarrow m^2 v^2 = 2m \times 6.6 \times 10^{-14}$$

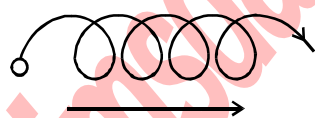
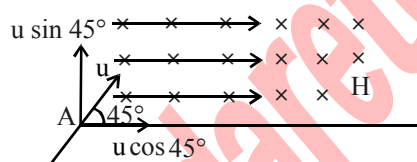
$$mv = \sqrt{2m \times 6.6 \times 10^{-14}}$$

$$= \sqrt{2 \times 9.1 \times 10^{-31} \times 6.6 \times 10^{-14}}$$

$$r = \frac{\sqrt{2 \times 9.1 \times 10^{-31} \times 6.6 \times 10^{-14}}}{4 \times 10^{-3} \times 1.6 \times 10^{-19}}$$

$$= 50 \text{ cm. approx.}$$

2. (b)



Helical Path

At point A, charge is entering in a magnetic field in which direction of field is shown in the figure. The velocity of particle is u making an angle of 45° with field. We resolve it in two directions, one along the field and other perpendicular to it. Since $u \sin 45^\circ$ is perpendicular to H , it will create a rotatory effect on the charge. So charge particle will start rotating with axis along the direction of H . At the same time it will

move forward with velocity $u \cos 45^\circ$. Under both these motions, it will have helical path as shown in the figure.

3. (b)



Magnetic field at the centre of a coil carrying current.

$$B = \frac{\mu_0 i}{2r}$$

$$7 \times 10^{-5} = \frac{4\pi \times 10^{-7} i}{2 \times 5 \times 10^{-2}}$$

$$i = \frac{70 \times 10^{-7}}{4\pi \times 10^{-7}} = 5.57 \text{ amp}$$

4. (a) Flux density, $B = \frac{\mu_0 i}{2r} \times n$

$$= \frac{4\pi \times 10^{-7} \times 4 \times 25}{2 \times 5/100} = \frac{4\pi \times 10^{-7} \times (100)^2}{10}$$

$$= 1.256 \times 10^{-3} \text{ tesla.}$$

5. (a) Cyclotron is used to accelerate positive ions. Electron can not be used as its velocity increases appreciably resulting into its mass becoming very large. It creates problem in synchronisation.

6. (b) Fields created at the centre
 $= 0.5 \times 10^{-5} \text{ Wb/m}^2$

Due to current in circular loop, field created

$$\text{in the centre} = \frac{\mu_0 i}{2r}$$

$$= \frac{4\pi \times 10^{-7} \times i}{2 \times 5 \times 10^{-2}} = 0.5 \times 10^{-5}$$

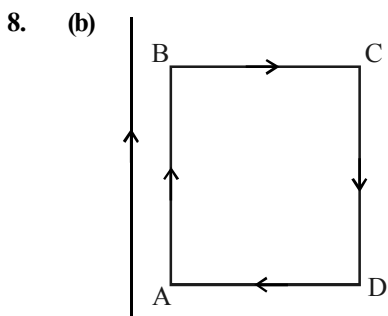
$$i = \frac{0.5 \times 10^{-5} \times 10 \times 10^{-2}}{4\pi \times 10^{-7}} = \frac{5}{4\pi} = \frac{35}{88}$$

$$= 0.3980 = 0.4 \text{ A}$$

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7. (b) When a charged particle enters a magnetic field, it experiences a force which is always directed perpendicular to its direction of motion. In that case the path of the charged particle becomes circular and the plane of the circle is perpendicular to the plane containing the magnetic field and velocity vector of the charged particle.



Current in AB is same as that current in straight wire so it will be attracted. CD portion will be repelled. Net force in the loop will be attractive. Force on BC and AD will be opposite to each other so energy will cancel out each other.

9. (d) For an electron gyrating in a magnetic field

$$\frac{mv^2}{r} = Bqv$$

$$r = \frac{mv}{Bq} \Rightarrow \frac{v}{r} = \frac{Bq}{m}$$

$$T = \frac{2\pi r}{v}; \quad n = \frac{1}{T} = \frac{v}{2\pi r} = \frac{Bq}{2\pi m}$$

$$n = \frac{1 \times 1.6 \times 10^{-19}}{2 \times \pi \times 9.1 \times 10^{-31}}$$

$$= \frac{1.6 \times 10^{12}}{2 \times \pi \times 9.1} = 28 \text{ GHz}$$

10. (d) Magnetic moment of a coil of radius r carrying current i is equal to
 $M = iAn$ [A is area of the coil, n is no. of turns]
 $= ni\pi r^2$
 So, $M \propto r^2$

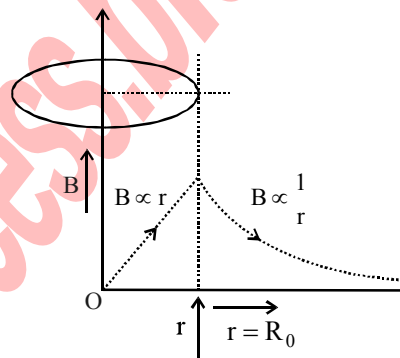
11. (d) Magnetic field on the axis of the coil is

$$B = \frac{1}{4\pi\epsilon_0} \frac{\pi a^2 ni x}{(x^2 + a^2)^{3/2}}$$

If $x \gg a$

$$B = \frac{1}{4\pi\epsilon_0} \frac{\pi a^2 ni}{x^3} \text{ or } B \propto \frac{1}{x^3}$$

12. (a) Inside the wire magnetic field will be directly proportional to the distance from the axis. Outside the wire, field is inversely proportional to distance.



13. (c) Two parallel beams of positron moving in same direction is equivalent to two current carrying conductor, carrying current in same direction. They will attract each other.
14. (a) When a charged particle enters a field, it takes a circular path. The radius of circular path is given by the relation

$$r = \frac{mv}{Bq}$$

For proton, $r_1 = \frac{mv}{Bq}$

For α -particle, $r_2 = \frac{4m \times v}{B \times 2q} = \frac{2mv}{Bq}$

$$\Rightarrow r_1 : r_2 :: 1 : 2$$

15. (a) Magnetic field due to straight wire = $\frac{\mu_0 I_c}{2\pi H}$

Magnetic field due to circular wire = $\frac{\mu_0 I_c}{2R}$

$$\text{Now } \frac{\mu_0 I_c}{2\pi H} = \frac{\mu_0 I_c}{2R}$$

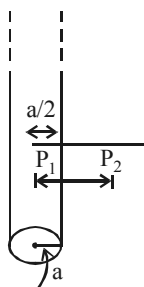
$$\Rightarrow H = \frac{R I_c}{\pi I_c}$$

16. (b) The magnetic field is $B = \frac{\mu_0 I r^2}{2(R^2 + r^2)^{3/2}}$

(see application of Biot-Savart law to magnetic field at a point along axis of coil)

17. (d) Here, current is uniformly distributed across the cross-section of the wire, therefore, current enclosed in the amperian

path formed at a distance $r_1 \left(= \frac{a}{2} \right)$



$$= \left(\frac{\pi r_1^2}{\pi a^2} \right) \times I, \text{ where } I \text{ is total current}$$

$\therefore$ Magnetic field at

$$P_1 (B_1) = \frac{\mu_0 \times \text{current enclosed}}{\text{Path}}$$

$$= \frac{\mu_0 \times \left(\frac{\pi r_1^2}{\pi a^2} \right) \times I}{2\pi r_1} = \frac{\mu_0 \times I r_1}{2\pi a^2}$$

Now, magnetic field at point P_2 ,

$$(B_2) = \frac{\mu_0}{2\pi} \cdot \frac{I}{(2a)} = \frac{\mu_0 I}{4\pi a}$$

$$\therefore \text{ Required Ratio} = \frac{B_1}{B_2} = \frac{\mu_0 I r_1}{2\pi a^2} \times \frac{4\pi a}{\mu_0 I}$$

$$= \frac{2r_1}{a} = \frac{2 \times \frac{a}{2}}{a} = 1.$$

18. (b) The centripetal force is provided by the magnetic force.

$$\text{i.e., } \frac{mv^2}{R} = qvB \quad \dots (1)$$

where m = mass of the ion, v = velocity, q = charge of ion, B = flux density of the magnetic field.

we have, $v = R\omega$

$$\text{or } \omega = \frac{v}{R} = \frac{qB}{m} \quad (\text{From (1)})$$

Energy of ion is given by,

$$E = \frac{1}{2} mv^2 = \frac{1}{2} m(R\omega)^2 = \frac{1}{2} mR^2 \frac{q^2 B^2}{m^2}$$

$$\text{or } E = \frac{1}{2} \frac{R^2 B^2 q^2}{m} \quad \dots (2)$$

If ions are accelerated by electric potential V , the energy attained by ions,

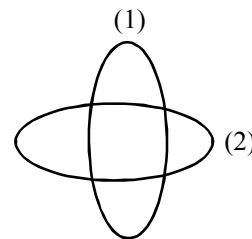
$$E = qV \quad \dots (3)$$

From eqns (2) and (3)

$$qV = \frac{1}{2} \frac{R^2 B^2 q^2}{m} \quad \text{or } \left(\frac{q}{m} \right) = \frac{2V}{R^2 B^2}$$

$$\text{i.e., } \left(\frac{q}{m} \right) \propto \frac{1}{R^2} \quad (\text{If } V \text{ and } B \text{ are const.})$$

19. (d)



$$B_1 = \frac{\mu_0 i_1}{2(2\pi)} = \frac{\mu_0 \times 3}{4\pi}$$

$$B_2 = \frac{\mu_0 i_2}{2(2\pi)} = \frac{\mu_0 \times 4}{4\pi}$$

$$B = \sqrt{B_1^2 + B_2^2} = \frac{\mu_0}{4\pi} \cdot 5$$

$$\Rightarrow B = 10^{-7} \times 5 \times 10^2$$

$$\Rightarrow B = 5 \times 10^{-5} \text{ Wb/m}^2$$

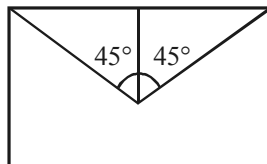
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20. (d) $B = \left[\frac{\mu_0 i}{4\pi a} (\cos 45^\circ - \cos 135^\circ) \right] \times 4$

$$= \frac{\mu_0 i}{\pi a} \frac{2}{\sqrt{2}}$$

$$= \sqrt{2} \frac{\mu_0 i}{\pi a}$$



21. (b) Radius of path is given by $r = \frac{mv}{Bq}$

Here, m and q remain unchanged

$$\text{So, } \frac{r_1}{r_2} = \frac{v_1}{v_2} \cdot \frac{B_2}{B_1} = \frac{v}{2v} \cdot \frac{B/2}{B} = \frac{1}{4}$$

$$\Rightarrow r_2 = 4r$$

22. (d) $B = 1.5 \times 10^{-2} \text{ T}$,
 $\theta = 90^\circ$, $\sin \theta = 1$, $v = 6 \times 10^7 \text{ m/s}$,

$$\frac{e}{m} = 1.7 \times 10^{11} \text{ C/kg}$$

$$r = \frac{mv}{Be} = \frac{6 \times 10^7}{1.5 \times 10^{-2} \times 1.7 \times 10^{11}}$$

$$= 2.35 \times 10^{-2} \text{ m} = 2.35 \text{ cm}$$

23. (c) $B = 2 \times 10^{-3} \text{ Wb/m}^2$,
 $E = 1 \times 10^4 \text{ V/m}^2$

Since the path of electron remains undeviated, $qvB = qE$ or

$$v = \frac{E}{B} = \frac{1 \times 10^4}{2 \times 10^{-3}} = 0.5 \times 10^7$$

$$= 5 \times 10^6 \text{ m/s}$$

If the electric field is removed, the path of the charged particle is circular and magnetic field provides the necessary centripetal force. i.e.,

$$\frac{mv^2}{r} = Bev \Rightarrow r = \frac{mv}{Be}$$

$$= \frac{9.1 \times 10^{-31} \times 5 \times 10^6}{2 \times 10^{-3} \times 1.6 \times 10^{-19}}$$

$$= 14.3 \times 10^{-3} \text{ m} = 1.43 \text{ cm}$$

24. (a)

The magnetic force on charged particle is zero.

25. (d) For a given perimeter the area of circle is maximum. So magnetic moment of (S) is greatest.

26. (d) $B_{\text{total}} = 4B_{\text{side}}$

$$B_{\text{total}} = 4 \frac{\mu_0 I}{2\pi \left(\frac{a}{2}\right)} \left[\sin \frac{\pi}{4} + \sin \frac{\pi}{4} \right]$$

$$B_{\text{total}} = \frac{2\sqrt{2}\mu_0 I}{a\pi}$$

27. (b) Magnetic force acts perpendicular to the velocity. Hence speed remains constant.

28. (c)

29. (c) $B_{\text{axis}} = \left(\frac{\mu_0 NI}{2x^3} \right) R^2$

$$B \propto R^2$$

So, when radius is doubled, magnetic field becomes four times.

30. (d) The straight part will not contribute magnetic field at the centre of the semicircle because every element of the straight part will be 0° or 180° with the line joining the centre and the element

Due to circular portion, the field is

$$\frac{1}{2} \frac{\mu_0 i}{2r} = \frac{\mu_0 i}{4r}$$

$$\text{Hence total field at O} = \frac{\mu_0 i}{4r} \text{ tesla}$$

31. (a) **Given:** No. of turns $N = 1000$

$$\text{Face area, } A = 4 \text{ cm}^2 = 4 \times 10^{-4} \text{ m}^2$$

Change in magnetic field,

$$\Delta B = 10^{-2} \text{ wbm}^{-2}$$

$$\text{Time taken, } t = 0.01 \text{ s} = 10^{-2} \text{ sec}$$

Emf induced in the coil $e = ?$

Applying formula,

$$\text{Induced emf, } e = \frac{-d\phi}{dt}$$

$$= N \left(\frac{\Delta B}{\Delta t} \right) A \cos \theta$$

$$= \frac{1000 \times 10^{-2} \times 4 \times 10^{-4}}{10^{-2}} = 400 \text{ mV}$$

Type B : Assertion Reason Questions

32. (c) Cyclotron is used to accelerate charged particles. So Assertion is correct.
We know that time period of a particle

$$T = \frac{2\pi r}{v_0}; \quad \frac{mv_0^2}{r} = Bqv_0 \Rightarrow v_0 = \frac{Bqr}{m}$$

$$T = \frac{2\pi r}{Bqr} \times m = \frac{2\pi}{Bq} m$$

$$\text{Frequency} = \frac{1}{T} = \frac{Bq}{2\pi m}$$

This does not depend upon velocity so Reason is incorrect.

33. (c) Cyclotron does not accelerate electron because mass of electron is very small. It gets accelerated very appreciably as a result of which its mass increases. It results in mismatch between frequency of a.c. used and frequency of rotation of electron in the Dees. So cyclotron stops accelerating electrons after some time.
34. (a) If the wires are twisted together, they can be formed as a single wire carrying currents in opposite directions. In this pattern, in wires no magnetic field is induced which does not affect adjacent circuits.
35. (b) Magnetic field inside the solenoid at point P is given by,

$$B = \frac{\mu_0}{4\pi} (2\pi n i) [\sin \alpha + \sin \beta]$$

where n = no. of turns per unit length
= N/ℓ

Thus it is clear that magnetic field is independent of length and cross sectional area.

Also the magnetic field within the solenoid is uniform and parallel to the axis of the solenoid.

36. (d) A charge, whether stationary or in motion, produces an electric field around it. If it is in motion, then in addition to the electric

field, it also produces a magnetic field, because moving charges produce magnetic field in the surrounding space.

37. (c) The radius of the circular path is given by

$$r = \frac{mv}{qB} = \frac{\sqrt{2mK}}{qB}; \quad \text{where } K = \frac{1}{2}mv^2$$

Since K and B are the same for the two

particles, $r \propto \frac{\sqrt{m}}{q}$. Now, the charge of an

alpha particle is twice that of a proton and its mass is four times the mass of a proton,

$\sqrt{m}/q$ will be the same for both particles.

Hence, r will be the same for both particles.

38. (c)

$$39. (d) \quad \frac{I_1}{I_2} = \frac{2\pi - \theta}{\theta} \Rightarrow I_1 \theta = I_2 (2\pi - \theta) \dots\dots (1)$$

$$B_1 = \frac{\theta}{2\pi} \cdot \frac{\mu_0 I_1}{2R} \quad \text{and} \quad B_2 = \frac{2\pi - \theta}{2\pi} \cdot \frac{\mu_0 I_2}{2R}$$

Using (1), we get $B_1 = B_2$.

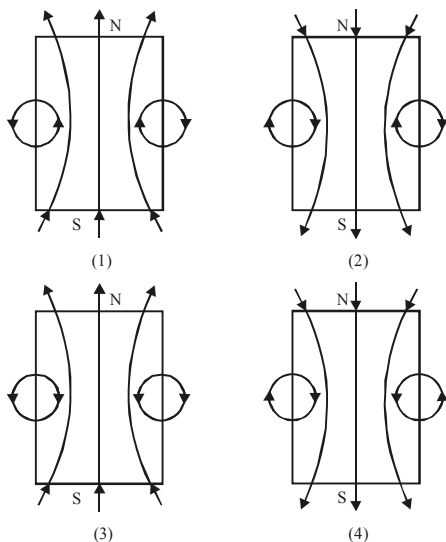
40. (d) Reversing the direction of the current reverses the direction of the magnetic field. However, it has no effect on the magnetic-field energy density, which is proportional to the square of the magnitude of the magnetic field.
41. (b) In the absence of the electric current, the free electrons in a conductor are in a state of random motion, like molecules in a gas. Their average velocity is zero. i.e. they do not have any net velocity in a direction. As a result, there is no net magnetic force on the free electrons in the magnetic field. On passing the current, the free electrons acquire drift velocity in a definite direction, hence magnetic force acts on them, unless the field has no perpendicular component.
42. (c) An ammeter should have a low resistance which we get when we connect low resistance in parallel with galvanometer.

Magnetism and Matter

TYPE A : MULTIPLE CHOICE QUESTIONS

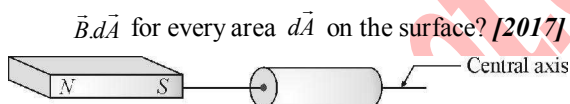
- Domain formation is the necessary feature of :
[1998]
(a) ferromagnetism (b) diamagnetism
(c) paramagnetism (d) all of these
- The best material for the core of a transformer is
(a) mild steel (b) stainless steel
(c) soft iron (d) hard steel [1998]
- The north pole of a magnet is brought near a metallic ring. Then the direction of the induced current in the ring will be:
[1999]
(a) Towards north (b) Towards south
(c) Anticlockwise (d) Clockwise
- Angle of dip is 90° at:
[1999]
(a) Equator (b) Middle point
(c) Poles (d) None of these
- What happens, when a magnetic substance is heated ?
[1999]
(a) It loses its magnetism
(b) It becomes a strong magnet
(c) Does not effect the magnetism
(d) Either (b) and (c)
- A magnet 10 cm long and having a pole strength 2 amp m is deflected through 30° from the magnetic meridian. The horizontal component of earth's induction is 0.32×10^{-4} tesla then the value of deflecting couple is:
[1999]
(a) 32×10^{-7} Nm (b) 16×10^{-7} Nm
(c) 64×10^{-7} Nm (d) 48×10^{-7} Nm
- Which one of the following statement is not correct about the magnetic field ? [2000]
(a) Inside the magnet the lines go from north pole to south pole of the magnet
(b) Tangents to the magnetic lines give the direction of the magnetic field
(c) The magnetic lines form a closed loop
(d) Magnetic lines of force do not cut each other
- Which one of the following are used to express intensity of magnetic field in vacuum ? [2000]
(a) oersted (b) tesla
(c) gauss (d) none of these
- A frog can be levitated in a magnetic field produced by a current in a vertical solenoid placed below the frog. This is possible because the body of the frog behaves as : [2003]
(a) paramagnetic (b) diamagnetic
(c) ferromagnetic (d) antiferromagnetic
- Liquid oxygen remains suspended between two pole forces of a magnet because it is : [2004]
(a) diamagnetic (b) paramagnetic
(c) ferromagnetic (d) antiferromagnetic
- The magnetic susceptibility of an ideal diamagnetic substance is [2007]
(a) -1 (b) 0
(c) +1 (d) ∞
- A magnet makes 40 oscillation per minute at a place having magnetic intensity of 0.1×10^{-5} tesla. At another place it takes 2.5 sec to complete one oscillation. The value of earth's horizontal field at that place is [2011]
(a) 0.76×10^{-6} tesla (b) 0.18×10^{-6} tesla
(c) 0.09×10^{-6} tesla (d) 0.36×10^{-6} tesla
- Curie temperature is the temperature above which [2012]
(a) a ferromagnetic material becomes paramagnetic
(b) a paramagnetic material becomes diamagnetic
(c) a ferromagnetic material becomes diamagnetic
(d) a paramagnetic material becomes ferromagnetic

14. Of the following Fig., the lines of magnetic induction due to a magnet SN, are given by



- (a) 1 (b) 2 [2012]
(c) 3 (d) 4
15. The materials suitable for making electromagnets should have [2013]
(a) high retentivity and low coercivity
(b) low retentivity and low coercivity
(c) high retentivity and high coercivity
(d) low retentivity and high coercivity
16. Magnetic lines of force due to a bar magnet do not intersect because [2014]
(a) a point always has a single net magnetic field
(b) the lines have similar charges and so repel each other
(c) the lines always diverge from a single force
(d) the lines need magnetic lenses to be made to interest
17. At a temperature of 30°C , the susceptibility of a ferromagnetic material is found to be χ . Its susceptibility at 333°C is [2015]
(a) χ (b) 0.5χ
(c) 2χ (d) 11.1χ
18. Two points A and B are situated at a distance x and $2x$ respectively from the nearer pole of a magnet 2 cm long. The ratio of magnetic field at A and B is [2016]
(a) 4 : 1 exactly (b) 4 : 1 approximately
(c) 8 : 1 approximately (d) 1 : 1 approximately

19. Imagine rolling a sheet of paper into a cylinder and placing a bar magnet near its end as shown in figure. What can you say about the sign of



- $\vec{B} \cdot d\vec{A}$ for every area $d\vec{A}$ on the surface? [2017]
(a) Positive
(b) Negative
(c) No sign
(d) Can be positive or negative

TYPE B : ASSERTION REASON QUESTIONS

Directions for (Qs. 20-27) : These questions consist of two statements, each printed as Assertion and Reason. While answering these questions, you are required to choose any one of the following five responses.

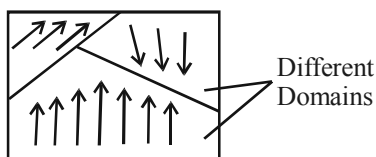
- (a) If both Assertion and Reason are correct and the Reason is a correct explanation of the Assertion.
(b) If both Assertion and Reason are correct but Reason is not a correct explanation of the Assertion.
(c) If the Assertion is correct but Reason is incorrect.
(d) If both the Assertion and Reason are incorrect.
(e) If the Assertion is incorrect but the Reason is correct.
20. **Assertion :** We cannot think of a magnetic field configuration with three poles
Reason : A bar magnet does exert a torque on itself due to its own field. [2002]
21. **Assertion :** In high latitudes one sees colourful curtains of light hanging down from high altitudes
Reason : The high energy charged particles from the sun are deflected to polar regions by the magnetic field of the earth. [2003]
22. **Assertion :** The true geographic north direction is found by using a compass needle.
Reason : The magnetic meridian of the earth is along the axis of rotation of the earth. [2004]
23. **Assertion :** A disc-shaped magnet is deviated above a superconducting material that has been cooled by liquid nitrogen.
Reason : Superconductors repel a magnet. [2005]

24. **Assertion :** Magnetic Resonance Imaging (MRI) is a useful diagnostic tool for producing images of various parts of human body.
Reason : Protons of various tissues of the human body play a role in MRI. [2006]
25. **Assertion :** Diamagnetic materials can exhibit magnetism.
Reason : Diamagnetic materials have permanent magnetic dipole moment. [2006]
26. **Assertion :** Ferro-magnetic substances become paramagnetic above Curie temp.
Reason : Domains are destroyed at high temperature. [2007]
27. **Assertion :** If a compass needle be kept at magnetic north pole of the earth the compass needle may stay in any direction.
Reason : Dip needle will stay vertical at the north pole of earth [2008]
- Directions for (Qs. 28-33) :** Each of these questions contains an Assertion followed by Reason. Read them carefully and answer the question on the basis of following options. You have to select the one that best describes the two statements.
- (a) If both Assertion and Reason are correct and Reason is the correct explanation of Assertion.
 (b) If both Assertion and Reason are correct, but Reason is not the correct explanation of Assertion.
 (c) If Assertion is correct but Reason is incorrect.
 (d) If both the Assertion and Reason are incorrect.
28. **Assertion :** The ferromagnetic substance do not obey Curie's law.
Reason : At Curie point a ferromagnetic substance start behaving as a paramagnetic substance. [2011]
29. **Assertion :** The ferromagnetic substance do not obey Curie's law.
Reason : At Curie point a ferromagnetic substance start behaving as a paramagnetic substance. [2014]
30. **Assertion :** A paramagnetic sample display greater magnetisation (for the same magnetic field) when cooled.
Reason : The magnetisation does not depend on temperature. [2015]
31. **Assertion :** Electromagnetic are made of soft iron.
Reason : Coercivity of soft iron is small. [2016]
32. **Assertion :** The sensitivity of a moving coil galvanometer is increased by placing a suitable magnetic material as a core inside the coil.
Reason : Soft iron has high magnetic permeability and cannot be easily magnetized or demagnetized. [2016]
33. **Assertion :** The poles of magnet can not be separated by breaking into two pieces.
Reason : The magnetic moment will be reduced to half when a magnet is broken into two equal pieces. [2017]

HINTS & SOLUTIONS

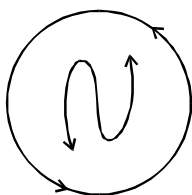
Type A : Multiple Choice Questions

1. (a) In ferromagnetic material atomic magnets of a substance form domain in which magnetic moment of all the tiny magnets are oriented in the same direction.



2. (c) Soft iron provides the best material for the core of a transformer as its permeability (μ) is very high. Its hysteresis curve is of small area and its coercivity is very low.

3. (c)



When we bring a north pole near a metallic ring applying Lenz's law the ring will behave as north pole so that repulsion occurs. So direction of current induced in it will be anti-clockwise as depicted above.

4. (c) At poles angle of dip will be 90° because earth's magnetic field will be almost vertical there.
5. (a) When a magnetic substance is heated it loses its magnetic property. It is because all the atomic magnet becomes randomly oriented due to heat.

6. (a) $M = 2 \times \frac{10}{100} = 0.2$

$$\begin{aligned} \text{Value of restoring couple} &= MH \sin \phi \\ &= 0.2 \times 0.32 \times 10^{-4} \sin 30^\circ \\ &= 0.2 \times 0.32 \times 10^{-4} \times \frac{1}{2} = 32 \times 10^{-7} \text{ Nm} \end{aligned}$$

7. (a) Inside the magnet, lines go from south pole to north pole. So, option (a) is correct.

8. (a) Intensity of magnetic field in vacuum is expressed in oersted in c.g.s. system and Am^{-1} in S.I. system. In the formula, $B = \mu H$

H is known as intensity of magnetic field.

9. (c) The frog will levitate in the magnetic field due to repulsion. It suggests that the body of frog is acting as ferromagnetic material.

10. (b) Oxygen is paramagnetic in nature. So if it will be attracted both by North pole or South pole. When it is placed exactly between two magnetic poles, the forces acting on it due to magnetic poles will be equal & opposite. Hence it will remain suspended between them.

11. (a) Magnetic susceptibility χ is related to permeability μ by $\mu = 1 + 4\pi\chi_m$. For diamagnetic substances χ_m is negative and $\mu < 1$ (negative). Ideal diamagnet should expel all magnetic field lines inside it i.e. $\chi_m < 0$ or $\chi_m = -1$

12. (d) Time period of vibration of a magnet is

$$T = 2\pi \sqrt{\frac{I}{MH}}$$

For the same magnet, I and M are constant where M = magnetic moment,

I = moment of inertia of magnet.

$$\Rightarrow T \propto \frac{1}{\sqrt{H}}$$

First case

$$T_1 = \frac{60}{40} = \frac{3}{2} = 1.5 \text{ sec.}$$

$$H_1 = 0.1 \times 10^{-5} \text{ T}, T_2 = 2.5 \text{ sec}, H_2 = ?$$

$$\Rightarrow \frac{1.5}{2.5} = \sqrt{\frac{H_2}{H_1}}$$

$$\Rightarrow \frac{15}{25} = \sqrt{\frac{H_2}{10^{-6}}}$$

$$\Rightarrow H_2 = \left(\frac{3}{5}\right)^2 \times 10^{-6}$$

$$\Rightarrow H_2 = \frac{9}{25} \times 10^{-6} = 0.36 \times 10^{-6} \text{T}$$

13. (a)

14. (a) As lines of magnetic induction B are continuous curves, they run continuously through the bar and outside, as shown in Fig. (1).

15. (b) Electro magnet should be amenable to magnetisation and demagnetization
 $\therefore$ retentivity should be low and coercivity should be low.

16. (a)

17. (b) According to Curie's law, $\chi_m = \frac{\mu_0 C}{T}$
where C is Curie constant, T = temperature

$$\therefore \chi_m \propto \frac{1}{T}$$

$$\frac{\chi_{m_1}}{\chi_{m_2}} = \frac{T_2}{T_1} = \frac{273 + 333}{273 + 30} = \frac{606}{303} = 2$$

$$\therefore \chi_{m_2} = \chi_{m_1} / 2 = 0.5\chi_{m_1} = 0.5\chi$$

$$(\because \chi_{m_1} = \chi)$$

18. (c) Taking distances from the centre of the magnet,

$$\frac{B_1}{B_2} = \left(\frac{x_2}{x_1}\right)^3 = \left(\frac{2x+1}{x+1}\right)^3 = 8:1, \text{ approximately.}$$

19. (b) The field is entering into the surface so flux is negative.

Type B : Assertion Reason Questions

20. (d) Magnetic field may be formed with the help of three poles. A bar magnet does not exert a torque on itself due to its own field.

21. (a) In polar region like north pole and south pole one sees colourful curtains of light hanging down from light altitude. It results from high energy charged particles from the sun being attracted by the poles of the earth. In northern hemisphere it is known as Aurora Borealis and in southern hemisphere it is known as Aurora Australis.

22. (d) The true geographic north-south direction is inclined at an angle with magnetic north-south direction. The angle between them is known as declination. Compass needle gives us direction of north-south (magnetic) direction. Magnetic meridian to pass through magnetic north-south direction. Axis of rotation of the earth gives us geographic north-south direction. So, both Assertion and Reason are incorrect.

23. (a) Superconductors are actually diamagnetic in nature so when it is placed above a magnet it will be repelled by magnet or it will tend to move from higher field to lower field. This is the principle behind levitation of a superconducting material above magnet.

24. (a) MRI is useful diagnostic tool for producing images of various parts of human body because it makes use of magnetic property of spinning proton inside the nucleus.

25. (c) Diamagnetic material exhibits magnetism in reverse direction. R is a wrong statement. Because due to absence of unpaired electron in diamagnetic material it does not exhibit permanent magnet dipole moment.

26. (a) Susceptibility of ferro magnets decreases with increase of temperature. At a transition temperature called Curie temperature they pass over to paramagnets. When temperature is increased, dipoles acquire kinetic energy and are disoriented, hence domain internal interaction called exchange coupling disappears.

27. (b) The earth has only vertical component of its magnetic field at the magnetic poles. Since compass needle is only free to rotate in horizontal plane where $H = 0$, hence the compass needle may stay in any direction. The dip needle rotates in a vertical plane and angle of dip at poles is 90° . So it will stand vertical.

28. (b) The susceptibility of ferromagnetic substance decreases with the rise of temperature in a complicated manner. After Curie point in the susceptibility of ferromagnetic substance varies inversely with its absolute temperature. Ferromagnetic substance obey's Curie's law only above its Curie point.

29. (c) The susceptibility of ferromagnetic substance decreases with the rise of temperature in a complicated manner. After Curie's point in the susceptibility of ferromagnetic substance varies inversely with its absolute temperature. Ferromagnetic substance obeys Curie's law only above its Curie point.
30. (d) A paramagnetic sample displays greater magnetisation when cooled, this is because at lower temperature, the tendency to disrupt the alignment of dipoles (due to magnetising field) decreases on account of reduced random thermal motion.
31. (b) Electromagnets are magnets, which can be turned on and off by switching the current on and off.

As the material in electromagnets is subjected to cyclic changes (magnetisation and demagnetisation), the hysteresis loss of the material must be small. The material should attain high value of I and B with low value of magnetising field intensity H . As soft iron has small coercivity, so it is a best choice for this purpose.

32. (c) Sensitivity of galvanometer,

$$s = \frac{\theta}{i} \approx \frac{\tan \theta}{i} = \frac{\mu_0 N}{2RB_H}$$

If a magnetic material is placed inside coil of galvanometer, then

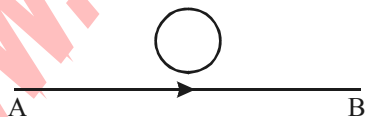
$$s' = \frac{\mu_r \mu_0 N}{2RB_H}$$

33. (b) When a magnet is cut into pieces, each piece becomes a new magnet. $M' = \frac{m\ell}{2} = \frac{M}{2}$.

Electromagnetic Induction

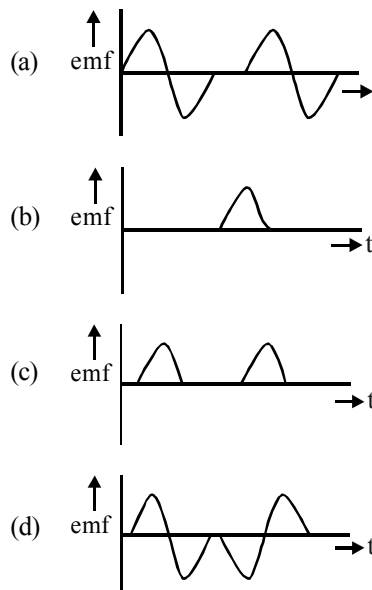
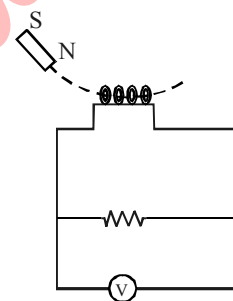
TYPE A : MULTIPLE CHOICE QUESTIONS

1. A coil of copper having 1000 turns is placed in a magnetic field ($B = 4 \times 10^{-5}$) perpendicular to its axis. The cross sectional area of the coil is 0.05 m^2 . If it turns through 180° in 0.01 second, then the e.m.f. induced in the coil will be ; [1997]
 (a) 4V (b) 0.04V
 (c) 0.4V (d) 0.2V
2. In a coil of self inductance of 5 henry, the rate of change of current is 2 ampere per second, the e.m.f. induced in the coil is : [1997]
 (a) 5V (b) -5V
 (c) -10V (d) 10V
3. According to Lenz's law there is a conversion of:
 (a) momentum (b) collision [1997]
 (c) voltage (d) energy
4. A 50 turn circular coil has a radius of 3 cm, it is kept in a magnetic field acting normal to the area of the coil. The magnetic field B is increased from 0.10 T to 0.35 T in 2 milli second, the average induced emf will be: [1999]
 (a) 177V (b) 1.77V
 (c) 0.177V (d) 17.7V
5. A solenoid is 1.5 m long and its inner diameter is 4.0 cm. It has 3 layers of windings of 1000 turns each and carries a current of 2.0 amperes. The magnetic flux for a cross-section of the solenoid is nearly [2000]
 (a) 4.1×10^{-5} weber (b) 5.2×10^{-5} weber
 (c) 6.31×10^{-3} weber (d) 2.5×10^{-7} weber
6. The current flows from A to B as shown in figure, then the direction of the induced current in the loop will be : [2001]

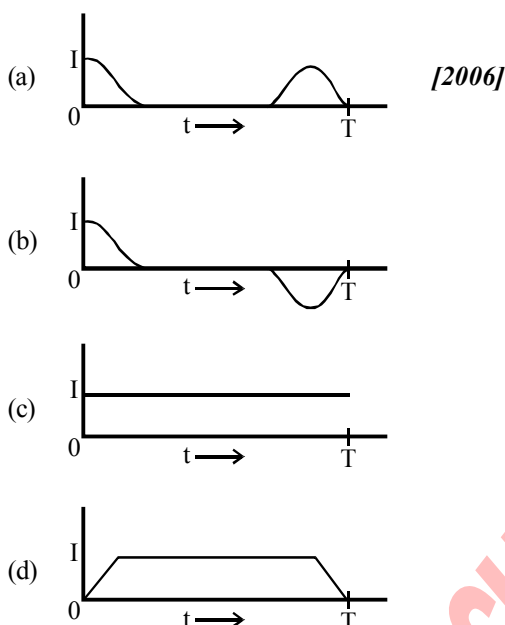


- (a) straight line (b) anti-clockwise
 (c) clockwise (d) none of these

7. A conducting ring of radius 1 metre is placed in an uniform magnetic field B of 0.01 tesla oscillating with frequency 100 Hz with its plane at right angle to B . What will be the induced electric field ? [2005]
 (a) π volt / m (b) 2 volt / m
 (c) 10 volt/m (d) 62 volt/m
8. A magnet is made to oscillate with a particular frequency, passing through a coil as shown in figure. The time variation of the magnitude of emf generated across the coil during on cycle is [2005]



9. A metallic ring is dropped down, keeping its plane perpendicular to a constant and horizontal magnetic field. The ring enters the region of magnetic field at $t = 0$ and completely emerges out at $t = T$ sec. The current in the ring varies as

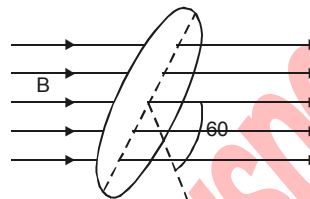


10. Which of the following conclusion can be drawn from the result

$$\oint \vec{B} \cdot d\vec{A} = 0$$

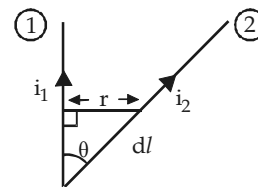
- (a) magnetic field is zero everywhere
 (b) magnetic monopole cannot exist
 (c) magnetic lines of force do not intersect each other
 (d) a current produces magnetic field
11. A wheel with ten metallic spokes each 0.50 m long is rotated with a speed of 120 rev/min in a plane normal to the earth's magnetic field at the place. If the magnitude of the field is 0.40 G, the induced emf between the axle and the rim of the wheel is equal to [2010]
- (a) 1.256×10^{-3} V (b) 6.28×10^{-4} V
 (c) 1.256×10^{-4} V (d) 6.28×10^{-5} V
12. The magnetic flux through a circuit carrying a current of 2.0 A is 0.8 weber. If the current reduces to 1.5 A in 0.1 s, the induced emf be : [2011]
- (a) 2.0 V (b) 4.0 V
 (c) 8.0 V (d) none of the above

13. Fig represents an area $A = 0.5 \text{ m}^2$ situated in a uniform magnetic field [2012]



$B = 2.0 \text{ weber/m}^2$ and making an angle of 60° with respect to magnetic field. The value of the magnetic flux through the area would be equal to

- (a) 2.0 weber (b) $\sqrt{3}$ weber
 (c) $\sqrt{3}/2$ weber (d) 0.5 weber
14. A charged particle moves through a magnetic field in a direction perpendicular to it. Then the
- (a) velocity remains unchanged [2013]
 (b) speed of the particle remains unchanged
 (c) direction of the particle remains unchanged
 (d) acceleration remains unchanged
15. Wires 1 and 2 carrying currents i_1 and i_2 respectively are inclined at an angle θ to each other. What is the force on a small element dl of wire 2 at a distance of r from wire 1 (as shown in figure) due to the magnetic field of wire 1?

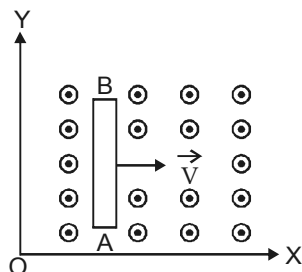


- (a) $\frac{\mu_0}{2\pi r} i_1 i_2 dl \tan \theta$ (b) $\frac{\mu_0}{2\pi r} i_1 i_2 dl \sin \theta$
 (c) $\frac{\mu_0}{2\pi r} i_1 i_2 dl \cos \theta$ (d) $\frac{\mu_0}{4\pi r} i_1 i_2 dl \sin \theta$
16. The flux linked with a coil at any instant 't' is given by $\phi = 10t^2 - 50t + 250$. The induced emf at $t = 3 \text{ s}$ is
- (a) -190 V (b) -10 V [2014]
 (c) 10 V (d) 190 V
17. In an AC generator, a coil with N turns, all of the same area A and total resistance R , rotates with frequency ω in a magnetic field B . The maximum value of emf generated in the coil is [2015]
- (a) $NABR\omega$ (b) NAB
 (c) $NABR$ (d) $NAB\omega$

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Topicwise AIIMS Solved Papers – PHYSICS

18. In an inductor of self-inductance $L = 2 \text{ mH}$, current changes with time according to relation $i = t^2 e^{-t}$. At what time emf is zero? (2016)
 (a) 4s (b) 3s
 (c) 2s (d) 1s
19. A conducting rod AB moves parallel to X-axis in a uniform magnetic field, pointing in the positive X-direction. The end A of the rod gets (2017)



- (a) positively charged
 (b) negatively charged
 (c) neutral
 (d) first positively charged and then negatively charged

TYPE B : ASSERTION REASON QUESTIONS

Directions for (Qs. 20-21) : These questions consist of two statements, each printed as Assertion and Reason. While answering these questions, you are required to choose any one of the following five responses.

- (a) If both Assertion and Reason are correct and the Reason is a correct explanation of the Assertion.
 (b) If both Assertion and Reason are correct but Reason is not a correct explanation of the Assertion.
 (c) If the Assertion is correct but Reason is incorrect.
 (d) If both the Assertion and Reason are incorrect.
 (e) If the Assertion is incorrect but the Reason is correct.

20. **Assertion :** An emf $\vec{E}$ is induced in a closed loop where magnetic flux is varied. The induced $\vec{E}$ is not a conservative field.

Reason : The line integral $\vec{E} \cdot d\vec{l}$ around the closed loop is nonzero. [2006]

21. **Assertion :** An electric motor will have maximum efficiency when back emf becomes equal to half of applied emf.

Reason : Efficiency of electric motor depends only on magnitude of back emf. [2008]

Directions for (Qs. 22-24) : Each of these questions contains an Assertion followed by Reason. Read them carefully and answer the question on the basis of following options. You have to select the one that best describes the two statements.

- (a) If both Assertion and Reason are correct and Reason is the correct explanation of Assertion.
 (b) If both Assertion and Reason are correct, but Reason is not the correct explanation of Assertion.
 (c) If Assertion is correct but Reason is incorrect.
 (d) If both the Assertion and Reason are incorrect.
22. **Assertion :** An induced current has a direction such that the magnetic field due to the current opposes the change in the magnetic flux that induces the current.
Reason : Above statement is in accordance with conservation of energy. [2011]
23. **Assertion :** Lenz's law violates the principle of conservation of energy.
Reason : Induced emf always opposes the change in magnetic flux responsible for its production. [2014]
24. **Assertion :** Faraday's laws are consequence of conservation of energy.
Reason : In a purely resistive ac circuit, the current lags behind the emf in phase. [2017]

HINTS & SOLUTIONS

Type A : Multiple Choice Questions

1. (c) Flux passing through the coil,
 $= 1000 \times 4 \times 10^{-5} = 2 \times 10^{-3}$ Weber
 Change in flux when the coil turns by 180° .

$$= 2 \times 10^{-3} - (-2 \times 10^{-3})$$

$$\Delta\phi = 4 \times 10^{-3}$$

$$\text{e.m.f.} = \frac{d\phi}{dt} = \frac{4 \times 10^{-3}}{0.01} = 0.4 \text{ V}$$

2. (c) $\text{e.m.f.} = -L \frac{di}{dt} = -5 \times 2 = -10 \text{ V}$

3. (d) Lenz's law deals with conversion of mechanical energy into electromagnetic energy in case of electromagnetic induction.

4. (b) Average flux in the beginning $= \pi r^2 n B_1$
 Average flux in the final $= \pi r^2 n B_2$

$$\text{Increase in flux } d\phi = \pi r^2 n (B_2 - B_1)$$

$$= 3.14 \times (0.03)^2 \times 50 (0.35 - 0.10)$$

$$= 314 \times 45 \times 25 \times 10^{-7}$$

$$\text{Given time } dt = 2 \times 10^{-3}$$

$$e = -\frac{d\phi}{dt} = \frac{314 \times 45 \times 25 \times 10^{-7}}{2 \times 10^{-3}}$$

$$= 1.77 \text{ V (approx.)}$$

5. (c) Magnetic flux $(\phi) = nBA$
 where n is number of turns, B is magnetic field and A is area

$$\text{Given, } n = 1000, i = 2 \text{ amp } r = 0.02$$

$$\text{and } l = 1.5 \text{ m}$$

Magnetic field of solenoid of length l is

$$B = \frac{\mu_0 i}{l}$$

$$\therefore \phi = \frac{\mu_0 n i A}{l}$$

$$\phi = \frac{3 \times 10^{-7} \times 4\pi \times (1000)^2 \times 2 \times \pi (2 \times 10^{-2})^2}{1.5}$$

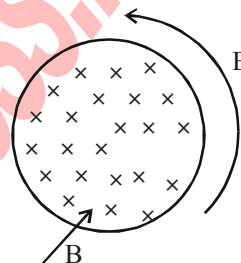
$$= 6.31 \times 10^{-3} \text{ Wb}$$

6. (c)



Direction of magnetic field due to indicated current will be in upward direction passing through the coil. So, a current in coil will be induced so that it decreases the flux in the coil. So, current in the clockwise direction will be induced.

7. (b) A changing magnetic field gives rise to electric field as shown in the figure.



The relation between electric field and changing magnetic field is

$$\oint \mathbf{E} d\ell = \frac{d\phi}{dt} = \frac{dB A}{dt}$$

$$2\pi r E = \frac{\pi r^2 dB}{dt} \Rightarrow E = \frac{r}{2} \frac{dB}{dt}$$

$$\text{Here } dB = 0.01 - (-0.01) = 0.02$$

$$dt = \frac{T}{2} = \frac{1}{2 \times 100}$$

$$E = \frac{1}{2} \times \frac{0.02}{\frac{1}{2 \times 100}} = \frac{2 \times 100 \times 0.02}{2} = 2 \text{ volt}$$

8. (a) We know that electromagnetic e.m.f. induced,

$$e = -\frac{d\phi}{dt}$$

Initially, $d\phi$ will be positive (during first $\frac{T}{4}$ time period) then it becomes negative during

the period from $\frac{T}{4}$ to $\frac{T}{2}$.

During the period $\frac{T}{2}$ to $\frac{3T}{4}$ it is again positive and in the last $\frac{T}{4}$ time it is negative. Accordingly sign of emf produced will be changed. Figure (a) fits exactly in this change pattern. So this figure represents the answer.

9. (b) When ring enters the field an emf is induced due to change in flux. Once with the magnetic field, there is no change in flux in the ring so there is no emf. When it emerges out of the field, once again there is a flux change which creates emf in reverse direction. Graph (b) shows this result.
10. (b) Flux of certain closed surface is zero and so it tells that net magnetic charge is equal to zero. This is possible when there are two equal and opposite poles.

11. (d) $e = \frac{B\omega\ell^2}{2}$

$$= \frac{(0.4 \times 10^4) \times \left(2\pi \times \frac{120}{60}\right) \times (0.5)^2}{2}$$

$$= 0.628 \times 10^{-4} \text{V}$$

12. (a) flux corresponds to 2A is = 0.8 weber
flux corresponds to 1.5 A is = 0.6 weber

$$|e| = \frac{\Delta\phi}{\Delta t} = \frac{0.2}{0.1} = 2.0 \text{V}$$

13. (d) $\phi = BA \cos\theta = 2.0 \times 0.5 \times \cos 60^\circ$
 $= \frac{2.0 \times 0.5}{2} = 0.5 \text{ Weber.}$

14. (b) Magnetic force acts perpendicular to the velocity. Hence speed remains constant.

15. (c)

16. (b) $\phi = 10t^2 - 50t + 250$

$$e = -\frac{d\phi}{dt} = -(20t - 50)$$

$$e_{t=3} = -10 \text{ V}$$

17. (d) $e = -\frac{d\phi}{dt} = -\frac{d(N\vec{B} \cdot \vec{A})}{dt}$

$$= -N \frac{d}{dt} (BA \cos \omega t) = NBA\omega \sin \omega t$$

$$\Rightarrow e_{\max} = NBA\omega$$

18. (c) $L = 2mH, i = t^2 e^{-t}$

$$E = -L \frac{di}{dt} = -L[-t^2 e^{-t} + 2te^{-t}]$$

$$\text{when } E = 0$$

$$-e^{-t} t^2 + 2te^{-t} = 0$$

$$2t e^{-t} = e^{-t} t^2$$

$$t = 2 \text{ sec.}$$

19. (a) According to right hand palm rule, the Lorentz force on free electrons in the conductor will be directed towards end B. Hence, the end A gets positively charged.

Type B : Assertion Reason Questions

20. (a) Assertion and Reason is correct and Reason explains Assertion. According to Faraday's law of electromagnetic induction

$$\int \vec{E} \cdot d\vec{\ell} = -\frac{d\phi}{dt}$$

So, (E) is non-conservative field as in conservative field line integral over a closed loop is zero.

21. (c) Efficiency of an electric motor is maximum when the back emf setup in the armature is half the value of the applied battery emf

$$\text{Efficiency, } \eta = \frac{P_{\text{out}}}{P_{\text{in}}} = \frac{e}{E} = \frac{\text{Back emf}}{\text{Supply voltage}}$$

22. (a)

23. (a) Lenz's law (that the direction of induced emf is always such as to oppose the change that cause it) is direct consequence of the law of conservation of energy.

24. (c) In purely resistive circuit, the current and emf are in the same phase.

Alternating Current

TYPE A : MULTIPLE CHOICE QUESTIONS

1. An A.C. circuit containing only capacitance, the current : [1997]

(a) lags the voltage by 90°
 (b) leads the voltage by 90°
 (c) remains in phase with voltage
 (d) leads the voltage in 180°

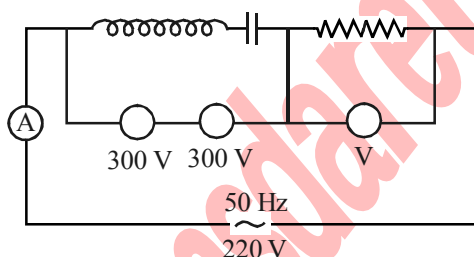
2. A choke coil has: [1999]

(a) Low inductance and low resistance
 (b) High inductance and high resistance
 (c) Low inductance and high resistance
 (d) High inductance and low resistance

3. Turn ratio in a step up transformer is 1 : 2 if a Leclanche cell of 1.5 V is connected across the input, then the voltage across the output will be

(a) 0.1 V (b) 1.5 V [2000]
 (c) 0.75 V (d) zero

4. In the circuit shown below what will be the reading of the voltmeter and ammeter ? [2000]
 (Total impedance of circuit $Z = 100\Omega$)



(a) 200 V, 1 A (b) 800 V, 2 A
 (c) 100 V, 2 A (d) 220 V, 2.2 A

5. In a circuit the coil of a choke : [2001]

(a) decreases the current
 (b) increases the current
 (c) has high resistance to D. C. circuit
 (d) no effect with the current

6. In a circuit, the current lags behind the voltage by a phase difference of $\pi/2$, the circuit will contain which of the following : [2001]

(a) only R (b) only C
 (c) R and C (d) only L

7. The coefficient of mutual inductance, when magnetic flux changes by 2×10^{-2} Wb and current changes by 0.01 A is [2002]

(a) 8 henry (b) 4 henry
 (c) 3 henry (d) 2 henry

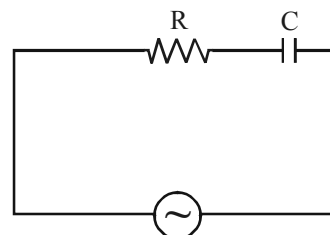
8. In an ideal parallel LC circuit, the capacitor is charged by connecting it to a D.C. source which is then disconnected. The current in the circuit

(a) becomes zero instantaneously [2003]
 (b) grows monotonically
 (c) decays monotonically
 (d) oscillates instantaneously

9. A capacitor of capacitance $2\mu\text{F}$ is connected in the tank circuit of an oscillator oscillating with a frequency of 1 kHz. If the current flowing in the circuit is 2 mA, the voltage across the capacitor will be : [2003]

(a) 0.16 V (b) 0.32 V
 (c) 79.5 V (d) 159 V

10. A 50 Hz a.c. source of 20 volt is connected across R and C as shown in figure. The voltage across R is 12 volt. The voltage across C is : [2004]



(a) 8 V
 (b) 16 V
 (c) 10 V
 (d) not possible to determine unless values of R and C are given

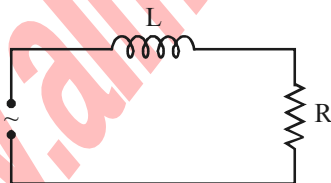
11. In an AC circuit the potential differences across an inductance and resistance joined in series are respectively 16 V and 20 V. The total potential difference of the source is [2007]

(a) 20.0 V (b) 25.6 V
 (c) 31.9 V (d) 53.5 V

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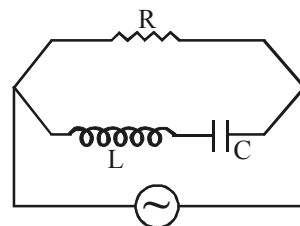
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12. With the decrease of current in the primary coil from 2 amperes to zero value in 0.01s the emf generated in the secondary coil is 1000 volts. The mutual inductance of the two coils is
(a) 1.25 H (b) 2.50 H [2007]
(c) 5.00 H (d) 10.00 H
13. An AC source of angular frequency ω is fed across a resistor R and a capacitor C in series. The current registered is I. If now the frequency of source is changed to $\omega/3$ (but maintaining the same voltage), the current in the circuit is found to be halved. Calculate the ratio of reactance to resistance at the original frequency ω [2008]
- (a) $\sqrt{\frac{3}{5}}$ (b) $\sqrt{\frac{2}{5}}$
(c) $\sqrt{\frac{1}{5}}$ (d) $\sqrt{\frac{4}{5}}$
14. If an AC main supply is given to be 220 V. The average emf during a positive half cycle will be
(a) 198 V (b) 220 V [2009]
(c) 240 V (d) $220\sqrt{2}$ V
15. A coil has an inductance of 0.7 henry and is joined in series with a resistance of $220\ \Omega$. When the alternating emf of 220 V at 50 Hz is applied to it then the phase through which current lags behind the applied emf and the wattless component of current in the circuit will be respectively [2010]
(a) 30° , 1 A (b) 45° , 0.5 A
(c) 60° , 1.5 A (d) none of these
16. An inductor and a resistor in series are connected to an A.C. supply of variable frequency. As the frequency of the source is increased, the phase angle between current and the potential difference across L will: [2010]



- (a) first increase and then decrease
(b) first decrease and then increase
(c) go on decreasing
(d) go on increasing

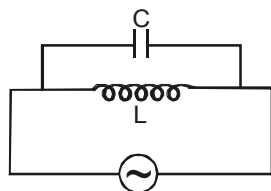
17. In a AC circuit the voltage and current are described
by $V = 200\sin\left(319t - \frac{\pi}{6}\right)$ volts [2010]
and $i = 50\sin\left(314t + \frac{\pi}{6}\right)$ mA
respectively. The average power dissipated in the circuit is : [2011]
(a) 2.5 watts (b) 5.0 watts
(c) 10.0 watts (d) 50.0 watts
18. If we decrease the frequency of the applied A.C. with a purely capacitive load, do (1) the amplitude of V_c and (2) amplitude of I_c increase, decrease or remain the same. [2011]
(a) (1) increase (2) same
(b) (1) same (2) increase
(c) (1) same (2) decrease
(d) (1) decrease (2) same
19. An inductor coil of inductance L is cut into two equal parts and both the parts are connected in parallel. The net inductance is : [2011]
(a) L (b) $L/2$
(c) $L/4$ (d) $2L$
20. The current in resistance R at resonance is



$$V = V_0 \sin \omega t$$

- (a) zero [2012]
(b) minimum but finite
(c) maximum but finite
(d) infinite
21. An inductance L having a resistance R is connected to an alternating source of angular frequency ω . The Quality factor Q of inductance is [2012]
(a) $R/\omega L$ (b) $(\omega L/R)^2$
(c) $(R/\omega L)^{1/2}$ (d) $\omega L/R$
22. In an A.C. circuit, the current flowing in inductance is $I = 5\sin(100t - \pi/2)$ amperes and the potential difference is $V = 200\sin(100t)$ volts. The power consumption is equal to [2013]
(a) 1000 watt (b) 40 watt
(c) 20 watt (d) zero

23. For the circuit shown in the fig., the current through the inductor is 0.9 A while the current through the condenser is 0.4 A. Then (2013)



- (a) current drawn from generator $I = 1.13$ A
 (b) $\omega = 1/(1.5 LC)$
 (c) $I = 0.5$ A
 (d) $I = 0.6$ A
24. L, C, R represent physical quantities inductance, capacitance and resistance respectively. The combinations which have the dimensions of frequency are [2013]
 (a) $1/RC$ (b) R/L
 (c) $1/\sqrt{LC}$ (d) C/L
25. An inductance L having a resistance R is connected to an alternating source of angular frequency ω . The Quality factor Q of inductance is [2014]
 (a) $R/\omega L$ (b) $(\omega L/R)^2$
 (c) $(R/\omega L)^{1/2}$ (d) $\omega L/R$
26. A step down transformer is connected to 2400 volts line and 80 amperes of current is found to flow in output load. The ratio of the turns in primary and secondary coil is 20 : 1. If transformer efficiency is 100%, then the current flowing in the primary coil will be [2015]
 (a) 1600 amp (b) 20 amp
 (c) 4 amp (d) 1.5 amp
27. The mutual inductance of a pair of coils, each of N turns, is M henry. If a current of I ampere in one of the coils is brought to zero in t second, the emf induced per turn in the other coil, in volt, will be [2015]
 (a) $\frac{MI}{t}$ (b) $\frac{NMI}{t}$
 (c) $\frac{MN}{It}$ (d) $\frac{MI}{Nt}$
28. The tuning circuit of a radio receiver has a resistance of 50Ω , an inductor of 10 mH and a variable capacitor. A 1 MHz radio wave produces a potential difference of 0.1 mV. The values of the capacitor to produce resonance is (Take $\pi^2 = 10$) [2015]
 (a) 2.5 pF (b) 5.0 pF
 (c) 25 pF (d) 50 pF
29. A coil has resistance 30 ohm and inductive reactance 20 ohm at 50 Hz frequency. If an ac source, of 200 volt, 100 Hz, is connected across the coil, the current in the coil will be [2016]
 (a) 4.0 A (b) 8.0 A
 (c) $\frac{20}{\sqrt{13}}$ A (d) 2.0 A
30. An ideal coil of 10H is connected in series with a resistance of 5Ω and a battery of 5V. After 2 sec the connection is made, the current flowing in ampere in the circuit is [2016]
 (a) $(1 - e^{-1})$ (b) $(1 - e)$
 (c) e (d) e^{-1}
31. An inductor, a resistor and a capacitor are joined in series with an AC source. As the frequency of the source is slightly increased from a very low value, the reactance of the [2017]
 (a) inductor increases
 (b) resistor increases
 (c) capacitor increases
 (d) circuit increases

TYPE B : ASSERTION REASON QUESTIONS

Directions for (Qs. 32-34) : These questions consist of two statements, each printed as Assertion and Reason. While answering these questions, you are required to choose any one of the following five responses.

- (a) If both Assertion and Reason are correct and the Reason is a correct explanation of the Assertion.
 (b) If both Assertion and Reason are correct but Reason is not a correct explanation of the Assertion.
 (c) If the Assertion is correct but Reason is incorrect.
 (d) If both the Assertion and Reason are incorrect.
 (e) If the Assertion is incorrect but the Reason is correct.

32. **Assertion :** In series LCR circuit resonance can take place.

Reason : Resonance takes place if inductance and capacitive reactances are equal and opposite. [1998]

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33. **Assertion :** Faraday's laws are consequences of conservation of energy.

Reason : In a purely resistive A.C. circuit, the current lags behind the e.m.f. in phase. [2002]

34. **Assertion :** No power loss associated with pure capacitor in ac circuit.

Reason : No current is flowing in this circuit.

[2007]

Directions for (Qs. 35-41) : Each of these questions contains an Assertion followed by Reason. Read them carefully and answer the question on the basis of following options. You have to select the one that best describes the two statements.

- (a) If both Assertion and Reason are correct and Reason is the correct explanation of Assertion.
- (b) If both Assertion and Reason are correct, but Reason is not the correct explanation of Assertion.
- (c) If Assertion is correct but Reason is incorrect.
- (d) If both the Assertion and Reason are incorrect.

35. **Assertion :** Ohm's law cannot be applied to a.c circuit.

Reason : Resistance offered by capacitor for a.c source depends upon the frequency of the source. [2009]

36. **Assertion :** The resistance offered by an inductor in a d.c circuit is always constant.

Reason : The resistance of inductor in steady state is non-zero. [2010]

37. **Assertion :** Long distance power transmission is done at high voltage.

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Reason : At high voltage supply power losses are less. [2011, 2013]

38. **Assertion :** A capacitor blocks direct current in the steady state.

Reason : The capacitive reactance of the capacitor is inversely proportional to frequency f of the source of emf. [2011]

39. **Assertion :** In the purely resistive element of a series LCR, AC circuit the maximum value of rms current increases with increase in the angular frequency of the applied e.m.f.

Reason :

$$I_{\max} = \frac{\epsilon_{\max}}{Z}, \quad Z = \sqrt{R^2 + \left(\omega L - \frac{1}{\omega C}\right)^2},$$

where $I_{\max}$ is the peak current in a cycle.

[2012]

40. **Assertion :** In the purely resistive element of a series LCR, AC circuit the maximum value of rms current increases with increase in the angular frequency of the applied emf.

Reason :

$$I_{\max} = \frac{\epsilon_{\max}}{Z}, \quad Z = \sqrt{R^2 + \left(\omega L - \frac{1}{\omega C}\right)^2},$$

where $I_{\max}$ is the peak current in a cycle.

[2016]

41. **Assertion :** A laminated core is used in transformers to increase eddy currents.

Reason : The efficiency of a transformer increases with increase in eddy currents. [2017]

HINTS & SOLUTIONS

Type A : Multiple Choice Questions

1. (b) In an a.c. circuit containing resistance only voltage & current remain in the same phase. If circuit contains inductance only, voltage remains ahead of current by phase difference of 90° .
If circuit contains capacitance only, current remains ahead of voltage by a phase difference of 90° .
2. (d) A choke coil has high inductance and low resistance so, it is capable of producing very high induced e.m.f. which produces discharge in the tube.
3. (d) A transformer can not step up a d.c. input so output potential here will be zero. No potential will be induced in the secondary coil.
4. (d) Total impedance of the circuit = 100Ω
Current = $\frac{220}{100} = 2.2\text{ A}$
Potential drop over inductance and capacitance is 300 V. As they are in opposite phase they will sum up to zero. So whole of 220 volt (external source) will come over the resistance.
 $(V_L - V_C)^2 + V_R^2 = (220)^2$
As $V_L = V_C$ so $V_R = 220\text{ volt}$
5. (a) In a circuit with a.c. source, choke coil which is essentially an inductor with high reactance, is used to decrease the current without loss of energy. No heat is generated so no loss of energy. When we use resistance to reduce current, there is loss of electrical energy in the form of heat generated.
6. (d) If a circuit contains L, voltage leads current by a phase angle of $\frac{\pi}{2}$.
7. (d) We know that
 $\phi = Mi$
 $d\phi = Mdi$
 $M = \frac{d\phi}{di} = \frac{2 \times 10^{-2}}{1 \times 10^{-2}} = 2\text{ henry}$

8. (d) In an LC circuit current oscillates between maximum and minimum value. So, LC circuit needs oscillations (electrical). It occurs due to discharging and charging of capacitor and magnetisation and demagnetisation of inductor.
9. (a) Here, oscillating frequency
= $1\text{ kHz} = 10^3\text{ Hz}$
Reactance of capacitor = $\frac{1}{\omega C}$
 $= \frac{1}{2\pi \times 10^3 \times 2 \times 10^{-6}} = \frac{10^3}{4\pi}$
Potential over capacitance
 $\frac{1}{\omega C} \times i = \frac{10^3}{4\pi} \times 2 \times 10^{-3} = \frac{2}{4\pi} = \frac{7}{44} = 0.16\text{ V}$
10. (b) $E^2 = V_R^2 + \left(\frac{1}{\omega C}\right)^2 = V_R^2 + V_C^2$
[Phase difference between V_R & V_C is 90°]
 $(20)^2 = (12)^2 + V_C^2$
 $\Rightarrow V_C^2 = 400 - 144 = 256$
 $\Rightarrow V_C = 16$
11. (b) In any ac (LR) circuit, total potential is given by $V = \sqrt{V_R^2 + V_L^2}$ where V_R and V_L are potential across resistance and inductance respectively.
Hence $V = \sqrt{(16)^2 + (20)^2} = \sqrt{256 + 400} = 25.6\text{ V}$
12. (c) The emf induced in secondary is given by
 $e = \frac{-Mdi}{dt} \Rightarrow 1000 = M \left(\frac{2-0}{0.01} \right)$
(since current is reduced $di = -ve$)
 $\Rightarrow M = \frac{1000 \times 0.01}{2} = 5.00\text{ H}$.
13. (a) At angular frequency ω , current through RC circuit is given by
 $I_{\text{rms}} = \frac{V_{\text{rms}}}{\sqrt{R^2 + X_C^2}} = \frac{V_{\text{rms}}}{\sqrt{R^2 + (1/\omega C)^2}} \dots (1)$
When angular frequency is changed to $\frac{\omega}{3}$, then the current becomes,

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$$\frac{I_{\text{rms}}}{2} = \frac{V_{\text{rms}}}{\sqrt{R^2 + \left(\frac{1}{\left(\frac{\omega}{3}\right)C}\right)^2}} = \frac{V_{\text{rms}}}{\sqrt{R^2 + \left(\frac{3}{\omega C}\right)^2}} \dots (2)$$

Dividing (i) by (ii)

$$2 = \frac{\sqrt{R^2 + (3/\omega C)^2}}{\sqrt{R^2 + (1/\omega C)^2}}$$

$$\text{or } 4 \left[R^2 + \left(\frac{1}{\omega C} \right)^2 \right] = R^2 + \left(\frac{3}{\omega C} \right)^2$$

$$3R^2 = \frac{5}{\omega^2 C^2} \Rightarrow \frac{1/\omega C}{R} = \sqrt{\frac{3}{5}}$$

$$\Rightarrow \frac{X_C}{R} = \sqrt{\frac{3}{5}}$$

14. (a) $E_{\text{rms}} = 220 \text{ V}$

$$\therefore E_{\text{rms}} = \frac{E_0}{\sqrt{2}} \Rightarrow E_0 = \sqrt{2} E_{\text{rms}}$$

Average e.m.f over half cycle

$$= \frac{2}{\pi} E_0 = 0.637 \times 1.41 \times 220 = 198.15 \text{ V}$$

15. (b) $L = 0.7 \text{ H}$, $R = 220 \Omega$, $E_0 = 220 \text{ V}$, $\nu = 50 \text{ Hz}$.

This is an L – R circuit

Phase difference,

$$\tan \phi = \frac{X_L}{R} = \frac{\omega L}{R} = \frac{2\pi\nu L}{R}$$

$$[X_L = 2\pi\nu L = 2 \times \frac{22}{7} \times 50 \times 0.7 = 220 \Omega]$$

$$= \frac{220}{220} = 1 \text{ or } \phi = 45^\circ$$

Wattless component of current

$$= I_0 \sin \phi = \frac{I_0}{\sqrt{2}} = \frac{1}{\sqrt{2}} \cdot \frac{E_0}{Z}$$

$$= \frac{1}{\sqrt{2}} \cdot \frac{220}{\sqrt{X_L^2 + R^2}} = \frac{1}{\sqrt{2}} \cdot \frac{220}{\sqrt{220^2 + 220^2}}$$

$$= \frac{1}{2} = 0.5 \text{ A}$$

16. (d) $\tan \theta = \frac{X_L}{R}$

17. (a) $P = \frac{V_0 i_0 \cos \phi}{2} = \frac{200 \times 50 \times 10^3}{2} \cos \frac{\pi}{3}$

18. (c) $X_c = \frac{1}{\omega c}$ and $i_c = \frac{V_c}{X_c}$

With decrease in frequency, X_c increases and hence i_c decreases.

19. (c) The inductance is proportional to the length of the coil. So each part will have inductance $\frac{L}{2}$. In parallel their equivalent becomes

$$\frac{L_1 L_2}{L_1 + L_2} = \frac{L}{4}$$

20. (c) At resonance $X_L = X_C$
 $\Rightarrow R$ & current is maximum but finite, which is $I_{\text{max}} = \frac{E}{R}$, where E is applied voltage.

21. (d) $Q = \frac{\text{Potential drop across capacitor or inductor}}{\text{Potential drop across R.}}$
 $= \frac{\omega L}{R}$

22. (d) Power, $P = I_{\text{r.m.s.}} \times V_{\text{r.m.s.}} \times \cos \phi$
 In the given problem, the phase difference between voltage and current is $\pi/2$. Hence $P = I_{\text{r.m.s.}} \times V_{\text{r.m.s.}} \times \cos(\pi/2) = 0$.

23. (c) The current drawn by inductor and capacitor will be in opposite phase. Hence net current drawn from generator
 $= I_L - I_C = 0.9 - 0.4 = 0.5 \text{ amp.}$

24. (c) $\frac{1}{\sqrt{LC}} = \frac{1}{\sqrt{(ML^2 T^{-2} A^{-2}) \times (M^{-1} L^{-2} T^4 A^2)}}$
 $= \frac{1}{\sqrt{T^2}} = T^{-1}$

25. (d) $Q = \frac{\text{Potential drop across capacitor or inductor}}{\text{Potential drop across R.}}$
 $= \frac{\omega L}{R}$

26. (c) $\frac{I_s}{I_p} = \frac{n_p}{n_s}$; $\frac{80}{I_p} = \frac{20}{1}$ or $I_p = 4 \text{ amp.}$

27. (a) $E = \frac{d}{dt} (NMI) \Rightarrow E = NM \frac{dI}{dt} \Rightarrow E = \frac{NMI}{t}$
 emf induced per unit turn = $\frac{E}{N} = \frac{MI}{t}$

28. (a) $L = 10 \text{ mHz} = 10^{-2} \text{ Hz}$
 $f = 1 \text{ MHz} = 10^6 \text{ Hz}$

$$f = \frac{1}{2\pi\sqrt{LC}}$$

$$f^2 = \frac{1}{4\pi^2 LC}$$

$$\Rightarrow C = \frac{1}{4\pi^2 f^2 L} = \frac{1}{4 \times 10 \times 10^{-2} \times 10^{12}}$$

$$= \frac{10^{-12}}{4} = 2.5 \text{ pF}$$

29. (a) If $\omega = 50 \times 2\pi$ then $\omega L = 20\Omega$
 If $\omega' = 100 \times 2\pi$ then $\omega' L = 40\Omega$
 Current flowing in the coil is

$$I = \frac{200}{Z} = \frac{200}{\sqrt{R^2 + (\omega' L)^2}} = \frac{200}{\sqrt{(30)^2 + (40)^2}}$$

$$I = 4 \text{ A.}$$

30. (a) We have, $I = I_0 \left(1 - e^{-\frac{R}{L}t}\right)$
 (When current is in growth in LR circuit)

$$= \frac{E}{R} \left(1 - e^{-\frac{R}{L}t}\right) = \frac{5}{5} \left(1 - e^{-\frac{5}{10} \times 2}\right)$$

$$= (1 - e^{-1})$$

31. (c) The phase angle is given by

$$\tan \phi = \frac{\omega L}{R} = \frac{2\pi \times 50 \times 0.21}{12} = 5.5$$

$$\phi = \tan^{-1} 5.5 = 80^\circ$$

Type B : Assertion Reason Questions

32. (a) In series resonance circuit, current becomes maximum because total impedance becomes zero. In case of LC circuit,

$$\text{Total impedance} = \omega L - \frac{1}{\omega C} = 0$$

$$\Rightarrow \omega L = \frac{1}{\omega C} \Rightarrow \omega^2 = \frac{1}{LC}$$

33. (c) Faraday's laws of electromagnetic induction are consequences of conservation of energy. It involves only transformation of energy into electrical energy.

In purely resistive circuit, current and voltage are in the same phase.

34. (c) For a pure capacitor circuit average power is given by $P_{av} = E_V I_V \cos(-\pi/2)$,

$$\therefore E_V I_V (0) = 0 \Rightarrow P_{av} = 0 \quad (\text{as } \phi = -\pi/2)$$

thus no power loss occurs. A pure capacitor acts as a block of direct current (d.c) and easy path to a.c since reactance

$X_C = \frac{1}{2\pi f_c} = \infty$ for d.c ($f=0$ for d.c). Hence we can say no d.c. flows but a.c part is there hence reason is false.

35. (d) Assertion is false and Reason is false.

36. (d) Resistance offered by an inductor in a d.c. circuit at $t = 0$ is infinity, which decreases to zero at steady state.

37. (a) Power loss $= I^2 R = \left(\frac{P}{V}\right)^2 R$
 [P = Transmitted power]

38. (a)

39. (c)

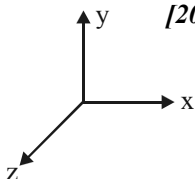
40. (c)

41. (d) Large eddy currents are produced in non-laminated iron core of the transformer by the induced emf, as the resistance of bulk iron core is very small. By using thin iron sheets as core the resistance is increased. Laminating the core substantially reduces the eddy currents. Eddy current heats up the core of the transformer. More the eddy currents greater is the loss of energy and the efficiency goes down.

Electromagnetic Waves

TYPE A : MULTIPLE CHOICE QUESTIONS

- According to Maxwell's hypothesis, changing of electric field give rise to : [1998]
(a) magnetic field (b) pressure gradient
(c) charge (d) voltage
- Frequency of infrared wave is approximately:
(a) 10^{18} Hz (b) 10^{14} Hz [1999]
(c) 10^9 Hz (d) 10^{16} Hz
- Which wavelength of sun is used finally as electric energy? [2007]
(a) Radio waves (b) Infra red waves
(c) Visible light (d) Micro waves
- If the magnetic field of a light wave oscillates parallel to y-axis and is given by $B_y = B_m \sin(kz - \omega t)$, the direction of wave travel and the axis along which the electric vector oscillates is : [2011]
(a) +ve y-axis, z-axis
(b) -ve z-axis, x-axis
(c) -ve x-axis, y-axis
(d) -ve x-axis, z-axis
- The energy of electromagnetic wave in vacuum is given by the relation (2013)
(a) $\frac{E^2}{2\epsilon_0} + \frac{B^2}{2\mu_0}$ (b) $\frac{1}{2}\epsilon_0 E^2 + \frac{1}{2}\mu_0 B^2$
(c) $\frac{E^2 + B^2}{c}$ (d) $\frac{1}{2}\epsilon_0 E^2 + \frac{B^2}{2\mu_0}$
- Which of the following are not electromagnetic waves? [2014]
(a) cosmic rays (b) γ -rays
(c) β -rays (d) X-rays.
- Light wave is travelling along y-direction. If the corresponding $\vec{E}$ vector at any time is along the x-axis, the direction of $\vec{B}$ vector at that time is along [2015]
(a) y-axis
(b) x-axis
(c) +z-axis
(d) -z-axis



- Electromagnetic wave consists of periodically oscillating electric and magnetic vectors
(a) in mutually perpendicular planes but vibrating with a phase difference of π
(b) in mutually perpendicular planes but vibrating with a phase difference of $\frac{\pi}{2}$
(c) in randomly oriented planes but vibrating in phase
(d) in mutually perpendicular planes but vibrating in phase [2017]

TYPE B : ASSERTION REASON QUESTIONS

Directions for (Qs. 9-10) : These questions consist of two statements, each printed as Assertion and Reason. While answering these questions, you are required to choose any one of the following five responses.

- If both Assertion and Reason are correct and the Reason is a correct explanation of the Assertion.
 - If both Assertion and Reason are correct but Reason is not a correct explanation of the Assertion.
 - If the Assertion is correct but Reason is incorrect.
 - If both the Assertion and Reason are incorrect.
 - If the Assertion is incorrect but the Reason is correct.
- Assertion :** X-ray travel with the speed of light.
Reason : X-rays are electromagnetic rays. [2001]
 - Assertion :** Dipole oscillations produce electromagnetic waves.
Reason : Accelerated charge produces electromagnetic waves. [2007]

Directions for (Qs. 11-13) : Each of these questions contains an Assertion followed by Reason. Read them carefully and answer the question on the basis of following options. You have to select the one that best describes the two statements.

- If both Assertion and Reason are correct and Reason is the correct explanation of Assertion.

- (b) If both Assertion and Reason are correct, but Reason is not the correct explanation of Assertion.
 (c) If Assertion is correct but Reason is incorrect.
 (d) If both the Assertion and Reason are incorrect.
11. **Assertion :** Environmental damage has increased the amount of ozone in the atmosphere.

Reason : Increase of ozone increases the amount of ultraviolet radiation on earth. [2014]

12. **Assertion :** Radio waves can be polarised.

Reason : Sound waves in air are longitudinal in nature. [2016]

13. **Assertion :** Microwaves are better carrier of signals than optical waves.

Reason : Microwaves move faster than optical waves. [2017]

HINTS & SOLUTIONS

Type A : Multiple Choice Questions

1. (a) Changing of electric field produces displacement current which produces magnetic field. So, changing electric field produces magnetic field.
 2. (b) We know that visible light has wavelength in the region of $4000\text{\AA}$ - $7000\text{\AA}$. If we take infrared as approximately having wavelength of $7000\text{\AA}$ then applying $v\lambda = c$

$$v \times 7000 \times 10^{-10} = 3 \times 10^8$$

$$v = \frac{3 \times 10^8}{7 \times 10^{-7}} = \frac{3}{7} \times 10^{15} \text{ Hz}$$

$$= 4.3 \times 10^{14} \text{ Hz}$$

3. (b) The heating property of Infra red waves is used in solar heater and solar cells. Hence option (b) is correct.
 4. (b) Given $B_y = B_m \sin(kz - \omega t)$. According to this equation the direction of propagation is along z axis. The direction of electric vector must be perpendicular both y and z-axis. So it is along x-axis.

5. (d) $\frac{1}{2} \epsilon_0 E_0^2$ is electric energy density.

$$\frac{B^2}{2\mu_0} \text{ is magnetic energy density.}$$

$$\text{So, total energy} = \frac{1}{2} \epsilon_0 E_0^2 + \frac{B_0^2}{2\mu_0}$$

6. (c) β -rays are the beam of fast moving electrons.

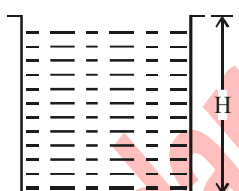
7. (c) Light wave is an electromagnetic wave in which E and B are at right angles to each other as well as at right angles to the direction of wave propagation.
 8. (d) Electromagnetic wave consists of periodically oscillating electric and magnetic vectors in mutually perpendicular planes but vibrating in phase.

Type B : Assertion Reason Questions

9. (a) All electromagnetic waves have same speed in vacuum. X-ray is a high energy electromagnetic wave.
 10. (b) Hertz produced em waves by oscillating charge between dipolar electric field.
 A charge moving with non-zero acceleration where both magnetic and electric field are varying emits em waves but this does not explain assertion.
 11. (a) Ozone layer in the stratosphere helps in protecting life of organism from ultraviolet radiation on earth. Ozone layer is depleted due to of several factors like use of chlorofluoro carbon (CFC) which is the cause of environmental damages.
 12. (c) Radio waves can be polarised because they are transverse in nature. Sound waves in air are longitudinal in nature.
 13. (d) The optical waves used in optical fibre communication are better carrier of signals than microwaves. The speed of microwave and optical wave is the same in vacuum.

Ray Optics and Optical Instruments

TYPE A : MULTIPLE CHOICE QUESTIONS

- If two mirrors are kept at 45° to each other and a body is placed in the middle then total number of images formed is : [1997]
 (a) 7 (b) 8
 (c) 14 (d) 4
- An astronomical telescope of ten fold angular magnification has a length of 44 cm. The focal length of the objective is : [1997]
 (a) 44 cm (b) 440 cm
 (c) 40 cm (d) 4 cm
- The refractive index of diamond is 2.0, velocity of light in diamond in cm per second is approximately : [1997]
 (a) 1.5×10^{10} (b) 2.0×10^{10}
 (c) 6×10^{10} (d) 3×10^{10}
- A cylindrical vessel is filled with water ($\mu = 4/3$) as shown in figure. A coin placed in water at the bottom appears upto maximum distance of : [1997]

 (a) $\frac{3H}{4}$ from the surface
 (b) $\frac{H}{4}$ from the surface
 (c) H from the surface
 (d) $\frac{H}{2}$ from the surface
- The critical angle for the material of a prism is 45° and its refracting angle is 30° . A monochromatic ray goes out perpendicular to the surface of emergence from the prism. Then the angle of incidence on the prism will be : [1997]
 (a) 60° (b) 75°
 (c) 45° (d) 30°
- How can the chromatic aberration be corrected [1997]
 (a) By providing different suitable curvature to its two surface
 (b) By combining it with another lens of opposite nature
 (c) By reducing its aperture
 (d) By providing proper polishing of its two surfaces
- When a beam of light from air enters into the water, the characteristics of light will not be changed, is : [1997]
 (a) frequency (b) speed
 (c) colour (d) amplitude
- Mirage is a phenomenon due to : [1998]
 (a) refraction of light
 (b) diffraction of light
 (c) total internal reflection of light
 (d) none of these
- In an astronomical microscope, the focal length of the objective is made : [1998]
 (a) shorter than that of the eye piece
 (b) greater than that of the eye piece
 (c) half of the eye piece
 (d) equal to that of the eye piece
- Light appears to travel in a straight line, because [1998]
 (a) its wavelength is very small
 (b) its velocity is large
 (c) it is not absorbed by surroundings
 (d) it is reflected by surroundings
- Sky appears to be blue in clear atmosphere due to which property of light : [1999]
 (a) Scattering (b) Polarization
 (c) Diffraction (d) Dispersion
- A doctor prescribes spectacles to a patient with a combination of a convex lens of focal length 40 cm, and concave lens of focal length 25 cm then the power of spectacles will be : [2000]
 (a) -6.5 D (b) 1.5 D
 (c) -1.5 D (d) -8.5 D

13. Match the items in list-I with items in list-II and collect the correct answers from the codes given below the lists [2000]

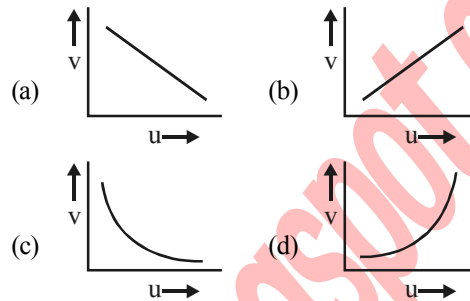
List-I

- I. Myopia
II. Hyper-metropia
III. Presbyopia
IV. Astigmatism

List-II

- A. Bifocal lens
B. Cylindrical lens
C. Concave lens
D. Convex lens

- (a) I-D, II-C, III-A, IV-B
(b) I-C, II-D, III-A, IV-B
(c) I-B, II-D, III-A, IV-C
(d) I-A, II-B, III-C, IV-D
14. When a ray of light enters a glass slab, then [2000]
(a) its frequency and wavelength changes
(b) its frequency does not change
(c) only frequency changes
(d) its frequency and velocity changes
15. An equilateral prism is made of a material of refractive index $\sqrt{3}$. The angle of minimum deviation for the prism is [2000]
(a) 90° (b) 60°
(c) 45° (d) 30°
16. A concave mirror having the focal length 15 cm, forms an image having twice of the linear dimensions of the object. If the image is virtual, then the position of the object will be : [2001]
(a) 7.5 cm (b) 22.5 cm
(c) 40 cm (d) 30 cm
17. Four lenses having the focal length of +15 cm, 20 cm, +150 cm, and +250 cm respectively are provided to make an astronomical telescope. The focal length of the eyepiece to produce the largest magnification, should be : [2001]
(a) +250 cm (b) +155 cm
(c) 25 cm (d) +15 cm
18. The Cauchy's dispersion formula is [2002]
(a) $h = A + B\lambda^2 + C\lambda^4$
(b) $\mu = A + B\lambda^{-2} + C\lambda^4$
(c) $\mu = A + B\lambda^2 + C\lambda^{-4}$
(d) $\mu = A + B\lambda^{-2} + C\lambda^{-4}$
19. In an experiment to find the focal length of a concave mirror, a graph is drawn between the magnitudes of u and v . The graph looks like : [2003]

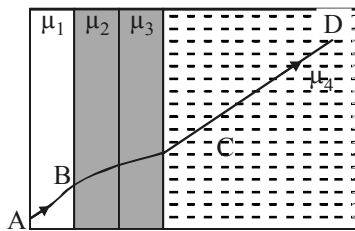


20. An object is immersed in a fluid. In order that the object becomes invisible, it should : [2004]
(a) behave as a perfect reflector
(b) absorb all light falling on it
(c) have refractive index one
(d) have refractive index exactly matching with that of the surrounding fluid
21. Sodium lamps are used in foggy conditions because : [2004]
(a) yellow light is scattered less by the fog particles
(b) yellow light is scattered more by the fog particles
(c) yellow light is unaffected during its passage through the fog
(d) Wavelength of yellow light is the mean of the visible part of the spectrum
22. An endoscope is employed by a physician to view the internal parts of a body organ. It is based on the principle of : [2004]
(a) refraction
(b) reflection
(c) total internal reflection
(d) dispersion
23. A telescope has an objective lens of focal length 200 cm and an eye piece with focal length 2 cm. If this telescope is used to see a 50 metre tall building at a distance of 2 km, what is the height of the image of the building formed by the objective lens? [2005]
(a) 5 cm (b) 10 cm
(c) 1 cm (d) 2 cm
24. In refraction, light waves are bent on passing from one medium to the second medium, because, in the second medium: [2006]
(a) the frequency is different
(b) the coefficient of elasticity is different
(c) the speed is different
(d) the amplitude is smaller

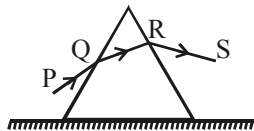
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Topicwise AIIMS Solved Papers – PHYSICS

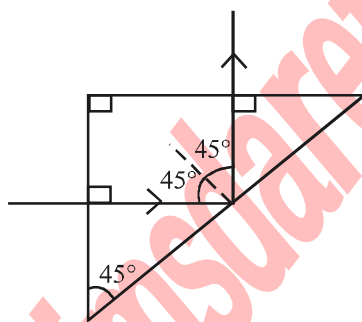
25. A wire mesh consisting of very small squares is viewed at a distance of S cm through a magnifying converging lens of focal length 10 cm, kept close to the eye. The magnification produced by the lens is: [2006]
- (a) 5 (b) 8
(c) 10 (d) 20
26. A lens is made of flint glass (refractive index = 1.5). When the lens is immersed in a liquid of refractive index 1.25, the focal length: [2006]
- (a) increases by a factor of 1.25
(b) increases by a factor of 2.5
(c) increases by a factor of 1.2
(d) decreases by a factor of 1.2
27. A leaf which contains only green pigments, is illuminated by a laser light of wavelength $0.6328 \mu\text{m}$. It would appear to be: [2006]
- (a) brown (b) black
(c) red (d) green
28. The focal length of the objective and eye lenses of a microscope are 1.6 cm and 2.5 cm respectively. The distance between the two lenses is 21.7 cm. If the final image is formed at infinity, what is the linear magnification? [2007]
- (a) 11 (b) 110
(c) 1.1 (d) 44
29. The camera lens has an aperture of f and the exposure time is $(1/60)\text{s}$. What will be the new exposure time if the aperture become $1.4 f$? [2007]
- (a) $\frac{1}{42}$ (b) $\frac{1}{56}$
(c) $\frac{1}{72}$ (d) $\frac{1}{31}$
30. A thin glass (refractive index 1.5) lens has optical power of -5 D in air. Its optical power in a liquid medium with refractive index 1.6 will be [2008]
- (a) -1 D (b) 1 D
(c) -25 D (d) 25 D
31. A fish looking up through the water sees the outside world contained in a circular horizon. If the refractive index of water is $\frac{4}{3}$ and the fish is 12 cm below the surface, the radius of this circle in cm is [2008]
- (a) $\frac{36}{\sqrt{7}}$ (b) $36\sqrt{7}$
(c) $4\sqrt{5}$ (d) $36\sqrt{5}$
32. A fish in an aquarium, 30 cm deep in water can see a light bulb kept 50 cm above the surface of water. The fish can also see the image of this bulb in the reflecting bottom surface of the aquarium. Total depth of water is 60 cm. Then the apparent distance between the two images seen by the fish is ($\mu_w = 4/3$) [2009]
- (a) 140 cm (b) $\frac{760}{3} \text{ cm}$
(c) $\frac{280}{3} \text{ cm}$ (d) $\frac{380}{3} \text{ cm}$
33. The focal length of the objective and eye piece of a telescope are respectively 200 cm and 5 cm. The maximum magnifying power of the telescope will be [2010]
- (a) -100 (b) -60
(c) -48 (d) -40
34. A thin prism P_1 with angle 6° and made from glass of refractive index 1.54 is combined with another thin prism P_2 of refractive index 1.72 to produce dispersion without deviation. The angle of prism P_2 will be [2011]
- (a) $4^\circ 30'$ (b) 8.5°
(c) 6.5° (d) none of these
35. The focal length of a converging lens are f_v and f_R for violet and red light respectively. Then [2012]
- (a) $f_v > f_R$ (b) $f_v = f_R$
(c) $f_v < f_R$ (d) any of the three is possible depending on the value of the average refractive index μ
36. A plano-convex lens of focal length 30 cm has its plane surface silvered. An object is placed 40 cm from the lens on the convex side. The distance of the image from the lens is [2013]
- (a) 18 cm (b) 24 cm
(c) 30 cm (d) 40 cm
37. A ray of light passes through four transparent media with refractive indices μ_1, μ_2, μ_3 and μ_4 as shown in the figure. The surfaces of all media are parallel. If the emergent ray CD is parallel to the incident ray AB, we must have [2013]



- (a) $\mu_1 = \mu_2$ (b) $\mu_2 = \mu_3$
 (c) $\mu_3 = \mu_4$ (d) $\mu_4 = \mu_1$
38. An equilateral prism is placed on a horizontal surface. A ray PQ is incident onto it. For minimum deviation [2014]



- (a) PQ is horizontal
 (b) QR is horizontal
 (c) RS is horizontal
 (d) Any one will be horizontal
39. A light ray is incident perpendicularly to one face of a 90° prism and is totally internally reflected at the glass-air interface. If the angle of reflection is 45° , we conclude that the refractive index [2014]



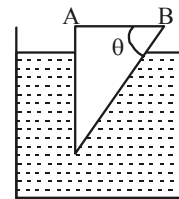
- (a) $n > \frac{1}{\sqrt{2}}$ (b) $n > \sqrt{2}$
 (c) $n < \frac{1}{\sqrt{2}}$ (d) $n < \sqrt{2}$
40. A man 160 cm high stands in front of a plane mirror. His eyes are at a height of 150 cm from the floor. Then the minimum length of the plane mirror for him to see his full length image is [2015]
- (a) 85 cm (b) 170 cm
 (c) 80 cm (d) 340 cm

41. An achromatic convergent lens of focal length 20 cms is made of two lenses (in contact) of materials having dispersive powers in the ratio of 1 : 2 and having focal lengths f_1 and f_2 . Which of the following is true? [2015]

- (a) $f_1 = 10$ cms, $f_2 = -20$ cms
 (b) $f_1 = 20$ cms, $f_2 = 10$ cms
 (c) $f_1 = -10$ cms, $f_2 = -20$ cms
 (d) $f_1 = 20$ cms, $f_2 = -20$ cms

42. A glass prism of refractive index 1.5 is immersed in water (refractive index $4/3$). A light beam incident normally on the face AB is totally reflected to reach on the face BC if [2016]

- (a) $\sin \theta \geq \frac{8}{9}$
 (b) $\frac{2}{3} < \sin \theta < \frac{8}{9}$
 (c) $\sin \theta \leq \frac{2}{3}$
 (d) None of these



43. A ray of light is incident at an angle of incidence, i , on one face of prism of angle A (assumed to be small) and emerges normally from the opposite face. If the refractive index of the prism is μ , the angle of incidence i , is nearly equal to [2016]

- (a) μA (b) $\frac{\mu A}{2}$
 (c) $\frac{A}{\mu}$ (d) $\frac{A}{2\mu}$

44. A green light is incident from the water to the air - water interface at the critical angle (θ). Select the correct statement. [2017]

- (a) The entire spectrum of visible light will come out of the water at an angle of 90° to the normal.
 (b) The spectrum of visible light whose frequency is less than that of green light will come out to the air medium.
 (c) The spectrum of visible light whose frequency is more than that of green light will come out to the air medium.
 (d) The entire spectrum of visible light will come out of the water at various angles to the normal.

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TYPE B : ASSERTION REASON QUESTIONS

Directions for (Qs. 45-61) : These questions consist of two statements, each printed as Assertion and Reason. While answering these questions, you are required to choose any one of the following five responses.

- If both Assertion and Reason are correct and the Reason is a correct explanation of the Assertion.
- If both Assertion and Reason are correct but Reason is not a correct explanation of the Assertion.
- If the Assertion is correct but Reason is incorrect.
- If both the Assertion and Reason are incorrect.
- If the Assertion is incorrect but the Reason is correct.

45. **Assertion :** The colour of the green flower seen through red glass appears to be dark.

Reason : Red glass transmits only red light.

[1997]

46. **Assertion :** Newton's rings are formed in the reflected system when the space between the lens and the glass plate is filled with a liquid of refractive index greater than that of glass, the central spot of the pattern is bright.

Reason : This is because the reflection in these cases will be from a denser to rarer medium and the two interfering rays are reflected under similar conditions.

[1998]

47. **Assertion :** Corpuscular theory fails in explaining the velocities of light in air and water.

Reason : According to corpuscular theory, light should travel faster in denser medium than in rarer medium.

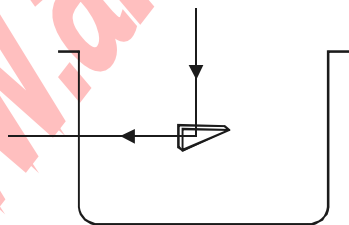
[1998]

48. **Assertion :** Different colours travel with different speed in vacuum.

Reason : Wavelength of light depends on refractive index of medium.

[1998]

49. **Assertion :** The maximum refractive index of liquid for total internal reflection of the ray passing through the prism as shown in figure must be $\sqrt{2}$.



Reason : Here, critical angle is 45°

[1999]

Topicwise AIIMS Solved Papers – PHYSICS

50. **Assertion :** A double convex lens ($\mu = 1.5$) has focal length 10 cm. When the lens is immersed in water ($\mu = 4/3$) its focal length becomes 40 cm.

Reason : $\frac{1}{f} = \frac{\mu_1 - \mu_m}{\mu_m} = \left(\frac{1}{R_1} - \frac{1}{R_2} \right)$ [1999]

51. **Assertion :** The refractive index of diamond is $\sqrt{6}$ and that of liquid is $\sqrt{3}$. If the light travels from diamond to the liquid, it will totally reflected when the angle of incidence is 30° .

Reason : $\mu = \frac{1}{\sin C}$, where μ is the refractive index of diamond with respect to liquid [2000]

52. **Assertion :** The setting sun appears to be red.

Reason : Scattering of light is directly proportional to the wavelength. [2000]

53. **Assertion :** In a movie, ordinarily 24 frames are projected per second from one end to the other of the complete film.

Reason : The image formed on retina of eye is sustained upto $1/10$ second after the removal of stimulus. [2001]

54. **Assertion :** Blue colour of sky appears due to scattering of blue colour.

Reason : Blue colour has shortest wave length in visible spectrum. [2001]

55. **Assertion :** The air bubble shines in water.

Reason : Air bubble in water shines due to refraction of light. [2002]

56. **Assertion :** The stars twinkle while the planets do not.

Reason : The stars are much bigger in size than the planets. [2003]

57. **Assertion :** A red object appears dark in the yellow light.

Reason : The red colour is scattered less. [2004]

58. **Assertion :** By roughening the surface of a glass sheet its transparency can be reduced.

Reason : Glass sheet with rough surface absorbs more light. [2005]

59. **Assertion :** Diamond glitters brilliantly.

Reason : Diamond does not absorb sunlight.

[2005]

60. **Assertion :** In optical fibre, the diameter of the core is kept small.

Reason : This smaller diameter of the core ensures that the fibre should have incident angle more than the critical angle required for total internal reflection. [2006]

61. **Assertion :** A concave mirror and convex lens both have the same focal length in air. When they are submerged in water, they will have same focal length.

Reason : The refractive index of water is smaller than the refractive index of air. [2008]

Directions for (Qs. 62-70) : Each of these questions contains an Assertion followed by Reason. Read them carefully and answer the question on the basis of following options. You have to select the one that best describes the two statements.

- (a) If both Assertion and Reason are correct and Reason is the correct explanation of Assertion.
 (b) If both Assertion and Reason are correct, but Reason is not the correct explanation of Assertion.
 (c) If Assertion is correct but Reason is incorrect.
 (d) If both the Assertion and Reason are incorrect.

62. **Assertion :** The image of a virtual object due to a plane mirror is real.

Reason : If the rays seem to be converging at a point behind a plane mirror, they are reflected and they actually meet in front of the mirror. [2009]

63. **Assertion :** The formula connecting u , v and f for a spherical mirror is valid only for mirrors whose sizes are very small compared to their radii of curvature.

Reason : Laws of reflection are strictly valid for plane surfaces, but not for large spherical surface. [2009]

64. **Assertion :** Position of image approaches focus of a lens, only when object approaches infinity.

Reason : Paraxial rays incident parallel to principal axis intersect at the focus after refraction from lens. [2010]

65. **Assertion :** There exists two angles of incidence for the same magnitude of deviation (except minimum deviation) by a prism kept in air.

Reason : In a prism kept in air, a ray is incident on first surface and emerges out of second surface. Now if another ray is incident on second surface (of prism) along the previous emergent

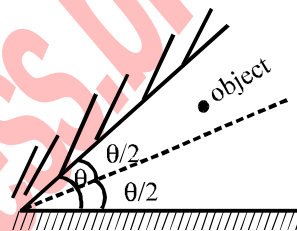
ray, then this ray emerges out of first surface along the previous incident ray. This principle is called principle of reversibility of light. [2011]

66. **Assertion :** A point object is placed at a distance of 26 cm from a convex mirror of focal length 26 cm. The image will not form at infinity.

Reason : For above given system the equation

$$\frac{1}{u} + \frac{1}{v} = \frac{1}{f} \text{ gives } v = \infty. \quad [2012]$$

67. **Assertion :** If the angle between the two plane mirror is 72° and the object is asymmetrically placed between the two mirrors, then 5 images of the object will be formed. [2012]



Reason : For given system of mirror the total number of images formed due to successive reflection is equal to either $\frac{360^\circ}{\theta}$ or $\frac{360^\circ}{\theta} - 1$

accordingly as $\frac{360^\circ}{\theta}$ is odd or even respectively.

68. **Assertion:** Two convex lenses joined together cannot produce an achromatic combination.

Reason : The condition for achromatism is $\frac{\omega_1}{f_1} + \frac{\omega_2}{f_2} = 0$ where symbols have their usual meaning. [2013]

69. **Assertion:** Critical angle is minimum for violet colour.

Reason : Because critical angle $\theta_c = \sin^{-1}\left(\frac{1}{\mu}\right)$ and $\mu \propto \frac{1}{\lambda}$. [2014]

70. **Assertion :** Plane mirror may form real image.

Reason : Plane mirror forms virtual image, if object is real. [2017]

HINTS & SOLUTIONS

Type A : Multiple Choice Questions

1. (a) No. of images = $\frac{360}{\theta} - 1 = \frac{360}{45} - 1 = 7$
2. (c) In case of telescope, in normal adjustment,
 $m = \frac{f_o}{f_e} = 10$
 and $f_o + f_e = \text{length of tube} = 44$
 $f_o = 10f_e$ $10f_e + f_e = 44 \Rightarrow f_e = 4$
 $f_o = 10 \times 4 = 40 \text{ cm}$

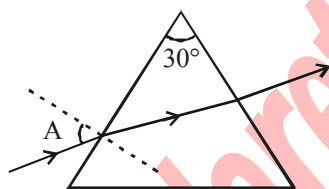
3. (a) $\mu = \frac{\text{velocity of light in air}}{\text{velocity of light in diamond}}$

$$2 = \frac{3 \times 10^{10} \text{ cm/sec}}{v}$$

$$\Rightarrow v = \frac{3}{2} \times 10^{10} \text{ cm/sec}$$

$$= 1.5 \times 10^{10} \text{ cm/sec}$$

4. (b)



5. (c)

In this case

$$r + r' = A \Rightarrow r + 0 = 30^\circ \Rightarrow r = 30^\circ$$

$$\mu = \frac{1}{\sin C} \Rightarrow \mu = \frac{1}{\sin 45^\circ} \Rightarrow \mu = \sqrt{2}$$

$$\text{Now, } \frac{\sin A}{\sin r} = \mu \Rightarrow \frac{\sin A}{\sin 30^\circ} = \sqrt{2}$$

$$\sin A = \sin 30^\circ \cdot \sqrt{2} = \frac{1}{2} \times \sqrt{2} = \frac{1}{\sqrt{2}} \Rightarrow A = 45^\circ$$

6. (b) Chromatic aberration takes place when white light is used as source. We get a series of images overlapping each other and made by a lens. By using combination of lenses of opposite nature (convex & concave) we can reduce this aberration.

7. (a) When electromagnetic wave enters into any other medium, its electric component induces dipole in the molecule of the medium. These dipoles have oscillating dipole moment and its time period is the same as inducing electric field of incoming wave. These dipole in turn radiates electromagnetic wave having same time period. So, in this phenomenon, time period or frequency of the wave remains unaltered.

8. (c) Mirage is a phenomenon in which we see an inverted image of plants and trees on the surface and it gives the impression that there is water around the trees. It occurs due to total internal reflection of light.

9. (b) In astronomical telescope the focal length of objective is larger in comparison.

10. (a) Light appears to travel in a straight line because diffraction (or deviation from the path) is least in light. Diffraction is least because of small wavelength of light. So small wave length of light causes the light to travel almost in straight line.

11. (a) Sky appears blue due to scattering of light.

12. (c) For combination of lenses, power

$$P = P_1 + P_2 = \frac{100}{40} - \frac{100}{25} = -1.5 \text{ D}$$

13. (b) In myopia, we use concave lens. In hypermetropia we use convex lens. In presbyopia we use bifocal lens and in astigmatism we use cylindrical lens.

14. (b) When an electromagnetic wave enters a medium (new), it undergoes change in velocity. $v = n\lambda$
 This change in velocity is due to change in wave-length. The frequency remains constant.

15. (b) $A = 60^\circ$

$$\mu = \frac{\sin\left(\frac{A + \delta_m}{2}\right)}{\frac{\sin A}{2}} \Rightarrow \sqrt{3} = \frac{\sin\left(\frac{60^\circ + \delta_m}{2}\right)}{\sin 30^\circ}$$

$$\sin\left(\frac{60^\circ + \delta_m}{2}\right) = \sqrt{3} \times \frac{1}{2} = \frac{\sqrt{3}}{2} = \sin 60^\circ$$

$$60^\circ + \delta_m = 120^\circ \Rightarrow \delta_m = 120^\circ - 60^\circ = 60^\circ$$

16. (a) Since, image is virtual v is +ve
 $f = -15$ cm, $u = ?$,

$$m = 2 = \frac{v}{u} \quad v = 2u$$

Applying mirror formula

$$\frac{1}{v} + \frac{1}{u} = \frac{1}{f}$$

$$\frac{1}{2u} - \frac{1}{u} = -\frac{1}{15} \Rightarrow \frac{1-2}{2u} = -\frac{1}{15}$$

$$-\frac{1}{2u} = -\frac{1}{15} \Rightarrow u = 7.5 \text{ cm}$$

or

We know that virtual and erect image is formed when we place an object within focal length of the mirror. As focal length given = 15 cm. So, object distance must be less than 15 cm out of four given option only one option is correct.

17. (d) In case of astronomical telescope, magni-

$$\text{fication} = \frac{f_o}{f_e}$$

For maximum magnification, f_e should be least. So, f_e should be 15 cm.

18. (d) The Cauchy's formula is based on the relation between wavelength of light and the refractive index. It is as follows

$$\mu = A + \frac{B}{\lambda^2} + \frac{C}{\lambda^4}$$

19. (c) $\frac{1}{v} + \frac{1}{u} = \frac{1}{f}$ is the formula which relates u & v .

$$\frac{1}{u} = \frac{1}{f} - \frac{1}{v}$$

Slope of this curve can be found by

$$\text{differentiation } -\frac{1}{u^2} du = 0 + \frac{dv}{v^2}$$

$$\Rightarrow \frac{dv}{du} = -\frac{v^2}{u^2}$$

$\frac{dv}{du}$ is the slope which is negative so either curve (c) or curve (a) is right. Now the slope depends upon the value of u & v i.e. it keeps changing at every point as per the equation above. So figure (c) is the answer.

20. (d) If the refractive index of the body becomes equal to surrounding liquid, there will not be any deviation in the direction of light neither will any light get reflected from its surface. So, the object becomes invisible.

21. (a) The higher the wavelength the lesser the scattering. Yellow light has higher wavelength so it is least likely to be scattered among all colours in the visible region (except red & orange). So this light is visible from long distance even when there is foggy weather.

22. (c) In endoscopy a fine thread of hollow glass tube is send into the body cavity. Light from the interior enters the tube & through internal reflector comes out at desired angle. These rays are picked up by microscopy to take a view of internal parts.

23. (a) $u = -2000$ m, $v = ?$, $f = 200$ cm = 2 m

$$\frac{1}{v} - \frac{1}{u} = \frac{1}{f} \Rightarrow \frac{1}{v} + \frac{1}{2000} = \frac{1}{2}$$

$$\frac{1}{v} = \frac{1}{2} - \frac{1}{2000} = \frac{1000-1}{2000} = \frac{999}{2000}$$

$$v = \frac{2000}{999}; \frac{v}{u} = m = \frac{2000}{999 \times 2000} = \frac{1}{999}$$

$$\text{Size of image} = \frac{1}{999} \times 50 \times 100 \text{ cm} \approx 5 \text{ cm}$$

24. (c) Since the speed of light changes in the second medium, its direction also changes.

25. (a) Using $\frac{1}{v} - \frac{1}{u} = \frac{1}{f}$

$$\frac{1}{v} + \frac{1}{8} = \frac{1}{10}$$

$$\frac{1}{v} = \frac{1}{10} - \frac{1}{8} = \frac{4-5}{40} = -\frac{1}{40}$$

$$v = -40 \text{ cm}$$

$$m = \frac{v}{u} = \frac{40}{8} = 5.$$

26. (b) $\frac{1}{f} = (\mu - 1) \left(\frac{1}{r_1} - \frac{1}{r_2} \right)$

$$\frac{1}{f_a} = (1.5 - 1) \left(\frac{1}{r_1} - \frac{1}{r_2} \right)$$

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$$\frac{1}{f_\ell} = (\mu_g - 1) \left(\frac{1}{r_1} - \frac{1}{r_2} \right)$$

$${}^\ell \mu_g = \frac{\mu_g}{\mu_\ell} = \frac{1.5}{1.25} = \frac{6}{5}$$

$$\frac{1}{f_\ell} = \left(\frac{6}{5} - 1 \right) \left(\frac{1}{r_1} - \frac{1}{r_2} \right) = \frac{1}{5} \left(\frac{1}{r_1} - \frac{1}{r_2} \right)$$

$$\frac{1/f_a}{1/f_\ell} = \frac{0.5}{1/5}$$

$$\Rightarrow \frac{f_\ell}{f_a} = 0.5 \times 5 = 2.5$$

$$f_\ell = 2.5 \times f_a$$

27. (b) $0.6328 \mu\text{m} = 6328 \text{\AA}$

This is wave length of Red colour. So this light will be absorbed by green pigments. The leaf will appear black.

28. (b) In normal adjustment, object lies close to focus of objective and image is formed at

$$\text{infinity, magnification, } m = \frac{Ld}{f_e f_0}$$

Where $f_0 = 1.6 \text{ cm}$, $f_e = 2.5 \text{ cm}$, $d = 21.7 \text{ cm}$,
 $L = d - f_0 = 21.7 - 1.6 = 20.1 \text{ cm}$ (approx.)

$$\Rightarrow m = \frac{21.7 \times 20.1}{1.6 \times 2.5} = \frac{436.17}{4} = 109.1 \approx 110$$

29. (d) aperture = f , exposure time $\frac{1}{60}$ sec.

$$\text{area of aperture} = f^2, \text{ area} \propto \frac{1}{\text{exposure time}}$$

$$\text{New aperture} = 1.4f \quad \text{area} = 1.96 f^2$$

Ratio of areas = 1.96. Since area of aperture has increased thus exposure time will decrease in same proportion, i.e.,

$$\text{new time} = \frac{1}{(60/1.96)} = \frac{1}{31} \text{ sec.}$$

30. (b) $\frac{1}{f_a} = \left(\frac{1.5}{1} - 1 \right) \left(\frac{1}{R_1} - \frac{1}{R_2} \right) \quad \dots(i)$

$$\frac{1}{f_m} = \left(\frac{\mu_g}{\mu_m} - 1 \right) \left(\frac{1}{R_1} - \frac{1}{R_2} \right)$$

$$\frac{1}{f_m} = \left(\frac{1.5}{1.6} - 1 \right) \left(\frac{1}{R_1} - \frac{1}{R_2} \right) \quad \dots(ii)$$

$$\text{Dividing (i) by (ii), } \frac{f_m}{f_a} = \left(\frac{1.5-1}{\frac{1.5}{1.6}-1} \right) = -8$$

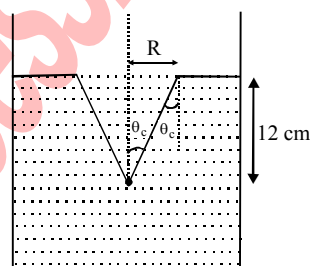
$$P_a = -5 = \frac{\mu}{f_a} = \frac{1}{f_a} \Rightarrow f_a = -\frac{1}{5}$$

$$\Rightarrow f_m = -8 \times f_a = -8 \times -\frac{1}{5} = \frac{8}{5}$$

$$P_m = \frac{\mu}{f_m} = \frac{1.6}{\frac{8}{5}} \times 5 = 1D$$

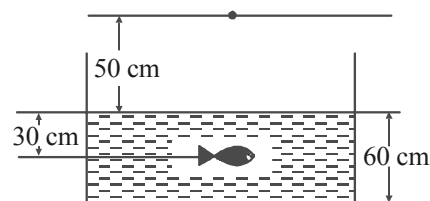
31. (a) $\sin \theta_c = \frac{1}{\mu} = \frac{3}{4}$

$$\text{or } \tan \theta_c = \frac{3}{\sqrt{16-9}} = \frac{3}{\sqrt{7}} = \frac{R}{12}$$



$$\Rightarrow R = \frac{36}{\sqrt{7}} \text{ cm}$$

32. (b) Apparent distance of the bulb from the fish
 $d_1 = 50\mu + 30$



apparent distance of the image

$$d_2 = 50\mu + 60 + 30$$

$$\therefore d_1 + d_2 = 100\mu + 120$$

$$= \frac{400}{3} + 120 = \frac{760}{3} \text{ cm}$$

$$= 253.3 \text{ cm}$$

33. (c) Magnifying power $M = \frac{f_0}{f_e} \left(1 + \frac{f_e}{d} \right)$

Least distance of distinct vision, $d = 25 \text{ cm}$

$$M = -\frac{200}{5} \left(1 + \frac{5}{25} \right) = -40 \left(1 + \frac{1}{5} \right)$$

$$= -40 \left(\frac{6}{5} \right) = -48 \text{ cm.}$$

34. (a) For dispersion without deviation, the necessary condition is

$$\frac{A_2}{A_1} = -\frac{\mu_1 - 1}{\mu_2 - 1} = -\frac{(1.54 - 1)}{(1.72 - 1)} = -\frac{0.54}{0.72}$$

$$\text{or, } A_2 = \frac{0.54}{0.72} \times 6^\circ = 4.5^\circ \approx 4^\circ 30'$$

35. (c) Since $\lambda_R > \lambda_V$ $\mu_R < \mu_V$

$$\left(\because \mu \propto \frac{1}{\lambda} \right) \Rightarrow f_V < f_R \left(\because \frac{1}{f} \propto (\mu - 1) \right)$$

36. (b)

37. (d)

38. (b) For minimum deviation, incident angle is equal to emerging angle.

$\therefore$ QR is horizontal.

39. (b) The incident angle is 45° incident angle $>$ critical angle, $i > i_c$

$$\therefore \sin i > \sin i_c \text{ or } \sin 45^\circ > \sin i_c$$

$$\sin i_c = \frac{1}{n}$$

$$\therefore \sin 45^\circ > \frac{1}{n} \text{ or } \frac{1}{\sqrt{2}} > \frac{1}{n} \Rightarrow n > \sqrt{2}$$

40. (c) The minimum length of the mirror is half the length of the man. This can be proved from the fact that $\angle i = \angle r$.

$$41. (a) \frac{f_1}{f_2} = -\frac{\omega_1}{\omega_2} = -\frac{1}{2} \therefore f_2 = -2f_1$$

$$\text{As } \frac{1}{F} = \frac{1}{f_1} + \frac{1}{f_2}$$

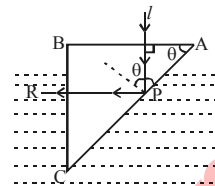
$$\therefore \frac{1}{20} = \frac{1}{f_1} - \frac{1}{2f_1} = \frac{1}{2f_1} \therefore f_1 = 10 \text{ cm}$$

$$f_2 = -20 \text{ cm}$$

42. (a) The phenomenon of total internal reflection takes place during reflection at P.

$$\sin \theta = \frac{1}{\frac{\omega}{g} \mu} \quad \dots (i)$$

When θ is the angle of incidence at P



$$\text{Now, } \frac{\omega}{g} \mu = \frac{a}{g} \frac{h}{\mu} = \frac{1.5}{4/3} = 1.125$$

$$\text{Putting in (i), } \sin \theta = \frac{1}{1.125} = \frac{8}{9}$$

$\therefore \sin \theta$ should be greater than or equal to $\frac{8}{9}$

43. (a) For normally emerge $e = 0$

Therefore $r_2 = 0$ and $r_1 = A$

Snell's Law for Incident ray's

$$1 \sin i = \mu \sin r_1 = \mu \sin A$$

For small angle

$$i = \mu A$$

44. (b) For critical angle θ_c ,

$$\sin \theta_c = \frac{1}{\mu}$$

For greater wavelength or lesser frequency μ is less. So, critical angle would be more. So, they will not suffer reflection and come out at angles less than 90° .

Type B : Assertion Reason Questions

45. (a) A green flower absorbs all the light except green coloured light. So when red glass transmits only red light and falls on green flower, it absorbs all the light. Therefore, colour of the green flower becomes dark.

46. (a) Newton's rings are formed in reflected system and if the refractive index of the first medium is more than the second medium, there is no reversal of phase in reflected ray so, central fringe remains bright.

47. (a) Corpuscular theory fails to explain the velocity of light in air and water because it predicted light to have more velocity in denser medium whereas the fact is just the opposite.

So option (a) is correct.

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48. (e) In vacuum all the colours have same velocity but their velocity changes when they enter in a medium. In the medium their velocity changes due to change in their wavelength.

$$v = n\lambda$$

If λ changes, v also changes for a particular colour therefore, different colours have different wavelength (λ).

49. (a) We know that in case of total internal reflection, the minimum refractive index is given by the relation.

$$\mu = \frac{1}{\sin c} = \frac{1}{\sin 45^\circ} = \frac{1}{1/\sqrt{2}} = \sqrt{2}$$

$$\mu = \sqrt{2}$$

50. (a) Using the given relation,

$$\frac{1}{10} = \left(\frac{1.5-1}{1} \right) \left(\frac{1}{R_1} - \frac{1}{R_2} \right)$$

$$\frac{1}{10} = 0.5 \left(\frac{1}{R_1} - \frac{1}{R_2} \right) \quad \dots\dots\dots(i)$$

In the second case, $\mu = \frac{4}{3}$;

$$\frac{1}{f} = \left(\frac{1.5 - \frac{4}{3}}{\frac{4}{3}} \right) \left(\frac{1}{R_1} - \frac{1}{R_2} \right) \quad \dots\dots\dots(ii)$$

Dividing (ii) from (i),

$$\frac{f}{10} = \frac{0.5}{0.5/4} = \frac{4 \times 0.5}{0.5}$$

$$f = 4 \times 10 = 40 \text{ cm}$$

51. (e) ${}^a\mu_d = \sqrt{6}$, ${}^a\mu_\ell = \sqrt{3}$,

$${}^\ell\mu_d = ? ; {}^a\mu_d \times {}^d\mu_\ell \times {}^\ell\mu_a = 1$$

$$\sqrt{6} \times {}^d\mu_\ell \times \frac{1}{\sqrt{3}} = 1$$

$${}^d\mu_\ell = \frac{\sqrt{3}}{\sqrt{6}} = \frac{1}{\sqrt{2}}; {}^\ell\mu_d = \sqrt{2}$$

If C be the critical angle, then

$$\sin C = \frac{1}{\mu} = \frac{1}{\sqrt{2}}$$

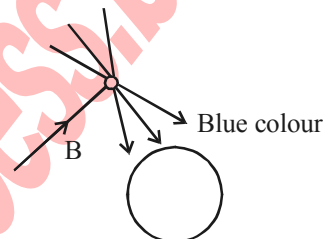
$C = 45^\circ$. As angle of incidence $< 45^\circ$, it will not be internally reflected. So Assertion is incorrect Reason is correct.

52. (c) Setting sun appears to be red because red light which has greatest wavelength is least scattered and reaches our eyes the most. Other wavelength are scattered to the longest extent. So, reason given is wrong.

53. (c) The image formed on retina of eye is

sustained upto $\frac{1}{16}$ th second after removal of stimulus. So, number of frames to be projected on the screen must be at most 16 per second.

54. (a) Blue colour of sky is due to scattering of blue colour to the maximum extent by dust particles. Blue colour appears to be coming from the sky. Blue colour has the least wavelength.



55. (c) Air bubble shines in water due to total internal reflection from the surface of the bubble.

So, Assertion is correct and Reason is incorrect.

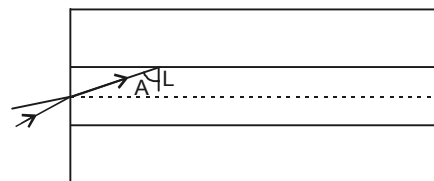
56. (b) Stars twinkle because of changing refractive index of atmosphere. As the apparent size of stars are small, the effect of this change on the direction of rays coming from star is more pronounced.

57. (b) A red object appears dark in the yellow light because red object absorbs all the light falling on it except red. The Reason which is a fact can not be assigned to the Assertion.

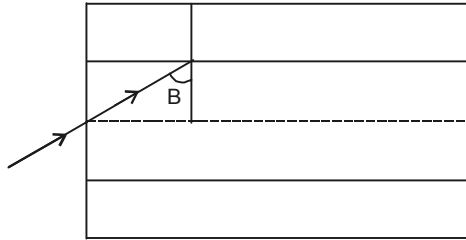
58. (c) The transparency of rough glass is reduced due to scattering of light.

59. (b) Diamond glitters brilliantly because of high refractive index and less critical angle.

60. (a) Assertion and Reason are correct and Reason explains Assertion.



Small diameter core, angle A is larger



Large diameter core, angle B is smaller. In the former case $\angle A$ is large so the possibility of this angle becoming greater than critical angle is more. Hence, the chance of internal reflection is more.

61. (d) If a mirror is placed in a medium other than air, its focal length does not change as $f = R/2$. But for the lens,

$$\frac{1}{f_g} = (n_g - 1) \left(\frac{1}{R_1} - \frac{1}{R_2} \right)$$

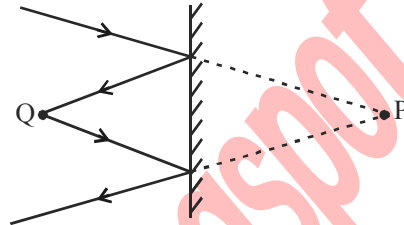
$$\text{and } \frac{1}{f_w} = (n_w - 1) \left(\frac{1}{R_1} - \frac{1}{R_2} \right)$$

As $n_w < n_g$, hence focal length of lens in water increase.

The refractive index of water is $4/3$ and that of air is 1

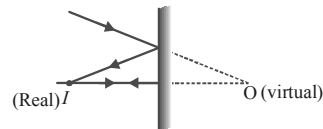
Hence, refractive index of water is greater than that of air.

62. (a)



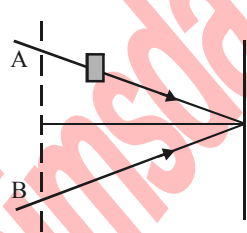
The image of a real object is virtual while that of a virtual object (as shown) is real.

63. (c) Assertion is correct. Laws of reflection can be applied to any type of surface.
 64. (b) Assertion is correct, Reason is correct.
 65. (a) Reason is correct explanation of Assertion.
 66. (c)
 67. (a)
 68. (a)
 69. (b)
 70. (b) Plane mirror may form real image, if object is virtual.

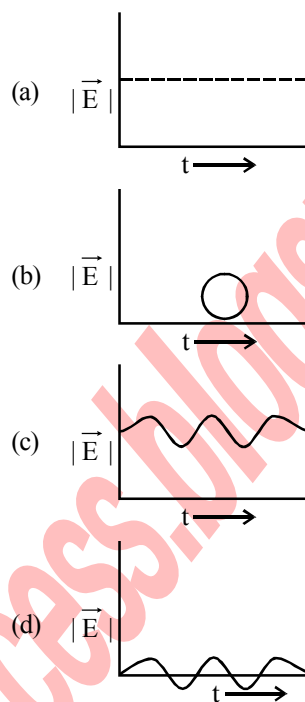


Wave Optics

TYPE A : MULTIPLE CHOICE QUESTIONS

- Two waves of intensities I and $4I$ superimposes. Then the maximum and minimum intensities are:
(a) $9I$ and I (b) $3I$ and I [1997]
(c) $9I$ and $3I$ (d) $6I$ and I
 - On a rainy day, if there is an oil drop on tar road, coloured rings are seen around this drop. This is because of : [1997]
(a) total internal reflection of light
(b) polarisation
(c) diffraction pattern
(d) interference pattern produced due to thin films
 - Interference occurs in which of the following waves? [1999]
(a) Transverse (b) Electromagnetic
(c) Longitudinal (d) All of these
 - In young's experiment the monochromatic light is used to illuminate two slits A and B as shown in figure. Interference fringes are observed on a screen placed in front of the slits. Now a thin glass plate is placed normally in the path of beam coming from the slit A, then : [1999, 2004]
- 
- There will be no change in fringe width
(b) Fringe width will decrease
(c) Fringe width will increase
(d) Fringes will disappear
 - The ratio of intensities of two waves is $9 : 1$. If they superimpose, the ratio of maximum to minimum intensity will be : [2000]
(a) $3 : 1$ (b) $4 : 9$
(c) $4 : 1$ (d) $1 : 9$
 - A light of intensity I_0 passes through a material of thickness d , then the intensity will be
(a) $I = I_0 e^{-d\lambda}$ (b) $I = I_0 e^{d\lambda}$ [2000]
(c) $I = I_0 (1 - e^{-\lambda d})$ (d) none of these
 - Light of wavelength 589.3 nm is incident normally on a slit of width 0.01 mm . The angular width of the central diffraction maximum at a distance of 1 m from the slit, is : [2000]
(a) 0.68° (b) 0.34°
(c) 2.05° (d) none of these
 - In an electron microscope the accelerating voltage is increased from 20 kV to 80 kV , the resolving power of the microscope will become
(a) $2R$ (b) $\frac{R}{2}$ [2000]
(c) $4R$ (d) $3R$
 - How does the red shift confirm that the universe is expanding ? [2001]
(a) wavelength of light emitted by galaxies appears to decrease
(b) wavelength of light emitted by galaxies appears to be the same
(c) wavelength of light emitted by galaxies appears to increase
(d) none of these
 - What change occurs, if the monochromatic light used in Young's double slit experiment is replaced by white light ? [2001]
(a) only the central fringe is white and all other fringes are observed coloured.
(b) no fringes are observed.
(c) all the bright fringes become white.
(d) all the bright fringes are coloured between violet and red.
 - Light of wavelength $6000 \text{ \AA}$ is reflected at nearly normal incidence from a soap films of refractive index 1.4 . The least thickness of the film that will appear black is : [2002]
(a) infinity (b) $200 \text{ \AA}$
(c) $2000 \text{ \AA}$ (d) $1000 \text{ \AA}$

12. A ray of light is incident on the surface of plate of glass of refractive index 1.5 at the polarising angle. The angle of refraction of the ray will be :
 (a) 33.7° (b) 43.7° [2002]
 (c) 23.7° (d) 53.7°
13. When a beam of light is used to determine the position of an object, the maximum accuracy is achieved if the light is : [2003]
 (a) polarised
 (b) of longer wavelength
 (c) of shorter wavelength
 (d) of high intensity
14. A double slit experiment is performed with light of wavelength 500 nm. A thin film of thickness $2\ \mu\text{m}$ and refractive index 1.5 is introduced in the path of the upper beam. The location of the central maximum will : [2003]
 (a) remain unshifted
 (b) shift downward by nearly two fringes
 (c) shift upward by nearly two fringes
 (d) shift downward by ten fringes
15. An astronaut is looking down on earth's surface from a space shuttle at an altitude of 400 km. Assuming that the astronaut's pupil diameter is 5 mm and the wavelength of visible light is 500 nm, the astronaut will be able to resolve linear objects of the size of about : [2003]
 (a) 0.5 m (b) 5 m
 (c) 50 m (d) 500 m
16. When a compact disc is illuminated by a source of white light, coloured lines are observed. This is due to : [2004]
 (a) dispersion (b) diffraction
 (c) interference (d) refraction
17. In case of linearly polarised light, the magnitude of the electric field vector : [2005]
 (a) does not change with time
 (b) varies periodically with time
 (c) increases and decreases linearly with time
 (d) is parallel to the direction of propagation
18. When exposed to sunlight, thin films of oil on water often exhibit brilliant colours due to the phenomenon of : [2005]
 (a) interference (b) diffraction
 (c) dispersion (d) polarisation
19. Which of the following diagrams represents the variation of electric field vector with time for a circularly polarized light? [2006]



20. Two point white dots are 1 mm apart on a black paper. They are viewed by eye of pupil diameter 3 mm. Approximately, what is the maximum distance at which these dots can be resolved by the eye? [Take wavelength of light = 500 nm]
 (a) 1 m (b) 5 m [2008]
 (c) 3 m (d) 6 m
21. What happens to fringe width in Young's double slit experiment if it is performed in glycerine instead of air [2009]
 (a) shrinks (b) disappears
 (c) unchanged (d) enlarged
22. If a polaroid is kept in the path of an unpolarized light, the intensity of the transmitted light to the intensity of the light when the polaroid was not kept in its path is [2009]
 (a) 1 (b) $\frac{1}{2}$
 (c) $\frac{1}{\sqrt{2}}$ (d) $\frac{1}{2\sqrt{2}}$
23. In a single slit diffraction experiment, the width of the slit is made double its original width. Then the central maximum of the diffraction pattern will become [2009]
 (a) narrower and fainter
 (b) narrower and brighter
 (c) broader and fainter
 (d) broader and brighter

24. If the source of light used in a Young's double slit experiment is changed from red to violet:
 (a) the fringes will become brighter [2011]
 (b) consecutive fringes will come closer
 (c) the intensity of minima will increase
 (d) the central fringe will become a dark fringe
25. Wavelength of light used in an optical instrument are $\lambda_1 = 4000 \text{ \AA}$ and $\lambda_2 = 5000 \text{ \AA}$, then ratio of their respective resolving powers (corresponding to λ_1 and λ_2) is [2012]
 (a) 16 : 25 (b) 9 : 1
 (c) 4 : 5 (d) 5 : 4
26. The correct formula for fringe visibility is [2012]
 (a) $V = \frac{I_{\max} - I_{\min}}{I_{\max} + I_{\min}}$
 (b) $V = \frac{I_{\max} + I_{\min}}{I_{\max} - I_{\min}}$
 (c) $V = \frac{I_{\max}}{I_{\min}}$
 (d) $V = \frac{I_{\min}}{I_{\max}}$
27. In Young's expt., the distance between two slits is $\frac{d}{3}$ and the distance between the screen and the slits is 3 D. The number of fringes in $\frac{1}{3} \text{ m}$ on the screen, formed by monochromatic light of wavelength 3λ , will be [2012]
 (a) $\frac{d}{9D\lambda}$ (b) $\frac{d}{27D\lambda}$
 (c) $\frac{d}{81D\lambda}$ (d) $\frac{d}{D\lambda}$
28. To demonstrate the phenomenon of interference, we require two sources which emit radiation of [2013]
 (a) nearly the same frequency
 (b) the same frequency
 (c) different wavelengths
 (d) the same frequency and having a definite phase relationship
29. Two sources of light of wavelengths 2500 Å and 3500 Å are used in Young's double slit expt. simultaneously. Which orders of fringes of two wavelength patterns coincide? [2013]
 (a) 3rd order of 1st source and 5th of the 2nd
 (b) 7th order of 1st and 5th order of 2nd
 (c) 5th order of 1st and 3rd order of 2nd
 (d) 5th order of 1st and 7th order of 2nd
30. In Young's double slit experiment, we get 10 fringes in the field of view of monochromatic light of wavelength 4000 Å. If we use monochromatic light of wavelength 5000 Å, then the number of fringes obtained in the same field of view is [2014]
 (a) 8 (b) 10
 (c) 40 (d) 50
31. The condition for obtaining secondary maxima in the diffraction pattern due to single slit is [2014]
 (a) $a \sin \theta = n\lambda$
 (b) $a \sin \theta = (2n - 1)\frac{\lambda}{2}$
 (c) $a \sin \theta = (2n - 1)\lambda$
 (d) $a \sin \theta = \frac{n\lambda}{2}$
32. The Fraunhofer 'diffraction' pattern of a single slit is formed in the focal plane of a lens of focal length 1 m. The width of slit is 0.3 mm. If third minimum is formed at a distance of 5 mm from central maximum, then wavelength of light will be [2015]
 (a) 5000 Å (b) 2500 Å
 (c) 7500 Å (d) 8500 Å
33. A parallel beam of monochromatic unpolarised light is incident on a transparent dielectric plate of refractive index $\frac{1}{\sqrt{3}}$. The reflected beam is completely polarised. Then the angle of incidence is [2015]
 (a) 30° (b) 60°
 (c) 45° (d) 75°
34. A single slit Fraunhofer diffraction pattern is formed with white light. For what wavelength of light the third secondary maximum in the diffraction pattern coincides with the second secondary maximum in the pattern for red light of wavelength 6500 Å? [2016]
 (a) 4400 Å (b) 4100 Å
 (c) 4642.8 Å (d) 9100 Å

35. A diffraction pattern is obtained by using beam of red. light what will happen, if red light is replaced by the blue light? [2017]
- (a) Bands disappear.
 - (b) Bands become broader and farther apart.
 - (c) No change will take place.
 - (d) Diffraction bands become narrow and crowded together.

TYPE B : ASSERTION REASON QUESTIONS

Directions for (Qs. 36–48) : These questions consist of two statements, each printed as Assertion and Reason. While answering these questions, you are required to choose any one of the following five responses.

- (a) If both Assertion and Reason are correct and the Reason is a correct explanation of the Assertion.
 - (b) If both Assertion and Reason are correct but Reason is not a correct explanation of the Assertion.
 - (c) If the Assertion is correct but Reason is incorrect.
 - (d) If both the Assertion and Reason are incorrect.
 - (e) If the Assertion is incorrect but the Reason is correct.
36. **Assertion :** The colour of the green flower seen through red glass appears to be dark.
Reason : Red glass transmits only red light. [1997]
37. **Assertion :** In Young's experiment, the fringe width for dark fringes is different from that for white fringes.
Reason : In Young's double slit experiment the fringes are performed with a source of white light, then only black and bright fringes are observed. [2001]
38. **Assertion :** Coloured spectrum is seen when we look through a muslin cloth.
Reason : It is due to the diffraction of white light on passing through fine slits [2002]
39. **Assertion :** When tiny circular obstacle is placed in the path of light from some distance, a bright spot is seen at the centre of the shadow of the obstacle.
Reason : Destructive interference occurs at the centre of the shadow. [2002]
40. **Assertion :** Thin films such as a soap bubble or a thin layer of oil on water show beautiful colours when illuminated by white light.
Reason : It happens due to the interference of light reflected from the upper surface of the thin film. [2002]
41. **Assertion :** At the first glance, the top surface of the Morpho butterfly's wing appears a beautiful blue-green. If the wind moves the colour changes.
Reason : Different pigments in the wing reflect light at different angles. [2004]
42. **Assertion :** A famous painting was painted by not using brush strokes in the usual manner, but rather a myriad of small colour dots. In this painting the colour you see at any given place on the painting changes as you move away.
Reason : The angular separation of adjacent dots changes with the distance from the painting. [2004]
43. **Assertion :** The clouds in sky generally appear to be whitish.
Reason : Diffraction due to clouds is efficient in equal measure at all wavelengths. [2005]
44. **Assertion :** The resolving power of a telescope is more if the diameter of the objective lens is more.
Reason : Objective lens of large diameter collects more light. [2005]
45. **Assertion :** Standard optical diffraction gratings can not be used for discriminating between X-ray wavelengths.
Reason : The grating spacing is not of the order of X-ray wavelengths. [2006]
46. **Assertion :** Goggles have zero power.
Reason : Radius of curvature of both sides of lens is same. [2007]
47. **Assertion :** A white source of light during interference forms only white and black fringes.
Reason : Width of fringe is inversely proportional to the wavelength of the light used. [2007]
48. **Assertion :** In Young's double slit experiment the two slits are at distance d apart. Interference pattern is observed on a screen at distance D from the slits. At a point on the screen when it is directly opposite to one of the slits, a dark fringe is observed. Then, the wavelength of wave is proportional to square of distance of two slits
Reason : For a dark fringe intensity is zero. [2008]

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Topicwise AIIMS Solved Papers – PHYSICS

Directions for (Qs. 49-51) : Each of these questions contains an Assertion followed by Reason. Read them carefully and answer the question on the basis of following options. You have to select the one that best describes the two statements.

- (a) If both Assertion and Reason are correct and Reason is the correct explanation of Assertion.
 (b) If both Assertion and Reason are correct, but Reason is not the correct explanation of Assertion.
 (c) If Assertion is correct but Reason is incorrect.
 (d) If both the Assertion and Reason are incorrect.
49. **Assertion :** No interference pattern is detected when two coherent sources are infinitely close to each other.

Reason : The fringe width is inversely proportional to the distance between the two slits. [2009]

50. **Assertion :** In Young's double slit experiment if wavelength of incident monochromatic light is just doubled, number of bright fringe on the screen will increase.

Reason : Maximum number of bright fringe on the screen is directly proportional to the wavelength of light used. [2015]

51. **Assertion :** Diffraction takes place for all types of waves mechanical or non-mechanical, transverse or longitudinal.

Reason : Diffraction's effect are perceptible only if wavelength of wave is comparable to dimensions of diffracting device. [2017]

HINTS & SOLUTIONS

Type A : Multiple Choice Questions

1. (a) Ratio of amplitudes = $\sqrt{\frac{4}{1}} = \frac{2}{1}$

$$\frac{\text{maximum amplitude}}{\text{minimum amplitude}} = \frac{2+1}{2-1} = \frac{3}{1}$$

$$\frac{\text{maximum intensity}}{\text{minimum intensity}} = \left(\frac{3}{1}\right)^2 = \frac{9}{1}$$

2. (d) When a thin layer of oil floats on the water level, interference takes place between ray of light reflected from upper interface and from lower interface. Due to interference coloured fringes are formed in oil film.
3. (d) Since, interference occurs both in sound and light waves so it will occur in all the forms of waves given.

4. (a) When we put a glass plate in the path of one of the beams interfering with each other then there is change of place of fringes on the screen. All the fringes including central fringe are shifted. It does not result in change of fringe width.

5. (c) $\frac{I_1}{I_2} = \frac{9}{1} \Rightarrow \frac{A_1}{A_2} = \sqrt{\frac{9}{1}} = \frac{3}{1}$

[Here A_1 & A_2 are amplitudes]

Maximum amplitude = $A_1 + A_2$

Minimum amplitude = $A_1 - A_2$

$$\frac{A_1 + A_2}{A_1 - A_2} = \frac{4}{2} = \frac{2}{1}$$

$$\frac{\text{maximum intensity}}{\text{minimum intensity}} = \frac{4}{1}$$

[Intensity $\propto$ (amplitude)²]

6. (a) When a light passes through a material its intensity goes on decreasing. First equation given represents exponentially decreasing intensity. Option (b) and (c) represents increasing intensity.

7. (a) In case of diffraction,

$$\text{Angular width of central fringe} = \frac{2\lambda}{a}$$

$$= \frac{2 \times 589.3 \times 10^{-9}}{1 \times 10^{-5}} = 2 \times 589.3 \times 10^{-4}$$

$$= 1178.6 \times 10^{-5} \text{ rad.}$$

$$= 1178.6 \times 10^{-5} \times \frac{180}{11} = 67563 \times 10^{-5}$$

$$= 0.68^\circ$$

8. (a) We know that wavelength and accelerating voltage for an electron is related to each other as follows

$$\lambda \propto \frac{1}{\sqrt{V}} \text{ [V is potential applied]}$$

$$\text{and resolving power} \propto \frac{1}{\lambda}$$

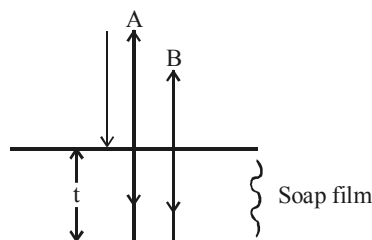
So, resolving power $\propto \sqrt{V}$

Now, if potential used is increased 4 times, resolving power will be increased 2 times.

So, if resolving power earlier is R. It becomes 2R.

9. (c) Red shift means shifting of colours in the spectrum of a moving star towards the red end of the spectrum. It happens when the radiation emitting source goes away from the earth. It is due to Doppler's effect as we observe in case of sound. The apparent frequency decreases or wavelength increases for a receding source.
10. (a) When we use white light in place of monochromatic light then only central fringe looks white and other fringes of different colour are observed. It is because central fringe for all the colours are formed at central point so it becomes white after mixing up. As fringes of others colours fall at different places we see fringes of all colours on the central bright fringe.

11. (c)



Interference occurs between two reflected rays A and B. A is reflected from upper surface and B is reflected from lower surface.

The path difference between the two becomes $2\mu t + \frac{\lambda}{2}$

If it is equal to $\frac{3\lambda}{2}$ then destructive interference occurs and we see dark fringes from above. So, the equation

$2\mu t + \frac{\lambda}{2} = \frac{3\lambda}{2}$ gives the least value of t for which we see dark fringes.

$$2\mu t = \lambda \Rightarrow t = \frac{\lambda}{2\mu} = \frac{6000}{2 \times 1.4} \cong 2000 \text{ \AA}$$

12. (a) If i_p be the polarising angle, then $\tan i_p = \mu = 1.5$
 $i_p = 56.3^\circ$
 Angle of refraction, $r = 90^\circ - i_p$
 $= 90^\circ - 56.3^\circ = 33.7^\circ$

13. (c) The resolving power of an instrument depends upon the wave length of light used. The lower the wavelength of light

higher is the accuracy in vision.

$$\left(\text{Resolving power} \propto \frac{1}{\lambda} \right)$$

14. (c) When we introduce a thin film of some thickness in the path of upper beam actually we are increasing the optical path of the upper beam. Now for the same path difference lower beam will shift upwards so that it is elongated so that path difference remains unchanged.
15. (c) The resolving power of an instrument is given by the formula, $1.22 = \frac{\lambda D}{d}$
- Here, d is aperture of the instrument, D is distance of satellite from the earth. Here eye is the optical instrument.

$$\begin{aligned} \text{R.P.} &= \frac{1.22 \times 500 \times 10^{-9}}{5 \times 10^{-3}} \times 400 \times 1000 \\ &= 1.22 \times \frac{10^{-2}}{10^{-3}} \times 4 = 1.22 \times 40 = 50 \text{ m} \end{aligned}$$

16. (b) A compact disc contains many fine circular lines on it so it acts as diffraction grating. When white light falls upon it, it is diffracted as a result of which different colours are diffracted at different angles. We see different colours when we look at it through different angles.
17. (b) In any type of light whether polarised or unpolarised, the magnitude of electric field vector always varies periodically with time. Actually the change in electric field vector gives rise to periodically changing magnetic field.
18. (a) We see spectrum of colours when thin films of oil on water is exposed to sunlight due to phenomenon of interference.
19. (a) In circularly polarised light the magnitude of electric vector remains constant with respect to time.
20. (b) $\frac{y}{D} \geq 1.22 \frac{\lambda}{d}$
 $\Rightarrow D \leq \frac{yd}{(1.22)\lambda} = \frac{10^{-3} \times 3 \times 10^{-3}}{(1.22) \times 5 \times 10^{-7}}$
 $= \frac{30}{6.1} \approx 5 \text{ m}$
 $\therefore D_{\max} = 5 \text{ m}$
21. (a) $\beta = \frac{D\lambda}{d}$

if it be performed in glycerine then

$$\lambda' = \lambda / \mu$$

$$\beta' = \frac{D\lambda}{\mu d} \quad \text{Since } \mu > 1$$

So, $\beta' < \beta$ (shrinks)

22. (b) The component of the Electric vector of all the electric vectors of unpolarised light in

$$\text{one direction only} = \frac{E_0}{\sqrt{2}}$$

$$\text{and } I \propto E^2 \Rightarrow I = \frac{I_0}{2}$$

23. (b) $\sin \theta = \frac{\lambda}{d} \quad \therefore \theta \propto \frac{1}{d}$

24. (b) The distance of n^{th} fringe is given by

$$y_n = \frac{nD\lambda}{d}$$

As $\lambda_{\text{violet}} < \lambda_{\text{red}}$,
 $\therefore$ fringes will come closer.

25. (d) Resolving power $\propto (1/\lambda)$.

$$\text{Hence, } \frac{(R.P)_1}{(R.P)_2} = \frac{\lambda_2}{\lambda_1} = \frac{5}{4}$$

26. (a) Fringe visibility (V) is given by

$$V = \frac{I_{\max} - I_{\min}}{I_{\max} + I_{\min}}$$

27. (c) $\beta = \frac{\lambda' D'}{d'} = \frac{3\lambda \cdot 3D}{d/3} = 27 \frac{\lambda D}{d}$

$$\text{No. of fringes} = \frac{1/3}{\beta} = \frac{d}{81\lambda D}$$

28. (d)

29. (b) Let n^{th} fringe of $2500 \text{ \AA}$ coincide with $(n-2)^{\text{th}}$ fringe of $3500 \text{ \AA}$.

$$\therefore 3500(n-2) = 2500 \times n$$

$$1000n = 7000, n = 7$$

$\therefore$ 7th order fringe of 1st source will coincide with 5th order fringe of 2nd source.

30. (a) As $\beta \propto \lambda$

$\therefore$ fringe width becomes $\frac{5}{4}$ times,

$$\text{No. of fringes} = \frac{4}{5} \times 10 = 8$$

31. (b)

32. (a) $a \sin \theta = n\lambda$

$$\frac{a x}{f} = 3\lambda$$

(since θ is very small so
 $\sin \theta \approx \tan \theta \approx \theta = x/f$)

$$\text{or } \lambda = \frac{a x}{3f} = \frac{0.3 \times 10^{-3} \times 5 \times 10^{-3}}{3 \times 1}$$

$$= 5 \times 10^{-7} \text{ m} = 5000 \text{ \AA}$$

33. (a) When angle of incidence i is equal to angle of polarisation i.e., then reflected light is completely plane-polarised whose vibration is perpendicular to plane of incidence.

$$34. (c) x = \frac{(2n+1)\lambda D}{2a}$$

$$\text{For red light, } x = \frac{(4+1)D}{2a} \times 6500 \text{ \AA}$$

$$\text{For other light, } x = \frac{(6+1)D}{2a} \times \lambda \text{ \AA}$$

x is same for each.

$$\therefore 5 \times 6500 = 7 \times \lambda$$

$$\Rightarrow \lambda = \frac{5}{7} \times 6500 = 4642.8 \text{ \AA}$$

35. (d) When red light is replaced by blue light the diffraction bands become narrow and crowded.

Type B : Assertion Reason Questions

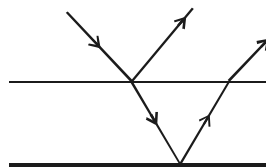
36. (b)

37. (d) In Young's experiments, fringe width of dark and white fringes are equal. If white light is used as source, coloured fringes are observed representing bright band of different colours.

38. (a) Porous muslin cloth has holes comparable to the wavelength of light falling on it. So, it get diffracted there forming fringes of different colours. We see it as colour spectrum.

39. (c) A bright spot is found at the centre of circular fringe patterns formed due to diffraction of light at the edge of circular obstacles. This bright spot is due to constructive interference there by secondary wavelets.

40. (c) Interference in between two rays, one is reflected from the upper surface & second from the lower surface.



41. (c) The Assertion is correct. When wind moves the colour of the wing changes. The visible colour of the wing is different from its original colour due to interference of light. Interference occurs between incident ray and reflected ray. Due to wind the reflectivity of the upper surface of the wing changes (as it is covered by tiny hairs) which changes the reflected wave. The resultant colour due to interference also changes. This is the principle behind the change of colour of wings of Morpho Butterfly.

So, (c) is the answer.

42. (a) We see two closely situated very small dots separate when their angular separation for the viewer is more than that required by Rayleigh's criterion.

$$\theta_R = 1.22 \frac{\lambda}{d}$$

Here, d is diameter of eye and λ is wavelength of light seen.

If distance between spot is D and L be the distance of observer from the painting then,

$$\theta = \frac{D}{L} ; \text{ So, } 1.22 \frac{\lambda}{d} = \frac{D}{L}$$

$$L = \frac{Dd}{1.22\lambda}$$

If for red light having greater λ , the value of L will be smaller and for violet colour, this distance is larger. If we move away from the painting, adjacent red dots become indistinguishable before adjacent blue dots do. So, to make two dots distinguishable we shall have to give distance of the observer (L) a minimum value. At a greater distance colours of adjacent dots blend together. In this way we can have different view of dots by looking at it from different distance (or changing L).

So, both assertion and reason are correct.

43. (c) The clouds in the sky appear white as the size of cloud particle is not small enough to permit diffraction. So all the wavelength gets reflected and it appears white.
44. (a) The resolving power of a telescope increases as diameter of objective lens increases.

$$\text{Resolving Power} = \frac{D}{1.22\lambda}$$

where D is diameter of objective and λ is wavelength of light used.

The Reason of this question is incorrect.

45. (a) For diffraction purpose, target should have size of the order of wavelength of light used. So, X-ray cannot be used in standard diffraction grating as target which is spacing between the lines in different grating is large as compared with very short wavelength of X-rays.

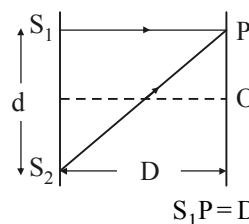
46. (b) Goggles protect from harmful UV light of sun rays and do not correct sight defects $\therefore$ have zero power.

Both lens of goggles are identical hence have same curvature. The Reason does not explain Assertion.

47. (d) A white source of light during interference will form coloured fringes.

Fringe width is given by $\beta = \frac{\lambda D}{d}$ i.e., it is directly proportional to wavelength.

48. (b) When dark fringe is obtained at the point opposite to one of the slits then



$$\begin{aligned} \text{and } S_2P &= \sqrt{D^2 + d^2} = D \left(1 + \frac{d^2}{D^2} \right)^{1/2} \\ &= D \left(1 + \frac{d^2}{2D^2} \right) \quad (\text{By binomial theorem}) \end{aligned}$$

$$\text{Path difference} = S_2P - S_1P$$

$$= D \left(1 + \frac{d^2}{2D^2} \right) - D = \frac{d^2}{2D} = \frac{\lambda}{2}$$

$$\text{or } \lambda = \frac{d^2}{D} \Rightarrow \lambda \propto d^2$$

Now, intensity of a dark fringe is zero.

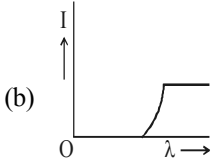
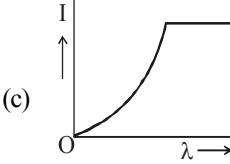
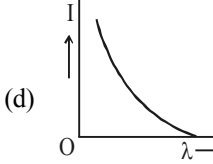
49. (a) When d is negligibly small, fringe width β which is proportional to $1/d$ may become too large. Even a single fringe may occupy the whole screen. Hence the pattern cannot be detected.

50. (d) 51. (b)

Dual Nature of Radiation and Matter

TYPE A : MULTIPLE CHOICE QUESTIONS

- X-ray will not show the phenomenon of: [1997]
 - interference
 - deflection by electric field
 - diffraction
 - superposition
- Which one of the following is not dependent on the intensity of incident photon in a photo-electric experiment? [1998]
 - work function of the surface
 - kinetic energy of photo-electron
 - stopping potential
 - amount of photo-electric current
- The kinetic energy of an electron, which is accelerated in the potential difference of 100 V, is: [1998]
 - $1.6 \times 10^{-10} \text{ J}$
 - $1.6 \times 10^8 \text{ J}$
 - $1.6 \times 10^{-17} \text{ J}$
 - $1.6 \times 10^{-18} \text{ J}$
- When cathode rays strike a metal target of high melting point with a very high velocity then which of the following are produced? [1999]
 - γ -waves
 - Ultrasonic
 - X-rays
 - α -rays
- Particle nature and wave nature of electromagnetic waves and electrons can be represented by: [2000]
 - photoelectricity and electron microscopy
 - light is refracted and diffracted
 - X-rays is diffracted, reflected by thick metal sheet
 - electrons have small mass, deflected by the metal sheet.
- The surface of zone material is radiated in turn by waves of $\lambda = 350 \text{ nm}$ and 540 nm respectively. The ratio of the stopping potential in the two cases is 2 : 1. The work function of the material is
 - 4.20 eV
 - 0.15 eV
 - 2.10 eV
 - 1.05 eV [2000]
- Light of wavelength $4000 \text{ \AA}$ is incident on a metal plate whose work function is 2 eV. What is maximum kinetic energy of emitted photoelectron? [2002]
 - 0.5 eV
 - 1.1 eV
 - 2.0 eV
 - 1.5 eV
- A laser beam is used for carrying out surgery because it [2003]
 - is highly monochromatic
 - is highly coherent
 - is highly directional
 - can be sharply focussed
- A proton is about 1840 times heavier than an electron. When it is accelerated by a potential difference of 1 kV, its kinetic energy will be [2003]
 - 1840 keV
 - 1/1840 keV
 - 1 keV
 - 920 V
- If an electron and a photon propagate in the form of waves having the same wavelength, it implies that they have the same [2003]
 - energy
 - momentum
 - velocity
 - angular momentum
- Characteristic X-rays are produced due to [2003]
 - transfer of momentum in collision of electrons with target atoms
 - transition of electrons from higher to lower electronic orbits of an atom
 - heating of the target
 - transfer of energy in collision of electrons with atoms in the target.
- A photon of energy 4 eV is incident on a metal surface whose work function is 2 eV. The minimum reverse potential to be applied for stopping the emission of electrons is [2004]
 - 2V
 - 4V
 - 6V
 - 8V

13. Solid targets of different elements are bombarded by highly energetic electron beams. The frequency (f) of the characteristic X-rays emitted from different targets varies with atomic number Z as [2005, 2017]
- (a) $f \propto \sqrt{Z}$ (b) $f \propto Z^2$
(c) $f \propto Z$ (d) $f \propto Z^{3/2}$
14. Hard X-rays for the study of fractures in bones should have a minimum wavelength of 10^{11} m. The accelerating voltage for electrons in X-ray machine should be [2006]
- (a) < 124.2 kV
(b) > 124.2 kV
(c) Between 60 kV and 70 kV
(d) $= 100$ kV
15. In photoelectric effect, the electrons are ejected from metals if the incident light has a certain minimum [2006]
- (a) Wavelength
(b) Frequency
(c) Amplitude
(d) Angle of incidence
16. In a photoemissive cell with executing wavelength λ , the fastest electron has speed v . If the exciting wavelength is changed to $\frac{3\lambda}{4}$, the speed of the fastest emitted electron will be [2008]
- (a) $v(3/4)^{1/2}$
(b) $v\left(\frac{4}{3}\right)^{1/2}$
(c) less than $v\left(\frac{4}{3}\right)^{1/2}$
(d) greater than $v\left(\frac{4}{3}\right)^{1/2}$
17. The stopping potential doubles when the frequency of the incident light changes from ν to $\frac{3\nu}{2}$. Then the work function of the metal must be [2009]
- (a) $\frac{h\nu}{2}$ (b) $h\nu$
(c) $2h\nu$ (d) none of the above
18. The force on a hemisphere of radius 1 cm if a parallel beam of monochromatic light of wavelength 500 nm. falls on it with an intensity of 0.5 W/cm^2 , striking the curved surface in a direction which is perpendicular to the flat face of the hemisphere is (assume the collisions to be perfectly inelastic) [2009]
- (a) $5.2 \times 10^{-13} \text{ N}$ (b) $5.2 \times 10^{-12} \text{ N}$
(c) $5.22 \times 10^{-9} \text{ N}$ (d) zero
19. The energy of a photon of light with wavelength 5000 Å is approximately 2.5 eV. This way the energy of an X-ray photon with wavelength 1 Å would be [2010]
- (a) $\frac{2.5}{(5000)^2} \text{ eV}$ (b) $2.5 \times 5000 \text{ eV}$
(c) $\frac{2.5}{(5000)^2} \text{ eV}$ (d) $\frac{2.5}{5000} \text{ eV}$
20. A 15.0 eV photon collides with and ionizes a hydrogen atom. If the atom was originally in the ground state (ionization potential = 13.6 eV), what is the kinetic energy of the ejected electron? [2014]
- (a) 1.4 eV (b) 13.6 eV
(c) 15.0 eV (d) 28.6 eV
21. The anode voltage of a photocell is kept fixed. The wavelength λ of the light falling on the cathode is gradually changed. The plate current I of the photocell varies as follows [2017]
- (a)  (b) 
(c)  (d) 

TYPE B : ASSERTION REASON QUESTIONS

Directions for (Qs. 22-28) : These questions consist of two statements, each printed as Assertion and Reason. While answering these questions, you are required to choose any one of the following five responses.

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- (a) If both Assertion and Reason are correct and the Reason is a correct explanation of the Assertion.
 (b) If both Assertion and Reason are correct but Reason is not a correct explanation of the Assertion.
 (c) If the Assertion is correct but Reason is incorrect.
 (d) If both the Assertion and Reason are incorrect.
 (e) If the Assertion is incorrect but the Reason is correct.

22. **Assertion :** Photosensitivity of a metal is high if its work function is small.

Reason : Work function = hf_0 where f_0 is the threshold frequency. [1997]

23. **Assertion:** Kinetic energy of photo electrons emitted by a photosensitive surface depends upon the intensity of incident photon.

Reason: The ejection of electrons from metallic surface is possible with frequency of incident photon below the threshold frequency. [1999]

24. **Assertion :** If the speed of charged particle increases both the mass as well as charge increases.

Reason : If m_0 = rest mass and m be mass at velocity v then

$$m = \frac{m_0}{\sqrt{1 - \frac{v^2}{c^2}}}$$

where c = speed of light. [2000]

25. **Assertion :** Mass of moving photon varies inversely as the wavelength.

Reason : Energy of the particle = mass $\times$ (speed of light)² [2000]

26. **Assertion :** Photoelectric effect demonstrates the wave nature of light.

Reason : The number of photoelectrons is proportional to the frequency of light. [2004]

27. **Assertion :** The energy (E) and momentum (p) of a photon are related by $p = E/c$.

Reason : The photon behaves like a particle. [2005]

28. **Assertion :** The photoelectrons produced by a monochromatic light beam incident on a metal surface, have a spread in their kinetic energies.

Reason : The work function of the metal varies as a function of depth from the surface. [2006]

Directions for (Qs. 29-34) : Each of these questions contains an Assertion followed by Reason. Read them carefully and answer the question on the basis of following options. You have to select the one that best describes the two statements.

- (a) If both Assertion and Reason are correct and Reason is the correct explanation of Assertion.
 (b) If both Assertion and Reason are correct, but Reason is not the correct explanation of Assertion.
 (c) If Assertion is correct but Reason is incorrect.
 (d) If both the Assertion and Reason are incorrect.

29. **Assertion :** Soft and hard X-rays differ in frequency as well as velocity.

Reason : The penetrating power of hard X-rays is more than the penetrating power of soft X-rays. [2010]

30. **Assertion :** In photoemissive cell inert gas is used.

Reason : Inert gas in the photoemissive cell gives greater current. [2010]

31. **Assertion :** When ultraviolet light is incident on a photocell, its stopping potential is V_0 and the maximum kinetic energy of the photoelectrons is K_{max} . When the ultraviolet light is replaced by X-rays, both V_0 and K_{max} increase.

Reason : Photoelectrons are emitted with speeds ranging from zero to a maximum value because of the range of frequencies present in the incident light. [2013]

32. **Assertion :** Photoelectric saturation current increases with the increase in frequency of incident light.

Reason : Energy of incident photons increases with increase in frequency and as a result photoelectric current increases. [2015]

33. **Assertion :** In process of photoelectric emission, all emitted electrons do not have same kinetic energy.

Reason : If radiation falling on photosensitive surface of a metal consists of different wavelength then energy acquired by electrons absorbing photons of different wavelengths shall be different. [2015]

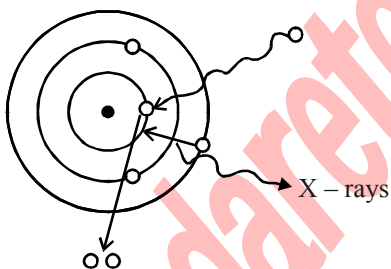
34. **Assertion :** The photoelectrons produced by a monochromatic light beam incident on a metal surface have a spread in their kinetic energies.

Reason : The work function of the metal is its characteristics property. [2017]

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Type A : Multiple Choice Questions

1. (b) X-rays are electromagnetic wave so it will remain undeflected in electric field.
2. (b) The intensity of incident photon determines the no. of electrons being ejected from the surface. The kinetic energy of the photoelectron is determined by the frequency of incident photon.
3. (c) $\lambda = \frac{1.227}{\sqrt{V}}$ and $E = \frac{hc}{\lambda}$
 $h = 6.6 \times 10^{-34} \text{ JS}$, $C = 3 \times 10^8 \text{ m/s}$
 and $V = 100 \text{ volt}$.
4. (c) When electrons strike a metal target of high melting point with high velocity, it knocks out inner electrons of the atoms of the target material. To fill up this vacancy, electrons from higher energy level make transition to lower level resulting in emission of radiation. If target material has very high atomic number then the emitted radiation is X-ray.



5. (a) In photo electricity, photon is acting as particles which knocks out electron from the surface of the metal. In electron microscopy electron behaves as waves so we can take image of objects with the help of ray of electrons.
6. (d) Let the work function be ϕ .
 Einstein's equation in photo-electricity,
 $h\nu = \phi + \frac{1}{2}mv^2$
 $h \frac{c}{\lambda} = \phi + \frac{1}{2}mv^2 = \phi + eV$
 $[eV = \frac{1}{2}mv^2, V \text{ is stopping potential}]$

$$h \left(\frac{c}{350 \times 10^{-9}} \right) = \phi + 2eV \quad \dots\dots(i)$$

$$h \left(\frac{c}{540 \times 10^{-9}} \right) = \phi + eV \quad \dots\dots(ii)$$

$$\frac{540}{350} = \frac{\phi + 2eV}{\phi + eV}$$

$$\Rightarrow 540\phi + 540eV = 350\phi + 700eV$$

$$\Rightarrow 190\phi = 160eV$$

$$\phi = \frac{16}{19} eV$$

$$\frac{6.6 \times 10^{-34} \times 3 \times 10^8}{350 \times 10^{-9}} = \phi + \frac{19 \times 2\phi}{16} = \frac{27}{8}\phi$$

$$\phi = \frac{8}{27} \times \frac{6.6 \times 3 \times 10^{-18}}{35}$$

$$= \frac{8}{27} \times \frac{6.6 \times 3 \times 10^{-18}}{35 \times 1.6 \times 10^{-19}} eV = 1.05 eV$$

7. (b) Applying Einstein's equation,

$$h\nu = \phi + \frac{1}{2}mv^2 = \phi + K.E$$

$$6.6 \times 10^{-34} \times \frac{3 \times 10^8}{4000 \times 10^{-10}}$$

$$= 2 \times 1.6 \times 10^{-19} + K.E$$

$$\frac{6.6 \times 3}{4} \times 10^{-19} = 3.2 \times 10^{-19} + K.E$$

$$4.95 \times 10^{-19} = 3.2 \times 10^{-19} + K.E$$

$$K.E = (4.95 - 3.2) \times 10^{-19}$$

$$= 1.75 \times 10^{-19} \text{ J.}$$

$$= \frac{1.75 \times 10^{-19}}{1.6 \times 10^{-19}} eV = 1.1 eV$$

8. (d) A laser beam has great power to be focussed so energy density of radiation is greatly enhanced which may have cutting effect.
9. (c) When a charge q is accelerated by a potential difference of V , the energy imparted to it is qV . It does not depend upon

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the mass. In the given problem potential diff = 1kV. Charge on the proton = charge on electron = 1.6×10^{-19} coulomb. The energy imparted = 1 keV.

[1eV is equal to energy acquired by an electron when it is accelerated under potential of 1eV]

10. (b) A photon and electron will have same momentum if their wavelength are equal.

For electron, momentum = $\frac{h}{\lambda}$.

For photon, momentum

$$= \frac{mc^2}{c} = \frac{E}{c} = \frac{h\nu}{c} = \frac{h}{\lambda}$$

11. (b) When we bombard electrons on a target consisting of heavier atoms, the electron of inner orbitals of target atoms get knocked out. So to fill their position, other electrons from the higher energy orbitals make transition to lower energy orbitals. Its results is emission of X-rays.

12. (a) From Einstein's equation of photoelectric effect

$$h\nu = \phi + \frac{1}{2}mv^2$$

$$h\nu = \phi + V_e \quad [V \text{ is stopping potential}]$$

$$4 \text{ eV} = 2 \text{ eV} + V_e$$

$$V_e = 2 \text{ eV}$$

$$V \times e = 2 \times e \times 1 \text{ volt}$$

$$V (\text{Stopping potential}) = 2 \text{ Volt}$$

13. (b) From Mosley law,
 $f = a(Z - b)^2$
 $f \propto Z^2$

$$14. (a) \frac{hc}{\lambda} = eV \Rightarrow \nu = \frac{hc}{e\lambda} = \frac{6.6 \times 10^{-34} \times 3 \times 10^8}{1.6 \times 10^{-19} \times 10^{-11}}$$

$$= \frac{33 \times 3}{8} \times 10^4 = 12.375 \times 10^4$$

$$= 124 \times 10^3 \text{ V} = 124 \text{ kV}$$

For minimum wavelength energy is 124 kV
 $\therefore$ The accelerating voltage should be $< 124 \text{ kV}$

15. (b) The incident wave must have a certain minimum frequency. This is known as threshold frequency.

16. (d) We have from Einsteins photo electric equation.

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$$v_{\max} = \sqrt{\frac{2hc(\lambda_0 - \lambda)}{m\lambda\lambda_0}}$$

If wavelength is changed to $\left(\frac{3\lambda}{4}\right)$

$$\text{then } v'_{\max} = \sqrt{\frac{2hc(\lambda_0 - 3\lambda/4)}{m\lambda_0(3\lambda/4)}}$$

$$\frac{v'_{\max}}{v_{\max}} = \frac{(\lambda_0 - 3\lambda/4)}{\frac{3}{4}\lambda\lambda_0} \times \frac{\lambda\lambda_0}{\lambda_0 - \lambda}$$

$$= \sqrt{\frac{4}{3} \frac{(\lambda_0 - 3\lambda/4)}{\lambda_0 - \lambda}}$$

$$\text{i.e., } v'_{\max} = \sqrt{\frac{4}{3}} \times v \times \sqrt{\frac{\lambda_0 - 3\lambda/4}{\lambda_0 - \lambda}}$$

$$(\because v_{\max} = v) \quad \text{i.e., } v'_{\max} > \sqrt{\frac{4}{3}} v$$

17. (a) $h\nu = \phi + V_s$ and $h\frac{3}{2}\nu = \phi + 2V_s$

$$\Rightarrow \phi = \frac{h\nu}{2}$$

18. (c) $p = \frac{h}{\lambda}$ of each photon

$$= \frac{6.63 \times 10^{-34}}{500 \times 10^{-9}} = 1.33 \times 10^{-27} \text{ kg-m/s}$$

and no. of photons

$$= \frac{0.5}{h\nu} / \text{cm}^2 = \frac{0.5\lambda}{hc} / \text{cm}^2$$

$$= \frac{0.5 \times 500}{1240 \times 1.6 \times 10^{-19}} / \text{cm}^2$$

$$= 1.25 \times 10^{18} \text{ photons/cm}^2$$

$$\therefore \text{force} = 1.25 \times 10^{18} \times 1.33 \times 10^{-27} \times \pi \times 1^2$$

$$= 5.22 \times 10^{-9} \text{ N}$$

19. (b) Energy of photon

$$E = \frac{hc}{\lambda}$$

$$\Rightarrow 2.5 \text{ eV} = \frac{hc}{5000 \times 10^{-10}} \quad (\text{as } \lambda = 5000 \text{ \AA})$$

$$\Rightarrow hc = 2.5 \times 5 \times 10^{-7} \text{ eV}$$

For X-ray photon, c = same, h = constant

$$\Rightarrow E = \frac{hc}{\lambda_{\text{x-ray}}}$$

$$= \frac{2.5 \times 5 \times 10^{-7}}{1 \times 10^{-10}} \text{ eV}$$

$$= 2.5 \times 5000 \text{ eV}$$

20. (a) Conservation of energy requires that the 15.0 eV photon energy first provides the ionization energy to unbind the electron, and then allows any excess energy to become the electron's kinetic energy. The kinetic energy in this case is $15.0 \text{ eV} - 13.6 \text{ eV} = 1.4 \text{ eV}$.
21. (d) As λ is increased, there will be a value of λ above which photoelectrons will cease to come out so photocurrent will become zero. Hence (d) is correct answer.

Type B : Assertion Reason Questions

22. (b) The photosensitivity of a metal is high when its work function is small. Work function of a metal depends not on the threshold frequency but on the nature of the metal.
23. (d) Intensity of incident photon decides the number of electrons ejected and not the kinetic energy.
Ejection of electron from metallic surface is possible only when frequency of incident photon is more than threshold frequency.
24. (e) When speed of particle increases, the mass increases as

$$m = \frac{m_0}{\sqrt{1 - \frac{v^2}{c^2}}}$$
 charge does not alter
25. (b) We know that for photon, $mv = \frac{h}{\lambda}$
 mass varies inversely as the wavelength.
 For particle $E = mc^2$, E is energy of particle if its mass is converted into energy. Both are uncorrelated.
26. (d) Photoelectric effect demonstrate the particle nature of light.
 The number of photoelectrons is proportional to the intensity of light.
 So, (d) is the answer.

27. (a) Photon when behaves as a particle carries momentum equal to $\frac{E}{c}$.
28. (a) Electrons being emitted as photoelectrons have different velocities. Actually all the electrons do not occupy the same level of energy but they occupy continuous band and levels. So, electrons being knocked off from different levels come out with different energies. Work function is the energy required to pull the electron out of metal surface. Naturally electrons on the surface will require less energy to be pulled out hence will have lesser work function as compared with those deep inside the metal. So, assertion and reason are correct and reason correctly explains the assertion.
29. (d) Soft and hard X-rays differ only in frequency. Soft X-rays have low frequency as compared to hard X-rays. But both types of X-ray travel with speed of light.
30. (a) The photoemissive cell contain two electrodes are enclosed in a glass bulb which may be evacuated or contain an inert gas at low pressure. An inert gas in the cell gives greater current but causes a time lag in the response of the cell to very rapid changes of radiation which may make it unsuitable for some purpose.
31. (c) We know that

$$eV_0 = K_{\max} = h\nu - \phi$$
 where, ϕ is the work function.
 Hence, as ν increases (note that frequency of X-rays is greater than that of U.V. rays), both V_0 and $K_{\max}$ increase. So assertion is correct.
32. (d) Photoelectric saturation current is independent of frequency. It only depends on intensity of light.
33. (a) Both statement I and II are true; but even if radiation of single wavelength is incident on photosensitive surface, electrons of different KE will be emitted.
34. (b) The kinetic energy of emitted photoelectrons varies from zero to a maximum value. Work function depends on metal used.

Atoms

TYPE A : MULTIPLE CHOICE QUESTIONS

- If the electron in hydrogen orbit jumps from third orbit to second orbit, the wavelength of the emitted radiation is given by : [1997]
 - $\lambda = \frac{R}{6}$
 - $\lambda = \frac{5}{R}$
 - $\lambda = \frac{36}{5R}$
 - $\lambda = \frac{5R}{36}$
- The radius of hydrogen atom in the first excited level is : [1998]
 - twice
 - four times
 - same
 - half
- In Bohr's theory, relation between principal quantum number n and radius of orbit r is : [1999]
 - $r \propto \frac{1}{n^2}$
 - $r \propto n$
 - $r \propto \frac{1}{n}$
 - $r \propto n^2$
- For an electron in the second orbit of hydrogen, the moment of momentum as per Bohr's model is [2000]
 - $\frac{h}{\pi}$
 - $\frac{2h}{\pi}$
 - $\frac{h}{2\pi}$
 - $2\pi h$
- The speed of an electron having a wavelength of 10^{-10}m is [2002]
 - $4.24 \times 10^6 \text{ m/s}$
 - $5.25 \times 10^6 \text{ m/s}$
 - $6.25 \times 10^6 \text{ m/s}$
 - $7.25 \times 10^6 \text{ m/s}$
- We wish to see inside an atom. Assuming the atom to have a diameter of 100 pm, this means that one must be able to resolve a width of say 10 pm. If an electron microscope is used, the minimum electron energy required is about [2004]
 - 1.5 keV
 - 15 keV
 - 150 keV
 - 1.5 MeV
- The ground state energy of hydrogen atom is -13.6 eV . What is the potential energy of the electron in this state ? [2005]
 - 0 eV
 - -27.2 eV
 - 1 eV
 - 2 eV
- In the following diagram, which particle has highest e/m value? [2007]
 
 - A
 - B
 - C
 - D
- What is the energy of He^+ electron in first orbit? [2007]
 - 40.8 eV
 - -27.2 eV
 - -54.4 eV
 - -13.6 eV
- What is the energy of photon whose wavelength is $6840 \text{ \AA}$? [2007]
 - 1.81 eV
 - 3.6 eV
 - -13.6 eV
 - 12.1 eV
- The ratio of the energy of the photon emitted by the k_α line to that of the k_β line is [2009]
 - greater than 1
 - Less than 1
 - 1
 - indeterminate
- The angular momentum of an electron in the 2nd excited state of a Helium ion (He^+) is [2009]
 - $\frac{h}{2\pi}$
 - $\frac{2h}{2\pi}$
 - $\frac{3h}{2\pi}$
 - $\frac{4h}{2\pi}$
- What is the wavelength of the least energetic photon emitted in the Lyman series of the hydrogen atom spectrum ? [2011]
 - 150 nm
 - 122 nm
 - 102 nm
 - 82 nm

14. The energy of electron in the n th orbit of hydrogen atom is expressed as $E_n = \frac{-13.6}{n^2} \text{ eV}$. The shortest and longest wavelength of Lyman series will be [2013]
 (a) 910 Å, 1213 Å (b) 5463 Å, 7858 Å
 (c) 1315 Å, 1530 Å (d) None of these
15. Which of the following statements are true regarding Bohr's model of hydrogen atom? [2015]
 (I) Orbiting speed of electron decreases as it shifts to discrete orbits away from the nucleus
 (II) Radii of allowed orbits of electron are proportional to the principal quantum number
 (III) Frequency with which electrons orbit around the nucleus in discrete orbits is inversely proportional to the cube of principal quantum number
 (IV) Binding force with which the electron is bound to the nucleus increases as it shifts to outer orbits
 Select correct answer using the codes given below.
 Codes :
 (a) I and II (b) II and IV
 (c) I, II and III (d) II, III and IV
16. The wavelength of the first line of Lyman series for hydrogen atom is equal to that of the second line of Balmer series for a hydrogen like ion. The atomic number Z of hydrogen like ion is [2016]
 (a) 3 (b) 4
 (c) 1 (d) 2
17. Which one did Rutherford consider to be supported by the results of experiments in which α -particles were scattered by gold foil? [2017]
 (a) The nucleus of an atom is held together by forces which are much stronger than electrical or gravitational forces.
 (b) The force of repulsion between an atomic nucleus and an α -particle varies with distance according to inverse square law.
 (c) α -particles are nuclei of Helium atoms.
 (d) Atoms can exist with a series of discrete energy levels
18. As an electron makes a transition from an excited state to the ground state of a hydrogen - like atom/ion [2017]
 (a) kinetic energy decreases, potential energy increases but total energy remains same
 (b) kinetic energy and total energy decrease but potential energy increases
 (c) its kinetic energy increases but potential energy and total energy decrease
 (d) kinetic energy, potential energy and total energy decrease

TYPE B : ASSERTION REASON QUESTIONS

Directions for (Qs. 19-21) : These questions consist of two statements, each printed as Assertion and Reason. While answering these questions, you are required to choose any one of the following five responses.

- (a) If both Assertion and Reason are correct and the Reason is a correct explanation of the Assertion.
 (b) If both Assertion and Reason are correct but Reason is not a correct explanation of the Assertion.
 (c) If the Assertion is correct but Reason is incorrect.
 (d) If both the Assertion and Reason are incorrect.
 (e) If the Assertion is incorrect but the Reason is correct.

19. **Assertion:** The specific charge of positive rays is not constant.

Reason: The mass of ions varies with speed.

[1999]

20. **Assertion :** Bohr had to postulate that the electrons in stationary orbits around the nucleus do not radiate.

Reason : According to classical physics all moving electrons radiate.

[2003]

21. **Assertion :** Balmer series lies in the visible region of the electromagnetic spectrum.

Reason : $\frac{1}{\lambda} = R \left[\frac{1}{2^2} - \frac{1}{n^2} \right]$, where $n = 3, 4, 5$

[2008]

Directions for (Qs. 22-25) : Each of these questions contains an Assertion followed by Reason. Read them carefully and answer the question on the basis of following options. You have to select the one that best describes the two statements.

- (a) If both Assertion and Reason are correct and Reason is the correct explanation of Assertion.
- (b) If both Assertion and Reason are correct, but Reason is not the correct explanation of Assertion.
- (c) If Assertion is correct but Reason is incorrect.
- (d) If both the Assertion and Reason are incorrect.

22. Assertion : In Lyman series, the ratio of minimum and maximum wavelength is $\frac{3}{4}$.

Reason : Lyman series constitute spectral lines corresponding to transition from higher energy to ground state of hydrogen atom. **[2011]**

23. Assertion : Between any two given energy levels, the number of absorption transitions is always less than the number of emission transitions.

Reason : Absorption transitions start from the lowest energy level only and may end at any higher energy level. But emission transitions may start from any higher energy level and end at any energy level below it. **[2015]**

24. Assertion : In Lyman series, the ratio of minimum and maximum wavelength is $\frac{3}{4}$.

Reason : Lyman series constitute spectral lines corresponding to transition from higher energy to ground state of hydrogen atom. **[2016]**

25. Assertion : Bohr had to postulate that the electrons in stationary orbits around the nucleus do not radiate.

Reason : According to classical physics all moving electrons radiate. **[2017]**

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Type A : Multiple Choice Questions

1. (c) We know that

$$\frac{1}{\lambda} = R \left(\frac{1}{n_1^2} - \frac{1}{n_2^2} \right)$$

$$\frac{1}{\lambda} = R \left(\frac{1}{2^2} - \frac{1}{3^2} \right) \Rightarrow R \left(\frac{1}{4} - \frac{1}{9} \right)$$

$$\frac{1}{\lambda} = \left(\frac{9-4}{36} \right) R = \frac{5R}{36} \Rightarrow \lambda = \frac{36}{5R}$$

2. (b) Radius of H-atom $\propto n^2$
So for excitation from $n = 1$ to $n = 2$, radius becomes 4 times.
3. (d) Radius of Bohr's orbit $\propto n^2$, where n is principal quantum no.
4. (a) The moment of momentum is also known as angular momentum of electron.
We know from Bohr's theory that in an orbit

$$\text{angular momentum} = n \cdot \frac{h}{2\pi}$$

For second orbit $n = 2$

$$\text{So, angular momentum} = 2 \times \frac{h}{2\pi} = \frac{h}{\pi} \text{ is the answer.}$$

5. (d) We know that De-Broglie wavelength is

$$mv = \frac{h}{\lambda} \Rightarrow \lambda = \frac{h}{mv}$$

$$10^{-10} = \frac{6.6 \times 10^{-34}}{9.1 \times 10^{-31} \times v}$$

$$v = \frac{6.6 \times 10^{-34}}{9.1 \times 10^{-41}} = 7.25 \times 10^6$$

6. (b) From the de-Broglie equation,

$$\lambda = \frac{h}{p} = \frac{h}{mv}$$

where λ is wavelength, h is plank's constant and p is momentum and v is velocity

$$v = \frac{h}{m\lambda} = \frac{6.6 \times 10^{-34}}{9.1 \times 10^{-31} \times 10^{-11}} = 7.25 \times 10^7 \text{ m/s}$$

$$\therefore \text{Energy of electron} = \frac{1}{2} mv^2$$

$$= \frac{1}{2} \times \frac{9.1 \times 10^{-31} \times (7.25 \times 10^7)^2}{1.6 \times 10^{-19}} = 15 \text{ keV}$$

7. (b) In case of hydrogen atom
If $-E$ = ground state energy (Total)
 E is kinetic energy then $-2E$ is potential energy.

$$\text{Here } E = 13.6 \text{ eV} \Rightarrow 2E = 27.2 \text{ eV}$$

$$\text{So, potential energy} = -27.2 \text{ eV}$$

8. (d) The deflection of a particle along y-axis is

$$\text{electric field is given by } y = \frac{Eex^2}{2mv^2}$$

$\Rightarrow y \propto \frac{e}{m}$ for all other values to be constant. Since y is maximum for D, hence it has highest e/m ratio.

9. (c) $E = \frac{-13.6Z^2}{n^2} \text{ eV}$, for He^+ , $Z=2$, $n=1$ (first orbit)

$$\therefore E = \frac{-13.6 \times 2}{1^2} = -54.4 \text{ eV}$$

10. (a) Energy of photon

$$E = \frac{hc}{\lambda} = \frac{6.6 \times 10^{-34} \times 3 \times 10^8}{6840 \times 10^{-10}}$$

$$= \frac{6.6 \times 3 \times 10^{-26}}{6.84 \times 10^{-7}} \text{ J}$$

$$= \frac{6.6 \times 3 \times 10^{-26}}{6.84 \times 10^{-7} \times 1.6 \times 10^{-19}} \text{ eV} = 1.8 \text{ eV}$$

11. (b) $\Delta E = E_0(Z-1)^2 \left(\frac{1}{n_1^2} - \frac{1}{n_2^2} \right)$

for k_α , $n_1 = 1$, $n_2 = 2$

for k_β , $n_1 = 1$, $n_2 = 3$

so energy of the photon corresponding to k_α line is less than that of k_β line.

12. (c) Angular momentum in the ground state

$$= \frac{h}{2\pi}$$
 Angular momentum in the first excited state

$$= \frac{2h}{2\pi}$$
 Angular momentum in the second excited state

$$= \frac{3h}{2\pi}$$
13. (b) The least energy is corresponding to longest wavelength, which is $\lambda = 1216\text{\AA}$.
14. (a) $\frac{1}{\lambda_{\max}} = R \left[\frac{1}{(1)^2} - \frac{1}{(2)^2} \right] \Rightarrow \lambda_{\max} = \frac{4}{3R} \approx 1213\text{\AA}$
 and $\frac{1}{\lambda_{\min}} = R \left[\frac{1}{(1)^2} - \frac{1}{\infty} \right] \Rightarrow \lambda_{\min} = \frac{1}{R} \approx 910\text{\AA}$.
15. (a) Orbital speed varies inversely as the radius of the orbit.

$$v \propto \frac{1}{n}$$
16. (d) For first line of Lyman series of hydrogen

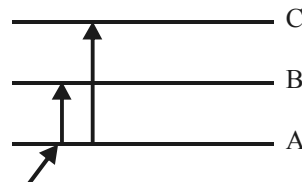
$$\frac{hc}{\lambda_1} = Rhc \left(\frac{1}{1^2} - \frac{1}{2^2} \right)$$
 For second line of Balmer series of hydrogen like ion

$$\frac{hc}{\lambda_2} = Z^2 Rhc \left(\frac{1}{2^2} - \frac{1}{4^2} \right)$$
 By question, $\lambda_1 = \lambda_2$

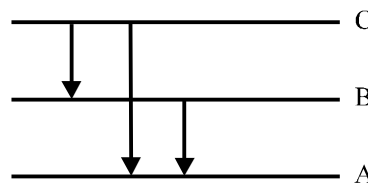
$$\Rightarrow \left(\frac{1}{1} - \frac{1}{2} \right) = Z^2 \left(\frac{1}{4} - \frac{1}{16} \right) \text{ or } Z = 2$$
17. (b)
18. (c) $U = -K \frac{ze^2}{r}$; $T.E = -\frac{k ze^2}{2r}$
 $K.E = \frac{k ze^2}{2r}$. Here r decreases
20. (b) According to classical physics all moving electrons around the nucleus will radiate because an accelerated electron in electric field will radiate e.m. wave. So Reason is correct. But Reason does not explain the Assertion.
 Bohr's postulates that the electron in stationary orbits do not radiate. His postulate was based not out of compulsion but on the quantum theory. So Assertion is also correct but Reason does not explain Assertion.
21. (b) Wavelength is Balmer series is,

$$\frac{1}{\lambda} = R \left[\frac{1}{2^2} - \frac{1}{n^2} \right]; \frac{1}{\lambda_{\max}} = R \left[\frac{1}{2^2} - \frac{1}{3^2} \right]$$
 or $\lambda_{\max} = \frac{36}{5R} = \frac{36}{5 \times 1.097 \times 10^7} = 6563\text{\AA}$

$$1/\lambda_{\min} = R \left[\frac{1}{2^2} - \frac{1}{\infty^2} \right]$$
 or $\lambda_{\min} = \frac{4}{R} = \frac{4}{1.097 \times 10^7} = 3646\text{\AA}$
 So it lies in the visible region.
22. (b)
23. (a) Absorption transition



Two possibilities in absorption transition.



Three possibilities in emission transition.
 Therefore, absorption transition < emission.

Type B : Assertion Reason Questions

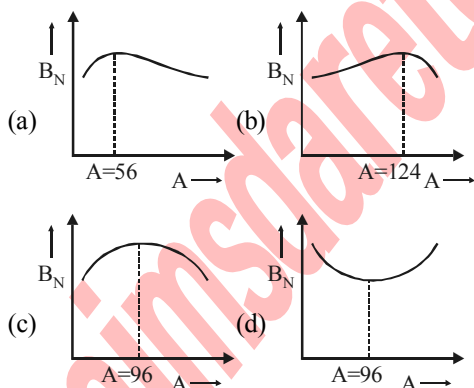
19. (a) The specific charge $\frac{e}{m}$ of positive ray is not constant because for different velocities the rest mass of particles change i.e. mass of ions varies with speed. So $\frac{e}{m}$ will differ. Hence, Reason and Assertion both are correct and Reason explains Assertion.
24. (b)
25. (b) Bohr postulated that electrons in stationary orbits around the nucleus do not radiate. This is the one of Bohr's postulate. According to this the moving electrons radiates only when they go from one orbit to the next lower orbit.

TYPE A : MULTIPLE CHOICE QUESTIONS

- In the nuclear reaction, there is a conservation of:
 - momentum
 - mass
 - energy
 - all of these
 [1997]
- If the radioactive decay constant of radium is 1.07×10^{-4} per year. Then its half life period approximately is equal to :
 - 5000 years
 - 6500 years
 - 7000 years
 - 8900 years
 [1998]
- In ${}_{88}\text{Ra}^{226}$ nucleus there are :
 - 226 protons and 88 electrons
 - 138 protons and 88 neutrons
 - 226 neutrons and 138 electrons
 - 138 neutrons and 88 protons
 [1998]
- The activity of radioactive sample is measured as 9750 counts per minute at $t = 0$ and as 975 counts per minute at $t = 5$ minutes, the decay constant is approximately :
 - 0.922 per minute
 - 0.270 per minute
 - 0.461 per minute
 - 0.39 per minute
 [1998]
- The activity of a radioactive sample is 1.6 curie and its half life is 2.5 days. Then activity after 10 days will be :
 - 0.16 curie
 - 0.8 curie
 - 0.1 curie
 - 0.4 curie
 [1999]
- Which one of the following is used as a moderator in nuclear reaction ?
 - Uranium
 - Heavy water
 - Cadmium
 - Plutonium
 [1999]
- The reaction responsible for the production of light energy from the sun will be:
 - fission
 - fusion
 - nuclear
 - none of these
 [1999]
- Half life of a substance is 20 minutes, then the time between 33 % decay and 67 % decay will be
 - 20 minute
 - 40 minute
 - 50 minute
 - 10 minute
 [2000]
- Consider the following nuclear reaction

$$X^{200} \rightarrow A^{110} + B^{90} + \text{Energy}$$
 If the binding energy per nucleon for X, A and B are 7.4 MeV, and 8.2 MeV and 8.2 MeV respectively, the energy released will be :
 - 90 MeV
 - 110 MeV
 - 200 MeV
 - 160 MeV
 [2000]
- In each fission of ${}_{92}\text{U}^{235}$ releases 200 MeV, how many fissions must occur per second to produce power of 1 kW ?
 - 1.25×10^{18}
 - 3.125×10^{13}
 - 3.2×10^{18}
 - 1.25×10^{13}
 [2000]
- The function of heavy water in a nuclear reactor to
 - slow down the neutrons
 - increase the neutrons
 - stop the electrons
 - none of these
 [2001]
- Which one of the following has the highest neutrons ratio ?
 - ${}_{92}\text{U}^{235}$
 - ${}_{8}\text{O}^{16}$
 - ${}_{2}\text{He}^4$
 - ${}_{26}\text{Fe}^{56}$
 [2001]
- When radioactive substance emits an α -particle, then its position in the periodic table is lowered by
 - two places
 - three places
 - five places
 - one place
 [2001]
- In an atom bomb, the energy is released because of the :
 - chain reaction of neutrons and ${}_{92}\text{U}^{238}$
 - chain reaction of neutrons and ${}_{92}\text{U}^{235}$
 - chain reaction of neutrons and ${}_{92}\text{U}^{236}$
 - chain reaction of neutrons and ${}_{92}\text{U}^{240}$
 [2001]
- A radioactive substance decays to $1/16^{\text{th}}$ of its initial activity in 40 days. The half-life of the radioactive substance expressed in days is
 - 2.5
 - 5
 - 10
 - 20
 [2003]

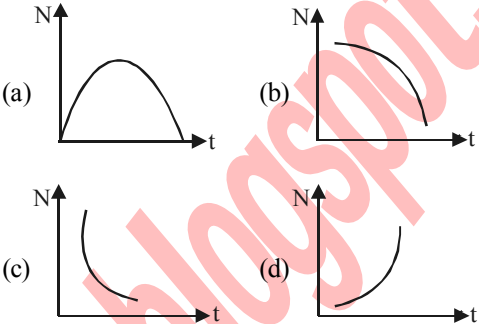
16. Nuclear fusion is possible [2003]
 (a) only between light nuclei
 (b) only between heavy nuclei
 (c) between both light and heavy nuclei
 (d) only between nuclei which are stable against β -decay
17. Radioactive nuclei that are injected into a patient collected at certain sites within its body, undergoing radioactive decay and emitting electromagnetic radiation. These radiations can then be recorded by a detector. This procedure provides an important diagnostic tool called [2003]
 (a) Gamma camera
 (b) CAT scan
 (c) Radiotracer technique
 (d) Gamma ray spectroscopy
18. In a material medium, when a positron meets an electron both the particles annihilate leading to the emission of two gamma ray photons. This process forms the basis of an important diagnostic procedure called [2003]
 (a) MRI (b) PET
 (c) CAT (d) SPECT
19. The dependence of binding energy per nucleon, B_N , on the mass number A , is represented by [2004]



20. Carbon dating is best suited for determining the age of fossils if their age in years is of the order of [2004]
 (a) 10^3 (b) 10^4
 (c) 10^5 (d) 10^6
21. In nucleus of mass number A , originally at rest, emits an α -particle with speed v . The daughter nucleus recoils with a speed : [2004]

- (a) $\frac{2v}{A+4}$ (b) $\frac{4v}{A+4}$
 (c) $\frac{4v}{A-4}$ (d) $\frac{2v}{A-4}$

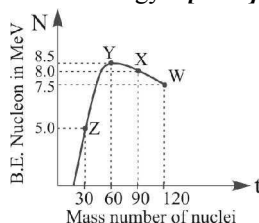
22. When an electron-positron pair annihilates, the energy released is about [2004]
 (a) $0.8 \times 10^{-13} \text{ J}$ (b) $1.6 \times 10^{-13} \text{ J}$
 (c) $3.2 \times 10^{-13} \text{ J}$ (d) $4.8 \times 10^{-13} \text{ J}$
23. A radioactive material has half-life of 10 days. What fraction of the material would remain after 30 days ? [2005]
 (a) 0.5 (b) 0.25
 (c) 0.125 (d) 0.33
24. The operation of a nuclear reactor is said to be critical, if the multiplication factor (K) has a value [2006]
 (a) 1 (b) 1.5
 (c) 2.1 (d) 2.5
25. $^{238}_{92}\text{U}$ has 92 protons and 238 nucleons. It decays by emitting an Alpha particle and becomes [2006]
 (a) $^{234}_{92}\text{U}$ (b) $^{234}_{90}\text{Th}$
 (c) $^{235}_{92}\text{U}$ (d) $^{237}_{93}\text{Np}$
26. The fossil bone has a $^{14}\text{C} : ^{12}\text{C}$ ratio, which is $\left(\frac{1}{16}\right)$ of that in a living animal bone. If the half-life time of ^{14}C is 5730 years, then the age of the fossil bone is [2006]
 (a) 11460 years (b) 17190 years
 (c) 22920 years (d) 45840 years
27. Which one of the following is a possible nuclear reaction [2006]
 (a) $^{10}_5\text{B} + ^4_2\text{He} \longrightarrow ^{13}_7\text{N} + ^1_1\text{H}$
 (b) $^{23}_{11}\text{Na} + ^1_1\text{H} \longrightarrow ^{20}_{10}\text{Ne} + ^4_2\text{He}$
 (c) $^{239}_{11}\text{Np} \longrightarrow ^{239}_{94}\text{Pu} + \beta^- + \bar{\nu}$
 (d) $^{11}_7\text{N} + ^1_1\text{H} \longrightarrow ^{12}_6\text{C} + \beta^- + \nu$
28. If Alpha, Beta and Gamma rays carry same momentum, which has the longest wavelength [2006]
 (a) Alpha rays
 (b) Beta rays
 (c) Gamma rays
 (d) None, all have some wavelength
29. What is the amount of energy released by deuterium and tritium fusion? [2007]
 (a) 60.6 eV (b) 123.6 eV
 (c) 17.6 eV (d) 28.3 eV

30. Calculate power output of ${}^{235}_{92}\text{U}$ reactor, if it takes 30 days to use up 2 kg of fuel, and if each fission gives 185 MeV of useable energy. Avogadro's number = 6×10^{23} /mol? [2007]
 (a) 56.3 MW (b) 60.3 MW
 (c) 58.3 MW (d) 54.3 MW
31. Starting with a sample of pure ${}^{66}\text{Cu}$, $\frac{7}{8}$ of it decays into Zn in 15 minutes. The corresponding half life is [2008]
 (a) 15 minutes (b) 10 minutes
 (c) $7\frac{1}{2}$ minutes (d) 5 minutes
32. A radioactive material decays by simultaneous emission of two particles with respective half-lives 1620 and 810 years. The time, in years, after which one-fourth of the material remains is [2008]
 (a) 1080 (b) 2430
 (c) 3240 (d) 4860
33. If the binding energy per nucleon of a nuclide is high then [2009]
 (a) It should be abundantly available in nature
 (b) It will decay instantly
 (c) It will have a large disintegration constant
 (d) It will have a small half-life.
34. Activity of a radioactive sample decreases to $(1/3)^{\text{rd}}$ of its original value in 3 days. Then, in 9 days its activity will become [2009]
 (a) $(1/27)$ of the original value
 (b) $(1/9)$ of the original value
 (c) $(1/18)$ of the original value
 (d) $(1/3)$ of the original value
35. The half life of a radioactive substance against α -decay is 1.2×10^7 s. What is the decay rate for 4.0×10^{15} atoms of the substance [2010]
 (a) 4.6×10^{12} atoms/s
 (b) 2.3×10^{11} atoms/s
 (c) 4.6×10^{10} atoms/s
 (d) 2.3×10^8 atoms/s
36. Actinium 231, ${}^{231}\text{Ac}_{89}$, emit in succession two β -particles, four alphas, one β and one alpha plus several γ rays. What is the resultant isotope: [2011]
 (a) ${}^{221}\text{Au}_{79}$ (b) ${}^{211}\text{Au}_{79}$
 (c) ${}^{221}\text{Pb}_{82}$ (d) ${}^{211}\text{Pb}_{82}$
37. Radioactive element decays to form a stable nuclide, then the rate of decay of reactant is [2012]
- 
38. A nuclear reaction is given by ${}_Z\text{X}^A \rightarrow {}_{Z+1}\text{Y}^A + {}_{-1}\text{e}^0 + \bar{\nu}$, represents [2012]
 (a) fission (b) β -decay
 (c) σ -decay (d) fusion
39. An archaeologist analyses the wood in a prehistoric structure and finds that C^{14} (Half life = 5700 years) to C^{12} is only one-fourth of that found in the cells of buried plants. The age of the wood is about [2013]
 (a) 5700 years (b) 2850 years
 (c) 11,400 years (d) 22,800 years
40. A radioactive nuclide is produced at the constant rate of n per second (say, by bombarding a target with neutrons). The expected number N of nuclei in existence t seconds after the number is N_0 is given by [2014]
 (a) $N = N_0 e^{-\lambda t}$
 (b) $N = \frac{n}{\lambda} + N_0 e^{-\lambda t}$
 (c) $N = \frac{n}{\lambda} + \left(N_0 - \frac{n}{\lambda}\right) e^{-\lambda t}$
 (d) $N = \frac{n}{\lambda} + \left(N_0 + \frac{n}{\lambda}\right) e^{-\lambda t}$
- Where λ is the decay constant of the sample
41. The fossil bone has a ${}^{14}\text{C} : {}^{12}\text{C}$ ratio, which is $\left[\frac{1}{16}\right]$ of that in a living animal bone. If the half-life of ${}^{14}\text{C}$ is 5730 years, then the age of the fossil bone is [2015]
 (a) 11460 years (b) 17190 years
 (c) 22920 years (d) 45840 years

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42. Binding energy per nucleon versus mass number curve for nuclei is shown in the figure. W, X, Y and Z are four nuclei indicated on the curve. The process that would release energy is [2016]

- (a) $Y \rightarrow 2Z$
 (b) $W \rightarrow X + Z$
 (c) $W \rightarrow 2Y$
 (d) $X \rightarrow Y + Z$



43. The activity of a radioactive sample is measured as N_0 counts per minute at $t = 0$ and N_0/e counts per minute at $t = 5$ minutes. The time (in minutes) at which the activity reduces to half its value is [2017]

- (a) $\log_e 2/5$ (b) $\frac{5}{\log_e 2}$
 (c) $5 \log_{10} 2$ (d) $5 \log_e 2$

TYPE B : ASSERTION REASON QUESTIONS

Directions for (Qs. 44-55) : These questions consist of two statements, each printed as Assertion and Reason. While answering these questions, you are required to choose any one of the following five responses.

- (a) If both Assertion and Reason are correct and the Reason is a correct explanation of the Assertion.
 (b) If both Assertion and Reason are correct but Reason is not a correct explanation of the Assertion.
 (c) If the Assertion is correct but Reason is incorrect.
 (d) If both the Assertion and Reason are incorrect.
 (e) If the Assertion is incorrect but the Reason is correct.

44. **Assertion :** Isobars are the elements having same mass number but different atomic number.

Reason : Neutrons and protons are present inside nucleus. [1997]

45. **Assertion :** If the half life of a radioactive substance is 40 days then 25% substance decay in 20 days. [1998]

$$\text{Reason : } N = N_0 \left(\frac{1}{2} \right)^n$$

$$\text{where, } n = \frac{\text{time elapsed}}{\text{half life period}}$$

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46. **Assertion:** Separation of isotope is possible because of the difference in electron numbers of isotope.

Reason: Isotope of an element can be separated by using a mass spectrometer. [1999]

47. **Assertion:** ${}_Z^AX^A$ undergoes 2α -decays, 2β -decays and 2γ -decays and the daughter product is ${}_{Z-2}X^{A-8}$.

Reason : In α -decays the mass number decreases by 4 and atomic number decreases by 2. In 2β -decays the mass number remains unchanged, but atomic number increases by 1 only. [2001]

48. **Assertion :** Radioactive nuclei emit β^- particles.

Reason : Electrons exist inside the nucleus. [2003]

49. **Assertion :** Neutrons penetrate matter more readily as compared to protons.

Reason : Neutrons are slightly more massive than protons. [2003]

50. **Assertion :** ${}^{90}\text{Sr}$ from the radioactive fall out from a nuclear bomb ends up in the bones of human beings through the milk consumed by them. It causes impairment of the production of red blood cells.

Reason : The energetic β -particles emitted in the decay of ${}^{90}\text{Sr}$ damage the bone marrow. [2004]

51. **Assertion :** Energy is released in nuclear fission.

Reason : Total binding energy of the fission fragments is larger than the total binding energy of the parent nucleus. [2004]

52. **Assertion :** It is not possible to use ${}^{35}\text{Cl}$ as the fuel for fusion energy.

Reason : The binding energy of ${}^{35}\text{Cl}$ is too small. [2005]

53. **Assertion :** The binding energy per nucleon, for nuclei with atomic mass number $A > 100$, decreases with A .

Reason : The nuclear forces are weak for heavier nuclei. [2006, 2013]

54. **Assertion :** Cobalt-60 is useful in cancer therapy.

Reason : Cobalt-60 is a source of γ -radiations capable of killing cancerous cells. [2006]

55. **Assertion :** Heavy water is a better moderator than normal water.

Reason : Heavy water absorbs neutrons more efficiently than normal water. [2007]

Directions for (Qs. 56-61) : Each of these questions contains an Assertion followed by Reason. Read them carefully and answer the question on the basis of following options. You have to select the one that best describes the two statements.

- (a) If both Assertion and Reason are correct and Reason is the correct explanation of Assertion.
- (b) If both Assertion and Reason are correct, but Reason is not the correct explanation of Assertion.
- (c) If Assertion is correct but Reason is incorrect.
- (d) If both the Assertion and Reason are incorrect.

56. Assertion : In a decay process of a nucleus, the mass of products is less than that of the parent.

Reason : The rest mass energy of the products must be less than that of the parent. [2012]

57. Assertion : Binding energy (or mass defect) of hydrogen nucleus is zero.

Reason : Hydrogen nucleus contain only one nucleon. [2012]

58. Assertion : The ionising power of β -particle is less compared to α -particles but their penetrating power is more.

Reason : The mass of β -particle is less than the mass of α -particle. [2014]

59. Assertion : Energy is released when heavy nuclei undergo fission or light nuclei undergo fusion and

Reason : For heavy nuclei, binding energy per nucleon increases with increasing Z while for light nuclei it decreases with increasing Z . [2015]

60. Assertion : Energy is released when heavy nuclei undergo fission or light nuclei undergo fusion and

Reason : For heavy nuclei, binding energy per nucleon increases with increasing Z while for light nuclei it decreases with increasing Z . [2017]

61. Assertion : Between any two given energy levels, the number of absorption transitions is always less than the number of emission transitions.

Reason : Absorption transitions start from the lowest energy level only and may end at any higher energy level. But emission transitions may start from any higher energy level and end at any energy level below it. [2017]

HINTS & SOLUTIONS

Type A : Multiple Choice Questions

1. (a) In a nuclear reaction, there may be conversion of some mass into energy. So, both mass and energy are not conserved. It is the momentum which is conserved.

2. (b) $\lambda = 1.07 \times 10^{-4}$

$$T_{1/2} = \frac{0.693}{1.07 \times 10^{-4}} = 6500 \text{ years}$$

3. (d) ${}_{88}\text{Ra}^{226}$

Number of protons = 88

Number of neutrons = $226 - 88 = 138$

4. (c) We know that

$$\frac{dN}{dt} = \lambda N$$

$$\text{Now, } \frac{dN_0}{dt} = \lambda N_0; \frac{dN_t}{dt} = \lambda N_t$$

$$9750 = \lambda N_0; 975 = \lambda N_t$$

$$\frac{N_0}{N_t} = \frac{9750}{975} = \frac{10}{1} \Rightarrow N_0 = 10N_t$$

We know that

$$N_t = N_0 e^{-\lambda t}$$

$$\frac{N_t}{N_0} = e^{-\lambda t} \Rightarrow \frac{1}{10} = e^{-\lambda \cdot 5}$$

$$10^{-1} = e^{-5\lambda}$$

Taking log on both sides,

$$-1 = -5\lambda \times \frac{1}{2.303}$$

$$\lambda = \frac{1}{5} \times 2.303 = 0.461 \text{ per minute.}$$

5. (c) After every 2.5 days its activity reduces to half the value,

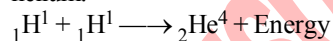
$$10 \text{ days} = \frac{10}{2.5} = 4 \text{ half lives}$$

$$\text{Reduced activity} = 1.6 \times \left(\frac{1}{2}\right)^4$$

$$= 1.6 \times \frac{1}{16} = 0.1 \text{ curie}$$

6. (b) Heavy water (D_2O) is used as a moderator in nuclear reaction.

7. (b) Fusion is the reaction responsible for the production of light energy from the Sun. In it two hydrogen molecules fuse to form helium.



8. (a) When the body is already 33% decayed to be decayed to a further 33%, it will require a period equal to its half life. So achieve level of decay from 33% to 67% it takes time equal to half life or 20 minutes.

9. (d) Energy released = total binding energy of A and B less total binding energy of X.

$$= (110 \times 8.2 + 90 \times 8.2) - (200 \times 7.4) = (902 + 738) - 1480 = 160 \text{ MeV}$$

10. (b) Let n be number of fission per second
 $n \times 200 \times 10^6 \text{ eV}$ is produced in one second
 $= n \times 200 \times 10^6 \times 1.6 \times 10^{-19} \text{ Joule per second}$

$$= \frac{n \times 200 \times 10^6 \times 1.6 \times 10^{-19}}{10^3} = 1 \text{ (given)}$$

$$n = \frac{10^3}{2 \times 1.6 \times 10^{-11}} = \frac{10^{14}}{3.2}$$

$$= \frac{10}{3.2} \times 10^{13} = 3.125 \times 10^{13}$$

11. (a) In a nuclear reactor neutrons are needed for nuclear reactions. The product of nuclear reaction is also neutrons. But fast neutrons can not induce nuclear reactions. It requires to be slowed down. Fast neutrons cannot transfer its energy to the target atom effectively due to its high velocity. So, its velocity is reduced. For it we uses heavy water.

12. (a) Neutrons ratio that is $\frac{n}{p}$ determines the stability of nucleus. (Here, n is number of neutrons and p is number of protons).

$$\text{Now, } n = 235 - 92 = 143$$

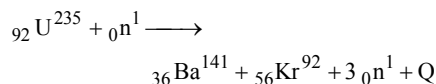
$$p = 92$$

$$\text{For } {}_{92}\text{U}^{235}; \text{Neutron ratio} = \frac{143}{92} = 1.55$$

Which is the highest no. So, ${}_{92}\text{U}^{235}$ is most unstable.

13. (a) When radioactive substance emits an α -particle then the atomic number is reduced by 2. Naturally its position in periodic table will be reduced by 2 places.

14. (b) The nuclear reaction taking place in the atom is as follows



$$Q = 200 \text{ MeV.}$$

The three neutrons generated are capable of reacting with three atoms individually which leads to chain reaction.

15. (c) Let half life = T

$$40 \text{ days} = \frac{40}{T} \text{ Half life}$$

$$\text{Ratio of substance left} = \left(\frac{1}{2}\right)^{\frac{40}{T}}$$

$$\text{So, } \left(\frac{1}{2}\right)^{\frac{40}{T}} = \left(\frac{1}{2}\right)^4$$

$$\frac{40}{T} = 4 \Rightarrow T = \frac{40}{4} = 10 \text{ days}$$

16. (a) Nuclear fusion is possible only between light nuclei as they become more stable by acquiring greater atomic no.

17. (c) In radiotracer technique we trace the existence of an atom by detecting the radiation emitted by it if atom is a radioactive one. The case as stated in the question confirms to it so it is an example of radiotracer technique.

18. (b) Positron emission tomography (PET) is a nuclear medicine medical imaging technique which produces a three dimensional image are map of functional process in the body. The positron annihilates with an electron producing a pair of annihilation photons (gamma rays) moving in opposite direction

19. (a) Binding energy per nucleon is maximum for atomic number (A) = 56, so figure (a) is correct alternative.

20. (b) Carbon dating is best suited for determining the age of fossils if their age in years is of the order of 10, 000 years. This is because

fossil older than this are destroyed due to time factor. The tracks that are built by the rays are destroyed. For fossil earlier than this, the tracks are so small that it cannot be measured with accuracy.

21. (c) Applying law of conservation of momentum

$$MV = mv$$

Let mass of each proton = m

Mass of daughter nucleus = (Am - 4m)

Mass of α -particle = 4m

$$\text{So, } (Am - 4m)V = 4m \times v$$

$$V = \frac{4mv}{m(A - 4)} = \frac{4v}{A - 4}$$

22. (b) When electron-positron pair annihilates the energy released is due to conversion of mass into energy.

$$\text{Total mass} = 2 \times 9 \times 10^{-31} \text{ kg}$$

Energy produced

$$= 2 \times 9 \times 10^{-31} \times (3 \times 10^8)^2$$

$$= 162 \times 10^{-15} = 1.62 \times 10^{-13} \text{ J}$$

23. (c) 30 days = 3 halflife

Fraction of material remained

$$= \left(\frac{1}{2}\right)^3 = \frac{1}{8} = 0.125$$

24. (a) The operation of a nuclear reactor is said to be critical if the multiplication factor is

$$k = \frac{\text{rate of production of neutrons}}{\text{rate of loss of neutrons}}$$

If $k > 1$ explosion occurs

If $k < 1$ the chain reaction comes to half.

25. (b) ${}_{92}\text{U}^{238} \longrightarrow {}_{90}\text{Th}^{234} + {}_2\text{He}^4$

26. (c) Let $\frac{p}{q}$ be the initial ratio of ${}^{14}\text{C} : {}^{12}\text{C}$. Let it

is $\frac{1}{16} \frac{p}{q}$ in the fossil. As q remains constant,

p must have reduced to $\frac{p}{16}$ during the period.

$$\frac{p}{q} = \frac{1}{16} = \frac{1}{(2)^4}$$

No. of half lives required = 4

$$\text{Age of fossil} = 4 \times 5730 = 22920 \text{ years}$$

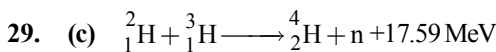
27. (c)

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28. (d) $\lambda = \frac{h}{mv}$

If they have same momentum (mv), they must have same wave length.



(Controlled thermonuclear fission reaction)

30. (c) No. of ${}^{235}\text{U}$ atoms in 2 kg of fuel

$$= \frac{6.023 \times 10^{23}}{235} \times 2000$$

fission energy per atom = 185 MeV

$\therefore$ Energy for 2 kg of fuel

$$= \frac{6.023 \times 10^{26} \times 2}{235} \times 185 \text{ MeV}$$

$$\text{Power} = \frac{\text{Energy released}}{\text{time}}$$

$$= \frac{6.023 \times 10^{26} \times 2 \times 185 \times 1.6 \times 10^{-13} \text{ J}}{235 \times 30 \text{ days}}$$

$$(\because 1 \text{ MeV} = 1.6 \times 10^{-13} \text{ J, } 30 \text{ days} = 30 \times 24 \times 60 \times 60 \text{ sec})$$

$$\therefore \text{Power} = \frac{6.023 \times 10^{26} \times 2 \times 185 \times 1.6 \times 10^{-13}}{235 \times 30 \times 24 \times 60 \times 60}$$

$$= \frac{3552 \times 10^{13}}{235 \times 3 \times 6 \times 6 \times 24 \times 10^3} \text{ W}$$

$$= \frac{3552 \times 10^{10}}{235 \times 3 \times 6 \times 6 \times 24}$$

$$= \frac{3552 \times 10^4}{235 \times 18 \times 6 \times 24} \text{ MW} = 58.3 \text{ MW}$$

31. (d) $\frac{7}{8}$ days of Cu decays.

$$\therefore \text{Cu undecayed, } N = 1 - \frac{7}{8} = \frac{1}{8} = \left(\frac{1}{2}\right)^3$$

$\therefore$ No. of half lifes = 3

$$n = \frac{t}{T} \text{ or } 3 = \frac{15}{T}$$

$$\Rightarrow \text{half life period, } T = \frac{15}{3} = 5 \text{ minutes}$$

32. (a) $\frac{-dN}{dt} = \lambda_1 N + \lambda_2 N \Rightarrow \log_e \frac{N}{N_0} = -(\lambda_1 + \lambda_2)t$

where N_0 is initial no. of atom

$$\text{Here } \lambda_1 = \frac{0.693}{1620} \text{ and } \lambda_2 = \frac{0.693}{810}$$

$$\frac{N}{N_0} = \frac{1}{4} \Rightarrow \log_e \frac{1}{4} = -\left(\frac{0.693}{1620} + \frac{0.693}{810}\right)t$$

$$\Rightarrow 2.303[-2 \times (.3010)]$$

$$= -0.693\left(\frac{0.693}{1620} + \frac{0.693}{810}\right)t$$

$$\Rightarrow \frac{2 \times 1620 \times 810}{2430} = t = 1080 \text{ year.}$$

33. (a) High binding energy per nucleon ensures very high life of the nuclide. Hence they should be abundant in nature.

34. (a) $R = R_0 e^{-\lambda t}$

$$\Rightarrow \frac{1}{3} = e^{-\lambda \times 3} = e^{-3\lambda} \quad \dots(1)$$

Let activity in 9 days be R' . Then

$$\frac{R'}{R_0} = e^{-\lambda \times 9} = e^{-9\lambda} \quad e^{-\lambda \times 3} = (e^{-3\lambda})^3$$

$$= \left(\frac{1}{3}\right)^3, \quad \text{from (1)}$$

$$= \frac{1}{27} \Rightarrow R' = \frac{R_0}{27}.$$

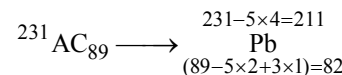
35. (d) We have, $\frac{dN}{dt} = \lambda N$

$$\lambda = \frac{0.693}{T} = \frac{0.693}{1.2 \times 10^7}$$

$$\frac{dN}{dt} = \frac{0.693}{1.2 \times 10^7} \times 4 \times 10^{15}$$

$$= 2.3 \times 10^8 \text{ atom/s}$$

36. (d) Five alpha and three beta particles results



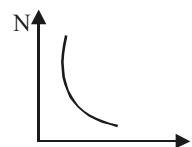
37. (c) No. of nuclide at time t is given by

$$N = N_0 e^{-\lambda t}$$

Where N_0 = initial nuclide

thus this equation is equivalent to $y = ae^{-kx}$

Thus correct graph is



38. (b) ${}_{-1}e^0$ is known as β^- particle & $\bar{\nu}$ is known as antineutrino. Since in this reaction $\bar{\nu}$ is emitted with ${}_{-1}e^0$ (β^- particle or electron), so it is known as β -decay.

39. (c) $\frac{C_{14}}{C_{12}} = \frac{1}{4} = \left(\frac{1}{2}\right)^{t/5700}$
 $\Rightarrow \frac{t}{5700} = 2 \Rightarrow t = 11400$ years

40. (c) $\frac{dN}{dt} = n - \lambda N$
 $dN = (n - \lambda N)dt$
 $\int_{N_0}^N \frac{dN}{n - \lambda N} = \int_0^t dt \Rightarrow -\frac{1}{\lambda} \int_{N_0}^N \frac{-\lambda dN}{n - \lambda N} = t$
 $\Rightarrow -\frac{1}{\lambda} [\log_e (n - \lambda N)]_{N_0}^N = t$
 $\Rightarrow -\frac{1}{\lambda} \left[\log_e \left(\frac{n - \lambda N}{n - \lambda N_0} \right) \right] = t$
 $\Rightarrow \lambda t = \left[\log_e \left(\frac{n - \lambda N_0}{n - \lambda N} \right) \right]$
 $e^{\lambda t} = \frac{n - \lambda N_0}{n - \lambda N}$

$$n - \lambda N = (n - \lambda N_0) e^{-\lambda t}$$

$$\frac{n}{\lambda} - \left(\frac{n}{\lambda} - N_0 \right) e^{-\lambda t} = N$$

41. (c) $\frac{{}^{14}\text{C}}{{}^{12}\text{C}} = \frac{1}{16} = \frac{N}{N_0}$
 $\therefore \frac{N}{N_0} = \left(\frac{1}{2}\right)^n$
 $\Rightarrow \frac{1}{16} = \left(\frac{1}{2}\right)^n \Rightarrow \left(\frac{1}{2}\right)^4 = \left(\frac{1}{2}\right)^n$
 or, $n = 4$
 or $\frac{t}{T} = 4$
 or $t = 4 \times T = 4 \times 5730 = 22920$ years

42. (c) Energy is released in a process when total binding energy (BE) of products is more than the reactants. By calculations we can see that this happens in option (c).

Given $W = 2Y$

BE of reactants = $120 \times 7.5 = 900$ MeV

BE of products = $2 \times (60 \times 8.5) = 1020$ MeV.

43. (d) $N = N_0 e^{-\lambda t}$

Here, $t = 5$ minutes

$$\frac{N_0}{e} = N_0 \cdot e^{-5\lambda}$$

$$\Rightarrow 5\lambda = 1, \text{ or } \lambda = \frac{1}{5}$$

$$\text{Now, } T_{1/2} = \frac{\ell n 2}{\lambda} = 5 \ell n 2$$

Type B : Assertion Reason Questions

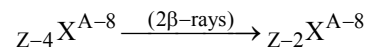
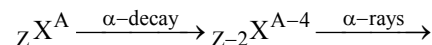
44. (b) By definition, isobars are elements having same mass number but different atomic number. Presence of neutron and proton inside nucleus has nothing to do with this definition.

45. (e) Half life of radioactive substance is 40 days. It means 50% substance decays in 40 days. During this period rate of decay is on decrease. So, 25% decay must have taken place is less than 20 days.

$$N = N_0 \left(\frac{1}{2}\right)^n, \text{ where } n = \frac{\text{time elapsed}}{\text{half life period}}$$

46. (e) Isotope of an element can be separated by using a mass spectrometer because isotopes have different atomic mass. Alternative (e) is correct.

47. (a) The reason given is true. If we test the authenticity of assertion,



47. (c) Radioactive nuclei emit β -particles. This β -particle comes from the splitting of neutron into β -particle and proton.

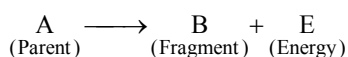
48. (b) Neutron is penetrate more readily as compared to protons because neutrons do not carry any charge so there is no repulsion between nucleus and neutrons. So assertion is true reason is also true as mass of neutron is more than proton but reason does not explain assertion.

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49. (a) RBC of blood are produced in the bone marrow. The radiation from the radioactive substances destroys of bone marrow which result in hampered production of RBC.

50. (a) Total binding energy of fragment nucleus is more than total binding energy of parent nucleus. Since, binding energy results in decrease of total energy. Hence there is great decrease in energy fragment nucleus because energy is released in nuclear fission.



Energy of B is decrease but the binding energy of B is increased due to release of energy from it. So, reason supports the assertion.

51. (a)

52. (c) Since, ^{35}Cl is stable so binding energy is high. So it is not capable of disintegration.

53. (a) Binding energy per nucleon decreases with A for nuclei with atomic mass number $A > 100$ due to weak nuclear forces. It can be explain as :

At short distances, the nuclear force is stronger than the Coulomb force; it can overcome the Coulomb repulsion of protons inside the nucleus. At typical nucleon separation (1.3 fm) it is a very strong attractive force (104 newtons). Beyond about 1.3 fm separation, the force exponentially dies off to zero. However, the Coulomb force between protons has a much larger range and becomes the only significant force between protons when their separation exceeds about (2.5 fm, $A > 100$).

54. (a) Cobalt 60 is radioactive isotope of cobalt. γ -radiation emitted by it is used in radiation therapy is cancer as it destroys cancerous cells.

So, assertion and reason is true and reason explains assertion.

55. (c) Heavy water has better ability to slow down neutrons by elastic collision between their protons and neutrons hence they are better moderators. Heavy water does not absorb neutrons.

56. (a)

57. (a)

58. (b) β -particles, being emitted with very high speed compared to α -particles, pass for very little time near the atoms of the medium. So the probability of the atoms being ionised is comparatively less. But due to this reason, their loss of energy is very slow and they can penetrate the medium through a sufficient depth.

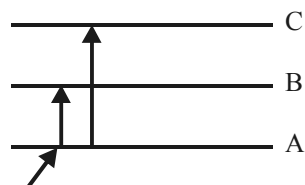
59. (c) We know that energy is released when heavy nuclei undergo fission or light nuclei undergo fusion. Therefore Assertion is correct.

The Reason is incorrect because for heavy nuclei the binding energy per nucleon decreases with increasing Z and for light nuclei, B.E/nucleon increases with increasing Z.

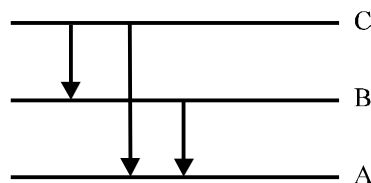
60. (d) We know that energy is released when heavy nuclei undergo fission or light nuclei undergo fusion. Therefore Assertion is correct.

The Reason is incorrect because for heavy nuclei the binding energy per nucleon decreases with increasing Z and for light nuclei, B.E/nucleon increases with increasing Z.

61. (a) Absorption transition



Two possibilities in absorption transition.



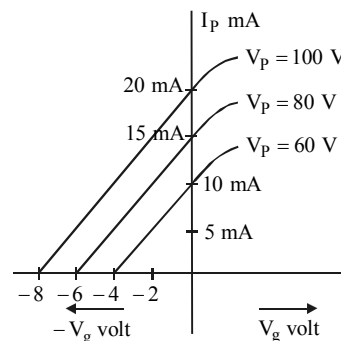
Three possibilities in emission transition. Therefore, absorption transition < emission.

Semi-Conductor, Electronics : Materials, Devices and Simple Circuits

TYPE A : MULTIPLE CHOICE QUESTIONS

- In p-type semiconductor major current carriers are: [1997]
(a) negative ions (b) holes
(c) electrons (d) all of these
- In a diode, when there is a saturation current, the plate resistance will be [1997]
(a) data insufficient
(b) zero
(c) some finite quantity
(d) infinite quantity
- When the two semiconductors *p*- and *n*-type are brought into contact they form a *p-n* junction, which acts like a/an: [1997]
(a) rectifier (b) amplifier
(c) conductor (d) oscillator
- The transfer ratio β of a transistor is 50. The input resistance of the transistor when used in the common emitter configuration is $1\text{ k}\Omega$. The peak value of the collector A.C. current for an A.C. input voltage of 0.01 V , is [1998]
(a) $500\text{ }\mu\text{A}$ (b) $0.25\text{ }\mu\text{A}$
(c) $0.01\text{ }\mu\text{A}$ (d) $100\text{ }\mu\text{A}$
- When n-p-n transistor is used as an amplifier, then [1999]
(a) electrons move from base to collector
(b) holes move from emitter to base
(c) electrons move from collector to base
(d) holes move from base to emitter
- Boolean algebra is essentially based on: [1999]
(a) Numbers (b) Symbol
(c) Logic (d) Truth
- A triode valve has an amplification factor of 20 and its plate is given a potential of 300 V . The grid voltage to reduce the plate current to zero, is [1999]
(a) 25 V (b) 15 V
(c) 12 V (d) 10 V
- Diode is used as a/an [1999]
(a) modulator (b) rectifier
(c) oscillator (d) amplifier
- In n-type semiconductor, majority charge carriers are [1999]
(a) electrons (b) neutrons
(c) holes (d) protons
- In a full wave rectifier circuit operating from 50 Hz mains frequency, what is the fundamental frequency in the ripple? [2000]
(a) 50 Hz (b) 100 Hz
(c) 70 Hz (d) 25 Hz
- | A | B | Q |
|---|---|---|
| 0 | 0 | 0 |
| 0 | 1 | 1 |
| 1 | 0 | 1 |
| 1 | 1 | 1 |

The truth table given above for which of the following gates is correct [2000]
(a) NAND gate (b) OR gate
(c) AND gate (d) NOT gate
- The variation of anode current in a triode valve corresponding to a change in grid potential at three different values of the plate potential is shown in the given figure. The mutual conductance of triode is [2000]

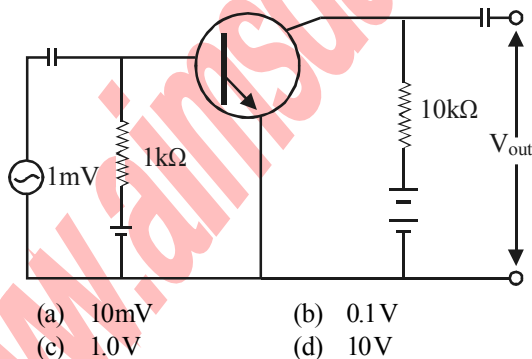


- (a) $5 \times 10^{-3}\text{ mho}$ (b) $2.5 \times 10^{-3}\text{ mho}$
(c) $7.5 \times 10^{-3}\text{ mho}$ (d) $9.5 \times 10^{-3}\text{ mho}$

- Which one of the following is true about the p-type and n-type semi-conductor? [2001]
(a) n-type semi-conductor have holes in majority.

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- (b) the concentration of electrons and holes are equal in both n-type and p-type semi-conductors.
- (c) n-type semi-conductors have free electrons in majority.
- (d) p-type semi-conductor has excess negative charge.
14. When added an impurity into the silicon which one of the following produces n-type of semi-conductors : [2001]
- (a) iron (b) magnesium
- (c) aluminium (d) phosphorous
15. At 0 K temperature, a p-type semiconductor [2002]
- (a) has equal number of holes and free electrons
- (b) has few holes but no free electrons
- (c) has few holes and few free electrons
- (d) does not have any charge carriers
16. The value of current gain α of a transistor is 0.98. The value of β will be [2002]
- (a) 490 (b) 4.9
- (c) 59 (d) 49
17. To a germanium sample, traces of gallium are added as an impurity. The resultant sample would behave like : [2003]
- (a) a conductor
- (b) a p-type semi-conductor
- (c) an n-type semi-conductor
- (d) an insulator
18. In the following common emitter configuration an npn transistor with current gain $\beta = 100$ is used. The output voltage of the amplifier will be : [2003]



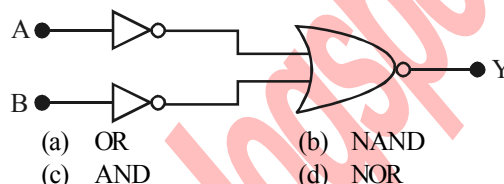
19. A Ge specimen is doped with Al. The concentration of acceptor atoms is $\sim 10^{21}$ atoms/ m^3 . Given that the intrinsic concentration of

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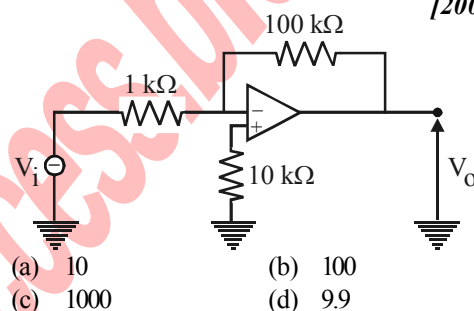
electron-hole pairs is $\sim 10^{19}/\text{m}^3$, the concentration of electrons in the specimen is [2004]

- (a) $10^{17}/\text{m}^3$ (b) $10^{15}/\text{m}^3$
- (c) $10^4/\text{m}^3$ (d) $10^2/\text{m}^3$

20. Which logic gate is represented by the following combination of logic gates ? [2004]



21. The voltage gain of the following amplifier is [2005]



22. Which of the following logic gates is an universal gate ? [2005]

- (a) OR (b) NOT
- (c) AND (d) NAND

23. Consider an n-p-n transistor amplifier in common emitter configuration. The current gain of the transistor is 100. If the collector current changes by 1mA, what will be the change in emitter current [2005]
- (a) 1.1 mA (b) 1.01 mA
- (c) 0.01 mA (d) 10 mA

24. In a semi-conducting material the mobilities of electrons and holes are μ_e and μ_h respectively. Which of the following is true ? [2005]

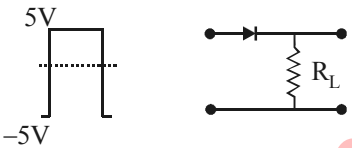
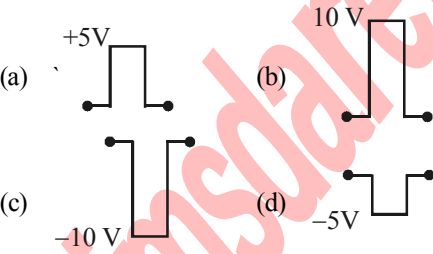
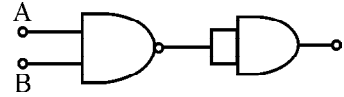
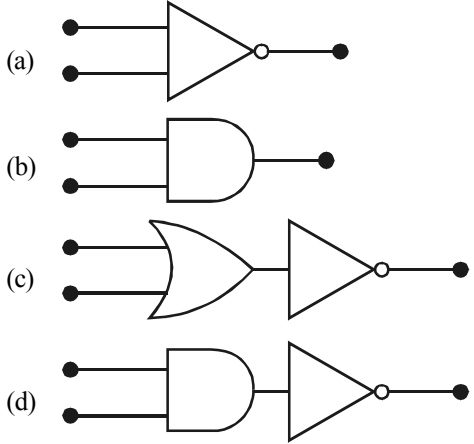
- (a) $\mu_e > \mu_h$ (b) $\mu_e < \mu_h$
- (c) $\mu_e = \mu_h$ (d) $\mu_e = 0; \mu_h > 0$

25. When a p-n diode is reverse biased, then [2006]

- (a) no current flows
- (b) the depletion region is increased
- (c) the depletion region is reduced
- (d) the height of the potential barrier is reduced

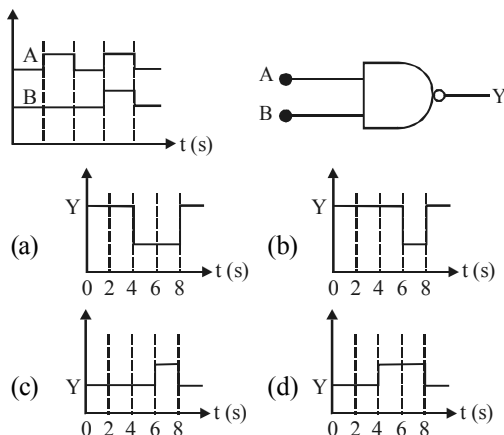
26. An amplifier has a voltage gain $A_v = 1000$. The voltage gain in dB is: [2006]

- (a) 30 dB (b) 60 dB
- (c) 3 dB (d) 20 dB

27. If the highest modulating frequency of the wave is 5 kHz, the number of stations that can be accommodated in a 150 kHz bandwidth are [2007]
 (a) 15 (b) 10
 (c) 5 (d) none of these
28. Zener diode acts as a/an [2007]
 (a) oscillator (b) regulator
 (c) rectifier (d) filter
29. In the half wave rectifier circuit operating from 50 Hz mains frequency, the fundamental frequency in the ripple would be [2007]
 (a) 25 Hz (b) 50 Hz
 (c) 70.7 Hz (d) 100 Hz
30. A transistor is a/an [2007]
 (a) chip (b) insulator
 (c) semiconductor (d) metal
31. If collector current is 120 mA and base current is 2 mA and resistance gain is 3, what is power gain? [2007]
 (a) 180 (b) 10800
 (c) 1.8 (d) 18
32. If in a p-n junction diode, a square input signal of 10 V is applied as shown [2008]
- 
- Then the output signal across R_L will be
- 
33. The input resistance of a common emitter transistor amplifier, if the output resistance is $500\text{ k}\Omega$, the current gain $\alpha = 0.98$ and power gain is 6.0625×10^6 , is [2008]
 (a) $198\text{ }\Omega$ (b) $300\text{ }\Omega$
 (c) $100\text{ }\Omega$ (d) $400\text{ }\Omega$
34. Mobilities of electrons and holes in a sample of intrinsic Ge at room temperature are $0.35\text{ m}^2/\text{V-s}$ and $0.18\text{ m}^2/\text{V-s}$ respectively. If the electron and hole densities are each equal to $2.5 \times 10^{19}/\text{m}^3$, the Ge conductivity will be [2010]
 (a) 3.12 S/m (b) 2.12 S/m
 (c) 1.12 S/m (d) 4.12 S/m
35. An LED (Light Emitting Diode) is constructed from a p-n junction based on a certain Ga-As-P semi-conducting material whose energy gap is 1.9 eV. What is the wavelength of the emitted light? [2010]
 (a) 650 nm (b) $65\text{ \AA}$
 (c) 800 nm (d) $8000\text{ \AA}$
36. In n-p-n transistor circuit the collector current is 10 mA. If 90% of the electron reach the collector, then emitter current will be [2010]
 (a) 1 mA (b) 0.1 mA
 (c) 2 mA (d) nearly 11 mA
37. The cause of the potential barrier in a p-n junction diode is [2011]
 (a) depletion of positive charges near the junction
 (b) concentration of positive charges near the junction
 (c) depletion of negative charges near the junction
 (d) concentration of positive and negative charges near the junction
38. Identify the logic operation of the following logic circuit : [2011]
- 
- (a) NAND (b) AND
 (c) NOR (d) OR
39. Which represents NAND gate ? [2012]
- 

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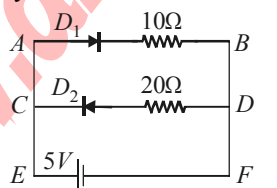
40. The real time variation of input signals A and B are as shown below. If the inputs are fed into NAND gate, then select the output signal from the following. [2012]



41. An oscillator is nothing but an amplifier with
(a) positive feedback [2013, 2014]
(b) large gain
(c) no feedback
(d) negative feedback
42. Following diagram performs the logic function of [2006, 2014]



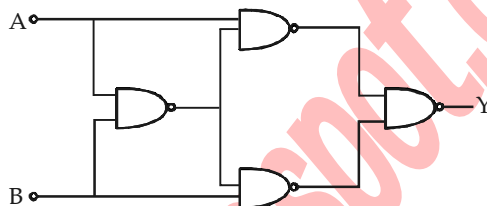
- (a) XOR gate (b) AND gate
(c) NAND gate (d) OR gate
43. Carbon, Silicon and Germanium atoms have four valence electrons each. Their valence and conduction bands are separated by energy band gaps represented by $(E_g)_C$, $(E_g)_{Si}$ and $(E_g)_{Ge}$ respectively. Which one of the following relationship is true in their case? [2015]
(a) $(E_g)_C > (E_g)_{Si}$ (b) $(E_g)_C < (E_g)_{Si}$
(c) $(E_g)_C = (E_g)_{Si}$ (d) $(E_g)_C < (E_g)_{Ge}$
44. Two ideal diodes are connected to a battery as shown in the circuit. The current supplied by the battery is [2017]



- (a) 0.75 A (b) 0.5 A
(c) 0.25 A (d) zero

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45. Truth table for system of four NAND gates as shown in figure is [2017]



A	B	Y
0	0	0
0	1	1
1	0	1
1	1	0

A	B	Y
0	0	1
0	1	1
1	0	0
1	1	0

A	B	Y
0	0	0
0	1	0
1	0	1
1	1	1

A	B	Y
0	0	1
0	1	0
1	0	1
1	1	1

TYPE B : ASSERTION REASON QUESTIONS

Directions for (Qs. 46-52) : These questions consist of two statements, each printed as Assertion and Reason. While answering these questions, you are required to choose any one of the following five responses.

- (a) If both Assertion and Reason are correct and the Reason is a correct explanation of the Assertion.
(b) If both Assertion and Reason are correct but Reason is not a correct explanation of the Assertion.
(c) If the Assertion is correct but Reason is incorrect.
(d) If both the Assertion and Reason are incorrect.
(e) If the Assertion is incorrect but the Reason is correct.
46. **Assertion :** The resistivity of a semi-conductor increases with temperature.
Reason : The atoms of semi-conductor vibrate with larger amplitude at higher temperatures thereby increasing its resistivity. [2003]
47. **Assertion :** In a transition the base is made thin.
Reason : A thin base makes the transistor stable. [2004]
48. **Assertion :** The logic gate NOT can be built using diode.
Reason : The output voltage and the input voltage of the diode have 180° phase difference. [2005]

49. **Assertion :** The number of electrons in a p-type silicon semiconductor is less than the number of electrons in a pure silicon semiconductor at room temperature.

Reason : It is due to law of mass action. [2005]

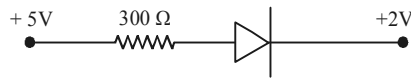
50. **Assertion :** In a common emitter transmitter amplifier the input current is much less than the output current.

Reason : The common emitter transistor amplifier has very high input impedance. [2005]

51. **Assertion :** In common base configuration, the current gain of the transistor is less than unity.

Reason : The collector terminal is reverse biased for amplification. [2006]

52. **Assertion :** The value of current through p-n junction in the given figure will be 10 mA.



Reason : In the above figure, p-side is at higher potential than n-side. [2008]

Directions for (Qs. 53-57) : Each of these questions contains an Assertion followed by Reason. Read them carefully and answer the question on the basis of following options. You have to select the one that best describes the two statements.

- (a) If both Assertion and Reason are correct and Reason is the correct explanation of Assertion.

- (b) If both Assertion and Reason are correct, but Reason is not the correct explanation of Assertion.

- (c) If Assertion is correct but Reason is incorrect.

- (d) If both the Assertion and Reason are incorrect.

53. **Assertion :** NAND or NOR gates are called digital building blocks.

Reason : The repeated use of NAND (or NOR) gates can produce all the basic or complicated gates. [2011]

54. **Assertion :** A p-n junction with reverse bias can be used as a photo-diode to measure light intensity.

Reason : In a reverse bias condition the current is small but is more sensitive to changes in incident light intensity. [2012]

55. **Assertion :** If the temperature of a semiconductor is increased then its resistance decreases.

Reason : The energy gap between conduction band and valence band is very small. [2015]

56. **Assertion :** A transistor amplifier in common emitter configuration has a low input impedance.

Reason : The base to emitter region is forward biased. [2016]

57. **Assertion :** Diode lasers are used as optical sources in optical communication.

Reason : Diode lasers consume less energy. [2017]

HINTS & SOLUTIONS

Type A : Multiple Choice Questions

1. (b) In p-type semiconductor, holes predominate, so, holes are major current carriers.

2. (d) Dynamic plate resistance = $\frac{\Delta V}{\Delta I}$
In case of saturation current, $\Delta I = 0$
Plate resistance = ∞

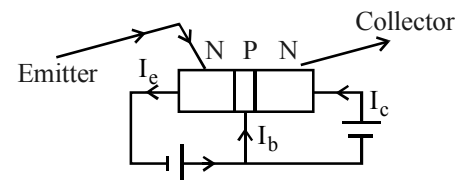
3. (a) In case of diode (formed by p-n junction) it acts as rectifier. It means it conducts only in case of forward biasing & not in reverse biasing.

4. (a) $\beta = \frac{I_c}{I_b} \Rightarrow I_b = \frac{0.01}{1 \times 10^3} = 10^{-5}$

$$\text{or } 50 = \frac{I_c}{10^{-5}} \Rightarrow I_c = 50 \times 10^{-5} = 500 \times 10^{-6}$$

$$I_c = 500 \mu\text{A}$$

5. (a)



The connection in case of n-p-n transistor is shown in the figure. Current is flowing from collector to base so electrons will flow in reverse direction i.e., from base to collector.

6. (c) Boolean algebra is based on logic.

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7. (b) Amplification factor = $20 = \frac{\text{Plate potential}}{\text{Grid potential}}$

$$20 = \frac{300}{V} \Rightarrow V = \frac{300}{20} = 15V$$

8. (b) In diode, current can flow only in one direction. In reverse bias it does not work. So, it is used as rectifier.
9. (a) In n-type semiconductor we add pentavalent impurities so there is excess of electrons inside the material. So, majority charge carriers are electrons.

10. (b) 
- Frequency = 1 Frequency = 2
Unrectified wave Rectified wave
- In case of full wave rectification, frequency becomes twice.

$$\text{So, new frequency} = 50 \times 2 = 100\text{Hz}$$

11. (b) Given table represents 'OR' gate.

12. (b) Mutual conductance

$$= \frac{\Delta I_p}{\Delta V_g} = \frac{5 \times 10^{-3}}{2} = 2.5 \times 10^{-3} \text{ mho}$$

13. (c) n-type semiconductors have free electrons in majority p-type semiconductors have holes in majority.
14. (d) Phosphorus which is pentavalent produces n-type semiconductor. Here only four electrons of phosphorus are used in making bonds with silicon crystal. The fifth electron remains free.
15. (d) At 0 K an electron hole pair is formed as all the electrons remain in the valence band. So we can say that there is no charge carrier at this temperature.

16. (d) $\alpha = \frac{I_c}{I_e}$ and $\beta = \frac{I_c}{I_b}$

[I_c , I_b and I_e are collector, base and emitter current]

$$I_e = I_c + I_b \Rightarrow \frac{I_e}{I_c} = 1 + \frac{I_b}{I_c}$$

$$\frac{1}{\alpha} = 1 + \frac{1}{\beta} \Rightarrow \beta = \frac{\alpha}{1 - \alpha} = \frac{0.98}{1 - 0.98}$$

$$= \frac{0.98}{0.02} = 49$$

17. (b) Gallium is a trivalent atom so, the resultant sample will behave as p-type semiconductor.

18. (c) $\beta = \frac{I_c}{I_b}$

$$\text{Here, } I_c = \frac{V}{10 \times 10^3} = \frac{V}{10^4}$$

$$I_b = \frac{1 \times 10^{-3}}{10 \times 10^3} = 10^{-6}; \beta = 100$$

$$\text{Now, } 100 = \frac{I_c}{I_b} = \frac{V}{10^4} \times 10^{-6}$$

$$V = 100 \times 10^4 \times 10^{-6} = 1 \text{ volt.}$$

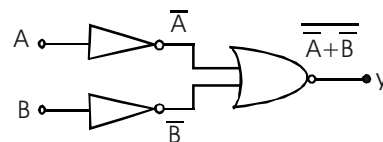
19. (a) $n_e n_h = n_i^2$
 n_e is concentration of electron, n_h is concentration of holes and n_i is concentration of electron hole pairs in intrinsic semi-conductor.

$$\text{Here } n_h = 10^{21}, n_e = ?, n_i = 10^{19}$$

$$10^{21} \times n_e = 10^{19} \times 10^{19}$$

$$n_e = \frac{10^{38}}{10^{21}} = 10^{17} \text{ m}^{-3}$$

20. (c) This is a case of AND gate. Input & output are shown below



$$\therefore y = \overline{\overline{A + B}} = \overline{\overline{A} \cdot \overline{B}} = AB \text{ (since } \overline{\overline{A + B}} = \overline{\overline{A} \cdot \overline{B}})$$

21. (b) Voltage gain = $\frac{\text{output voltage } (V_o)}{\text{input voltage } (V_i)}$

From Ohm's law $V = iR$

$$\therefore \text{Voltage gain, } A_v = \frac{R}{R_i} = \frac{100\text{k}\Omega}{1\text{k}\Omega} = 100$$

22. (d) NAND gate is considered universal gate. As other gates can be formed from this gate.

23. (b) $100 = \frac{\Delta I_c}{\Delta I_b} \Rightarrow \Delta I_b = \frac{1}{100} \text{ mA} = 0.01 \text{ mA}$

$$\Delta I_e = \Delta I_c + \Delta I_b = 1 + 0.01 = 1.01 \text{ mA}$$

24. (a) Mobility of electron is more than that of holes.

25. (b) When p-n junction is reverse biased, the depletion region is increased i.e., the potential barrier increased.

26. (a) Voltage gain = $\log 1000$ Bel
 $\log 10^3 = 3\text{Bel} = 30\text{ dB}$ [1 Bel = 10 dB]
 27. (a) In case of complex audio signals,
 bandwidths (B.W) = $2 \times$ maximum frequency
 of modulating signal = $2 \times 5\text{ kHz} = 10\text{ kHz}$.
 This is B.W for one channel.

$$\therefore \text{No. of stations} = \frac{\text{Total B.W}}{\text{B.W for each channel}}$$

$$= \frac{150\text{ kHz}}{10\text{ kHz}} = 15$$

28. (b) Zener diode is used to supply constant voltage in voltage regulator circuit hence option (b) is correct.
 29. (b) In half wave rectifier, negative half of an a.c. cycle is removed from the sinusoidal pulse, but the time lag between two positive pulses is same, hence frequency remains same as the input (mains) frequency i.e., 50 Hz.
 30. (c) As transistor is made of two p-types with n-type semiconductor in between or two n-types with p-type in between.
 31. (b) $I_c = 120\text{ mA}$, $I_b = 2\text{ mA} \Rightarrow I_e = I_b + I_c$
 (emitter current)

$$\Rightarrow I_e = 120 + 2 = 122\text{ mA}$$

$$\text{Resistance gain} = 3$$

$$\text{d.c power gain}$$

$$= (\text{current gain})^2 \times \text{resistance gain}$$

$$= \left(\frac{I_c}{I_b} \right)^2 \times \text{resistance gain}$$

$$= \left(\frac{120}{2} \right)^2 \times 3$$

$$= (60)^2 \times 3 = 3600 \times 3 = 10800$$

32. (a) The current will flow through R_L when the diode is forward biased.

33. (a) $R_0 = 500\text{ k}\Omega$; $\alpha = 0.98$
 Power gain = 6.0625×10^6

$$\text{we have, voltage gain } A_V = \beta \cdot \frac{R_0}{R_i}$$

$$\text{But current gain,}$$

$$\beta = \frac{\alpha}{1 - \alpha} = \frac{0.98}{1 - 0.98} = 49$$

$$\therefore A_V = 49 \times \frac{500 \times 10^3}{R_i} = \frac{24.5 \times 10^6}{R_i}$$

$$\text{Given } 6.0625 \times 10^6 = A_V \times \beta$$

$$= \left(\frac{24.5 \times 10^6}{R_i} \right) \times 49$$

$$\text{or } R_i = \frac{24.5 \times 49}{6.0625} = 198\ \Omega$$

34. (b) Conductivity of Ge
 $\sigma = e(n_e \mu_e + n_h \mu_h)$
 Here $n_e = n_h = 2.5 \times 10^{19}/\text{m}^3$
 $e = 1.6 \times 10^{-19}\text{C}$,
 $\mu_e = 0.35\text{ m}^2/\text{V-s}$, $\mu_h = 0.18\text{ m}^2/\text{V-s}$
 $\therefore \sigma = 1.6 \times 10^{-19}$
 $(2.5 \times 10^{19} \times 0.35 + 2.5 \times 10^{19} \times 0.18)$
 $= 1.6 \times 10^{-19} \times 2.5 \times 10^{19} \times 0.53$
 $= 2.12\text{ S/m}$

35. (a) The wavelength of emitted light

$$\lambda = \frac{hc}{E_g}$$

$$\text{where } E_g = \text{energy gap of semiconductor}$$

$$= 1.9\text{ eV}$$

$$= 1.9 \times 1.6 \times 10^{-19}\text{ V}$$

$$\lambda = \frac{6.6 \times 10^{-34} \times 3 \times 10^8}{1.9 \times 1.6 \times 10^{-19}}\text{ m}$$

$$= 6.5 \times 10^{-7}\text{ m}$$

$$= 650 \times 10^{-9}\text{ m}$$

$$= 650\text{ nm}$$

36. (d) $I_c = 10\text{ mA}$; $I_e = I_c + I_b$

$$\text{If } I_c = 90\% \text{ of } I_e,$$

$$\text{then } I_c = \frac{90}{100} \times I_e$$

$$\Rightarrow I_c = \frac{100}{90} I_e$$

37. (d) During the formation of a junction diode, holes from p-region diffuse into n-region and electrons from n-region diffuse into p-region. In both cases, when an electrons meets a hole, they cancel the effect at each other and as a result, a thin layer at the junction becomes free from any of charges carriers. This is called depletion layer. There is a potential gradient in the depletion layer, negative on the p-side, and positive on the n-side. The potential difference thus developed across the junction is called potential barrier.

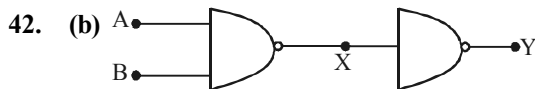
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38. (b) NAND + NAND
 $\Rightarrow$ AND
39. (d) NAND is combination of AND gate and NOT gate.
40. (b) From input signals, we have,

A	B	Output NAND gate
0	0	1
1	0	1
0	1	1
1	1	0
0	0	1

The output signal is shown at B.

41. (a)



$$X = \overline{AB}$$

$$\therefore Y = \overline{X} = \overline{\overline{AB}}$$

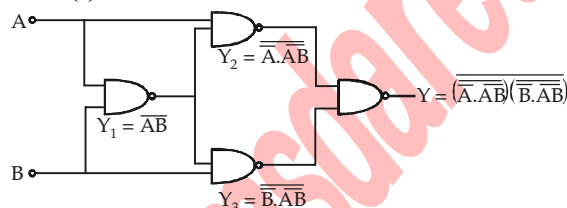
$Y = AB$ by Demorgan theorem

$\therefore$ This diagram performs the function of AND gate.

43. (a) Due to strong electronegativity of carbon.
44. (b) Here D_1 is in forward bias and D_2 is in reverse bias so, D_1 will conduct and D_2 will not conduct. Thus, no current will flow through DC.

$$I = \frac{V}{R} = \frac{5}{10} = \frac{1}{2} \text{ A}$$

45. (a)



By expanding this Boolean expression

$$Y = A.\overline{A}.B + B.\overline{A}.B$$

Type B : Assertion Reason Questions

46. (d) The resistivity of semiconductor decreases with increase in temperature as more electrons jump into conduction band increasing its conductivity.
47. (c) In a transistor the base is made thin so that base current remains small and we can get output or collector current. We know that

$$I_c = I_e - I_b$$

Reason is incorrect.

Topicwise AIIMS Solved Papers – PHYSICS

48. (d) The diode is unidirectional it allows current to pass through it in a particular direction. It does not change the phase of input signal.
49. (a) We know that $n_e n_h = n_i^2$
 This formula is based on law of mass action.
 In p-type semiconductor $n_h > n_i$
 So, $n_e < n_i$
50. (c) In an amplifier output current is always more than input current. Amplifier has low input impedance.
51. (b) For common base, Input is I_c and output is I_e .
 Current gain = $\frac{I_c}{I_e} = \frac{I_c}{I_c + I_b}$ which is less than unity.

Collector terminal is reversed biased to increase the collector current. Both Assertion and Reason are correct but they are uncorrelated statements.

52. (b) The p-side of the junction diode is at a higher potential than the n-side. So p-n junction is forward biased. Hence a current flows through it and is given by
- $$I = \frac{V}{R} = \frac{5-2}{300} = 10^{-2} \text{ A} = 10 \text{ mA}$$

53. (a) These gates are called digital building blocks because using these gates only (either NAND or NOR) we can compile all other gates also (like OR, AND, NOT, XOR).
54. (a)
55. (a) In semiconductors the energy gap between conduction band and valence band is small ($\approx 1 \text{ eV}$). Due to temperature rise, electron in the valence band gain thermal energy and may jump across the small energy gap, (to the conduction band). Thus conductivity increases and hence resistance decreases.
56. (a) Input impedance of common emitter configuration.

$$= \left| \frac{\Delta V_{BE}}{\Delta i_B} \right|_{V_{CE} = \text{constant}}$$

where ΔV_{BE} = voltage across base and emitter (base emitter region is forward biased)

Δi_B = base current which is order of few microampere.

57. (c)

TYPE A : MULTIPLE CHOICE QUESTIONS

1. In communication with help of antenna if height is double then the range covered which was initially r would become [2007]
 - (a) $\sqrt{2}r$
 - (b) $3r$
 - (c) $4r$
 - (d) $5r$
2. Communication on ground is through electromagnetic waves of wavelength [2010]
 - (a) larger than 600 m
 - (b) between 200 and 600 m
 - (c) between 1 and 5 m
 - (d) between 10^{-3} and 0.1
3. 12 signals each band limited to 5 kHz are to be transmitted by frequency-division multiplexer. If AM-SSB modulation guard band of 1 kHz is used then the bandwidth of multiplexed signal is [2012]
 - (a) 101 kHz
 - (b) 99 kHz
 - (c) 84 kHz
 - (d) 71 kHz
4. For 100% modulation (AM), the useful part of the total power radiated is [2013]
 - (a) $\frac{1}{2}$ of the total power
 - (b) $\frac{1}{3}$ of the total power
 - (c) $\frac{1}{4}$ of the total power
 - (d) $\frac{2}{3}$ of the total power
5. Sky wave propagation is not possible for frequencies [2014]
 - (a) equal to 30 MHz
 - (b) less than 30 MHz
 - (c) greater than 30 MHz
 - (d) None of these

6. For 100% modulation (AM), the useful part of the total power radiated is [2015]
 - (a) $\frac{1}{2}$ of the total power
 - (b) $\frac{1}{3}$ of the total power
 - (c) $\frac{1}{4}$ of the total power
 - (d) $\frac{2}{3}$ of the total power
7. For transmission of e.m. wave of audible frequency, these waves are superimposed with waves of [2017]
 - (a) frequency less than 20 Hz
 - (b) frequency between 20 Hz and 10 KHz
 - (c) frequency in the audible range
 - (d) radio-frequency

TYPE B : ASSERTION REASON QUESTIONS

Directions for (Qs. 8) : These questions consist of two statements, each printed as Assertion and Reason. While answering these questions, you are required to choose any one of the following five responses.

- (a) If both Assertion and Reason are correct and the Reason is a correct explanation of the Assertion.
 - (b) If both Assertion and Reason are correct but Reason is not a correct explanation of the Assertion.
 - (c) If the Assertion is correct but Reason is incorrect.
 - (d) If both the Assertion and Reason are incorrect.
 - (e) If the Assertion is incorrect but the Reason is correct.
8. **Assertion :** Optical fibres are used for telecommunication.
Reason : Optical fibres are based on the phenomenon of total internal reflection. [2007]

HINTS & SOLUTIONS

Type A : Multiple Choice Questions

1. (a) Range of antenna = $r\sqrt{2hr}$, h = height of antenna,
 R = radius of earth
 if h is doubled i.e., $h' = 2h$, then new range
 $r' = \sqrt{2h'r}$
 $\Rightarrow r' = \sqrt{2 \cdot 2hr} = \sqrt{2}\sqrt{2hr} = \sqrt{2}r$
2. (d) The required wavelength should be from 10^{-3}m to 0.1m .
 $\Rightarrow I_e = \frac{100}{90} \times 10\text{mA} \approx 11.1\text{mA}$
3. (d) Total signal B.W = $12 \times 5 = 60\text{kHz}$
 11 guard band are required between 12 signal
 $\therefore$ guard bandwidth = $11 \times 1\text{kHz} = 11\text{kHz}$
 $\therefore$ total bandwidth = $60 + 11 = 71\text{kHz}$
4. (b) 100% modulation $\Rightarrow m_a = 1$

$$\frac{\text{useful power}}{\text{total power radiated}} = \frac{m_a^2}{2 + m_a^2}$$

$$= \frac{1}{2+1} = \frac{1}{3}$$

$\Rightarrow$ Useful power

$$= \frac{1}{3} (\text{total power radiated})$$

5. (c) Sky wave propagation is not possible for frequency $> 30\text{MHz}$ because they are not reflected by ionosphere.
6. (b) 100% modulation $\Rightarrow m_a = 1$

$$\frac{\text{useful power}}{\text{total power radiated}} = \frac{m_a^2}{2 + m_a^2}$$

$$= \frac{1}{2+1} = \frac{1}{3}$$

$$\Rightarrow \text{Useful power} = \frac{1}{3} (\text{total power radiated})$$
7. (d) Since radio frequency waves can travel long distances because these waves are of wave length of the order of 100m and their energy content is quite large therefore e.m.wave of audible frequency are superimposed with radio frequency waves.

Type B : Assertion Reason Questions

8. (a) Both parts are true but optical fibres are used for telecommunication because they produce the same signal with the same intensity at the other end of the optical fibre even if fibre is several kilometre long i.e., total internal reflection. They have other advantages like being light weight, flexible, etc.

Some Basic Concepts
of Chemistry

TYPE A : MULTIPLE CHOICE QUESTIONS

- The weight of a single atom of oxygen is : [1997]
(a) 1.057×10^{23} g (b) 3.556×10^{23} g
(c) 2.656×10^{-23} g (d) 4.538×10^{-23} g
- Volume of a gas at NTP is 1.12×10^{-7} cc. The number of molecule in it is : [1998]
(a) 3.01×10^{12} (b) 3.01×10^{18}
(c) 3.01×10^{24} (d) 3.01×10^{30}
- The oxide of an element contains 67.67% oxygen and the vapour density of its volatile chloride is 79. Equivalent weight of the element is : [1998]
(a) 2.46 (b) 3.82
(c) 4.36 (d) 4.96
- 60 gm of an organic compound on analysis is found to have C = 24 g, H = 4 g and O = 32 g. The empirical formula of compound is : [1998]
(a) CH_2O (b) CHO
(c) $\text{C}_2\text{H}_2\text{O}$ (d) $\text{C}_2\text{H}_2\text{O}_2$
- The molar concentration of 20 g of NaOH present in 5 litre of solution is : [1998]
(a) 0.1 moles/litre (b) 0.2 moles/litre
(c) 1.0 moles/litre (d) 2.0 moles/litre
- The normality of solution obtained by mixing 10 ml of N/5 HCl and 30 ml of N/10 HCl is : [1999]
(a) $\frac{N}{15}$ (b) $\frac{N}{5}$
(c) $\frac{N}{7.5}$ (d) $\frac{N}{8}$
- The empirical formula of a compound is CH_2O . Its molecular weight is 180. The molecular formula of compound is : [1999]
(a) $\text{C}_4\text{H}_8\text{O}_4$ (b) $\text{C}_3\text{H}_6\text{O}_3$
(c) $\text{C}_6\text{H}_{12}\text{O}_6$ (d) $\text{C}_5\text{H}_{10}\text{O}_5$
- 0.4 moles of HCl and 0.2 moles of CaCl_2 were dissolved in water to have 500 mL of solution, the molarity of Cl^- ion is : [2000]
(a) 0.8 M (b) 1.6 M
(c) 1.2 M (d) 10.0 M
- 10^{21} molecules are removed from 200 mg of CO_2 . The moles of CO_2 left are : [2001]
(a) 2.88×10^{-3} (b) 28.8×10^{-3}
(c) 288×10^{-3} (d) 28.8×10^3
- The weight of NaCl decomposed by 4.9 g of H_2SO_4 , if 6 g of sodium hydrogen sulphate and 1.825 g of HCl, were produced in the reaction is : [2001]
(a) 6.921 g (b) 4.65 g
(c) 2.925 g (d) 1.4 g
- Temperature does not affect : [1997, 2001]
(a) Molality (b) Formality
(c) Molarity (d) Normality
- The molarity of H_2SO_4 solution, which has a density 1.84 g/cc. at 35°C and contains 98% by weight, is : [2001]
(a) 1.84 M (b) 18.4 M
(c) 20.6 M (d) 24.5 M
- The normality of orthophosphoric acid having purity of 70 % by weight and specific gravity 1.54 is : [2001]
(a) 11 N (b) 22 N
(c) 33 N (d) 44 N
- The weight of one molecule of a compound of molecular formula $\text{C}_{60}\text{H}_{122}$ is : [2002]
(a) 1.2×10^{-20} g (b) 5.025×10^{23} g
(c) 1.4×10^{-21} g (d) 6.023×10^{-20} g
- During electrolysis of water the volume of O_2 liberated is 2.24 dm^3 . The volume of hydrogen liberated, under same conditions will be [2008]
(a) 2.24 dm^3 (b) 1.12 dm^3
(c) 4.48 dm^3 (d) 0.56 dm^3

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Topicwise AIIMS Solved Papers – CHEMISTRY

16. Calculate the millimoles of SeO_3^{2-} in solution on the basis of following data : [2009]
- 70ml of $\frac{M}{60}$ solution of KBrO_3 was added to SeO_3^{2-} solution. The bromine evolved was removed by boiling and excess of KBrO_3 was back titrated with 12.5 mL of $\frac{M}{25}$ solution of NaAsO_2 .
The reactions are given below.
- I. $\text{SeO}_3^{2-} + \text{BrO}_3^- + \text{H}^+ \rightarrow \text{SeO}_4^{2-} + \text{Br}_2 + \text{H}_2\text{O}$
II. $\text{BrO}_3^- + \text{AsO}_2^- + \text{H}_2\text{O} \rightarrow \text{Br}^- + \text{AsO}_4^{3-} + \text{H}^+$
(a) 1.6×10^{-3} (b) 1.25
(c) 2.5×10^{-3} (d) None of these
17. The reaction of calcium with water is represented by the equation
 $\text{Ca} + 2\text{H}_2\text{O} \longrightarrow \text{Ca(OH)}_2 + \text{H}_2$
What volume of H_2 at STP would be liberated when 8 gm of calcium completely reacts with water? [2010]
(a) 0.2 cm^3 (b) 0.4 cm^3
(c) 2240 cm^3 (d) 4480 cm^3
18. A solution is prepared by dissolving 24.5 g of sodium hydroxide in distilled water to give 1 L solution. The molarity of NaOH in the solution is [2010]
(a) 0.2450 M (b) 0.6125 M
(c) 0.9800 M (d) 1.6326 M
(Given that molar mass of NaOH = 40.0 g mol^{-1})
19. Which of the following pairs of solutions are expected to be isotonic, temperature being the same? [2011]
(a) 0.1 M glucose and 0.1M $\text{C}_6\text{H}_5\text{N}^+\text{H}_3\text{Cl}^-$
(b) 0.1 M NaCl and 0.05 M BaCl_2
(c) 0.1 M Na_2SO_4 and 0.1 M KNO_3
(d) 0.1 M BaCl_2 and 0.075 M FeCl_3
20. For preparing 0.1 N solution of a compound from its impure sample of which the percentage purity is known, the weight of the substance required will be [2012]
(a) less than the theoretical weight
(b) more than the theoretical weight
(c) same as the theoretical weight
(d) none of these
21. In a hydrocarbon, mass ratio of hydrogen and carbon is 1:3, the empirical formula of hydrocarbon is [2012]
(a) CH_4 (b) CH_2
(c) C_2H (d) CH_3
22. The vapour density of a mixture containing NO_2 and N_2O_4 is 27.6. Mole fraction of NO_2 in the mixture is [2012]
(a) 0.8 (b) 0.6
(c) 0.4 (d) 0.2
23. An aqueous solution of 6.3 g of oxalic acid dihydrate is made up to 250 ml. The volume of 0.1 N NaOH required to completely neutralise 10 ml of this solution is [2013]
(a) 20ml (b) 40ml
(c) 10ml (d) 4ml
24. KMnO_4 reacts with oxalic acid according to the equation: [2013]
 $2\text{MnO}_4^- + 5\text{C}_2\text{O}_4^{2-} + 16\text{H}^+ \rightarrow 2\text{Mn}^{++} + 10\text{CO}_2 + 8\text{H}_2\text{O}$
Here 20 mL of 0.1 M KMnO_4 is equivalent to:
(a) 20 mL of 0.5 M $\text{H}_2\text{C}_2\text{O}_4$
(b) 50 mL of 0.5 M $\text{H}_2\text{C}_2\text{O}_4$
(c) 50 mL of 0.1 M $\text{H}_2\text{C}_2\text{O}_4$
(d) 20 mL of 0.1 M $\text{H}_2\text{C}_2\text{O}_4$
25. Calculate the normality of 10 volume H_2O_2 ? [2013]
(a) 1.7 N (b) 12 N
(c) 30.3 N (d) 0.0303 N
26. Which has the maximum number of molecules among the following ? [2014]
(a) 44 g CO_2 (b) 48 g O_3
(c) 8 g H_2 (d) 64 g SO_2
27. Sulphur forms the chlorides S_2Cl_2 and SCl_2 . The equivalent mass of sulphur in SCl_2 is [2015]
(a) 8 g/mol (b) 16 g/mol
(c) 64.8 g/mol (d) 32 g/mol
28. Arrange the following in the order of increasing mass (atomic mass: O = 16, Cu = 63, N = 14)
I. one atom of oxygen
II. one atom of nitrogen
III. 1×10^{-10} mole of oxygen
IV. 1×10^{-10} mole of copper [2016]
(a) $\text{II} < \text{I} < \text{III} < \text{IV}$ (b) $\text{I} < \text{II} < \text{III} < \text{IV}$
(c) $\text{III} < \text{II} < \text{IV} < \text{I}$ (d) $\text{IV} < \text{II} < \text{III} < \text{I}$
29. Volume of water needed to mix with 10 mL 10N HNO_3 to get 0.1 N HNO_3 is : [2017]
(a) 1000 mL (b) 990 mL
(c) 1010 mL (d) 10 mL

TYPE B : ASSERTION REASON QUESTIONS

Directions for (Qs. 30-32) : These questions consist of two statements, each printed as Assertion and Reason. While answering these questions, you are required to choose any one of the following five responses.

- (a) If both Assertion and Reason are correct and the Reason is a correct explanation of the Assertion.
- (b) If both Assertion and Reason are correct but Reason is not a correct explanation of the Assertion.
- (c) If the Assertion is correct but Reason is incorrect.
- (d) If both the Assertion and Reason are incorrect.
- (e) If the Assertion is incorrect but the Reason is correct.

30. Assertion : Atoms can neither be created nor destroyed.

Reason : Under similar condition of temperature and pressure, equal volume of gases does not contain equal number of atoms. [2002]

31. Assertion : Equivalent weight of a base

$$= \frac{\text{Molecular weight}}{\text{Acidity}}$$

Reason : Acidity is the number of replaceable hydrogen atoms in one molecule of the base. [2008]

32. Assertion : One molal aqueous solution of glucose contains 180g of glucose in 1 kg water.

Reason : Solution containing one mole of solute in 1000 g of solvent is called one molal solution. [2008]

Directions for (Qs.33-34) : Each of these questions contains an Assertion followed by Reason. Read them carefully and answer the question on the basis of following options. You have to select the one that best describes the two statements.

- (a) If both Assertion and Reason are correct and Reason is the correct explanation of Assertion.
- (b) If both Assertion and Reason are correct, but Reason is not the correct explanation of Assertion.
- (c) If Assertion is correct but Reason is incorrect.
- (d) If both the Assertion and Reason are incorrect.

33. Assertion : The normality of 0.3 M aqueous solution of H_3PO_3 is equal to 0.6 N.

Reason : Equivalent weight of H_3PO_3
$$= \frac{\text{Molecular weight of } \text{H}_3\text{PO}_3}{3}$$
 [2011, 13]

34. Assertion : Equal moles of different substances contain same number of constituent particles. [2017]

Reason : Equal weights of different substances contain the same number of constituent particles.

HINTS & SOLUTIONS

Type A : Multiple Choice Questions

1. (c) Weight of single atom of oxygen

$$= \frac{16}{6.02 \times 10^{23}} = 2.656 \times 10^{-23} \text{ g}$$

2. (a) No. of molecules

$$= \frac{6.02 \times 10^{23} \times 1.12 \times 10^{-7}}{22400}$$

$$= \frac{6.02 \times 10^{-7} \times 1.12 \times 10^{23}}{2.24 \times 10^4} = 3.01 \times 10^{12}$$

3. (b) Equivalent weight of an element is its weight which reacts with 8 gm of oxygen to form oxide.

Thus eq. weight of the given element

$$= \frac{32.33}{67.67} \times 8 = 3.82$$

4. (a) Ratio of no. of atoms =
- $\frac{24}{12} : \frac{4}{1} : \frac{32}{16}$

$$= 2 : 4 : 2 = 1 : 2 : 1$$

Empirical formula = CH_2O .

5. (a) molar concentration =
- $\frac{\text{Mole}}{\text{Vol. in L}} = \frac{20/40}{5}$

$$= \frac{20}{5 \times 40} = 0.1 \text{ mole/litre.}$$

6. (d) Normality of a mixture of two or more acids is given by

$$N = \frac{N_1 V_1 + N_2 V_2}{V_1 + V_2}$$

$$= \frac{\frac{1}{5} \times 10 + \frac{1}{10} \times 30}{10 + 30} = \frac{5}{40} = \frac{1}{8} \text{ or } \frac{N}{8}$$

7. (c) Empirical formula weight =
- $12 + 2 + 16 = 30$

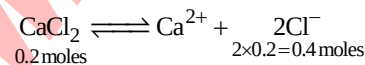
$$n = \frac{180}{30} = 6$$

Molecular formula = $(\text{CH}_2\text{O})_6 = \text{C}_6\text{H}_{12}\text{O}_6$.

8. (b)
- $\text{HCl} \rightleftharpoons \text{H}^+ + \text{Cl}^-$

0.4 moles

0.4 moles



0.2 moles

 $2 \times 0.2 = 0.4 \text{ moles}$ Total Cl^- moles = $0.4 + 0.4 = 0.8 \text{ moles}$

$$\text{Molarity} = \frac{\text{Moles}}{\text{Vol. in L}}$$

$$\therefore \text{Molarity of } \text{Cl}^- = \frac{0.8}{0.5} = 1.6 \text{ M.}$$

9. (a) No. of moles =
- $\frac{\text{Wt. in g}}{\text{Mol. wt}}$

$$\text{No. of moles in } 200 \text{ mg} = \frac{200}{1000 \times 44}$$

$$= 4.5 \times 10^{-3} \text{ moles}$$

No. of moles in 10^{21} molecules

$$= \frac{10^{21}}{6.02 \times 10^{23}} = 1.67 \times 10^{-3} \text{ moles}$$

$$\text{No. of moles left} = (4.5 - 1.67) \times 10^{-3}$$

$$= 2.88 \times 10^{-3}$$

10. (c)
- $\text{NaCl} + \text{H}_2\text{SO}_4 \longrightarrow \text{NaHSO}_4 + \text{HCl}$

x g 4.9 g

6 g

1.825 g

According to law of conservation of mass
"mass is neither created nor destroyed during a chemical change" $\therefore$ Mass of the reactants = Mass of products

$$x + 4.9 = 6 + 1.825$$

or $x = 2.925 \text{ g}$

11. (a) Temperature does not affect molality as it does not depend upon volume factor.

12. (b) 100 gm solution contains 98 gm
- H_2SO_4
- .

$$\frac{100}{1.84} \text{ c.c contains } 98 \text{ gm } \text{H}_2\text{SO}_4.$$

1000 c.c solution contains

$$= \frac{98}{100} \times 1.84 \times 1000 \text{ gm } \text{H}_2\text{SO}_4$$

$$= \frac{98}{100} \times \frac{1.84 \times 1000}{98} \text{ moles of } \text{H}_2\text{SO}_4$$

= 18.4 M.

13. (c) 70% by weight means

Wt. of solute = 70 g

Wt of solution = 100 g

$$\therefore V_{\text{cc}} \text{ of solution} = \frac{\text{mass}}{\text{density}} = \frac{100}{1.54}$$

We know that

$$N = \frac{W \times 1000}{\text{Eq. Wt} \times V_{\text{cc}}}$$

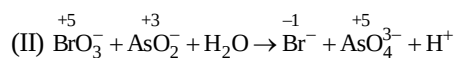
$$= \frac{70 \times 3}{98} \times \frac{1000 \times 1.54}{100} = 33 \text{ N}$$

14. (c) M.W. = $60 \times 12 + 122 = 842$

$$\begin{aligned}\text{Weight of one molecule} &= \frac{842}{6.02 \times 10^{23}} \text{ gm} \\ &= 140 \times 10^{-23} \text{ gm} = 1.4 \times 10^{-21} \text{ gm}\end{aligned}$$

15. (c) $2\text{H}_2\text{O} \xrightarrow{\text{Electrolysis}} 2\text{H}_2 + \text{O}_2$
 2 vol. 2 vol. 1 vol.
 Thus, the volume of hydrogen liberated is twice that of the volume of oxygen liberated. When 2.24 dm^3 of oxygen is liberated the volume of hydrogen liberated will be $2 \times 2.24 \text{ dm}^3$ or 4.48 dm^3

16. (c) (I) $\overset{+4}{\text{SeO}_3^{2-}} + \overset{+5}{\text{BrO}_3^-} + \text{H}^+ \rightarrow \overset{+6}{\text{SeO}_4^{2-}} + \overset{0}{\text{Br}_2} + \text{H}_2\text{O}$



In reaction (II)

$$\text{gm. eq. of } \text{BrO}_3^- = \text{gm. eq. of } \text{AsO}_2^-$$

$$n_{\text{BrO}_3^-} \times 6 = n_{\text{AsO}_2^-} \times 2$$

$$= \frac{12.5}{1000} \times \frac{1}{25} \times 2 = 10^{-3}$$

$$n_{\text{BrO}_3^-} = \frac{10^{-3}}{6}$$

In reaction (I)

moles of BrO_3^- consumed

$$= \frac{70}{1000} \times \frac{1}{60} - \frac{10^{-3}}{6} = 10^{-3}$$

$$\text{gm eq. of } \text{SeO}_3^{2-} = \text{gm. eq. of } \text{BrO}_3^-$$

$$n_{\text{SeO}_3^{2-}} \times 2 = 10^{-3} \times 5 ;$$

$$n_{\text{SeO}_3^{2-}} = 2.5 \times 10^{-3}$$

17. (d) $\text{Ca} + 2\text{H}_2\text{O} \longrightarrow \text{Ca(OH)}_2 + \text{H}_2$

According to the stoichiometry of reaction, 40 gm of Ca on complete reaction with water liberates = 2 gm H_2

$\therefore$ 8 gm of Ca, on complete reaction with

$$\text{water liberates} = \frac{2}{40} \times 8 \text{ gm } \text{H}_2$$

$$= 0.40 \text{ gm } \text{H}_2$$

$$= \frac{0.40}{2} \times 22400 \text{ cm}^3$$

$$= 4480 \text{ cm}^3 \text{ of } \text{H}_2 \text{ at S.T.P.}$$

18. (b) Given $W_{\text{NaOH}} = 24.5 \text{ g}$

$$\begin{aligned}\text{No. of moles of NaOH} &= \frac{24.5}{40} \text{ moles} \\ &= 0.6125 \text{ moles}\end{aligned}$$

\ Molarity of solution

$$= \frac{0.6125 \text{ moles}}{1 \text{ L}} = 0.6125 \text{ M}$$

19. (d) Effective molarity of $\text{BaCl}_2 = 3 \times 0.1 = 0.3$;
 effective molarity of $\text{FeCl}_3 = 4 \times 0.075 = 0.3$

20. (b) More than theoretical weight since impurity will not contribute.

21. (a) Mass ratio of H : C = 1 : 12

However, given mass ratio of H : C = 1 : 3

Therefore, for every C atom, there are 4 H atoms, hence empirical formula = CH_4

22. (a) $V.D_{\text{max}} =$

$$X_{\text{NO}_2} (V.D)_{\text{NO}_2} + X_{\text{N}_2\text{O}_4} (V.D)_{\text{N}_2\text{O}_4}$$

$$27.6 = X \times 23 + (1 - x) \times 46$$

$$\therefore X_{\text{NO}_2} = 0.8$$

23. (b) Normality of oxalic acid

$$= \frac{6.3 \times 1000}{63 \times 250} = 0.4 \text{ N}$$

$$N_1 V_1 = N_2 V_2 \quad 10 \times 0.4 = V \times 0.1 = 40 \text{ ml.}$$

24. (c) Meq of A = Meq of B.

$$0.1 \text{ M KMnO}_4 = 0.5 \text{ N KMnO}_4$$

$$\therefore \text{Meq of KMnO}_4 = 20 \times 0.5 = 10 \text{ (n factor = 5)}$$

$$\text{Meq of 50 ml of } 0.1 \text{ M H}_2\text{C}_2\text{O}_4 = 50 \times 0.2 = 10$$

$$(0.1 \text{ M H}_2\text{C}_2\text{O}_4 = 0.2 \text{ N H}_2\text{C}_2\text{O}_4)$$

25. (a) Normality of 10V of H_2O_2

$$\frac{68 \times 10}{22.4} = 17 \times N \quad \therefore N = 1.78$$

26. (c)

No. of molecules

$$\text{Moles of } \text{CO}_2 = \frac{44}{44} = 1$$

N_A

$$\text{Moles of } \text{O}_3 = \frac{48}{48} = 1$$

N_A

$$\text{Moles of } \text{H}_2 = \frac{8}{2} = 4$$

$4N_A$

$$\text{Moles of } \text{SO}_2 = \frac{64}{64} = 1$$

N_A

27. (b) The atomic weight of sulphur = 32

In SCl_2 valency of sulphur = 2

$$\text{So equivalent mass of sulphur} = \frac{32}{2} = 16$$

c-6

Topicwise AIIMS Solved Papers – CHEMISTRY

28. (a) Mass of 6.023×10^{23} atoms of oxygen = 16 g
Mass of one atom of oxygen

$$= \frac{16}{6.023 \times 10^{23}} = 2.66 \times 10^{-23} \text{ g}$$

Mass of 6.023×10^{23} atoms of nitrogen = 14 g
Mass of one atom of nitrogen

$$= \frac{14}{6.023 \times 10^{23}} = 2.32 \times 10^{-23} \text{ g}$$

Mass of 1×10^{-10} mole of oxygen = 16×10^{-10}

Mass of 1 mole of copper = 63 g

Mass of 1 mole of oxygen = 16 g

Mass of 1×10^{-10} mole of copper
 $= 63 \times 1 \times 10^{-10}$
 $= 63 \times 10^{-10}$

So, the order of increasing mass is
 $\text{II} < \text{I} < \text{III} < \text{IV}$.

29. (b) Given $N_1 = 10\text{N}$, $V_1 = 10 \text{ ml}$, $N_2 = 0.1\text{N}$,
 $V_2 = ?$

$$N_1 V_1 = N_2 V_2$$

$$\text{or } 10 \times 10 = 0.1 \times V_2$$

$$\text{or } V_2 = \frac{10 \times 10}{0.1}, V_2 = 1000 \text{ ml}$$

Volume of water to be added
 $= V_2 - V_1 = 1000 - 10 = 990 \text{ ml}$.

Type B : Assertion Reason Questions

30. (d) Atoms can be created and can be destroyed.
 At N.T.P., number of molecules or atoms
 contained in same volume remains equal.

31. (c) Yes, Eq. wt of a base = $\frac{\text{Molecular weight}}{\text{Acidity}}$

Thus, assertion is correct.

Acidity is the number of replacable $-\text{OH}$
 groups (not hydrogen atoms) present in a
 molecule. Thus, reason is false.

32. (a) Molality = $\frac{\text{No. of moles of solute}}{\text{Wt of solvent in kg.}}$

Here, No. of moles = $\frac{\text{Molecular mass}}{\text{Wt of solvent}}$

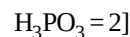
$$= \frac{180}{180} = 1$$

$$\therefore \text{Molality} = \frac{1}{1} = 1$$

Hence assertion and reason, both are correct,
 and reason is the correct explanation of
 assertion.

33. (c) Assertion is true, reason is false.

$$\text{Eq. wt. of } \text{H}_3\text{PO}_3 = \frac{\text{mol. wt}}{2} \quad [\because \text{Basicity of}$$



34. (c) Equal moles of different substances contain
 same number of constituent particles but
 equal weights of different substances do
 not contain the same number of constituent
 particles.

TYPE A : MULTIPLE CHOICE QUESTIONS

- The configuration $1s^2, 2s^2 2p^5, 3s^1$ shows :
 (a) excited state of O_2^- [1997]
 (b) excited state of neon atom
 (c) excited state of fluorine atom
 (d) ground state of fluorine atom
- The total number of orbitals in a shell with principal quantum number 'n' is : [1997]
 (a) n^2 (b) $n + 1$
 (b) $2n$ (d) $2n^2$
- Positron is : [1997]
 (a) electron with positive charge
 (b) a nucleus with one neutron and one proton
 (c) a nucleus with two protons
 (d) a helium nucleus
- The wavelength of visible light is : [1998]
 (a) $2000 \text{ \AA} - 3700 \text{ \AA}$ (b) $7800 \text{ \AA} - 8900 \text{ \AA}$
 (c) $3800 \text{ \AA} - 7600 \text{ \AA}$ (d) None of these
- The wavelength of a 150 g rubber ball moving with a velocity of 50 ms^{-1} is : [1998]
 (a) $3.43 \times 10^{-33} \text{ cm}$ (b) $5.86 \times 10^{-33} \text{ cm}$
 (c) $7.77 \times 10^{-33} \text{ cm}$ (d) $8.83 \times 10^{-33} \text{ cm}$
- If $e = 1.60206 \times 10^{-19} \text{ C}$, [1999]
 $\frac{e}{m} = 1.75875 \times 10^{11} \text{ C kg}^{-1}$
 then the mass of electron is
 (a) $7.5678 \times 10^{-31} \text{ kg}$ (b) $9.1091 \times 10^{-31} \text{ kg}$
 (c) $11.2531 \times 10^{-31} \text{ kg}$ (d) $13.0513 \times 10^{-31} \text{ kg}$
- The energy of electron in first energy level is $-21.79 \times 10^{-12} \text{ erg per atom}$. The energy of electron in second energy level is : [1999]
 (a) $-54.47 \times 10^{-12} \text{ erg atom}^{-1}$
 (b) $-5.447 \times 10^{-12} \text{ erg atom}^{-1}$
 (c) $-0.5447 \times 10^{-12} \text{ erg atom}^{-1}$
 (d) $-0.05447 \times 10^{-12} \text{ erg atom}^{-1}$
- Deuterium nucleus contains: [2000]
 (a) 1 proton, 1 electron
 (b) 1 proton, 1 neutron
 (c) 2 protons, 1 electron
 (d) 1 proton, 2 electrons
- The outermost configuration of most electronegative element is: [2000]
 (a) $ns^2 np^5$ (b) $ns^2 np^6$
 (c) $ns^2 np^4$ (d) $ns^2 np^3$
- Bohr's theory is not applicable to: [2000]
 (a) H (b) He^+
 (c) Li^{2+} (d) H^+
- The de-Broglie wavelength of an electron in the ground state of hydrogen atom is :
 $[\text{K.E.} = 13.6 \text{ eV}; 1 \text{ eV} = 1.602 \times 10^{-19} \text{ J}]$ [2000]
 (a) 33.28 nm (b) 3.328 nm
 (c) 0.3328 nm (d) 0.0332 nm
- The de-Broglie wavelength associated with a particle of mass 10^{-6} kg moving with a velocity of 10 ms^{-1} is : [2001]
 (a) $6.63 \times 10^{-7} \text{ m}$ (b) $6.63 \times 10^{-16} \text{ m}$
 (c) $6.63 \times 10^{-21} \text{ m}$ (d) $6.63 \times 10^{-29} \text{ m}$
- The velocity of electron in second shell of hydrogen atom is : [2001]
 (a) $10.94 \times 10^6 \text{ ms}^{-1}$ (b) $18.88 \times 10^6 \text{ ms}^{-1}$
 (c) $1.888 \times 10^6 \text{ ms}^{-1}$ (d) $1.094 \times 10^6 \text{ ms}^{-1}$

c-8

Topicwise AIIMS Solved Papers – CHEMISTRY

14. Which of the following element is represented by electronic configuration $1s^2 2s^2 2p_x^1 2p_y^1 2p_z^1$? [2001]
 (a) nitrogen (b) oxygen
 (c) fluorine (d) sulphur
15. Quantum numbers of an atom can be defined on the basis of [2002]
 (a) Hund's rule
 (b) Pauli's exclusion principle
 (c) Aufbau's principle
 (d) Heisenberg's uncertainty principle
16. Spectrum of Li^{2+} is similar to that of [2002]
 (a) H (b) Be
 (c) He (d) Ne
17. Azimuthal quantum number defines [2002]
 (a) e/m ratio of electron
 (b) angular momentum of electron
 (c) spin of electron
 (d) magnetic momentum of electron
18. The quantum number ' m ' of a free gaseous atom is associated with : [2003]
 (a) the effective volume of the orbital
 (b) the shape of the orbital
 (c) the spatial orientation of the orbital
 (d) the energy of the orbital in the absence of a magnetic field
19. For principle quantum number $n = 4$, the total number of orbitals having $l = 3$ is : [2004]
 (a) 3 (b) 7
 (c) 5 (d) 9
20. The isoelectronic pair is : [2005]
 (a) Cl_2O_3 and ICl_2^- (b) ICl_2^- and ClO_2
 (c) IF_2^+ and I_3^- (d) ClO_2^- and ClF_2^+
21. The most probable radius (in pm) for finding the electron in He^+ is [2005]
 (a) 0.0 (b) 52.9
 (c) 26.5 (d) 105.8
22. The de Broglie wavelength associated with a ball of mass 1 kg having kinetic energy 0.5 J is : [2006]
 (a) $6.626 \times 10^{-34} \text{ m}$ (b) $13.20 \times 10^{-34} \text{ m}$
 (c) $10.38 \times 10^{-21} \text{ m}$ (d) $6.626 \times 10^{-34} \text{ \AA}$
23. The uncertainties in the velocities of two particles, A and B are 0.05 and 0.02 ms^{-1} respectively. The mass of B is five times to that of the mass of A. What is the ratio of uncertainties $\frac{\Delta x_A}{\Delta x_B}$ in their positions? [2008]
 (a) 2 (b) 0.25
 (c) 4 (d) 1
24. Find the frequency of light that corresponds to photons of energy $5.0 \times 10^{-5} \text{ erg}$ [2010]
 (a) $7.5 \times 10^{-21} \text{ sec}^{-1}$ (b) $7.5 \times 10^{-21} \text{ sec}$
 (c) $7.5 \times 10^{21} \text{ sec}^{-1}$ (d) $7.5 \times 10^{21} \text{ sec}$
25. Ratio of energy of photon of wavelength $3000 \text{ \AA}$ and $6000 \text{ \AA}$ is [2012]
 (a) 3:1 (b) 2:1
 (c) 1:2 (d) 1:3
26. Which of the following combinations of quantum numbers is allowed? [2013]
- | | n | l | m | m_s |
|-----|-----|-----|-----|----------------|
| (a) | 3 | 2 | 1 | 0 |
| (b) | 2 | 0 | 0 | $-\frac{1}{2}$ |
| (c) | 3 | -3 | -2 | $+\frac{1}{2}$ |
| (d) | 1 | 0 | 1 | $+\frac{1}{2}$ |
27. Among the following groupings which represents the collection of isoelectronic species? [2013]
 (a) NO^+ , C_2^{2-} , O_2^- , CO
 (b) N_2 , C_2^{2-} , CO , NO
 (c) CO , NO^+ , CN^- , C_2^{2-}
 (d) NO , CN^- , N_2 , O_2^-
28. The electrons, identified by quantum numbers n and l (i) $n = 4, l = 1$ (ii) $n = 4, l = 0$ (iii) $n = 3, l = 2$ (iv) $n = 3, l = 1$ can be placed in order of increasing energy, from the lowest to highest, as [2014]
 (a) (iv) < (ii) < (iii) < (i)
 (b) (ii) < (iv) < (i) < (iii)
 (c) (i) < (iii) < (ii) < (iv)
 (d) (iii) < (i) < (iv) < (ii)

29. In hydrogen atomic spectrum, a series limit is found at 12186.3 cm^{-1} . Then it belong to

[2014]

- (a) Lyman series (b) Balmer series
(c) Paschen series (d) Brackett series

30. Based on equation $E = -2.178 \times 10^{-18} \text{ J} \left(\frac{Z^2}{n^2} \right)$,

certain conclusions are written. Which of them is not correct ? [2015]

- (a) Larger the value of n , the larger is the orbit radius.
(b) Equation can be used to calculate the change in energy when the electron changes orbit.
(c) For $n = 1$, the electron has a more negative energy than it does for $n = 6$ which mean that the electron is more loosely bound in the smallest allowed orbit.
(d) The negative sign in equation simply means that the energy or electron bound to the nucleus is lower than it would be if the electrons were at the infinite distance from the nucleus.

31. Let m_p be the mass of a proton, m_n that of a neutron, M_1 that of a $^{20}_{10}\text{Ne}$ nucleus and M_2 that of a $^{40}_{20}\text{Ca}$ nucleus. Then [2015]

- (a) $M_2 = 2M_1$ (b) $M_1 < 10(m_p + m_n)$
(c) $M_2 > 2M_1$ (d) $M_1 = M_2$

32. Which transition in the hydrogen atomic spectrum will have the same wavelength as the transition, $n = 4$ to $n = 2$ of He^+ spectrum?

[2016]

- (a) $n = 4$ to $n = 3$ (b) $n = 3$ to $n = 2$
(c) $n = 4$ to $n = 2$ (d) $n = 2$ to $n = 1$

33. In Bohr series of lines of hydrogen spectrum, the third line from the red end corresponds to which one of the following inter-orbit jumps of the electron for Bohr orbits in an atom of hydrogen

[2017]

- (a) $5 \rightarrow 2$ (b) $4 \rightarrow 1$
(c) $2 \rightarrow 5$ (d) $3 \rightarrow 2$

TYPE B : ASSERTION REASON QUESTIONS

Directions for (Qs. 34-42) : These questions consist of two statements, each printed as Assertion and Reason. While answering these questions, you are required to choose any one of the following five responses.

- (a) If both Assertion and Reason are correct and the Reason is a correct explanation of the Assertion.
(b) If both Assertion and Reason are correct but Reason is not a correct explanation of the Assertion.
(c) If the Assertion is correct but Reason is incorrect.
(d) If both the Assertion and Reason are incorrect.
(e) If the Assertion is incorrect but the Reason is correct.

34. **Assertion :** An atom is electrically neutral

Reason : Atom contains equal number of protons and neutrons. [1997]

35. **Assertion :** The sum of protons and neutrons is always different in isobars.

Reason : Isobars are atoms of different elements having same mass number but different atomic number. [1997]

36. **Assertion :** All photons possess the same amount of energy.

Reason : Energy of photon does not depend upon wavelength of light used. [1998]

37. **Assertion :** Atoms are not electrically neutral.

Reason : Number of protons and electrons are different [1999]

38. **Assertion :** For Balmer series of hydrogen spectrum, the value $n_1 = 2$ and $n_2 = 3, 4, 5$.

Reason : The value of n for a line in Balmer series of hydrogen spectrum having the highest wave length is 4 and 6. [2002]

39. **Assertion :** Absorption spectrum consists of some bright lines separated by dark spaces.

Reason : Emission spectrum consists of dark lines. [2002]

40. **Assertion :** Nuclear binding energy per nucleon is in the order $^9_4\text{Be} > ^7_3\text{Li} > ^4_2\text{He}$.

Reason : Binding energy per nucleon increases linearly with difference in number of neutrons and protons. [2004]

C-10

Topicwise AIIMS Solved Papers – CHEMISTRY

41. **Assertion :** A spectral line will be observed for a $2p_x - 2p_y$ transition.

Reason : The energy is released in the form of wave of light when electron drops from $2p_x$ to $2p_y$ orbital. [2008]

42. **Assertion :** An orbital designated by $n = 3$, $l = 1$ has double dumb-bell shape.

Reason : It belongs to p -subshell. [2011]

Directions for (Qs.43-46) : Each of these questions contains an Assertion followed by Reason. Read them carefully and answer the question on the basis of following options. You have to select the one that best describes the two statements.

- If both Assertion and Reason are correct and Reason is the correct explanation of Assertion.
- If both Assertion and Reason are correct, but Reason is not the correct explanation of Assertion.
- If Assertion is correct but Reason is incorrect.
- If both the Assertion and Reason are incorrect.

43. **Assertion :** Angular momentum of an electron in any orbit is given by angular momentum

$$= \frac{n \cdot h}{2\pi}, \text{ where } n \text{ is the principal quantum number.}$$

Reason : The principal quantum number, n , can have any integral value. [2012, 13]

44. **Assertion :** Spin quantum number can have two

$$\text{values, } +\frac{1}{2} \text{ and } -\frac{1}{2}.$$

Reason : + and – signs signify the positive and negative wave functions. [2014]

45. **Assertion :** It is impossible to determine the exact position and exact momentum of an electron simultaneously.

Reason : The path of an electron in an atom is clearly defined. [2016]

46. **Assertion :** The radius of the first orbit of hydrogen atom is $0.529 \text{ \AA}$. [2017]

Reason : Radius of each circular orbit (r_n) - $0.529 \text{ \AA}$ (n^2/Z), where $n = 1, 2, 3$ and Z = atomic number.

HINTS & SOLUTIONS

Type A : Multiple Choice Questions

1. (b) Atomic number of the given element = 10
Electronic configuration = $1s^2, 2s^2 2p^6$
 $1s^2 2s^2 2p^6$ is electronic configuration of Ne.
 $1s^2 2s^2 2p^5 3s^1$ is excited oxidation state.

2. (a) The total no of orbital in a shell is n^2 .
3. (a) Positron is electron with positive charge, ${}_{+1}e^0$
4. (c) Wavelength of visible light is $3800\text{\AA} - 7600\text{\AA}$.
5. (d) From the de-Broglie formula for wavelength

$$\lambda = \frac{h}{p} = \frac{h}{mv} = \frac{6.6 \times 10^{-34}}{150 \times 50} = 8.83 \times 10^{-33} \text{ cm.}$$

6. (b) $\frac{e}{m} = 1.75875 \times 10^{11}$

$$\frac{1.60206 \times 10^{-19}}{m} = 1.75875 \times 10^{11}$$

$$m = \frac{1.60206 \times 10^{-19}}{1.75875 \times 10^{11}} = \frac{1.60206}{1.75875} \times 10^{-30}$$

$$= 9.1091 \times 10^{-31} \text{ kg.}$$

7. (b) For a particular element,

$$E_n = \frac{13.6Z^2}{n^2} \text{ erg atm}^{-1}$$

$$\therefore E_n \propto \frac{1}{n^2}$$

$$\therefore \frac{E_1}{E_2} = \frac{(n_2)^2}{(n_1)^2}$$

$$\text{or } E_2 = \frac{(1)^2 \times (-21.79 \times 10^{-12})}{(2)^2}$$

$$= -5.447 \times 10^{-12} \text{ erg atm}^{-1}$$

8. (b) Deuterium nucleus contains 1 proton and 1 neutron because it is an isotope of hydrogen.
9. (a) Most electronegative element corresponds to $ns^2 np^5$ configuration.
10. (d) Bohr's Theory is not applicable to H^+ as it has no electron.

11. (c) We know that

$$K.E. = \frac{1}{2}mv^2$$

$$\therefore v = \sqrt{\frac{2 \times K.E.}{m}}$$

$$= \sqrt{\frac{2 \times 13.6 \times 1.602 \times 10^{-19}}{9.1 \times 10^{-31}}}$$

$$= 2.18824 \times 10^6 \text{ m/s}$$

$$\text{No since, } \lambda = \frac{h}{mv}$$

$$= \frac{6.626 \times 10^{-34}}{9.1 \times 10^{-31} \times 2.18824 \times 10^6}$$

$$= 0.3328 \times 10^{-9} = 0.3328 \text{ nm}$$

12. (d) $\lambda = \frac{h}{mc} = \frac{6.6 \times 10^{-34}}{10^{-6} \times 10} = 6.63 \times 10^{-29} \text{ m}$

13. (d) According to Bohr, velocity (v) of an electron is given by relation.

$$v = 2.188 \times 10^6 \frac{Z}{n} \text{ m/s}$$

$$\text{Here } n = 2, \text{ and } Z (\text{for H}) = 1$$

$$\therefore v = \frac{2.188 \times 10^6 \times 1}{2}$$

$$= 1.094 \times 10^6 \text{ m/s}$$

14. (a) Electronic configuration corresponds to atomic number 7; hence the element is nitrogen.
15. (b) Quantum numbers of an atom can be defined on the basis of Pauli's exclusion principle which states that no two electrons can have the same value of all the four quantum numbers.
16. (a) Li^{2+} will have only one electron in its outermost electron. Its spectrum will be very similar to that of hydrogen.
17. (b) Azimuthal quantum no. ' m ' defines angular momentum of electron.
18. (c) Magnetic quantum no. ' m ' represents the spatial orientation of the orbital.

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19. (b) For $n = 4$ and $\ell = 3$, the orbital is $4f$.
No. of values of $m = (2\ell + 1) = 7$

20. (d) No. of electrons in $\text{ClO}_2^- = 17 + 16 + 1 = 34$
No. of electrons in $\text{ClF}_2^+ = 17 + 9 \times 2 - 1 = 34$

21. (c) Bohr's radius (r)

$$= \frac{0.529 \times 10^{-10} n^2}{Z} \text{ m} = \frac{52.9 n^2}{Z} \text{ pm}$$

Here n (No of shell) = 1

Z (At. No) = 2

$$\therefore r = \frac{52.9 \times 1^2}{2} = 26.45 \text{ pm}$$

22. (a) $\lambda = \frac{h}{mv} = \frac{h}{\sqrt{2mE}}$
 $= \frac{6.6 \times 10^{-34}}{\sqrt{2 \times 1 \times 0.5}} = 6.6 \times 10^{-34} \text{ m}$

23. (a) Using the relation,

$$\Delta x \cdot \Delta v = \frac{h}{4\pi m}$$

[Heisenberg's uncertainty principle]

$$\text{or } \Delta x = \frac{h}{4\pi m \cdot \Delta v}$$

$$\text{Thus, } \Delta x_A = \frac{h}{4\pi \times 0.05 \times m} \quad \dots (i)$$

$$\Delta x_B = \frac{h}{4\pi \times 0.02 \times 5m} \quad \dots (ii)$$

Dividing (i) by (ii), we get

$$\frac{\Delta x_A}{\Delta x_B} = \frac{0.02 \times 5}{0.05} = \frac{10}{5} \text{ or } 2$$

24. (c) Using $E = h\nu$, we get

$$\nu = \frac{E}{h} = \frac{5.0 \times 10^{-5} \text{ erg}}{6.63 \times 10^{-34} \text{ Js}}$$

$$= \frac{5.0 \times 10^{-5} \text{ erg}}{6.63 \times 10^{-34} \times 10^7 \text{ erg sec}}$$

[$\because 1 \text{ J} = 10^7 \text{ erg}$]

$$= 7.54 \times 10^{21} \text{ sec}^{-1}$$

25. (b) $E = \frac{hc}{\lambda}; \frac{E_1}{E_2} = \frac{\lambda_2}{\lambda_1} = \frac{6000}{3000} = 2:1$

26. (b)

27. (c) The species CO , NO^+ , CN^- and C_2^{2-} contain 14 electrons each.

28. (a) $(n + l)$ rule the higher the value of $(n + l)$, the higher is the energy. When $(n + l)$ value is the same see value of n .

	i	ii	iii	iv
$(n + l)$	$(4 + 1)$	$(4 + 0)$	$(3 + 2)$	$(3 + 1)$
	5	4	5	4

$$\therefore \text{iv} < \text{ii} < \text{iii} < \text{i}$$

29. (c) Series limit is the last line of the series, i.e. $n_2 = \infty$.

$$\therefore \frac{1}{\bar{\nu}} = \frac{1}{\lambda} = R \left[\frac{1}{n_1^2} - \frac{1}{n_2^2} \right] = R \left[\frac{1}{n_1^2} - \frac{1}{\infty^2} \right] = \frac{R}{n_1^2}$$

$$\therefore \bar{\nu} = 12186.3 = \frac{109677.76}{n_1^2}$$

$$\Rightarrow n_1^2 = \frac{109677.76}{12186.3} = 9 \Rightarrow n_1 = 3$$

$\therefore$ The line belongs to Paschen series.

30. (c) Energy of an electron at infinite distance from the nucleus is zero. As an electron approaches the nucleus, the electron attraction increases and hence the energy of electron decreases and thus becomes negative. Thus as the value of n decreases, i.e. lower the orbit is, more negative is the energy of the electron in it.

31. (a) ${}_{10}^{20}\text{Ne}$ contains 10 protons and 10 neutrons

$$\therefore M_1 = 10 m_p + 10 m_n$$

${}_{20}^{40}\text{Ca}$ contains 20 protons and 20 neutrons

$$\therefore M_2 = 20 m_p + 20 m_n$$

$$\therefore M_2 = 2M_1$$

32. (d) For He^+ ion, $\frac{1}{\lambda} = Z^2 R \left[\frac{1}{n_1^2} - \frac{1}{n_2^2} \right]$

$$(2)^2 R \left[\frac{1}{2^2} - \frac{1}{4^2} \right] = \frac{3R}{4}$$

$$\text{For hydrogen atom, } \frac{1}{\lambda} = R \left[\frac{1}{n_1^2} - \frac{1}{n_2^2} \right]$$

$$\frac{3R}{4} = R \left[\frac{1}{n_1^2} - \frac{1}{n_2^2} \right] \text{ or } \frac{1}{n_1^2} - \frac{1}{n_2^2} = \frac{3}{4}$$

$$n_1 = 1 \text{ and } n_2 = 2.$$

33. (a) The lines falling in the visible region comprise Balmer series. Hence the third line would be $n_1 = 2$, $n_2 = 5$ i.e. $5 \rightarrow 2$.

Type B : Assertion Reason Questions

34. (c) Atom is electrically neutral. Atoms necessarily contain equal number of protons and electrons, but not neutrons.
35. (e) Isobars have the same atomic mass (sum of protons and neutrons) but different atomic numbers.
36. (d) Energy of a photon $= h\nu = h \cdot \frac{c}{\lambda}$.
So, energy depends upon wavelength.
37. (d) Atoms are electrically neutral as number of electrons and protons are same.
38. (c) The value of n for a line in Balmer series of hydrogen spectrum having the highest wave length will be $n_1 = 2$ and $n_2 = 3$ because this transition will have lowest energy and so highest wavelength.
39. (d) Absorption spectrum consists of dark lines separated by bright space and emission spectrum consists of bright lines.
40. (d) Binding energy depends on the mass defect (mass lost when the constituent protons and neutrons combine to form nucleus). Binding energy is direct measurement of stability of nucleus. Higher the binding energy (means high loss of energy during formation of nucleus from protons and neutrons) per

nucleon, higher is stability of the nucleus. The order of binding energy is

$${}^4_2\text{He} > {}^7_3\text{Li} > {}^9_4\text{Be}$$

41. (d) In this case both assertion and reason are false. Both $2p_x$ and $2p_y$ orbitals have equal energy ($2p$ orbitals are degenerate), there is no possibility of electron transition and hence no energy is released and thus no spectral line will be observed.
42. (d) The orbital has dumb-bell shape and belongs to p -subshell.
43. (b) Both assertion and reason are correct. Reason is **not** the correct explanation of assertion.
44. (c) Plus and minus signs of spin quantum numbers imply that spin angular momentum of the electron, a vector quantity, acts in the same or opposite directions of orbital angular momentum.
45. (c)
46. (a) Both assertion and reason are true and reason is the correct explanation of assertion.

$$\text{Radius, } r_n = \frac{n^2 h^2}{4\pi e^2 m Z} = \frac{n^2}{Z} \times 0.529 \text{ \AA} \cdot r_n$$

For first orbit of H-atom

$$n = 1$$

$$r_1 = \frac{(1)^2}{1} \times 0.529 \text{ \AA} = 0.529 \text{ \AA}$$

Chapter

3

Classification of Elements and Periodicity in Properties

TYPE A : MULTIPLE CHOICE QUESTIONS

- The first ionisation potential is maximum for:
(a) Lithium (b) Uranium [1998]
(c) Iron (d) Hydrogen
- Which element has high electron affinity?
(a) Na (b) Cl [1998]
(c) Be (d) Ca
- Which group of periodic table contains no metal:
(a) IA (b) IIIA [1999]
(c) VIIA (d) VIII
- Which of the following is the atomic number of metal? [2000]
(a) 32 (b) 34 (c) 36 (d) 38
- The correct order of hydration energy of alkali is [2000]
(a) $\text{Li}^+ > \text{Na}^+ > \text{K}^+ > \text{Rb}^+$
(b) $\text{Rb}^+ > \text{K}^+ > \text{Na}^+ > \text{Li}^+$
(c) $\text{Na}^+ > \text{K}^+ > \text{Li}^+ > \text{Rb}^+$
(d) $\text{K}^+ > \text{Rb}^+ > \text{Na}^+ > \text{Li}^+$
- Sodium forms Na^+ ion but it does not form Na^{2+} because of [2001]
(a) very low value of 1st and IInd I.E.
(b) very high value of 1st and IInd I.E.
(c) high value of 1st I.E. and low value of IInd I.E.
(d) low value of 1st I.E. and high value of IInd I.E.
- Which of the following has maximum energy? [2002]

3s	3p	3d
(a) $\uparrow\downarrow$	$\uparrow\downarrow \uparrow \uparrow$	$\square \square \square$
3s	3p	3d
(b) $\uparrow\downarrow$	$\uparrow \uparrow \uparrow \uparrow$	$\square \uparrow \square \square$
3s	3p	3d
(c) $\uparrow\downarrow$	$\uparrow \uparrow \uparrow \uparrow$	$\uparrow \uparrow \square \square$
3s	3p	3d
(d) $\uparrow\downarrow$	$\uparrow \uparrow \uparrow \uparrow$	$\uparrow \square \square \square$
- Which of the following does not have valence electron in 3d-subshell? [2002]
(a) Fe(III) (b) Cr(I)
(c) Mn(II) (d) P(0)
- Which of the following statement is correct about ionization potential? [2010]
(a) It is independent of atomic radii
(b) It remains constant with change in atomic radii
(c) It increases with an increase in atomic radii
(d) It decreases with an increase in atomic radii
- Consider the following statements [2012]
I. The radius of an anion is larger than that of the parent atom.
II. The ionization energy generally increases with increasing atomic number in a period.
III. The electronegativity of an element is the tendency of an isolated atom to attract an electron.
Which of the above statements is/are correct?
(a) I alone (b) II alone
(c) I and II (d) II and III
- Which of the order for ionization energy is correct? [2013]
(a) $\text{Be} < \text{B} < \text{C} < \text{N} < \text{O}$
(b) $\text{B} < \text{Be} < \text{C} < \text{O} < \text{N}$
(c) $\text{Be} > \text{B} > \text{C} > \text{N} > \text{O}$
(d) $\text{B} < \text{Be} < \text{N} < \text{C} < \text{O}$
- The element with atomic number 117 has not been discovered yet. In which family would you place this element if discovered? [2014]
(a) Alkali metals
(b) Alkaline earth metals
(c) Halogens
(d) Noble gases
- In which of the following arrangements, the order is NOT according to the property indicated against it? [2015]
(a) $\text{Li} < \text{Na} < \text{K} < \text{Rb}$:
Increasing metallic radius

- (b) $I < Br < F < Cl$:
Increasing electron gain enthalpy
(with negative sign)
- (c) $B < C < N < O$
Increasing first ionization enthalpy
- (d) $Al^{3+} < Mg^{2+} < Na^+ < F^-$
Increasing ionic size
14. The correct decreasing order of first ionisation enthalpies of five elements of the second period is [2016]
(a) $Be > B > C > N > F$ (b) $N > F > C > B > Be$
(c) $F > N > C > Be > B$ (d) $N > F > B > C > Be$
15. The law of triads is applicable to a group of [2017]
(a) Cl, Br, I (b) C, N, O
(c) Na, K, Rb (d) H, O, N
- TYPE B : ASSERTION REASON QUESTIONS**
- Directions for (Qs.16-19) :** Each of these questions contains an Assertion followed by Reason. Read them carefully and answer the question on the basis of following options. You have to select the one that best describes the two statements.
- (a) If both Assertion and Reason are correct and Reason is the correct explanation of Assertion.
- (b) If both Assertion and Reason are correct, but Reason is not the correct explanation of Assertion.
- (c) If Assertion is correct but Reason is incorrect.
- (d) If both the Assertion and Reason are incorrect.
16. **Assertion :** First ionization energy for nitrogen is lower than oxygen.
Reason : Across a period effective nuclear charge decreases. [2005]
17. **Assertion :** Electron affinity refers to an isolated atom's attraction for an additional electron while electronegativity is the ability of an atom of an element to attract electrons towards itself in a shared pair of electrons.
Reason : Electron affinity is a relative number and electronegativity is experimentally measurable. [2010]
18. **Assertion :** Element has a tendency to lose the electron(s) to attain the stable configuration.
Reason : Ionization enthalpy is the energy released to remove an electron from an isolated gaseous atom in its ground state. [2011]
19. **Assertion :** Both Be and Al can form complexes such as BeF_4^{2-} and AlF_6^{3-} respectively, BeF_6^{3-} is not formed. [2015]
Reason : In case of Be, no vacant d-orbitals are present in its outermost shell.

HINTS & SOLUTIONS

Type A : Multiple Choice Questions

1. (d) First ionisation potential is maximum for hydrogen, as electron is withdrawn from the first orbital which is very near to nucleus.
2. (b) Cl has high electron affinity.
3. (c) Group IA and III A contain mostly metals. Group VIII contains transition elements which are metals. Group VII A contains mostly non-metals (F, Cl, Br).
4. (d) Elements having 1, 2 or 3 electrons in its last shell act as metals.
 $32 = [\text{Ar}] 3d^{10} 4s^2 p^2$
 $34 = [\text{Ar}] 3d^{10} 4s^2 p^4$
 $36 = [\text{Ar}] 3d^{10} 4s^2 p^6$
 $38 = [\text{Ar}] 3d^{10}, 4s^2 p^6, 5s^2$
5. (a) Hydration energy $\propto \frac{1}{\text{Size}}$
 In a group, size increases on going down the group from top to bottom i.e.,
 $\text{Rb}^+ > \text{K}^+ > \text{Na}^+ > \text{Li}^+$
 $\therefore$ Increasing order of hydration energy
 $\text{Li}^+ > \text{Na}^+ > \text{K}^+ > \text{Rb}^+$
6. (d) Na ($Z = 11$; $1s^2, 2s^2 2p^6, 3s^1$) readily gives one electron because the resulting Na^+ ($1s^2 2s^2 2p^6$) has stable configuration. Thus the first IE of Na is less. However, removal of an electron from a stable (noble gas) configuration requires high energy and thus IE_2 of Na will be very high.
7. (c) The atomic no of this element is highest which indicates that it will have highest energy.
8. (d) Electronic configuration of Cr (I) is $1s^2 2s^2 2p^6 3s^2 3p^6 3d^5$.
 Electronic configuration of Fe(III) is $1s^2 2s^2 2p^6 3s^2 3p^6 3d^5$.
 Electronic configuration of Mn (II) is $1s^2 2s^2 2p^6 3s^2 3p^6 3d^5$.
 So, all these have valence electrons in $3d$ -subshell. So, option (d) is correct answer.
9. (d) The ionisation potential decreases with increase in atomic radii.
10. (c)
11. (b)
12. (c)
13. (c) In a period the value of ionisation potential increases from left to right with breaks where the atoms have some what stable configuration. In this case N has half filled stable orbital. Hence has highest ionisation energy. Thus the correct order is
 $\text{B} < \text{C} < \text{O} < \text{N}$ not $\text{B} < \text{C} < \text{N} < \text{O}$
14. (c) As we move along the period, the atomic size decreases due to increase in nuclear charge. Therefore, it is more difficult to remove electron from an atom. Hence the sequence of first ionization enthalpy in decreasing order is
 $\text{F} > \text{N} > \text{C} > \text{Be} > \text{B}$
 But ionization enthalpy of boron is less as compared to beryllium because first electron in boron is to be removed from p -orbital while in beryllium, it is to be removed from s -orbital.
 As s -orbital is closer to nucleus in comparison to p -orbital thus energy required to remove an electron from s -orbital is greater.
15. (a) According to the law of triads the atomic wt of the middle element is arithmetic mean of I and III.

$$\text{At wt of Br} = \frac{\text{At.wt of Cl} + \text{At wt of I}}{2}$$

Type B : Assertion Reason Questions

16. (d) The ionisation energy of N is more than that of O because N has exactly half filled valence p orbital.
 ${}_7\text{N } 1s^2 2s^2 p^3$ ${}_8\text{O } 1s^2 2s^2 p^4$
 The nuclear charge increases across a period.
17. (c) Assertion is true but Reason is false. Electron affinity is experimentally measurable while electronegativity is a relative number.
18. (c) Ionization enthalpy is the energy required to remove an electron from an isolated gaseous atom in its ground state.
19. (a) Both assertion and reason are correct and reason is correct explanation of assertion.

Chemical Bonding and Molecular Structure

TYPE A : MULTIPLE CHOICE QUESTIONS

- The strongest hydrogen bond is : [1997]
 (a) O—H.....S (b) S—H.....O
 (c) F—H.....F (d) F—H.....O
- Shape of XeF_4 molecule is: [1998]
 (a) Pyramidal (b) Square planar
 (c) Triangular planar (d) Linear
- The shape of NH_3 molecule is : [2001]
 (a) Tetrahedral (b) Trigonal planar
 (c) Trigonal pyramidal (d) Linear
- Which of the following molecule has highest bond energy? [2002]
 (a) F—F (b) N—N
 (c) C—C (d) O—O
- Which of the following has the highest dipole moment? [2002]
 (a) $\begin{array}{c} \text{H} \\ \diagdown \\ \text{C}=\text{O} \\ \diagup \\ \text{H} \end{array}$ (b) $\begin{array}{c} \text{CH}_3 \quad \text{H} \\ | \quad | \\ \text{C}=\text{C} \\ | \quad | \\ \text{CH}_3 \quad \text{H} \end{array}$
 (c) $\begin{array}{c} \text{H} \quad \text{CH}_3 \\ | \quad | \\ \text{C}=\text{C} \\ | \quad | \\ \text{CH}_3 \quad \text{H} \end{array}$ (d) $\begin{array}{c} \text{Cl} \quad \text{CH}_3 \\ | \quad | \\ \text{C}=\text{C} \\ | \quad | \\ \text{CH}_3 \quad \text{Cl} \end{array}$
- The number of σ - and π -bonds present in pent-4-en-1-yne is [2002]
 (a) 10, 3 (b) 4, 9
 (c) 3, 10 (d) 9, 4
- Which of the following are arranged in the decreasing order of dipole moment? [2003]
 (a) $\text{CH}_3\text{Cl}, \text{CH}_3\text{Br}, \text{CH}_3\text{F}$
 (b) $\text{CH}_3\text{Cl}, \text{CH}_3\text{F}, \text{CH}_3\text{Br}$
 (c) $\text{CH}_3\text{Br}, \text{CH}_3\text{Cl}, \text{CH}_3\text{F}$
 (d) $\text{CH}_3\text{Br}, \text{CH}_3\text{F}, \text{CH}_3\text{Cl}$
- The paramagnetic species is : [2003]
 (a) KO_2 (b) SiO_2
 (c) TiO_2 (d) BaO_2
- Shape of O_2F_2 is similar to that of : [2004]
 (a) C_2F_2 (b) H_2O_2
 (c) H_2F_2 (d) C_2H_2
- The ONO angle is maximum in : [2004]
 (a) NO_3^- (b) NO_2^-
 (c) NO_2 (d) NO_2^+
- Among the following molecules
 (i) XeO_3 (ii) XeOF_4 (iii) XeF_6
 Those having same number of lone pair of Xe are : [2005]
 (a) (i) and (ii) only (b) (i) and (iii) only
 (c) (ii) and (iii) only (d) (i), (ii) and (iii)
- Among the following, the species having square planar geometry for central atom are
 (i) XeF_4 (ii) SF_4
 (iii) $[\text{NiCl}_4]^{2-}$ (iv) $[\text{PtCl}_4]^{2-}$ [2006]
 (a) (i) and (iv) (b) (i) and (ii).
 (c) (ii) and (iii) (d) (iii) and (iv)
- In $[\text{Ag}(\text{CN})_2]^-$, the number of π bonds is : [2006]
 (a) 2 (b) 3
 (c) 4 (d) 6
- Bond length order is [2007]
 (a) $\text{O}_2 < \text{O}_3 < \text{O}_2^{2-}$ (b) $\text{O}_2 < \text{O}_2^{2-} < \text{O}_3$
 (c) $\text{O}_2^{2-} < \text{O}_3 < \text{O}_2$ (d) $\text{O}_2 = \text{O}_2^{2-} > \text{O}_3$
- Sulphur reacts with chlorine in 1 : 2 ratio and forms X. Hydrolysis of X gives a sulphur compound Y. What is the structure and hybridisation of anion of Y? [2008]
 (a) tetrahedral, sp^3 (b) linear, sp
 (c) pyramidal, sp^3 (d) trigonal planar, sp^2
- Which of the following molecule has highest dipole moment? [2010]
 (a) B_2H_6 (b) NF_3
 (c) NH_3 (d) BF_3
- The geometry of ClO_3^- according to valence shell electron pair repulsion (VSEPR) theory will be [2012]
 (a) Planar triangle (b) Pyramidal
 (c) Tetrahedral (d) Square planar

C-18

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18. N_2 and O_2 are converted into monocations, N_2^+ and O_2^+ respectively. Which of the following statements is wrong? [2013]
- In N_2^+ , the N—N bond weakens
 - In O_2^+ , the O—O bond order increases
 - In O_2^+ , paramagnetism decreases
 - N_2^+ becomes diamagnetic
19. Match List I and List II and pick out correct matching codes from the given choices : [2015]
- | List I | List II |
|------------|-------------------------|
| Compound | Structure |
| A. ClF_3 | 1. Square planar |
| B. PCl_5 | 2. Tetrahedral |
| C. IF_5 | 3. Trigonal bipyramidal |
| D. CCl_4 | 4. Square pyramidal |
| E. XeF_4 | 5. T-shaped |
- Codes**
- A-5, B-4, C-3, D-2, E-1
 - A-5, B-3, C-4, D-2, E-1
 - A-5, B-3, C-4, D-1, E-2
 - A-4, B-3, C-5, D-2, E-1
20. XeO_4 molecule is tetrahedral having : [2016]
- Two $p\pi - d\pi$ bonds
 - One $p\pi - d\pi$ bonds
 - Four $p\pi - d\pi$ bonds
 - Three $p\pi - d\pi$ bonds
21. Among the following species, identify the pair having same bond order CN^- , O_2^- , NO^+ , CN^+ [2016]
- CN^- and O_2^-
 - O_2^- and NO^+
 - CN^- and NO^+
 - CN^- and CN^+
22. Which of the following substances has the least covalent character? [2017]
- Cl_2O
 - NCl_3
 - $PbCl_2$
 - $BaCl_2$
- If the Assertion is correct but Reason is incorrect.
 - If both the Assertion and Reason are incorrect.
 - If the Assertion is incorrect but the Reason is correct.
23. **Assertion** : Water is liquid but H_2S is a gas.
Reason : Oxygen is paramagnetic. [1999]
24. **Assertion** : Boiling and melting points of amides are higher than corresponding acids.
Reason : It is due to strong intermolecular hydrogen bonding in their molecules. [2002]
25. **Assertion** : Sigma (σ) is a strong bond, while pi (π) is a weak bond.
Reason : Atoms rotate freely about pi (π) bond. [2002]
26. **Assertion** : The O—O bond length in H_2O_2 is shorter than that of O_2F_2 .
Reason : H_2O_2 is an ionic compound. [2003]
27. **Assertion** : All F—S—F angle in SF_4 are greater than 90° but less than 180° .
Reason : The lone pair-bond pair repulsion is weaker than bond pair-bond pair repulsion. [2004]
28. **Assertion** : $SeCl_4$ does not have a tetrahedral structure.
Reason : Se in $SeCl_4$ has two lone pairs. [2005]
29. **Assertion** : B_2 molecule is diamagnetic.
Reason : The highest occupied molecular orbital is of σ type. [2005]
30. **Assertion** : Ozone is powerful oxidising agent in comparison to O_2 .
Reason : Ozone is diamagnetic but O_2 is paramagnetic. [2005]
31. **Assertion** : Molecular nitrogen is less reactive than molecular oxygen.
Reason : The bond length of N_2 is shorter than that of oxygen. [2007, 2006]
32. **Assertion** : Fluorine molecule has bond order one.
Reason : The number of electrons in the antibonding molecular orbitals is two less than that in bonding molecular orbitals. [2008]

TYPE B : ASSERTION REASON QUESTIONS

Directions for (Qs. 23-32) : These questions consist of two statements, each printed as Assertion and Reason. While answering these questions, you are required to choose any one of the following five responses.

- If both Assertion and Reason are correct and the Reason is a correct explanation of the Assertion.
 - If both Assertion and Reason are correct but Reason is not a correct explanation of the Assertion.
- If both Assertion and Reason are correct and Reason is the correct explanation of Assertion.

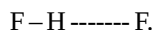
Directions for (Qs.33-38) : Each of these questions contains an Assertion followed by Reason. Read them carefully and answer the question on the basis of following options. You have to select the one that best describes the two statements.

- (b) If both Assertion and Reason are correct, but Reason is not the correct explanation of Assertion.
- (c) If Assertion is correct but Reason is incorrect.
- (d) If both the Assertion and Reason are incorrect.
33. **Assertion :** Molecules of larger size have higher polarizability.
Reason : Polarizability is observed only in those molecules which has permanent dipole moment. [2010]
34. **Assertion :** Bond angle of H_2S is smaller than H_2O .
Reason : Electronegativity of the central atom increases, bond angle decreases. [2011]
35. **Assertion :** Bond angle of H_2S is smaller than H_2O .
Reason : Electronegativity of the central atom increases, bond angle decreases. [2013]
36. **Assertion :** LiCl is predominantly a covalent compound.
Reason : Electronegativity difference between Li and Cl is too small. [2014]
37. **Assertion :** Cuprous ion (Cu^+) has unpaired electrons while cupric ion (Cu^{++}) does not.
Reason : Cuprous ion (Cu^+) is colourless whereas cupric ion (Cu^{++}) is blue in the aqueous solution. [2014]
38. **Assertion :** Lone pair-lone pair repulsive interactions are greater than lone pair-bond pair and bond pair-bond pair interactions.
Reason : The space occupied by lone pair electrons is more as compared to bond pair electrons. [2016]

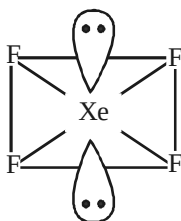
HINTS & SOLUTIONS

Type A : Multiple Choice Questions

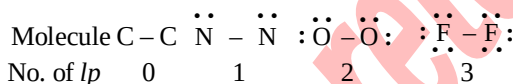
1. (c) Higher the electronegativity of the other atom, greater is the strength of hydrogen bond. Strongest hydrogen bond is between H and F.



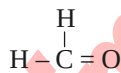
2. (b) Shape of XeF_4 molecule is square planar. It involves sp^3d^2 hybridisation.



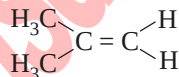
3. (c) In NH_3 , N is sp^3 hybridised; N of NH_3 has a lone pair of electrons. The lone pair distorts the normal tetrahedral geometry due to $lp-bp$ interaction to trigonal bipyramidal.
4. (c) Greater the number of lone pairs present on the bonded atoms, greater is the repulsive force between them and hence smaller the bond energy.



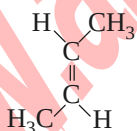
5. (a) Greater the difference in electronegativity between the two atoms, larger will be polarity and hence dipole moment. Thus (a) has maximum dipole moment.



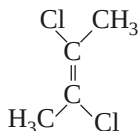
(a)
(C-O bond is more polar)



(b)
(very less polar)



(c)



(d)

Symmetrical molecules ($\mu = 0$)

6. (a) $\text{HC}\equiv\text{C}-\text{CH}_2-\text{CH}=\text{CH}_2$
Pent-4-en-1-yne

Triple bond between C and C contains one σ bond and two π bonds. Double bond between C and C contains one σ bond and one π bond.

Total σ bonds = 10

Total π bonds = 3

7. (b) Fluorine is most electronegative and Br is least electronegative. So CH_3F should have highest dipole moment but as C-F bond length is very small so in spite of greater polarity in CH_3F , it has less dipole moment than CH_3Cl .

8. (a) Species having unpaired electron or odd number of electrons are paramagnetic while species having paired or even number of electrons are called diamagnetic.

KO_2 has 35 electrons — paramagnetic

SiO_2 has 30 electrons — diamagnetic

TiO_2 has 38 electrons — diamagnetic

BaO_2 has 72 electrons — diamagnetic

9. (b) Shape of O_2F_2 is similar to that of H_2O_2 because both of them are peroxides.

10. (d) In NO_2^+ nitrogen is in sp hybridised state. So, the molecule is linear. So ONO angle is 180° which is maximum among all other molecules.

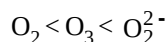
11. (d) In all compounds, Xe will have same no. of lone pair (one only)

12. (a) Square Planar Structure: XeF_4 and $[\text{PtCl}_4]^{2-}$

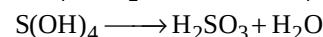
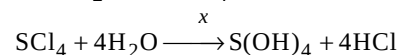
13. (c) In one $-\text{C}\equiv\text{N}$, No. of π bonds = 2

So in $[\text{Ag}(\text{CN})_2]^-$, No. of π bonds = $2 \times 2 = 4$

14. (a) Bond length is inversely proportional to bond order. Bond orders of O_2 , O_3 and O_2^{2-} are 2, 1.5 and 1 respectively. Hence the correct sequence of bond lengths is

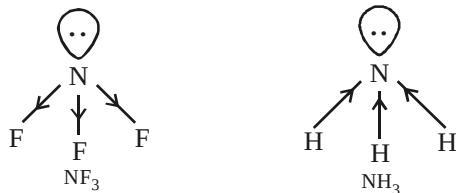


15. (c) $\text{S} + 2\text{Cl}_2 \longrightarrow \text{SCl}_4$



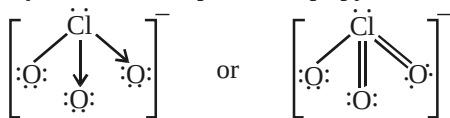
The anion of y is SO_3^{2-} in which S is sp^3 hybridised with one lone pair of electrons on S, giving SO_3^{2-} pyramidal shape.

16. (c) BF_3 and B_2H_6 being non-polar molecules do not show dipole moment. In NF_3 , the electronegative F pulls the electron toward itself due to which bond moments of the three N–F bonds is opposite to that of lone pair while in NH_3 bond moments of the N–H bonds are in same direction to that of lone pair.



Hence, bond moments add up in NH_3 resulting in highest dipole moment among the given options.

17. (b) Hybridisation is sp^3 and shape pyramidal



18. (d) N_2^+ is paramagnetic
 $\sigma 1s^2, \sigma^* 1s^2, \sigma 2s^2, \pi 2p_x^2, \sigma 2p_z^1$

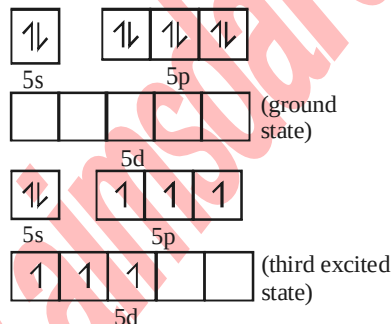
19. (b) **List I**
Compound

- (A) ClF_3
 (B) PCl_5
 (C) IF_5
 (D) CCl_4
 (E) XeF_4

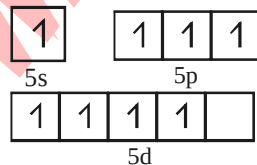
- List II**
Structure

- T-shaped
 Trigonal bipyramidal
 Square pyramidal
 Tetrahedral
 Square planar

20. (c) Xenon undergo sp^3 hybridization.



In the fourth excited state xenon atom, has 8 unpaired electrons



One s and three p orbital undergo sp^3 hybridization. Four sp^3 hybrid orbitals form four σ bonds with oxygen atoms. They are σsp^3-p . Four $p\pi-d\pi$ bonds are also formed with oxygen atoms by the unpaired electrons.

21. (c) M.O. electronic configuration of CN^- is
 $\sigma 1s^2, \sigma^* 1s^2, \sigma 2s^2, \sigma^* 2s^2, \pi 2p_x^2, \pi 2p_y^2, \sigma 2p_z^2$

$$\therefore \text{B.O.} = \frac{10-4}{2} = 3$$

M.O. electronic configuration of O_2^- is

$$\sigma 1s^2, \sigma^* 1s^2, \sigma 2s^2, \sigma^* 2s^2, \sigma 2p_z^2, \pi 2p_x^2, \pi 2p_y^2, \pi^* 2p_x^1, \pi^* 2p_y^1$$

$$\therefore \text{B.O.} = \frac{10-7}{2} = 1.5$$

M.O. electronic configuration of CN^+

$$\sigma 1s^2, \sigma^* 1s^2, \sigma 2s^2, \sigma^* 2s^2, \pi 2p_x^2, \pi 2p_y^2, \sigma 2p_z^1$$

$$\therefore \text{B.O.} = \frac{9-4}{2} = 2.5$$

M.O. electronic configuration of NO^+ is

$$\sigma 1s^2, \sigma^* 1s^2, \sigma 2s^2, \sigma^* 2s^2, \sigma 2p_z^2, \pi 2p_x^2, \pi 2p_y^2$$

$$\therefore \text{B.O.} = \frac{10-4}{2} = 3$$

$\therefore \text{CN}^-$ and NO^+ have bond order equal to 3

22. (d) According to Fajan's rule :

$$\text{Covalent character} \propto \frac{1}{\text{size of cation}} \\ \propto \text{size of anion}$$

Among the given species order of size of cations

$$\text{N}^{3+} < \text{O}^{2+} < \text{Pb}^{2+} < \text{Ba}^{2+}$$

order of size of anions $\text{O}^{2-} > \text{Cl}^-$.

Hence the order of covalent character is

$$\text{NCl}_3 > \text{Cl}_2\text{O} > \text{PbCl}_2 > \text{BaCl}_2$$

BaCl_2 is least covalent in nature.

Type B : Assertion Reason Questions

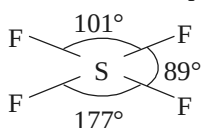
23. (b) Water is liquid but H_2S is gas due to hydrogen bond in water. Oxygen is paramagnetic.
24. (a)
25. (c) Sigma (σ) bond is formed by axial overlap of atomic orbitals while pi (π) bond is formed by lateral overlap. Since axial overlapping takes place to a greater extent than the

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lateral overlapping, former (σ) bond is stronger than pi bond. Atoms attached to doubly bonded atom can't rotate freely around the double bond.

26. (d) H_2O_2 is a covalent compound. In O_2F_2 , O–O bond is shorter than in H_2O_2 due to higher electronegativity of F.
27. (d) SF_4 has see-saw type structure in which bond angles are different between different S–F atoms. It has non-planar structure.



According to VSEPR theory $\ell p - \ell p$ repulsion $> \ell p - bp > bp - bp$ repulsion

28. (c) SeCl_4 has distorted trigonal pyramidal geometry; here Se has only one lone pair of electrons hence it has sp^3d hybridisation.
29. (d) B_2 molecule has no of electrons = 10
Molecular orbital configuration

$$\sigma(1s)^2 \sigma^*(1s)^2 \sigma(2s)^2 \sigma^*(2s)^2 \pi 2p_x^1 \pi 2p_y^1$$
 Due to unpaired electron, it is paramagnetic. The highest occupied MO is of π -type.
30. (b) Ozone is a powerful oxidising agent because it is unstable and breaks into oxygen as it has higher energy content than oxygen.

$$\text{O}_3 \rightarrow \text{O}_2 + \text{O}$$
 It is also true that O_3 is diamagnetic, while O_2 is paramagnetic.
31. (a) Nitrogen molecule has triple bond, whereas oxygen has double bond. N–N Bond length of N_2 is shorter. Hence, it is difficult to break the triple bond of N_2 . Hence N_2 is less reactive. Both A and R are true.
32. (a) MO electronic configuration of F_2 molecule.

$$\sigma 1s^2, \sigma^* 1s^2, \sigma 2s^2, \sigma^* 2s^2, \sigma 2p_x^2, \pi 2p_y^2 \approx \pi 2p_z^2, \pi^* 2p_y^2 \approx \pi^* 2p_z^2$$
 Thus there are 10 electrons in bonding orbitals and 8 electrons in antibonding

orbitals. Thus, reason is true and it is also the correct explanation of assertion because

$$\text{Bond order} = \frac{N_b - N_a}{2} = \frac{10 - 8}{2} = 1$$

33. (c) Assertion is true but Reason is false.
 As the size of the atom increases the influence of the electric dipole also increases.
34. (c) Bond angle of H_2S (92°) $<$ H_2O ($104^\circ 31'$). As the electronegativity of the central atom decreases, bond angle decreases. In the present case, S is less electronegative than oxygen. Thus bond pairs in H_2S are more away from the central atom than in H_2O and thus repulsive forces between bond pairs are smaller producing smaller bond angle.
35. (c) Bond angle of H_2S (92°) $<$ H_2O ($104^\circ 31'$). As the electronegativity of the central atom decreases, bond angle decreases. In the present case, S is less electronegative than oxygen. Thus bond pairs in H_2S are more away from the central atom than in H_2O and thus repulsive forces between bond pairs are smaller producing smaller bond angle.
36. (c) LiCl is a covalent compound. Due to the large size of the anion (Cl^-) its effective nuclear charge lessens and its valence shell is held less tightly towards its nucleus. Here, assertion is correct but reason is incorrect.
37. (d)
38. (a) While the lone pairs are localised on the central atom, each bonded pair is shared between two atoms. As a result, the lone pair electrons in a molecule occupy more space as compared to the bonding pairs of electrons. This results in greater repulsion between lone pairs of electrons as compared to the lone pair - bond pair and bond pair - bond pair repulsions.
 Hence (b) is the correct option.

TYPE A : MULTIPLE CHOICE QUESTIONS

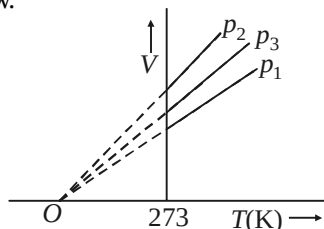
- A gas occupies a volume of 300 cc at 27°C and 620 mm pressure. The volume of gas at 47°C and 640 mm pressure is : [1997]
 - 260 cc
 - 310 cc
 - 390 cc
 - 450 cc
- The compressibility factor of an ideal gas is : [1997]
 - 0
 - 2
 - 1
 - 4
- A gas cylinder containing cooling gas can withstand a pressure of 14.9 atmosphere. The pressure gauge of cylinder indicates 12 atmosphere at 27°C. Due to sudden fire in the building the temperature starts rising. The temperature at which cylinder explodes is : [1997]
 - 87.5°C
 - 99.5°C
 - 115.5°C
 - 135.5°C
- Van der Waal's equation [1998]

$$\left[P + \frac{a}{V^2}\right](V - b) = nRT$$
 is applicable for :
 - Ideal gas
 - Non-ideal gas
 - Both (a) and (b)
 - None of these
- For the diffusion of a gas at pressure P , the rate of diffusion is expressed by: [1998]
 - $r \propto \frac{1}{\sqrt{M}}$
 - $r = \frac{P}{M}$
 - $r \propto \frac{M}{\sqrt{P}}$
 - $r = \frac{P}{\sqrt{M}}$
- The transport of matter in the absence of bulk flow is known as: [1999]
 - Diffusion
 - Transfusion
 - Translation
 - Rotation
- At 298 K, equal volumes of SO_2 , CH_4 and O_2 are mixed in empty container. The total pressure exerted is 2.1 atm. The partial pressure of CH_4 in mixture is : [2000]
 - 0.6 atm.
 - 1.2 atm
 - 2.4 atm
 - 3.6 atm.
- Which equation shows correct form of Berthelot equation. [2000]
 - $\left(P + \frac{a}{T(V+C)^2}\right)(V-b) = RT$
 - $\left(P + \frac{a}{T(V-C)^2}\right)(V-b) = RT$
 - $\left(P + \frac{a}{TV^2}\right)(V-b) = RT$
 - $\left(P + \frac{a}{TV^2}\right)(V+b) = RT$
- If P is pressure and ρ is density of a gas, then P and ρ are related as [2002]
 - $P \propto \rho$
 - $P \propto (1/\rho)$
 - $P \propto \rho^2$
 - $P \propto (1/\rho^2)$
- Dominance of strong repulsive forces among the molecules of the gas (Z = compressibility factor): [2006]
 - Depends on Z and indicated by $Z = 1$
 - Depends on Z and indicated by $Z > 1$
 - Depends on Z and indicated by $Z < 1$
 - Is independent of Z .
- In P versus V graph, the horizontal line is found in which _____ exits. [2007]
 - Gas
 - Liquid
 - Equilibrium between gas and liquid
 - Super critical temperature.
- Critical temperatures for A, B, C and D gases are 25°C, 10°C, -80°C and 15°C respectively. Which gas will be liquefied more easily? [2007]
 - A
 - B
 - C
 - D

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13. The volume-temperature graphs of a given mass of an ideal gas at constant pressure are shown below. [2008]



What is the correct order of pressures ?

- (a) $p_1 > p_3 > p_2$ (b) $p_1 > p_2 > p_3$
 (c) $p_2 > p_3 > p_1$ (d) $p_2 > p_1 > p_3$
14. The inversion temperature T_i (K) of hydrogen is (given van der Waal's constants a and b are $0.244 \text{ atm L}^2 \text{ mol}^{-2}$ and 0.027 L mol^{-1} respectively) [2010]
 (a) 440 (b) 220 (c) 110 (d) 330
15. Amongst the following statements, the correct one is : [2011]
 (a) The gas can not be compressed below the critical temperature.
 (b) Below critical temperature, thermal motion of the molecules is slow enough for the intermolecular forces to come into play leading to condensation of the gas.
 (c) At critical temperature liquid and gaseous phase can be distinguished.
 (d) An ideal gas has a characteristic critical temperature.
16. X ml of H_2 gas effuse through a hole in a container in 5 seconds. The time taken for the effusion of the same volume of the gas specified below under identical conditions is [2012]
 (a) 10 seconds : He (b) 20 seconds : O_2
 (c) 25 seconds : CO (d) 55 seconds : CO_2
17. The rate of diffusion of SO_2 , CO_2 , PCl_3 and SO_3 are in the following order [2013]
 (a) $\text{PCl}_3 > \text{SO}_3 > \text{SO}_2 > \text{CO}_2$
 (b) $\text{CO}_2 > \text{SO}_2 > \text{PCl}_3 > \text{SO}_3$
 (c) $\text{SO}_2 > \text{SO}_3 > \text{PCl}_3 > \text{CO}_2$
 (d) $\text{CO}_2 > \text{SO}_2 > \text{SO}_3 > \text{PCl}_3$

18. A bottle of dry ammonia and a bottle of dry hydrogen chloride connected through a long tube are opened simultaneously at both ends the white ammonium chloride ring first formed will be [2014]

- (a) at the centre of the tube.
 (b) near the hydrogen chloride bottle.
 (c) near the ammonia bottle.
 (d) throughout the length of the tube.

19. The gas with the highest critical temperature is [2014]

- (a) H_2 (b) He
 (c) N_2 (d) CO_2

20. Cyclopropane and oxygen at partial pressures 170 torr and 570 torr respectively are mixed in a gas cylinder. What is the ratio of the number of moles of cyclopropane to the number of moles of oxygen ($n_{\text{C}_3\text{H}_6}/n_{\text{O}_2}$)? [2015]

- (a) $\frac{170 \times 42}{570 \times 32} = 0.39$
 (b) $\frac{170}{42} / \left(\frac{170}{42} + \frac{570}{32} \right) \approx 0.19$
 (c) $\frac{170}{740} = 0.23$
 (d) $\frac{170}{570} = 0.30$

21. When a sample of gas is compressed at constant temperature from 15 atm to 60 atm, its volume changes from 76 cm^3 to 20.5 cm^3 . Which of the following statements are possible explanations of this behaviour?

- (1) The gas behaves non-ideally
 (2) The gas dimerises
 (3) The gas is adsorbed into the vessel walls [2016]

- (a) 1, 2 and 3 (b) 1 and 2 only
 (c) 2 and 3 only (d) 1 only

22. Pure hydrogen sulphide is stored in a tank of 100 litre capacity at 20°C and 2 atm pressure. The mass of the gas will be [2017]

- (a) 34 g (b) 340 g
 (c) 282.68 g (d) 28.24 g

TYPE B : ASSERTION REASON QUESTIONS

Directions for (Qs. 23-28) : These questions consist of two statements, each printed as Assertion and Reason. While answering these questions, you are required to choose any one of the following five responses.

- (a) If both Assertion and Reason are correct and the Reason is a correct explanation of the Assertion.
- (b) If both Assertion and Reason are correct but Reason is not a correct explanation of the Assertion.
- (c) If the Assertion is correct but Reason is incorrect.
- (d) If both the Assertion and Reason are incorrect.
- (e) If the Assertion is incorrect but the Reason is correct.

23. **Assertion :** Ice melts faster at high altitude.

Reason : At high altitude, atmospheric pressure is high. [1997]

24. **Assertion :** Gases do not settle to the bottom of container.

Reason : Gases have high kinetic energy [1997]

25. **Assertion :** Wet air is heavier than dry air.

Reason : The density of dry air is more than density of water. [1999]

26. **Assertion :** Use of pressure cooker reduces cooking time.

Reason : At higher pressure cooking occurs faster. [2000]

27. **Assertion :** All molecules in a gas have same speed.

Reason : Gas contains molecules of different size and shape. [2001]

28. **Assertion :** Compressibility factor for hydrogen varies with pressure with positive slope at all pressures.

Reason : Even at low pressure, repulsive forces dominate hydrogen gas. [2005]

Directions for (Qs.29-33) : Each of these questions contains an Assertion followed by Reason. Read them carefully and answer the question on the basis of following options. You have to select the one that best describes the two statements.

- (a) If both Assertion and Reason are correct and Reason is the correct explanation of Assertion.
- (b) If both Assertion and Reason are correct, but Reason is not the correct explanation of Assertion.
- (c) If Assertion is correct but Reason is incorrect.
- (d) If both the Assertion and Reason are incorrect.

29. **Assertion :** The molecules of the dissolved gas present in a liquid gain kinetic energy as temperature is raised.

Reason : Gases tends to be more soluble in liquids as the temperature is raised. [2009]

30. **Assertion :** Greater the value of van der Waal's constant 'a' greater is the liquefaction of gas.

Reason : 'a' indirectly measures the magnitude of attractive forces between the molecules. [2014]

31. **Assertion :** Compressibility factor (Z) for non-ideal gases can be greater than 1. [2015]

Reason : Non-ideal gases always exert higher pressure than expected.

32. **Assertion :** Gases do not liquefy above their critical temperature, even on applying high pressure.

Reason : Above critical temperature, the molecular speed is high and intermolecular attractions cannot hold the molecules together because they escape because of high speed. [2016]

33. **Assertion :** At critical temperature liquid passes into gaseous state imperceptibly and continuously.

Reason : The density of liquid and gaseous phase is equal to critical temperature.

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Type A : Multiple Choice Questions

- (b) From $\frac{P_1 V_1}{T_1} = \frac{P_2 V_2}{T_2}$

$$\frac{V_1 \times 640}{(273 + 47)} = \frac{620 \times 300}{(273 + 27)}$$

$$V_1 = \frac{620 \times 300 \times 320}{640 \times 300} = 310 \text{ cc}$$
- (c) Compressibility factor (Z) is a convenient method of showing deviation of real gases from an ideal gas

$$Z = \frac{PV}{nRT}$$

For ideal gas, $PV = nRT$; $\therefore Z = 1$
 For real gases, $PV \neq nRT$; $\therefore Z \neq 1$
 When, $Z > 1$, it refers positive deviation i.e., gas is less compressible than ideal gas.
 $Z < 1$, it refers negative deviation, i.e., gas is more compressible than ideal gas.
- (b) From Charles's law, $\frac{P_1}{T_1} = \frac{P_2}{T_2}$

$$\frac{12}{(273 + 27)} = \frac{14.9}{T_2}$$

$$T_2 = \frac{14.9 \times 300}{12} = 372.5 \text{ K}$$

$$= 372.5 - 273 = 99.5^\circ \text{C}$$
- (b) Van der Waal's equation is applicable for real (non-ideal) gases.
- (a) According to Graham's law of diffusion or effusion "under similar conditions of temperature and pressure, rate of diffusion is inversely proportional to square root of molecular weight" $r \propto \frac{1}{\sqrt{M}}$.
- (a) Diffusion is the process by which matter is transported in small quantities.
- (b) Let the wt. of each gas mixed = x g

$$\therefore \text{mole of SO}_2 = \frac{x}{64}$$

$$\text{mole of CH}_4 = \frac{x}{16}$$

$$\text{mole of O}_2 = \frac{x}{32}$$

Total number of moles of the three gases

$$= \frac{x}{64} + \frac{x}{16} + \frac{x}{32} = \frac{7x}{64}$$

Partial pressure exerted by a gas in the mixture of non-reacting gases (p) is given by

$$p = \frac{\text{moles of that gas}}{\text{total moles}} \times \text{Total pressure}$$

$$\therefore p_{\text{CH}_4} = \frac{x}{16} \times \frac{64}{7x} \times 2.1 = 1.2 \text{ atm}$$

$$8. \quad (c) \quad \left(P + \frac{a}{TV^2} \right) (V - nb) = RT \text{ is}$$

Berthelot equation. The volume correction is same as in van der Waal's equation, but the pressure correction is different. He introduced the pressure correction as $\frac{a}{TV^2}$

in place of $\frac{a}{V^2}$

$$9. \quad (a) \quad P \propto \frac{1}{V} \text{ and } \frac{m}{V} = \rho; \frac{1}{V} = \frac{\rho}{m}$$

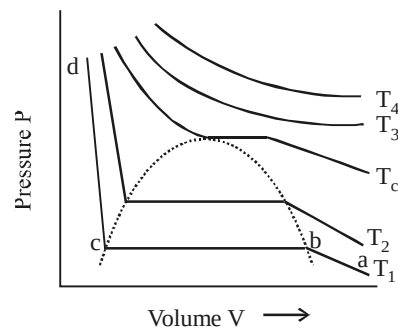
So, $P \propto \frac{\rho}{m}$ i.e. Pressure $\propto \rho$

10. (b) Repulsive force will decrease the compressibility factor i.e. so, value of $Z > 1$ as

$$Z = \frac{PV}{RT}$$

Due to repulsion value of PV will be greater than RT so $Z > 1$.

11. (c) Generally most of real gases show the same type of isotherm.



ab represents the gaseous state, line bc which is horizontal line shows liquid and vapour equilibrium. Pressure corresponding to the line bc is known as vapour pressure of liquid. Line cd represents liquid state.

12. (a) Critical temperature of a gas is given by

$$T_C = \frac{8a}{27Rb} \quad \text{b} \quad a \propto T_C$$

where a is measure of vander Waal's forces of attraction. Higher the critical temperature of a gas greater the intermolecular forces of attraction between the molecules of gas and easily the gas can be liquefied. Hence gas A whose critical temperature (25°C) is highest among all the given options will be liquified more easily.

13. (a) From the graph we can see the correct order of pressures $p_1 > p_3 > p_2$

14. (b) Gases become cooler during Joule Thomson's expansion only if they are below a certain temperature known as inversion temperature (T_i). The inversion temperature is characteristic of each gas and is given by

$$T_i = \frac{2a}{bR}$$

where R is gas constant

Given $a = 0.244 \text{ atm L}^2 \text{ mol}^{-2}$

$b = 0.027 \text{ L mol}^{-1}$

$R = 0.0821 \text{ L atm deg}^{-1} \text{ mol}^{-1}$

$$\therefore T_i = \frac{2 \times 0.244}{0.027 \times 0.0821} = 220 \text{ K}$$

15. (b)

16. (b) For effusion of same volume,

$$\frac{t_1}{t_2} = \sqrt{\frac{M_1}{M_2}} \Rightarrow \frac{t_1}{\sqrt{M_1}} = \frac{t_2}{\sqrt{M_2}}$$

This is clearly seen from the options that

the ratio of $\frac{t}{\sqrt{M}}$ is same for H_2 and O_2 .

$$\left(\frac{5}{\sqrt{2}} = \frac{20}{\sqrt{32}} = \frac{5}{\sqrt{2}} \right)$$

17. (d) Rate $\propto \sqrt{\frac{1}{M}}$. The smaller the value of M the more is the rate of diffusion

18. (b) Rate of diffusion $\propto \sqrt{\frac{1}{\text{Molecular mass}}}$
 $\therefore$ Molecular mass of $\text{HCl} >$ Molecular mass of NH_3
 $\therefore$ HCl diffuses at slower rate and white ammonium chloride is first formed near HCl bottle.

19. (d) CO_2 has highest critical temperature of 304.2 K

20. (d) By ideal gas equation

$$P_1 V = n_1 R T$$

$$n_1 \propto P_1 \text{ and } n_2 \propto P_2$$

$$\frac{n_1}{n_2} = \frac{P_1}{P_2} \Rightarrow \frac{n_1}{n_2} = \frac{170}{570} = 0.30$$

21. (d) Given, $P_1 = 15 \text{ atm}$, $P_2 = 60 \text{ atm}$

$$V_1 = 76 \text{ cm}^3, V_2 = 20.5 \text{ cm}^3$$

If the gas is an ideal gas, then according to Boyle's law, it must follow the equation,

$$P_1 V_1 = P_2 V_2$$

$$P_1 \times V_1 = 15 \times 76 = 1140$$

$$P_2 \times V_2 = 60 \times 20.5 = 1230$$

$$\therefore P_1 V_1 \neq P_2 V_2$$

$\therefore$ The gas behaves non-ideally.

The given information is not sufficient to comment on other statements.

22. (c) $n = \frac{PV}{RT} = \frac{m}{M}$

$$m = \frac{MPV}{RT} = \frac{34 \times 2 \times 100}{0.082 \times 293} = 282.68 \text{ gm}$$

Type B : Assertion Reason Questions

23. (d) Ice does not melt faster at high altitude because melting is favoured at high pressure, whereas atmospheric pressure decreases as we go higher. So, assertion and reason both are false.
24. (a) Gases do not settle to the bottom because of its kinetic energy. They are always in motion. Because of small mass, the effect of gravity on them is negative.
25. (e) Wet air is lighter than dry air because density of air is more than water.

C-28

Topicwise AIIMS Solved Papers – CHEMISTRY

26. (a) Use of pressure cooker reduces cooking time because increase of pressure increases b.p and so cooking occurs faster.
27. (d) All molecules of a gas are identical in shape and size, but have different energies due to which they have different speeds.
28. (a) In case of hydrogen, Z increases with pressure. At $273K$, $Z > 1$, which shows that it is difficult to compress the gas as compared to ideal gas. In this case repulsive forces dominate.
29. (c) When the temperature is raised, the molecules of the dissolved gas present in a liquid gain kinetic energy. Higher kinetic energy of the gas molecules make them to escape from its solution. That is why, gases tend to be less soluble in liquids at higher temperature.
30. (a) Both assertion and reason are true and reason is the correct explanation of assertion. Considering the attractive force pressure in ideal gas equation ($PV = nRT$) is corrected by introducing a factor of $\frac{an^2}{V^2}$ where a is van der waal constant.
31. (c) Z can be greater than 1 or less than 1. Non-ideal gases exert less pressure than expected due to backward pull by other molecules.
32. (a)
33. (a)

TYPE A : MULTIPLE CHOICE QUESTIONS

- The enthalpy change of a reaction does not depend on : **[1997]**
 - initial and final enthalpy change of reaction
 - state of reactants and products
 - different intermediate reactions
 - nature of reactants and products
- $$\text{S} + \text{O}_2 \rightarrow \text{SO}_2 + x \text{ kcal} \quad \dots(1)$$

$$\text{SO}_2 + \frac{1}{2} \text{O}_2 \rightarrow \text{SO}_3 + y \text{ kcal} \quad \dots(2)$$

The heat of formation of SO_3 in the above reaction is **[1997]**

 - $(x+y)$
 - $(x-y)$
 - $(2x-y)$
 - $(2x+y)$
- At a constant volume the specific heat of a gas is 0.075 and its molecular weight is 40. The gas is: **[1998]**
 - Monoatomic
 - Diatomic
 - Triatomic
 - None of the above
- The heat of combustion of yellow phosphorous is -9.91 kJ and of red phosphorous is -8.78 kJ . The heat of transition of yellow phosphorus to red phosphorus is : **[1998]**
 - -9.91 kJ
 - -8.78 kJ
 - -9.34 kJ
 - -1.13 kJ
- Combustion of glucose takes place according to the equation:

$$\text{C}_6\text{H}_{12}\text{O}_6 + 6\text{O}_2 \rightarrow 6\text{CO}_2 + 6\text{H}_2\text{O},$$

$$\Delta H = -72 \text{ k cal}$$

The energy required for production of 1.6 g of glucose is [molecular mass of glucose is 180 g]

 - 0.064 k cal
 - 0.64 k cal **[1998]**
 - 6.4 k cal
 - 64 k cal
- For a spontaneous process, entropy: **[1998]**
 - Increases
 - Decreases
 - Unchanged
 - Not clear
- Internal energy does not include: **[1999]**
 - Rotational energy
 - Nuclear energy
 - Vibrational energy
 - Energy due to gravitational pull
- A gas expands isothermally against a constant external pressure of 1 atm from a volume of 10 dm^3 to a volume of 20 dm^3 . It absorbs 300 J of thermal energy from its surrounding. The ΔU is:

(a) -312 J	(b) $+123 \text{ J}$	[1999]
(c) -213 J	(d) $+231 \text{ J}$	
- During isothermal expansion of one mole of an ideal gas from 10 atm to 1 atm at 273 K, the work done is [gas constant = 2] : **[2000]**
 - -895.8 cal
 - -1172.6 cal
 - -1257.43 cal
 - -1499.6 cal
- One mole of an ideal gas for which $C_v = (3/2)R$ is heated reversibly at a constant pressure of 1 atm from 25°C to 100°C . The ΔH is : **[2000]**
 - 3.775 cal
 - 37.256 cal
 - 372.56 cal
 - 3725.6 cal
- Enthalpy of neutralisation of CH_3COOH by NaOH is -50.6 kJ/mol and the heat of neutralisation of a strong acid with NaOH is -55.9 kJ/mol . The value of ΔH for the ionisation of CH_3COOH is : **[2000]**
 - 3.5 kJ/mol
 - 4.6 kJ/mol
 - 5.3 kJ/mol
 - 6.4 kJ/mol
- The internal energy of a substance : **[2001]**
 - increases with increase in temperature
 - decreases with increase in temperature
 - remains unaffected with temperature
 - can be calculated by the reaction, $E = mc^2$

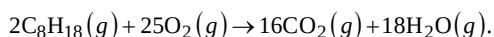
13. The heat of reaction for :
 $\text{C}_{10}\text{H}_8(\text{s}) + 12\text{O}_2(\text{g}) \rightarrow 10\text{CO}_2(\text{g}) + 4\text{H}_2\text{O}(\text{l})$
 at constant volume is -1228.2 kcal at 25°C . The heat of reaction at constant pressure and same temperature is : [2001]
 (a) -1228.2 kcal (b) -1229.3 kcal
 (c) -1232.9 kcal (d) -1242.6 kcal
14. Two moles of an ideal gas are compressed isothermally (100°C) and reversibly from a pressure of 10 atm to 25 atm, then the free energy change is : [2001]
 (a) $+15.482 \text{ kJ}$ (b) $+10.462 \text{ kJ}$
 (c) $+5.684 \text{ kJ}$ (d) $+3.364 \text{ kJ}$
15. In the exothermic reaction, the enthalpy of reaction is always : [2001]
 (a) zero (b) positive
 (c) negative (d) none of these
16. The heat of neutralization of a strong base and a strong acid is 57 kJ . The heat released when 0.5 moles of HNO_3 solution is added to 0.20 moles of NaOH solution, is [2002]
 (a) 11.4 kJ (b) 34.7 kJ
 (c) 23.5 kJ (d) 58.8 kJ
17. One gram sample of NH_4NO_3 is decomposed in a bomb calorimeter, the temperature of the calorimeter increases by 6.12 K . The heat capacity of the system is 1.23 kJ/g/deg . What is the molar heat of decomposition for NH_4NO_3 ? [2003]
 (a) -7.53 kJ/mol (b) -398.1 kJ/mol
 (c) -16.1 kJ/mol (d) -602 kJ/mol
18. Which one of the following has ΔS° greater than zero? [2003]
 (a) $\text{CaO}(\text{s}) + \text{CO}_2(\text{g}) \rightleftharpoons \text{CaCO}_3(\text{s})$
 (b) $\text{NaCl}(\text{aq}) \rightleftharpoons \text{NaCl}(\text{s})$
 (c) $\text{NaNO}_3(\text{s}) \rightleftharpoons \text{Na}^+(\text{aq}) + \text{NO}_3^-(\text{aq})$
 (d) $\text{N}_2(\text{g}) + 3\text{H}_2(\text{g}) \rightleftharpoons 2\text{NH}_3(\text{g})$
19. Which of the following is arranged in the increasing order of enthalpy of vaporisation? [2004]
 (a) $\text{NH}_3, \text{PH}_3, \text{AsH}_3$ (b) $\text{AsH}_3, \text{PH}_3, \text{NH}_3$
 (c) $\text{NH}_3, \text{AsH}_3, \text{PH}_3$ (d) $\text{PH}_3, \text{AsH}_3, \text{NH}_3$
20. How much energy is released when 6 moles of octane is burnt in air? Given ΔH_f° for $\text{CO}_2(\text{g})$, $\text{H}_2\text{O}(\text{g})$ and $\text{C}_8\text{H}_{18}(\text{l})$ respectively are -490 , -240 and $+160 \text{ J/mol}$. [2004]
 (a) -6.2 kJ (b) -37.4 kJ
 (c) -35.5 kJ (d) -20.0 kJ
21. ΔH_f° (298K) of methanol is given by the chemical equation : [2005]
 (a) $\text{CH}_4(\text{g}) + \frac{1}{2}\text{O}_2(\text{g}) \rightarrow \text{CH}_3\text{OH}(\text{g})$
 (b) $\text{C}(\text{graphite}) + \frac{1}{2}\text{O}_2(\text{g}) + 2\text{H}_2(\text{g}) \rightarrow \text{CH}_3\text{OH}(\text{l})$
 (c) $\text{C}(\text{diamond}) + \frac{1}{2}\text{O}_2(\text{g}) + 2\text{H}_2(\text{g}) \rightarrow \text{CH}_3\text{OH}(\text{l})$
 (d) $\text{CO}(\text{g}) + 2\text{H}_2(\text{g}) \rightarrow \text{CH}_3\text{OH}(\text{l})$
22. For the reaction of one mole of zinc dust with one mole of sulphuric acid in a bomb calorimeter, ΔU and w corresponds to [2005]
 (a) $\Delta U < 0, w = 0$ (b) $\Delta U < 0, w < 0$
 (c) $\Delta U > 0, w = 0$ (d) $\Delta U > 0, w > 0$
23. For a spontaneous process, the correct statement is : [2006]
 (a) Entropy of the system always increases
 (b) Free energy of the system always increases
 (c) Total entropy change is always negative
 (d) Total entropy change is always positive
24. For a phase change,
 $\text{H}_2\text{O}(\text{l}) \xrightleftharpoons[0^\circ\text{C}, 1\text{bar}]{} \text{H}_2\text{O}(\text{s})$ [2006]
 (a) $\Delta G = 0$ (b) $\Delta S = 0$
 (c) $\Delta H = 0$ (d) $\Delta U = 0$
25. The enthalpy change (ΔH) for the reaction,
 $\text{N}_2(\text{g}) + 3\text{H}_2(\text{g}) \longrightarrow 2\text{NH}_3(\text{g})$ is -92.38 kJ at 298 K . The internal energy change ΔU at 298 K is [2006]
 (a) -92.38 kJ (b) -87.42 kJ
 (c) -97.34 kJ (d) -89.9 kJ
26. ΔS_{surr} for an exothermic reaction is [2007]
 (a) always positive
 (b) always negative
 (c) zero
 (d) may be positive or negative.
27. Calculate change in internal energy if [2007]
 $\Delta H = -92.2 \text{ kJ}$, $P = 40 \text{ atm}$ and $\Delta H = -1\text{L}$.
 (a) -42 kJ (b) -88 kJ
 (c) $+88 \text{ kJ}$ (d) $+42 \text{ kJ}$

28. ΔH_{fusion} of a substance is 'x' and ΔH_{vap} is 'y', then $\Delta H_{\text{sublimation}}$ will be [2007]
 (a) $x + y$ (b) $x - y$
 (c) x/y (d) y/x
29. For a reaction to be spontaneous at all temperatures [2008]
 (a) $\Delta G - \text{ve}$, $\Delta H + \text{ve}$ and $\Delta S + \text{ve}$
 (b) $\Delta G + \text{ve}$, $\Delta H - \text{ve}$ and $\Delta S + \text{ve}$
 (c) $\Delta G - \text{ve}$, $\Delta H - \text{ve}$ and $\Delta S - \text{ve}$
 (d) $\Delta G - \text{ve}$, $\Delta H - \text{ve}$ and $\Delta S + \text{ve}$
30. What will be the heat of formation of methane, if the heat of combustion of carbon is '-x' kJ, heat of formation of water is '-y' kJ and heat of combustion of methane is 'z' kJ? [2008]
 (a) $(-x - y + z)$ kJ (b) $(-z - x + 2y)$ kJ
 (c) $(-x - 2y - z)$ kJ (d) $(-x - 2y + z)$ kJ
31. When a solid melts reversibly [2009]
 (a) H decreases (b) G increases
 (c) E decreases (d) S increases
32. 6 moles of an ideal gas expand isothermally and reversibly from a volume of 1 litre to a volume of 10 litres at 27°C . What is the maximum work done? [2009]
 (a) 47 kJ (b) 100 kJ
 (c) 0 (d) 34.465 kJ
33. The standard enthalpy of combustion at 25°C of hydrogen, cyclohexene (C_6H_{10}) and cyclohexane (C_6H_{12}) are -241, -3800 and -3920 kJ/mole respectively. Calculate the heat of hydrogenation of cyclohexene. [2009]
 (a) -111 kJ/mol (b) -121 kJ/mol
 (c) -118 kJ/mol (d) -128 kJ/mol
34. One mole of an ideal gas at 300 K is expanded isothermally from an initial volume of 1 litre to 10 litres. The value of ΔE for this process is ($R = 2 \text{ cal mol}^{-1} \text{ K}^{-1}$) [2010]
 (a) 163.7 cal (b) zero
 (c) 138.1 cal (d) 9 litre atm
35. For the reaction, $2\text{Cl(g)} \longrightarrow \text{Cl}_2(\text{g})$, the signs of ΔH and ΔS respectively, are: [2010]
 (a) +, - (b) +, +
 (c) -, - (d) -, +
36. One mole of an ideal gas is allowed to expand reversibly and adiabatically from a temperature of 27°C . If the work done during the process is 3 kJ, then final temperature of the gas is ($C_v = 20 \text{ J/K}$) [2010]
 (a) 100 K (b) 150 K
 (c) 195 K (d) 255 K
37. Enthalpy of formation of HF and HCl are -161 kJ and -92 kJ respectively. Which of the following statements is incorrect? [2010]
 (a) HCl is more stable than HF
 (b) HF and HCl are exothermic compounds
 (c) The affinity of fluorine to hydrogen is greater than the affinity of chlorine to hydrogen
 (d) HF is more stable than HCl
38. Which of the following processes takes place with decrease of entropy? [2011]
 (a) Solid $\rightarrow$ gas
 (b) sugar + water $\rightarrow$ solution
 (c) $\text{NH}_3(\text{g}) + \text{HCl}(\text{g}) \rightarrow \text{NH}_4\text{Cl}(\text{s})$
 (d) $\text{A}(\text{g}) + \text{B}(\text{g}) \rightarrow \text{mixture}$
39. Enthalpy of combustion of CH_4 , C_2H_6 and C_3H_8 are -210.8, -368.4 and -526.2 k cal mol^{-1} respectively. Enthalpy of combustion of hexane can be predicted as [2011]
 (a) -840 k cal mol^{-1} (b) -684 k cal mol^{-1}
 (c) -1000 k cal mol^{-1} (d) none of these
40. AB, A_2 and B_2 are diatomic molecules. If the bond enthalpies of A_2 , AB and B_2 are in the ratio 1:1:0.5 and enthalpy of formation of AB from A_2 and B_2 is -100 kJ mol^{-1} . What is the bond energy of A_2 : [2012]
 (a) 200 kJ mol^{-1} (b) 100 kJ mol^{-1}
 (c) 300 kJ mol^{-1} (d) 400 kJ mol^{-1}
41. Which of the following condition favours the reduction of a metal oxide to metal? [2012]
 (a) $\Delta H = +\text{ve}$, $T\Delta S = +\text{ve}$ at low temperature
 (b) $\Delta H = +\text{ve}$, $T\Delta S = -\text{ve}$ at any temperature
 (c) $\Delta H = -\text{ve}$, $T\Delta S = -\text{ve}$ at high temperature
 (d) $\Delta H = -\text{ve}$, $T\Delta S = +\text{ve}$ at any temperature
42. The ΔH_f° for $\text{CO}_2(\text{g})$, $\text{CO}(\text{g})$ and $\text{H}_2\text{O}(\text{g})$ are -393.5, -110.5 and -241.8 kJ mol^{-1} respectively. The standard enthalpy change (in kJ) for the reaction [2013]
 $\text{CO}_2(\text{g}) + \text{H}_2(\text{g}) \rightarrow \text{CO}(\text{g}) + \text{H}_2\text{O}(\text{g})$ is
 (a) 524.1 (b) 41.2
 (c) -262.5 (d) -41.2

43. What is the enthalpy change for,
 $2\text{H}_2\text{O}_2(l) \rightarrow 2\text{H}_2\text{O}(l) + \text{O}_2(g)$ if heat of formation of $\text{H}_2\text{O}_2(l)$ and $\text{H}_2\text{O}(l)$ are -188 and -286 kJ/mol respectively? [2014]

(a) -196 kJ/mol (b) $+948$ kJ/mol
 (c) $+196$ kJ/mol (d) -948 kJ/mol

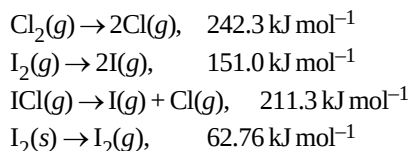
44. Following reaction occurs in an automobile



The sign of ΔH , ΔS and ΔG would be [2015]

(a) $+, -, +$ (b) $-, +, -$
 (c) $-, +, +$ (d) $+, +, -$

45. The enthalpy changes for the following processes are listed below : [2015]



Given that the standard states for iodine and chlorine are $\text{I}_2(s)$ and $\text{Cl}_2(g)$, the standard enthalpy of formation for $\text{ICl}(g)$ is:

(a) $+16.8$ kJ mol $^{-1}$ (b) $+244.8$ kJ mol $^{-1}$
 (c) -14.6 kJ mol $^{-1}$ (d) -16.8 kJ mol $^{-1}$

46. Choose the reaction in which ΔH is not equal to ΔU ? [2016]

(a) $\text{C}_{(\text{graphite})} + \text{O}_{2(g)} \rightarrow \text{CO}_{2(g)}$
 (b) $\text{C}_2\text{H}_{4(g)} + \text{H}_{2(g)} \rightarrow \text{C}_2\text{H}_{6(g)}$
 (c) $2\text{C}_{(\text{graphite})} + \text{H}_{2(g)} \rightarrow \text{C}_2\text{H}_{2(g)}$
 (d) $\text{H}_{2(g)} + \text{I}_{2(g)} \rightarrow 2\text{HI}_{(g)}$

47. The standard enthalpies of combustion of $\text{C}_6\text{H}_{6(l)}$, $\text{C}_{(\text{graphite})}$ and $\text{H}_{2(g)}$ are respectively -3270 kJ mol $^{-1}$, -394 kJ mol $^{-1}$ and -286 kJ mol $^{-1}$. What is the standard enthalpy of formation of $\text{C}_6\text{H}_{6(l)}$ in kJ mol $^{-1}$? [2016]

(a) -48 (b) $+48$
 (c) -480 (d) $+480$

48. The molar heat capacity of water at constant pressure is $75 \text{ JK}^{-1} \text{ mol}^{-1}$. When 1 kJ of heat is supplied to 100 g of water, which is free to expand, the increase in temperature of water is [2017]

(a) 6.6 K (b) 1.2 K
 (c) 2.4 K (d) 4.8 K

49. The $\Delta_f H^\circ$ for $\text{CO}_2(g)$, $\text{CO}(g)$ and $\text{H}_2\text{O}(g)$ are -393.5 , -110.5 and -241.8 kJ/mol respectively, the standard enthalpy change (in kJ) for the reaction



(a) 524.1 (b) 41.2
 (c) -262.5 (d) -41.2

TYPE B : ASSERTION REASON QUESTIONS

Directions for (Qs. 50-60) : These questions consist of two statements, each printed as Assertion and Reason. While answering these questions, you are required to choose any one of the following five responses.

- (a) If both Assertion and Reason are correct and the Reason is a correct explanation of the Assertion.
 (b) If both Assertion and Reason are correct but Reason is not a correct explanation of the Assertion.
 (c) If the Assertion is correct but Reason is incorrect.
 (d) If both the Assertion and Reason are incorrect.
 (e) If the Assertion is incorrect but the Reason is correct.

50. **Assertion :** Ionic reactions are not instantaneous.
Reason : Oppositely charged ions exert strong forces. [1997]

51. **Assertion :** Entropy of ice is less than water.
Reason : Ice has cage like structure. [2000]

52. **Assertion :** During an adiabatic process, heat energy is not exchanged between system and its surroundings.

Reason : The temperature of a gas increases when it undergoes an adiabatic expansion. [2002]

53. **Assertion :** Mass and volume are extensive properties.

Reason : Mass / volume is also an extensive parameter. [2002]

54. **Assertion :** Absolute values of internal energy of substances cannot be determined.

Reason : It is impossible to determine exact values of constituent energies of the substances. [2002]

55. **Assertion :** The increase in internal energy (ΔE) for the vaporization of one mole of water at 1 atm and 373 K is zero.

Reason : For all isothermal processes, $\Delta E = 0$ [2003]

56. **Assertion :** ΔH and ΔE are almost same for the reaction $\text{N}_2(\text{g}) + \text{O}_2(\text{g}) \rightleftharpoons 2\text{NO}(\text{g})$
Reason : All reactants and products are gases. [2003]
57. **Assertion :** Molar enthalpy of vaporisation of water is different from ethanol.
Reason : Water is more polar than ethanol. [2004]
58. **Assertion :** Water in liquid state is more stable than ice at room temperature.
Reason : Water in liquid form has higher entropy than ice. [2006]
59. **Assertion :** When a salt such as NaCl dissolves, the Na^+ and Cl^- ions leaving the crystal lattice acquire far greater freedom.
Reason : In thermodynamic terms, the formation of solution occurs with a favourable change in free energy, i.e., ΔH has a high positive value and $T\Delta S$ a low negative value. [2007]
60. **Assertion :** For a reaction $2\text{NH}_3(\text{g}) \longrightarrow \text{N}_2(\text{g}) + 3\text{H}_2(\text{g}); \Delta H > \Delta E$
Reason : Enthalpy change is always greater than internal energy change. [2008]
- Directions for (Qs.61-64) :** Each of these questions contains an Assertion followed by Reason. Read them carefully and answer the question on the basis of following options. You have to select the one that best describes the two statements.
- (a) If both Assertion and Reason are correct and Reason is the correct explanation of Assertion.
(b) If both Assertion and Reason are correct, but Reason is not the correct explanation of Assertion.
(c) If Assertion is correct but Reason is incorrect.
(d) If both the Assertion and Reason are incorrect.
61. **Assertion :** For an isothermal reversible process $Q = -W$ i.e. work done by the system equals the heat absorbed by the system.
Reason : Enthalpy change (ΔH) is zero for isothermal process. [2011]
62. **Assertion :** Many endothermic reactions that are not spontaneous at room temperature become spontaneous at high temperature.
Reason : Entropy of the system increases with increase in temperature. [2012]
63. **Assertion :** For an isothermal reversible process $Q = -W$ i.e. work done by the system equals the heat absorbed by the system. [2013]
Reason : Enthalpy change (ΔH) is zero for isothermal process.
64. **Assertion :** For a reaction $2\text{NH}_3(\text{g}) \rightarrow \text{N}_2(\text{g}) + 3\text{H}_2(\text{g}); \Delta H > \Delta E$.
Reason : Enthalpy change is always greater than internal energy change. [2014]

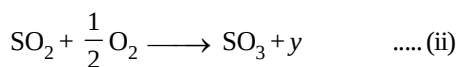
HINTS & SOLUTIONS

Type A : Multiple Choice Questions

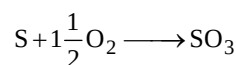
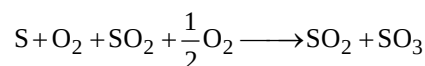
1. (c) Enthalpy change of a reaction does not depend upon different intermediate reactions.

$$\Delta H = H_p - H_r$$

2. (a) $S + O_2 \longrightarrow SO_2 + x$ (i)



Adding (i) and (ii), we have



So, heat of formation of SO_3 will be $(x + y)$.

3. (a) We know that,
Molar heat capacity at constant volume,
 C_v = Specific heat at constant volume $\times$
Mol. wt.
 $= 0.075 \times 40 = 3.0$ cal

$$\therefore C_p - C_v = R$$

$$\text{or } C_p = R + C_v = 2 + 3 = 5$$

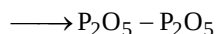
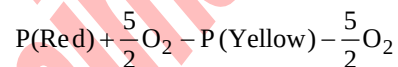
$$\text{Now, } \frac{C_p}{C_v} = \gamma; \therefore \gamma = \frac{5}{3} = 1.66$$

This value shows that the gas is monoatomic.

4. (d) $P(\text{red}) + \frac{5}{2} O_2 \longrightarrow P_2O_5; \Delta H = -8.78$



Subtracting



$$P(\text{Red}) - P(\text{Yellow}) = 0;$$

$$\Delta H = -8.78 + 9.91 = 1.113$$

$$P(\text{Red}) \rightarrow P(\text{Yellow}), \Delta H = 1.13$$

$$P(\text{Yellow}) \rightarrow P(\text{Red}), \Delta H = -1.13$$

5. (b) Formation of glucose will be the given by reaction taking place in reverse direction.



For production of 180 g of glucose, heat energy is 72 k cal.

So required heat for 1.6 g of glucose

$$= \frac{72}{180} \times 1.6 = 0.64 \text{ k cal}$$

6. (a) For a spontaneous process, the entropy should increase.
7. (d) Internal Energy of a gas consists of (i) kinetic energy of gas molecules (ii) potential energy of gas molecules due to intermolecular attractions. It does not include any other form of energy. So, potential energy due to gravitational pull is not included in it.

8. (c) $W = - \int_{V_1}^{V_2} P dV = -P(V_2 - V_1)$

$$W = -(1 \text{ atm})(20 - 10) = -10 \text{ dm}^3 \text{ atm.}$$

$$= -10 \text{ dm}^3 \times \frac{8.314 \text{ J/K/mol}}{0.08206 \text{ dm}^3/\text{K/mol}} = -1013 \text{ J}$$

According to 1st law of thermodynamics,

$$\Delta U = q + W = 800 \text{ J} + (-1013 \text{ J}) = -213 \text{ J}$$

9. (c) Work done in expansion of gas

$$= -2.303 nRT \log \frac{P_1}{P_2}$$

$$= -2.303 \times 1 \times 2 \times 273 \log \frac{10}{1}$$

$$= -1257.43 \text{ cal.}$$

10. (c) $\Delta H = \Delta E + P\Delta V \left[\begin{array}{l} PV = RT; P\Delta V = R\Delta T \\ \Delta E = \Delta C_V \times (T_2 - T_1) \end{array} \right]$

$$= \frac{3}{2} R \times 75 + R \times 75 = 75 \times \frac{5}{2}$$

$$= 372.56 \text{ cal}$$

11. (c) Enthalpy of neutralisation of CH_3COOH by $NaOH$ is -50.6 kJ/mole; for strong acid and base this value is 55.9 kJ/mole. Heat evolved in the first case is less as some heat is used up in ionisation of CH_3COOH . So, ΔH for ionisation of $CH_3COOH = 55.9 - 50.6 = 5.3$ kJ/mol.

12. (a) The internal energy of a substance increases with increase in temperature due to increase in rotational, translational and vibrational energy of the molecule.
13. (b) $\Delta E = -1228.2 \text{ kcal} = -1228.2 \times 10^3 \text{ cal}$
 $\Delta H = \Delta E + \Delta nRT$
 $= -1228.2 \times 10^3 + (-2)(2)(298)$
 $= -1229392 \text{ cal}$
 $= -1229.392 \text{ kcal}$
14. (c) For isothermal reversible process,

$$W_{\text{rev}} = -2.303 nRT \log \frac{P_1}{P_2}$$

$$= -2.303 \times 2 \times 8.314 \times 373 \log \frac{10}{25}$$

$$= +5684.1 \text{ J} = 5.684 \text{ kJ}$$
15. (c) Enthalpy of reaction (ΔH) = $H_p - H_R$
 For exothermic reactions, $H_p < H_R$
 $\therefore \Delta H$ is negative
16. (a) The chemical reaction between strong base and strong acid is a neutralisation reaction between H^+ ion and OH^- ion.
 $H^+ + OH^- \longrightarrow H_2O + \text{Heat}$
 One mole of H^+ and one mole of OH^- give 57 kJ. When 0.5 moles of H^+ (from HNO_3) reacts with 0.2 mole of OH^- (from $NaOH$), 0.2 mole of H^+ is neutralised by 0.2 mole of OH^- and 0.3 mole of H^+ remains unreacted.

$$\begin{array}{ccc} H^+ & + & OH^- & \longrightarrow & H_2O \\ 0.2 \text{ mole} & & 0.2 \text{ mole} & & \end{array}$$

 Heat evolved will be = $\frac{57 \times 0.2}{1} = 11.4 \text{ kJ}$
17. (d) Heat produced (Q) = $mC\Delta T$
 $= 1 \times 1.23 \times 6.12 \text{ kJ}$
 Molecule weight of $NH_4NO_3 = 80 \text{ g}$
 Heat produced per mole = $80 \times 1.23 \times 6.12 = 602 \text{ kJ/mol}$
18. (c) Entropy (ΔS) of a reaction is positive if the products are in more random state as compared to reactants.
 Order of randomness : Gas > Liquid > Solid
 (i) In (b), product $NaCl$ (solid) has lesser entropy as compared to $NaCl$ (aq) (Na^+ and Cl^-) in reactant.
 (ii) In (a), product (solid) has lesser entropy as compared to reactants.
- (iii) In (d), both reactants and products are in gaseous state, but number of moles of products are decreasing.
- (iv) In (c), products are in liquid state hence high entropy than reactant which is present in solid state.
19. (d) The order of heat of vaporisation or boiling point of the hydrides of VA group depend upon their molecular weight. Anomalous behaviour of NH_3 is due to H-bonding present in NH_3 . Thus the correct order is $NH_3 > AsH_3 > PH_3$
20. (c) $C + O_2 = CO_2 \quad \Delta H = -490 \text{ kJ/mol}$ (i)
 $H_2 + \frac{1}{2}O_2 = H_2O \quad \Delta H = -240 \text{ kJ/mol}$ (ii)
 $8C + 9H_2 = C_8H_{18} \quad \Delta H = +160 \text{ kJ/mol}$ (iii)
 $2C_8H_{18} + 25O_2 = 16CO_2 + 18H_2O$
 The required reaction can be obtained by $2 \times \text{(iii)} - 16 \times \text{(i)} - 18 \times \text{(ii)}$
 $16C + 18H_2 - 16C - 16O_2 - 18H_2 - 9O_2$
 $= 2C_8H_{18} - 16CO_2 - 18H_2O$
 or $-25O_2 = 2C_8H_{18} - 16CO_2 - 18H_2O$
 $2C_8H_{18} + 25O_2 = 16CO_2 + 18H_2O$
 $[\Delta H = 2 \times 160 - 16 \times -490 - 18 \times -240]$
 $\Delta H = -11840 \text{ J} = -11.840 \text{ kJ}$ for 2 moles of octane. Energy released for 6 moles of octane = $-11.840 \times 3 = -35.5 \text{ kJ}$
21. (b) Heat of formation is defined as the heat exchange when one mole of a compound is formed from its constituent elements at STP. In case of allotropes, most stable allotrope is taken into account. Among graphite and diamond, graphite is stable. Hence, heat of formation of CH_3OH is represented by the eqn.

$$C(\text{graphite}) + \frac{1}{2}O_{2(g)} + 2H_{2(g)} \rightarrow CH_3OH_{(l)}$$
22. (a) $Zn + H_2SO_4 \longrightarrow ZnSO_4 + H_2$
 In bomb calorimeter, there is no expansion in volume, so, work done will be zero. This reaction is exothermic. So, some heat will be evolved which will result in lowering of internal energy. Hence,
 $\Delta U < 0$ & $w = 0$

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23. (d) Total entropy change (system and surrounding) is always positive.

24. (a) $\Delta G = 0$ at equilibrium

25. (b) $\Delta E = \Delta H - \Delta nRT$

$$= -92.38 - \left(\frac{-2 \times 8.31 \times 298}{1000} \right)$$

$$= -92.38 + 4.95 = -87.43 \text{ kJ}$$

26. (d) Heat is released in an exothermic process which increases the entropy of surroundings.

When entropy of the system is positive, overall entropy change is also positive. In some exothermic reactions, entropy of system may decrease.

27. (b) $\Delta H = -92.2 \text{ kJ}$, $P = 40 \text{ atm}$, $\Delta V = -1 \text{ L}$

Using $\Delta H = \Delta E + P\Delta V$

$$\Rightarrow \Delta E = \Delta H - P\Delta V$$

$$= (-92.2 \text{ kJ}) - (40 \text{ atm})(-1 \text{ L}) \times \frac{R}{R}$$

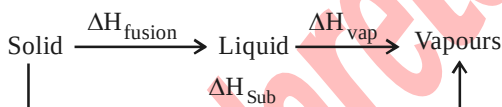
$$= -92.2 \text{ kJ} + (40 \text{ atm L}) \times$$

$$\frac{8.314 \text{ (JK}^{-1}\text{mol}^{-1})}{0.0821 \text{ (atm L K}^{-1}\text{mol}^{-1})}$$

$$= -92200 \text{ J} + 4050.66 \text{ J} = -88149.34 \text{ J}$$

$$= -88.149 \text{ kJ} \approx -88 \text{ kJ}$$

28. (a)



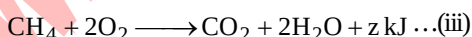
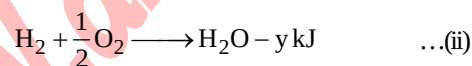
So using Hess law, we get

$$\Delta H_{\text{sub.}} = \Delta H_{\text{fus.}} + \Delta H_{\text{vap.}} = x + y$$

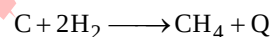
29. (d) Since $\Delta G = \Delta H - T\Delta S$

If ΔG is negative, ΔH is negative and ΔS is positive, then the reaction will be spontaneous at all temperatures.

30. (d) From given data, we have

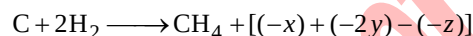


The required equation is



To get the required equation, operate (i) + 2 × (ii) – (iii)

Thus, we get



Thus, heat of formation of methane is $(-x - 2y + z) \text{ kJ}$

31. (d) When solid melts S increases because when solid changes into liquid randomness increases.

$$32. \text{ (d) } W = -2.303 nRT \log \frac{V_2}{V_1}$$

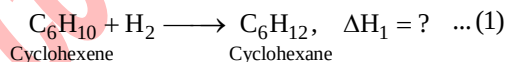
$$\text{Given } n = 6, T = 27^\circ\text{C} = 273 + 27 = 300 \text{ K}$$

$$V_1 = 1 \text{ L}, V_2 = 10 \text{ L}$$

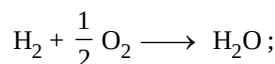
$$\therefore W = -2.303 \times 6 \times 8.314 \times 300 \log \frac{10}{1}$$

$$= -34.465 \text{ kJ}$$

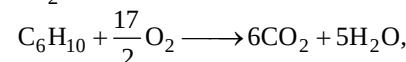
33. (b) The required reaction is



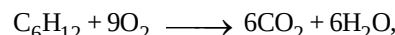
Let us write the given facts



$$\Delta H_2 = -241 \text{ kJ/mol} \quad \dots (2)$$

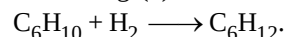


$$\Delta H_3 = -3800 \text{ kJ/mol} \quad \dots (3)$$



$$\Delta H_4 = -3920 \text{ kJ/mol} \quad \dots (4)$$

The required reaction (1) can be obtained by adding equations (2) and (3), and subtracting (4) from the sum of (2) and (3).



$$\Delta H_1 = (\Delta H_2 + \Delta H_3) - \Delta H_4$$

$$= [-241 + (-3800)] - (-3920)$$

$$= (-241 - 3800) - (-3920)$$

$$= -4041 + 3920 = -121 \text{ kJ/mol}$$

34. (b) Change in internal energy (ΔE) is zero during isothermal expansion of a gas.



Entropy is decreasing (–ve) in the reaction. Further the reaction is exothermic since a bond is being formed, i.e., ΔH is also –ve.

36. (b) Since the gas expands adiabatically (i.e., no change in enthalpy) so the heat is totally converted into work.

For the gas, $C_V = 20 \text{ J/K}$. Thus, 20 J of heat is required for 1° change in temperature of the gas.

Heat change involved during the process i.e., work done = 3 kJ = 3000 J.

$$\text{Change in temperature} = \frac{3000}{20} \text{ K} = 150 \text{ K}$$

Initial temperature = 300 K

Since, the gas expands so the temperature decreases and thus final temperature is

$$300 - 150 = 150 \text{ K}$$

37. (a) More the enthalpy of formation less will be the stability of the compound.

38. (c)

$$\begin{aligned} 39. \quad (c) \quad \Delta H_c(\text{C}_2\text{H}_6) - \Delta H_c(\text{CH}_4) \\ = -368.2 - (-210.8) = -157.4 \end{aligned}$$

$$\begin{aligned} \Delta H_c(\text{C}_3\text{H}_8) - \Delta H_c(\text{C}_2\text{H}_6) \\ = -526.2 - (-368.4) = -157.8 \end{aligned}$$

Thus, average

$$\Delta H_c(-\text{CH}_2) = -\frac{157.4 + 157.8}{2}$$

$$= -157.6 \text{ kcal mol}^{-1}$$

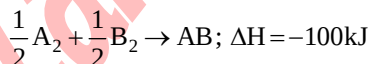
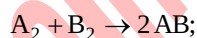
Then,

$$\Delta H_c(\text{C}_6\text{H}_{14}) = \Delta H_c(\text{C}_3\text{H}_8) + 3\Delta H_c(-\text{CH}_2)$$

$$= -526.2 + 3(-157.6) = -999 \text{ kcal mol}^{-1}$$

40. (d) Let bond energy of A_2 be x then bond energy of AB is also x and bond energy of B_2 is $x/2$.

Enthalpy of formation of AB is -100 kJ/mole :



$$\text{or } -100 = \left(\frac{1x}{2} + \frac{x}{4} \right) - x$$

$$\therefore -100 = \frac{2x + x - 4x}{4} \therefore x = 400 \text{ kJ mol}^{-1}$$

41. (d)

$$\begin{aligned} 42. \quad (b) \quad \Delta H = H^\circ_f(\text{products}) - H^\circ_f(\text{reactants}) \\ = -110.5 + (-241.8) - (-393.5 + 0) = 41.2 \text{ kJ} \end{aligned}$$

$$43. \quad (a) \quad 2\text{H}_2\text{O}_2(l) \rightarrow 2\text{H}_2\text{O}(l) + \text{O}_2(g) \quad \Delta H = ?$$

$$\begin{aligned} \Delta H = [2 \times \Delta H_f \text{ of } \text{H}_2\text{O}(l) + (\Delta H_f \text{ of } \text{O}_2) \\ - (2 \times \Delta H_f \text{ of } \text{H}_2\text{O}_2(l))] \end{aligned}$$

$$= [(2 \times -286) + (0) - (2 \times -188)]$$

$$= [-572 + 376] = -196 \text{ kJ/mol}$$

44. (b) For combustion reaction, ΔH is negative, $\Delta n = (16 + 18) - (25 + 2) = +7$, so ΔS is +ve, reaction is spontaneous, hence ΔG is -ve.

$$\begin{aligned} 45. \quad (a) \quad \text{I}_2(s) + \text{Cl}_2(g) \longrightarrow 2\text{ICl}(g) \\ \Delta_r H = [\Delta H(\text{I}_2(s) \rightarrow \text{I}_2(g)) + \Delta H_{\text{I-I}} \\ + \Delta H_{\text{Cl-Cl}}] - [\Delta H_{\text{I-Cl}}] \\ = 151.0 + 242.3 + 62.76 - 2 \times 211.3 = 33.46 \end{aligned}$$

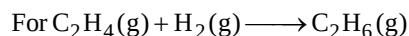
$$\Delta_f H^\circ(\text{ICl}) = \frac{33.46}{2} = 16.73 \text{ kJ/mol}$$

46. (b) ΔH is given by

$$\Delta H = \Delta U + \Delta n_g RT$$

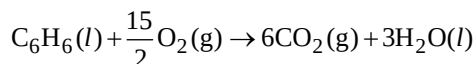
$$\text{When } \Delta n_g = 0, \Delta H = \Delta U$$

$$\text{When } \Delta n_g \neq 0, \Delta H \neq \Delta U$$

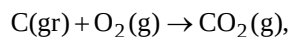


$$\Delta n_g = 1 - 2 = -1$$

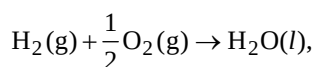
47. (b) We are given,



$$\Delta H = -3270 \text{ kJ mol}^{-1} \quad \dots(i)$$



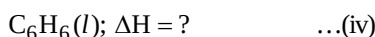
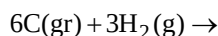
$$\Delta H = -394 \text{ kJ mol}^{-1} \quad \dots(ii)$$



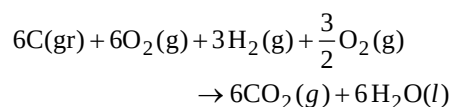
$$\Delta H = -286 \text{ kJ mol}^{-1} \quad \dots(iii)$$

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Topicwise AIIMS Solved Papers – CHEMISTRY

Formation of C_6H_6 

By multiplying eq. (ii) with 6 and eq. (iii) with 3 and adding we get,

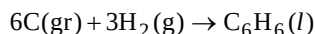


$$\Delta H = 6(-394) + 3(-286)$$

$$= (-2364) + (-858)$$

$$= -3222 \text{ kJ/mol}$$

Now, by subtracting eq. (i) from (v) we get



$$\Delta H = -3222 - (-3270) = +48 \text{ kJ/mol}$$

48. (c) Given $C_p = 75 \text{ JK}^{-1} \text{ mol}^{-1}$

$$n = \frac{100}{18} \text{ mole}, Q = 1000 \text{ J}, \Delta T = ?$$

$$Q = nC_p\Delta T \Rightarrow \Delta T = \frac{1000 \times 18}{100 \times 75} = 2.4 \text{ K}$$

49. (b) $\Delta H = \sum [\Delta H_f^\circ \text{ products}] - \sum [\Delta H_f^\circ \text{ reactants}]$

$$\Delta H^\circ = [\Delta H_f^\circ (CO)(g) + \Delta H_f^\circ (H_2O)(g)] -$$

$$[\Delta H_f^\circ (CO_2)(g) + \Delta H_f^\circ (H_2)(g)]$$

$$= [-110.5 + (-241.8)] - [-393.5 + 0]$$

$$= 41.2 \text{ kJ}$$

Type B : Assertion Reason Questions

50. (e) Ionic reactions are spontaneous as oppositely charged ions exert stronger forces and combine immediately.
51. (b) Entropy is defined as the extent of randomness in a system. When a substance is heated, its randomness and hence entropy increases. Thus entropy of ice is less than water because of lesser molecular motion in ice. It is also true that ice has an open cage like structure.
52. (c) The temperature of a gas decreases when it undergoes adiabatic expansion.

53. (c) The properties of a system which depend upon quantity of matter contained in it are called extensive properties, e.g., mass, volume, heat capacity etc. But mass / volume = density is an intensive property as density does not depend upon quantity of matter in a system.

54. (a) Absolute values of internal energy of substance can not be determined because it is impossible to determine exact values of constituent energies of the substances.

55. (a) For all isothermal process change in internal energy is zero.

56. (c) $\Delta H = \Delta E + (RT)^{\Delta n}$

If there is no change in the moles of reactants (gaseous) and products (gaseous) $\Delta n = 0$

$$\therefore \Delta H = \Delta E$$

57. (b) Molar heat of vaporisation of water is more than ethanol because of presence of stronger H-bonding in water as compared to ethanol. It is also true that water is more polar than ethanol.

58. (a) At room temperature water is more stable because ice will tend to melt at room temperature. So, A is true. But water will have larger entropy than ice because ice absorbs heat to be converted into water.

$$\Delta S = \frac{\Delta H}{T}$$

We know that greater the entropy, greater the stability. Hence, water is more stable than ice. Both A and R is true and R explains A.

59. (c) In NaCl crystal Na^+ and Cl^- are strongly bonded due to electrostatic attraction. As it is dissolved in solvent, Na^+ and Cl^- acquire greater freedom. In thermodynamic terms formation of solution occurs with a favourable change in ΔG . $T\Delta S$ is largely -ve which overcomes the small +ve value of ΔH . Thus ΔG is negative for dissolution of salt. Hence assertion is true but reason is false.

60. (c) For given reaction $\Delta H > \Delta E$ because $\{\Delta H = \Delta E + \Delta nRT\}$. In this reaction $\Delta n_{(g)}$ is $[(3 + 1) - 2 = +2]$ so $\Delta H > \Delta E$. Thus, assertion is true.
In some cases, the enthalpy change may be less than internal energy change (in these cases $\Delta n_{(g)}$, is negative), so the reason is false.
61. (b) In an isothermal process change in internal energy (ΔE) is zero (as it is a function of temperature).
 $\therefore$ According to first law of thermodynamics $\therefore Q + W = \Delta E$. Hence $Q = -W$ (if $\Delta E = 0$)
If a system undergoes a change in which internal energy of the system remains constant (i.e. $\Delta E = 0$) then $-W = Q$. This means that work done by the system equals the heat absorbed by the system.
62. (b) The factor $T\Delta S$ increases with increase in temperature.
63. (b) In an isothermal process change in internal energy (ΔE) is zero (as it is a function of temperature).
 $\therefore$ According to first law of thermodynamics
 $\therefore Q + W = \Delta E$. Hence $Q = -W$ (if $\Delta E = 0$)
If a system undergoes a change in which internal energy of the system remains constant (i.e. $\Delta E = 0$) then $-W = Q$. This means that work done by the system equals the heat absorbed by the system.
64. (c) Assertion is true but reason is false.
 $\Delta H = \Delta E + n_g RT$
 $\Delta n_g = (1 + 3) - 2 \quad \Delta H > \Delta E$.
If the value of Δn_g is less than one then $\Delta H < \Delta E$.

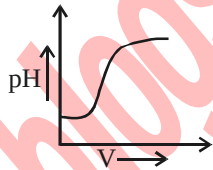
Chapter

7

Equilibrium

TYPE A : MULTIPLE CHOICE QUESTIONS

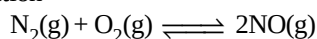
- In the reaction $I_2 + I^- \longrightarrow I_3^-$, the Lewis base is : [1997]
 - I_3^-
 - I_2
 - I^-
 - none of the above
- The equilibrium constant for the following reaction will be : $3A + 2B \longrightarrow C$ [1997]
 - $\frac{[3A][2B]}{[C]}$
 - $\frac{[C]}{[3A][2B]}$
 - $\frac{[C]}{[A]^2[B]^2}$
 - $\frac{[C]}{[A]^3[B]^2}$
- Which is Lewis acid ? [1998]
 - C_2H_5OH
 - BF_3
 - Cl^-
 - NH_3
- The pH value of ordinary water is: [1998]
 - 7
 - 6.5
 - 5.3
 - 7.8
- The value of K_p for the reaction: $2H_2S(g) = 2H_2(g) + S_2(g)$ is 1.2×10^{-2} at $1065^\circ C$. The value for K_C is: [1999]
 - $< 1.2 \times 10^{-2}$
 - $> 1.2 \times 10^{-2}$
 - 1.2×10^{-2}
 - 0.12×10^{-2}
- One mole of CH_3COOH and one mole of C_2H_5OH reacts to produce $\frac{2}{3}$ mole of $CH_3COOC_2H_5$. The equilibrium constant is : [1999]
 - 2
 - +2
 - 4
 - +4
- The pH of a solution having the H^+ ion concentration of 1×10^{-4} ions/litre is [1999]
 - 2
 - 3
 - 4
 - 5
- $A + 2B \rightleftharpoons 2C + D$, initial concentration of B was 1.5 times that of A, but the equilibrium concentration of A and B are found to be equal. The equilibrium constant for the reaction is: [2000]
 - 4
 - 8
 - 12
 - 16
- pK_a value of four acids are given below. The strongest acid is: [2000]
 - 4.0
 - 3.5
 - 2.5
 - 2
- Ostwald's dilution law is applicable on: [2000]
 - Strong electrolytes
 - Weak electrolytes
 - Both strong and weak electrolytes
 - None of them
- The pH value of N/10 NaOH is : [2001]
 - 9
 - 10
 - 12
 - 13
- A solution having hydrogen ion concentration is 0.0005 g eqvt./litre, its pOH is : [2001]
 - 8.2798
 - 10.6990
 - 12.7854
 - 13.3344
- The pH of solution containing 0.10 M sodium acetate and 0.03 M acetic acid is (pK_a for $CH_3COOH = 4.57$) [2002]
 - 4.09
 - 6.09
 - 5.09
 - 7.09
- The solubility of CuBr is 2×10^{-4} mol/L at $25^\circ C$. The K_{sp} value of CuBr is [2002]
 - $4 \times 10^{-8} \text{ mol}^2 \text{ L}^{-2}$
 - $4 \times 10^{-4} \text{ mol}^2 \text{ L}^{-2}$
 - $4 \times 10^{-11} \text{ mol}^2 \text{ L}^{-2}$
 - $4 \times 10^{-15} \text{ mol}^2 \text{ L}^{-2}$
- At $80^\circ C$, distilled water (H_3O^+) has concentration equal to 1×10^{-6} mole/litre. The value of K_w at this temperature will be [2002]
 - 1×10^{-6}
 - 1×10^{-12}
 - 1×10^{-9}
 - 1×10^{-15}
- Which one of the following is NOT a buffer solution? [2003]
 - 0.8 M H_2S + 0.8 M KHS
 - $2MC_6H_5NH_2 + 2MC_6H_5N^+H_3Br^-$
 - $3MH_2CO_3 + 3MKHCO_3$
 - 0.05 M $KClO_4$ + 0.05 M $HClO_4$

17. In which of the following acid-base titration, pH is greater than 8 at equivalence point. [2003]
 (a) Acetic acid versus ammonia
 (b) Acetic acid versus sodium hydroxide
 (c) Hydrochloric acid versus ammonia
 (d) Hydrochloric acid versus sodium hydroxide
18. What is the pH of 0.01 M glycine solution? For glycine, $K_{a1} = 4.5 \times 10^{-3}$ and $K_{a2} = 1.7 \times 10^{-10}$ at 298 K? [2004]
 (a) 3.0 (b) 10.0
 (c) 6.1 (d) 7.1
19. Of the following which change will shift the reaction towards the product?
 $I_2(g) \rightleftharpoons 2I(g)$, ΔH_r^0 (298 K) = + 150 kJ
 (a) Increase in concentration of I_2 [2004]
 (b) Decrease in concentration of I_2
 (c) Increase in temperature
 (d) Increase in total pressure
20. For the equilibrium
 $H_2O(l) \rightleftharpoons H_2O(g)$ at 1 atm and 298 K: [2004]
 (a) standard free energy change is equal to zero ($\Delta G^\circ = 0$)
 (b) free energy change is less than zero ($\Delta G < 0$)
 (c) standard free energy change is less than zero ($\Delta G^\circ < 0$)
 (d) standard free energy change is greater than zero ($\Delta G^\circ > 0$)
21. When 10 mL of 0.1 M acetic acid ($pK_a = 5.0$), is titrated against 10 mL of 0.1 M ammonia solution ($pK_b = 5.0$), the equivalence point occurs at pH: [2005]
 (a) 5.0 (b) 6.0
 (c) 7.0 (d) 9.0
22. For reaction, $2NOCl(g) \rightleftharpoons 2NO(g) + Cl_2(g)$; K_c at 427°C is $3 \times 10^{-6} \text{ L mol}^{-1}$. The value of K_p is nearly: [2005]
 (a) 7.50×10^{-5} (b) 2.50×10^{-5}
 (c) 2.50×10^{-4} (d) 1.75×10^{-4}
23. 40 mL of 0.1 M ammonia solution is mixed with 20 mL of 0.1 M HCl. What is the pH of the mixture? (pK_b of ammonia solution is 4.74). [2006]
 (a) 4.74 (b) 2.26
 (c) 9.26 (d) 5.00
24. During titration of acetic acid with aq. NaOH solution, the neutralisation graph has a vertical line. This line indicates [2007]
- 
- (a) alkaline nature of equivalence
 (b) acidic nature of equivalence
 (c) neutral nature of equivalence
 (d) depends on experimental proceeding.
25. The pH of the solution obtained on neutralisation of 40 mL 0.1 M NaOH with 40 mL 0.1 M CH_3COOH is [2007]
 (a) 7 (b) 8
 (c) 6 (d) 3
26. What is the pH value of $M H_2SO_4$? [2008]
 (a) 0 (b) -0.213
 (c) -2 (d) -0.3010
27. In which of the following reactions, the concentration of the product is higher than the concentration of reactant at equilibrium? (K = equilibrium constant) [2008]
 (a) $A \rightleftharpoons B$; $K = 0.001$
 (b) $M \rightleftharpoons N$; $K = 10$
 (c) $X \rightleftharpoons Y$; $K = 0.005$
 (d) $R \rightleftharpoons P$; $K = 0.01$
28. On adding 0.1 M solution each of $[Ag^+]$, $[Ba^{2+}]$, $[Ca^{2+}]$ in a Na_2SO_4 solution, species first precipitated is [2008]
 $[K_{sp} BaSO_4 = 10^{-11}$, $K_{sp} CaSO_4 = 10^{-6}$, $K_{sp} Ag_2SO_4 = 10^{-5}]$
 (a) Ag_2SO_4 (b) $BaSO_4$
 (c) $CaSO_4$ (d) All of these
29. A weak acid, HA is found to be 10% ionized in 0.01 M aqueous solution. Calculate the pH of a solution which is 0.1 M in HA and 0.05 M in NaA. [2009]
 (a) 5.365 (b) 6.355
 (c) 3.653 (d) 6.593

30. The solubility of PbF_2 in water at 25°C is $\sim 10^{-3}$ M. What is its solubility in 0.05 M NaF solution? Assume the latter to be fully ionised. [2009]

(a) 1.6×10^{-6} M (b) 1.2×10^{-6} M
(c) 1.2×10^{-5} M (d) 1.6×10^{-4} M

31. Air containing 79% of nitrogen and 21% of oxygen by volume is heated at 2200 K and 1 atm until equilibrium is established according to the reaction



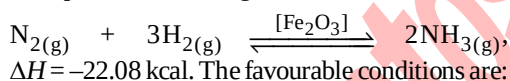
If the K_p of the reaction is 1.1×10^{-3} , calculate the amount of nitric oxide produced in terms of volume percent. [2009]

(a) 1.33 (b) 1.12
(c) 1.02 (d) 1.44

32. Solubility product of a salt AB is 1×10^{-8} in a solution in which the concentration of A^+ ions is 10^{-3} M. The salt will precipitate when the concentration of B^- ions is kept [2010]

(a) between 10^{-8} M to 10^{-7} M
(b) between 10^{-7} M to 10^{-8} M
(c) $> 10^{-5}$ M
(d) $< 10^{-8}$ M

33. In the manufacture of NH_3 in Haber's continuous flow process involving the reaction [2011]

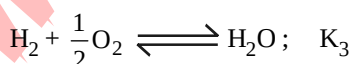
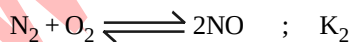
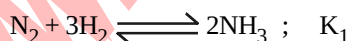


(a) High pressure and low temperature due to low activation energy (E_a).
(b) Low pressure and low temperature due to low E_a
(c) High pressure and elevated optimum temperature due to high E_a .
(d) None of these

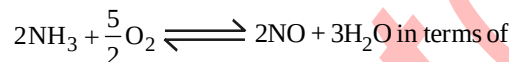
34. In which of the following cases, pH is greater than 7? [2011]

(a) 50 ml of 0.1 M HCl + 50 ml of 0.1 M NaCl
(b) 50 ml of 0.1 M H_2SO_4 + 50 ml of 0.2 M NaOH
(c) 50 ml of 0.1 M CH_3COOH + 50 ml of 0.1 M KOH
(d) 50 ml of 0.1 M HNO_3 + 50 ml of 0.1 M NH_3

35. The following equilibria are given : [2012]



The equilibrium constant of the reaction



K_1, K_2 and K_3 is

(a) $\frac{K_1 K_2}{K_3}$

(b) $\frac{K_1 K_3^2}{K_2}$

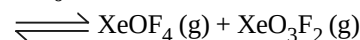
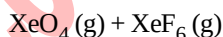
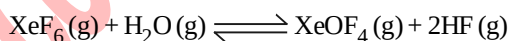
(c) $\frac{K_2 K_3^3}{K_1}$

(d) $K_1 K_2 K_3$

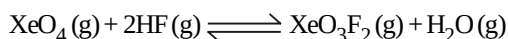
36. The pH of blood does not appreciably change by a small addition of acid or a base because blood

(a) contains serum protein which acts as buffer
(b) contains iron as a part of the molecule
(c) can be easily coagulated
(d) is body fluid [2012]

37. If K_1 and K_2 are respective equilibrium constants for the two reactions [2013]



the equilibrium constant for the reaction



will be

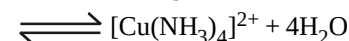
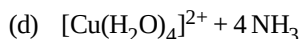
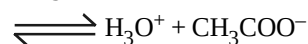
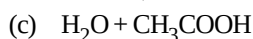
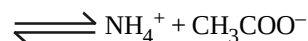
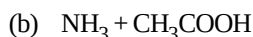
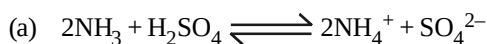
(a) $\frac{K_1}{K_2^2}$

(b) $K_1 \cdot K_2$

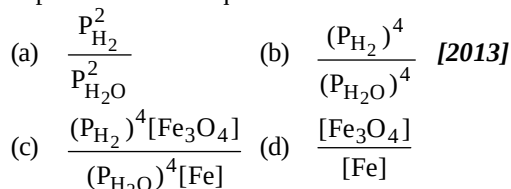
(c) $\frac{K_1}{K_2}$

(d) $\frac{K_2}{K_1}$

38. Which equilibrium can be described as an acid-base reaction using the Lewis acid-base definition but not using the Bronsted-Lowry definition? [2013]



39. Steam reacts with iron at high temperature to give hydrogen gas and Fe_3O_4 (s). The correct expression for the equilibrium constant is



40. Why only As^{3+} gets precipitated as As_2S_3 and not Zn^{2+} as ZnS when H_2S is passed through an acidic solution containing As^{3+} and Zn^{2+} ?

- (a) Solubility product of As_2S_3 is less than that of ZnS [2013]
 (b) Enough As^{3+} are present in acidic medium
 (c) Zinc salt does not ionise in acidic medium
 (d) Solubility product changes in presence of an acid

41. K_{sp} of $\text{M}(\text{OH})_2$ is 3.2×10^{-11} . The pH of saturated solution in water is [2014]

- (a) 3.40 (b) 10.30
 (c) 10.60 (d) 3.70

42. Which of the following equilibria will shift to right side on increasing the temperature? [2014]

- (a) $\text{CO}(\text{g}) + \text{H}_2\text{O}(\text{g}) \rightleftharpoons \text{CO}_2(\text{g}) + \text{H}_2(\text{g})$
 (b) $2\text{SO}_2(\text{g}) + \text{O}_2(\text{g}) \rightleftharpoons 2\text{SO}_3(\text{g})$
 (c) $\text{H}_2\text{O}(\text{g}) \rightleftharpoons \text{H}_2(\text{g}) + \frac{1}{2}\text{O}_2(\text{g})$
 (d) $4\text{HCl}(\text{g}) + \text{O}_2(\text{g}) \rightleftharpoons 2\text{H}_2\text{O}(\text{g}) + 2\text{Cl}_2(\text{g})$

43. The reaction $2\text{A}(\text{g}) + \text{B}(\text{g}) \rightleftharpoons 3\text{C}(\text{g}) + \text{D}(\text{g})$ is began with the concentrations of A and B both at an initial value of 1.00 M. When equilibrium is reached, the concentration of D is measured and found to be 0.25 M. The value for the equilibrium constant for this reaction is given by the expression [2015]

- (a) $[(0.75)^3(0.25)] \div [(0.75)^2(0.25)]$
 (b) $[(0.75)^3(0.25)] \div [(1.00)^2(1.00)]$
 (c) $[(0.75)^3(0.25)] \div [(0.50)^2(0.75)]$
 (d) $[(0.75)^3(0.25)] \div [(0.50)^2(0.25)]$

44. The solubility product (K_{sp}) of the following compounds are given at 25°C .

Compound	K_{sp}
AgCl	1.1×10^{-10}
AgI	1.0×10^{-16}
PbCrO_4	4.0×10^{-14}
Ag_2CO_3	8.0×10^{-12}

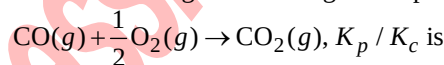
The most soluble and least soluble compounds are respectively. [2016]

- (a) AgCl and PbCrO_4
 (b) AgI and Ag_2CO_3
 (c) AgCl and Ag_2CO_3
 (d) Ag_2CO_3 and AgI

45. Two equilibria, $\text{AB} \rightleftharpoons \text{A}^+ + \text{B}^-$ and $\text{AB} + \text{B}^- \rightleftharpoons \text{AB}_2^-$ are simultaneously maintained in a solution with equilibrium constants, K_1 and K_2 respectively. The ratio of $[\text{A}^+]$ to $[\text{AB}_2^-]$ in the solution is [2016]

- (a) directly proportional to $[\text{B}^-]$
 (b) inversely proportional to $[\text{B}^-]$
 (c) directly proportional to the square of $[\text{B}^-]$
 (d) inversely proportional to the square of $[\text{B}^-]$

46. For the following reaction in gaseous phase



[2017]

- (a) $(RT)^{1/2}$ (b) $(RT)^{-1/2}$
 (c) (RT) (d) $(RT)^{-1}$

47. At 25°C , the solubility product of $\text{Mg}(\text{OH})_2$ is 1.0×10^{-11} . At which pH, will Mg^{2+} ions start precipitating in the form of $\text{Mg}(\text{OH})_2$ from a solution of 0.001 M Mg^{2+} ions? [2017]

- (a) 9 (b) 10
 (c) 11 (d) 8

TYPE B : ASSERTION REASON QUESTIONS

Directions for (Qs. 48-53) : These questions consist of two statements, each printed as Assertion and Reason. While answering these questions, you are required to choose any one of the following five responses.

- (a) If both Assertion and Reason are correct and the Reason is a correct explanation of the Assertion.
 (b) If both Assertion and Reason are correct but Reason is not a correct explanation of the Assertion.
 (c) If the Assertion is correct but Reason is incorrect.
 (d) If both the Assertion and Reason are incorrect.
 (e) If the Assertion is incorrect but the Reason is correct.

48. **Assertion:** The aqueous solution of FeCl_3 is basic in nature.

Reason: FeCl_3 hydrolyses in water. [1998]

49. **Assertion :** Addition of silver ions to a mixture of aqueous sodium chloride and sodium bromide solution will first precipitate AgBr rather than AgCl
Reason : K_{sp} of AgCl $<$ K_{sp} of AgBr [2004]
50. **Assertion :** Addition of NH_4OH to an aqueous solution of BaCl_2 in the presence of NH_4Cl (excess) precipitates $\text{Ba}(\text{OH})_2$.
Reason : $\text{Ba}(\text{OH})_2$ is insoluble in water [2005]
51. **Assertion :** Mixture of CH_3COOH and $\text{CH}_3\text{COONH}_4$ is an example of acidic buffer.
Reason : Acidic buffer contains equimolar mixture of a weak acid and its salt with weak base. [2007]
52. **Assertion :** The equilibrium constant is fixed and a characteristic for any given chemical reaction at a specified temperature.
Reason : The composition of the final equilibrium mixture at a particular temperature depends upon the starting amount of reactants. [2007]
53. **Assertion :** For reaction

$$\text{N}_2(\text{g}) + 3\text{H}_2(\text{g}) \rightleftharpoons 2\text{NH}_3(\text{g})$$
Unit of $K_C = \text{L}^2\text{mol}^{-2}$
Reason : For the reaction

$$\text{N}_2(\text{g}) + 3\text{H}_2(\text{g}) \rightleftharpoons 2\text{NH}_3(\text{g})$$
Equilibrium constant, $K_C = \frac{[\text{NH}_3]^2}{[\text{N}_2][\text{H}_2]^3}$ [2008]
- Directions for (Qs.54-59) :** Each of these questions contains an Assertion followed by Reason. Read them carefully and answer the question on the basis of following options. You have to select the one that best describes the two statements.
- (a) If both Assertion and Reason are correct and Reason is the correct explanation of Assertion.
- (b) If both Assertion and Reason are correct, but Reason is not the correct explanation of Assertion.
- (c) If Assertion is correct but Reason is incorrect.
- (d) If both the Assertion and Reason are incorrect.
54. **Assertion :** In a titration of weak acid and NaOH, the pH at half equivalence point is pK_a .
Reason : At half equivalence point, it forms an acidic buffer and the buffer capacity is maximum where $[\text{acid}] = [\text{salt}]$ [2009]
55. **Assertion :** $[\text{Al}(\text{H}_2\text{O})_6]^{3+}$ is a stronger acid than $[\text{Mg}(\text{H}_2\text{O})_6]^{2+}$.
Reason : Size of $[\text{Al}(\text{H}_2\text{O})_6]^{3+}$ is smaller than $[\text{Mg}(\text{H}_2\text{O})_6]^{2+}$ and possesses more effective nuclear charge. [2008, 2010]
56. **Assertion :** Reaction quotient is defined in the same way as equilibrium constant at any stage of the reaction.
Reason : If Q_c (reaction quotient) $<$ K_C (equilibrium constant) reaction moves in direction of reactants. [2011]
57. **Assertion :** KOH is more soluble in water than NaOH.
Reason : NaOH is a stronger base than KOH. [2011]
58. **Assertion :** Buffer system of carbonic acid and sodium bicarbonate is used for the precipitation of hydroxides of third group elements. [2015]
Reason : It maintains the pH to a constant value, about 7.4.
59. **Assertion :** Addition of silver ions to a mixture of aqueous sodium chloride and sodium bromide solution will first precipitate AgBr rather than AgCl.
Reason : K_{sp} of AgCl $>$ K_{sp} of AgBr. [2016]

HINTS & SOLUTIONS

Type A : Multiple Choice Questions

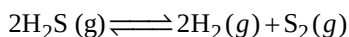
1. (c) Here I^- is Lewis base as it is giving electron to I_2 molecule.

2. (d) Equilibrium constant, $K = \frac{[C]}{[A]^3[B]^2}$.

3. (b) In BF_3 , B is electron deficient because it has incomplete octet and thus can accept electron pair (Lewis acid).

4. (c) pH value of ordinary water is about 5.3 because some CO_2 from atmosphere dissolves in pure water to form H_2CO_3 (carbonic acid), thus making water slightly acidic.

5. (a) For the given reaction,

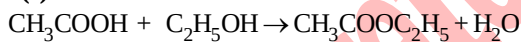


$$\Delta n = 3 - 2 = 1$$

$$K_c = \frac{K_p}{(RT)^n} = \frac{1.2 \times 10^{-2}}{(RT)^1}$$

$$\therefore K_c < K_p \text{ or } K_c < 1.2 \times 10^{-2}$$

6. (d)



$$\text{At start} \quad 1 \text{ mole} \quad 1 \text{ mole} \quad 0 \quad 0$$

$$\text{At equb.} \quad 1 - \frac{2}{3} \quad 1 - \frac{2}{3} \quad \frac{2}{3} \quad \frac{2}{3}$$

Let the total volume = V L

$$\therefore [CH_3COOH] = \frac{1}{3}V \text{ mol/L}$$

$$[C_2H_5OH] = \frac{1}{3}V \text{ mol/L}$$

$$[CH_3COOC_2H_5] = \frac{2}{3}V \text{ mol/L}$$

$$[H_2O] = \frac{2}{3}V \text{ mol/L}$$

$$\therefore K = \frac{\frac{2}{3}V \times \frac{2}{3}V}{\frac{1}{3}V \times \frac{1}{3}V} = 4$$

7. (c) $pH = -\log [H^+]$
 $= -\log 10^{-4}$
 $= -(-4) \log 10$
 $= 4$

8. (a)

	A	+	2B	$\rightleftharpoons$	2C	+	D
Initial	1		1.5		0		0
Equb.	1 - x		1.5 - 2x		2x		x

At equilibrium, $[A] = [B]$

$$1 - x = 1.5 - 2x$$

$$x = 0.5$$

$$\therefore K_c = \frac{[C]^2[D]}{[A][B]^2}$$

$$= \frac{(2x)^2(x)}{(1-x)(1.5-2x)^2}$$

$$= \frac{1 \times 1 \times 0.5}{0.5 \times 0.5 \times 0.5} = 4$$

9. (d) Strength of acid $\propto K_a$

or $\propto \frac{1}{pK_a}$

Hence acid with lowest pK_a value (2.0) will be strongest.

10. (b) Ostwald's dilution law is applicable for weak electrolytes because strong electrolytes are 100% ionised at all concentrations while ionisation of weak electrolytes increases with increase in dilution.

11. (d) $0.1 \text{ N NaOH} \rightleftharpoons Na^+ + OH^-$

Normality of NaOH = Molarity of NaOH

$$= \frac{M}{10}$$

$$[OH^-] = 10^{-1}$$

$$[H^+][OH^-] = 10^{-14}$$

$$[H^+] = \frac{10^{-14}}{10^{-1}} = 10^{-13}$$

$$\therefore pH = -\log 10^{-13}$$

$$\therefore pH = 13$$

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12. (b) $\text{pH} = -\log [\text{H}^+] = -\log [5 \times 10^{-4}]$
 $= 4 - \log 5 = 4 - [\log 10 - \log 2]$
 $= 3 + \log 2 = 3.3010$

$$\text{pOH} = 14 - \text{pH} = 14 - 3.3 = 10.7.$$

13. (c) According to Henderson equation, pH of acidic buffer is given as

$$\begin{aligned}\text{pH} &= \text{p}K_a + \log \frac{\text{Salt}}{\text{Acid}} \\ &= 4.57 + \log \frac{0.10}{0.03} \\ &= 4.57 + [\log 10 - \log 3] \\ &= 4.57 + \log 3.33 \\ &= 4.57 + 0.52 = 5.09\end{aligned}$$

14. (a) $\text{CuBr} \rightleftharpoons \text{Cu}^+ + \text{Br}^-$
 [CuBr will be fully dissociated]
 $\therefore [\text{Cu}^+] = 2 \times 10^{-4}$

$$\begin{aligned}\text{and } [\text{Br}^-] &= 2 \times 10^{-4} \\ [\text{Cu}^+][\text{Br}^-] &= 2 \times 10^{-4} \times 2 \times 10^{-4} \\ &= 4 \times 10^{-8} \text{ mol}^2 \text{ L}^{-2}\end{aligned}$$

15. (b) $[\text{H}_3\text{O}^+] = [\text{H}^+] = 10^{-6}$
 $K_w = [\text{H}^+][\text{OH}^-]$
 In pure water, $[\text{H}^+] = [\text{OH}^-]$
 So, $[\text{OH}^-] = [\text{H}^+] = [\text{H}_3\text{O}^+] = 10^{-6}$
 $K_w = [10^{-6}][10^{-6}] = 10^{-12}$.
 Remember that K_w increases with increase in temperature.

16. (d) Buffer solution contains weak base + salt of weak base with strong acid or weak acid + salt of weak acid with strong base.
 In option (d) the acid used is HClO_4 which is strong acid and KClO_4 is salt of this acid with strong base. So it is not an example of buffer solution.

17. (b) Acetic acid is a weak acid and sodium hydroxide is strong base. Salt of the two will hydrolyse to give basic solution. So at neutral point pH of the solution will be greater than 8.

18. (d) For glycine solution ;
 $K = K_{a1} \times K_{a2}$
 $= 4.5 \times 10^{-13} \times 1.7 \times 10^{-10}$
 $= 7.65 \times 10^{-23}$

$$\begin{aligned}[\text{H}^+] &= \sqrt{K \cdot C} \\ &= \sqrt{7.65 \times 10^{-23} \times 0.01} = 8.7 \times 10^{-8}\end{aligned}$$

$$\text{Hence, pH} = -\log [\text{H}^+]$$

$$\begin{aligned}&= -\log [8.7 \times 10^{-8}] \\ &= -(\log 10^{-8} + \log 8.7) \\ &= 8 - 0.93 = 7.07 \approx 7.1\end{aligned}$$

19. (c) The given reaction is endothermic. If we increase the temp. forward reaction will be promoted so that heat is absorbed to decrease the temp.

20. (b) The process, $\text{H}_2\text{O}(\ell) \rightleftharpoons \text{H}_2\text{O}(\text{g})$, is an endothermic process, ($\Delta H = +\text{ve}$) and entropy increases during this change ($\Delta S = +\text{ve}$). Hence this process is spontaneous at all temperatures above 0°C ($T\Delta S > \Delta H$, so ΔG is negative, $\Delta G = \Delta H - T\Delta S$). Thus free energy change (ΔG) will be less than zero (negative) at 1 atm and 298 K.

21. (c) $\text{CH}_3\text{COOH} + \text{NH}_4\text{OH} \rightarrow \text{CH}_3\text{COONH}_4 + \text{H}_2\text{O}$
 For salt of weak base & weak acid

$$\begin{aligned}\text{pH} &= -\frac{1}{2}[\log K_a + \log K_w - \log K_b] \\ &= -\frac{1}{2}[-\text{p}K_a + \log K_w + \text{p}K_b] \\ &= -\frac{1}{2}[-5 + \log 10^{-14} + 5] \\ &= -\frac{1}{2}[-5 - 14 + 5] \\ &= 7\end{aligned}$$

22. (d) $K_p = K_c[\text{RT}]^{\Delta n}$
 $= 3 \times 10^{-6} \times (0.082 \times 700)^1$
 $= 3 \times 10^{-6} \times 0.082 \times 7 \times 10^2 = 1.75 \times 10^{-4}$

23. (c) $\text{NH}_3 + \text{HCl} \longrightarrow \text{NH}_4\text{Cl}$
 $\text{pOH} = \text{p}K_b + \log \frac{[\text{Salt}]}{[\text{Base}]}$

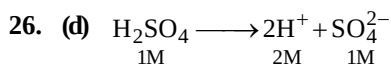
$$\text{pOH} = 4.74 + \log \frac{0.1/60}{0.1/60}$$

$$\text{pOH} = 4.74 + 0 = 4.74$$

$$\text{pH} = 14 - 4.74 = 9.26$$

24. (a) In the titration of weak acid (CH_3COOH) with a strong base (NaOH), there is a change in the pH value at the end point. But it is not sharp due to weak ionisation of CH_3COOH . Due to the excess of free base beyond the equivalence point, there is steep rise in pH which is indicated by vertical line. Hence, the vertical line in the graph indicates alkaline nature of equivalence.

25. (b) As NaOH is a strong base and CH_3COOH is a weak acid. So on neutralisation of 40 mL 0.1 M NaOH with 40 mL 0.1 M CH_3COOH , we obtain a basic solution of $\text{pH} > 7$. Hence, option (b) is correct.



$$[\text{H}^+] = 2$$

$$\text{pH} = -\log[\text{H}^+] = -\log 2$$

$$= -0.3010 \quad [\because \log 2 = 0.3010]$$

27. (b) $K = \frac{[\text{Product}]}{[\text{Reactant}]}$

$$\text{Hence, } [\text{Product}] = K[\text{Reactant}]$$

$$\therefore [\text{Product}] > \text{Reactant, when } K > 1$$

28. (b) The species having minimum value of K_{sp} will get precipitated first of all because ionic product will exceed the solubility product of such a species.

The K_{sp} value is minimum for $\text{BaSO}_4 (10^{-11})$, so, BaSO_4 will get precipitated first of all.

29. (c) $\alpha = 0.1$,
 $K_a = \frac{\alpha^2 C}{1 - \alpha} = \frac{(0.1)^2 \times (0.01)}{(1 - 0.1)} = 1.11 \times 10^{-4}$
 Now $\text{p}K_a = -\log 1.11 \times 10^{-4} = 3.9542$

$$\text{pH} = \text{p}K_a + \log \frac{[\text{salt}]}{[\text{acid}]}$$

$$= 3.9542 + \log \left[\frac{0.05}{0.10} \right] = 3.653$$

30. (a) Solubility of $\text{PbF}_2 \approx 10^{-3}$ M
 $\therefore K_{\text{sp}} = 4S^3 = 4 \times 10^{-9}$
 In 0.05 M NaF we have 0.05 M of F^- ion contributed by NaF . If the solubility of PbF_2

in this solution is S M, then

$$\text{total } [\text{F}^-] = [2S + 0.05] \text{ M.}$$

$$\therefore S[2S + 0.05]^2 = 4 \times 10^{-9}$$

Assuming $2S \ll 0.05$,

$$S \times 25 \times 10^{-4} = 4 \times 10^{-9}$$

$$\therefore S = 0.16 \times 10^{-5} \text{ M} \Rightarrow 1.6 \times 10^{-6} \text{ M}$$

We observe that our approximation that $2S \ll 0.05$ is justified.

31. (a) $\text{N}_2(\text{g}) + \text{O}_2(\text{g}) \rightleftharpoons 2\text{NO}(\text{g})$
 At equilibrium, we have $[\text{N}_2] = 0.79(1 - \alpha)$;
 $[\text{O}_2] = 0.21(1 - \alpha)$; $[\text{NO}] = 2\alpha$
 Total number of moles
 $= 0.79(1 - \alpha) + 0.21(1 - \alpha) + 2\alpha = 1 + \alpha$

$$p_{\text{N}_2} = \frac{0.79(1 - \alpha)}{1 + \alpha} \times 1;$$

$$p_{\text{O}_2} = \frac{0.21(1 - \alpha)}{1 + \alpha} \times 1; \quad p_{\text{NO}} = \frac{2\alpha}{1 + \alpha} \times 1$$

$$K_p = \frac{p_{\text{NO}}^2}{p_{\text{N}_2} \cdot p_{\text{O}_2}}$$

$$1.1 \times 10^{-3} = \frac{4\alpha^2}{0.79 \times 0.21(1 - \alpha)^2}$$

$$\text{or } \alpha = 0.0067$$

$$\Rightarrow \text{vol \% of NO} = 2\alpha \times 100$$

$$= 2 \times 0.0067 \times 100 = 1.33 \%$$

32. (c) $\text{AB} \rightleftharpoons \text{A}^+ + \text{B}^-$

$$K_{\text{sp}} = [\text{A}^+][\text{B}^-]$$

Salt will precipitate if ionic conc. $> K_{\text{sp}}$
 $[\text{A}^+][\text{B}^-] > 1 \times 10^{-8}$
 $(1 \times 10^{-3})[\text{B}^-] > 1 \times 10^{-8}$

$$[\text{B}^-] > \frac{1 \times 10^{-8}}{1 \times 10^{-3}} \text{ or } 1 \times 10^{-5}$$

33. (c) The reaction is exothermic and takes place with a decrease in number of molecules of gaseous species. Obviously high pressure and low temperature are the favourable conditions for the shift of equilibrium to products side. However, in continuous flow process, optimum elevated temperature is required to have more NH_3 due to high activation energy of the reaction.

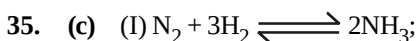
34. (c) (a) $[\text{H}_3\text{O}^+] = \frac{0.1}{2} = 0.05;$

$$\text{pH} = -\log 0.05 = 1.301$$

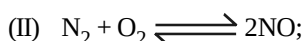
(b) Complete neutralization of strong acid and strong base, pH = 7.

(c) Hydrolysis of the salt CH_3COOK , pH > 7 (salt of weak acid with strong base)

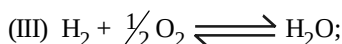
(d) Hydrolysis of the salt NH_4NO_3 , pH < 7 (salt of strong acid with weak base)



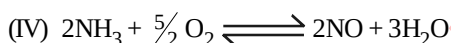
$$K_1 = \frac{[\text{NH}_3]^2}{[\text{N}_2][\text{H}_2]^3}$$



$$K_2 = \frac{[\text{NO}]^2}{[\text{N}_2][\text{O}_2]}$$



$$K_3 = \frac{[\text{H}_2\text{O}]}{[\text{H}_2][\text{O}_2]^{1/2}}$$



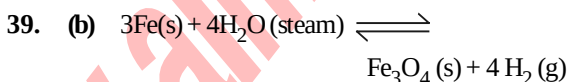
$$K_c = \frac{[\text{NO}]^2[\text{H}_2\text{O}]^3}{[\text{NH}_3]^2[\text{O}_2]^{5/2}} = \frac{K_2 K_3^3}{K_1}$$

36. (a) Blood contains serum protein which acts as buffer.

37. (d) Reaction (II) and reverse of reaction (I) gives the desired reaction hence

$$K = K_2 \times \frac{1}{K_1} = \frac{K_2}{K_1}$$

38. (d) $[\text{Cu}(\text{H}_2\text{O})_4]^{2+} + 4\text{NH}_3 \rightleftharpoons [\text{Cu}(\text{NH}_3)_4]^{2+} + 4\text{H}_2\text{O}$ involves lose and gain of electrons. H_2O is coordinated to Cu by donating electrons (LHS). It is then removed by withdrawing electrons.



$$K_p = \frac{(p_{\text{H}_2})^4}{(p_{\text{H}_2\text{O}})^4} \text{ only gaseous products and reactants.}$$

40. (a) K_{sp} of As_2S_3 is less than ZnS . In acid medium ionisation of H_2S is suppressed (common ion effect) and K_{sp} of ZnS does not exceed.

41. (c) $K_{\text{sp}} = 4S^3 = 3.2 \times 10^{-11} \therefore S = 2 \times 10^{-4} \text{ M}$

$$[\text{OH}^-] = 2S = 2 \times 2 \times 10^{-4} \text{ M}$$

$$\therefore \text{pH} = 14 - \text{pOH}$$

$$= 14 + \log 4 \times 10^{-4} = 10.60$$

42. (c) Reaction (c) is endothermic. Electrolysis or decomposition of H_2O is endothermic in nature.



Mole ratio 2 1 3 1

Molar conc. 1 1 0 0

att = 0

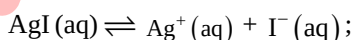
Equilibrium 1-0.5 1-0.25 0.75 0.25

molar

Concentration = 0.50 = 0.75

$$K_c = \frac{[\text{C}]^3[\text{D}]}{[\text{A}]^2[\text{B}]} = \frac{(0.75)^3(0.25)}{(0.50)^2(0.75)}$$

44. (d) The solubility equilibrium for AgI is



$$K_{\text{sp}} = [\text{Ag}^+][\text{I}^-]$$

Let solubility of AgI be S moles per litre,

$$[\text{Ag}^+] = S, [\text{I}^-] = S$$

$$K_{\text{sp}} = [\text{Ag}^+][\text{I}^-]$$

$$1 \times 10^{-16} = (S) \times (S) = S^2$$

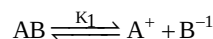
$$S = (1 \times 10^{-16})^{1/2} = 1 \times 10^{-8}$$

On calculating solubility of all given compounds

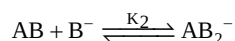
Compound	Solubility
AgCl	1×10^{-5}
AgI	1×10^{-8}
PbCrO ₄	2×10^{-7}
Ag ₂ CO ₃	1.26×10^{-4}

$\therefore \text{Ag}_2\text{CO}_3$ is most soluble and AgI is least soluble.

45. (d) Given,



$$K_1 = \frac{[\text{A}^+][\text{B}^-]}{[\text{AB}]}$$



$$K_2 = \frac{[AB_2^-]}{[AB][B^-]}$$

Dividing K_1 and K_2 we get

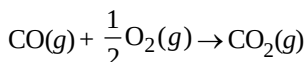
$$K = \frac{K_1}{K_2} = \frac{[A^+][B^-]^2}{[AB_2^-]}$$

$$\therefore \frac{[A^+]}{[AB_2^-]} = \frac{K}{[B^-]^2}$$

46. (b) For a gaseous phase reaction K_p and K_c are related as

$$K_p = K_c (RT)^{\Delta n_g}$$

For the given reaction,



$$\Delta n_g = 1 - (1 + 0.5) = -0.5 \text{ or } -\frac{1}{2}$$

$$\therefore K_p = K_c (RT)^{-\frac{1}{2}}$$

$$\text{or } \frac{K_p}{K_c} = (RT)^{-\frac{1}{2}}$$

47. (b) $Mg(OH)_2 \rightleftharpoons Mg^{++} + 2OH^-$

$$K_{sp} = [Mg^{++}][OH^-]^2$$

$$1.0 \times 10^{-11} = 10^{-3} \times [OH^-]^2$$

$$[OH^-] = \sqrt{\frac{10^{-11}}{10^{-3}}} = 10^{-4}$$

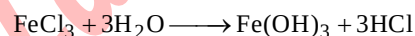
$$\therefore pOH = 4$$

$$\therefore pH + pOH = 14$$

$$\therefore pH = 10$$

Type B : Assertion Reason Questions

48. (e) $FeCl_3$ is acidic in nature due to hydrolysis.



49. (c) K_{sp} of $AgCl > K_{sp}$ of $AgBr$

50. (e) Presence of NH_4Cl suppresses the dissociation of NH_4OH , hence, concentration of OH^- is reduced to

minimum. Further, $Ba(OH)_2$ is soluble in water.

51. (d) Acidic buffer is the solution of a mixture of weak acid and a salt of this weak acid with a strong base.

CH_3COOH is weak acid and CH_3COONH_4 is a salt of CH_3COOH with weak base. So the mixture of CH_3COOH and CH_3COONH_4 is not an example of acidic buffer. Hence, both assertion and reason are false.

52. (c) The equilibrium constant has a fixed value for every reaction at a particular temperature. However composition of final equilibrium mixture at a particular temperature does not depend upon the starting amount of reactant.

Hence, assertion is true but reason is false.

53. (a) For the reaction

$$K_c = \frac{[NH_3]^2}{[N_2][H_2]^3}$$

$$K_c = \frac{\text{mol}^2 \times L \times L^3}{L^2 \times \text{mol} \times \text{mol}^3} = L^2 \text{ mol}^{-2}$$

So, the units for K_c are $L^2 \text{ mol}^{-2}$

The assertion and reason, both are true and reason is correct explanation of assertion.

54. (a) Both assertion and reason are correct and reason is the correct explanation of assertion.

55. (a) The size of $[Al(H_2O)_6]^{3+}$ is smaller than $[Mg(H_2O)_6]^{2+}$. Also, the former possesses more effective nuclear charge and thus, attracts electron pair from donor more effectively. This gives rise to relatively strong acidic nature of $[Al(H_2O)_6]^{3+}$.

56. (c) $aA + bB \rightleftharpoons cC + dD$, $Q_c = \frac{[C]^c [D]^d}{[A]^a [B]^b}$

If $Q_c > K_c$, reaction will proceed in the direction of reactants

If $Q_c < K_c$, reaction will move in direction of products.

If $Q_c = K_c$, the reaction mixture is already at equilibrium.

57. (c) NaOH is a weaker base than KOH.
58. (d) In biological systems buffer system of carbonic acid and sodium bicarbonate is found in our blood. It maintains the pH of blood to a constant value of about 7.4.
59. (a) Ionic product of AgBr is greater than that of AgCl in comparison with there solubility product AgBr will precipitate first rather than that of AgCl.

TYPE A : MULTIPLE CHOICE QUESTIONS

- Oxidation is : [1999]
 - Gain of electrons
 - Loss of neutrons
 - Loss of electrons
 - Decrease in positive valency
- Oxidation number of Os in OsO_4 : [1999]
 - +2
 - +4
 - +8
 - +10
- The oxidation number of sulphur in $\text{H}_2\text{S}_2\text{O}_7$ is: [2000]
 - +2
 - +6
 - +4
 - +8
- In the following chemical reaction:
 $\text{Ag}_2\text{O} + \text{H}_2\text{O} + 2\text{e}^- \rightarrow 2\text{Ag} + 2\text{OH}^-$ [2000]
 - Hydrogen is reduced
 - Electrons are reduced
 - Water is oxidised
 - Silver is oxidised
- Both oxidation and reduction takes place in : [2001]
 - $\text{NaBr} + \text{HCl} \rightarrow \text{NaCl} + \text{HBr}$
 - $\text{HBr} + \text{AgNO}_3 \rightarrow \text{AgBr} + \text{HNO}_3$
 - $\text{H}_2 + \text{Br}_2 \rightarrow 2\text{HBr}$
 - $\text{CaO} + \text{H}_2\text{SO}_4 \rightarrow \text{CaSO}_4 + \text{H}_2\text{O}$
- The oxidation number of Cr in $\text{K}_2\text{Cr}_2\text{O}_7$ is : [1997, 2001]
 - +3
 - 3
 - +6
 - 6
- Oxidation state of Fe in Fe_3O_4 is [2002]
 - $\frac{3}{2}$
 - $\frac{5}{4}$
 - $\frac{4}{5}$
 - $\frac{8}{3}$
- MnO_4^{2-} (1 mole) in neutral aqueous medium disproportionates to [2003]
 - $\frac{2}{3}$ mole of MnO_4^- and $\frac{1}{3}$ mole of MnO_2
 - $\frac{1}{3}$ mole of MnO_4^- and $\frac{2}{3}$ mole of MnO_2
 - $\frac{1}{3}$ mole of Mn_2O_7 and $\frac{1}{3}$ mole of MnO_2
 - $\frac{2}{3}$ mole of Mn_2O_7 and $\frac{1}{3}$ mole of MnO_2
- For decolourisation of 1 mole of KMnO_4 , the moles of H_2O_2 required is: [2004]
 - $\frac{1}{2}$
 - $\frac{3}{2}$
 - $\frac{5}{2}$
 - $\frac{7}{2}$
- In the balanced chemical reaction,
 $\text{IO}_3^- + a\text{I}^- + b\text{H}^+ \rightarrow c\text{H}_2\text{O} + d\text{I}_2$
 a, b, c and d respectively corresponds to : [2005]
 - 5, 6, 3, 3
 - 5, 2, 6, 3
 - 3, 5, 3, 6
 - 5, 6, 5, 5
- The oxidation states of iodine in HIO_4 , H_3IO_5 and H_5IO_6 are respectively [2008]
 - +1, +3, +7
 - +7, +7, +3
 - +7, +7, +7
 - +7, +5, +3
- Which of the following molecules can act as an oxidizing as well as a reducing agent ? [2008]
 - H_2S
 - SO_3
 - H_2O_2
 - F_2
- The oxidation states of sulphur in S_8 , S_2F_2 , H_2S respectively, are [2010, 12]
 - 0, +1 and -2
 - +2, +1 and -2
 - 0, +1 and +2
 - 2, +1 and -2
- The strength of an aqueous solution of I_2 can be determined by titrating the solution with standard solution of: [2012]
 - Oxalic acid
 - Sodium thiosulphate
 - Sodium hydroxide
 - Mohr's salt

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15. Which of the following is a redox reaction ?
 (a) H_2SO_4 with NaOH [2013]
 (b) In atmosphere, O_3 from O_2 by lightening
 (c) Nitrogen oxides from nitrogen and oxygen by lightening
 (d) Evaporation of H_2O
16. Which of the following involves transfer of five electrons ? [2014]
 (a) $\text{MnO}_4^- \rightarrow \text{Mn}^{2+}$
 (b) $\text{CrO}_4^{2-} \rightarrow \text{Cr}^{3+}$
 (c) $\text{MnO}_4^{2-} \rightarrow \text{MnO}_2$
 (d) $\text{Cr}_2\text{O}_7^{2-} \rightarrow 2\text{Cr}^{3+}$
17. Oxidation numbers of P in PO_4^{3-} , of S in SO_4^{2-} and that of Cr in $\text{Cr}_2\text{O}_7^{2-}$ are respectively [2015]
 (a) +3, +6 and +5 (b) +5, +3 and +6
 (c) -3, +6 and +6 (d) +5, +6 and +6
18. Which of the following species can function both as oxidizing as well as reducing agent ? [2016]
 (a) Cl^- (b) ClO_4^-
 (c) ClO^- (d) MnO_4^-
19. Consider the following reaction occurring in basic medium [2017]

$$2\text{MnO}_4^-(\text{aq}) + \text{Br}^-(\text{aq}) \longrightarrow 2\text{MnO}_2(\text{s}) + \text{BrO}_3^-(\text{aq})$$

 How the above reaction can be balanced further?
 (a) By adding 2 OH^- ions on right side
 (b) By adding one H_2O molecule to left side
 (c) By adding 2 H^+ ions on right side
 (d) Both (a) and (b)

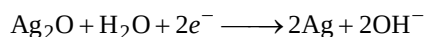
HINTS & SOLUTIONS

Type A : Multiple Choice Questions

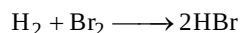
- (c) Oxidation involves loss of electrons.
- (c) Oxidation No. of Os in OsO_4 is +8.
- (b) Oxidation no. of sulphur in $\text{H}_2\text{S}_2\text{O}_7$ can be calculated as follows : $2 + 2x - 14 = 0$
 $2x = 14 - 2 = 12$

$$x = \frac{12}{2} = 6$$

- (c) In the given reaction, water is being oxidised because it is accepting oxygen from Ag_2O , while Ag^+ is reduced.



- (c) In the reaction :



Oxidation number of H in H_2 is zero whereas its value is +1 in HBr ; similarly oxidation number of Br in Br_2 is zero whereas its value is -1 in HBr . So, here H is oxidised and Br reduced. In all other reactions, there is no change in the oxidation number of any element.

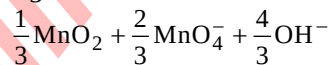
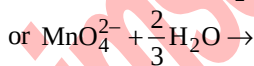
- (c) Oxidation no of Cr in $\text{K}_2\text{Cr}_2\text{O}_7$
 $= 2 + 2 \times x - 7 \times 2 = 0$

$$x = \frac{14 - 2}{2} = +6$$

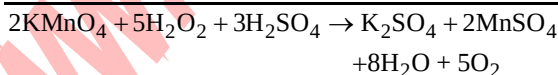
- (d) Oxidation state of Fe in Fe_3O_4

$$3x - 8 = 0; \quad x = \frac{8}{3}$$

- (a) $3\text{MnO}_4^{2-} + 2\text{H}_2\text{O} \rightarrow \text{MnO}_2 + 2\text{MnO}_4^- + 4\text{OH}^-$



- (c)

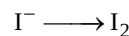


2 mol of KMnO_4 oxidise 5 mol of H_2O_2

1 mol of KMnO_4 will oxidise $\frac{5}{2}$ mol of H_2O_2

- (a) $\overset{+5}{\text{I}}\text{O}_3^- + \text{I}^- + \text{H}^+ \longrightarrow \text{H}_2\text{O} + \overset{0}{\text{I}}_2$

(A) Oxidation half cell



(i) Balancing the number of atoms



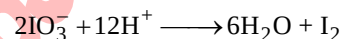
(ii) Balancing charge



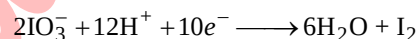
(B) Reduction half reaction



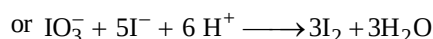
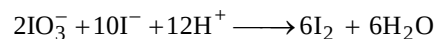
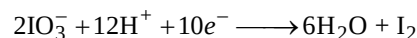
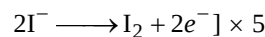
(i) Balancing number of atoms



(ii) Balancing the charge



Multiplying the balanced oxidation half reaction by 5 and adding it to balanced reduction half reaction

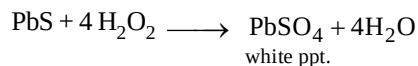


Hence $a = 5$, $b = 6$, $c = 3$ and $d = 3$

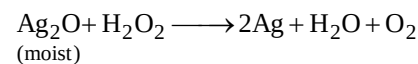
- (c) Calculating the oxidation states of I, we get
 H_5IO_6 ; $5 + x - 12 = 0$ or $x = +7$
 H_3IO_5 ; $3 + x - 10 = 0$ or $x = +7$
 HIO_4 ; $1 + x - 8 = 0$ or $x = +7$
 Thus, the correct answer is +7, +7, +7

- (c) H_2O_2 can act both as an oxidising as well as a reducing agent.

Oxidising agent



Reducing agent



13. (a) Oxidation number of S in $S_8 = \frac{0}{8} = 0$

Let oxidation number of S in S_2F_2 be x

$$2x + 2(-1) = 0$$

$$2x - 2 = 0$$

$$2x = 2; x = +1$$

Let oxidation number of S in H_2S be x .

$$2(+1) + x = 0$$

$$2 + x = 0$$

$$x = -2$$

14. (b) $I_2 + 2Na_2S_2O_3 \rightarrow Na_2S_4O_6 + 2NaI$

15. (c) $N_2 + O_2 \rightarrow 2NO$

O.N. of N changes from 0 to +2 (oxidation) and O.N. of O changes from 0 to -2 (reduction).

16. (a) O.N. of Mn in MnO_4^- is +7 and in Mn^{2+} it is +2. The difference is of 5 electrons.

17. (d) $PO_4^{3-} = x + 4(-2) = -3; x - 8 = -3; x = +5$

$$SO_4^{2-} = x + 4(-2) = -2; x - 8 = -2; x = +6$$

$$Cr_2O_7^{2-} = 2x + 7(-2) = -2; 2x - 14 = -2;$$

$$2x = 12; x = +6$$

18. (c) Species O.N.

$$Cl^- \quad -1$$

$$\underline{Cl}O_4^- \quad +7$$

$$\underline{Cl}O^- \quad +1$$

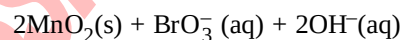
$$\underline{Mn}O_4^- \quad +7$$

$$\underline{N}O_3^- \quad +5$$

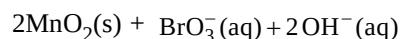
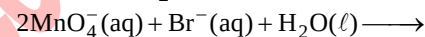
In ClO^- chlorine is in +1 oxidation state which can be increased or decreased thus it acts as an oxidising or reducing agent.

In other given species the underlined elements are either in their minimum or maximum oxidation state.

19. (d) Since reaction is occurring in basic medium therefore $2OH^-$ are added on right side.



Now, hydrogen atoms can be balanced by adding one H_2O molecule to the left side



TYPE A : MULTIPLE CHOICE QUESTIONS

- Hydrogen is not more reactive at ordinary temperature, because at ordinary temperature it is in its: [1997]
(a) gaseous state (b) liquid state
(c) molecular state (d) atomic state
- Hydrogen has high ionization energy than alkali metals because it has : [1999]
(a) Ionic bond (b) Covalent bond
(c) Large size (d) Small size
- Which of the following statement is not correct regarding hydrogen atom? [2000]
(a) It resembles with halogens in some properties
(b) It resembles with alkali metals in some properties.
(c) It cannot be placed in first group of periodic table.
(d) It is the lightest element
- Which of the following reaction produces hydrogen? [2002]
(a) $\text{Mg} + \text{H}_2\text{O}$ (b) $\text{H}_2\text{S}_2\text{O}_8 + \text{H}_2\text{O}$
(c) $\text{BaO}_2 + \text{HCl}$ (d) $\text{Na}_2\text{O}_2 + 2\text{HCl}$
- Consider the following statements : [2012]
 - Atomic hydrogen is obtained by passing hydrogen through an electric arc.
 - Hydrogen gas will not reduce heated aluminium oxide.
 - Finely divided palladium adsorbs large volume of hydrogen gas
 - Pure nascent hydrogen is best obtained by reacting Na with $\text{C}_2\text{H}_5\text{OH}$
 Which of the above statements is/are correct ?
(a) 1 alone (b) 2 alone
(c) 1, 2 and 3 (d) 2, 3 and 4
- Which of the following statement is not correct about Ellingham diagram? [2012]
(a) ΔG increases with an increase in temperature
(b) It consists of plots of $\Delta_f G^\circ$ vs T for formation of oxides
(c) a coupling reaction can be well expressed by this diagram
(d) It express the kinetics of the reduction process

- The alkali metals form salt-like hydrides by the direct synthesis at elevated temperature. The thermal stability of these hydrides decreases in which of the following orders ? [2015]
(a) $\text{CsH} > \text{RbH} > \text{KH} > \text{NaH} > \text{LiH}$
(b) $\text{KH} > \text{NaH} > \text{LiH} > \text{CsH} > \text{RbH}$
(c) $\text{NaH} > \text{LiH} > \text{KH} > \text{RbH} > \text{CsH}$
(d) $\text{LiH} > \text{NaH} > \text{KH} > \text{RbH} > \text{CsH}$
- Which of the following statements is incorrect?
(a) Ionic hydrides are stoichiometric compounds of dihydrogen formed with most of s-block elements [2016]
(b) Ionic hydrides are crystalline, non-volatile and non-conducting in solid state.
(c) Melts of ionic hydrides conduct electricity and liberate dihydrogen gas at cathode.
(d) Both (a) and (c)
- When zeolite (hydrated sodium aluminium silicate) is treated with hard water the sodium ions are exchanged with [2017]
(a) H^+ ions (b) Ca^{2+} ions
(c) SO_4^{2-} ions (d) OH^- ions

TYPE B : ASSERTION REASON QUESTIONS

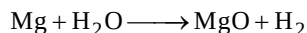
Directions for (Qs. 10-11) : Each of these questions contains an Assertion followed by Reason. Read them carefully and answer the question on the basis of following options. You have to select the one that best describes the two statements.

- If both Assertion and Reason are correct and Reason is the correct explanation of Assertion.
 - If both Assertion and Reason are correct, but Reason is not the correct explanation of Assertion.
 - If Assertion is correct but Reason is incorrect.
 - If both the Assertion and Reason are incorrect.
- Assertion :** HOF bond angle in HFO is higher than HOCl bond angle in HClO.
Reason : Oxygen is more electronegative than halogens. [2014]
 - Assertion :** Hydrogen combines with other elements by losing, gaining or sharing of electrons. [2015]
Reason : Hydrogen forms electrovalent and covalent bonds with other elements.

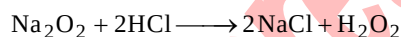
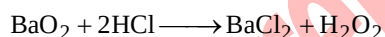
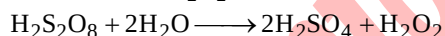
HINTS & SOLUTIONS

Type A : Multiple Choice Questions

1. (c) Hydrogen is not reactive at ordinary temperature because it is in molecular state i.e., as H_2 with its complete duplet which makes it stable and lesser reactive. At very high temperature, hydrogen exists in atomic form having one electron i.e., incomplete duplet which makes it less stable and highly reactive.
2. (d) Hydrogen has high ionisation energy in comparison with alkali metals because it has only one orbital i.e. smaller size. Due to smaller size, hold of nucleus on outermost electron is greater in case of hydrogen.
3. (c) Actually hydrogen is in the first group of periodic table due to its much resemblance with alkali metals
4. (a) Mg reacts with hot water to produce H_2 because it is more electropositive than hydrogen.



All other reactions are used for manufacture of H_2O_2 .



5. (c) Pure hydrogen is evolved by reacting absolute alcohol and Na

$$C_2H_5OH + Na \rightarrow C_2H_5ONa + \frac{1}{2}H_2$$
 other statements are correct.
6. (d) Ellingham diagrams are based on thermodynamic concepts. It does not tell anything about the kinetics of the reduction process.
7. (d) The stability of alkali metal hydrides decreases from Li to Cs. It is due to the fact that M-H bonds become weaker with increase in size of alkali metals as we move down the group from Li to Cs. Thus the order of stability of hydrides is $LiH > NaH > KH > RbH > CsH$ i.e. option (d) is correct answer.
8. (c) Melts of ionic hydrides conduct electricity and liberate dihydrogen gas at anode.
9. (b) $Na\text{ zeolite} + CaCl_2 \rightarrow Ca\text{ zeolite} + 2NaCl$

Type B : Assertion Reason Questions

10. (d) Both assertion and reason are false.
 HOF bond angle in HFO is lesser than that of $HOCl$ bond angle in $HClO$. Oxygen is more electronegative than all halogens except fluorine.
11. (a)

The s-Block Elements

TYPE A : MULTIPLE CHOICE QUESTIONS

- An inorganic compound which on heating first melts, then solidifies and liberates a gas, is
(a) Al_2O_3 (b) KMnO_4 [1997]
(c) MnO_2 (d) KClO_3
- Sodium carbonate is soluble in water because of
(a) high lattice energy [1997]
(b) low lattice energy
(c) low molecular weight
(d) high molecular weight
- Chemical A is used for softening of water to remove temporary hardness. A reacts with sodium carbonate to produce caustic soda. When CO_2 is bubbled through 'A', it turns cloudy. Chemically 'A' is : [1999]
(a) CaO (b) CaCO_3
(c) $\text{Ca}(\text{HCO}_3)_2$ (d) $\text{Ca}(\text{OH})_2$
- Sodium on heating with moist air produces
(a) NaO (b) NaOH [1999]
(c) Na_2O (d) Na_2CO_3
- Nitrolim is: [2000]
(a) CaC_2 and graphite
(b) CaCN_2 and graphite
(c) $\text{Ca}(\text{CN})_2$ and graphite
(d) $\text{CaCN}_2 + \text{N}_2$
- The molecular formula of Plaster of paris is:
(a) $2\text{CaSO}_4 \cdot \text{H}_2\text{O}$ [2000]
(b) $\text{CaSO}_4 \cdot 2\text{H}_2\text{O}$
(c) $\text{CaSO}_4 \cdot 3\text{H}_2\text{O}$
(d) $2\text{CaSO}_4 \cdot 1/2\text{H}_2\text{O}$
- Which one of the following hydroxide is insoluble in water ? [2001]
(a) $\text{Ca}(\text{OH})_2$ (b) $\text{Ba}(\text{OH})_2$
(c) $\text{Be}(\text{OH})_2$ (d) $\text{Mg}(\text{OH})_2$
- 1 g equimolecular mixture of Na_2CO_3 and NaHCO_3 is reacted with 0.1 N HCl. The mL of 0.1N HCl required to react completely with the above mixture is : [2001]
(a) 15.78 mL (b) 153.8 mL
(c) 198.4 mL (d) 295.5 mL
- On dissolving moderate amount of sodium metal in liquid NH_3 at low temperature, which one of the following does not occur? [2003]
(a) Blue coloured solution is obtained
(b) Na^+ ions are formed in the solution
(c) Liquid NH_3 becomes good conductor of electricity
(d) Liquid ammonia remains diamagnetic
- The pair whose both species are used in anti-acid medicinal preparations is : [2006]
(a) NaHCO_3 and $\text{Mg}(\text{OH})_2$
(b) Na_2CO_3 and $\text{Ca}(\text{HCO}_3)_2$
(c) $\text{Ca}(\text{HCO}_3)_2$ and $\text{Mg}(\text{OH})_2$
(d) $\text{Ca}(\text{OH})_2$ and NaHCO_3
- Largest difference in radii is found in case of the pair [2007]
(a) Li, Na (b) Na, K
(c) K, Rb (d) Rb, Cs.
- Among the following components of cement which is present in highest amount? [2007]
(a) Ca_2SiO_4 (b) Ca_3SiO_5
(c) Al_2O_3 (d) $\text{Ca}_3\text{Al}_2\text{O}_6$
- The commercial salt is purified by passing [2009]
(a) H_2S gas through an alkaline solution of salt
(b) HCl gas through a saturated solution of salt
(c) H_2 gas through a solution of salt
(d) Cl_2 gas through a saturated solution of salt
- Na_2CO_3 reacts with SO_2 in alkaline medium to form: [2010]
(a) Na_2SO_3 (b) NaHSO_3
(c) Na_2SO_4 (d) NaHSO_4
- The correct sequence of increasing melting points of BeCl_2 , MgCl_2 , CaCl_2 , SrCl_2 and BaCl_2 is [2011]
(a) $\text{BaCl}_2 < \text{SrCl}_2 < \text{CaCl}_2 < \text{MgCl}_2 < \text{BeCl}_2$
(b) $\text{BeCl}_2 < \text{MgCl}_2 < \text{CaCl}_2 < \text{SrCl}_2 < \text{BaCl}_2$
(c) $\text{BeCl}_2 < \text{CaCl}_2 < \text{MgCl}_2 < \text{SrCl}_2 < \text{BaCl}_2$
(d) $\text{MgCl}_2 < \text{BeCl}_2 < \text{SrCl}_2 < \text{CaCl}_2 < \text{BaCl}_2$

C-58

Topicwise AIIMS Solved Papers – CHEMISTRY

16. Which one of the alkaline earth metals shows some anomalous behaviour and has same electronegativity as aluminium? [2011]
 (a) Sr (b) Ca
 (c) Ba (d) Be
17. Which property of sodium is being used in street lights? [2011]
 (a) It shows photoelectric effect
 (b) It has low melting point
 (c) Sodium atom emits photons in the yellow region of visible spectrum, due to electrically stimulated transitions
 (d) Sodium vapours show golden colour
18. A metal salt solution forms a yellow precipitate with potassium chromate in acetic acid, a white precipitate with dil H_2SO_4 , but gives no precipitate with NaCl . The metal salt solution will consist of [2011]
 (a) PbCO_3 (b) BaCO_3
 (c) MgCO_3 (d) CaCO_3
19. The order of solubility of lithium halides in non polar solvents follows the order : [2012]
 (a) $\text{LiI} > \text{LiBr} > \text{LiCl} > \text{LiF}$
 (b) $\text{LiF} > \text{LiI} > \text{LiBr} > \text{LiCl}$
 (c) $\text{LiCl} > \text{LiF} > \text{LiI} > \text{LiBr}$
 (d) $\text{LiBr} > \text{LiCl} > \text{LiF} > \text{LiI}$
20. The following compounds have been arranged in order of their increasing thermal stabilities. Identify the correct order. [2012]
 K_2CO_3 (I) MgCO_3 (II)
 CaCO_3 (III) BeCO_3 (IV)
 (a) $\text{I} < \text{II} < \text{III} < \text{IV}$ (b) $\text{IV} < \text{II} < \text{III} < \text{I}$
 (c) $\text{IV} < \text{II} < \text{I} < \text{III}$ (d) $\text{II} < \text{IV} < \text{III} < \text{I}$
21. Chemical A is used for water softening to remove temporary hardness. A reacts with Na_2CO_3 to generate caustic soda. When CO_2 is bubbled through A, it turns cloudy. What is the chemical formula of A [2013]
 (a) CaCO_3 (b) CaO
 (c) Ca(OH)_2 (d) $\text{Ca(HCO}_3)_2$
22. Which of the following is commercially known as **oxone**? [2014]
 (a) $\text{Na}_2\text{O}_2 + \text{HCl}$ (b) $\text{Na}_2\text{O} + \text{HCl}$
 (c) $\text{Na}_2\text{O}_2 + \text{Na}_2$ (d) none of these
23. Which of the following is not correct? [2016]
 (a) $2\text{Li}_2\text{O} \xrightarrow[673\text{K}]{\text{heat}} \text{Li}_2\text{O}_2 + 2\text{Li}$
 (b) $2\text{K}_2\text{O} \xrightarrow[673\text{K}]{\text{heat}} \text{K}_2\text{O}_2 + 2\text{K}$
 (c) $2\text{Na}_2\text{O} \xrightarrow[673\text{K}]{\text{heat}} \text{Na}_2\text{O}_2 + 2\text{Na}$
 (d) $2\text{Rb}_2\text{O} \xrightarrow[673\text{K}]{\text{heat}} \text{Rb}_2\text{O}_2 + 2\text{Rb}$

TYPE B : ASSERTION REASON QUESTIONS

Directions for (Qs. 24-28) : These questions consist of two statements, each printed as Assertion and Reason. While answering these questions, you are required to choose any one of the following five responses.

- (a) If both Assertion and Reason are correct and the Reason is a correct explanation of the Assertion.
 (b) If both Assertion and Reason are correct but Reason is not a correct explanation of the Assertion.
 (c) If the Assertion is correct but Reason is incorrect.
 (d) If both the Assertion and Reason are incorrect.
 (e) If the Assertion is incorrect but the Reason is correct.

24. **Assertion :** Magnesium continues to burn in nitric oxide.

Reason : During burning heat evolved does not decompose NO . [2001]

25. **Assertion :** Potassium and caesium are used in photoelectric cells.

Reason : Potassium and caesium emit electrons on exposure to light. [2002]

26. **Assertion :** Barium is not required for normal biological function in human

Reason : Barium does not show variable oxidation state. [2003]

27. **Assertion :** BaCO_3 is more soluble in HNO_3 than in plain water.

Reason : Carbonate is a weak base and reacts with the H^+ from the strong acid, causing the barium salt to dissociate. [2003]

28. **Assertion :** Mg is not present in enamel of human teeth.

Reason : Mg is an essential element for biological functions of human. [2004]

Directions for (Qs.29-37) : Each of these questions contains an Assertion followed by Reason. Read them carefully and answer the question on the basis of following options. You have to select the one that best describes the two statements.

- (a) If both Assertion and Reason are correct and Reason is the correct explanation of Assertion.
(b) If both Assertion and Reason are correct, but Reason is not the correct explanation of Assertion.
(c) If Assertion is correct but Reason is incorrect.
(d) If both the Assertion and Reason are incorrect.

29. Assertion : We feel cold on touching the ice.

Reason : Ice is a solid form of water. [2009]

30. Assertion : s-Block elements do not occur free in nature.

Reason : s-Block elements are highly electropositive in nature. [2009]

31. Assertion : Both Be and Al can form complexes such as BeF_4^{2-} and AlF_6^{3-} respectively, BeF_6^{3-} is not formed.

Reason : In case of Be, no vacant d-orbitals are present in its outermost shell. [2009]

32. Assertion : In fused state, calcium chloride cannot be used to dry alcohol or NH_3 .

Reason : CaCl_2 is not a good desiccant. [2010]

33. Assertion : LiCl is predominantly a covalent compound.

Reason : Electronegativity difference between Li and Cl is too small. [2012]

34. Assertion : Of the various chlorides of alkaline earth metals BeCl_2 is covalent in nature, where as MgCl_2 and CaCl_2 are ionic compounds.

Reason : Be is the first member of group 2. [2012]

35. Assertion : Best diagonal relationship is shown between Be and Al.

Reason : Ionization energy of Be is almost the same as that of Al. [2013]

36. Assertion : K, Rb and Cs (all belonging to group 1) can also form superoxides.

Reason : The ionic radii of K, Rb and Cs show the following trend $\text{Cs}^+ < \text{Rb}^+ < \text{K}^+$. [2014]

37. Assertion : Lithium carbonate is not so stable to heat.

Reason : Lithium being very small in size polarizes large CO_3^{2-} ion leading to the formation of more stable Li_2O and CO_2 . [2017]

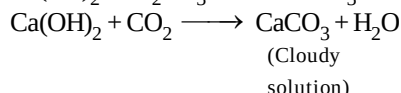
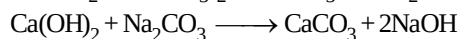
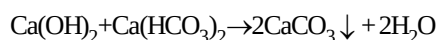
HINTS & SOLUTIONS

Type A : Multiple Choice Questions

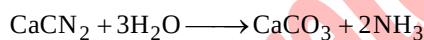
1. (d) $2\text{KClO}_3 \xrightarrow[\text{solid}]{\text{heat melts}} 2\text{KCl} + 3\text{O}_2$
2. (b) Sodium carbonate ionises in aqueous solution. It is soluble in water because of low lattice energy. Low lattice energy helps in solubility. For substances which do not ionise

$$\text{Solubility} \propto \frac{1}{\text{Molecular mass}}$$

3. (d) Ca(OH)_2 is used to remove temporary hardness of water.

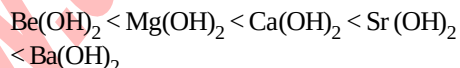


4. (c) Sodium on heating with moist air produces Na_2O .
- $$2\text{Na} + \text{H}_2\text{O} \rightarrow \text{Na}_2\text{O} + \text{H}_2$$
5. (b) Nitrolim is $\text{CaCN}_2 + \text{C}$. It is used as fertilizer since it reacts with H_2O to form NH_3 .



6. (d) $2\text{CaSO}_4 \cdot \frac{1}{2}\text{H}_2\text{O}$.

7. (c) In hydroxides of alkaline earth metals, hydration energy does not alter very much while lattice energy decreases down the group due to increase in size. The overall effects of the two factors is that ΔH solution of the hydroxides ($\Delta H_{\text{solution}} = \Delta H_{\text{lattice}} - \Delta H_{\text{hydration}}$) becomes more negative from Be to Ba and hence solubility increases from top to bottom.



8. (b) $\text{Na}_2\text{CO}_3 + 2\text{HCl} \rightarrow 2\text{NaCl} + \text{H}_2\text{O} + \text{CO}_2$
- $$\text{NaHCO}_3 + \text{HCl} \rightarrow \text{NaCl} + \text{H}_2\text{O} + \text{CO}_2$$

$$\text{Mole of Na}_2\text{CO}_3 = \frac{0.5}{106} = 0.0047$$

$$\text{Mole of NaHCO}_3 = \frac{0.5}{84} = 0.0059$$

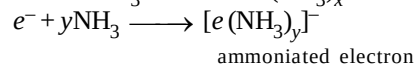
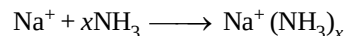
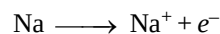
$$0.0047 \text{ mole of Na}_2\text{CO}_3 \equiv 0.0047 \times 2 \text{ mole of HCl} \\ \equiv 0.0094 \text{ mole of HCl}$$

$$0.0059 \text{ mole of NaHCO}_3 \equiv 0.0059 \text{ mole of HCl}$$

Total mole required = 0.0153 moles of HCl
If V be the volumes in litre of HCl required then mole of HCl required = $V \times 0.1$

$$V = \frac{0.0153}{0.1} = 0.153 \text{ litre} \\ = 153 \text{ ml}$$

9. (d) Sodium dissolves in liquid ammonia to form blue solution which is good conductor of electricity. The blue colour of the solution is due to formation of ammoniated electrons.



Due to presence of unpaired electron liquid ammonia become paramagnetic.

10. (a) NaHCO_3 is used in medicine to neutralise the acidity in the stomach. Mg(OH)_2 is basic in nature and dissolves in acids forming corresponding salts. So both are used in antacid medicinal preparations.
11. (b) Radii of atoms increase as we go down the group due to the addition of extra energy shell. Nuclear charge also increases on moving down the group but the influence of addition of energy shell predominates. This predomination is larger in case when we move from Na to K among all the options given.
12. (b) Composition of cement depends upon its type. Portland cement is most common kind and contains 51% tricalcium silicate, 24% of dicalcium silicate and 6% of tricalcium aluminate.

13. (b) The common table salt is prepared by passing HCl gas through a saturated solution of salt. The precipitation is due to common ion effect.
- $$\underset{\substack{\text{Salt} \\ \text{solution}}}{\text{NaCl}} + \text{H}^+ + \text{Cl}^- \longrightarrow \underset{\text{ppt}}{\text{NaCl}}$$
14. (a) In alkaline medium Na_2CO_3 reacts with SO_2 to form Na_2SO_3 (sodium sulphite).
On reaction with caustic alkalies SO_2 forms two types of salts – bisulphites and sulphites. In alkaline medium, it forms Na_2SO_3 .
15. (b) The ionic character and hence the m.pt. increases as the size of cation increases.
16. (d) Be shows diagonal relationship with Al
17. (c) The property of sodium atom to emit photons in yellow region of visible spectrum, due to electrically stimulated electron transitions is used in street lights.
18. (b) BaCO_3 forms a yellow ppt of barium chromate. BaCO_3 forms a white precipitate of BaSO_4 . BaCl_2 is soluble in water.
19. (a) As the size of the anion increases from, F^- to I^- the covalent character increase and hence the solubility in non-polar solvent increases.
- $$\text{LiI} > \text{LiBr} > \text{LiCl} > \text{LiF}$$
20. (b)
21. (c)
- $$\underset{\substack{\text{Ca}(\text{HCO}_3)_2 + \text{Ca}(\text{OH})_2 \\ \text{temp. hardness}}}{\longrightarrow} 2\text{CaCO}_3 \downarrow + 2\text{H}_2\text{O}$$
- $$\underset{\text{A}}{\text{Ca}(\text{OH})_2} + \underset{\substack{\text{Caustic soda}}}{\text{Na}_2\text{CO}_3} \longrightarrow 2\text{NaOH} + \text{CaCO}_3$$
- $$\underset{\text{A}}{\text{Ca}(\text{OH})_2} + \text{CO}_2 \longrightarrow \underset{\substack{\text{milky}}}{\text{CaCO}_3} \downarrow + \text{H}_2\text{O}$$
22. (a) ($\text{Na}_2\text{O}_2 + \text{HCl}$) is commercially known as oxone and is used for bleaching of delicate fibres.
23. (a) Lithium does not form peroxide.
24. (c) Magnesium continues to burn in nitric oxide because the heat evolved decomposes NO to give N_2 and O_2 and Mg burns readily in the atmosphere of N_2 and O_2 .
25. (a) Potassium and Cesium are electropositive elements with very low ionisation potential so they emit electrons on exposure to light.
26. (b) Both the assertion and reason are correct. The reason is not the explanation of the assertion.
Note that alkaline earth metals are bivalent, i.e. have an oxidation state of +2.
27. (a) Barium carbonate is more soluble in HNO_3 than in water because carbonate is a weak base and reacts with the H^+ ion of HNO_3 causing the barium salt to dissociate.
- $$\text{BaCO}_3 + 2\text{HNO}_3 \longrightarrow \text{Ba}(\text{NO}_3)_2 + \text{CO}_2 + \text{H}_2\text{O}$$
28. (e) Calcium is present in the enamel but Mg is an essential element for biological functions of human.
29. (b) It is correct that on touching the ice we feel cold because ice absorbs heat from our hand.
30. (a) The s-block elements are highly electropositive in nature. So, these are very reactive. That is why these elements do not occur free in nature. Usually, the s-group elements occur in nature as halides, carbonates and sulphates. These metals are obtained from their molten halides by electrolytic reduction.
31. (a) Both assertion and reason are correct and reason is correct explanation of assertion.
32. (c) Assertion is true but Reason is false. CaCl_2 forms addition products with alcohol and ammonia.
33. (c) LiCl is a covalent compound. Due to the large size of the anion (Cl^-) its effective nuclear charge lessens and its valence shell is held less tightly towards its nucleus. Here, assertion is correct but reason is incorrect.
34. (b) Both assertion and reason are true but reason is not the correct explanation of assertion. The ionic nature of MgCl_2 and CaCl_2 is due to the large difference in electronegativity values of Mg, Ca to that of chlorine.
35. (a) Reason is the correct explanation of Assertion.
36. (c) Assertion is correct. Reason is incorrect.
37. (a) Lithium carbonate is unstable to heat; lithium being very small in size polarises a large CO_3^{2-} ion leading to the formation of more stable Li_2O and CO_2 .

Type B : Assertion Reason Questions

Chapter

11

The p-Block Elements

TYPE A : MULTIPLE CHOICE QUESTIONS

- The approximate percentage of silica in cement is: [1998]
 - 5 – 10%
 - 15 – 20%
 - 20 – 25%
 - 25 – 30%
- The most abundant metal in the earth crust is: [1998]
 - Pb
 - Cu
 - Al
 - Mg
- Bell metal is an alloy of: [1999]
 - Sn and Pb
 - Cu and Pb
 - Sn and Cu
 - In, Sn and Cu
- Al_2O_3 on heating with carbon in an atmosphere of N_2 at high temperature produces : [1999]
 - $\text{Al} + \text{CO}_2$
 - $\text{Al} + \text{CO}_2 + \text{NO}$
 - $\text{Al}_4\text{C}_3 + \text{CO}_2$
 - $\text{AlN} + \text{CO}$
- Producer gas is a mixture of: [1998, 2000]
 - $\text{CO} + \text{H}_2$
 - $\text{H}_2 + \text{CH}_4$
 - $\text{CO} + \text{N}_2$
 - $\text{CO} + \text{H}_2\text{O}$
- Solid CO_2 is known as dry ice: [2000]
 - It melts at 0°C
 - Its B.P. is more than 199°C
 - It evaporates at -78°C without melting
 - None of the above
- Water glass is : [2001]
 - Na_2SiO_3
 - Mg_2Si
 - SiCl_4
 - $\text{Ca}(\text{H}_2\text{PO}_4)_2$
- Water gas is produced by : [2001]
 - passing steam over red hot coke
 - passing steam and air over red hot coke
 - burning coke in excess of air
 - burning coke in limited supply of air
- In lake test of Al^{3+} ion, there is formation of coloured floating. It is due to : [2001]
 - adsorption of litmus by H_2O
 - adsorption of litmus by $\text{Al}(\text{OH})_3$
 - adsorption of litmus by $\text{Al}(\text{OH})_4^-$
 - none of these
- In diamond crystal, each carbon atom is linked with carbon atoms? The number of carbon atoms linked is : [2001]
 - 2
 - 4
 - 3
 - 1
- The electrical conductivity of semiconductors : [2001]
 - decreases with temperature
 - increases with temperature
 - remains constant on heating
 - none of the above
- Which of the following is only acidic in nature? [2004]
 - $\text{Be}(\text{OH})_2$
 - $\text{Mg}(\text{OH})_2$
 - $\text{B}(\text{OH})_3$
 - $\text{Al}(\text{OH})_3$
- The liquefied metal expanding on solidification is : [2004]
 - Ga
 - Al
 - Zn
 - Cl
- In diborane, the two H–B–H angles are nearly : [2005]
 - $60^\circ, 120^\circ$
 - $95^\circ, 120^\circ$
 - $95^\circ, 150^\circ$
 - $120^\circ, 180^\circ$
- The pair of amphoteric hydroxides is [2005]
 - $\text{Al}(\text{OH})_3, \text{LiOH}$
 - $\text{Be}(\text{OH})_2, \text{Mg}(\text{OH})_2$
 - $\text{B}(\text{OH})_3, \text{Be}(\text{OH})_2$
 - $\text{Zn}(\text{OH})_2, \text{Be}(\text{OH})_2$
- Borax is used as cleansing agent because on dissolving in water it gives [2006]
 - Alkaline solution
 - Acidic solution
 - Bleaching solution
 - Colloidal solution
- The energy gaps (E_g) between valence band and conduction band, for diamond, silicon and germanium are in the order: [2006]
 - $E_g(\text{diamond}) > E_g(\text{silicon}) > E_g(\text{germanium})$
 - $E_g(\text{diamond}) < E_g(\text{silicon}) < E_g(\text{germanium})$
 - $E_g(\text{diamond}) = E_g(\text{silicon}) = E_g(\text{germanium})$
 - $E_g(\text{diamond}) > E_g(\text{germanium}) > E_g(\text{silicon})$

18. The repeating unit in silicone is [2007]
- (a) SiO_2 (b) $\begin{array}{c} \text{R} \\ | \\ -\text{Si}-\text{O}^- \\ | \\ \text{R} \end{array}$
- (c) $\begin{array}{c} \text{R} \\ | \\ \text{O}-\text{Si}-\text{O}^- \\ | \\ \text{R} \end{array}$ (d) $\begin{array}{c} | \\ -\text{Si}-\text{O}-\text{O}-\text{R} \\ | \\ \text{R} \end{array}$
19. Select correct statement(s). [2008]
- (a) Cyanamide ion (CN_2^{2-}) is isoelectronic with CO_2 and has the same linear structure
 (b) Mg_2C_3 reacts with water to form propyne
 (c) CaC_2 has NaCl type lattice
 (d) All of the above
20. Non-oxide ceramics can be [2008]
- (a) B_4C (b) SiC
 (c) Si_3N_4 (d) All of these
21. The chemical formula of 'tear gas' is [2008]
- (a) COCl_2 (b) CO_2
 (c) Cl_2 (d) CCl_3NO_2
22. Thermodynamically, the most stable form of carbon is [2009]
- (a) Diamond (b) Graphite
 (c) Fullerenes (d) Coal
23. Which of the following product is formed when SiF_4 reacts with water? [2010]
- (a) SiF_3 (b) H_4SiO_4
 (c) H_2SO_4 (d) H_2SiF_4
24. BCl_3 does not exist as dimer but BH_3 exists as dimer (B_2H_6) because [2012]
- (a) Chlorine is more electronegative than hydrogen
 (b) there is π - π back bonding in BCl_3 but BH_3 does not contain such multiple bonding
 (c) large sized chlorine atoms do not fit in between the small boron atoms where as small sized hydrogen atoms get fitted in between boron atoms
 (d) none of the above
25. Ge(II) compounds are powerful reducing agents whereas Pb(IV) compounds are strong oxidants. It can be due to [2012]
- (a) Pb is more electropositive than Ge
 (b) Ionization potential of lead is less than that of Ge
 (c) Ionic radii of Pb^{2+} and Pb^{4+} are larger than those of Ge^{2+} and Ge^{4+}
 (d) More pronounced inert pair effect in lead than in Ge
26. Carbon cannot be used to produce magnesium by chemical reduction of MgO because: [2014]
- (a) Carbon is not a powerful reducing agent
 (b) Magnesium reacts with carbon to form carbides
 (c) Carbon does not react with magnesium
 (d) Carbon is a non-metal
27. Carborundum is obtained when silica is heated at high temperature with [2014]
- (a) carbon (b) carbon monoxide
 (c) carbon dioxide (d) calcium carbonate
28. An inorganic salt (A) is decomposed on heating to give two products (B) and (C). Compound (C) is a liquid at room temperature and is neutral to litmus while the compound (B) is a colourless neutral gas. Compounds (A), (B) and (C) are [2014]
- (a) NH_4NO_3 , N_2O , H_2O
 (b) NH_4NO_2 , NO , H_2O
 (c) CaO , H_2O , CaCl_2
 (d) $\text{Ba}(\text{NO}_3)_2$, H_2O , NO_2
29. Which of the following oxides is strongly basic? [2015]
- (a) B_2O_3 (b) Al_2O_3
 (c) Ga_2O_3 (d) Tl_2O_3
30. Chemically borax is [2015]
- (a) Sodium metaborate
 (b) Sodium orthoborate
 (c) Sodium tetraborate
 (d) Sodium tetraborate decahydrate
31. Match List – I with List – II for the compositions of substances and select the correct answer using the code given below the lists : [2015]
- | List - I | | List - II | |
|----------------------|---|-------------|--|
| Substances | | Composition | |
| (A) Plaster of paris | (i) $\text{CaSO}_4 \cdot 2\text{H}_2\text{O}$ | | |
| (B) Epsomite | (ii) $\text{CaSO}_4 \cdot \frac{1}{2} \text{H}_2\text{O}$ | | |
| (C) Kieserite | (iii) $\text{MgSO}_4 \cdot 7 \text{H}_2\text{O}$ | | |
| (D) Gypsum | (iv) $\text{MgSO}_4 \cdot \text{H}_2\text{O}$ | | |
| | (v) CaSO_4 | | |
- Code :
- | | | | |
|-----------|-------|-------|------|
| (A) | (B) | (C) | (D) |
| (a) (iii) | (iv) | (i) | (ii) |
| (b) (ii) | (iii) | (iv) | (i) |
| (c) (i) | (ii) | (iii) | (v) |
| (d) (iv) | (iii) | (ii) | (i) |

C-64

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32. The liquefied metal which expands on solidification is : [2016]
 (a) Ga (b) Al
 (c) Zn (d) In
33. A neutral molecule XF_3 has a zero dipole moment. The element X is most likely [2016]
 (a) chlorine (b) boron
 (c) nitrogen (d) carbon
34. The correct formula of borax is [2016]
 (a) $\text{Na}_2[\text{B}_4\text{O}_4(\text{OH})_3] \cdot 9\text{H}_2\text{O}$
 (b) $\text{Na}_2[\text{B}_4\text{O}_5(\text{OH})_4] \cdot 8\text{H}_2\text{O}$
 (c) $\text{Na}_2[\text{B}_4\text{O}_6(\text{OH})_5] \cdot 7\text{H}_2\text{O}$
 (d) $\text{Na}_2[\text{B}_4\text{O}_7(\text{OH})_6] \cdot 6\text{H}_2\text{O}$
40. **Assertion :** PbI_4 is a stable compound.
Reason : Iodide stabilizes higher oxidation state [2003]
41. **Assertion :** SiF_6^{2-} is known but SiCl_6^{2-} is not
Reason : Size of fluorine is small and its lone pair of electrons interacts with *d*-orbitals of Si strongly. [2005]
42. **Assertion :** Silicones are hydrophobic in nature.
Reason : Si-O-Si linkages are moisture sensitive. [2006]
43. **Assertion :** PbCl_2 is more stable than PbCl_4 .
Reason : PbCl_4 is powerful oxidising agent. [2008]

TYPE B : ASSERTION REASON QUESTIONS

Directions for (Qs. 35-43) : These questions consist of two statements, each printed as Assertion and Reason. While answering these questions, you are required to choose any one of the following five responses.

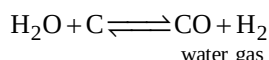
- (a) If both Assertion and Reason are correct and the Reason is a correct explanation of the Assertion.
 (b) If both Assertion and Reason are correct but Reason is not a correct explanation of the Assertion.
 (c) If the Assertion is correct but Reason is incorrect.
 (d) If both the Assertion and Reason are incorrect.
 (e) If the Assertion is incorrect but the Reason is correct.
35. **Assertion :** $\text{Al}(\text{OH})_3$ is insoluble in NH_4OH but soluble in NaOH .
Reason : NaOH is strong alkali. [1997]
36. **Assertion :** Boron is metalloid.
Reason : Boron shows metallic nature. [1997]
37. **Assertion :** NH_3 is absorbed more readily over activated charcoal than CO_2 .
Reason : NH_3 is non-polar. [2000]
38. **Assertion :** Stannous chloride gives grey precipitate with mercuric chloride, but stannic chloride does not do so.
Reason : Stannous chloride is a powerful oxidising agent which oxidises mercuric chloride to metallic mercury. [2002]
39. **Assertion :** Diamond is a bad conductor.
Reason : Graphite is a good conductor. [2002]
44. **Assertion :** Coloured cations can be identified by borax bead test.
Reason : Transparent bead ($\text{NaBO}_2 + \text{B}_2\text{O}_3$) forms coloured bead with coloured cation. [2009]
45. **Assertion :** Pb^{4+} compounds are stronger oxidizing agents than Sn^{4+} compounds.
Reason : The higher oxidation states for the group 14 elements are more stable for the heavier members of the group due to 'inert pair effect'. [2014]
46. **Assertion :** Pb^{4+} compounds are stronger oxidizing agents than Sn^{4+} compounds.
Reason : The higher oxidation states for the group 14 elements are more stable for the heavier members of the group due to 'inert pair effect'. [2016]
47. **Assertion :** Atomic radius of gallium is higher than that of aluminium [2017]
Reason : The presence of additional *d*-electron offer poor screening effect for the outer electrons from increased nuclear charge. [2017]

HINTS & SOLUTIONS

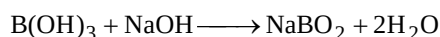
Type A : Multiple Choice Questions

1. (c) The approximate composition of cement is :
 Lime (CaO) = 50 – 60%
 Silica (SiO₂) = 20 – 25 %
 Alumina (Al₂O₃) = 5 – 10 %
 Magnesia (MgO) = 2 – 3%
 Ferric oxide (Fe₂O₃) = 2 – 3%

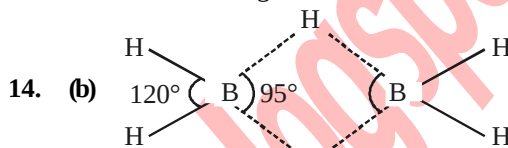
2. (c)
 3. (d) Bell metal is an alloy of Cu and Sn.
 4. (d) $\text{Al}_2\text{O}_3 + \text{N}_2 + 3\text{C} \longrightarrow 2\text{AlN} + 3\text{CO}$
 5. (c) Producer gas is a mixture of CO and N₂.
 6. (c) Solid CO₂ is known as dry ice because it evaporates at –78°C without melting.
 7. (a) Sodium silicate (Na₂SiO₃) is known as water glass. It is soluble in water. Just as plants grow in the soil, coloured crystals grow in the water glass.
 8. (a) Water gas is produced by passing steam over hot coke.



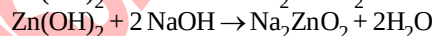
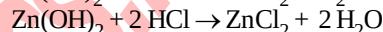
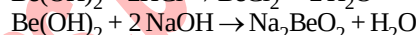
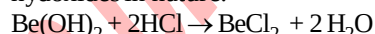
9. (b) In lake test of Al³⁺, a coloured floating lake is formed as Al(OH)₃ which being a solid surface (suspension), adsorbs litmus colour, resulting in coloured floating lake appearance.
 10. (b) In diamond crystal, carbon atom is in sp³ hybridised state so each carbon is linked with four other carbons by σ – bond.
 11. (b) With the increase in temperature, more number of covalent bonds are broken, resulting large increase in current carrier concentration (i.e. electrons and holes). Due to which the conductivity of semiconductor increases.
 12. (c) B(OH)₃ is actually H₃BO₃ which is an acid (boric acid): It is a monobasic acid. It is not a proton donor (Bronsted acid), but behaves as Lewis acid. It can accept a lone pair of electrons from OH[–] ion.



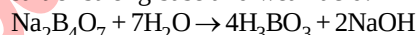
13. (a) Gallium (Ga) is soft, silvery metal. Its melting point is 30°C. This metal expands by 3.1% when it solidifies and hence, it should not be stored in glass or metal containers.



15. (d) Be(OH)₂ and Zn(OH)₂ are amphoteric hydroxides in nature.



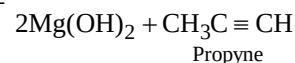
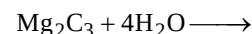
16. (a) Borax is Na₂B₄O₇·10H₂O. It gives alkaline solution on dissolution in water as it is a salt of strong base and weak acid.



17. (a) In diamond, it is highest (6 eV), for silicon, it is 1.1 eV and for germanium, it is 0.72 eV.

18. (b) Polymeric organosilicon compounds containing Si–O–Si bonds are called silicones. Silicones have general formula (R₂SiO)_n. Hence repeating unit of silicone is R₂SiO[–].

19. (d) In CO₂ we have 22 (6 + 8 + 8 = 22) electrons. In (CN₂)₂^{2–}, we have 22 (6 + 7 + 7 + 2 = 22) electrons. Both CO₂ and (CN₂)₂^{2–} have linear structures. Thus, statement (a) is correct.



i.e., statement (b) is also correct.

The structure of CaC₂ is of NaCl type

i.e., statement (c) is also correct.

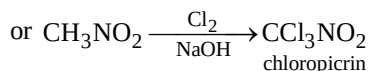
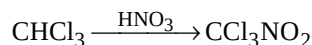
20. (d) **Ceramics** are inorganic, non-metallic, solid minerals. They come in a variety of forms, including silicates (silica, SiO₂ with metal oxides), oxides (oxygen and metals), carbides (carbon and metals), aluminates (alumina, Al₂O₃ with metal oxides) and nitrides.

The given ceramics are B₄C (carbides), SiC (carbides), Si₃N₄ (nitrides) and thus, none of these is an oxide. All of these are non-oxide ceramics.

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21. (d) "Tear gas" is the name given to the compound, CCl_3NO_2 . It is also called **chloropicrin**.

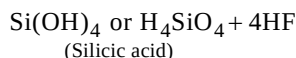
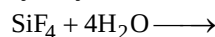


22. (b) Graphite is thermodynamically, the most stable allotrope of carbon. That is why $\Delta_f H^\circ$ (graphite) is taken as zero.

$$\Delta_f H^\circ (\text{diamond}) = +1.90 \text{ kJ mol}^{-1}$$

$$\Delta_f H^\circ (\text{fullerene}) = +38.1 \text{ kJ mol}^{-1}$$

23. (b) In reaction with water, SiF_4 (like SiCl_4) gets hydrolysed to form H_4SiO_4 (silicic acid).

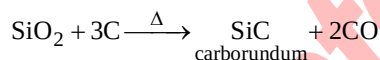


24. (c)

25. (d) Ge(II) tends to acquire Ge (IV) state by loss of electrons. Hence it is reducing in nature. Pb (IV) tends to acquire Pb (II) O.S. by gain of electrons. Hence it is oxidising in nature. This is due to inert pair effect.

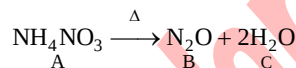
26. (b)

27. (a) Silica on heating with carbon at elevated temperature, gives carborundum (silicon carbide)



Carborundum is a very hard substance.

28. (a) Reaction involved is :



Hence option (a) is correct.

29. (d) The correct sequence of increasing basic strength is



30. (d) Chemically borax is sodium tetraborate decahydrate and it has the formula $\text{Na}_2\text{B}_4\text{O}_7 \cdot 10\text{H}_2\text{O}$.

31. (b) (A) Plaster of paris = $\text{CaSO}_4 \cdot \frac{1}{2}\text{H}_2\text{O}$

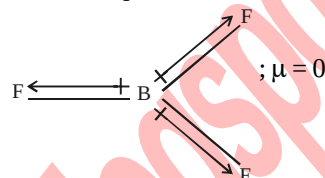
(B) Epsomite = $\text{MgSO}_4 \cdot 7\text{H}_2\text{O}$

(C) Kieserite = $\text{MgSO}_4 \cdot \text{H}_2\text{O}$

(D) Gypsum = $\text{CaSO}_4 \cdot 2\text{H}_2\text{O}$

32. (a) Gallium (Ga) is soft, silvery metal. Its melting point is 30°C . This metal expands by 3.1% when it solidifies and hence, it should not be stored in glass or metal containers.

33. (b) BF_3 has planar and symmetrical structure thus as a result the resultant of two bond moments, being equal and opposite to the third, cancels out and hence molecule possess zero dipole moment.



34. (b) Borax is sodium tetraborate decahydrate i.e. $\text{Na}_2[\text{B}_4\text{O}_5(\text{OH})_4] \cdot 10\text{H}_2\text{O}$

Type B : Assertion Reason Questions

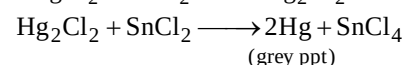
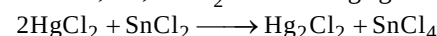
35. (a) Al(OH)_3 is soluble in strong alkali like NaOH because of formation of meta-aluminate ion
 $\text{NaOH} + \text{Al(OH)}_3 \longrightarrow \text{NaAlO}_2 + 2\text{H}_2\text{O}$

36. (c) Boron is a metalloid. Thus, assertion is true. Metalloids possess metallic as well as non-metallic nature. Hence, reason is false.

37. (c) It is correct that NH_3 is absorbed more readily over activated charcoal than CO_2 because of its polar nature.

38. (c) Sn^{4+} is more stable than Sn^{2+} .

So, Sn^{2+} is oxidised to Sn^{4+} by losing 2 electrons when it reacts with mercuric chloride, i.e., SnCl_2 is a reducing agent.



So assertion is correct but reason is wrong. Hence correct option is (c).

39. (b) Diamond is a bad conductor because of lack of free electrons in its lattice. Graphite is a good conductor of electricity because of free electron in its lattice.

So both assertion and reason are correct but reason is not correct explanation of assertion.

40. (d) As we move down the group IVA, +2 oxidation state becomes more stable. Thus Pb^{4+} is not possible, i.e., PbI_4 is highly unstable. I_2 is a weak oxidising agent so it cannot oxidise Pb to Pb^{4+} oxidation state. So assertion and reason both are wrong.

41. (a) SiF_6^{2-} is known because F has small size and thus the ion is quite stable unlike SiCl_6^{2-} in which size of Cl atom is large which destabilise it.

42. (c) Silicons are hydrophobic in nature i.e. it is water repellent because most of the groups which form bulky silicon molecule are organic in nature so they are water repellent. Thus assertion is true. The Si–O–Si linkages are stable, so these are moisture resistant. Hence reason is false.

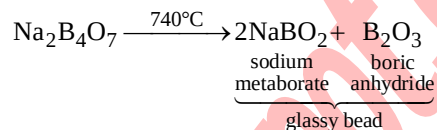
43. (b) Pb^{2+} is more stable than Pb^{4+} due to inert pair effect. Due to this reason, PbCl_4 decomposes readily into PbCl_2 and Cl_2
 $\text{PbCl}_4 \rightarrow \text{PbCl}_2 + \text{Cl}_2$

Thus Pb^{4+} salts are better oxidising agents

44. (a) Borax ($\text{Na}_2\text{B}_4\text{O}_7$) when heated at about 740°C , forms a glassy bead which gives different colour beads with different cations.

Hence, it is used to identify cations in

qualitative analysis. This test is called borax bead test.



45. (c) Assertion is true because lower oxidation state becomes more & more stable for heavier elements in *p*-block due to inert pair effect. Hence Reason is false.

46. (c) Assertion is true because lower oxidation state becomes more & more stable for heavier elements in *p*-block due to inert pair effect. Hence Reason is false.

47. (c) Atomic radius of gallium is less than that of aluminium.

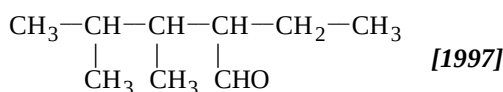
Chapter

12

Organic Chemistry—Some Basic Principles and Techniques

TYPE A : MULTIPLE CHOICE QUESTIONS

1. The IUPAC name of following compound is



- (a) 2-ethyl-3,4-dimethylpentanal
(b) 2,3-dimethyl-4-aldohexane
(c) 3-Aldo-4,5-dimethylhexane
(d) 1,3,4,5-tetraethylbutanal

2. The number of enantiomers of the compound

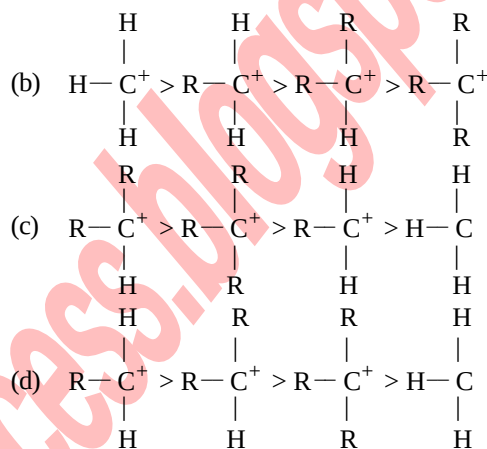
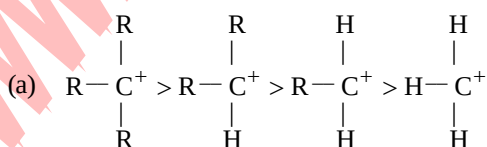


- (a) 2 (b) 3
(c) 4 (d) 6
3. The process of decomposition of organic compound by the application of heat is : [1999]
(a) pyrolysis (b) evaporation
(c) sublimation (d) condensation
4. Turpentine oil can be purified by: [1999]
(a) Steam distillation
(b) Sublimation
(c) Vacuum distillation
(d) Fractional distillation

5. Which pairs have same percentage of carbon?

- (a) CH_3COOH and $\text{C}_6\text{H}_{12}\text{O}_6$ [2000]
(b) CH_3COOH and $\text{C}_{12}\text{H}_{22}\text{O}_{11}$
(c) CH_3COOH and $\text{C}_2\text{H}_5\text{OH}$
(d) $\text{C}_6\text{H}_{12}\text{O}_6$ and $\text{C}_{12}\text{H}_{22}\text{O}_{11}$

6. The decreasing order of stability of alkyl carbonium ion is in the order of : [2001]

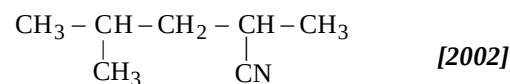


7. The number of sigma electrons in toluene are
(a) 6 (b) 9 [2001]
(c) 15 (d) 30

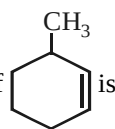
8. The most suitable method for removing water traces from ethanol is : [2001]

- (a) distillation
(b) passing dry HCl
(c) reacting it with Mg
(d) heating with sodium metal

9. IUPAC name of

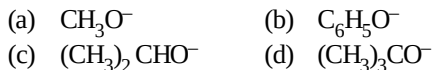


- (a) 2-cyano-3-methylhexane
(b) 2,4-dimethylcyanopentane
(c) 3-methyl-5-cyanoheptane
(d) 2-cyano-3-methylhexane

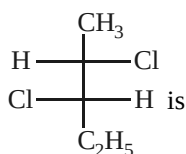
10. IUPAC name of  is [2003]

- (a) 3-methylcyclohexene
(b) 1-methylcyclohex-2-ene
(c) 6-methylcyclohexene
(d) 1-methylcyclohex-5-ene

11. The most reactive nucleophile among the following is : [2003]



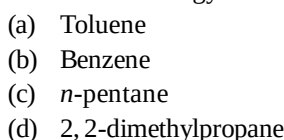
12. The absolute configuration of the following :



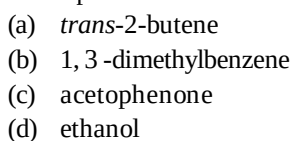
[2003]



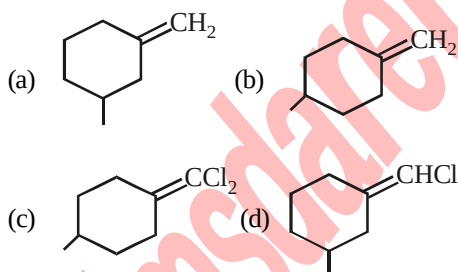
13. Which of the following compound possesses the C—H bond with the lowest bond dissociation energy? [2003]



14. The dipole moment is the highest for : [2004]



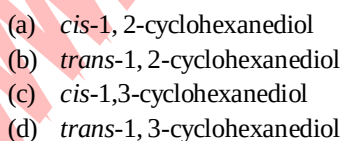
15. The geometrical isomerism is shown by [2004]



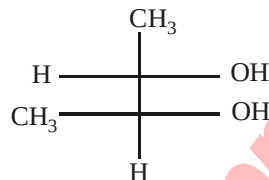
16. Among the following, the strongest nucleophile is : [2005]



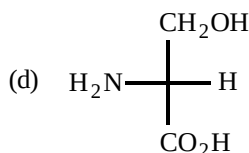
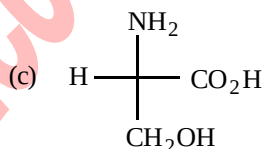
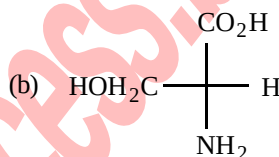
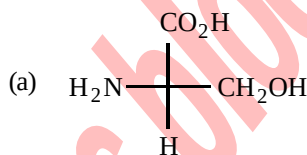
17. Among the following the most stable compound is : [2005]



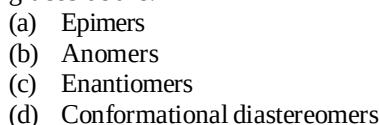
18. Correct configuration of the following is [2005]



19. Among the following, L-serine is : [2006]



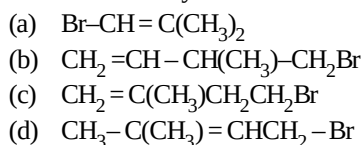
20. Methyl- α -D-glucoside and methyl- β -D-glucoside are: [2006]



21. Chain transfer reagent is [2007]

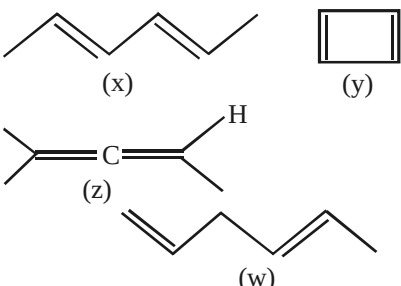
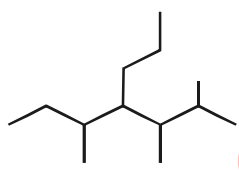
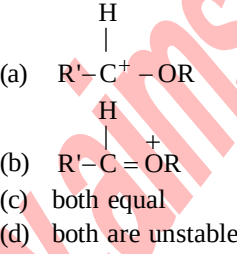
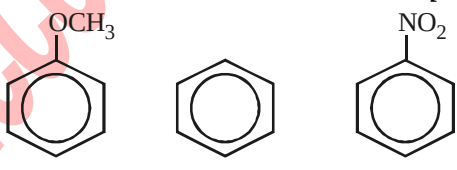
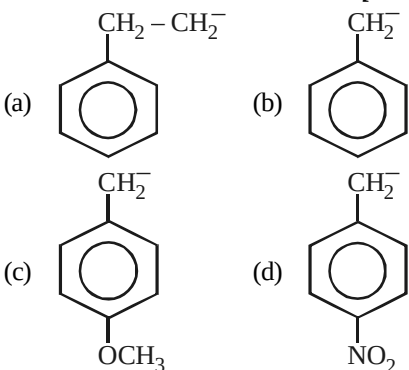


22. The correct structure of 4-bromo-3-methylbut-1-ene is [2008]

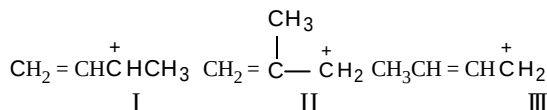


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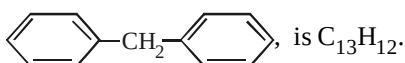
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23. Spin isomerism is shown by [2008]
 (a) dichlorobenzene (b) hydrogen
 (c) dibasic acid (d) *n*-butane
24. The correct stability order of following species is – [2009]

 (a) $x > y > w > z$ (b) $y > x > w > z$
 (c) $x > w > z > y$ (d) $z > x > y > w$
25. Which one of the following compounds is resistant to nucleophilic attack by hydroxyl ions? [2010]
 (a) Methyl acetate (b) Acetonitrile
 (c) Diethyl ether (d) Acetamide
26. The correct IUPAC name for [2011]

 (a) 5-methyl-4-(1'-2'-dimethylpropyl) heptane
 (b) 3-methyl-4-(1',2'-dimethylpropyl) heptane
 (c) 2,3,5-trimethyl-4-propylheptane
 (d) 4-propyl-2,3,5-trimethylpeptane
27. Which of the cations is more stable? [2011]

 (a) $R'-C^+(H)-OR$
 (b) $R'-C^+(H)=OR$
 (c) both equal
 (d) both are unstable
28. The Lassaigne's extract is boiled with dil. HNO_3 before testing for halogens because [2012]
 (a) Silver halides are soluble in HNO_3
 (b) Na_2S and $NaCN$ are decomposed by HNO_3
 (c) Ag_2S is soluble in HNO_3
 (d) $AgCN$ is soluble in HNO_3
29. The incorrect IUPAC name is [2012]
 (a) $CH_3-C(=O)-CH(CH_3)-CH_3$
 2-methyl-3-butanone
 (b) $CH_3-CH(CH_3)-CH(CH_2CH_3)-CH_3$
 2,3-dimethylpentane
 (c) $CH_3-C \equiv CCH(CH_3)_2$
 4-methyl-2-pentyne
 (d) $CH_3-CH(Cl)-CH(Br)-CH_3$
 3-chloro-2-bromobutane
30. Among the following compounds (I-III), the correct order of reactivity towards electrophilic substitution reaction is [2012]

 (a) $II > III > I$ (b) $III < I < II$
 (c) $I > II > III$ (d) $I = II > III$
31. The most stable carbanion among the following is [2012, 2013]

 (a) $CH_2-CH_2^-$
 (b) CH_2^-
 (c) CH_2^-
 (d) CH_2^-
32. Which one of the statements about $HOH_2CCH(OH)CHO$ is not correct? It [2013]
 (a) is an isomer of 1,3-dihydroxypropanone
 (b) contains a tertiary alcoholic group
 (c) has the same empirical formula as glucose
 (d) can show optical isomerism

33. Which is the correct order of stability of the following three carbonium ions? [2014]



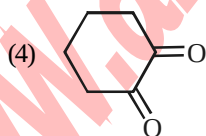
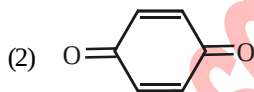
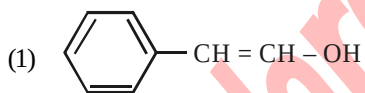
- (a) $\text{I} > \text{II} > \text{III}$
 (b) $\text{II} > \text{I} > \text{III}$
 (c) $\text{I} \approx \text{III} > \text{II}$
 (d) All are equally stable
34. The molecular formula of diphenyl methane,



How many structural isomers are possible when one of the hydrogens is replaced by a chlorine atom? [2014]

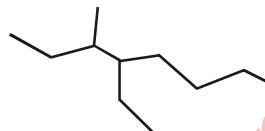
- (a) 6 (b) 4
 (c) 8 (d) 7
35. The compound $\text{CHCl} = \text{CHCHOHCOOH}$ with molecular formula $\text{C}_4\text{H}_5\text{O}_3\text{Cl}$ can exhibit [2014]
- (a) geometric, optical position and functional isomerism
 (b) geometric, optical and functional isomerism only
 (c) position and functional isomerism only
 (d) geometric and optical isomerism only

36. Tautomerism is exhibited by – [2015]



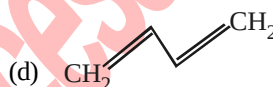
- (a) (1), (3) and (4) (b) (2), (3), and (4)
 (c) All of these (d) None of these

37. Name of the compound given below is



- (a) 3-methyl-4-ethyloctane [2013, 2015]
 (b) 2,3-diethylheptane
 (c) 5-ethyl-6-methyloctane
 (d) 4-ethyl-3-methyloctane
38. Which of the following represents the given mode of hybridisation $sp^2-sp^2-sp-sp$ from left to right? [2015]

- (a) $\text{H}_2\text{C} = \text{CH} - \text{C} \equiv \text{N}$
 (b) $\text{CH} \equiv \text{C} - \text{C} \equiv \text{CH}$
 (c) $\text{H}_2\text{C} = \text{C} = \text{C} = \text{CH}_2$



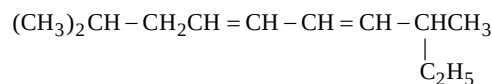
39. In Lassaigne's test for the detection of halogens, the sodium fusion extract is first boiled with concentrated nitric acid. This is [2016]

- (a) to remove silver halides
 (b) to decompose Na_2S and NaCN , if present
 (c) to dissolve Ag_2S
 (d) to dissolve AgCN , if formed

40. Which one among the following cannot exhibit enantiomerism? [2016]

- (a) Diphenyl methanol
 (b) 1-Bromo-2-chlorobutane
 (c) 2-Butanol
 (d) Tartaric acid

41. The IUPAC name of the following compound is

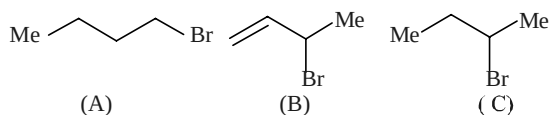


- [2016]
 (a) 1,1,7,7-tetramethyl-2,5-octadiene
 (b) 2,8-dimethyl-3,6-decadiene
 (c) 1,5-di-iso-propyl-1,4-hexadiene
 (d) 2,8-dimethyl-4,6-decadiene

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42. Consider the following bromides :



The correct order of $\text{S}_{\text{N}}1$ reactivity is

[2016]

- (a) $\text{B} > \text{C} > \text{A}$ (b) $\text{B} > \text{A} > \text{C}$
 (c) $\text{C} > \text{B} > \text{A}$ (d) $\text{A} > \text{B} > \text{C}$

43. The strongest ortho - para and strongest meta - directing groups respectively are [2017]

- (a) $-\text{NO}_2$ and $-\text{NH}_2$
 (b) $-\text{CONH}_2$ and $-\text{NH}_2$
 (c) $-\text{NH}_2$ and $-\text{CONH}_2$
 (d) $-\text{NH}_2$ and $-\text{NO}_2$

44. Hybridisation states of C in CH_3^+ and CH_4 are

[2017]

- (a) sp^2 & sp^3 (b) sp^3 & sp^2
 (c) sp^2 & sp^2 (d) sp^3 & sp^3

45. The increasing order of stability of the following free radicals is [2017]

- (a) $(\text{C}_6\text{H}_5)_2\dot{\text{C}}\text{H} < (\text{C}_6\text{H}_5)_3\dot{\text{C}} < (\text{CH}_3)_3\dot{\text{C}} < (\text{CH}_3)_2\dot{\text{C}}\text{H}$
 (b) $(\text{CH}_3)_2\dot{\text{C}}\text{H} < (\text{CH}_3)_3\dot{\text{C}} < (\text{C}_6\text{H}_5)_2\dot{\text{C}}\text{H} < (\text{C}_6\text{H}_5)_3\dot{\text{C}}$
 (c) $(\text{CH}_3)_2\dot{\text{C}}\text{H} < (\text{CH}_3)_3\dot{\text{C}} < (\text{C}_6\text{H}_5)_2\dot{\text{C}}\text{H} < (\text{C}_6\text{H}_5)_3\dot{\text{C}}$
 (d) $(\text{C}_6\text{H}_5)_3\dot{\text{C}} < (\text{C}_6\text{H}_5)_2\dot{\text{C}}\text{H} < (\text{CH}_3)_3\dot{\text{C}} < (\text{CH}_3)_2\dot{\text{C}}\text{H}$

TYPE B : ASSERTION REASON QUESTIONS

Directions for (Qs.46-48) : Each of these questions contains an Assertion followed by Reason. Read them carefully and answer the question on the basis of following options. You have to select the one that best describes the two statements.

- (a) If both Assertion and Reason are correct and Reason is the correct explanation of Assertion.
 (b) If both Assertion and Reason are correct, but Reason is not the correct explanation of Assertion.
 (c) If Assertion is correct but Reason is incorrect.
 (d) If both the Assertion and Reason are incorrect.

46. **Assertion :** In the third group of qualitative analysis, NH_4Cl is added to NH_4OH medium.

Reason : This is to convert the ions of group into their respective chlorides. [2014]

47. **Assertion :** Carbanions like ammonia have pyramidal shape. [2015]

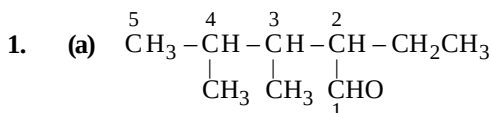
Reason : The carbon atom carrying negative charge has an octet of electrons.

48. **Assertion :** NF_3 is a weaker ligand than $\text{N}(\text{CH}_3)_3$. [2017]

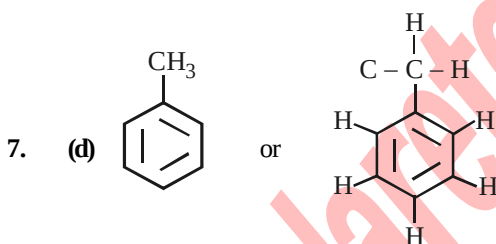
Reason : NF_3 ionizes to give F^- ions in aqueous solution.

HINTS & SOLUTIONS

Type A : Multiple Choice Questions



2. (c) No. of asymmetric carbon = 2
No. of enantiomers = $2^2 = 4$.
3. (a) Pyrolysis is the process of decomposition of organic compound by the application of heat.
4. (a) Turpentine oil is volatile and is insoluble in water. Therefore, it can be purified by steam distillation.
5. (a) Molecular formula of $\text{CH}_3\text{COOH} = \text{C}_2\text{H}_4\text{O}_2$
Both the compounds given have same empirical formula that is CH_2O . So, percentage of carbon in both of them will be same.
6. (a) Tertiary carbonium ion has highest stability followed by secondary and then primary carbonium ion. So, option (a) is correct.

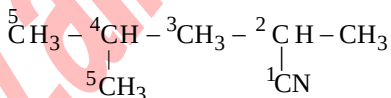


There are 15 σ bonds in toluene, so 30 σ -electrons.

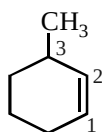
8. (c) Magnesium reacts only with H_2O to form insoluble $\text{Mg}(\text{OH})_2$ and not with alcohol.



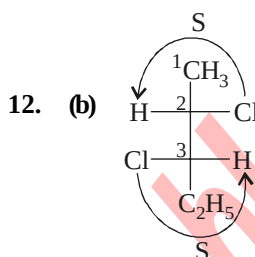
9. (b) 2,4-Dimethylcyanopentane



10. (a) The IUPAC name is 3-methylcyclohexene.

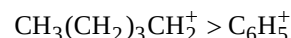
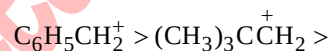


11. (d) The most reactive nucleophile will be $(\text{CH}_3)_3\text{CO}^-$ due to +I effect of three $-\text{CH}_3$ groups.



So compound is (2S, 3S)

13. (a) Among the carbonium ions formed by the cleavage of the C—H bond, the order of stability is :



As $\text{C}_6\text{H}_5\text{CH}_2^+$ is most stable so, in $\text{C}_6\text{H}_5\text{CH}_2-\text{H}$, C—H bond energy will be lowest.

14. (c) Dipole moment will be highest in case of acetophenone as it has strong electron withdrawing group.
15. (d) Geometrical isomerism is observed when different groups are attached to each of the doubly bonded carbon atom.
16. (a) Strongest nucleophile is $\text{C}_2\text{H}_5\text{SH}$.
In this compound S is electron pair donor. Since S is least electronegative, hence, its tendency to donate electron pair is highest.
17. (d) Among 1, 2- and 1, 3- configurations, 1, 3- is more stable due to less repulsion.
Further among *cis* and *trans* isomers, *trans* is more stable due to less crowding.

18. (a)

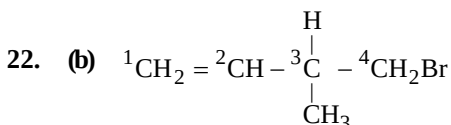
19. (c)

20. (b) In α -D glucoside $-\text{OCH}_3$ group at C_1 is towards right while in β -D glucose, it is towards left at C_1 . Such pairs which differ around only C_1 in configuration are called *anomers*.

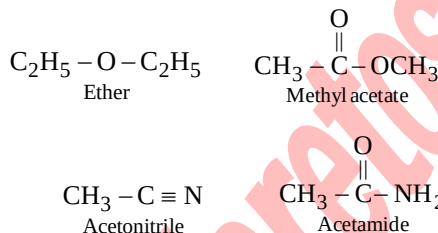
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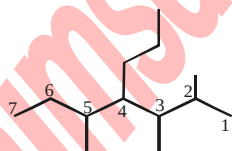
21. (a) Some molecules react with main growing chain to interrupt further growth of the original chain. This leads to lowering of average molecular mass of the polymer. Such reagents are called chain transfer agents. CCl_4 is the only chain transfer agent among the given options.



23. (b) Spin isomerism is shown by hydrogen. In *ortho*-hydrogen, the spin of nuclei of two atoms of the molecule are in same direction whereas in case of *para* hydrogen, the spin of nuclei of two atoms are in opposite direction.
24. (c) x is a conjugated diene system, w is an isolated diene system, z is a cumulated diene system, y is antiaromatic system.
25. (c) Diethyl ether $(\text{CH}_3\text{CH}_2)_2\text{O}$ is resistant to nucleophilic attack because it does not have an electron deficient carbon.



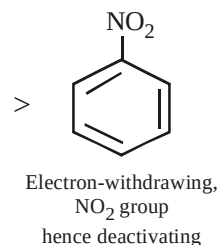
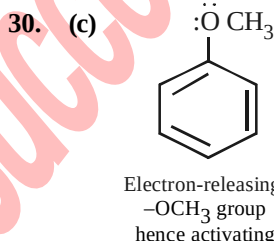
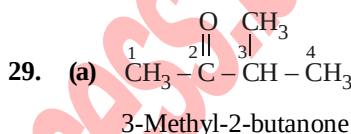
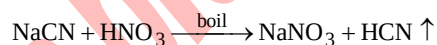
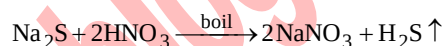
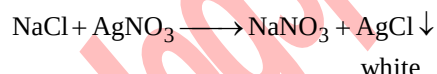
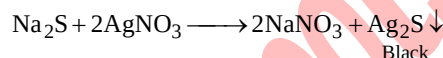
26. (c) In case two or more chains are of equal length, then the chain with greater number of side chains is selected as the principal chain.



2, 3, 5-Trimethyl-4-propylheptane

27. (b) Although (b) has positive charge on O (an electronegative element), it is more stable because here every atom has octet of electrons.
28. (b) Na_2S and NaCN , formed during fusion with metallic sodium, must be removed before adding AgNO_3 , otherwise black ppt. due

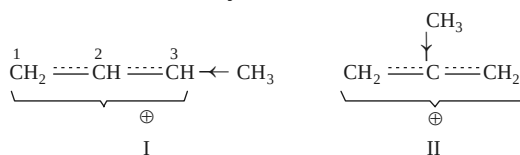
to Na_2S or white precipitate due to AgCN will be formed and thus white precipitate of AgCl will not be identified easily.

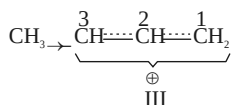


31. (d) $-\text{NO}_2$ group, being strong electron-withdrawing, disperses the negative charge, hence stabilizes the concerned carbanion.

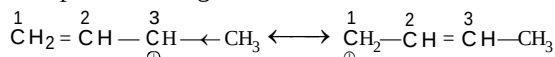
32. (b) It has 1° and 2° alcoholic group, but not 3°

33. (c) Let us first write the resonance hybrid of the three allyl carbonium ions.



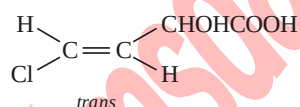
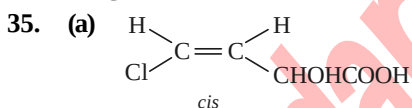
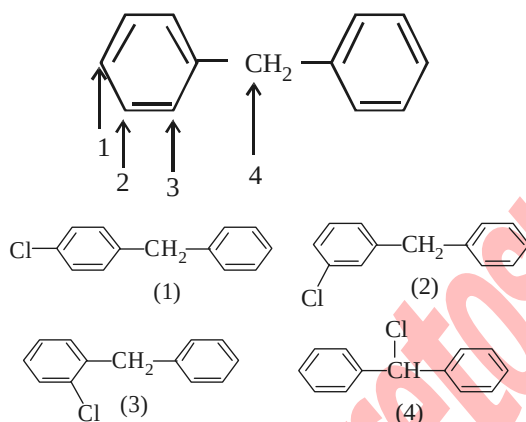


We know that better the dispersal of + charge, more will be the stability of the carbonium ion. Further, we know that C_1 and C_3 carry most of the positive charge which is

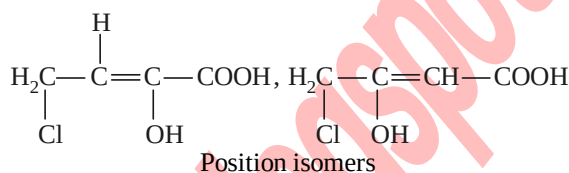
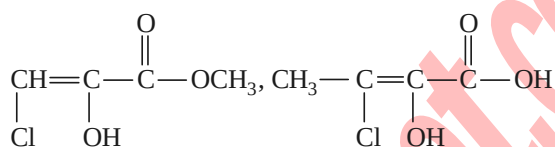
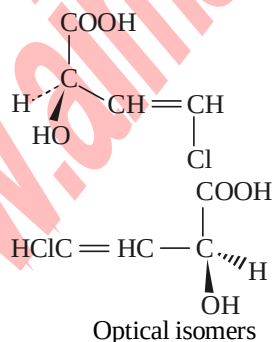


dispersed by the methyl group (+ I group) present on I and III, thus these two are more and equally stable than the II in which methyl group is present on C_2 which carry little of the positive charge.

34. (b) In diphenylmethane monochlorination at following positions will produce structured isomers

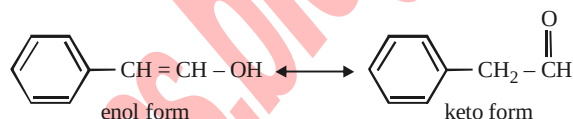


Geometric isomers



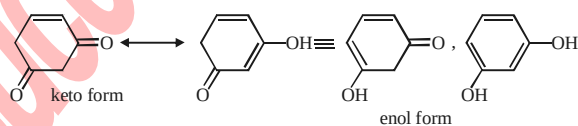
36. (a)

(a)

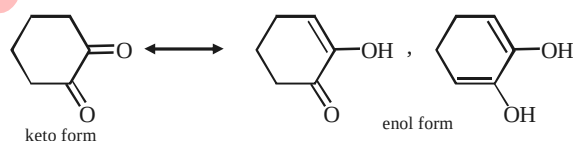


(b) $\text{O}=\text{C}_6\text{H}_4=\text{O}$ cannot tautomerise

(c)

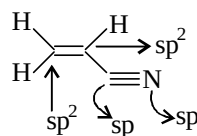


(d)



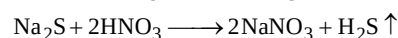
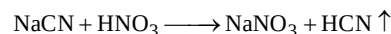
37. (d)

38. (a)



39. (b)

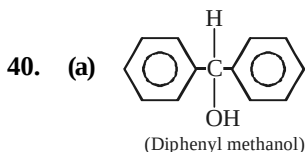
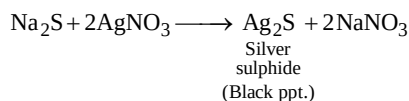
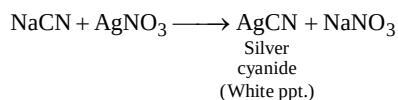
If the organic compound also contains nitrogen or sulphur, the Lassaigne's extract on boiling with dil. HNO_3 decomposes sodium cyanide or sodium sulphide formed during fusion.



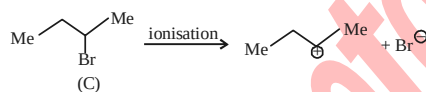
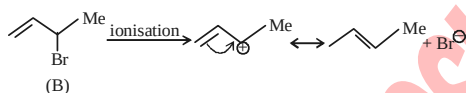
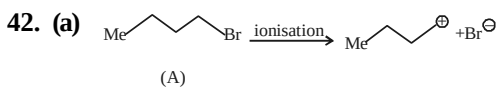
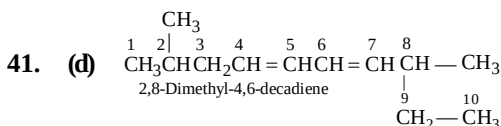
If cyanide and sulphide ions are not decomposed, they will react with silver nitrate and hence will interfere with the test.

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It does not contain any chiral carbon atom.



Since $\text{S}_{\text{N}}1$ reactions involve the formation of carbocation as intermediate in the rate

determining step, more is the stability of carbocation higher will be the reactivity of alkyl halides towards $\text{S}_{\text{N}}1$ route. Now we know that stability of carbocations follows the order : $3^\circ > 2^\circ > 1^\circ$, so $\text{S}_{\text{N}}1$ reactivity should also follow the same order.

$3^\circ > 2^\circ > 1^\circ > \text{Methyl}$ ($\text{S}_{\text{N}}1$ reactivity)

43. (d)

44. (a) Hybridisation of carbon in CH_3^+ is sp^2 and in CH_4 its hybridisation is sp^3

45. (b) The order of stability of free radicals



The stabilisation of first two is due to resonance and last two is due to inductive effect.

Type B : Assertion Reason Questions

46. (c) Assertion is true but reason is false. NH_4Cl suppresses the ionisation of NH_4OH due to common ion effect and so ions of third group get precipitated as their hydroxides.

47. (b)

48. (c) It is correct statement that NF_3 is a weaker ligand than $\text{N}(\text{CH}_3)_3$, the reason is that fluorine is highly electronegative therefore, it will draw electrons from nitrogen atom. Hence, the lone pair of nitrogen atom cannot be ligated. While $\text{N}(\text{CH}_3)_3$ is a strong ligand because CH_3 is electron releasing group.

TYPE A : MULTIPLE CHOICE QUESTIONS

- Which is not aromatic compound ? [1997]
(a) Cyclohexane (b) Trinitrotoluene
(c) Picric acid (d) Xylene
- 1-Butyne and cold alkaline KMnO_4 react to produce : [1997]
(a) $\text{CH}_3\text{CH}_2\text{COOH}$
(b) $\text{CH}_3\text{CH}_2\text{COOH} + \text{CO}_2$
(c) $\text{CH}_3\text{CH}_2\text{COOH} + \text{HCOOH}$
(d) $\text{CH}_3\text{CH}_2\text{CH}_2\text{COOH}$
- Which is used as antiknock in petrol ? [1997]
(a) Tetraethyl lead (b) Tetramethyl lead
(c) Tetrapropyl lead (d) Tetrabutyl lead
- In the following reaction, Z is identified as [1997]
$$\text{CH} \equiv \text{CH} \xrightarrow{\text{Z}} \text{CH}_3\text{CHO}$$

(a) concentrated H_2SO_4
(b) CH_3COCl
(c) 20 % $\text{H}_2\text{SO}_4 + \text{HgSO}_4$
(d) CH_3OH
- The number of σ and π bonds present in ethene is : [1997]
(a) 6σ (b) 3σ
(c) $4\sigma, 2\pi$ (d) $5\sigma, 1\pi$
- Glycerol contains [1997]
(a) one primary and two secondary alcoholic groups
(b) two primary and one secondary alcoholic groups
(c) one primary, one secondary and one tertiary alcoholic groups
(d) one secondary and two tertiary alcoholic groups
- Prestone is a mixture of: [1998]
(a) Glycol + H_2O (b) Glycerol + H_2O
(c) Acetone + H_2O (d) propanal + H_2O
- $$\underset{\text{Benzene}}{\text{C}_6\text{H}_6} + \underset{\text{Methyl chloride}}{\text{CH}_3\text{Cl}} \xrightarrow{\text{AlCl}_3} \underset{\text{Toluene}}{\text{C}_6\text{H}_5\text{CH}_3} + \text{HCl}$$

The above reaction is: [1998]
(a) Wurtz Fittig reaction
(b) Grignard reaction
(c) Friedel-Craft's reaction
(d) Ullmann reaction
- Geometrical isomerism is possible in case of : [1999]
(a) tartaric acid (b) 1-butene
(c) 2-butene (d) propene
- Alkynes usually show which type of reaction? [1999]
(a) Substitution (b) Elimination
(c) Addition (d) Replacement
- The product obtained by treating benzene with chlorine in presence of ultraviolet light is: [1999]
(a) CCl_4 (b) $\text{C}_6\text{H}_5\text{Cl}$
(c) $\text{C}_6\text{H}_6\text{Cl}_6$ (d) C_6Cl_6
- The natural gas mainly contains : [1999]
(a) methane (b) propane
(c) butane (d) pentane
- Which compound can be sulphonated easily ? [1999]
(a) benzene (b) toluene
(c) nitrobenzene (d) chlorobenzene
- With ammonical cuprous chloride solution, a reddish brown precipitate is obtained on treating with : [2001]
(a) CH_4 (b) C_2H_4
(c) C_2H_2 (d) C_3H_6
- The boiling points of four saturated hydrocarbons are given below. Which boiling point suggests maximum number of carbon atoms in its molecule : [2001]
(a) -162°C (b) -88.6°C
(c) -0.5°C (d) -42.2°C

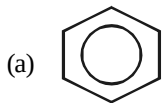
31. 1-Butyne can be distinguished most easily from 2-butyne by [2011]

- (a) bromine water (b) ozonolysis
(c) Tollen's reagent (d) KMnO_4 solution

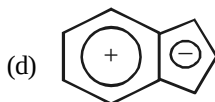
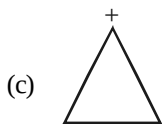
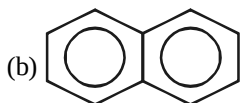
32. Compound X of molecular formula C_4H_6 takes up one equivalent of hydrogen in presence of Pt to form another compound Y which on ozonolysis gives only ethanoic acid. The compound X can be [2011]

- (a) $\text{CH}_2 = \text{CH} - \text{CH} = \text{CH}_2$
(b) $\text{CH}_2 = \text{C} = \text{CHCH}_3$
(c) $\text{CH}_3\text{C} \equiv \text{CCH}_3$
(d) All the three

33. The chemical system that is non-aromatic is



[2012]



34. Consider the following statements : A hydrocarbon of molecular formula C_5H_{10} is a

- I. monosubstituted alkene
II. disubstituted alkene
III. trisubstituted alkene

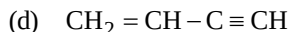
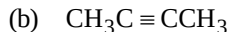
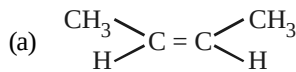
Which of the following statement(s) is(are) correct? [2012]

- (a) I, II and III (b) I and II
(c) II and III (d) I and III

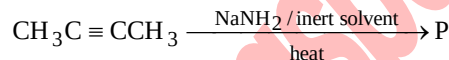
35. Which one of the following cannot be prepared by Wurtz reaction ? [2012]

- (a) CH_4 (b) C_2H_6
(c) C_3H_8 (d) C_4H_{10}

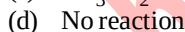
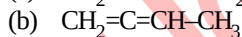
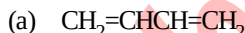
36. Which of the following has the lowest dipole moment ? [2013]



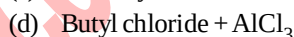
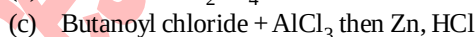
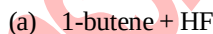
37. Predict the nature of P in the following reaction



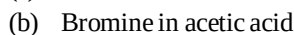
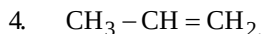
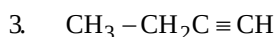
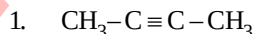
[2014]



38. Which of the following would not give 2-phenylbutane as the major product in a Friedel-Crafts alkylation reaction ? [2014]

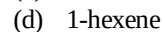
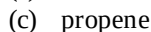
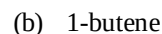
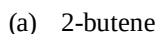


39. Which is the most suitable reagent among the following to distinguish compound (3) from rest of the compounds ? [2015]

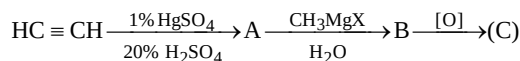


40. The alkene that will give the same product with HBr in the absence as well as in the presence of peroxide is

[2016]



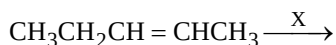
41. The end product (C) in the following sequence of reactions is [2017]



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42. In the given reaction



The X is

[2017]

- (a) $\text{C}_2\text{H}_5\text{ONa}$
 (b) $\text{Conc. HCl} + \text{Anhy. ZnCl}_2$
 (c) Anh. AlCl_3
 (d) $\text{KMnO}_4/\text{OH}^-$

TYPE B : ASSERTION REASON QUESTIONS

Directions for (Qs. 43-53) : These questions consist of two statements, each printed as Assertion and Reason. While answering these questions, you are required to choose any one of the following five responses.

- (a) If both Assertion and Reason are correct and the Reason is a correct explanation of the Assertion.
 (b) If both Assertion and Reason are correct but Reason is not a correct explanation of the Assertion.
 (c) If the Assertion is correct but Reason is incorrect.
 (d) If both the Assertion and Reason are incorrect.
 (e) If the Assertion is incorrect but the Reason is correct.

43. **Assertion :** CH_4 does not react with Cl_2 in dark.

Reason : Chlorination of CH_4 takes place in sunlight. [2001]

44. **Assertion :** Alkylbenzene is not prepared by Friedel-Craft alkylation of benzene.

Reason : Alkyl halides are less reactive than acyl halides. [2003]

45. **Assertion :** *trans*-2-Butene on reaction with Br_2 gives *meso*-2, 3-dibromobutane.

Reason : The reaction involves *syn*-addition of bromine. [2003]

46. **Assertion :** 2-Bromobutane on reaction with sodium ethoxide in ethanol gives 1-butene as a major product.

Reason : 1-Butene is more stable than 2-butene [2004]

According to Saytzeff's rule, 2-butene should be the product which is more branched or substituted compound and hence, more stable than butene-1

47. **Assertion :** Rates of nitration of benzene and hexadeuterobenzene are different.

Reason : C-H bond is stronger than C-D bond. [2005]

48. **Assertion :** Cyclopentadienyl anion is much more stable than allyl anion.

Reason : Cyclopentadienyl anion is aromatic in character. [2005]

49. **Assertion :** 1, 3-Butadiene is the monomer for natural rubber.

Reason : Natural rubber is formed through anionic addition polymerization. [2006]

50. **Assertion :** Addition of HBr on 2-butene gives two isomeric products.

Reason : Addition of HBr on 2-butene follows Markovnikov rule. [2006]

51. **Assertion :** *trans*-butene-2 on reaction with bromine forms racemic mixture.

Reason : *trans*-Compound in *trans* addition forms two types of stereoisomers. [2007]

52. **Assertion :** Acetylene on reacting with sodamide gives sodium acetylide and ammonia.

Reason : *sp* hybridised carbon atoms of acetylene are considerably electronegative. [2007]

53. **Assertion :** Friedel-Craft's reaction is used to introduce an alkyl or acyl group in benzene nucleus.

Reason : Benzene is a solvent for the Friedel-Craft's alkylation of bromobenzene. [2008]

Directions for (Qs.54-61) : Each of these questions contains an Assertion followed by Reason. Read them carefully and answer the question on the basis of following options. You have to select the one that best describes the two statements.

- (a) If both Assertion and Reason are correct and Reason is the correct explanation of Assertion.
 (b) If both Assertion and Reason are correct, but Reason is not the correct explanation of Assertion.
 (c) If Assertion is correct but Reason is incorrect.
 (d) If both the Assertion and Reason are incorrect.
54. **Assertion :** 1-Butene on reaction with HBr in the presence of a peroxide produces 1-bromobutane.

Reason : It involves the free radical mechanism. [2009]

55. **Assertion :** Benzene removes a butter stain from a table cloth.

Reason : Butter has an affinity towards benzene.

[2010]

56. **Assertion :** Trans-2-butene on reaction with Br_2 gives meso-2, 3-dibromobutane.

Reason : The reaction involves syn-addition of bromine.

[2009, 2014]

57. **Assertion :** 1-Butene on reaction with HBr in the presence of a peroxide produces 1-bromobutane.

[2015]

Reason : It involves the formation of a primary radical.

58. **Assertion :** Nitrating mixture used for carrying out nitration of benzene consists of conc. HNO_3 + conc. H_2SO_4 .

[2015]

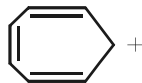
Reason : In presence of H_2SO_4 , HNO_3 acts as a base and produces NO_2^+ ions.

59. **Assertion :** Energy of resonance hybrid is equal to the average of energies of all canonical forms.

Reason : Resonance hybrid cannot be presented by a single structure.

[2016]

60. **Assertion :** Tropylium cation is aromatic in nature



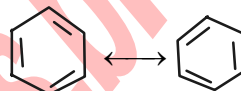
Reason : The only property that determines its aromatic behaviour is its planar structure.

[2014, 2016]

61. **Assertion :** Benzene exhibit two different bond lengths, due to $\text{C}-\text{C}$ single and $\text{C}=\text{C}$ double bonds.

[2017]

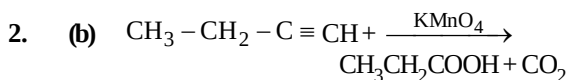
Reason : Actual structure of benzene is a hybrid of following two structures.



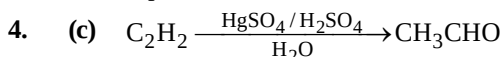
HINTS & SOLUTIONS

Type A : Multiple Choice Questions

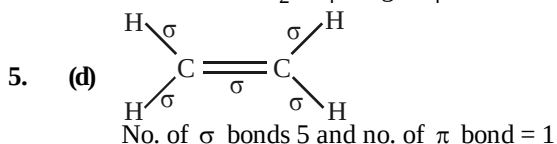
1. (a) Aromatic compounds are closed chain planar compounds with $(4n + 2)\pi$ electrons and show delocalization of π electrons. Cyclohexane does not coincide with this definition as it does not have benzene ring, while other three have benzene ring.



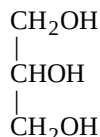
3. (a) Tetraethyl lead (TEL) is used as antiknock in petrol.



So, z is 20% $\text{H}_2\text{SO}_4 + \text{HgSO}_4$



6. (b) The structure of glycerol is



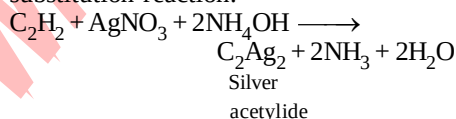
It contains two primary and one secondary alcoholic groups.

7. (a) Prestone is a mixture of glycol & H_2O . It has freezing point much below 0°C , hence it is used as an antifreeze for automobile radiators.

8. (c) The given reaction is known as Friedel-Craft reaction.

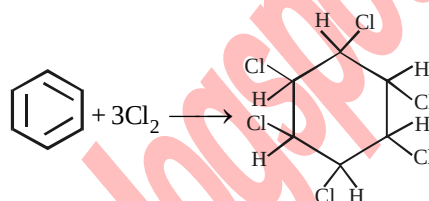
9. (c) Geometrical isomerism is shown by molecules containing double bond having unlike groups on each of the doubly bonded carbon atom.

10. (c) In most cases, alkynes show addition reactions as they contain two double bonds. In some cases, it undergoes substitution reaction.



This reaction occurs only in terminal alkynes.

11. (c) In presence of sunlight, benzene reacts with chlorine to form addition product.

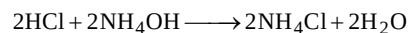


Benzene hexachloride

12. (a) Natural gas contains mainly methane

13. (b) Sulphonation is electrophilic substitution reaction of benzene. This reaction is facilitated by any group having +I effect (inductive effect). As CH_3 has +I effect, toluene facilitates this reaction most.

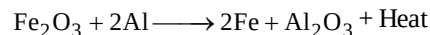
14. (c) Acetylene forms brown copper acetylide with ammonical cuprous chloride solution.



15. (c) The heavier the molecule, greater is the boiling point. So molecule with boiling point -0.5°C will have maximum number of carbon atoms.

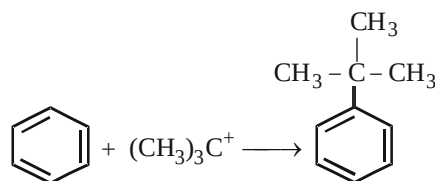
16. (c) The size of C – C bond in benzene is $1.39 \text{ \AA}$ which lies between $1.34 \text{ \AA}$ (bond length of C – C) and $1.54 \text{ \AA}$ (bond length of C = C).

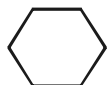
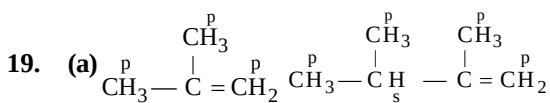
17. (d) Thermite is a mixture of iron oxide and Al powder. Al reduces iron oxide to iron giving out enormous heat.



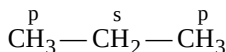
18. (b) $\text{CH}_2 = \underset{\text{CH}_3}{\text{C}} - \text{CH}_3 + \text{H}^+ \longrightarrow \text{CH}_3 - \underset{\text{CH}_3}{\text{C}^+} - \text{CH}_3$

Highly stable

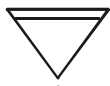
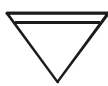




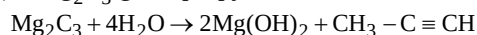
All H's are secondary



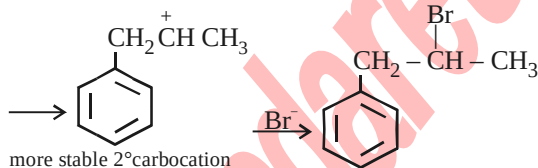
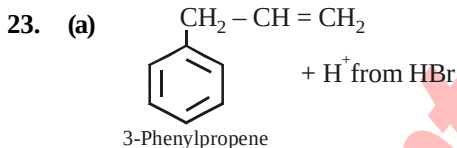
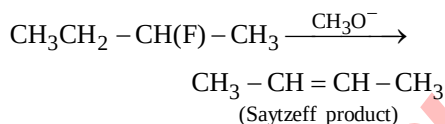
20. (a) According to Huckel's rule, the cyclic planar conjugated system having $(4n + 2)$ π electrons show aromaticity.

2 π electrons4 π electrons4 π electrons4 π electrons

21. (b) Mg_2C_3 gives propyne.

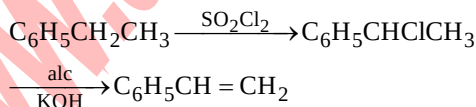


22. (b) $\text{CH}_3\text{CH}_2 - \text{CH}(\text{F}) - \text{CH}_3$ is a secondary halide. So, it will undergo dehydrohalogenation to form alkene.

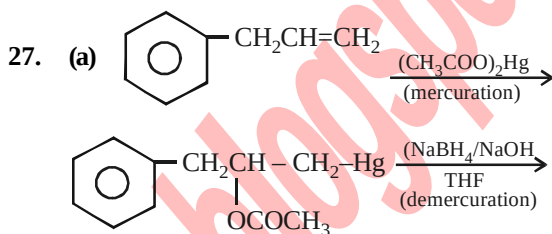
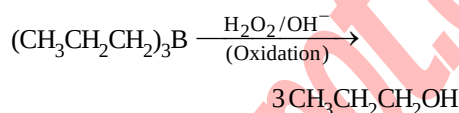
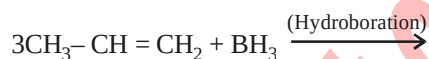


24. (c) V_2O_5 is used as a catalyst in contact process for the manufacture of SO_3 and hence H_2SO_4 . In Haber-Bosch process for the manufacture of NH_3 , finely divided Fe + molybdenum are used.

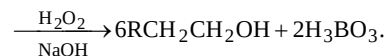
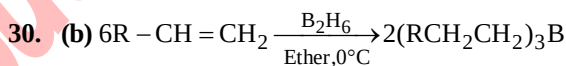
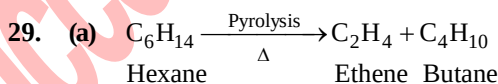
25. (b) SO_2Cl_2 causes free radical substitution at benzylic position.



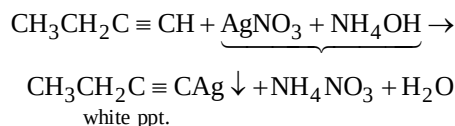
26. (a) Propene on hydroboration and oxidation produces propanol.



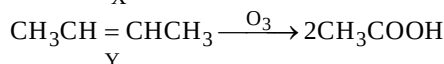
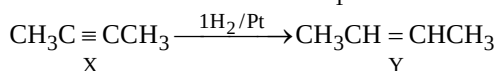
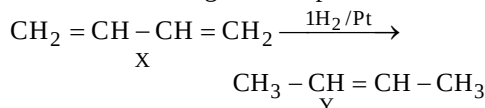
28. (b) SO_3 participates in sulphonation of benzene.



31. (c) Tollen's reagent is ammoniacal silver nitrate which reacts with 1-alkynes to form white precipitate of silver alkynide.



32. (d) Formation of only CH_3COOH by ozonolysis indicates that the compound Y should be $\text{CH}_3\text{CH} = \text{CHCH}_3$ which can be formed by all of the three given compounds

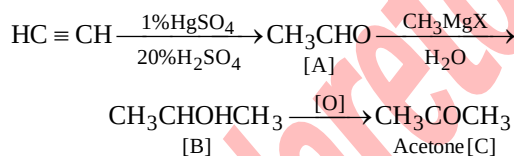


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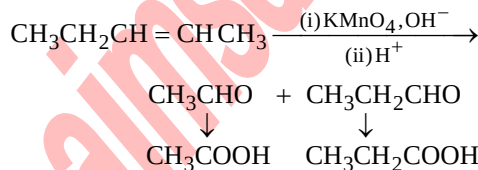
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33. (c) 34. (a)
 35. (a) CH_4 has only one carbon atom, hence it can't be prepared by Wurtz reaction, which involves two molecules of alkyl halide.
 36. (b) $\text{CH}_3\text{C} \equiv \text{CCH}_3$, being symmetrical, has the lowest dipole moment
 37. (c) When non-terminal alkynes are heated with NaNH_2 in an inert solvent, the triple bond migrates to the end carbon atom.
 38. (c) The Friedel-Crafts alkylation reaction will give propyl phenyl ketone which further on Clemmenson's reduction will give butyl benzene
 39. (d) Br_2 in CCl_4 (a), Br_2 in CH_3COOH (b) and alk. KMnO_4 (c) will react with all unsaturated compounds, i.e., 1, 3 and 4 while ammonical AgNO_3 (d) reacts only with terminal alkynes, i.e., 3 and hence 3 can be distinguished from 1, 2 and 4 by ammonical AgNO_3 (d).
 40. (a) The addition of HBr takes place according to anti-Markovnikoff's rule in presence of peroxide for unsymmetrical alkenes. The addition of HBr to symmetrical alkenes is not affected by the presence or absence of peroxide.

41. (c)



42. (d) A doubly bonded carbon atom having an alkyl group is oxidised to aldehyde which is further oxidised to carboxylic acid.

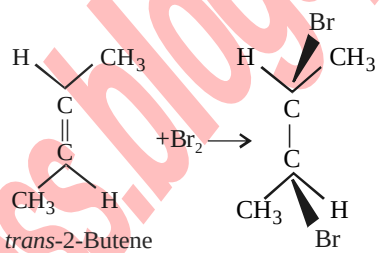


Type B : Assertion Reason Questions

43. (b) Chlorination of CH_4 takes place either in presence of light or at high temperature, and not in dark because in darkness, Cl free radicals are not produced.
 44. (b) Alkylbenzene is not prepared by Friedel-Craft alkylation because monoalkyl product

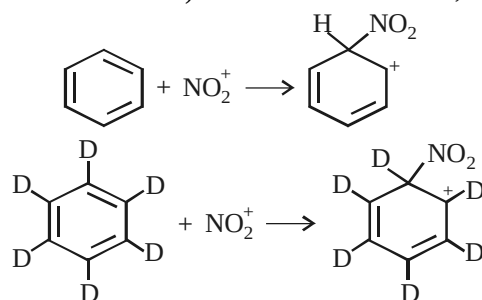
undergoes alkylation to produce polyalkylated benzene. Further the reason that "acyl halides are more reactive than alkyl halides" although not correct explanation of the assertion it is true because acyl halides are more electron deficient than alkyl halides



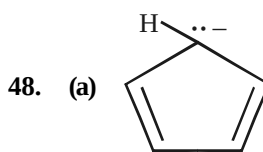
45. (c) 
 The reaction is *trans* addition of Br_2 and not *syn* addition.

46. (d) $\text{CH}_3-\text{CH}_2-\overset{\text{Br}}{\underset{|}{\text{CH}}}-\text{CH}_3 \longrightarrow \text{CH}_3-\text{CH}=\text{CH}-\text{CH}_3$
 2-Butene

47. (d) Rates of nitration of benzene and hexadeutero benzene are same because the rate determining step (formation of carbocation) is same in both the cases, i.e.,



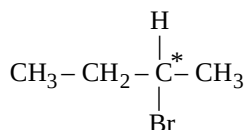
it does not involve the cleavage of $\text{C}-\text{H}$ / $\text{C}-\text{D}$ bond which takes in the second step.



Cyclopentadienyl anion contains 6π electrons, so it is aromatic and stabilised

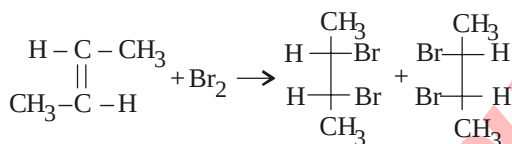
by resonance. Thus it is more stable than allyl anion which is not aromatic, although it is also stabilised by resonance.

49. (d) Natural rubber is polymer of isoprene. Thus assertion is false. Further the reason is also false because 1, 3-butadiene undergoes free radical polymerisation rather than anionic.
50. (c) $\text{CH}_3-\text{CH}=\text{CH}-\text{CH}_3$ on reaction with HBr gives



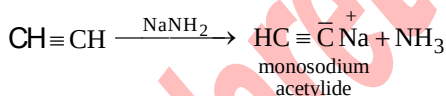
which contains one chiral carbon. So, it will give two optical isomers. Hence A is correct. Since 2-butene is symmetrical molecule so it will not follow Markownikov rule. Thus R is false.

51. (d) On *anti* addition of Br_2 to *trans*-butene-2, we get *meso* compounds



While *syn* addition gives a racemic mixture. Hence both assertion and reason are false.

52. (a) Acetylene on reaction with sodamide gives sodium acetylide and ammonia.



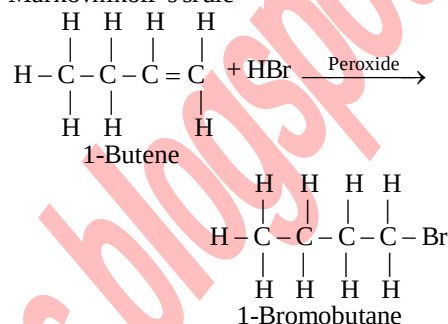
Here formation of sodium acetylide can be explained by *sp*-hybridisation of carbon atom. As we know that an electron in *s*-orbital is more tightly held than in a *p*-orbital. In *sp* hybridisation, *s*-character is 50% as compared to *sp*² (33%) or *sp*³ (25%). So, due to large *s*-character the carbon atom is quite electronegative and hence Na of NaNH_2 can replace H^+ of C-H bond.

Hence assertion and reason both are true and reason is the correct explanation of assertion.

53. (c) Yes, we use Friedel-Crafts reaction for introducing an alkyl or acyl group in benzene nucleus. Thus, assertion is true. However, the reason is not true because if benzene is used as a solvent, during

alkylation of bromobenzene, benzene will be alkylated in preference to bromobenzene because benzene is more reactive for S_{E} than bromobenzene.

54. (a) This reaction takes place against Markovnikoff's rule

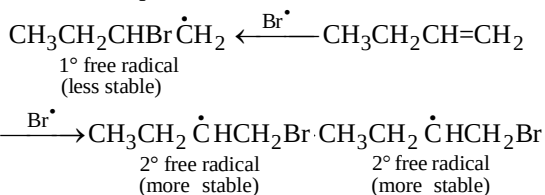


In this reaction *anti*-Markovnikoff's addition is explained on the basis of the fact that in the presence of peroxide the addition takes place via a free radical mechanism.

55. (b) Benzene is a non-polar solvent. Butter is composed of organic compounds of low polarity. So, it gets dissolved in benzene.

56. (c) The assertion that *trans*-2 butene reacts with Br_2 to product *meso*-2, 3-dibromobutane is correct but it does not involve *syn*-addition of Br_2 .

57. (c) Here assertion is correct but reasoning is incorrect. In presence of peroxide, addition of HBr on alkenes takes place via free radicals; here two free radical are formed, 2° free radical, being more stable, governs the product.



58. (a) $\text{HNO}_3 + 2\text{H}_2\text{SO}_4 \rightleftharpoons 2\text{HSO}_4^- + \text{NO}_2^+ + \text{H}_3\text{O}^+$

59. (d)

60. (c) $(4n+2)\pi$ electrons and planar structure are the essential conditions for aromaticity.

61. (c) Benzene has a uniform C-C bond distance of 139 pm, a value intermediate between the C-C single (154 pm) and C=C double (134 pm) bonds.

Environmental Chemistry

TYPE A : MULTIPLE CHOICE QUESTIONS

- Nitrolium is; [1999]
 (a) CaCN_2 (b) $\text{Ca}(\text{CN})_2$
 (c) $\text{CaCN}_2 + \text{C}$ (d) $\text{Ca}(\text{NO}_3)_2$
- Which one of the following is not a green house gas? [2001]
 (a) CO_2 (b) H_2O
 (c) N_2 (d) O_3
- Which of the following is not a green house gas? [2003]
 (a) Carbon dioxide (b) Water vapour
 (c) Oxygen (d) Methane
- Ozone in stratosphere is depleted by : [2004]
 (a) CF_2Cl_2 (b) C_7F_{16}
 (c) $\text{C}_6\text{H}_6\text{Cl}_6$ (d) C_6F_6
- The secondary precursors of photochemical smog are [2014]
 (a) SO_2 and NO_2
 (b) SO_2 and hydrocarbons
 (c) NO_2 and hydrocarbons
 (d) O_3 and PAN
- The irritant red haze in the traffic and congested places is due to presence of which of the following?
 (i) Oxides of sulphur
 (ii) Oxides of nitrogen

- Carbon dioxide
 - Mists, smoke and dust
 - Smog
- (a) (i), (iv) and (v) (b) (iii) only
 (c) (ii) only (d) (ii) and (v)

[2016]

TYPE B : ASSERTION REASON QUESTIONS

Directions for (Qs.7-8) : Each of these questions contains an Assertion followed by Reason. Read them carefully and answer the question on the basis of following options. You have to select the one that best describes the two statements.

- If both Assertion and Reason are correct and Reason is the correct explanation of Assertion.
 - If both Assertion and Reason are correct, but Reason is not the correct explanation of Assertion.
 - If Assertion is correct but Reason is incorrect.
 - If both the Assertion and Reason are incorrect.
- Assertion :** Photochemical smog is produced by nitrogen oxides.
Reason : Vehicular pollution is a major source of nitrogen oxides. [2003]
 - Assertion :** Suspended particulate matter (SPM) is an important pollutant released by diesel vehicles. [2015]
Reason : Catalytic converters greatly reduce pollution caused by automobiles.

HINTS & SOLUTIONS**Type A : Multiple Choice Questions**

1. (c) Nitrolim is the name of a fertilizer which is chemically a mixture of $\text{CaCN}_2 + \text{C}$. It reacts with water to form ammonia, vital for plants.
 $\text{CaCN}_2 + 3\text{H}_2\text{O} \longrightarrow \text{CaCO}_3 + 2\text{NH}_3$
2. (c) Most of the radiations of the sun falling on earth are radiated back in the space. However, certain atmospheric gases, like CO_2 , O_3 , water vapour, chlorofluorocarbons, oxides of nitrogen etc. trap these radiations. This is known as green house effect.
3. (c) **Greenhouse gases** (GHGs) are gaseous components of the atmosphere that contribute to the "greenhouse effect". Although uncertainty exists about exactly how earth's climate responds to these gases, global temperatures are rising. Some greenhouse gases occur naturally in the atmosphere, while others result from human activities. Naturally occurring greenhouse gases include water vapor, carbon dioxide, methane, nitrous oxide, and ozone. Certain human activities, however, add to the levels of most of these naturally occurring gases.
Note : Greenhouse gases act as blanket to the earth and keep it at about 33°C ; warmer than it would be without these gases in the atmosphere.
4. (a) Ozone is depleted by CF_2Cl_2 (dichlorodifluoromethane or freon.)
5. (d)
6. (c) The irritant red haze in the traffic and congested places is due to the presence of oxides of nitrogen.

Type B : Assertion Reason Questions

7. (b) It is correct that photochemical smog is produced by oxides of nitrogen and it is also a fact that vehicular pollution is a major source of nitrogen oxides but it is not the correct explanation of assertion.
8. (b) SPM (Suspended Particulate Matter) is defined as particles floating in the air with a diameter below $10\text{ }\mu\text{m}$. Studies have shown that high SPM concentrations in the air can have a detrimental impact on respiratory organs. SPM is generated from natural sources (e.g., volcanoes or dust storms) and human activities (vehicles, incinerators and industrial plants).

SPM	Other aerosols
Less than $10\text{ }\mu\text{m}$	Less than $100\text{ }\mu\text{m}$
Tend to float longer in Air due to small size	Tend to settle fairly due to comparative quickly heaviness

Catalytic converters is a device designed to reduce the amount of emissions from automobiles. The current (so-called three-way) systems use a heated metal catalyst to reduce the emissions of carbon monoxide (CO), hydrocarbons, and nitric oxide (NO), all of which contribute to the formation of photochemical smog. In an automobile's exhaust system, a catalytic converter provides an environment for a chemical reaction where unburned hydrocarbons completely combust.

Chapter

15

The Solid State

TYPE A : MULTIPLE CHOICE QUESTIONS

- Schottky defect defines imperfection in the lattice structure of [2002]
 - solid
 - gas
 - liquid
 - plasma
- An AB_2 type structure is found in [2002]
 - $NaCl$
 - CaF_2
 - Al_2O_3
 - N_2O
- An element (atomic mass 100 g/mol) having bcc structure has unit cell edge 400 pm. The density of element is (No. of atoms in bcc , $Z = 2$). [2002]
 - 2.144 g/cm³
 - 7.289 g/cm³
 - 5.188 g/cm³
 - 10.376 g/cm³
- What is the coordination number of sodium in Na_2O ? [2003]
 - 6
 - 4
 - 8
 - 2
- The crystal system of a compound with unit cell dimensions " $a = 0.387$, $b = 0.387$ and $c = 0.504$ nm and $\alpha = \beta = 90^\circ$ and $\gamma = 120^\circ$ " is : [2004]
 - cubic
 - hexagonal
 - orthorhombic
 - rhombohedral
- If z is the number of atoms in the unit cell that represents the closest packing sequence ABC ABC, the number of tetrahedral voids in the unit cell is equal to : [2005]
 - z
 - $2z$
 - $z/2$
 - $z/4$
- The compound, found in nature in gas phase but ionic in solid state is : [2006]
 - PCl_5
 - CCl_4
 - PCl_3
 - $POCl_3$
- The Ca^{2+} and F^- are located in CaF_2 crystal, respectively at face centred cubic lattice points and in [2006]
 - Tetrahedral voids
 - Half of tetrahedral voids
 - Octahedral voids
 - Half of octahedral voids
- The coordination number in hcp is [2007]
 - 6
 - 12
 - 18
 - 24
- The space lattice of graphite is [2009]
 - Cubic
 - Tetragonal
 - Rhombic
 - Hexagonal
- Coordination numbers of Zn^{2+} and S^{2-} in the crystal structure of wurtzite are [2010]
 - 4, 4
 - 6, 6
 - 8, 4
 - 8, 8
- Gold has a face centred cubic lattice with an edge length of the unit cube of 407 pm. Assuming the closest packing, the diameter of the gold atom is [2011]
 - 576.6 pm
 - 287.8 pm
 - 352.5 pm
 - 704.9 pm
- Which is *not* correct about the Schottky defects? [2011]
 - Both cations and anions are missing from their lattice sites without affecting the stoichiometry of the compound
 - Because of presence of holes the lattice energy decreases.
 - The presence of holes causes the density of the crystal to decrease.
 - The defect increases the electrical conductivity of the solid due to migration of the ions into the holes.
- The existence of a substance in more than one solid modifications is known as [2012]
 - isomorphism
 - Polymorphism
 - Amorphism
 - Allotropy
- An element (atomic mass = 100 g / mol) having bcc structure has unit cell edge 400 pm. Then, density of the element is [2013]
 - 10.376 g/cm³
 - 5.188 g/cm³
 - 7.289 g/cm³
 - 2.144 g/cm³

16. If AgI crystallises in zinc blende structure with I^- ions at lattice points. What fraction of tetrahedral voids is occupied by Ag^+ ions?

[2014]

- (a) 25% (b) 50%
(c) 100% (d) 75%

17. Which set of following characteristics for ZnS crystal is correct?

[2015]

- (a) Coordination number (4 : 4); *ccp*; Zn^{2+} ion in the alternate tetrahedral voids
(b) Coordination number (6 : 6); *hcp*; Zn^{2+} ion in all tetrahedral voids.
(c) Coordination number (6 : 4); *hcp*; Zn^{2+} ion in all octahedral voids
(d) Coordination number (4 : 4); *ccp*; Zn^{2+} ion in all tetrahedral voids.

18. Molecules/ions and their magnetic properties are given below.

[2016]

Molecule/ion	Magnetic property
(i) C_6H_6	(1) Antiferromagnetic
(ii) CrO_2	(2) Ferrimagnetic
(iii) MnO	(3) Ferromagnetic
(iv) Fe_3O_4	(4) Paramagnetic
(v) Fe^{3+}	(5) Diamagnetic

The correctly matched pairs in the above is

- (a) i-5, ii-3, iii-2, iv-1, v-4
(b) i-3, ii-5, iii-1, iv-4, v-2
(c) i-5, ii-3, iii-1, iv-2, v-4
(d) i-5, ii-3, iii-1, iv-4, v-2

19. Which one of the following statements about packing in solids is **incorrect**?

[2016]

- (a) Coordination number in bcc mode of packing is 8.
(b) Coordination number in hcp mode of packing is 12.
(c) Void space in hcp mode of packing is 32%.
(d) Void space in ccp mode of packing is 26%.

20. Sodium metal crystallizes in a body centred cubic lattice with a unit cell edge of 4.29 Å. The radius of sodium atom is approximately :

[2017]

- (a) 5.72 Å (b) 0.93 Å
(c) 1.86 Å (d) 3.22 Å

TYPE B : ASSERTION REASON QUESTIONS

Directions for (Qs.21-26) : Each of these questions contains an Assertion followed by Reason. Read them carefully and answer the question on the basis of following options. You have to select the one that best describes the two statements.

- (a) If both Assertion and Reason are correct and Reason is the correct explanation of Assertion.
(b) If both Assertion and Reason are correct, but Reason is not the correct explanation of Assertion.
(c) If Assertion is correct but Reason is incorrect.
(d) If both the Assertion and Reason are incorrect.

21. **Assertion :** Graphite is an example of tetragonal crystal system.

Reason : For a tetragonal system, $a = b \neq c$, $\alpha = \beta = 90^\circ$, $\gamma = 120^\circ$. [2006]

22. **Assertion :** No compound has both Schottky and Frenkel defects.

Reason : Both defects change the density of the solid. [2008]

23. **Assertion :** Stability of a crystal is reflected in the magnitude of its melting.

Reason : The stability of a crystal depends upon the strength of the interparticle attractive force. [2009]

24. **Assertion :** Due to Frenkel defect, there is no effect on the density of the crystalline solid.

Reason : In Frenkel defect, no cation or anion leaves the crystal. [2011]

25. **Assertion :** On heating ferromagnetic or ferrimagnetic substances, they become paramagnetic.

Reason : The electrons change their spin on heating. [2014]

26. **Assertion :** In close packing of spheres, a tetrahedral void is surrounded by four spheres whereas an octahedral void is surrounded by six spheres.

Reason : A tetrahedral void has a tetrahedral shape whereas an octahedral void has an octahedral shape. [2015]

HINTS & SOLUTIONS

Type A : Multiple Choice Questions

1. (a) Schottky defects are found in solids.
2. (b) $AB_2 \rightleftharpoons A^{2+} + 2B^-$
 $CaF_2 \rightleftharpoons Ca^{2+} + 2F^-$
3. (c) Mass of two atoms = $\frac{100}{6.02 \times 10^{23}} \times 2 \text{ g}$
 $= \frac{2}{6.02} \times \frac{10^{-21}}{10^3} \text{ kg}$
 Volume of cell = $(4 \times 10^{-10})^3 = 64 \times 10^{-30}$
 Density = $\frac{\text{mass}}{\text{volume}} = \frac{2 \times 10^{-24}}{64 \times 10^{-30} \times 6.02}$
 Density = $\frac{2}{6.02 \times 64} \times 10^6 \text{ kg/m}^3$
 $= \frac{2 \times 10^6 \times 10^3}{6.02 \times 64 \times 10^6} \text{ g/cc}$
 $= \frac{2}{6.02 \times 64} \times 10^3 \text{ g/cc} = 5.188 \text{ g/cc}$
4. (b) In Na_2O there is antifluorite structure. Here negative ions form the ccp arrangement so that each positive ion is surrounded by 4 negative ions and each negative ion is surrounded by 8 positive ions. So coordination no. of Na^+ is 4.
5. (b) $a = b \neq c$, $\alpha = \beta = 90^\circ$, $\gamma = 120^\circ$
 These are the characteristics of a hexagonal system.
6. (b) In cubic closed pack system (ccp system) ABCABC..... type of arrangement of layers is found. In this system, there are atoms at the corners as well as centre of the unit cell.
 $\therefore$ No. of atoms per unit cell = $8 \times \frac{1}{8} + 1 = 2$
 Hence, the no. of tetrahedral voids in a unit cell = $2z$
7. (a) PCl_5 exists in gas phase, however it remains in solid state in ionic form in the form of $[PCl_4]^+ [PCl_6]^-$. The cation is tetrahedral and anion is octahedral.
8. (a) F^- are in tetrahedral voids. Four atoms of Ca^{2+} and eight atoms of F^- are in unit cell. Each F^- atom occupies 8 tetrahedral voids.
9. (b) In this structure, each atom is surrounded by twelve nearest touching neighbours. Hence coordination number is 12.
10. (d) In graphite, the carbon atoms are arranged in regular hexagons in flat parallel layers and this fact is responsible for its softness and lubricating action.
11. (a) Wurtzite has *face centred cubic* structure in which each Zn^{2+} ion is attached to four S^{2-} ions and each S^{2-} ion remains in contact with four Zn^{2+} ions. Hence coordination number of each ion is 4.
12. (b) For fcc lattice,
 $4r = \text{diagonal of the face} = a\sqrt{2}$
 or $2r = \text{diameter}$
 $= \frac{a\sqrt{2}}{2} = \frac{407 \times \sqrt{2}}{2} = 287.8 \text{ pm}$
13. (b)
14. (b)
15. (b) $\rho = \frac{z \times M}{N_A \times a^3} = \frac{2 \times 100}{6.023 \times 10^{23} \times (400 \times 10^{-10})^3}$
 $= 5.188 \text{ g/cm}^3$
16. (b) For each central atom there are two tetrahedral voids in AgI crystal. The number of Ag^+ ion is equal to number of I^- ion. It means only 50% of the void will be occupied by Ag^+ ion.
17. (a) ZnS has cubic close packed (ccp) structure. The S^{2-} ions are present at the corners of the cube and at the centre of each face. Zinc ions occupy half of the tetrahedral sites. Each zinc ion is surrounded by four sulphide ions which are disposed towards the corners of a regular tetrahedron. Similarly, S^{2-} ion is surrounded by four Zn^{2+} ions.
18. (c) C_6H_6 is diamagnetic (i – 5)
 CrO_2 is ferromagnetic (ii – 3)
 MnO is antiferromagnetic (iii – 1)
 Fe_3O_4 is ferrimagnetic (iv – 2)

Fe^{3+} is paramagnetic with 5 unpaired electron ($v-4$)

19. (c) The *hcp* arrangement of atoms occupies 74% of the available space and thus has 26% vacant space.

20. (c) In bcc the atoms touch along body diagonal

$$\therefore 2r + 2r = \sqrt{3}a$$

$$\therefore r = \frac{\sqrt{3}a}{4} = \frac{\sqrt{3} \times 4.29}{4} = 1.857 \text{ \AA}$$

Type B : Assertion Reason Questions

21. (d) Like quartz and ice, graphite is an example of hexagonal system for which $\alpha = \beta = 90^\circ$ and $\gamma = 120^\circ$ and $a = b \neq c$. So, A is incorrect and R is also incorrect as for tetragonal system $a = b \neq c$ and $\alpha = \beta = \gamma = 90^\circ$.
22. (d) Certain ionic solids (for example, AgBr) have both Schottky and Frenkel defects. Only Schottky defects change the density of solids because anions or cations are

missing, while Frenkel defects do not involve any change in density because number of cations and anions are same, there is only change of position of ions.

23. (a) The stability of a crystal depends upon the strength of the interparticle attractive force. The melting point of a solid depends on the strength of the attractive force acting between the constituent particles. Therefore, the stability of a crystal gets reflected in its melting point.
24. (a) In a Frenkel defect an ion leaves its position in the lattice and occupies normally vacant interstitial position.
25. (a) All magnetically ordered solids (ferromagnetic, ferrimagnetic and antiferromagnetic solids) transform to the paramagnetic state at high temperature due to the randomisation of spins.
26. (c) Tetrahedral void is so called because it is surrounded by four spheres tetrahedrally while octahedral void is so called because it is surrounded by six spheres octahedrally.

Chapter

16

Solutions

TYPE A : MULTIPLE CHOICE QUESTIONS

- The vapour pressure of benzene at 30°C is 121.8 mm. By adding 15 g of non-volatile solute in 250 g of benzene, its vapour pressure is decreased to 120.2 mm. The molecular weight of solute is :
(a) 156.6 g (b) 267.4 g [1997]
(c) 356.3 g (d) 467.4 g
- Pure benzene freezes at 5.45°C . A 0.374 m solution of tetrachloroethane in benzene freezes at 3.55°C . The K_f for benzene is: [1998]
(a) 0.508 (b) 5.08
(c) 50.8 (d) 508
- 0.450 g of urea (mol.wt.60) in 22.5 g of water show 0.170°C of elevation in boiling point. The molal elevation constant of water is: [1998]
(a) 0.051°C (b) 0.51°C
(c) 5.1°C (d) 0.83°C
- Van't Hoff factor is: [2000]
(a) More than one in case of association
(b) Less than one in case of dissociation
(c) $\frac{\text{normal molecular mass}}{\text{observed molecular mass}}$
(d) $\frac{\text{observed molecular mass}}{\text{normal molecular mass}}$
- On mixing 3 g of non - volatile solute in 200 mL of water, its boiling point (100°C) becomes 100.52°C . If K_b for water is 0.6°C/m then molecular wt. of solute is : [2000]
(a) 10.5 g mol^{-1} (b) 12.6 g mol^{-1}
(c) 15.7 g mol^{-1} (d) 17.3 g mol^{-1}
- The colligative property is not represented by : [2001]
(a) elevation in boiling point
(b) osmotic pressure
(c) optical activity
(d) relative lowering of vapour pressure
- 20 g of a substance were dissolved in 500 mL of water and the osmotic pressure of the solution was found to be 600 mm of mercury at 15°C . The molecular weight of substance is : [2001]
(a) 998 (b) 1028
(c) 1098 (d) 1198
- Which one of the statements given below concerning properties of solutions, describes a colligative effect? [2003]
(a) Boiling point of pure water decreases by the addition of ethanol
(b) Vapour pressure of pure water decreases by the addition of nitric acid
(c) Vapour pressure of pure benzene decreases by the addition of naphthalene
(d) Boiling point of pure benzene increases by the addition of toluene
- The average osmotic pressure of human blood is 7.8 bar at 37°C . What is the concentration of an aqueous NaCl solution that could be used in the blood stream? [2004]
(a) 0.16 mol/L (b) 0.31 mol / L
(c) 0.60 mol / L (d) 0.45 mol / L
- A 5% solution (by mass) of cane sugar in water has freezing point of 271 K and freezing point of pure water is 273.15 K. The freezing point of a 5% solution (by mass) of glucose in water is
(a) 271 K (b) 273.15K [2006]
(c) 269.07 K (d) 277.23 K
- The vapour pressure of pure benzene at a certain temperature is 0.850 bar. A non-volatile, non-electrolyte solid weighing 0.5 g is added to 39.0 g of benzene (molar mass 78 g/mol). The vapour pressure of the solution then is 0.845 bar. What is the molecular mass of the solid substance?
(a) 58 (b) 180 [2007]
(c) 170 (d) 145.

12. 1 mol each of the following compounds is dissolved in 1L of solution. Which will have the largest ΔT_b value? [2007]
(a) HF (b) HCl
(c) HBr (d) HI.
13. 0.01 M solution of KCl and BaCl_2 are prepared in water. The freezing point of KCl is found to be -2°C . What is the freezing point of BaCl_2 to be completely ionised? [2008]
(a) -3°C (b) $+3^\circ\text{C}$
(c) -2°C (d) -4°C
14. An aqueous solution of hydrochloric acid [2009]
(a) Obeys Raoult's law
(b) Shows negative deviation from Raoult's law
(c) Shows positive deviation from Raoult's law
(d) Obeys Henry's law at all compositions
15. At 300K, the vapour pressure of an ideal solution containing 3 mole of A and 2 mole of B is 600 torr. At the same temperature, if 1.5 mole of A and 0.5 mole of C (non-volatile) are added to this solution the vapour pressure of solution increases by 30 torr. What is the value of p_B^0 ? [2009]
(a) 940 (b) 405
(c) 90 (d) None of these
16. Exactly 1 g of urea dissolved in 75 g of water gives a solution that boils at 100.114°C at 760 torr. The molecular weight of urea is 60.1. The boiling point elevation constant for water is [2010]
(a) 1.02 (b) 0.51
(c) 3.06 (d) 1.51
17. An aqueous solution of NaCl shows the depression of freezing point of water equal to 0.372 K. The boiling point of BaCl_2 solution of same molality will be [$K_f(\text{H}_2\text{O}) = 1.86 \text{ K kg mol}^{-1}$; $K_b(\text{H}_2\text{O}) = 0.52 \text{ K kg mol}^{-1}$] [2011]
(a) 100.52°C (b) 100.104°C
(c) 101.56°C (d) 100.156°C
18. 12g of urea is dissolved in 1 litre of water and 68.4 g of sucrose is dissolved in 1 litre of water. The lowering of vapour pressure of first case is [2012]
(a) equal to second
(b) greater than second
(c) less than second
(d) double that of second
19. At a particular temperature, the vapour pressures of two liquids A and B are respectively 120 and 180 mm of mercury. If 2 moles of A and 3 moles of B are mixed to form an ideal solution, the vapour pressure of the solution at the same temperature will be (in mm of mercury) [2013]
(a) 156 (b) 145
(c) 150 (d) 108
20. The freezing point of equimolal aqueous solution will be highest for [2013]
(a) $\text{C}_6\text{H}_5\text{NH}_3^+\text{Cl}^-$ (b) $\text{Ca}(\text{NO}_3)_2$
(c) $\text{La}(\text{NO}_3)_2$ (d) $\text{C}_6\text{H}_{12}\text{O}_6$
21. Which of the following 0.10 m aqueous solutions will have the lowest freezing point? [2014]
(a) $\text{Al}_2(\text{SO}_4)_3$ (b) $\text{C}_6\text{H}_{12}\text{O}_6$
(c) KCl (d) $\text{C}_{12}\text{H}_{22}\text{O}_{11}$
22. A solution containing 10g per dm^3 of urea (molecular mass = 60 g mol^{-1}) is isotonic with a 5% solution of a non volatile solute. The molecular mass of this non volatile solute is [2014]
(a) 300 g mol^{-1} (b) 350 g mol^{-1}
(c) 200 g mol^{-1} (d) 250 g mol^{-1}
23. The vapour pressure of a solvent decreases by 10 mm of Hg when a non-volatile solute was added to the solvent. The mole fraction of the solute in the solution is 0.2. What should be the mole fraction of the solvent if the decrease in the vapour pressure is to be 20 mm of Hg? [2015]
(a) 0.8 (b) 0.6
(c) 0.4 (d) 0.2
24. A solution of urea (mol. mass 56 g mol^{-1}) boils at 100.18°C at the atmospheric pressure. If K_f and K_b for water are 1.86 and $0.512 \text{ K kg mol}^{-1}$ respectively, the above solution will freeze at [2015]
(a) 0.654°C (b) -0.654°C
(c) 6.54°C (d) -6.54°C
25. A solution containing 1.8 g of a compound (empirical formula CH_2O) in 40 g of water is observed to freeze at -0.465°C . The molecular formula of the compound is [K_f of water = $1.86 \text{ K kg mol}^{-1}$] [2016]
(a) $\text{C}_2\text{H}_4\text{O}_2$ (b) $\text{C}_3\text{H}_6\text{O}_3$
(c) $\text{C}_4\text{H}_8\text{O}_4$ (d) $\text{C}_6\text{H}_{12}\text{O}_6$

26. Which observation(s) reflect(s) colligative properties? [2017]

- (i) A 0.5 m NaBr solution has a higher vapour pressure than a 0.5 m BaCl₂ solution at the same temperature
- (ii) Pure water freezes at the higher temperature than pure methanol
- (iii) a 0.1 m NaOH solution freezes at a lower temperature than pure water

Choose the correct answer from the codes given below

- (a) (i), (ii) and (iii) (b) (i) and (ii)
- (c) (ii) and (iii) (d) (i) and (iii)

TYPE B : ASSERTION REASON QUESTIONS

Directions for (Qs. 27-30) : These questions consist of two statements, each printed as Assertion and Reason. While answering these questions, you are required to choose any one of the following five responses.

- (a) If both Assertion and Reason are correct and the Reason is a correct explanation of the Assertion.
- (b) If both Assertion and Reason are correct but Reason is not a correct explanation of the Assertion.
- (c) If the Assertion is correct but Reason is incorrect.
- (d) If both the Assertion and Reason are incorrect.
- (e) If the Assertion is incorrect but the Reason is correct.

27. **Assertion :** Molecular mass of benzoic acid when determined by colligative properties is found high

Reason : Dimerisation of benzoic acid. [1998]

28. **Assertion :** The molecular weight of acetic acid determined by depression in freezing point method in benzene and water was found to be different.

Reason : Water is polar and benzene is non-polar. [2005]

29. **Assertion :** If red blood cells were removed from the body and placed in pure water, pressure inside the cells increases.

Reason : The concentration of salt content in the cells increases. [2006]

30. **Assertion :** The water pouch of instant cold pack for treating athletic injuries breaks when squeezed and NH₄NO₃ dissolves lowering the temperature.

Reason : Addition of non-volatile solute into solvent results into depression of freezing point of the solvent. [2006]

Directions for (Qs.31-33) : Each of these questions contains an Assertion followed by Reason. Read them carefully and answer the question on the basis of following options. You have to select the one that best describes the two statements.

- (a) If both Assertion and Reason are correct and Reason is the correct explanation of Assertion.
- (b) If both Assertion and Reason are correct, but Reason is not the correct explanation of Assertion.
- (c) If Assertion is correct but Reason is incorrect.
- (d) If both the Assertion and Reason are incorrect.

31. **Assertion :** Lowering of vapour pressure is directly proportional to osmotic pressure of the solution. [2012]

Reason : Osmotic pressure is a colligative property.

32. **Assertion :** If a liquid solute more volatile than the solvent is added to the solvent, the vapour pressure of the solution may increase i.e., $p_s > p^\circ$.

Reason : In the presence of a more volatile liquid solute, only the solute will form the vapours and solvent will not. [2016]

33. **Assertion :** If one component of a solution obeys Raoult's law over a certain range of composition, the other component will not obey Henry's law in that range. [2011, 2013, 2017]

Reason : Raoult's law is a special case of Henry's law.

HINTS & SOLUTIONS

Type A : Multiple Choice Questions

1. (c) According to Raoult's law,

$$\frac{p^0 - p_s}{p_s} = \frac{w \times M}{m \times W}$$

$$\frac{121.8 - 120.2}{121.8} = \frac{15}{m} \times \frac{78}{250}$$

$$\therefore m = \frac{15 \times 78 \times 121.8}{250 \times 1.6} = 356.265 \text{ g}$$

2. (b)
- $\Delta T_f = K_f \times m$

$$(5.45 - 3.55) = K_f \times 0.374$$

$$K_f = \frac{1.9}{0.374} = 5.08$$

3. (b)
- $\Delta T = K_b \frac{w}{m} \times \frac{1000}{W}$

$$0.170 = K_b \frac{0.450}{60} \times \frac{1000}{22.5}$$

$$K_b = \frac{0.170 \times 60 \times 22.5}{1000 \times 0.450} = 0.51^\circ\text{C}$$

4. (c) Van't Hoff factor

$$= \frac{\text{Normal Molecular Mass}}{\text{Observed Molecular Mass}}$$

5. (d)
- $\Delta T = K_b \frac{w}{m} \times \frac{1000}{W}$

$$0.52 = 0.6 \times \frac{3}{m} \times \frac{1000}{200}$$

$$m = \frac{1.8 \times 5}{0.52} = 17.3 \text{ g mol}^{-1}$$

6. (c) Optical activity is not dependent upon number of molecules of the compound, so it is not a colligative property.

7. (d)
- $\pi V = nRT$

$$\frac{500}{1000} \pi = \frac{20}{m} \times 0.082 \times (273 + 15)$$

$$\frac{500}{1000} \times \frac{600}{760} = \frac{20}{m} \times 0.082 \times 288$$

$$m = \frac{20 \times 0.082 \times 288 \times 1000 \times 760}{500 \times 600} = 1198$$

8. (c) The decrease in vapour pressure of benzene by addition of naphthalene is an example of colligative property.

Change in vapour pressure of solvent or change in boiling point of solvent may also be due to formation of hydrogen bond or interaction between solvent molecule and solute molecule.

9. (b)
- $\pi = cRT$
-
- $7.8 = c \times 0.082 \times 310$

$$c = \frac{7.8}{0.082 \times 310} = 0.31 \text{ mol/L}$$

10. (c) From the relation

$$\Delta T_f = K_f \times \frac{w}{m} \times \frac{1000}{W}$$

It is obvious that

$$\Delta T_f \propto \frac{1}{m}$$

$$\therefore \frac{\Delta T_{f1}}{\Delta T_{f2}} = \frac{m_2}{m_1}$$

Cane sugar solution

Glucose solution

$$\Delta T_{f1} = 273.15 - 271$$

$$\Delta T_{f2} = ?$$

$$m_1 = 342$$

$$m_2 = 180$$

$$\text{Hence } \frac{2.15}{\Delta T_{f2}} = \frac{180}{342}$$

$$\Delta T_{f2} = \frac{342 \times 2.15}{180} = 4.085 \text{ K}$$

So, freezing point of glucose solution
 $= 273.15 - 4.085$
 $= 269.07 \text{ K}$

11. (c)
- $p_{\text{benzene}}^\circ = 0.850 \text{ bar}$
- ;
- $W_{\text{benzene}} = 39.0 \text{ g}$
- .
-
- M.W. = 78 g/mol.

$$p_{\text{solution}}^\circ = 0.845 \text{ bar}; \quad w = 0.5 \text{ g}.$$

Let n be the no. of moles of non volatile solid; w and m be the weight of solid and molecular mass respectively.

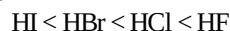
$$\text{Using, } \frac{p_{\text{benzene}}^{\circ} - p_{\text{solution}}^{\circ}}{p_{\text{benzene}}^{\circ}} = \frac{n_{\text{solid}}}{n_{\text{benzene}}}$$

$$\frac{0.850 - 0.845}{0.850} = \frac{\frac{0.5}{m}}{\frac{39}{78}}$$

$$\frac{0.005}{0.850} = \frac{0.5}{m} \cdot \frac{78}{39}$$

$$m = \frac{100 \times 0.850}{0.005} = 170$$

12. (d) The value of ΔT_b depends upon two factors 'i' and 'm'. It is given that 1 mol of each compound is dissolved in 1 L of solution. Hence molarity is same for all the compounds. Now the van't Hoff factor depends on number of particle i.e. on degree of ionisation which further depends on the bond dissociation energy which is in the order



i.e., bond dissociation energy of HI is least. Lower the bond dissociation energy, higher is the degree of ionisation and hence higher the number of particles, thus *i* will be maximum for HI and hence ΔT_b value will be larger for HI.

13. (a) $\Delta T_f \propto i$

$$\therefore \frac{\Delta T_f \text{ for KCl}}{\Delta T_f \text{ for BaCl}_2} = \frac{i \text{ for KCl}}{i \text{ for BaCl}_2}$$

$$\therefore \frac{\Delta T_f \text{ for KCl}}{\Delta T_f \text{ for BaCl}_2} = \frac{2}{3} \quad (\because \Delta T_f \text{ for KCl} = 2)$$

$$\therefore \Delta T_f \text{ for BaCl}_2 = \frac{3 \times 2}{2} = 3$$

$$\therefore \text{Freezing point of BaCl}_2 = -3^\circ\text{C}$$

14. (b) Shows negative deviation from Raoult's law.

If the attraction between different molecules, for example between HCl and H₂O molecules, is stronger, the escaping tendency from the solution to the vapour

phase will be smaller, then the partial vapour pressure will be smaller than predicted by Raoult's law and the system exhibits a negative deviation.

15. (c) $P = p_A^{\circ} x_A + p_B^{\circ} x_B$

$$600 = p_A^{\circ} \left(\frac{3}{3+2} \right) + p_B^{\circ} \left(\frac{2}{2+3} \right);$$

$$3p_A^{\circ} + 2p_B^{\circ} = 3000$$

$$630 = p_A^{\circ} \left(\frac{4.5}{4.5+2+0.5} \right) + p_B^{\circ} \left(\frac{2}{4.5+2+0.5} \right)$$

$$4.5 p_A^{\circ} + 2 p_B^{\circ} = 4410$$

$$1.5 p_A^{\circ} = 1410; p_A^{\circ} = 940 \text{ and } p_B^{\circ} = 90$$

16. (b) Weight of solute (*w*) = 1 g

Weight of solvent (*W*) = 75 g

Boiling point of solution = 100.114°C

Boiling point of solvent = 100°C

$$\Delta T = 100.114 - 100 = 0.114^\circ\text{C}$$

Molecular weight of solute (*m*) = 60.1

Boiling point elevation constant (*K*) = ?

$$m = \frac{1000 \times K \times w}{\Delta T \times W}$$

$$K = \frac{m \times \Delta T \times W}{100 \times w}$$

$$= \frac{60.1 \times 0.114 \times 75}{1000 \times 1}$$

$$= \frac{513.8}{1000} = 0.513$$

17. (d) $\frac{\Delta T_f}{\Delta T_b} = \frac{i_1 K_f m}{i_2 K_b m} = \frac{2 \times 1.86}{3 \times 0.52};$

$$\Delta T_f = 0.372. \text{ Hence, } \Delta T_b = 0.156^\circ\text{C}$$

$$\text{i.e., } T_b = 100.156^\circ\text{C}$$

18. (a) Moles of urea = $\frac{12}{60} = 0.2$

$$\text{Moles of sucrose} = \frac{68.4}{342} = 0.2$$

Both are non electrolyte hence lowering of V.P. will be same.

19. (a) Vapour pressure of solution = $P_A + P_B$

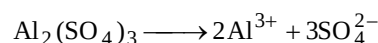
$$= p_A^0 x_A + p_B^0 x_B = \frac{120 \times 2}{5} + \frac{180 \times 3}{5} = 156 \text{ mm Hg}$$

20. (d) Glucose is non electrolyte hence depression in freezing point will be minimum, hence freezing point will be highest.

21. (a) Depression in freezing point $\propto$ No. of particles.

(when concentration of different solutions is equal)

$\text{Al}_2(\text{SO}_4)_3$ provides five ions on ionisation



while KCl provides two ions



$\text{C}_6\text{H}_{12}\text{O}_6$ and $\text{C}_{12}\text{H}_{22}\text{O}_{11}$ are not ionised so they have single particle in solution.

Hence, $\text{Al}_2(\text{SO}_4)_3$ have maximum value of depression in freezing point or lowest freezing point.

22. (a) Molar concentration of urea = $\frac{10}{60}$ per dm^3

Molar concentration of volatile solute solution

$$= \frac{5}{M} \text{ per } 100 \text{ ml. or, } \frac{50}{M} \text{ per } \text{dm}^3$$

For solution of same concentration or, isotonic solution at same temperature

$$\frac{10}{60} = \frac{50}{M} \text{ or, } M = 300 \text{ g mol}^{-1}$$

23. (b) According to Raoult's law

$$\frac{\Delta p}{p^0} = \frac{n}{n+N} \text{ (mole fraction of solute)}$$

$$\frac{10}{p^0} = 0.2 \therefore p^0 = 50 \text{ mm of Hg}$$

For other solution of same solvent

$$\frac{20}{p^0} = \frac{n}{n+N} \text{ (Mole fraction of solute)}$$

$$\Rightarrow \frac{20}{50} = \text{Mole fraction of solute}$$

$$\Rightarrow \text{Mole fraction of solute} = 0.4$$

As mole fraction of solute + mole fraction of solvent = 1

$$\text{Hence, mole fraction of solvent} = 1 - 0.4 = 0.6$$

24. (b) As $\Delta T_f = K_f \cdot m$

$$\Delta T_b = K_b \cdot m$$

$$\text{Hence, we have } m = \frac{\Delta T_f}{K_f} = \frac{\Delta T_b}{K_b}$$

$$\text{or } \Delta T_f = \Delta T_b \frac{K_f}{K_b}$$

$$\Rightarrow [\Delta T_b = 100.18 - 100 = 0.18^\circ\text{C}]$$

$$= 0.18 \times \frac{1.86}{0.512} = 0.654^\circ\text{C}$$

As the Freezing Point of pure water is 0°C ,

$$\Delta T_f = 0 - T_f$$

$$0.654 = 0 - T_f$$

$$\therefore T_f = -0.654$$

Thus the freezing point of solution will be -0.654°C .

25. (d) $\Delta T_f = K_f \times m$

$$M = \frac{1000 \times K_f \times w_2 (\text{solute})}{\Delta T_f \times w_1 (\text{solvent})}$$

$$= \frac{1000 \times 1.86 \times 1.8}{0.465 \times 40} \Rightarrow M = 180$$

Molecular formula = (empirical formula)_n

$$n = \frac{\text{Molecular mass}}{\text{Empirical formula mass}} = \frac{180}{30} = 6$$

Molecular formula = $(\text{CH}_2\text{O})_6 = \text{C}_6\text{H}_{12}\text{O}_6$.

26. (d) Colligative properties depends upon the no. of particles. Since methanol is non electrolyte hence cannot be considered.

Type B : Assertion Reason Questions

27. (a) A molecular mass of benzoic acid is found high because of dimerisation of benzoic acid.
28. (a) In polar solvent, acetic acid will dissociate leading to greater depression in freezing point.

29. (c) A is true. Pressure inside the cell increases due to osmosis. Water enters the cell because concentration is higher inside the cell. This results in lowering of concentration of medium inside the cell. So, A is true but R is false.

30. (a) A is true and B is also true and B is correct explanation of A.

31. (b) Both assertion and reason are correct but reason is not the correct explanation of assertion.

The relationship between lowering of vapour pressure and osmotic pressure can be derived as follows:

Van't Hoff equation for dilute solutions is

$$\pi = \frac{n}{V} RT \quad \dots(i)$$

In case of a dilute solution, the volume of solution can be taken as equal to that of solvent. If N is the number of moles of solvent of molecular weight M and density ρ , the volume V is given by

$$V = \frac{NM}{\rho} \quad \dots(ii)$$

$$\text{or } \frac{n}{N} = \frac{\pi M}{\rho RT} \quad \dots(iii)$$

From Raoult's law,

$$\frac{P^\circ - P}{P^\circ} = \frac{n}{N} \quad \dots(iv)$$

$$\therefore \frac{P^\circ - P}{P^\circ} = \frac{\pi M}{\rho RT} \quad [\text{From (iii) and (iv)}]$$

$$\text{or } (P^\circ - P) = \frac{\pi M}{\rho RT} \times P^\circ$$

The factor $\frac{MP^\circ}{\rho RT}$ is constant at constant temperature.

$$\therefore (P^\circ - P) \propto \pi$$

or lowering of V.P. $\propto$ osmotic pressure

Thus assertion is correct.

Osmotic pressure is a colligative property is correct.

32. (c) Both the solute and solvent will form the vapours but vapour phase will become richer in the more volatile component.

33. (b)

TYPE A : MULTIPLE CHOICE QUESTIONS

- Effect of dilution on conductivity of solution:
(a) Increases (b) Decreases [1998]
(c) Unchanged (d) None of the above
- Through a solution of CuSO_4 a current of 3 amperes was passed for 2 hours. At cathode 3 g of Cu^{2+} ions were discharged. The current efficiency is [At. wt. of Cu = 63.5] [1998]
(a) 33.3% (b) 42.2%
(c) 48.7% (d) 54.4%
- Which shows electrical conductance? [1999]
(a) Sodium (b) Diamond
(c) Potassium (d) Graphite
- Which cannot displace hydrogen from its compound? [1999]
(a) Al (b) Fe
(c) Hg (d) Pb
- For reducing one mole of $\text{Cr}_2\text{O}_7^{2-}$ to Cr^{3+} the charge required is : [2000]
(a) 3×96500 coulomb (b) 6×96500 coulomb
(c) 0.3 Faradays (d) 0.6 Faradays
- Which of the following reactions is used to make a fuel cell? [2003]
(a) $\text{Cd(s)} + 2\text{Ni(OH)}_3\text{(s)} \longrightarrow \text{CdO(s)} + 2\text{Ni(OH)}_2\text{(s)} + \text{H}_2\text{O(l)}$
(b) $\text{Pb(s)} + \text{PbO}_2\text{(s)} + 2\text{H}_2\text{SO}_4\text{(aq)} \longrightarrow 2\text{PbSO}_4\text{(s)} + 2\text{H}_2\text{O(l)}$
(c) $2\text{H}_2\text{(g)} + \text{O}_2\text{(g)} \longrightarrow 2\text{H}_2\text{O(l)}$
(d) $2\text{Fe(s)} + \text{O}_2\text{(g)} + 4\text{H}^+\text{(aq)} \longrightarrow 2\text{Fe}^{2+}\text{(aq)} + 2\text{H}_2\text{O(l)}$
- Time required to deposit one millimole of aluminium metal by the passage of 9.65 amperes through aqueous solution of aluminium ion is
(a) 30 s (b) 10 s [2003]
(c) 30,000 s (d) 10,000 s
- Which of the following statements is true for the electrochemical Daniel cell? [2004]
(a) Electrons flow from copper electrode to zinc electrode
(b) Current flows from zinc electrode to copper electrode
(c) Cations move toward copper electrode
(d) Cations move toward zinc electrode
- The chemical reaction,
 $2\text{AgCl}_{(\text{s})} + \text{H}_{2(\text{g})} \rightarrow 2\text{HCl}_{(\text{aq})} + 2\text{Ag}_{(\text{s})}$
taking place in a galvanic cell is represented by the notation : [2005]
(a) $\text{Pt}_{(\text{s})} | \text{H}_{2(\text{g})}, 1 \text{ bar} | 1 \text{ M KCl}_{(\text{aq})} | \text{AgCl}_{(\text{s})} | \text{Ag}_{(\text{s})}$
(b) $\text{Pt}_{(\text{s})} | \text{H}_{2(\text{g})}, 1 \text{ bar} | 1 \text{ M HCl}_{(\text{aq})} | 1\text{MAg}^+_{(\text{aq})} | \text{Ag}_{(\text{s})}$
(c) $\text{Pt}_{(\text{s})} | \text{H}_{2(\text{g})}, 1 \text{ bar} | 1 \text{ M HCl}_{(\text{aq})} | \text{AgCl}_{(\text{s})} | \text{Ag}_{(\text{s})}$
(d) $\text{Pt}_{(\text{s})} | \text{H}_{2(\text{g})}, 1 \text{ bar} | 1 \text{ M HCl}_{(\text{aq})} | \text{Ag}_{(\text{s})} | \text{AgCl}_{(\text{s})}$
- The charge required for the reduction of 1 mol of MnO_4^- to MnO_2 is : [2006]
(a) 1F (b) 3F
(c) 5F (d) 6F
- The products formed when an aqueous solution of NaBr is electrolysed in a cell having inert electrodes are: [2006]
(a) Na and Br_2
(b) Na and O_2
(c) H_2 , Br_2 and NaOH
(d) H_2 and O_2
- The emf of Daniell cell at 298 K is E_1 [2008]
 $\text{Zn} | \text{ZnSO}_4 (0.01 \text{ M}) || \text{CuSO}_4 (1.0 \text{ M}) | \text{Cu}$
When the concentration of ZnSO_4 is 1.0 M and that of CuSO_4 is 0.01 M, the emf changed to E_2
What is the relation between E_1 and E_2 ?
(a) $E_1 = E_2$ (b) $E_2 = 0 \neq E_1$
(c) $E_1 > E_2$ (d) $E_1 < E_2$

C-100

Topicwise AIIMS Solved Papers – CHEMISTRY

13. Equivalent conductance of an electrolyte containing NaF at infinite dilution is $90.1 \text{ Ohm}^{-1}\text{cm}^2$. If NaF is replaced by KF what is the value of equivalent conductance? [2009]
 (a) $90.1 \text{ Ohm}^{-1}\text{cm}^2$ (b) $111.2 \text{ Ohm}^{-1}\text{cm}^2$
 (c) 0 (d) $222.4 \text{ Ohm}^{-1}\text{cm}^2$
14. For a cell reaction involving two electron change, the standard EMF of the cell is 0.295 V at 2°C . The equilibrium constant of the reaction at 25°C will be [2010]
 (a) 29.5×10^{-2} (b) 10
 (c) 1×10^{10} (d) 2.95×10^{-10}
15. A 0.5 M NaOH solution offers a resistance of 31.6 ohm in a conductivity cell at room temperature. What shall be the approximate molar conductance of this NaOH solution if cell constant of the cell is 0.367 cm^{-1} . [2010]
 (a) $234 \text{ S cm}^2 \text{ mole}^{-1}$ (b) $23.2 \text{ S cm}^2 \text{ mole}^{-1}$
 (c) $4645 \text{ S cm}^2 \text{ mole}^{-1}$ (d) $5464 \text{ S cm}^2 \text{ mole}^{-1}$
16. Molar conductances of BaCl_2 , H_2SO_4 and HCl at infinite dilutions are x_1 , x_2 and x_3 respectively. Equivalent conductance of BaSO_4 at infinite dilution will be: [2011]
 (a) $(x_1 + x_2 - x_3)/2$ (b) $x_1 + x_2 - 2x_3$
 (c) $(x_1 - x_2 - x_3)/2$ (d) $(x_1 + x_2 - 2x_3)/2$
17. Given that $E^\circ_{\text{K}^+/\text{K}} = -2.93 \text{ V}$;
 $E^\circ_{\text{Fe}^{2+}/\text{Fe}} = -0.44 \text{ V}$; $E^\circ_{\text{Zn}^{2+}/\text{Zn}} = -0.76 \text{ V}$;
 $E^\circ_{\text{Cu}^{2+}/\text{Cu}} = 0.34 \text{ V}$
 Based on this data, which of the following is the strongest reducing agent? [2011]
 (a) $\text{Cu}_{(\text{s})}$ (b) $\text{K}^+_{(\text{aq})}$
 (c) $\text{Zn}^{2+}_{(\text{aq})}$ (d) $\text{Fe}_{(\text{s})}$
18. The cell constant of a given cell is 0.47 cm^{-1} . The resistance of a solution placed in this cell is measured to be 31.6 ohm . The conductivity of the solution (in S cm^{-1} where S has usual meaning) is [2012]
 (a) 0.15 (b) 1.5
 (c) 0.015 (d) 150
19. The standard reduction potentials at 298 K for the following half reactions are given against each
 $\text{Zn}^{2+}(\text{aq}) + 2\text{e}^- \rightleftharpoons \text{Zn}(\text{s}); -0.762 \text{ V}$
 $\text{Cr}^{3+}(\text{aq}) + 3\text{e}^- \rightleftharpoons \text{Cr}(\text{s}); -0.740 \text{ V}$
 $2\text{H}^+(\text{aq}) + 2\text{e}^- \rightleftharpoons \text{H}_2(\text{g}); 0.00 \text{ V}$
 $\text{Fe}^{3+}(\text{aq}) + \text{e}^- \rightleftharpoons \text{Fe}^{2+}(\text{aq}); 0.770 \text{ V}$
 Which is the strongest reducing agent? [2013]
 (a) $\text{Zn}(\text{s})$ (b) $\text{Cr}(\text{s})$
 (c) $\text{H}_2(\text{g})$ (d) $\text{Fe}^{3+}(\text{aq})$
20. A 1.0 M with respect to each of the metal halides AX_3 , BX_2 , CX_3 and DX_2 is electrolysed using platinum electrodes. If
 $E^\circ_{\text{A}^{3+}/\text{A}} = 1.50 \text{ V}$, $E^\circ_{\text{B}^{2+}/\text{B}} = 0.3 \text{ V}$,
 $E^\circ_{\text{C}^{3+}/\text{C}} = -0.74 \text{ V}$, $E^\circ_{\text{D}^{2+}/\text{D}} = -2.37 \text{ V}$.
 The correct sequence in which the various metals are deposited at the cathode is [2014]
 (a) A, B, C, D (d) A, B, C
 (c) D, C, B, A (b) C, B, A
21. A hydrogen electrode is immersed in a solution with $\text{pH} = 0$ (HCl). By how much will the potential (reduction) change if an equivalent amount of NaOH is added to the solution.
 (Take $p_{\text{H}_2} = 1 \text{ atm}$), $T = 298 \text{ K}$. [2015]
 (a) increase by 0.41 V (b) increase by 59 mV
 (c) decrease by 0.41 V (d) decrease by 59 mV
22. Given that the standard reduction potentials for M^+/M and N^+/N electrodes at 298 K are 0.52 V and 0.25 V respectively. Which of the following is correct in respect of the following electrochemical cell?
 $\text{M}/\text{M}^+ || \text{N}^+/\text{N}$ [2016]
 (a) The overall cell reaction is a spontaneous reaction.
 (b) The standard EMF of the cell is -0.27 V .
 (c) The standard EMF of the cell is 0.77 V .
 (d) The standard EMF of the cell is -0.77 V .
23. On the basis of the following E° values, the strongest oxidizing agent is: [2017]
 $[\text{Fe}(\text{CN})_6]^{4-} \rightarrow [\text{Fe}(\text{CN})_6]^{3-} + \text{e}^-; E^\circ = -0.35 \text{ V}$
 $\text{Fe}^{2+} \rightarrow \text{Fe}^{3+} + \text{e}^-; E^\circ = -0.77 \text{ V}$
 (a) $[\text{Fe}(\text{CN})_6]^{4-}$ (b) Fe^{2+}
 (c) Fe^{3+} (d) $[\text{Fe}(\text{CN})_6]^{3-}$
24. Consider the following cell reaction: [2017]
 $2\text{Fe}(\text{s}) + \text{O}_2(\text{g}) + 4\text{H}^+(\text{aq}) \rightarrow$
 $2\text{Fe}^{2+}(\text{aq}) + 2\text{H}_2\text{O}(\text{l}); E^\circ = 1.67 \text{ V}$
 At $[\text{Fe}^{2+}] = 10^{-3} \text{ M}$, $p(\text{O}_2) = 0.1 \text{ atm}$ and $\text{pH} = 3$, the cell potential at 25°C is
 (a) 1.47 V (b) 1.77 V
 (c) 1.87 V (d) 1.57 V

TYPE B : ASSERTION REASON QUESTIONS

Directions for (Qs. 25-32) : These questions consist of two statements, each printed as Assertion and Reason. While answering these questions, you are required to choose any one of the following five responses.

- (a) If both Assertion and Reason are correct and the Reason is a correct explanation of the Assertion.
- (b) If both Assertion and Reason are correct but Reason is not a correct explanation of the Assertion.
- (c) If the Assertion is correct but Reason is incorrect.
- (d) If both the Assertion and Reason are incorrect.
- (e) If the Assertion is incorrect but the Reason is correct.

25. **Assertion:** Electrical conductivity of copper increases with increase in temperature

Reason: The electrical conductivity of metals is due to motion of electrons. [1998]

26. **Assertion :** A small amount of acid or alkali is added before electrolysis of water.

Reason : Pure water is weak electrolyte. [1999]

27. **Assertion :** Copper reacts with HCl and liberates hydrogen.

Reason : Hydrogen is present above Cu in the reactivity series. [2000]

28. **Assertion :** Copper metal gets readily corroded in an acidic aqueous solution.

Reason : Free energy change for this process is positive. [2004]

29. **Assertion :** Galvanised iron does not rust.

Reason : Zinc has a more negative electrode potential than iron. [2005]

30. **Assertion :** E° for $\text{Mn}^{3+}/\text{Mn}^{2+}$ is more positive than $\text{Cr}^{3+}/\text{Cr}^{2+}$

Reason : The third ionization energy of Mn is larger than that of Cr. [2006]

31. **Assertion :** For the Daniel cell, $\text{Zn}|\text{Zn}^{2+}||\text{Cu}^{2+}|\text{Cu}$ with, $E_{\text{cell}} = 1.1 \text{ V}$, the application of opposite potential greater than 1.1 V results into flow of electron from cathode to anode.

Reason : Zn is deposited at anode, and Cu is deposited at cathode. [2006]

32. **Assertion :** The cell potential of mercury cell is 1.35V, which remains constant.

Reason : In mercury cell, the electrolyte is a paste of KOH and ZnO. [2008]

Directions for (Qs.33-37) : Each of these questions contains an Assertion followed by Reason. Read them carefully and answer the question on the basis of following options. You have to select the one that best describes the two statements.

- (a) If both Assertion and Reason are correct and Reason is the correct explanation of Assertion.
- (b) If both Assertion and Reason are correct, but Reason is not the correct explanation of Assertion.
- (c) If Assertion is correct but Reason is incorrect.
- (d) If both the Assertion and Reason are incorrect.

33. **Assertion :** If $\lambda^\circ_{\text{Na}^+}$ and $\lambda^\circ_{\text{Cl}^-}$ are molar limiting conductivity of sodium and chloride ions respectively, then the limiting molar conductivity for sodium chloride is given by the equation :

$$\Lambda^\circ_{\text{NaCl}} = \lambda^\circ_{\text{Na}^+} + \lambda^\circ_{\text{Cl}^-}$$

Reason : This is according to Kohlrausch law of independent migration of ions. [2011]

34. **Assertion :** On increasing dilution, the specific conductance keep on increasing.

Reason : On increasing dilution, degree of ionisation of weak electrolyte increases and molality of ions also increases. [2014]

35. **Assertion :** During electrolysis of $\text{CuSO}_4(\text{aq})$ using copper electrodes, copper is dissolved at anode and deposited at cathode.

Reason : Oxidation takes place at anode and reduction at cathode. [2014]

36. **Assertion :** On increasing dilution, the specific conductance keep on increasing.

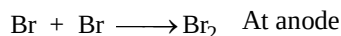
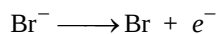
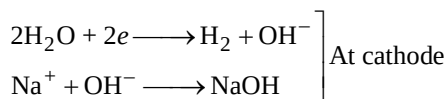
Reason : On increasing dilution, degree of ionisation of weak electrolyte increases and molality of ions also increases. [2015, 2016]

37. **Assertion :** Zinc can be used while copper cannot be used in the recovery of Ag from the complex $[\text{Ag}(\text{CN})_2]^-$. [2017]

Reason : Zinc is a powerful reducing agent than copper.

10. (b) $\text{MnO}_4^- + 4\text{H}^+ + 3\text{e}^- \longrightarrow \text{MnO}_2 + 2\text{H}_2\text{O}$
So, 3 F of charge will be required to reduce 1 mole of MnO_4^- .

11. (c) $\text{NaBr} \rightleftharpoons \text{Na}^+ + \text{Br}^-$



So the products are H_2 and NaOH (at cathode) and Br_2 (at anode)

12. (c) Using the relation

$$\begin{aligned} E_{\text{cell}} &= E_{\text{cell}}^0 - \frac{0.0591}{n} \log \frac{[\text{anode}]}{[\text{cathode}]} \\ &= E_{\text{cell}}^0 - \frac{0.0591}{n} \log \frac{[\text{Zn}^{2+}]}{[\text{Cu}^{2+}]} \end{aligned}$$

Substituting the given values in two cases.

$$\begin{aligned} E_1 &= E^0 - \frac{0.0591}{2} \log \frac{0.01}{1.0} \\ &= E^0 - \frac{0.0591}{2} \log 10^{-2} \\ &= E^0 + \frac{0.0591}{2} \times 2 \quad \text{or} \quad (E^0 + 0.0591)\text{V} \end{aligned}$$

$$\begin{aligned} E_2 &= E^0 - \frac{0.0591}{2} \log \frac{1}{0.01} \\ &= E^0 - \frac{0.0591}{2} \log 10^2 \\ &= E^0 - \frac{2 \times 0.0591}{2} \quad \text{or} \quad (E^0 - 0.0591)\text{V} \end{aligned}$$

Thus, $E_1 > E_2$

13. (a) Because at infinite dilution the equivalent conductance of strong electrolytes furnishing same number of ions is same.

14. (c) Using the relation,

$$E_{\text{cell}}^0 = \frac{2.303RT}{nF} \log K_c = \frac{0.0591}{n} \log K_c$$

$$\therefore 0.295\text{V} = \frac{0.0591}{2} \log K_c$$

$$\text{or } \log K_c = \frac{2 \times 0.295}{0.0591} = 10$$

$$\text{or } K_c = 1 \times 10^{10}$$

15. (b) Here, $R = 31.6\text{ ohm}$

$$\therefore C = \frac{1}{R} = \frac{1}{31.6} \text{ ohm}^{-1} = 0.0316 \text{ ohm}^{-1}$$

Specific conductance

= conductance $\times$ cell constant

$$= 0.0316 \text{ ohm}^{-1} \times 0.367 \text{ cm}^{-1}$$

$$= 0.0116 \text{ ohm}^{-1} \text{ cm}^{-1}$$

Now, molar concentration = 0.5 M (given)

$$= 0.5 \times 10^{-3} \text{ mole cm}^{-3}$$

$$\therefore \text{Molar conductance} = \frac{k}{\text{molar conc.}}$$

$$\begin{aligned} &= \frac{0.0116}{0.5 \times 10^{-3}} \\ &= 23.2 \text{ S cm}^2 \text{ mol}^{-1} \end{aligned}$$

16. (d) $\lambda_m^\infty(\text{BaSO}_4) = \lambda_{\text{Ba}^{2+}}^\infty + \lambda_{\text{SO}_4^{2-}}^\infty$
 $= \lambda_m^\infty(\text{BaCl}_2) + \lambda_m^\infty(\text{H}_2\text{SO}_4) - 2\lambda_{\text{HCl}}^\infty$
 $= x_1 + x_2 - 2x_3; \quad \lambda_e^\circ = \frac{1}{2} \lambda_m^\circ(\text{BaSO}_4)$

17. (d) $\text{K}_{(\text{aq})}^+$ and $\text{Zn}_{(\text{aq})}^{2+}$ can not lose electron(s). Fe has greater tendency to lose electrons than Cu.

$$[E_{\text{Fe}/\text{Fe}^{2+}}^\circ = 0.44\text{V} > E_{\text{Cu}/\text{Cu}^{2+}}^\circ = -0.34\text{V}]$$

18. (c) $k = \frac{1}{R} \times \text{Cell constant} = \frac{0.47}{31.6} = 0.01487$

19. (a) Since oxidation potential of Zn is highest hence strongest reducing agent.

20. (b) The more the reduction potential, the more is the deposition of metals at cathode. Cation having E° value less than -0.83V (reduction potential of H_2O) will not deposit from aqueous solution.

21. (c) pH changes from 0 to 7.

$\therefore [\text{H}^+]$ changes from 1 to 10^{-7}M .

$$\text{Accordingly } E_{\text{red.}} = \frac{-0.059}{n} \log \frac{1}{[\text{H}^+]}$$

$$= 0.059 \log 10^{-7}$$

$$\text{i.e., } 0.059 \times (-7) = -0.41 \text{ volt.}$$

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22. (b) $E_{\text{cell}}^{\circ} = E_{\text{cathode}}^{\circ} - E_{\text{anode}}^{\circ} = E_{\text{right}}^{\circ} - E_{\text{left}}^{\circ}$

$$E_{\text{cell}}^{\circ} = 0.25 - 0.52 = -0.27\text{V}$$

23. (c) From the given data we find Fe^{3+} is strongest oxidising agent. More the positive value of E° , more is the tendency to get oxidized. Thus correct option is (c).

24. (d) Here $n = 4$, and $[\text{H}^{+}] = 10^{-3}$ (as $\text{pH} = 3$)

Applying Nernst equation

$$\begin{aligned} E &= E^{\circ} - \frac{0.059}{n} \log \frac{[\text{Fe}^{2+}]^2}{[\text{H}^{+}]^4 (\text{pO}_2)} \\ &= 1.67 - \frac{0.059}{4} \log \frac{(10^{-3})^2}{(10^{-3})^4 \times 0.1} \\ &= 1.67 - \frac{0.059}{4} \log 10^7 \\ &= 1.67 - 0.103 = 1.567 \end{aligned}$$

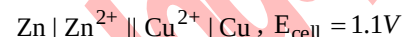
Type B : Assertion Reason Questions

25. (e) Electrical conductivity of every metal decreases with increase in temperature due to increase in molecular motion which increases resistance.
26. (a) Water is a covalent compound, hence pure water is a weak electrolyte and feebly ionised and thus bad conductor of electricity. However, addition of a small amount of acid or alkali increases ionisation of water making it good conductor of electricity.
27. (e) Copper does not liberate hydrogen from HCl because copper is above hydrogen in reactivity series.
28. (d) Copper lies below hydrogen in electrochemical series so it cannot displace H_2 from dilute acids. Hence it is not easily corroded in acidic solutions. Further, corrosion is a spontaneous process for which free energy change must be negative.
29. (a) Galvanised iron does not rust easily because zinc (which is present in the form of coating) has more negative electrode

potential (-0.76V) than iron (-0.41V) i.e., Zn is less reactive than Fe.

30. (a) Reduction potential of Mn^{3+} is more than Cr^{3+} . So, Mn^{3+} is easily reduced in comparison with Cr^{3+} or Cr^{2+} is easily oxidised than Mn^{2+} . Hence Mn^{2+} will lose electrons with difficulty or ionisation potential of Mn^{2+} is more than Cr^{2+} . Both A and R are true.

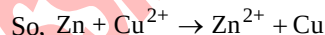
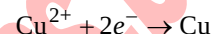
31. (a) In a Daniel cell,



The oxidation half cell is



The reduction half cell is



Thus here Zn is oxidised and deposited at anode, and Cu is reduced and deposited at cathode. If the opposite potential is greater than 1.1 V, then electrons flow from cathode to anode. So both A and R are correct.

32. (b) $\text{Zn(l)} + \text{HgO(s)} \rightarrow \text{Zn(s)} + \text{Hg(l)}$

The cell potential remains constant during its life as the overall reaction does not involve any ion in solution whose concentration changes during its life time.

33. (a) According to Kohlrausch law, "limiting molar conductivity of an electrolyte can be represented as the sum of the individual contributions of the anion and cation of the electrolyte."
34. (d) The specific conductivity decreases while equivalent and molar conductivities increase with dilution.
35. (a) At cathode : $\text{Cu}^{2+}(\text{aq}) + 2e^{-} \rightarrow \text{Cu(s)}$
(Reduction)
At anode : $\text{Cu(s)} \rightarrow \text{Cu}^{2+}(\text{aq}) + 2e^{-}$
(Oxidation)
36. (d) The specific conductivity decreases while equivalent and molar conductivities increase with dilution.
37. (a)

TYPE A : MULTIPLE CHOICE QUESTIONS

1. The rate constant of first order reaction is 3×10^{-6} per second. The initial concentration is 0.10 M. The initial rate is: [1998]

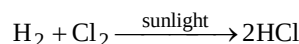
(a) 3×10^{-7} mol/litre/sec
 (b) 3×10^{-8} mol/litre/sec
 (c) 3×10^{-5} mol/litre/sec
 (d) 3×10^{-8} mol/litre/sec

2. Which of the following statement is true for the reaction, $\text{H}_2 + \text{Br}_2 \rightarrow 2\text{HBr}$. The rate law is

$$\frac{dx}{dt} = k[\text{H}_2][\text{Br}_2]^{1/2}; \quad [2000]$$

(a) order of reaction is 1.5
 (b) molecularity of the reaction is 2
 (c) by increasing the concentration of Br_2 four times the rate of reaction is doubled
 (d) all the above are correct.

3. For the reaction :

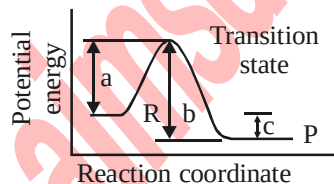


the order of reaction is

(a) 0 (b) 2
 (c) 1 (d) 3 [2002]

4. The potential energy diagram for a reaction

$\text{R} \longrightarrow \text{P}$ is given below

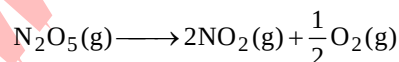


ΔH° of the reaction corresponds to the energy :

[2003]

(a) a (b) b
 (c) c (d) a + b

5. The rate constant k , for the reaction



is $1.3 \times 10^{-2}\text{s}^{-1}$. Which equation given below describes the change of $[\text{N}_2\text{O}_5]$ with time ? $[\text{N}_2\text{O}_5]_0$ and $[\text{N}_2\text{O}_5]_t$ correspond to concentration of N_2O_5 initially and at time t .

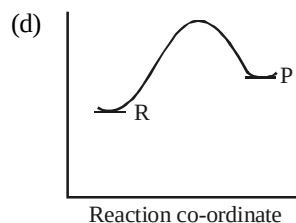
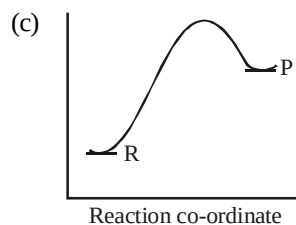
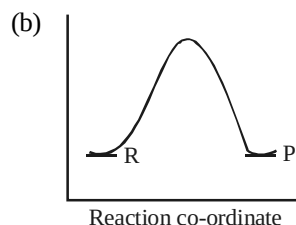
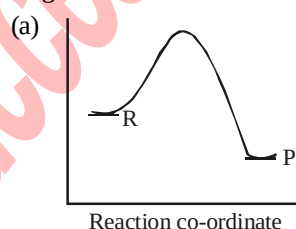
(a) $[\text{N}_2\text{O}_5]_t = [\text{N}_2\text{O}_5]_0 + kt$ [2004]

(b) $[\text{N}_2\text{O}_5]_0 = [\text{N}_2\text{O}_5]_t e^{kt}$

(c) $\log [\text{N}_2\text{O}_5]_t = \log [\text{N}_2\text{O}_5]_0 + kt$

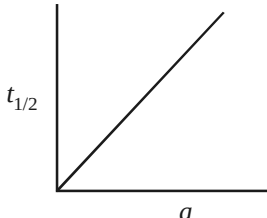
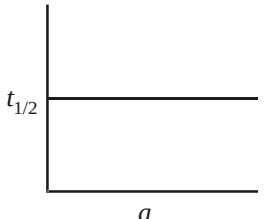
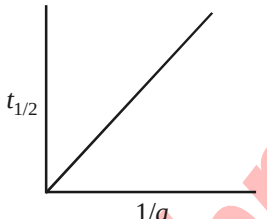
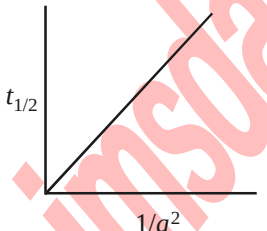
(d) $\log \frac{[\text{N}_2\text{O}_5]_0}{[\text{N}_2\text{O}_5]_t} = kt$

6. An endothermic reaction with high activation energy for the forward reaction is given by the diagram : [2005]



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7. For reaction $aA \rightarrow xP$, when $[A] = 2.2 \text{ mM}$, the rate was found to be 2.4 mM s^{-1} . On reducing concentration of A to half, the rate changes to 0.6 mM s^{-1} . The order of reaction with respect to A is : [2005]
- (a) 1.5 (b) 2.0
(c) 2.5 (d) 3.0
8. Which of the following graphs represent relation between initial concentration of reactants and half-life for third order reaction?
- (a) 
- (b) 
- (c) 
- (d) 
9. For the reaction,

$$2\text{N}_2\text{O}_5 \longrightarrow 4\text{NO}_2 + \text{O}_2$$
the rate of reaction is : [2006]
- (a) $\frac{1}{2} \frac{d}{dt} [\text{N}_2\text{O}_5]$ (b) $2 \frac{d}{dt} [\text{N}_2\text{O}_5]$
(c) $\frac{1}{4} \frac{d}{dt} [\text{NO}_2]$ (d) $4 \frac{d}{dt} [\text{NO}_2]$
10. For a first order reaction, to obtain a positive slope, we need to plot {where $[A]$ is the concentration of reactant A} [2008]
- (a) $-\log_{10}[A]$ vs t (b) $-\log_e[A]$ vs t
(c) $\log_{10}[A]$ vs $\log t$ (d) $[A]$ vs t
11. T_{50} of first -order reaction is 10 min. Starting with 10 mol L^{-1} , rate after 20 min is [2008]
- (a) $0.0693 \text{ mol L}^{-1} \text{ min}^{-1}$
(b) $0.0693 \times 2.5 \text{ mol L}^{-1} \text{ min}^{-1}$
(c) $0.0693 \times 5 \text{ mol L}^{-2} \text{ min}^{-1}$
(d) $0.0693 \times 10 \text{ mol L}^{-1} \text{ min}^{-1}$
12. The first order rate constant for a certain reaction increases from $1.667 \times 10^{-6} \text{ s}^{-1}$ at 727°C to $1.667 \times 10^{-4} \text{ s}^{-1}$ at 1571°C . The rate constant at 1150°C , assuming constancy of activation energy over the given temperature range is [Given : $\log 19.9 = 1.299$] [2009]
- (a) $3.911 \times 10^{-5} \text{ s}^{-1}$ (b) $1.139 \times 10^{-5} \text{ s}^{-1}$
(c) $3.318 \times 10^{-5} \text{ s}^{-1}$ (d) $1.193 \times 10^{-5} \text{ s}^{-1}$
13. In most cases, for a rise of 10K temperature the rate constant is doubled to tripled. This is due to the reason that [2011]
- (a) collision frequency increases by a factor of 2 to 3.
(b) fraction of molecules possessing threshold energy increases by a factor of 2 to 3
(c) Activation energy is lowered by a factor of 2 to 3.
(d) none of these
14. The rate constant for the reaction,

$$2\text{N}_2\text{O}_5 \longrightarrow 4\text{NO}_2 + \text{O}_2$$
is $3.0 \times 10^{-4} \text{ s}^{-1}$. If start made with 1.0 mol L^{-1} of N_2O_5 , calculate the rate of formation of NO_2 at the moment of the reaction when concentration of O_2 is 0.1 mol L^{-1} . [2011]
- (a) $2.7 \times 10^{-4} \text{ mol L}^{-1} \text{ s}^{-1}$
(b) $2.4 \times 10^{-4} \text{ mol L}^{-1} \text{ s}^{-1}$
(c) $4.8 \times 10^{-4} \text{ mol L}^{-1} \text{ s}^{-1}$
(d) $9.6 \times 10^{-4} \text{ mol L}^{-1} \text{ s}^{-1}$

15. A reaction which is of first order w.r.t. reactant A, has a rate constant 6 min^{-1} . If we start with $[A] = 0.5 \text{ mol L}^{-1}$, when would $[A]$ reach the value of 0.05 mol L^{-1} [2013]
 (a) 0.384 min (b) 0.15 min
 (c) 3 min (d) 3.84 min
16. Half-lives of a first order and a zero order reaction are same. Then the ratio of the initial rates of first order reaction to that of the zero order reaction is [2014]
 (a) $\frac{1}{0.693}$ (b) 2×0.693
 (c) 0.693 (d) $\frac{2}{0.693}$
17. Select the rate law that corresponds to the data shown for the following reaction $A + B \longrightarrow C$ [2012, 2015]
- | Expt. No. | (A) | (B) | Initial Rate |
|-----------|-------|-------|--------------|
| 1 | 0.012 | 0.035 | 0.10 |
| 2 | 0.024 | 0.070 | 0.80 |
| 3 | 0.024 | 0.035 | 0.10 |
| 4 | 0.012 | 0.070 | 0.80 |
- (a) $\text{Rate} = k[B]^3$ (b) $\text{Rate} = k[B]^4$
 (c) $\text{Rate} = k[A][B]^3$ (d) $\text{Rate} = k[A]^2[B]^2$
18. Collision theory is used to explain how chemical species undergo a reaction. Using this theory and the kinetic molecular model, which of the following does NOT influence the rate of a chemical reaction? [2016]
 (a) The temperature of the system
 (b) The geometry or orientation of the collision
 (c) The velocity of the reactants at the point of collision
 (d) All of the above influence the rate
19. For the following reaction: $\text{NO}_2(\text{g}) + \text{CO}(\text{g}) \rightarrow \text{NO}(\text{g}) + \text{CO}_2(\text{g})$, the rate law is: $\text{Rate} = k[\text{NO}_2]^2$. If 0.1 mole of gaseous carbon monoxide is added at constant temperature to the reaction mixture which of the following statements is true? [2016]
 (a) Both k and the reaction rate remain the same
 (b) Both k and the reaction rate increase
 (c) Both k and the reaction rate decrease
 (d) Only k increases, the reaction rate remain the same
20. Which of the following relation represents correct relation between standard electrode potential and equilibrium constant? [2017]
 I. $\log K = \frac{nFE^\circ}{2.303 RT}$
 II. $K = e^{\frac{nFE^\circ}{RT}}$
 III. $\log K = \frac{nFE^\circ}{2.303 RT}$
 IV. $\log K = 0.4342 \frac{nFE^\circ}{RT}$
 Choose the correct statement(s).
 (a) I, II and III are correct
 (b) II and III are correct
 (c) I, II and IV are correct
 (d) I and IV are correct

TYPE B : ASSERTION REASON QUESTIONS

Directions for (Qs. 21-26) : These questions consist of two statements, each printed as Assertion and Reason. While answering these questions, you are required to choose any one of the following five responses.

- (a) If both Assertion and Reason are correct and the Reason is a correct explanation of the Assertion.
 (b) If both Assertion and Reason are correct but Reason is not a correct explanation of the Assertion.
 (c) If the Assertion is correct but Reason is incorrect.
 (d) If both the Assertion and Reason are incorrect.
 (e) If the Assertion is incorrect but the Reason is correct.

21. **Assertion :** According to transition state theory for the formation of an activated complex, one of the vibrational degree of freedom is converted into a translational degree of freedom.

Reason : Energy of the activated complex is higher than the energy of reactant molecules.

[2006]

22. **Assertion :** The order of a reaction can have fractional value.

Reason : The order of a reaction cannot be written from balanced equation of a reaction.

[2008]

23. **Assertion :** In rate law, unlike in the expression for equilibrium constants, the exponents for concentrations do not necessarily match the stoichiometric coefficients.
Reason : It is the mechanism and not the balanced chemical equation for the overall change that governs the reaction rate. [2009]
24. **Assertion :** The rate of the reaction is the rate of change of concentration of a reactant or a product.
Reason : Rate of reaction remains constant during the course of reaction. [2010]
25. **Assertion :** If the activation energy of a reaction is zero, temperature will have no effect on the rate constant. [2015]
Reason : Lower the activation energy, faster is the reaction.
26. **Assertion :** The kinetics of the reaction –
$$mA + nB + pC \longrightarrow m'X + n'Y + p'Z$$
obey the rate expression as $\frac{dX}{dt} = k[A]^m[B]^n$.
Reason : The rate of the reaction does not depend upon the concentration of C. [2011, 17]

HINTS & SOLUTIONS

Type A : Multiple Choice Questions

- (a) $\frac{dc}{dt} = k[c] = 3 \times 10^{-6} \times 0.1$
 $\frac{dc}{dt} = 3 \times 10^{-7} \text{ mol litre}^{-1} \text{ sec}^{-1}$
- (d) All the statements are correct.
 Order of reaction = $1 + \frac{1}{2} = 1.5$
 Molecularity = $1 + 1 = 2$
 $\frac{dx}{dt} \propto [\text{Br}_2]^{1/2}$
 So, reaction rate will be doubled if concentration of Br_2 is increased by 4 times.
- (a) The order of all photochemical reactions is zero as it does not depend upon the concentration of reactants.
- (c) Activation energy of forward reaction = a
 Activation energy of backward reaction = b
 $\therefore \Delta H = b - a$
 Since $b > a$, therefore reaction is exothermic
- (d) As the unit of rate constant is sec^{-1} , so the reaction is first order reaction. Hence
 $k = \frac{1}{t} = \log \frac{a}{(a-x)} \text{ or } kt = \log \frac{[\text{N}_2\text{O}_5]_0}{[\text{N}_2\text{O}_5]_t}$
- (c) Reactions which involve absorption of heat energy are called endothermic reactions. For such reactions.
 $\Sigma H_p > \Sigma H_R$
 In graphs (c) and (d), the heat of products is more than heat of reactants and thus they represent endothermic reactions. But in (d) only small amount of energy is absorbed (less difference between energy of reactants and products). Thus, (c) represents maximum activation energy.
Note : Activation energy is the excess energy that the reactant molecule must possess to cross energy barrier.
- (b) When the concentration of reactant is reduced to half its initial value, the rate is reduced by $\frac{2.4}{0.6} = 4$ times

It means, rate $\propto [\text{reactant}]^2$

So, order of reaction = 2

- (d) Graph (d) represents graph between $t_{1/2}$ and initial concentration for 3rd order reaction :

(a) Zero order reaction
 (b) 1st order reaction
 (c) 2nd order reaction.

- (c) Rate of reaction

$$= -\frac{1}{2} \frac{d[\text{N}_2\text{O}_5]}{dt} = \frac{1}{4} \frac{d[\text{NO}_2]}{dt}$$

- (b) For a first order reaction the positive slope is obtained when we plot $-\log_e [A]$ vs t .

- (b) Initial concentration = 10 mol L^{-1}
 $\therefore$ Conc. after 20 min (two half lives) = 2.5 mol L^{-1}

$$\text{Now, } k = \frac{0.693}{t_{1/2}} = \frac{0.693}{10 \text{ min}}$$

$$\text{or } 0.0693 \text{ min}^{-1}$$

$$\therefore \text{rate} = k \times [\text{reactant}]$$

$$= 0.0693 \times 2.5 \text{ mol L}^{-1} \text{ min}^{-1}$$

- (c) $\log \frac{k_2}{k_1} = \frac{E_a}{2.303R} \left[\frac{T_2 - T_1}{T_1 T_2} \right]$

$$\text{or } 2.303 \log \frac{k_2}{k_1} = \frac{E_a}{R} \left[\frac{T_2 - T_1}{T_1 T_2} \right]$$

$$2.303 \log \left[\frac{1.667 \times 10^{-4}}{1.667 \times 10^{-6}} \right] = -\frac{E_a}{R} \left[\frac{1}{1844} - \frac{1}{1000} \right]$$

$$2.303 \times 2 = \frac{E_a}{R} \times \frac{844}{1844 \times 1000} \quad \dots\dots(1)$$

$$\therefore \frac{E_a}{R} = \frac{4.606 \times 1844 \times 1000}{844}$$

$$2.303 \log \left[\frac{k_3}{1.667 \times 10^{-6}} \right] = \frac{E_a}{R} \times \frac{1423 - 1000}{1423 \times 1000}$$

$$= \frac{E_a}{R} \times \frac{423}{1423 \times 1000} \quad \dots\dots(2)$$

Dividing equation (2) by equation (1)

$$\frac{\log \left[\frac{k_3}{1.667 \times 10^{-6}} \right]}{2}$$

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$$= \frac{423}{1423 \times 1000} \times \frac{1844 \times 1000}{844}$$

$$\therefore \log \left[\frac{k_3}{1.667 \times 10^{-6}} \right]$$

$$= 2 \times \frac{423 \times 1844}{1423 \times 844} = 1.299$$

On taking Antilog, $k_3 = 19.9$

$$\therefore k_3 = 19.9 \times 1.667 \times 10^{-6} = 3.318 \times 10^{-5} \text{ s}^{-1}$$

13. (b) For a 10 K rise in temperature, collision frequency increases merely by 1 to 2% but the number of effective collisions increases by 100 to 200%.

14. (d) Mol L^{-1} of N_2O_5 reacted $= 2 \times 0.1 = 0.2$

$$[\text{N}_2\text{O}_5] \text{ left} = 1.0 - 0.2 = 0.8 \text{ mol L}^{-1}$$

$$\text{Rate of reaction} = k \times [\text{N}_2\text{O}_5]$$

$$= 3.0 \times 10^{-4} \times 0.8$$

$$= 2.4 \times 10^{-4} \text{ mol L}^{-1} \text{ s}^{-1}$$

Rate of formation of NO_2

$$= 4 \times 2.4 \times 10^{-4} = 9.6 \times 10^{-4} \text{ mol L}^{-1} \text{ s}^{-1}$$

15. (a) $t = \frac{2.303}{k} \log \frac{a}{a-x}$

$$= \frac{2.303}{6} \log \frac{0.5}{0.05} = 0.384 \text{ min.}$$

16. (b) For first order reaction,

$$\text{Rate} = kA_0 = \frac{0.693}{t_{1/2}} \cdot A_0$$

$$\text{For zero order reaction, Rate} = kA_0^0 = \frac{A_0}{2t_{1/2}}$$

Ratio in rates $= 2 \times 0.693$

17. (a) Let the rate law be $r = k[A]^x[B]^y$

$$\text{Divide (3) by (1)} \quad \frac{0.10}{0.10} = \frac{[0.024]^x [0.035]^y}{[0.012]^x [0.035]^y}$$

$$\therefore 1 = [2]^x, x = 0$$

$$\text{Divide (2) by (3)} \quad \frac{0.80}{0.10} = \frac{[0.024]^x [0.070]^y}{[0.024]^x [0.035]^y}$$

$$\therefore 8 = (2)^y, y = 3$$

$$\text{Hence rate equation, } R = k[A]^0[B]^3 = k[B]^3$$

18. (d)

19. (a) k remains constant at constant temperature and CO does not effect the rate of reaction.

20. (c) $\Delta G = -2.303 RT \log K$
 $-nFE^\circ = -2.303 RT \log K$

$$\log K = \frac{nFE^\circ}{2.303 RT}$$

$$= 0.4342 \frac{nFE^\circ}{RT} \quad \dots\dots (i)$$

$$\ln K = \frac{nFE^\circ}{RT}$$

$$K = e^{\frac{nFE^\circ}{RT}} \quad \dots\dots (ii)$$

Type B : Assertion Reason Questions

21. (b) The formation of an activated complex takes place when vibrational degree of freedom convert into a translational degree of freedom. This statement is given by transition state theory. Also the energy of activated complex is higher than the energy of reactant molecule is true but it is not the correct explanation of the assertion.

22. (b) The order of a reaction can have fractional value. Assertion is true.

The order of a reaction can not be written from balanced equation of a reaction because its value changes with pressure, temperature and concentration. It can only be determined experimentally. Thus the reason is also correct, but the reason is not the correct explanation of assertion.

23. (a) Rate law is always written according to the slowest step and thus the exponents for concentrations do not necessarily match the stoichiometric coefficients.

24. (c) Rate of reaction does not remain constant during the complete reaction because rate depends upon the concentration of reactants which decreases with time.

25. (b) According to Arrhenius equation, $k = Ae^{-E_a/RT}$

When $E_a = 0$, $k = A$.

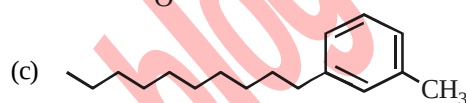
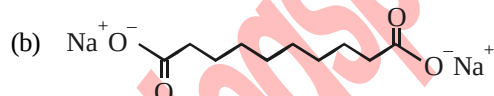
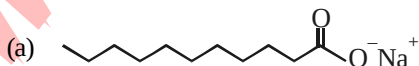
26. (a) Rate expression $\frac{dX}{dt} = k[A]^m[B]^n$ shows

that the total order of reaction is $m + n + 0 = m + n$

As the rate of reaction is independent of concentration of C, i.e., the order with respect to C is zero. This is the reason that C does not figure in the rate expression.

TYPE A : MULTIPLE CHOICE QUESTIONS

- The physical adsorption of gases on the solid surface is due to: [1998]
 - Covalent bond
 - Hydrogen bond
 - Ionic bond
 - Van der waal's forces
- The electrical charge on a colloidal particle is observed by: [1998]
 - Ultramicroscope
 - Scattering
 - Brownian movement
 - Electrophoresis
- Lyophilic colloids are stable due to: [1998]
 - Small size of the particle
 - Large size of the particle
 - Layer of dispersion medium on the particle
 - Charge on the particle
- Purple of cassius is colloidal solution of: [1999]
 - Silver
 - Lead
 - Gold
 - Mercury
- Milk is colloid in which: [2000]
 - Liquid is dispersed in liquid
 - Gas is dispersed in liquid
 - Sugar is dispersed in water
 - Solid is dispersed in liquid
- The colloid is: [2001]
 - urea
 - blood
 - cane sugar
 - NaCl
- The movement of colloidal particles, under applied electric current is known as: [2001]
 - electrodialysis
 - dialysis
 - electrophoresis
 - none of the above
- The size of colloidal particle is [2002]
 - 10^{-3} to 10^{-9} m
 - 10^{-3} to 10^{-12} m
 - 10^{-6} to 10^{-9} m
 - 10^{-12} to 10^{-19} m
- Which of the following molecules is most suitable to disperse benzene in water? [2005]



- A catalyst [2007]
 - changes the equilibrium constant
 - lowers the activation energy
 - increases the forward and backward reactions at different speeds.
 - follows same mechanism for the reaction.
- Which of the following is a lyophobic colloidal solution? [2008]
 - Aqueous starch solution
 - Aqueous protein solution
 - Gold solution
 - Polymer solvent in some organic solvents
- The density of gold is 19 g/cm^3 . If $1.9 \times 10^{-4} \text{ g}$ of gold is dispersed in one litre of water to give a sol having spherical gold particles of radius 10 nm , then the number of gold particles per mm^3 of the sol will be [2010]
 - 1.9×10^{12}
 - 6.3×10^{14}
 - 6.3×10^{10}
 - 2.4×10^6
- Which of the following electrolyte will have maximum flocculation value for $\text{Fe}(\text{OH})_3$ sol? [2010]
 - NaCl
 - Na_2S
 - $(\text{NH}_4)_3\text{PO}_4$
 - K_2SO_4
- Which of the following ions will have the minimum coagulating value for the sol obtained by adding FeCl_3 solution to slight excess of NaOH [2011]
 - SO_4^{2-}
 - $[\text{Fe}(\text{CN})_6]^{3-}$
 - Ba^{2+}
 - Al^{3+}

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Topicwise AIIMS Solved Papers – CHEMISTRY

15. Preparation of Lyophobic sols by chemical method involves [2012]
 (a) double decomposition
 (b) oxidation & reduction
 (c) hydrolysis
 (d) all of these
16. A colloidal solution is subjected to an electrical field. The particles move towards anode. The coagulation of same sol is studied using NaCl, BaCl₂ and AlCl₃ solutions. Their coagulating power should be [2013]
 (a) NaCl > BaCl₂ > AlCl₃
 (b) BaCl₂ > AlCl₃ > NaCl
 (c) AlCl₃ > BaCl₂ > NaCl
 (d) BaCl₂ > NaCl > AlCl₃
17. Under the influence of an electric field, the particles in a sol migrate towards cathode. The coagulation of the same sol is studied using NaCl, Na₂SO₄ and Na₃PO₄ solutions. Their coagulating values will be in the order [2014]
 (a) NaCl > Na₂SO₄ > Na₃PO₄
 (b) Na₂SO₄ > Na₃PO₄ > NaCl
 (c) Na₃PO₄ > Na₂SO₄ > NaCl
 (d) Na₂SO₄ > NaCl > Na₃PO₄
18. Gold numbers of protective colloids A, B, C and D are 0.50, 0.01, 0.10 and 0.005, respectively. The correct order of their protective powers is [2015]
 (a) D < A < C < B (b) C < B < D < A
 (c) A < C < B < D (d) B < D < A < C
19. The disease kala azar is caused by [2016]
 (a) colloidal antimony
 (b) milk of magnesia
 (c) argyrols
 (d) colloidal gold
20. Which one of the following impurities present in colloidal solution cannot be removed by electro dialysis? [2017]
 (a) Sodium chloride
 (b) Potassium sulphate
 (c) Urea
 (d) Calcium chloride
- (a) If both Assertion and Reason are correct and the Reason is a correct explanation of the Assertion.
 (b) If both Assertion and Reason are correct but Reason is not a correct explanation of the Assertion.
 (c) If the Assertion is correct but Reason is incorrect.
 (d) If both the Assertion and Reason are incorrect.
 (e) If the Assertion is incorrect but the Reason is correct.
21. **Assertion:** A catalyst is more effective in finely divided form.
Reason: Finely divided form has more surface area. [1998]
22. **Assertion :** Sky appears blue.
Reason : Colloidal particles of dust scatter blue light. [2000]
23. **Assertion :** Physical absorption of molecules takes place on surface only.
Reason : In this process, the bonds of the absorbed molecules are broken. [2002]
24. **Assertion :** The micelle formed by sodium stearate in water has —COO⁻ groups at the surface.
Reason : Surface tension of water is reduced by the addition of stearate. [2003]
25. **Assertion :** Aqueous gold colloidal solution is red in colour.
Reason : The colour arises due to scattering of light by colloidal gold particles. [2004]
26. **Assertion :** Alcohols are dehydrated to hydrocarbons in the presence of acidic zeolites.
Reason : Zeolites are porous catalysts. [2004]
27. **Assertion :** Colloidal solutions are stable but colloidal particles do not settle down.
Reason : Brownian movement counters the force of gravity actively on colloidal particles. [2008]
- Directions for (Qs.28-31) :** Each of these questions contains an Assertion followed by Reason. Read them carefully and answer the question on the basis of following options. You have to select the one that best describes the two statements.
- (a) If both Assertion and Reason are correct and Reason is the correct explanation of Assertion.
 (b) If both Assertion and Reason are correct, but Reason is not the correct explanation of Assertion.
 (c) If Assertion is correct but Reason is incorrect.
 (d) If both the Assertion and Reason are incorrect.

TYPE B : ASSERTION REASON QUESTIONS

Directions for (Qs. 21-27) : These questions consist of two statements, each printed as Assertion and Reason. While answering these questions, you are required to choose any one of the following five responses.

28. **Assertion :** In chemisorption, adsorption first increases with temperature and then decreases.

Reason : Heat keeps on providing more and more activation energy. [2009]

29. **Assertion :** A catalyst does not alter the equilibrium constant of a reaction.

Reason : The catalyst forms a complex with the reactants and provides an alternate path with lower energy of activation for the reaction; the forward and the backward reactions are affected to the same extent. [2010]

30. **Assertion :** The relation $\frac{x}{m} = k.p^{1/n}$ is known as Freundlich adsorption isotherm, where x is

the mass of gas adsorbed by m grams of adsorbate, p is the equilibrium pressure, k and n are constants for given system and temperature.

Reason : When several substances have same

value of $\frac{1}{n}$, the lines by which their adsorption

isotherms can be represented will meet at a point.

[2013]

31. **Assertion :** The enthalpy of physisorption is greater than chemisorption. [2016, 17]

Reason : Molecules of adsorbate and adsorbent are held by van der Waal's forces in physisorption and by chemical bonds in chemisorption.

HINTS & SOLUTIONS

Type A : Multiple Choice Questions

1. (d) Vander Waal's forces are responsible for formation of bonds in case of physical adsorption.
2. (d) The electrical change on a colloidal particle is observed by electrophoresis. Under electric field, charged particles move in a particular direction.
3. (c) Lyophilic colloids are stable due to layer of dispersion medium on the particle.
4. (c) Purple of cassius is colloidal solution of gold.
5. (a) Milk is colloid in which liquid (liquid fat) is dispersed in liquid (water).
6. (b) Blood is a colloidal solution with plasma as dispersion medium and biomolecules as colloidal particles.
7. (c) The movement of colloidal particles under applied electric potential is known as electrophoresis.
8. (c) Size of colloidal particle = 10^{-9} to 10^{-6} m.
9. (c) Benzene is non-polar and hence dissolves non-polar compounds (like dissolves like). Among the given compounds, only (c) is non-polar hence it dissolves in benzene.
10. (b) A catalyst lowers down the activation energy. Greater is decrease in activation energy, higher will be the reaction rate.
11. (c) Of the given solution the gold sol is lyophobic colloidal solution. Gold particles have very less affinity towards dispersion medium, hence its sol can be easily coagulated.
12. (d) Volume of gold present in solution

$$= \frac{\text{Mass of gold}}{\text{Density of gold}} = \frac{1.9 \times 10^{-4} \text{ g}}{19 \text{ g/cm}^3} = 0.1 \times 10^{-4} \text{ cm}^3.$$

For spherical particles of gold with radius equal to 10 nm

The volume of each particle

$$= \frac{4}{3} \pi r^3 = \frac{4}{3} \times \frac{22}{7} \times (10 \times 10^{-7} \text{ cm})^3 = \frac{88}{21} \times 10^{-18} \text{ cm}^3$$

Number of gold particles present

$$= \frac{\text{Volume of gold in solution}}{\text{Volume of each particle}}$$

$$= \frac{0.1 \times 10^{-4} \text{ cm}^3}{\frac{88}{21} \times 10^{-18} \text{ cm}^3}$$

$$= \frac{21}{88} \times 10^{13} \text{ particles}$$

$$= 2.4 \times 10^{12} \text{ particles}$$

2.4×10^{12} particles of gold are present in 1000 cm^3 (1 litre).

$\therefore$ Number of particles present per mm^3

$$= \frac{2.4 \times 10^{12}}{10^6} \quad [1 \text{ L} = 10^6 \text{ mm}^3]$$

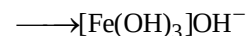
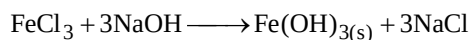
$$= 2.4 \times 10^6$$

13. (a) Flocculating value $\propto \frac{1}{(z)}$, where z = valency

of coagulating ion.

Since, $\text{Fe}(\text{OH})_3$ is a positively charged sol so it will be coagulated by negative ions considering the valencies of various negative ions used i.e., Cl^- , S^{2-} , PO_4^{3-} and SO_4^{2-} , we find that the valency of Cl^- is least so it will have maximum flocculation value i.e., NaCl.

14. (d)



The sol is negatively charged and would be coagulated most effectively by Al^{3+} .

15. (d)

16. (c) The movement towards anode shows that sol is negative. For coagulation of negative sol. Cation with higher charge is more effective.

17. (a) Since the sol particles migrate towards cathode, they are positively charged. Hence, anions would be effective in coagulation.

Greater is the valence of effective ion, smaller will be its coagulating value.

18. (c) For a protective colloid lesser the value of gold number more will be the protective power. Thus the correct order of protective power of A, B, C and D is

$\Rightarrow$ (A) < (C) < (B) < (D)
Gold number 0.50 0.10 0.01 0.005

Hence (c) is the correct answer

19. (a) Colloidal antimony is used in curing kala-azar.
20. (c) Electrodialysis involves movement of ions towards oppositely charged electrodes. Urea being a covalent compound does not dissociate to give ions and hence it cannot be removed by electrodialysis. However all the other given compounds are ionic which can undergo dissociation to give oppositely charged ions and thus can be separated.

Type B : Assertion Reason Questions

21. (a) A catalyst is more effective in finely divided form because of more surface area.
22. (a) Sky appears blue colour due to scattering of light by the colloidal particles (dust) of air. Most scattered ray is blue.
23. (d) The assertion that physical absorption of molecules takes place on surface only is false. Actually absorption takes place on the whole body. Further it is a simple physical phenomenon which involves no breaking of bond. Hence, both are false.
24. (b) The assertion that the micelle formed by sodium stearate in water has -COO^- groups at the surface is true as it is hydrophilic end. The given reason is also true but is not the correct explanation. Micelle is formed if molecules with polar and nonpolar ends assemble in the bulk.
25. (a) The colour of the gold sol is due to scattering of light by colloidal particles.
26. (b) In petroleum industry zeolites are used to convert alcohol directly to hydrocarbon by dehydrating it. Zeolites are porous catalysts but this is not the reason for its use to convert alcohol into petrol.
27. (a) The Brownian movement of particles is due to bombardment on the particles by the molecules of the dispersion medium. Thus Brownian movement does not permit the particles to settle down and induces stability of colloidal solution.
28. (c) In chemisorption, adsorption first increases with temperature and then decreases. The heat initially supplied acts as activation energy for the chemical reaction occurring between adsorbate and adsorbent.
29. (a) Catalyst has an equal effect over forward and backward reactions and hence, it does not affect the equilibrium state.
30. (c) Assertion is true, reason is false. When several lines have the same value of $\frac{1}{n}$, then the lines by which their adsorption isotherms can be represented will be parallel and will not meet at a point.
31. (d) Assertion is false but Reason is true. The enthalpy of chemisorption is of the order of 40 - 400 kJmol⁻¹ while for physical adsorption it is of the order of 20 - 40 kJmol⁻¹.

General Principles and Processes of Isolation of Elements

TYPE A : MULTIPLE CHOICE QUESTIONS

- The process does not involve a catalyst is : [1997]
 - Haber process
 - Contact process
 - Thermite process
 - Ostwald process
- Chief ore of Al is : [1997]
 - cryolite
 - bauxite
 - feldspar
 - kaolin
- Froth floatation is a process of: [1998]
 - Oxidation
 - Reduction
 - Refining
 - Concentration
- Flux is used to remove : [1999]
 - basic impurities
 - acidic impurities
 - all types of impurities
 - acidic and basic both impurities
- Mac Arthur process is used for the extraction of: [2000]
 - Au
 - Pt
 - Cu
 - Zn
- In the extraction of copper from its sulphide ore, the metal is formed by reduction of Cu_2O with : [2003]
 - FeS
 - CO
 - Cu_2S
 - SO_2
- Which of the following is a carbonate ore? [2005]
 - Pyrolusite
 - Malachite
 - Diaspore
 - Cassiterite
- Carbon and CO gas are used to reduce which of the following pairs of metal oxides for extraction of metals? [2007]
 - FeO, SnO
 - SnO, ZnO
 - BaO, Na_2O_2
 - FeO, ZnO
- In metallurgical process of aluminium, cryolite is mixed with alumina in its molten state, because it [2011]
 - decreases the amount of alumina
 - oxidises the alumina
 - increases the melting point of alumina
 - decreases the melting point of alumina
- Match list I with list II and select the correct answer using the codes given below the lists: [2013]

List I	List II
I. Cyanide process	A. Ultrapure Ge
II. Floatation process	B. Pine oil
III. Electrolytic reduction	C. Extraction of Al
IV. Zone refining	D. Extraction of Au

Codes:

 - I-C, II-A, III-D, IV-B
 - I-D, II-B, III-C, IV-A
 - I-C, II-B, III-D, IV-A
 - I-D, II-A, III-C, IV-B
- Sulfide ores are common for the metals [2015]
 - Ag, Cu and Pb
 - Ag, Mg and Pb
 - Ag, Cu and Sn
 - Al, Cu and Pb
- Match List I with List II and select the correct answer using the codes given below the list [2015]

List I	List II
1. Ti	A. Bauxite
2. Si	B. Cerussite
3. Al	C. Van-Arkel method
4. Pb	D. Zone refining

 - 1-B, 2-A, 3-C, 4-D
 - 1-B, 2-C, 3-A, 4-B
 - 1-C, 2-A, 3-B, 4-D
 - 1-C, 2-D, 3-A, 4-B
- The main reactions occurring in blast furnace during extraction of iron from haematite are _____ [2016]
 - $\text{Fe}_2\text{O}_3 + 3\text{CO} \longrightarrow 2\text{Fe} + 3\text{CO}_2$
 - $\text{FeO} + \text{SiO}_2 \longrightarrow \text{FeSiO}_3$
 - $\text{Fe}_2\text{O}_3 + 3\text{C} \longrightarrow 2\text{Fe} + 3\text{CO}$
 - $\text{CaO} + \text{SiO}_2 \longrightarrow \text{CaSiO}_3$
 - (i) and (iii)
 - (ii) and (iv)
 - (i) and (iv)
 - (i), (ii) and (iii)
- $2\text{CuFeS}_2 + \text{O}_2 \longrightarrow \text{Cu}_2\text{S} + 2\text{FeS} + \text{SO}_2$ [2017]
Which process of metallurgy of copper is represented by above equation?
 - Concentration
 - Roasting
 - Reduction
 - Purification

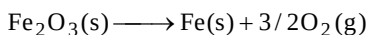
TYPE B : ASSERTION REASON QUESTIONS

Directions for (Q. 15) : These questions consist of two statements, each printed as Assertion and Reason. While answering these questions, you are required to choose any one of the following five responses.

- (a) If both Assertion and Reason are correct and the Reason is a correct explanation of the Assertion.
- (b) If both Assertion and Reason are correct but Reason is not a correct explanation of the Assertion.
- (c) If the Assertion is correct but Reason is incorrect.
- (d) If both the Assertion and Reason are incorrect.
- (e) If the Assertion is incorrect but the Reason is correct.

15. **Assertion :** Extraction of iron metal from iron oxide ore is carried out by heating with coke.

Reason : The reaction,



is a spontaneous process.

[2005]

Directions for (Qs.16-18) : Each of these questions contains an Assertion followed by Reason. Read them carefully and answer the question on the basis of following options. You have to select the one that best describes the two statements.

- (a) If both Assertion and Reason are correct and Reason is the correct explanation of Assertion.
- (b) If both Assertion and Reason are correct, but Reason is not the correct explanation of Assertion.
- (c) If Assertion is correct but Reason is incorrect.
- (d) If both the Assertion and Reason are incorrect.

16. **Assertion :** Copper obtained after bassemmerization is known as **blister copper**.

Reason : Blisters are produced on the surface of the metal due to escaping of dissolved SO_2 .

[2013]

17. **Assertion :** Coke and flux are used in smelting.

[2017]

Reason : The phenomenon in which ore is mixed with suitable flux and coke is heated to fusion is known as smelting.

18. **Assertion :** Galvanised iron does not rust. [2017]

Reason : Zinc has a more negative electrode potential than iron.

HINTS & SOLUTIONS

Type A : Multiple Choice Questions

1. (c) In thermite process, no catalyst is required.
 $\text{Fe}_2\text{O}_3 + 2\text{Al} \longrightarrow \text{Al}_2\text{O}_3 + 2\text{Fe} + \text{Heat}$
 This reaction evolves a lot of heat which provides energy to the reaction.
2. (b)
3. (d) Froth floatation is a process of concentration of sulphide ore.
4. (d) Flux is the material which is used in the metallurgy of metals to remove acidic and basic impurities.
 Acidic flux like silica is used to remove basic impurities present in ore like CaO.
 $\text{CaO} + \text{SiO}_2 \longrightarrow \text{CaSiO}_3$
 Basic flux like limestone is used to remove silica like acidic impurities.
 $\text{SiO}_2 + \text{CaCO}_3 \longrightarrow \text{CaSiO}_3 + \text{CO}_2$.
5. (a) Mac Arthur process involves extraction of gold from sulphide ore with the help of KCN.
6. (c) $\text{Cu}_2\text{S} + 2\text{Cu}_2\text{O} \longrightarrow 6\text{Cu} + \text{SO}_2$
7. (b) Malachite is carbonate ore.
 $\text{Cu}(\text{OH})_2\text{CuCO}_3$
8. (d) $\text{ZnO} + \text{C} \xrightarrow{\frac{3}{4}} \text{Zn} + \text{CO}$
 $\text{FeO} + \text{C} \xrightarrow{\frac{3}{4}} \text{Fe} + \text{CO}$
 In the process of smelting the oxide ore is reduced by carbon and the metal may be obtained in the molten state or as vapours which are condensed. Metals like Zn, Fe, Pb or Sn are obtained by this process.
9. (d)
10. (b) Cyanide process is for gold (I-D); floatation process - pine oil (II-B); Electrolytic reduction - Al (III-C); Zone refining-Ge (IV-A).

11. (a) Silver, copper and lead are commonly found in earth's crust as Ag_2S (silver glance), CuFeS_2 (copper pyrites) and PbS (galena).
12. (d) Ti – van-Arkel method
 Si – Zone refining method
 Al – Bauxite (Al_2O_3)
 Pb – Cerussite (PbCO_3)
13. (c) 14. (b)

Type B : Assertion Reason Questions

15. (c) Iron is obtained from Fe_2O_3 by heating it with a mixture of coke and CaCO_3 in a blast furnace in which CO formed reduces Fe_2O_3 to Fe.
 $\text{Fe}_2\text{O}_3 + \text{CO} \rightarrow \text{Fe} + \text{CO}_2$
 However, the reason is false because the reaction $\text{Fe}_2\text{O}_3(\text{s}) \rightarrow \text{Fe}(\text{s}) + \frac{3}{2}\text{O}_2(\text{g})$ is not spontaneous as for this reaction both ΔH and ΔS are negative, so ΔG will be positive.
16. (a) Both assertion and reason are correct and reason is the correct explanation of assertion.
17. (b) Both assertion and reason are true but reason is not the correct explanation of assertion. Non fusible mass present in ore in mixing with suitable flux are fused which are then reduced by coke to give free metal.
18. (a) Zinc metal which has a more negative electrode potential than iron will provide electrons in preference of the iron, and therefore corrodes first. Only when all the zinc has been oxidised, the iron start to rust.

The p-Block Elements (Group 15, 16, 17 and 18)

TYPE A : MULTIPLE CHOICE QUESTIONS

- The ion or group detected by $K_2[HgI_4]$ is :
(a) NO (b) Cl^- (c) NH_2^- (d) NH_4^+ [1997]
- Which gas cannot be collected over water ?
(a) O_2 (b) PH_3 (c) N_2 (d) SO_2 [1997]
- The correct order of increasing oxidising power is :
(a) $Cl_2 < Br_2 < F_2 < I_2$ (b) $F_2 < Br_2 < Cl_2 < I_2$
(c) $F_2 > Br_2 > Cl_2 > I_2$ (d) $I_2 < Br_2 < Cl_2 < F_2$ [1997]
- H_2S does not produce metallic sulphide with :
(a) $CuCl_2$ (b) $COCl_2$ (c) $CdCl_2$ (d) $ZnCl_2$ [1997]
- The correct order of acid strength of oxyacids is :
(a) $HClO > HClO_2 > HClO_3 > HClO_4$
(b) $HClO_2 > HClO_3 > HClO > HClO_4$
(c) $HClO_4 > HClO_3 > HClO_2 > HClO$
(d) $HClO_3 > HClO_4 > HClO > HClO_2$ [1998]
- Chlorine acts as a bleaching agent only in presence of :
(a) Sunlight (b) Moisture (c) Dry air (d) Pure oxygen [1998]
- The laughing gas is :
(a) NO (b) N_2O (c) N_2O_4 (d) N_2O_5 [1998]
- The correct decreasing order of basic strength is :
(a) $AsH_3 > SbH_3 > PH_3 > NH_3$ (b) $SbH_3 > AsH_3 > PH_3 > NH_3$
(c) $NH_3 > PH_3 > AsH_3 > SbH_3$ (d) $PH_3 > AsH_3 > SbH_3 > NH_3$ [1999]
- Iodide of Millon's base is :
(a) HIO_3 (b) K_2HgI_4 (c) $NH_2HgO.HgI$ (d) $Hg(NH_2)I$ [1999]
- Which of the following is not the characteristic of interhalogen compounds?
(a) they are covalent (b) more reactive than halogens
(c) have low B.P. and high volatile (d) quite unstable but not explosive [1999]
- Hypo on treatment with iodine produces :
(a) H_2S (b) Na_2SO_4 (c) Na_2SO_3 (d) $Na_2S_4O_6$ [2000]
- The tribasic acid is :
(a) H_3PO_4 (b) H_3PO_3 (c) H_3PO_2 (d) HPO_3 [2001]
- The strongest oxidising agent is :
(a) F_2 (b) Cl_2 (c) I_2 (d) Br_2 [2001]
- The correct order of solubility in water for He, Ne, Ar, Kr, Xe is
(a) $He > Ne > Ar > Kr > Xe$ (b) $Xe > Kr > Ar > Ne > He$
(c) $Ne > Ar > Kr > He > Xe$ (d) $Ar > Ne > He > Kr > Xe$ [2002]
- Which of the following compound is a tribasic acid?
(a) H_3PO_2 (b) H_3PO_4 (c) H_3PO_3 (d) $H_4P_2O_7$ [2002]
- The true statement for the acids of phosphorus. H_3PO_2 , H_3PO_3 , and H_3PO_4 is :
(a) the order of their acidity is $H_3PO_4 < H_3PO_3 < H_3PO_2$ (b) all of them are reducing in nature
(c) all of them are tribasic acids (d) the geometry of phosphorus is tetrahedral in all the three [2003]

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Topicwise AIIMS Solved Papers – CHEMISTRY

17. The mixture of concentrated HCl and HNO_3 made in 3 : 1 ratio contains : [2003]
 (a) ClO_2 (b) NOCl
 (c) NCl_3 (d) N_2O_4
18. The element which forms oxides in all oxidation states varying from +1 to +5 is [2004]
 (a) N (b) P
 (c) As (d) Sb
19. The statement true for N_3^- is : [2004]
 (a) it has non-linear structure
 (b) it is called pseudohalogen
 (c) the formal oxidation state of nitrogen in this anion is – 1
 (d) it is isoelectronic with NO_2
20. For electron affinity of halogens which of the following is correct? [2004]
 (a) $\text{Br} > \text{F}$ (b) $\text{F} > \text{Cl}$
 (c) $\text{Br} > \text{Cl}$ (d) $\text{F} > \text{I}$
21. The number of P–O–P bridges in the structure of phosphorus pentoxide and phosphorus trioxide are respectively : [2005]
 (a) 6, 6 (b) 5, 5
 (c) 5, 6 (d) 6, 5
22. The incorrect statement among the following is: [2006]
 (a) C_{60} is an allotropic form of carbon [2006]
 (b) O_3 is an allotropic form of oxygen
 (c) S_8 is the only allotropic form of sulphur.
 (d) Red phosphorus is more stable in air than white phosphorus
23. Tincture of iodine is : [2006]
 (a) Aqueous solution of I_2
 (b) Solution of I_2 in aqueous KI
 (c) Alcoholic solution of I_2
 (d) Aqueous solution of KI
24. Which two of the following salts are used for preparing iodized salt? [2006]
 (i) KIO_3 (ii) KI
 (iii) I_2 (iv) HI
 (a) (i) and (ii) (b) (i) and (iii)
 (c) (ii) and (iv) (d) (iii) and (iv)
25. XeF_6 on hydrolysis produces [2007]
 (a) XeOF_4 (b) XeO_2F_2
 (c) XeO_3 (d) XeO_2
26. Inert gases are mixed in iodine vapours. Then there are _____ between them. [2007]
 (a) H-bonding
 (b) vander Waal's forces
 (c) Electrostatic forces
 (d) Metallic bonds.
27. The element which is the most abundant in the earth crust is [2007]
 (a) O (b) S
 (c) Al (d) H.
28. Cyanogen gas is obtained in the reaction [2007]
 (a) $\text{CuSO}_{4(\text{aq})} + \text{KCN} \longrightarrow$
 (b) $\text{K}_4[\text{Fe}(\text{CN})_6] \xrightarrow{\text{heat}}$
 (c) $\text{CH}_3\text{CN} + \text{H}_2\text{O} \xrightarrow{\Delta}$
 (d) $\text{CH}_3\text{CONH}_2 + \text{P}_2\text{O}_5 \xrightarrow{\Delta}$
29. Perdisulphuric acid has the following bond [2008]
 (a) $\text{O} \leftarrow \text{O} = \text{O}$ (b) $\leftarrow \text{O} = \text{O} \rightarrow$
 (c) $> \text{O} \rightarrow \text{O} <$ (d) $-\text{O}-\text{O}-$
30. S^{2-} and SO_3^{2-} can be distinguished by using [2008]
 (a) $(\text{CH}_3\text{COO})_2\text{Pb}$ (b) $\text{Na}_2[\text{Fe}(\text{CN})_5\text{NO}]$
 (c) both (a) and (b) (d) None of these
31. Choose the correct statement – [2009]
 (a) White or yellow phosphorus is stored under water
 (b) Ignition temperature of red phosphorus is low
 (c) Black phosphorus is non crystalline in nature
 (d) Phosphorus does not form hydrides.
32. An element (X) forms compounds of the formula XCl_3 , X_2O_5 and Ca_3X_2 , but does not form XCl_5 . Which of the following is the element [2009]
 (a) B (b) Al
 (c) N (d) P
33. H_2S gas is not evolved when SO_3^{2-} ion reacts with following reagents. [2009]
 (a) $\text{Zn} + \text{dil. H}_2\text{SO}_4$ (b) $\text{Al} + \text{Conc. NaOH}$
 (c) $\text{Al} + \text{dil. HCl}$ (d) None of these

34. In the nitrogen family the H – M – H bond angle in the hydrides MH_3 gradually becomes closer to 90° on going from N to Sb. This shows that gradually – [2009]
 (a) The basic strength of hydrides increases
 (b) Almost pure p-orbitals are used for M – H bonding
 (c) The bond energies of M – H bond increases
 (d) The bond pairs of electrons becomes nearer to the central atom
35. Which of the following oxides is most acidic?
 (a) Ag_2O (b) V_2O_5 [2009]
 (c) CO (d) N_2O_5
36. Iodine exists in which form in iodised salt
 (a) I_2 (b) NaIO_3 [2009]
 (c) ICl (d) IO_4^-
37. When chlorine water is added to a solution of KBr, the solution immediately turns orange red, because [2009]
 (a) Chlorine is reduced to chloride ion
 (b) Of the formation of BrCl
 (c) Bromide ion is oxidized to bromine
 (d) Of the formation of Br_3^-
38. Which of the following halides is the most stable?
 (a) CCl_4 (b) CBr_4 [2010]
 (c) CF_4 (d) Cl_4
39. Noble gases are absorbed by [2010]
 (a) anhydrous calcium chloride
 (b) ferric hydroxide
 (c) conc. H_2SO_4
 (d) activated coconut charcoal
40. Which one of the following is the correct decreasing order of boiling point? [2010]
 (a) $\text{H}_2\text{Te} > \text{H}_2\text{O} > \text{H}_2\text{Se} > \text{H}_2\text{S}$
 (b) $\text{H}_2\text{O} > \text{H}_2\text{S} > \text{H}_2\text{Se} > \text{H}_2\text{Te}$
 (c) $\text{H}_2\text{Te} > \text{H}_2\text{Se} > \text{H}_2\text{S} > \text{H}_2\text{O}$
 (d) $\text{H}_2\text{O} > \text{H}_2\text{Te} > \text{H}_2\text{Se} > \text{H}_2\text{S}$
41. Total number of lone pair of electrons in XeOF_4 is [2011]
 (a) 0 (b) 1 (c) 2 (d) 3
42. The reason for **not** storing XeF_6 in a glass or a quartz vessel is that [2011]
 (a) it forms an explosive having the formula XeO_2F_2
 (b) it forms an explosive having the formula XeOF_4
 (c) it forms XeO_2 which is explosive substance
 (d) it forms XeO_6^{4-} which is explosive in nature
43. What are the products formed in the reaction of xenon hexafluoride with silicon dioxide?
 (a) $\text{XeSiO}_4 + \text{HF}$ (b) $\text{XeF}_2 + \text{SiF}_4$ [2012]
 (c) $\text{XeOF}_4 + \text{SiF}_4$ (d) $\text{XeO}_3 + \text{SiF}_2$
44. P_4O_{10} is not used to dry NH_3 gas because
 (a) P_4O_{10} reacts with moisture in NH_3 [2012]
 (b) P_4O_{10} is not a drying agent
 (c) P_4O_{10} is acidic and NH_3 is basic
 (d) P_4O_{10} is basic and NH_3 is acidic
45. Oxygen is more electronegative than sulphur, yet H_2S is acidic while H_2O is neutral. This is because [2012]
 (a) Water is a highly associated
 (b) H—S bond is weaker than H—O bond
 (c) H_2S is a gas while H_2O is a liquid
 (d) The molecular weight of H_2S is more than that of H_2O
46. When chlorine reacts with cold and dilute solution of sodium hydroxide, the products obtained are [2013]
 (a) $\text{Cl}^- + \text{OCl}^-$ (b) $\text{Cl}^- + \text{ClO}_2^-$
 (c) $\text{Cl}^- + \text{ClO}_3^-$ (d) $\text{Cl}^- + \text{ClO}_4^-$
47. When Br_2 is treated with aqueous solutions of NaF, NaCl and NaI separately [2014]
 (a) F_2 , Cl_2 and I_2 are liberated
 (b) only F_2 and Cl_2 are liberated
 (c) only I_2 is liberated
 (d) only Cl_2 is liberated
48. Which one of the following statements regarding helium is incorrect? [2015]
 (a) It is used to produce and sustain powerful superconducting magnets.
 (b) It is used as a cryogenic agent for carrying out experiments at low temperatures.
 (c) It is used to fill gas balloons instead of hydrogen because it is lighter and non-inflammable.
 (d) It is used in gas-cooled nuclear reactors.
49. Regarding F^- and Cl^- which of the following statements is/are correct? [2015]
 (i) Cl^- can give up an electron more easily than F^-
 (ii) Cl^- is a better reducing agent than F^-
 (iii) Cl^- is smaller in size than F^-
 (iv) F^- can be oxidized more readily than Cl^-
 (a) (i) and (ii) (b) (i), (ii) and (iv)
 (c) (iii) and (iv) (d) Only (i)

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Topicwise AIIMS Solved Papers – CHEMISTRY

50. What is X and Y in the given reactions ? [2016]
 $2X_2(g) + 2H_2O(l) \rightarrow 4H^+(aq) + 4X^-(aq) + O_2(g)$
 $Y_2(g) + H_2O(l) \rightarrow HY(aq) + HOY(aq)$
 (a) $X = Cl, Y = F$ (b) $X = Cl, Y = Br$
 (c) $X = F, Y = Cl$ (d) $X = I, Y = F$
51. Which of the following fluorides does not exist? [2017]
 (a) NF_5 (b) PF_5
 (c) AsF_5 (d) SbF_5
52. Which of the following are peroxoacids of sulphur? [2017]
 (a) H_2SO_5 and $H_2S_2O_8$
 (b) H_2SO_5 and $H_2S_2O_7$
 (c) $H_2S_2O_7$ and $H_2S_2O_8$
 (d) $H_2S_2O_6$ and $H_2S_2O_7$

TYPE B : ASSERTION REASON QUESTIONS

Directions for (Qs. 53-64) : These questions consist of two statements, each printed as Assertion and Reason. While answering these questions, you are required to choose any one of the following five responses.

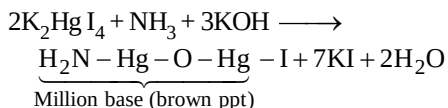
- (a) If both Assertion and Reason are correct and the Reason is a correct explanation of the Assertion.
 (b) If both Assertion and Reason are correct but Reason is not a correct explanation of the Assertion.
 (c) If the Assertion is correct but Reason is incorrect.
 (d) If both the Assertion and Reason are incorrect.
 (e) If the Assertion is incorrect but the Reason is correct.
53. **Assertion:** A mixture of He and O_2 is used for respiration for deep sea divers.
Reason: He is soluble in blood. [1998]
54. **Assertion :** Iodine is more soluble in water than in carbon tetrachloride.
Reason : Iodine is a polar compound. [1999]
55. **Assertion :** Inert gases are monoatomic.
Reason : Inert gases have stable configuration. [1999]
56. **Assertion :** Anhydrous BaO_2 is used for preparing H_2O_2 .
Reason : Hydrated BaO_2 is not available. [2001]
57. **Assertion :** Fluorine exists only in -1 oxidation state.
Reason : Fluorine has $2s^2 2p^5$ configuration. [2001]
58. **Assertion :** The fluorine has lower reactivity.
Reason : F – F bond has low bond dissociation energy. [2002]
59. **Assertion :** Dinegative anion of oxygen (O^{2-}) is quite common but dinegative anion of sulphur (S^{2-}) is less common.
Reason : Covalency of oxygen is two. [2002]
60. **Assertion :** The halogens absorb visible light.
Reason : All halogens are coloured. [2002]
61. **Assertion :** $HClO_4$ is a strong acid than $HClO_3$.
Reason : Oxidation state of Cl in $HClO_4$ is $+7$ and in $HClO_3$, it is $+5$. [2004]
62. **Assertion :** Reaction of SO_2 and H_2S in the presence of Fe_2O_3 catalyst gives elemental sulphur.
Reason : SO_2 is a reducing agent [2005]
63. **Assertion :** Ozone is an allotrope of oxygen.
Reason : Oxygen is bluish coloured liquid and in singlet state it is para-magnetic. [2007]
64. **Assertion :** F is more electronegative than Cl.
Reason : F has high electron affinity than Cl. [2007]
- Directions for (Qs.65-73) :** Each of these questions contains an Assertion followed by Reason. Read them carefully and answer the question on the basis of following options. You have to select the one that best describes the two statements.
- (a) If both Assertion and Reason are correct and Reason is the correct explanation of Assertion.
 (b) If both Assertion and Reason are correct, but Reason is not the correct explanation of Assertion.
 (c) If Assertion is correct but Reason is incorrect.
 (d) If both the Assertion and Reason are incorrect.
65. **Assertion :** The S–S–S bond angle in S_8 molecule is 105° .
Reason : S_8 has a V-shape. [2008, 2009]
66. **Assertion :** Sulphuric acid is more viscous than water.
Reason : Concentrated sulphuric acid has a great affinity for water. [2009]

67. **Assertion :** Although PF_5 , PCl_5 and PBr_5 are known, the pentahalides of nitrogen have not been observed.
Reason : Phosphorus has lower electronegativity than nitrogen. [2010]
68. **Assertion :** White phosphorus is more reactive than red phosphorus.
Reason : Red phosphorus consists of P_4 tetrahedral units linked to one another to form linear chains. [2012]
69. **Assertion :** When a metal is treated with conc. HNO_3 it generally yields a nitrate, NO_2 and H_2O .
Reason : Conc. HNO_3 reacts with metal and first produces a metal nitrate and nascent hydrogen. The nascent hydrogen then further reduces HNO_3 to NO_2 . [2013]
70. **Assertion :** Silicones are hydrophobic in nature. [2015]
Reason : $\text{Si} - \text{O} - \text{Si}$ linkages are moisture sensitive.
71. **Assertion :** SF_6 cannot be hydrolysed but SF_4 can be.
Reason : Six F atoms in SF_6 prevent the attack of H_2O on sulphur atom of SF_6 . [2016]
72. **Assertion :** Both rhombic and monoclinic sulphur exist as S_8 but oxygen exists as O_2 . [2017]
Reason : Oxygen forms $\text{p}\pi - \text{p}\pi$ multiple bond due to small size and small bond length but $\text{p}\pi - \text{p}\pi$ bonding is not possible in sulphur.
73. **Assertion :** HClO_4 is a stronger acid than HClO_3 . [2017]
Reason : Oxidation state of Cl in HClO_4 is +VII and in HClO_3 +V.

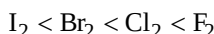
HINTS & SOLUTIONS

Type A : Multiple Choice Questions

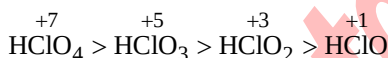
1. (d) The ion or group detected by $K_2[HgI_4]$ is NH_4^+ . It is known as Nessler's reagent test.



2. (d) SO_2 cannot be collected over water because it is soluble in water.
3. (d) Metals are good reducing agents, while non-metals are good oxidising agents. Further among halogens, metallic character increases as we move from top to bottom in a group, i.e., the oxidising nature is



4. (b) $COCl_2$ is carbonyl chloride and does not have any metal atom. Further it is a covalent compound.
5. (c) The acid strength of oxyacids of the same halogen increases with increase in oxidation state of the halogen



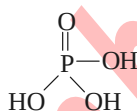
Thus Cl in $HClO_4$ is in highest oxidation state (+7) and hence strongest acid, while $HClO$ (Cl is in +1 oxidation state) is weakest.

6. (b) Chlorine acts as bleaching agent only in presence of moisture.
 $Cl_2 + H_2O \longrightarrow 2HCl + O$.
7. (b) Nitrous oxide (N_2O) is known as laughing gas. A mixture of N_2O & O_2 is used as anaesthesia in dental surgery.
8. (c) Lone pair of electrons on N, P, As and Sb are dispersed in a greater way as the size of atom increases from N to Sb. Therefore, NH_3 is most basic and SbH_3 is least basic.
9. (c) Iodide of Millon's Base is $NH_2.HgO.HgI$. It is formed when Nessler's reagent is reacted with NH_3 .
10. (c) Interhalogen compounds are covalent in nature. More reactive than halogens because of low bond energy due to dissimilar size of atoms in molecule. As the

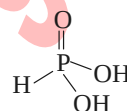
molecule becomes a little polar the boiling point increases due to inter-molecular attraction. They are reactive and unstable because of low bond energy.

11. (d) $2Na_2S_2O_3 + I_2 \longrightarrow Na_2S_4O_6 + 2NaI$
 Sodium thiosulphate Sodium tetrathionate

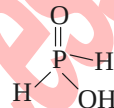
12. (a) Orthophosphoric acid (H_3PO_4) is tribasic because it has three replaceable H-atoms.



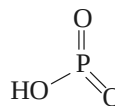
Orthophosphoric acid,
 H_3PO_4 (tribasic)



Phosphorous acid, H_3PO_3
(dibasic)

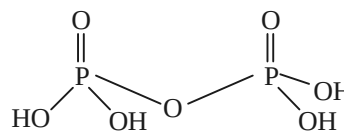


Hypophosphorous acid
 H_3PO_2 (monobasic)



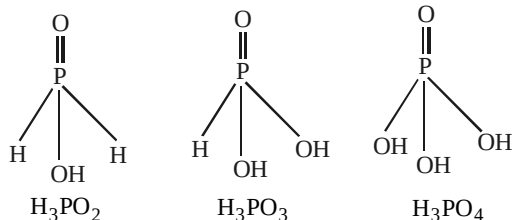
Metaphosphoric acid
 HPO_3 (monobasic)

13. (a) An element which can readily accept an electron is a good oxidising agent. Halogens are good oxidising agents because they have strong tendency to accept an electron due to (i) small atomic size, (ii) high electronegativity and (iii) high electron affinity. Fluorine, being smallest, is best oxidising agent.
14. (b) As the molecular weight of noble gas atoms increases down the group its polarity increases due to which van-der-waal's force between them increases. Due to increased polarity of heavier inert gas, its solubility in water also increases. So, most soluble gas will be Xe and least soluble will be He. So correct order is $Xe > Kr > Ar > Ne > He$.
15. (b) H_3PO_4 is tribasic acid

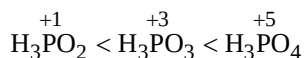


Pyrophosphoric acid
 $H_4P_2O_7$ (tetrabasic)

16. (d) (i) The geometry of phosphorus is tetrahedral in all the three.



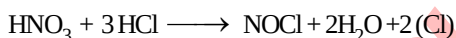
- (ii) The acidity increases with increase in oxidation number of central atom



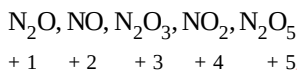
- (iii) H_3PO_4 is not reducing.

- (iv) H_3PO_3 is diacidic, while H_3PO_2 is monobasic.

17. (b) The mixture of 1 part of conc. HNO_3 and 3 parts of conc. HCl is known as aqua regia. It contains NOCl .



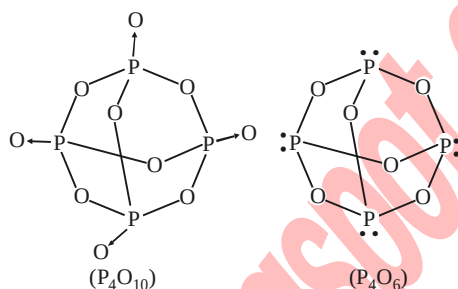
18. (a) Nitrogen has oxidation states from +1 to +5 in its oxides



19. (d) Azide ion, N_3^- has a linear structure. It has 22 (21 + 1) electrons, thus it is iso-electronic with N_2O (14 + 8 = 22).

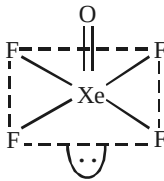
20. (d) Electron affinity decreases in a group from top to bottom due to increase in size, so the expected order of electron affinity for halogens is $\text{F} > \text{Cl} > \text{Br} > \text{I}$. However, it is not so. The electron affinity of elements of III period is higher than that of II period because elements of II period have small size and greater electron density so the incoming electrons suffer a repulsive force. Thus the order of electron affinity is $\text{Cl} > \text{F} > \text{Br} > \text{I}$.

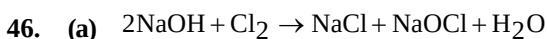
21. (a) Both have six P—O—P bonds as shown in the figure.



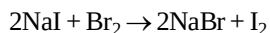
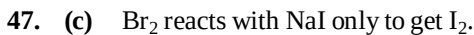
Hence, number of P—O—P bridges is 6 in both.

22. (c) S_8 is not the only allotropic form of sulphur.
23. (c) Tincture of iodine is 2% solution of iodine in alcohol.
24. (a) KIO_3 and KI are used for preparing iodised salt.
25. (c) Complete hydrolysis of XeF_6 yields XeO_3 .
 $\text{XeF}_6 + 3\text{H}_2\text{O} \xrightarrow{\text{3/4}} \text{XeO}_3 + 6\text{HF}$
26. (b) All molecules have short range London dispersive forces which is type of vander Waals forces. When inert gases are mixed in iodine vapours there exists short range London dispersive forces.
27. (a) A little more than 47% of earth crust consists of oxygen. The more common rock constituents of earth's crust are nearly all oxides.
28. (a) Among the given options, only $\text{CuSO}_4(\text{aq.})$ and KCN react to form an unstable copper (II) cyanide which rapidly decomposes to give copper (I) cyanide and cyanogen.
 $2\text{CuSO}_4(\text{aq.}) + 4\text{KCN} \xrightarrow{\text{3/4}} 2\text{Cu}(\text{CN})_2 + 2\text{K}_2\text{SO}_4$
 $2\text{Cu}(\text{CN})_2 \xrightarrow{\text{3/4}} 2\text{CuCN} + (\text{CN})_2$
Cyanogen
29. (d) The structure of peroxydisulphuric acid ($\text{H}_2\text{S}_2\text{O}_8$) is
-
30. (c) $\text{S}^{2-} + (\text{CH}_3\text{COO})_2\text{Pb} \longrightarrow$
 $\text{Pbs} \downarrow + 2\text{CH}_3\text{COO}^-$
black
 $\text{S}^{2-} + [\text{Fe}(\text{CN})_5\text{NO}]^{2-} \rightarrow [\text{Fe}(\text{CN})_5\text{NOS}]^{4-}$
violet
 Thus S^{2-} and SO_3^{2-} can be distinguished by using both the given reagents.

31. (a) Due to low ignition temperature of white phosphorus, it undergoes oxidation in presence of air which slowly raises its temperature and after a few moments it catches fire spontaneously. Due to this reason, it is stored under water. Ignition temperature of red phosphorus is high. Black phosphorus is crystalline in nature. Phosphorus forms a number of hydrides.
32. (c) N forms NCl_3 , N_2O_5 and Ca_3N_2 . Nitrogen, due to absence of empty d-orbitals, cannot extend its covalency by more than three and hence do not form NCl_5 . Due to its small size and high electronegativity it can accept 3 electrons to form N^{3-} ion (Ca_3N_2)
33. (b) $\text{SO}_3^{2-} + 2\text{Al} + 2\text{OH}^- + 3\text{H}_2\text{O} \longrightarrow$
 $\text{S}^{2-} + 2[\text{Al}(\text{OH})_4]^-$
 H_2S does not evolve as liberated H_2S is neutralized by NaOH and Na_2S is formed.
34. (b) The hydrides have a pyramidal or tetrahedral shape with a lone pair of electrons in one of the orbitals. The $\text{H}-\text{M}-\text{H}$ bond angle is less than the original $109^\circ 28'$ tetrahedral bond angle ($\text{H}-\text{N}-\text{H}$ in NH_3 is $106^\circ 45'$) because of greater repulsion between lone pair and a bond pair than between two bond pairs of electrons. Because electro-negativity of M decreases from N to Bi, the bond pair lie farther away from the central atom, and the lone pair causes greater distortion of bond angle. Thus $\text{H}-\text{P}-\text{H}$ bond in PH_3 is 94° , while in AsH_3 and SbH_3 it is about 91.8° and 91.3° respectively (closer to 90°). This suggests that orbitals used for bonding are closer to pure p-orbitals.
35. (d) The oxide with the highest positive oxidation state on the element other than O should be most acidic. Oxidation state of V in V_2O_5 and N in N_2O_5 are +5. But the electronegativity of N is higher, making N_2O_5 the most acidic oxide.
36. (b) Iodised salt is table salt mixed with a minute amount of one of the four iodine containing salts of hydroiodic acid or iodic acid : potassium iodate or potassium iodide and sodium iodate or sodium iodide.
37. (b) Br_2 , formed by adding chlorine water to a solution of KBr , further reacts with Cl_2 to form reddish yellow or orange red BrCl .
 $\text{Br}_2 + \text{Cl}_2 \longrightarrow 2\text{BrCl}$
38. (c) Stability of carbon tetrahalides decreases with increase in the size of halogen atom. So, CF_4 is the most stable halide among the given options.
39. (d) Activated charcoal is a very good absorbent of gas, whereas anhydrous CaCl_2 , $\text{Fe}(\text{OH})_3$ and conc. H_2SO_4 are dehydrating agents.
40. (d) Among the hydrides of group 16 elements, boiling point of H_2O is higher than H_2S (difference in boiling points of H_2O and H_2S is around 200°C) because of strong intermolecular hydrogen bonding. After the decrease in boiling point from H_2O to H_2S , from H_2S to H_2Te , it increases due to increase in size of the atoms from S to Te which increases the magnitude of van der Waal's forces among the molecules. So, the correct order of boiling points is
 $\text{H}_2\text{O} > \text{H}_2\text{Te} > \text{H}_2\text{Se} > \text{H}_2\text{S}$
41. (b) 
42. (b) $2\text{XeF}_6 + \text{SiO}_2 \longrightarrow 2\text{XeOF}_4 + \text{SiF}_4$
(glass) (explosive nature)
 $2\text{XeOF}_4 + \text{SiO}_2 \longrightarrow 2\text{XeO}_2\text{F}_2 + \text{SiF}_4$
 $2\text{XeO}_2\text{F}_2 + \text{SiO}_2 \longrightarrow 2\text{XeO}_3 + \text{SiF}_4$
(explosive)
43. (c) $2\text{XeF}_6 + \text{SiO}_2 \rightarrow \text{SiF}_4 + 2\text{XeOF}_4$
44. (c) $\text{P}_4\text{O}_{10} + 2\text{H}_2\text{O} \longrightarrow 4\text{HPO}_3$
Acidic meta phosphoric acid
 $\xrightarrow{\text{NH}_3}$ basic meta ammonium phosphate
 NH_4PO_3
45. (b) H - S bond is weaker than H—O bond due to large size of S. Moreover due to high electronegativity of oxygen it forms hydrogen bond in H_2O .

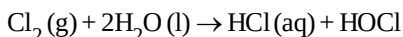
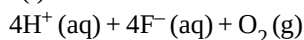
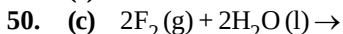


hence Cl^- and OCl^-



48. (c) Helium is twice as heavy as hydrogen it is inflammable but not lighter than hydrogen. Helium has the lowest melting and boiling point of any element which makes liquid helium an ideal coolant for many extremely low temperature application such as super conducting magnet and cryogenic research where temperature close to absolute zero are needed. He is used in gas cooled atomic reactors as a heat transfer agent.

49. (d)



51. (a) NF_5 does not exist because N does not form pentahalides due to the absence of d-orbital in its valence shell. While P, As and Sb form pentahalides of the general formula MX_5 (where, M = P, As and Sb) due to the presence of vacant d-orbitals in their respective valence shell.

52. (a) Both have peroxy linkage

Type B : Assertion Reason Questions

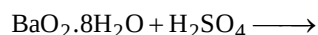
53. (c) A mixture of He and O_2 is used for respiration by deep sea divers but He is not soluble in blood.

54. (d) Iodine is less soluble in water than in carbon tetrachloride. Iodine is a non polar compound.

Iodine, being a non-polar compound is more soluble in CCl_4 (non-polar compound) than in water because "like dissolves like". so both the assertion and reason are false.

55. (a) Inert gases are monoatomic because they have stable configuration as their octet is complete.

56. (d) H_2O_2 is prepared by the action of H_2SO_4 on hydrated BaO_2 and not on dehydrated BaO_2 . When dehydrated BaO_2 is used, then a layer of BaSO_4 is formed around it which prevents reaction to proceed.



57. (a) Fluorine exists in only -1 oxidation state as it does not have vacant d-orbital to receive more than one electron.

58. (e) Fluorine is a highly reactive non-metal due to low bond dissociation energy.

59. (c) Dinegative anion of oxygen is quite common due to higher electron gain enthalpy of oxygen.

60. (a) All halogens are coloured as they absorb light in the visible region.

61. (a) HClO_4 is a stronger acid than HClO_3 because in the former Cl is in higher oxidation state (+7) than that in HClO_3 (+5).

62. (c) $2\text{H}_2\text{S} + \text{SO}_2 \longrightarrow 2\text{H}_2\text{O} + 3\text{S} \downarrow$
Here H_2S is oxidised to sulphur, while SO_2 is reduced to water. Thus SO_2 is oxidising agent and H_2S is reducing agent.

63. (c) Here the assertion given is true and reason is false. Ozone (O_3) is a triatomic molecule consisting of three oxygen atoms. It is an allotrope of oxygen that is much less stable than the diatomic O_2 . Liquid O_2 is a clear substance with a light sky blue colouration. In triplet form it is paramagnetic due to spin magnetic moments of the unpaired electrons in the molecule and the negative exchange energy between neighbouring O_2 molecules.

In singlet oxygen all the electron spins are paired and hence it is not paramagnetic in nature.

64. (c) Here assertion is true but reason is false. F is more electronegative than chlorine, in fact it is most electronegative element of the periodic table but its electron affinity, the tendency to accommodate electrons, is less than the Cl due to non availability of d-electrons.

65. (c) S_8 has puckered ring type structure and S-S-S bond angle ranges from 102° - 108° . Thus, assertion is correct but reason is incorrect.

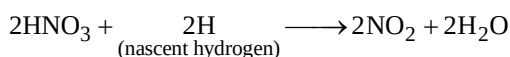
66. (b) Both assertion and reason are true but reason is not the correct explanation of assertion. Molecules of H_2SO_4 are

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associated due to large number of intermolecular H-bonds.

67. (b) Nitrogen cannot form pentahalides because it cannot expand its octet due to non-availability of *d*-orbitals. So, Reason is not the correct explanation of Assertion.
68. (b) White phosphorus exists as P_4 tetrahedral molecule having P-P-P bond angle 60° . Hence the molecule is under strain and more reactive. On the other hand red phosphorus exists as P_4 tetrahedra which are joined together through covalent bonds giving polymeric structure.
69. (a) Both assertion and reason are true and reason is the correct explanation of assertion.



70. (b) 71.(a) 72. (a)

73. (b) Both Assertion and Reason are true but reason is not the correct explanation of assertion. Greater the number of negative atoms present in the oxy-acid make the acid stronger. In general, the strengths of acids that have general formula $(HO)_mZO_n$ can be related to the value of *n*. As the value of *n* increases, acidic character also increases. The negative atoms draw electrons away from the Z-atom and make it more positive. The Z-atom, therefore, becomes more effective in withdrawing electron density away from the oxygen atom that bonded to hydrogen. In turn, the electrons of H – O bond are drawn more strongly away from the H-atom. The net effect makes it easier from the proton release and increases the acid a strength.

The *d*- and *f*-Block Elements

TYPE A : MULTIPLE CHOICE QUESTIONS

- Malachite is an ore of: [1998]
 - Silver
 - Mercury
 - Magnesium
 - Copper
- The chief ore of Hg is: [1999]
 - Pyrolusite
 - Bauxite
 - Galena
 - Cinnabar
- The transition element which shows the highest oxidation state is: [1999]
 - Iron
 - Vanadium
 - Manganese
 - Chromium
- Gun metal is: [1999]
 - Cu + Zn
 - Cu + Sn + Zn
 - Cu + Sn
 - Zn + Sn
- Transition elements form coloured ions due to: [1999]
 - d-d* transition
 - fully filled *d*-orbitals
 - smaller atomic radii
 - availability of *s*-electrons
- CuSO_4 and KCN react to produce: [1999]
 - CuCN_2
 - CuCN
 - $\text{K}_3[\text{Cu}(\text{CN})_4]$
 - $\text{K}_4[\text{Cu}(\text{CN})_6]$
- Which of the following is greatest paramagnetic? [2000]
 - Cu^+
 - Fe^{2+}
 - Fe^{3+}
 - Cu^{2+}
- The Mohr's salt is shown by: [2000]
 - $\text{FeSO}_4(\text{NH}_4)_2\text{SO}_4 \cdot 6\text{H}_2\text{O}$
 - $\text{FeSO}_4(\text{NH}_3)_2\text{SO}_4 \cdot 6\text{H}_2\text{O}$
 - $\text{K}_2\text{SO}_4\text{Al}_2(\text{SO}_4)_3 \cdot 24\text{H}_2\text{O}$
 - $\text{FeSO}_3(\text{NH}_2)_4\text{SO}_4 \cdot 6\text{H}_2\text{O}$
- German silver is an alloy of: [2000]
 - Fe, Cr, Ni
 - Ag, Cu, Au
 - Cu, Zn, Ni
 - Cu, Zn, Sn
- The composition of duralumin is: [2001]
 - Al 94%, Mg 6%
 - Cu 56%, Zn 24%, Ni 20%
 - Cu 95%, Al 5%
 - Al 95%, Cu 4%, Mn 0.5%, Mg 0.5%
- The number of water molecules in Mohr's salt is: [2001]
 - 2
 - 4
 - 6
 - 8
- Philosopher's wool on heating with BaO at 1100°C produces: [2001]
 - $\text{Ba} + \text{ZnCl}_2$
 - BaCdO_2
 - BaZnO_2
 - $\text{BaO}_2 + \text{Zn}$
- Which of the following is not an ore of iron? [2002]
 - limonite
 - casiterite
 - magnetite
 - none of these
- The colourless species is: [2003]
 - VCl_3
 - VO_2
 - Na_3VO_4
 - $[\text{V}(\text{H}_2\text{O})_6]\text{SO}_4 \cdot \text{H}_2\text{O}$
- Lanthanide for which +II and +III oxidation states are common is: [2003]
 - La
 - Pr
 - Ce
 - Eu
- Among the following pairs of ions, the lower oxidation state in aqueous solution is more stable than the other, in: [2005]
 - $\text{Ti}^+, \text{Ti}^{3+}$
 - $\text{Cu}^+, \text{Cu}^{2+}$
 - $\text{Cr}^{2+}, \text{Cr}^{3+}$
 - $\text{V}^{2+}, \text{VO}^{2+}$
- F_2 is formed by reacting K_2MnF_6 with: [2005]
 - SbF_5
 - MnF_3
 - KSbF_6
 - MnF_4
- The colour imparted by Co(II) compounds to glass is: [2006]
 - Green
 - Deep blue
 - Yellow
 - Red

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19. Which of the following radioisotopes is used as anticancerous? [2007]
 (a) Na-24 (b) C-14
 (c) U-235 (d) Co-60
20. Which of the following compound is coloured?
 (a) TiCl_3 (b) FeCl_3 [2008]
 (c) CoCl_2 (d) All of these
21. The purple colour of KMnO_4 is due to the transition [2009]
 (a) C.T. ($L \rightarrow M$) (b) C.T. ($M \rightarrow L$)
 (c) $d-d$ (d) $p-d$
22. To obtain silver from silver amalgam, it is heated in vessel which is made of – [2009]
 (a) Cu (b) Fe
 (c) Ni (d) Zn
23. The compounds containing complex oxyanion CrO_4^{2-} are intensely yellow coloured because [2010]
 (a) Chromium ion in CrO_4^{2-} is a transition metal ion
 (b) Cr and O are π -bonded and the allowed $\pi \rightarrow \pi^*$ transition occurs in the visible region
 (c) $\text{Cr} \rightarrow \text{O}$ charge transfer is responsible for yellow colour
 (d) Compounds have strong absorption at $\sim 640 \text{ nm}$
24. The only cations present in a slightly acidic solutions are Fe^{3+} , Zn^{2+} and Cu^{2+} . The reagent that when added in excess to this solution would identify and separate Fe^{3+} in one step is [2010]
 (a) 2 M HCl (b) 6 M NH_3
 (c) 6 M NaOH (d) H_2S gas
25. The colour of copper sulphide is [2010]
 (a) Blue (b) Black
 (c) Red (d) Green
26. Which one of the following statements concerning lanthanide elements is false? [2010]
 (a) Lanthanides are separated from one another by ion exchange method
 (b) The ionic radii of trivalent lanthanides steadily increase with increase in atomic number
 (c) All lanthanides are highly dense metals
 (d) Most characteristic oxidation state of lanthanides is +3
27. White silver surface turns black when O_3 is passed over it. This is due to the formation of [2011]
 (a) silver hydroxide
 (b) freshly reduced silver which is black in colour
 (c) silver oxide
 (d) a complex compound of silver and ozone
28. In which of the following cases, the stability of two oxidation states is correctly represented [2011]
 (a) $\text{Ti}^{3+} > \text{Ti}^{4+}$ (b) $\text{Mn}^{2+} > \text{Mn}^{3+}$
 (c) $\text{Fe}^{2+} > \text{Fe}^{3+}$ (d) $\text{Cu}^+ > \text{Cu}^{2+}$
29. Cuprous ion is colourless while cupric ion is coloured because [2012]
 (a) Both have half filled p-and d-orbitals
 (b) Cuprous ion has incomplete d-orbital and cupric ion has a complete d-orbital
 (c) Both have unpaired electrons in the d-orbitals
 (d) Cuprous ion has complete d-orbital and cupric ion has an incomplete d-orbital.
30. A compound of a metal ion M^{x+} ($Z = 24$) has a spin only magnetic moment of $\sqrt{15}$ Bohr Magnetons. The number of unpaired electrons in the compound are [2013]
 (a) 2 (b) 4
 (c) 5 (d) 3
31. Identify the incorrect statement among the following: [2015]
 (a) Lanthanoid contraction is the accumulation of successive shrinkages.
 (b) As a result of lanthanoid contraction, the properties of $4d$ series of the transition elements have no similarities with the $5d$ series of elements.
 (c) Shielding power of $4f$ electrons is quite weak.
 (d) There is a decrease in the radii of the atoms or ions as one proceeds from La to Lu.
32. Consider the following statements [2016]
 (I) $\text{La}(\text{OH})_3$ is the least basic among hydroxides of lanthanides.
 (II) Zr^{4+} and Hf^{4+} possess almost the same ionic radii.
 (III) Ce^{4+} can act as an oxidizing agent.

Which of the above is/are true ?

- (a) (I) and (III) (b) (II) and (III)
(c) (II) only (d) (I) and (II)

33. For d-block elements the first ionization potential is of the order [2017]

- (a) $\text{Zn} > \text{Fe} > \text{Cu} > \text{Cr}$ (b) $\text{Sc} = \text{Ti} < \text{V} = \text{Cr}$
(c) $\text{Zn} < \text{Cu} < \text{Ni} < \text{Co}$ (d) $\text{V} > \text{Cr} > \text{Mn} > \text{Fe}$

TYPE B : ASSERTION REASON QUESTIONS

Directions for (Qs. 34-42) : These questions consist of two statements, each printed as Assertion and Reason. While answering these questions, you are required to choose any one of the following five responses.

- (a) If both Assertion and Reason are correct and the Reason is a correct explanation of the Assertion.
(b) If both Assertion and Reason are correct but Reason is not a correct explanation of the Assertion.
(c) If the Assertion is correct but Reason is incorrect.
(d) If both the Assertion and Reason are incorrect.
(e) If the Assertion is incorrect but the Reason is correct.

34. **Assertion:** Pure iron is not used for making tools and machines.

Reason: Pure iron is hard. [1998]

35. **Assertion :** Iron is found in free state in nature.

Reason : Iron is highly reactive element. [2001]

36. **Assertion :** A solution of FeCl_3 in water produces brown precipitate on standing.

Reason : Hydrolysis of FeCl_3 takes place in water. [2001]

37. **Assertion :** Cuprous ion (Cu^+) has unpaired electrons while cupric ion (Cu^{2+}) does not.

Reason : Cuprous ion (Cu^+) is colourless whereas cupric ion (Cu^{2+}) is blue in the aqueous solution. [2002]

38. **Assertion :** Solution of Na_2CrO_4 in water is intensely coloured.

Reason : Oxidation state of Cr in Na_2CrO_4 is +VI [2003]

39. **Assertion :** The free gaseous Cr atom has six unpaired electrons

Reason : Half-filled s orbital has greater stability. [2004]

40. **Assertion :** SnI_4 is an orange solid.

Reason : The colour arises due to charge transfer. [2007]

41. **Assertion :** Magnetic moment of Dy is highest among lanthanoids.

Reason : Orbital motion contributes magnetic moment. [2007]

42. **Assertion :** C – O bond in metal carbonyls is long.

Reason : There is delocalisation of electrons from filled d orbitals into the empty orbitals on the CO ligands. [2007]

Directions for (Qs.43-47) : Each of these questions contains an Assertion followed by Reason. Read them carefully and answer the question on the basis of following options. You have to select the one that best describes the two statements.

- (a) If both Assertion and Reason are correct and Reason is the correct explanation of Assertion.
(b) If both Assertion and Reason are correct, but Reason is not the correct explanation of Assertion.

- (c) If Assertion is correct but Reason is incorrect.
(d) If both the Assertion and Reason are incorrect.

43. **Assertion :** Europium (II) is more stable than cerium (II).

Reason : Cerium salts are used as catalyst in petroleum cracking. [2010]

44. **Assertion :** Lead, tin and bismuth are purified by liquation method.

Reason : Lead, tin and bismuth have low m.p. as compared to impurities [2010]

45. **Assertion :** Transition metals are good catalysts. [2015]

Reason : V_2O_5 or Pt is used in the preparation of H_2SO_4 by contact process.

46. **Assertion :** Magnetic moment values of actinides are lesser than the theoretically predicted values.

Reason : Actinide elements are strongly paramagnetic. [2013, 2016]

47. **Assertion :** Transition metals show variable valency.

Reason : Transition metals have a large energy difference between the ns^2 and $(n-1)d$ electrons. [2017]

HINTS & SOLUTIONS

Type A : Multiple Choice Questions

- (d) Malachite is an ore of copper
 $\text{Cu}(\text{OH})_2 \cdot \text{CuCO}_3$
- (d) The chief ore of mercury is HgS (cinnabar).
- (c) Out of all the elements given, manganese has the highest oxidation state of + 7 in KMnO_4 . Chromium has highest oxidation state of +6 in $\text{K}_2\text{Cr}_2\text{O}_7$, Vanadium has + 5 in V_2O_5 and iron has maximum of + 3 in Fe_2O_3 .
- (b) Gun metal is an alloy of Cu, Zn and Sn.
- (a) Transition elements form coloured ions due to $d-d$ transitions. In the presence of ligands, there is splitting of energy levels of d -orbitals. They no longer remain degenerated. So, electronic transition may occur between two d -orbitals.
- (c) CuSO_4 and KCN reacts to form complex.
 $\text{CuSO}_4 + 2\text{KCN} \longrightarrow \text{Cu}(\text{CN})_2 + \text{K}_2\text{SO}_4$
 $\text{Cu}(\text{CN})_2 \longrightarrow 2\text{CuCN} + (\text{CN})_2$
 $2\text{CuCN} + 6\text{KCN} \longrightarrow 2\text{K}_3[\text{Cu}(\text{CN})_4]$
- (c) The paramagnetic character is exhibited by species having unpaired electrons. Further paramagnetic character is directly proportional to number of unpaired electrons.

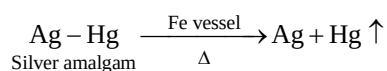
Configuration	Unpaired electron
$\text{Cu}^+ [\text{Ne}] 3s^2 3p^6 3d^{10}$	0
$\text{Cu}^{2+} [\text{Ne}] 3s^2 3p^6 3d^9$	1
$\text{Fe}^{2+} [\text{Ne}] 3s^2 3p^6 3d^6$	4
$\text{Fe}^{3+} [\text{Ne}] 3s^2 3p^6 3d^5$	5
- (a) Mohr's salt is $\text{FeSO}_4 \cdot (\text{NH}_4)_2\text{SO}_4 \cdot 6\text{H}_2\text{O}$
- (c) German silver is alloy of Cu, Zn and Ni. Cu is 60%, Zn is 20%, and Ni is 20%.
- (d) Composition of duralumin is 95% Al, 4% Cu, 0.5% Mn, 0.5% Mg.
 It is light tough and anti-corrosive alloy which is used in making aeroplanes etc.
- (c) Mohr's salt is $(\text{NH}_4)_2\text{SO}_4 \cdot \text{FeSO}_4 \cdot 6\text{H}_2\text{O}$.
- (c) $\text{BaO} + \text{ZnO} \rightarrow \text{BaZnO}_2$
 Philosopher's wool
- (b) Cassiterite is an ore of tin (Sn).
- (c) Species having incompletely filled d -orbitals also have unpaired electron in d -orbital and hence will be coloured. Species having completely filled or vacant d -orbitals does not have any unpaired electron in d orbital, hence it will be colourless.
 V^{3+} in VCl_3 : $[\text{Ne}] 3s^2 3p^6 3d^2$
 V^{2+} in VSO_4 : $[\text{Ne}] 3s^2 3p^6 3d^3$
 V^{5+} in Na_3VO_4 : $[\text{Ne}] 3s^2 3p^6 3d^0$
 V^{2+} in $[\text{V}(\text{H}_2\text{O})_6]\text{SO}_4$: $[\text{Ne}] 3s^2 3p^6 3d^3$
- (d)
- (a) As we move down in groups 13, 14 and 15, inertness of s^2 electrons of valence shell increases (inert pair effect). Thus in metals present at the bottom of the groups 13, 14, and 15 lower oxidation state becomes more important, viz. Pb (+2 state rather than +4), Bi (+3 state rather than +5) and Ti (+1 rather than +3).
- (a) SbF_5 , being the stronger Lewis acid, displaces the weaker one (MnF_4) from its salt. MnF_4 , being unstable, decomposes to give MnF_3 and fluorine.
 $\text{K}_2\text{MnF}_6 + 2\text{SbF}_5 \rightarrow 2\text{SbF}_6 + \text{MnF}_4$
 Unstable
 $\text{MnF}_4 \rightarrow \text{MnF}_3 + \frac{1}{2}\text{F}_2$
- (b) Deep Blue.
- (d) Co-60 is used as anticancerous among the given radioactive isotopes. It emits β -particles and energetic gamma rays, for which reason it is used in radiation therapy.
- (d) The colour is due to presence of unpaired d -electrons.
 $\text{Ti}^{3+} = [\text{Ar}] 3d^1$ (one unpaired electron)
 $\text{Fe}^{3+} = [\text{Ar}] 3d^5$ (five unpaired electrons)
 $\text{Co}^{2+} = [\text{Ar}] 3d^7$ (three unpaired electrons)
 So all of them are coloured.
- (a) The permanganate ion has an intense purple colour. Mn (+ VII) has a d^0 configuration. So the colour arises from charge transfer and not from $d-d$ spectra.

In MnO_4^- an electron is momentarily changing O^{2-} to O^- and reducing the oxidation state of the metal from Mn(VII) to Mn(VI). Charge transfer requires that the energy levels on the two different atoms are fairly close.

$$\text{O} = (8) = \underset{\text{K}}{2}, \underset{\text{L}}{6}; \quad \text{Mn} (25) = \underset{\text{K}}{2}, \underset{\text{L}}{8}, \underset{\text{M}}{15}$$

Hence the charge transfer occurs from $\text{L} \rightarrow \text{M}$.

22. (b) Fe and Pt do not form amalgam

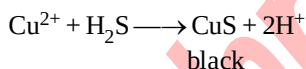


Vessel made of other metal will form amalgam with liberated mercury.

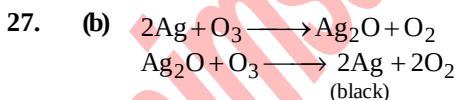
23. (c) Chromium is in VI oxidation state in CrO_4^{2-} ion and therefore, it has no unpaired electron in its d-orbital. However, due to charge transfer $\text{Cr} \rightarrow \text{O}$, this ion shows intense yellow colour.

24. (b) Fe^{3+} does not form complex compound with NH_3 whereas Cu^{2+} and Zn^{2+} form complex with NH_3 .

25. (b) Copper sulphide is black in colour. Cu^{2+} is placed in II group of inorganic qualitative analysis. It is precipitated in the form of sulphide by passing H_2S in presence of dil. HCl.



26. (b) The ionic radii of trivalent lanthanides decreases progressively with increase in atomic number. This decrease is known as lanthanide contraction.



28. (b) $\text{Mn}^{2+} (3d^5)$ is more stable than $\text{Mn}^{3+} (3d^4)$.

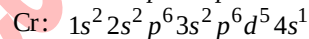
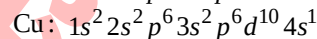
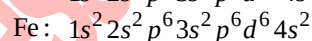
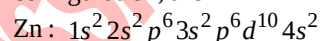
29. (d) In $\text{Cu}^+ [\text{Ar}] 3d^{10}$ there is no unpaired electron, $\text{Cu}^{2+} [\text{Ar}] 3d^9$ contains one unpaired electron hence coloured.

30. (d) Magnetic moment $\mu = \sqrt{n(n+2)}$ where $n = \text{number of unpaired electrons}$
 $\sqrt{15} = \sqrt{n(n+2)} \therefore n = 3$

31. (b) As a result of lanthanoid contraction change in ionic radii on going from elements of 4d to 5d transition series is very small. Thus chemical properties of 4d and 5d series of transition elements are similar.

32. (b) As a result of lanthanide contraction Zr^{4+} and Hf^{4+} possess almost the same ionic radii. Ce^{4+} is an oxidising agent. Ce^{4+} gains electron to acquire more stable Ce^{3+} state. $\text{La}(\text{OH})_3$ is the most basic among lanthanide hydroxides.

33. (a) The ionisation energies increase with increase in atomic number. However, the trend is irregular among some d-block elements. On the basis of electronic configuration, the



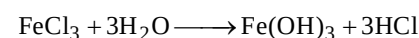
IE_1 follows the order : $\text{Zn} > \text{Fe} > \text{Cu} > \text{Cr}$

Type B : Assertion Reason Questions

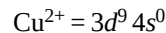
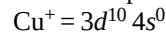
34. (c) Pure iron is not used for making tools and machines as it is soft. However, an alloy of iron with carbon is hard and less reactive than pure iron.

35. (e) Iron is not found in free state in nature because it is highly reactive.

36. (a) Solution of FeCl_3 produces brown precipitate on standing due to hydrolysis in water



37. (e) Cu^+ (cuprous ion) does not have any unpaired electron while cupric (Cu^{2+}) ion has one unpaired electron in 3d shell.



Cuprous ion is colourless because it does not have any unpaired electron but Cu^{2+} ion is blue in aqueous solution due to formation of complex with water molecules. So assertion is wrong but reason is true.

38. (b) The colour of CrO_4^{2-} is due to charge transfer spectra. There is no electron in the d-orbital of Cr (VI). So, no electronic excitation is possible with their d-orbital.

39. (c) The free gaseous Cr atom has six unpaired electrons, because one electron jumps from $4s^2$ orbital to $3d$ orbital making latter exactly half-filled, a comparatively stable entity. $\text{Cr}_{24} [\text{Ar}] 3d^5 4s^1$.
40. (a) The orange colour of SnI_4 is due to charge transfer spectra. Blue light is absorbed by the compound which causes the transfer of an e^- from I to Sn. (Here charge is transferred from one atom to another atom.) The reflected light thus contains a higher proportion of red and orange.
41. (a) In lanthanide ions the $4f e^-$ are well shielded from external field by the overlying $5s$ and $5p$ electrons. Thus the magnetic effect of the motion of the electron in its orbital is not quenched out. Thus the magnetic moment must be calculated taking into account both the magnetic moment from unpaired e^- spins and that from orbital motion.
- $$\mu = g\sqrt{J(J+1)}$$
- Where $g = 1 + \frac{S(S+1) - L(L+1)}{2J(J+1)}$
- $J = L - S$ when the shell is less than half fill
 $= L + S$ when the shell is more than half fill.
 In $\text{Dy}^{3+} ([\text{Xe}] 4f^9)$ f -level is more than half fill hence spin and orbital motion work together, highest in lanthanoids.
 Hence, both assertion and reason are true and reason is correct explanation of assertion.
42. (a) In metal carbonyls a pair of π -bond arises from overlap of filled d -orbitals on the metal with a pair of π -antibonding orbitals projecting from the carbon of the CO. The π -bonding has the effect of weakening the C–O bond as compared with free CO. Hence C–O bond in metal carbonyls is long. Hence assertion and reason both are true and reason is a correct explanation of assertion.
43. (b) The electronic configurations of Europium (II) and cerium (II) are $\text{Eu}^{2+} : [\text{Xe}] 4f^7, 5d^{10}$
 $\text{Ce}^{2+} : [\text{Xe}] 4f^1, 5d^1$
 In Eu^{2+} , f -subshell is half filled and d -subshell is completely filled and thus more stable.
44. (a)
45. (b) Due to larger surface area and variable valencies to form intermediate absorbed complex easily, transition metals are used as catalysts.
46. (b) The magnetic moment values are lesser than the theoretically predicted values due to the fact that $5f$ electrons of actinides are less effectively shielded which results in quenching of orbital contribution.
47. (c) The assertion is correct but the reason is false. Actually transition metal show variable valency due to very small difference between the ns^2 and $(n-1)d$ electrons.

TYPE A : MULTIPLE CHOICE QUESTIONS

- The compound which is not coloured is [1997]
 - $K_4[Fe(CN)_6]$
 - $K_3[Fe(CN)_6]$
 - $Na_2[CdCl_4]$
 - $Na_2[CuCl_4]$
- The number of unpaired electrons in $Ni(CO)_4$ is [1997]
 - 0
 - 1
 - 3
 - 5
- The organometallic compound is : [1997]
 - $Ti(OCOCH_3)_4$
 - $Ti(C_2H_5)_4$
 - $Ti(OC_6H_5)_4$
 - $Ti(OC_2H_5)_4$
- Mercuric chloride is soluble in KI solution due to : [1997]
 - the formation of complex ion
 - common iodide ion
 - none of the above
 - both (a) and (b)
- The EAN of Zn in $Zn(OH)_4^{2-}$ complex is: [2000]
 - 16
 - 26
 - 36
 - 46
- The reagent commonly used to determine hardness of water titrimetrically is : [2003]
 - oxalic acid
 - disodium salt of EDTA
 - sodium citrate
 - sodium thiosulphate
- The ion which is not tetrahedral in shape is [2003]
 - BF_4^-
 - NH_4^+
 - $[Cu(NH_3)_4]^{2+}$
 - $NiCl_4^{2-}$
- The complex used as an anticancer agent is [2003]
 - meso*- $[Co(NH_3)_3Cl_3]$
 - cis*- $[PtCl_2(NH_3)_2]$
 - cis*- $K_2[PtCl_2Br_2]$
 - Na_2CoCl_4
- The ligand called π acid is : [2003]
 - CO
 - NH_3
 - $C_2O_4^{2-}$
 - Ethylenediamine
- Which one of the following forms, with an excess of CN^- (cyanide), a complex having co-ordination number two? [2004]
 - Cu^+
 - Ag^+
 - Ni^{2+}
 - $Al(OH)_3$
- Which of the following is not considered as an organometallic compound? [2004]
 - cis*-platin
 - Ferrocene
 - Zeise's salt
 - Grignard reagent
- Which of the following does not have optical isomer? [2004]
 - $[Co(NH_3)_3Cl_3]$
 - $[Co(en)_3]Cl_3$
 - $[Co(en)_2Cl_2]Cl$
 - $[Co(en)(NH_3)_2Cl_2]Cl$
- In which of the following pairs both the complexes show optical isomerism? [2005]
 - cis*- $[Cr(C_2O_4)_2Cl_2]^{3-}$, *cis*- $[Co(NH_3)_4Cl_2]$
 - $[Co(en)_3]Cl_3$, *cis*- $[Co(en)_2Cl_2]Cl$
 - $[PtCl(dien)]Cl$, $[NiCl_2Br_2]^{2-}$
 - $[Co(NO_3)_3(NH_3)_3]$, *cis*- $[Pt(en)_2Cl_2]$
- An aqueous solution of $CoCl_2$ on addition of excess of concentrated HCl turns blue due to formation of : [2005]
 - $[Co(H_2O)_4Cl_2]$
 - $[Co(H_2O)_2Cl_4]^{2-}$
 - $[CoCl_4]^{2-}$
 - $[Co(H_2O)_2Cl_2]$
- The diamagnetic species is : [2005]
 - $[Ni(CN)_4]^{2-}$
 - $[NiCl_4]^{2-}$
 - $[CoCl_4]^{2-}$
 - $[CoF_6]^{2-}$
- The correct order for the wavelength of absorption in the visible region is : [2005]
 - $[Ni(NO_2)_6]^{4-} < [Ni(NH_3)_6]^{2+} < [Ni(H_2O)_6]^{2+}$
 - $[Ni(NO_2)_6]^{4-} < [Ni(H_2O)_6]^{2+} < [Ni(NH_3)_6]^{2+}$
 - $[Ni(H_2O)_6]^{2+} < [Ni(NH_3)_6]^{2+} < [Ni(NO_2)_6]^{4-}$
 - $[Ni(NH_3)_6]^{2+} < [Ni(H_2O)_6]^{2+} < [Ni(NO_2)_6]^{4-}$

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17. The pair in which both species have same magnetic moment (spin only value) is : [2006]
 (a) $[\text{Cr}(\text{H}_2\text{O})_6]^{2+}$, $[\text{CoCl}_4]^{2-}$
 (b) $[\text{Cr}(\text{H}_2\text{O})_6]^{2+}$, $[\text{Fe}(\text{H}_2\text{O})_6]^{2+}$
 (c) $[\text{Mn}(\text{H}_2\text{O})_6]^{2+}$, $[\text{Cr}(\text{H}_2\text{O})_6]^{2+}$
 (d) $[\text{CoCl}_4]^{2-}$, $[\text{Fe}(\text{H}_2\text{O})_6]^{2+}$
18. The number of possible isomers of an octahedral complex $[\text{Co}(\text{C}_2\text{O}_4)_2(\text{NH}_3)_2]^-$ is : [2006]
 (a) 1 (b) 2
 (c) 3 (d) 4
19. The ligands in anti-cancer drug *cis*-platin are:
 (a) NH_3 , Cl (b) NH_3 , H_2O [2006]
 (c) Cl, H_2O (d) NO, Cl
20. Which statement is true for ferrocene? [2007]
 (a) All Fe-C are of equal length
 (b) It has sandwich type structure
 (c) It was the first discovered organometallic compound
 (d) All of these.
21. During estimation of nickel, we prepare nickel dimethylglyoxime, a scarlet red solid. This compound is _____. [2007]
 (a) ionic (b) covalent
 (c) metallic (d) non-ionic complex.
22. Which of the following metal ions will form complexes with the same magnetic moment and geometry irrespective of the nature of ligands?
 (a) Ni^{2+} (b) Fe^{2+} [2007]
 (c) Cu^{2+} (d) Co^{2+}
23. Wavelength of red light is absorbed by the complex [2007]
 (a) $[\text{Cu}(\text{CN})_4]^{2-}$ (b) $[\text{Cu}(\text{NH}_3)_4]^{2+}$
 (c) CuSO_4 (d) $\text{Cu}(\text{CN})_2$
24. In the change $[\text{Cu}(\text{H}_2\text{O})_6]^{2+} \xrightarrow{\text{HCl}} [\text{CuCl}(\text{H}_2\text{O})_5]^+$, the colour changes from [2007]
 (a) blue to green (b) blue to pink
 (c) pink to green (d) pink to blue.
25. $[\text{Fe}(\text{NO}_2)_3\text{Cl}_3]$ and $[\text{Fe}(\text{ONO})_3\text{Cl}_3]$ shows [2008]
 (a) linkage isomerism
 (b) geometrical isomerism
 (c) optical isomerism
 (d) none of the above
26. Among the following the compound that is both paramagnetic and coloured is [2009]
 (a) $\text{K}_2\text{Cr}_2\text{O}_7$ (b) $(\text{NH}_4)_2[\text{TiCl}_6]$
 (c) VOSO_4 (d) $\text{K}_3\text{Cu}(\text{CN})_4$
27. Which of the following complex has zero magnetic moment (spin only)? [2009]
 (a) $[\text{Ni}(\text{NH}_3)_6]\text{Cl}_2$ (b) $\text{Na}_3[\text{FeF}_6]$
 (c) $[\text{Cr}(\text{H}_2\text{O})_6]\text{SO}_4$ (d) $\text{K}_4[\text{Fe}(\text{CN})_6]$
28. A chemist wants to determine the molecular geometry of the $[\text{CoCl}_4]^{2-}$ ion. Which of the following gives the best suggestion for a measurement and for the interpretation of that measurement? [2009]
 (a) Using absorption spectroscopy, measure λ_{max} then calculate Δ_o for octahedral geometry
 (b) Measure the molecule's magnetic moment and use the result to estimate the number of unpaired spins in the molecule. If this number is low, the geometry is likely to be square planar; otherwise, it is likely to be tetrahedral
 (c) Measure the molecule's magnetic moment and use the result to estimate the number of unpaired spins in the molecule. If this number is low, the geometry is likely to be tetrahedral; otherwise, it is likely to be square planar
 (d) Measure the molecule's magnetic moment and use the result to estimate the number of unpaired spins in the molecule. If this number is low, the geometry is likely to be tetrahedral; otherwise, it is likely to be octahedral
29. How many pairs of enantiomers are possible for following complex compound, $[\text{M}(\text{AB})(\text{CD})\text{ef}]^{\text{n}\pm}$ (where AB, CD – Unsymmetrical bidentate ligand, e, f – monodentate ligands) [2009]
 (a) 20 (b) 5
 (c) 10 (d) 8

30. A complex $[\text{CoL}_6]^{n+}$ where L is neutral ligand has a magnetic moment $\mu = 4.5$ B. M. Hence,
(a) Co must be in +2 oxidation state [2010]
(b) L must be a strong ligand
(c) The complex must be highly dist
(d) Co must be in +3 oxidation state
31. Silver chloride dissolves in: [2010]
(a) Water (b) Conc. HCl
(c) NH_4OH (d) CCl_4
32. The IUPAC name of the complex $\text{Hg}[\text{Co}(\text{CNS})_4]$ is [2010]
(a) mercury tetrathiocyanatocobaltate (II)
(b) mercury cobalttetrasulphocyano (II)
(c) mercury tetrasulphocyanidecobalt (II)
(d) tetrasulphocyanatocobalt mercurate (II)
33. What is incorrect about homoleptic metal carbonyls? [2010]
(a) $\text{M}-\text{C}$, σ -bond is formed by donation of lone pair of electrons from CO
(b) $\text{M}-\text{C}$, π -bond is formed by back donation of electron from filled d -orbital of metal to vacant p -orbital of carbon
(c) $\text{M}-\text{CO}$ bonding produce synergic effect
(d) Metal carbonyl contain only σ -bonds
34. In $\text{Fe}_2(\text{CO})_9$, the two iron atoms are [2011]
(a) linked only directly
(b) linked directly along with 3 CO molecules as bridging ligands
(c) linked only through 3 CO molecules as bridging ligands
(d) joined through one CO group as bridging ligands.
35. Which method can be used to distinguish $[\text{Co}(\text{NH}_3)_6][\text{Cr}(\text{NO}_2)_6]$ and $[\text{Cr}(\text{NH}_3)_6][\text{Co}(\text{NO}_2)_6]$ [2011]
(a) by measurement of their conductivity
(b) by titration method
(c) by precipitation method with AgNO_3
(d) by electrolysis of their aqueous solutions
36. The $[\text{Fe}(\text{CN})_6]^{3-}$ complex ion [2011]
(a) exhibits planar geometry
(b) is diamagnetic
(c) should be very stable
(d) has 2 unpaired electrons
37. When AgNO_3 is added to a solution of $\text{Co}(\text{NH}_3)_5\text{Cl}_3$, the precipitate of AgCl shows two ionizable chloride ions. This means: [2012]
(a) Two chlorine atoms satisfy primary valency and one secondary valency
(b) One chlorine atom satisfies primary as well as secondary valency
(c) Three chlorine atoms satisfy primary valency
(d) Three chlorine atoms satisfy secondary valency
38. The hypothetical complex chloro-diaquatriamminecobalt (III) chloride can be represented as [2013]
(a) $[\text{CoCl}(\text{NH}_3)_3(\text{H}_2\text{O})_2]\text{Cl}_2$
(b) $[\text{Co}(\text{NH}_3)_3(\text{H}_2\text{O})\text{Cl}_3]$
(c) $[\text{Co}(\text{NH}_3)_3(\text{H}_2\text{O})_2\text{Cl}]$
(d) $[\text{Co}(\text{NH}_3)_3(\text{H}_2\text{O})_3]\text{Cl}_3$
39. The coordination number and the oxidation state of the element 'E' in the complex $[\text{E}(\text{en})_2(\text{C}_2\text{O}_4)]\text{NO}_2$ (where (en) is ethylene diamine) are, respectively, [2014]
(a) 6 and 2 (b) 4 and 2
(c) 4 and 3 (d) 6 and 3
40. In the isoelectronic series of metal carbonyl, the CO bond strength is expected to increase in the order: [2014]
(a) $[\text{Mn}(\text{CO})_6]^+ < [\text{Cr}(\text{CO})_6] < [\text{V}(\text{CO})_6]^-$
(d) $[\text{V}(\text{CO})_6]^- < [\text{Cr}(\text{CO})_6] < [\text{Mn}(\text{CO})_6]^+$
(c) $[\text{V}(\text{CO})_6]^- < [\text{Mn}(\text{CO})_6]^+ < [\text{Cr}(\text{CO})_6]$
(d) $[\text{Cr}(\text{CO})_6] < [\text{Mn}(\text{CO})_6]^+ < [\text{V}(\text{CO})_6]^-$

41. Which of the following is paramagnetic? [2014]
- (a) $[\text{Fe}(\text{CN})_6]^{4-}$ (b) $[\text{Ni}(\text{CO})_4]$
- (c) $[\text{Ni}(\text{CO})_4]^{2-}$ (d) $[\text{CoF}_6]^{3-}$
42. Coordination compounds have great importance in biological systems. In this context which of the following statements is **incorrect**? [2015]
- (a) Cyanocobalamin is B_{12} and contains cobalt
- (b) Haemoglobin is the red pigment of blood and contains iron
- (c) Chlorophylls are green pigments in plants and contain calcium
- (d) Carboxypeptidase - A is an exzyme and contains zinc.
43. Consider the following complex $[\text{Co}(\text{NH}_3)_5\text{CO}_3]\text{ClO}_4$. The coordination number, oxidation number, number of d -electrons and number of unpaired d -electrons on the metal are respectively [2015]
- (a) 6, 3, 6, 0 (b) 7, 2, 7, 1
- (c) 7, 1, 6, 4 (d) 6, 2, 7, 3
44. The deep blue colour produced on adding excess of ammonia to copper sulphate is due to presence of [2016]
- (a) Cu^{2+} (b) $[\text{Cu}(\text{NH}_3)_4]^{2+}$
- (c) $[\text{Cu}(\text{NH}_3)_6]^{2+}$ (d) $[\text{Cu}(\text{NH}_3)_2]^{2+}$
45. 0.02 mole of $[\text{Co}(\text{NH}_3)_5\text{Br}]\text{Cl}_2$ and 0.02 mole of $[\text{Co}(\text{NH}_3)_5\text{Cl}]\text{SO}_4$ are present in 200 cc of a solution X. The number of moles of the precipitates Y and Z that are formed when the solution X is treated with excess silver nitrate and excess barium chloride are respectively [2016]
- (a) 0.02, 0.02 (b) 0.01, 0.02
- (c) 0.02, 0.04 (d) 0.04, 0.02
46. Which of the following coordination compounds would exhibit optical isomerism? [2017]
- (a) pentamminenitrocobalt(III) iodide
- (b) diamminedichloroplatinum(II)
- (c) trans-dicyanobis (ethylenediamine) chromium (III) chloride
- (d) tris-(ethylenediamine) cobalt (III) bromide

TYPE B : ASSERTION REASON QUESTIONS

Directions for (Qs. 47-52) : These questions consist of two statements, each printed as Assertion and Reason. While answering these questions, you are required to choose any one of the following five responses.

- (a) If both Assertion and Reason are correct and the Reason is a correct explanation of the Assertion.
- (b) If both Assertion and Reason are correct but Reason is not a correct explanation of the Assertion.
- (c) If the Assertion is correct but Reason is incorrect.
- (d) If both the Assertion and Reason are incorrect.
- (e) If the Assertion is incorrect but the Reason is correct.
47. **Assertion:** AgCl dissolves in NH_4OH solution.
Reason: Due to formation of a complex [1998]
48. **Assertion :** NF_3 is a weaker ligand than $\text{N}(\text{CH}_3)_3$
Reason : NF_3 ionizes to give F^- ions in aqueous solution. [2003]
49. **Assertion :** The $[\text{Ni}(\text{en})_3]\text{Cl}_2$ (en = ethylenediamine) has lower stability than $[\text{Ni}(\text{NH}_3)_6]\text{Cl}_2$.
Reason : In $[\text{Ni}(\text{en})_3]\text{Cl}_2$, the geometry of Ni is trigonal bipyramidal. [2004]
50. **Assertion :** Potassium ferrocyanide is diamagnetic, whereas potassium ferricyanide is paramagnetic.
Reason : Crystal field splitting in ferrocyanide ion is greater than that of ferricyanide ion. [2005]

51. **Assertion** : $[\text{Co}(\text{NO}_2)_3(\text{NH}_3)_3]$ does not show optical isomerism.

Reason : It has a plane of symmetry. [2006]

52. **Assertion** : Copper sulphate solution is not stored in zinc vessel.

Reason : Zinc forms complex with CuSO_4 . [2007]

Directions for (Qs.53-58) : Each of these questions contains an Assertion followed by Reason. Read them carefully and answer the question on the basis of following options. You have to select the one that best describes the two statements.

- (a) If both Assertion and Reason are correct and Reason is the correct explanation of Assertion.
- (b) If both Assertion and Reason are correct, but Reason is not the correct explanation of Assertion.
- (c) If Assertion is correct but Reason is incorrect.
- (d) If both the Assertion and Reason are incorrect.

53. **Assertion** : When NO reacts with FeSO_4 , a brown coloured complex is formed.

Reason : In the complex, the coordination number of Fe is 6. [2009]

54. **Assertion** : A chelating ligand must possess two or more lone pairs at such a distance that it may form suitable strain free rings at the metal ion.

Reason : $\text{H}_2\text{N}-\text{NH}_2$ is a chelating ligand. [2010]

55. **Assertion** : Low spin complexes have lesser number of unpaired electrons.

Reason : $[\text{FeF}_6]^{3-}$ is a low spin complex. [2011]

56. **Assertion** : $[\text{FeF}_6]^{3-}$ is a low spin complex.

Reason : Low spin complexes have lesser number of unpaired electrons. [2013]

57. **Assertion** : Ethylenediaminetetraacetate ion forms an octahedral complex with the metal ion.

Reason : It has six donor atoms which coordinate simultaneously to the metal ion. [2014]

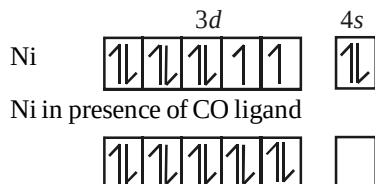
58. **Assertion** : $[\text{Fe}(\text{CN})_6]^{3-}$ is weakly paramagnetic while $[\text{Fe}(\text{CN})_6]^{4-}$ is diamagnetic.

Reason : $[\text{Fe}(\text{CN})_6]^{3-}$ has +3 oxidation state while $[\text{Fe}(\text{CN})_6]^{4-}$ has +2 oxidation state. [2017]

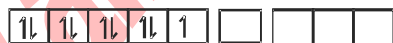
HINTS & SOLUTIONS

TYPE A : MULTIPLE CHOICE QUESTIONS

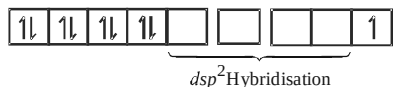
1. (c) In $\text{Na}_2[\text{CdCl}_4]$, Cd has oxidation state +2, so, its electronic configuration is $4d^{10}4s^0$. or all the 4 d orbitals are fully filled. Hence, there will not be $d-d$ transition resulting in colour. So, it is colourless.
2. (a) No. of unpaired electrons in $\text{Ni}(\text{CO})_4$ is zero as CO is a strong ligand which pairs up the unpaired electrons of Ni.



3. (b) Organo-metallic compound is (b) as it contains metal-carbon bonds. In others, direct link of carbon with metal is not present.
4. (a) $\text{HgCl}_2 + 4\text{KI} \longrightarrow \text{K}_2\text{HgI}_4 + 2\text{KCl}$
 HgCl_2 is soluble due to formation of complex ion HgI_4^{2-} ion.
5. (c) EAN for any complex ion
 $= [\text{At.No. of the central atom} - \text{Oxd. No. of the central atom} + 2 (\text{coordination No. of central atom})]$
 $= 30 - 2 + 2(4) = 36$
6. (b) The reagent commonly used is EDTA (ethylene diamine tetraacetate) which acts as ligand for metal ions responsible for hardness of water. They form metal ligand complex which renders the metal ion inactive by making them non-ionisable.
7. (c) In $[\text{Cu}(\text{NH}_3)_4]^{2+}$ the hybridisation is dsp^2
 $\text{Cu}^{2+} = 3d^9 4s^0$

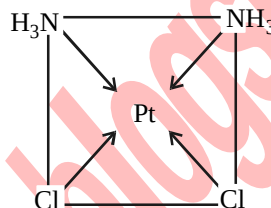


When ammonia approaches towards the Cu^{2+} it is observed that the unpaired electron in the d -orbital gets excited to $4p$ -orbital resulting in dsp^2 hybridisation.

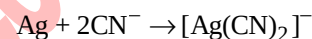


The shape of dsp^2 hybridisation is square planar.

8. (b) The complex used as an anticancer agent is *cis*-platin, *cis*- $[\text{PtCl}_2(\text{NH}_3)_2]$.

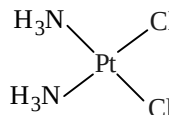


9. (a) Due to back bonding present between metal and carbonyl ligand in metal carbonyl, CO is termed as π -acid ligand.
10. (b) Among the given metal ions only Ag^+ forms complex with CN^- having co-ordination number 2.



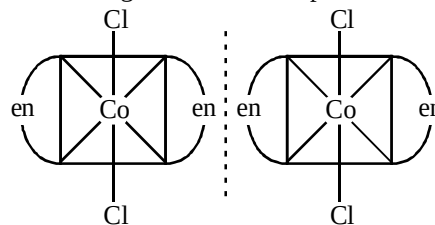
Coordination number of metals is defined as the number of σ bonds by which ligands are attached to the metal atom.

11. (a) The structural formula of *cis*-platin is



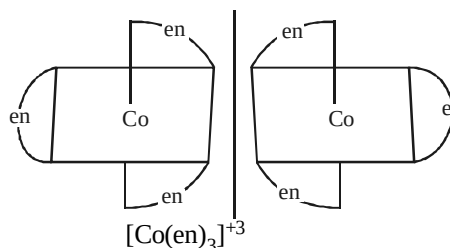
Since no carbon-metal bond is present, it is not an organometallic compound.

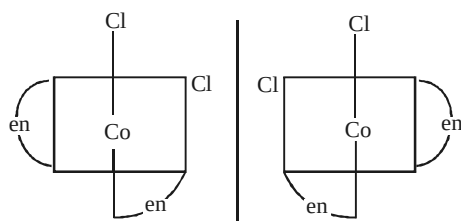
12. (c)



As clear from the figure, the mirror image is superimposable. So, they are not different compounds.

13. (b)

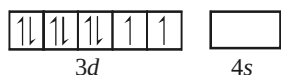




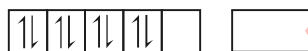
$\text{cis}[\text{Co}(\text{en})_2\text{Cl}_2]^+$

They form non-superimposable mirror image, so, they are optically active compounds.

14. (c) CoCl_2 is a weak Lewis acid. It reacts with chloride ion to produce salt containing the tetrahedral $[\text{CoCl}_4]^{2-}$ ion which is blue in colour.
15. (a) In $[\text{Ni}(\text{CN})_4]^{2-}$, nickel has oxidation no. of +2. So, electronic configuration of its outer most orbital is as follows :



However, CN^- is a strong ligand which forces the electron to pair up. Thus two unpaired electrons are forced to pair up by CN^- .



So, it becomes diamagnetic.

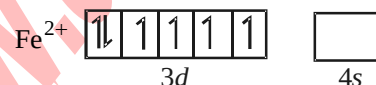
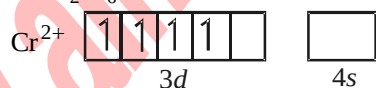
16. (a) For any metal cation, the magnitude of Δ_0 depends upon the nature of ligand. Higher the value of Δ_0 , lower will be the wave length absorbed. Δ_0 is crystal field stabilisation energy.

The value of Δ_0 for ligands varies as follows



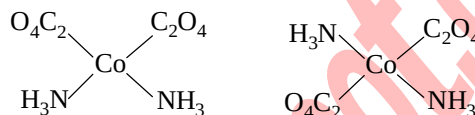
So, the wavelength absorbed will vary in reverse order or $\text{NO}_2^- < \text{NH}_3 < \text{H}_2\text{O}$

17. (b) $[\text{Cr}(\text{H}_2\text{O})_6]^{2+}$. Here Cr is in Cr^{2+} form



In $[\text{Fe}(\text{H}_2\text{O})]^{2+}$, Fe is in Fe^{2+} form. Both will have 4 unpaired electrons.

18. (c) The complex has three isomers (*cis*- and *trans*); *cis*-isomer shows optical isomerism



cis- (shows optical isomerism)

trans-

19. (a) The ligands in *cis*-platin $[\text{PtCl}_2(\text{NH}_3)_2]$ are Cl and NH_3 .

20. (d)

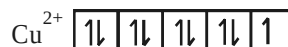


Ferrocene was the first organometallic compound discovered by G. Wilkinson in 1957. The bonding in these aromatic sandwich type structure is better considered as π -bonding involving the lateral overlap of d_{xz} and d_{yz} orbitals on Fe with the delocalized π -aromatic orbital from each cyclopentadienyl ring. All the five C-atoms are equidistant from Fe.

Hence all of these statements are true.

21. (d) Nickel dimethylglyoxime is a non ionic complex.
22. (c) Cu^{2+} forms complexes with the same magnetic moment and geometry irrespective of the nature of ligand. It can be explained by electronic configuration.

3d

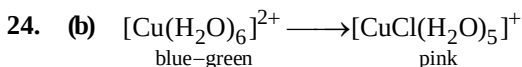


It has 9 electrons in 3d shell. Hence any incoming ligand whether it is strong or weak will result in the formation of same geometry (if number of ligands is same) because any ligand can do nothing with this unpaired e^- in 3d shell. Moreover, the complex formed will have same magnetic moment due to this unpaired e^- .

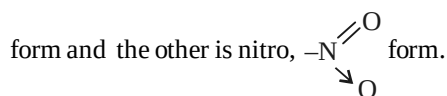
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23. (b) The compound which appears blue green, absorb red light as blue-green is complementary to red colour. Here $[\text{Cu}(\text{NH}_3)_4]^{2+}$ appears blue-green, so it absorbs red colour.



25. (a) The given compound contains $-\text{NO}_2$ group which can donate electrons either from O- or from -N. Thus, it shows linkage isomerism. Thus the two given compounds are linkage isomers, one is nitrite $-\text{O}-\text{N}=\text{O}$

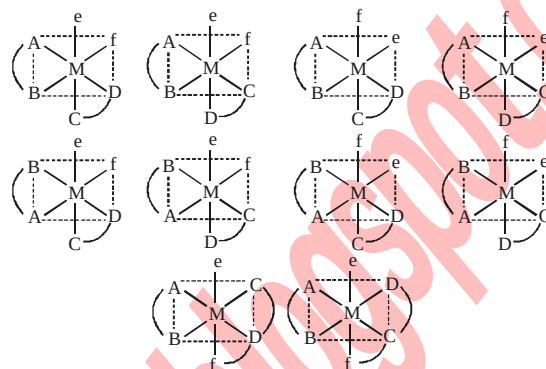


26. (c) (d) In $\text{K}_3[\text{Cu}(\text{CN})_4]$ Cu is in +1 oxidation state hence has no unpaired electron hence colourless and diamagnetic.
 (b) In $(\text{NH}_4)_2[\text{TiCl}_6]$ Ti is in +4 oxidation state, hence has no unpaired electron hence colourless and diamagnetic.
 (c) In VOSO_4 , V is in +4 oxidation state hence has one unpaired electron, thus it is coloured and paramagnetic.
 (a) In $\text{K}_2\text{Cr}_2\text{O}_7$, Cr is in +6 oxidation state, hence has no unpaired electron and thus it is diamagnetic. Though $\text{K}_2\text{Cr}_2\text{O}_7$ has no unpaired electron but it is coloured. This is due to charge transfer.

27. (d) $[\text{Ni}(\text{NH}_3)_6]\text{Cl}_2$ sp^3d^2 hybridisation
 2 unpaired electrons
 $\text{Na}_3[\text{FeF}_6]$ sp^3d^2 hybridisation
 3 unpaired electrons
 $[\text{Cr}(\text{H}_2\text{O})_6]\text{SO}_4$ d^2sp^3 hybridisation
 3 unpaired electrons
 $\text{K}_4[\text{Fe}(\text{CN})_6]$ d^2sp^3 hybridisation
 No unpaired electron
 Zero magnetic moment means all the electrons paired.

28. (b) In the complexes of C.N. 4, square planar geometry gives rise to low spin (spin paired) configurations whereas tetrahedral complexes display high spin configurations.

29. (c)

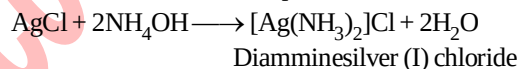


30. (d) Co must be in +3 oxidation state and the ligand L should be a weak ligand.



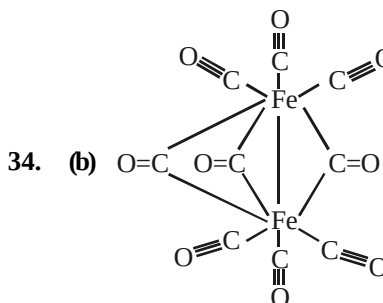
$n = 4, \mu = 4.5 \text{ BM.}$

31. (c) AgCl is insoluble in water, conc. HCl and CCl_4 . It dissolves in NH_4OH solution due to the formation of complex salt.



32. (a) The IUPAC name of the given complex is mercury tetrathiocyanatocobaltate (II).

33. (c) It is incorrect statement.
 All other statements, i.e. (a), (b) and (d) are correct.



34. (b)

35. (d) In one case, on electrolysis of aqueous solution, the complex ion of cobalt i.e., $[\text{Co}(\text{NH}_3)_6]^{3+}$ of the complex $[\text{Co}(\text{NH}_3)_6][\text{Cr}(\text{NO}_2)_6]$ moves towards cathode (i.e., negative electrode) and on this electrode finally cobalt would be deposited. In another case, on electrolysis of aqueous solution, the complex ion of chromium i.e., $[\text{Cr}(\text{NH}_3)_6]^{3+}$ of the complex

$[\text{Cr}(\text{NH}_3)_6][\text{Co}(\text{NO}_2)_6]$ moves towards cathode (i.e., negative electrode) and on this electrode chromium would finally be deposited.

36. (c) Both the high charge density of Fe^{3+} in $[\text{Fe}(\text{CN})_6]^{3-}$ and strong basic (Lewis) character of the ligand CN^- attribute to the stability of the complex.

37. (a) Since the precipitate of AgCl shows two ionisable chloride ion the complex must have the structure.



Hence two chlorine atoms satisfy the primary valency and one, secondary valency.

38. (a) The complex chlorodiaquatrimmine cobalt (III) chloride can have the structure $[\text{CoCl}(\text{NH}_3)_3(\text{H}_2\text{O})_2]\text{Cl}_2$

39. (d) In the given complex we have two bidentate ligands (i.e. en and C_2O_4), so coordination number of E is 6

$$(2 \times 2 + 1 \times 2 = 6)$$

Let the oxidation state of E in complex be x, then

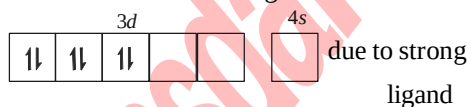
$$[x + (-2) = 1] \text{ or } x - 2 = 1$$

or $x = +3$, so its oxidation state is +3

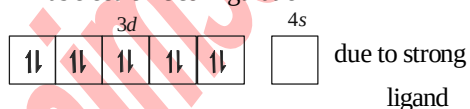
Thus option (d) is correct.

40. (b) CO bond strength is reciprocal to the extent of back donation involved in synergic bonding.

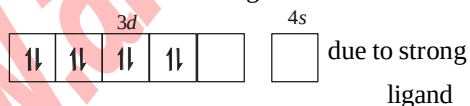
41. (d) Fe^{2+} has electronic configuration



Ni has electronic configuration



Ni^{2+} has electronic configuration



Co^{3+} has electronic configuration



electrons due to weak ligand hence

$[\text{CoF}_6]^{3-}$ is paramagnetic.

42. (c) The chlorophyll molecule plays an important role in photosynthesis, contain porphyrin ring and the metal Mg not Ca.

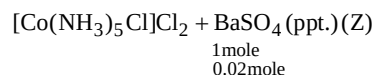
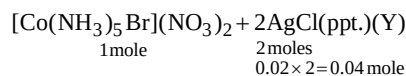
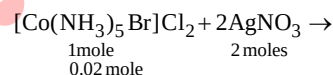
43. (a) $[\text{Co}(\text{NH}_3)_5\text{CO}_3]\text{ClO}_4$. Six monodentate ligands are attached to Co hence C. N. of Co = 6;

$$\text{O. N.} = x + 5 \times (0) + 1 \times (-2) + 1 \times (-1) = 0$$

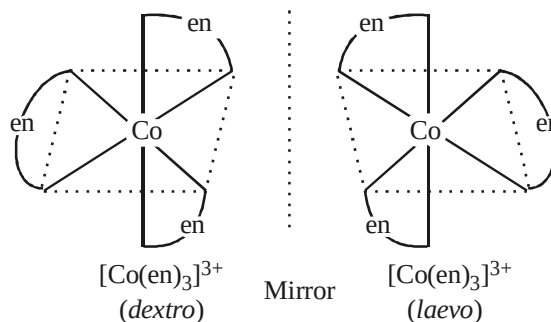
$$\therefore x = +3; \text{ electronic configuration of } \text{Co}^{3+} [\text{Ar}] 3d^6 4s^0 \text{ hence number of d electrons is 6. All d-electrons are paired due to strong ligand hence unpaired electron is zero.}$$

44. (b) $\text{CuSO}_4 + 4\text{NH}_3 \rightarrow [\text{Cu}(\text{NH}_3)_4]\text{SO}_4$
Blue complex due to $[\text{Cu}(\text{NH}_3)_4]^{2+}$

45. (d) When excess of AgNO_3 and BaCl_2 are added to solution X.



46. (d) The optical isomers are pair of molecules which are non superimposable mirror images of each other.



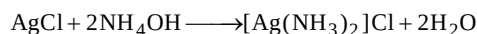
The two optically active isomers are collectively called enantiomers.

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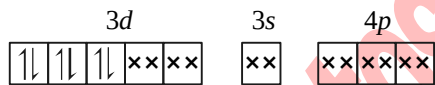
Type B : Assertion Reason Questions

47. (a) AgCl dissolves in NH_4OH due to formation of complex.



48. (c) NF_3 is a weak ligand due to high electronegativity of fluorine which withdraws electrons from N, with the result lone pair of electrons on N atom can't be ligated. $\text{N}(\text{CH}_3)_3$ is a strong ligand because CH_3 groups are electron releasing and thus increase electron availability on N atom.
49. (d) $[\text{Ni}(\text{en})_3]\text{Cl}_2$ is more stable than $[\text{Ni}(\text{NH}_3)_6]\text{Cl}_2$ because ethylenediamine is a bidentate ligand, hence it forms chelating ring with Ni^{2+} ion.

50. (c) In potassium ferrocyanide, Fe is in the form Fe^{2+} and in potassium ferricyanide, Fe is in the form Fe^{3+} . CN^- is a strong ligand. So, it will pair up all the $3d^6$ electrons of Fe^{3+} and make it diamagnetic. In Fe^{2+} , all the $3d^5$ electrons are not paired up. One electron remains unpaired. So, it is paramagnetic. Fe^{2+} in presence of CN^- in $\text{K}_4[\text{Fe}(\text{CN})_6]$



$n = 0$, diamagnetic, d^2sp^3 hybridization

Fe^{3+} in presence of CN^- in $\text{K}_3[\text{Fe}(\text{CN})_6]$

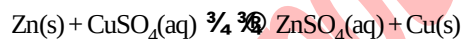


$m = 1$, paramagnetic, d^2sp^3 hybridization

However, the reason is false because crystal field splitting in ferrocyanide is less than in ferricyanide ion (higher the oxidation state of the metal, greater the crystal field splitting).

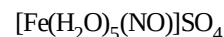
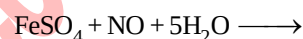
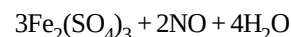
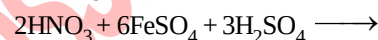
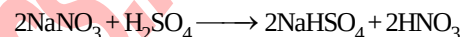
51. (a) Optical isomerism is found in octahedral complexes with 1, 2 or 3 symmetrical bidentate ligands only. Since given compound is not having any bidentate ligand, it will not show optical isomerism. It is because it has plane of symmetry, a plane which is perpendicular to equatorial plane. Thus both A and R are true and R is explanation of A.

52. (c) Copper sulphate solution is not stored in zinc vessel as Zn is more reactive than copper and has tendency to replace Cu from its aqueous solution.



Zn cannot form complex with CuSO_4 although $[\text{Zn}(\text{H}_2\text{O})_4]\text{SO}_4$ exists in aqueous ZnSO_4 solution. Hence assertion is true but reason is false.

53. (b) In the qualitative analysis of nitrate, brown ring is formed due to the formation of $[\text{Fe}(\text{H}_2\text{O})_5(\text{NO})]^{2+}$. The chemical reactions showing the formation of complex are as follows:



It is clearly seen from the formula, that the coordination number of Fe in the brown ring complex is six (five H_2O and one NO). Thus both assertion and reason correct but reason is not the correct explanation of assertion.

54. (c) $\text{H}_2\text{N}-\text{NH}_2$ does not act as chelating ligand. The coordination by hydrazine leads to a three membered highly unstable strained ring and thus, it does not act as chelating agent.
55. (c) $[\text{FeF}_6]^{3-}$ is a high spin complex since F^- is a weak ligand.
56. (d) $[\text{FeF}_6]^{3-}$ is a high spin complex since F^- is a weak ligand.
57. (a) Reason is the correct explanation of Assertion.
58. (b) Both Assertion and Reason are true but Reason is not the correct explanation of statement-1. $[\text{Fe}(\text{CN})_6]^{3-}$ is weakly paramagnetic as it has unpaired electrons while $[\text{Fe}(\text{CN})_6]^{2-}$ has no unpaired electron. $\therefore$ It is diamagnetic.

TYPE A : MULTIPLE CHOICE QUESTIONS

1. Chloroform and conc. HNO_3 react to produce

[1997]

- (a) CHCl_2NO_2 (b) $\text{CHCl}_2\text{HNO}_3$
(c) CCl_3NO_2 (d) CCl_3NO_3

2. Benzene diazonium chloride reacts with hypophosphorous acid to produce: [1998]

- (a) phenol
(b) benzene
(c) *p*-hydroxyazobenzene
(d) benzonitrile

3. B.H.C. is used as an: [1998]

- (a) Insecticide (b) Disinfectant
(c) Mosquito repellent (d) Antiseptic

4. Which one of the following produces acyl halide by treatment with PCl_5 ? [1998]

- (a) Alcohols
(b) Esters
(c) Acids
(d) Carbonyl compounds

5. When two halogens are attached to same carbon atom, it is known as : [1997, 1999]

- (a) *vic*-dihalide (b) *gem*-dihalide
(c) α, ω -dihalide (d) α, β -dihalide

6. Gammexane is : [1999]

- (a) Chloral (b) BHC
(c) DDT (d) HCB

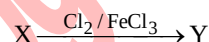
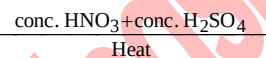
7. The product obtained by treating



[1999]

- (a) $\text{CH}_3-\text{CH}_2-\text{CH}_2\text{Br}$
(b) $\text{CH}_3-\underset{\text{Br}}{\text{CH}}-\text{CH}_3$
(c) $\text{CH}_2\text{BrCH}=\text{CH}_2$
(d) $\text{CH}_3-\text{CH}=\text{CHBr}$

8.



The product Y is

[2000]

- (a) *p*-chloronitrobenzene
(b) *m*-chloronitrobenzene
(c) *o*-chloronitrobenzene
(d) *o-p*-dichloronitrobenzene

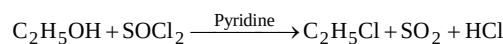
9. Among the following, insecticide is : [2001]

- (a) BHC (b) Phosphene
(c) Chloral (d) Aspirin

10. Which of the following is a chiral compound? [2002]

- (a) hexane
(b) *n*-butane
(c) methane
(d) 2,3,4-trimethylhexane

11. The reaction :



is known as

[2002]

- (a) Kharasch effect
(b) Williamson's synthesis
(c) Darzen's procedure
(d) Hunsdiecker reaction

12. Which of the following is most stable? [2002]

- (a) 1-butene (b) 1-pentene
(c) 2-butene (d) 2-pentene

13. Among the following, the most reactive towards alcoholic KOH is : [2004]

- (a) $\text{CH}_2=\text{CHBr}$ (b) $\text{CH}_3\text{COCH}_2\text{CH}_2\text{Br}$
(c) $\text{CH}_3\text{CH}_2\text{Br}$ (d) $\text{CH}_3\text{CH}_2\text{CH}_2\text{Br}$

14. Among the following, the dissociation constant is highest for : [2004]

- (a) $\text{C}_6\text{H}_5\text{OH}$ (b) $\text{C}_6\text{H}_5\text{CH}_2\text{OH}$
(c) $\text{CH}_3\text{C}\equiv\text{CH}$ (d) $\text{CH}_3\text{NH}_3^+\text{Cl}^-$

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15. Among the following which one can have a *meso* form? [2006]
- $\text{CH}_3\text{CH}(\text{OH})\text{CH}(\text{Cl})\text{C}_2\text{H}_5$
 - $\text{CH}_3\text{CH}(\text{OH})\text{CH}(\text{OH})\text{CH}_3$
 - $\text{C}_2\text{H}_5\text{CH}(\text{OH})\text{CH}(\text{OH})\text{CH}_3$
 - $\text{HOCH}_2\text{CH}(\text{Cl})\text{CH}_3$
16. The correct increasing order of the reactivity of halides for $\text{S}_{\text{N}}1$ reaction is : [2006]
- $\text{CH}_3 - \text{CH}_2 - \text{X} < (\text{CH}_3)_2\text{CH} - \text{X} < \text{CH}_2 = \text{CH} - \text{CH}_2 - \text{X} < \text{PhCH}_2 - \text{X}$
 - $(\text{CH}_3)_2\text{CH} - \text{X} < \text{CH}_3 - \text{CH}_2 - \text{X} < \text{CH}_2 = \text{CH} - \text{CH}_2\text{X} < \text{PhCH}_2 - \text{X}$
 - $\text{PhCH}_2 - \text{X} < (\text{CH}_3)_2\text{CH} - \text{X} < \text{CH}_3 - \text{CH}_2 - \text{X} < \text{CH}_2 = \text{CH} - \text{CH}_2 - \text{X}$
 - $\text{CH}_2 = \text{CH} - \text{CH}_2 - \text{X} < \text{PhCH}_2 - \text{X} < (\text{CH}_3)_2\text{CH} - \text{X} < \text{CH}_3 - \text{CH}_2 - \text{X}$
17. Which of the following compounds has the highest boiling point? [2006]
- $\text{CH}_3\text{CH}_2\text{CH}_2\text{Cl}$
 - $\text{CH}_3\text{CH}_2\text{CH}_2\text{CH}_2\text{Cl}$
 - $\text{CH}_3\text{CH}(\text{CH}_3)\text{CH}_2\text{Cl}$
 - $(\text{CH}_3)_3\text{CCl}$
18. The major product formed in the following reaction:
- $$\text{CH}_3\text{CH}(\text{Cl})\text{CH}_2 - \text{CH}_2\text{OH} \xrightarrow{\text{Aq. KOH}} \text{is:}$$
- $\text{CH}_3\text{CH} = \text{CH} - \text{CH}_2\text{OH}$ [2006]
 - $\text{CH}_2 = \text{CH} - \text{CH}_2\text{OH}$
 - $\text{CH}_3 - \text{CH} - \text{CH}_2$
 $\quad \quad \quad |$
 $\quad \quad \quad \text{O} - \text{CH}_2$
 - $\text{CH}_3 - \text{CH} - \text{CH}_2 - \text{CH}_2\text{OH}$
 $\quad \quad \quad |$
 $\quad \quad \quad \text{OH}$
19. In the following sequence of the reactions, what is D? [2007]
- $$\text{C}_6\text{H}_5\text{CH}_3 \xrightarrow{[\text{O}]} \text{A} \xrightarrow{\text{SOCl}_2} \text{B}$$
- $$\xrightarrow{\text{NaN}_3} \text{C} \xrightarrow{\text{Heat}} \text{D}$$
- (a) Primary amine
 (b) An amide
 (c) Phenyl isocyanate
 (d) A chain lengthened hydrocarbon
20. Which of the following is optically inactive? [2007]
- $\begin{array}{c} \text{H} \\ | \\ \text{H}_3\text{C} - \text{C} - \text{Cl} \\ | \\ \text{Cl} - \text{C} - \text{CH}_3 \\ | \\ \text{H} \end{array}$ (b) $\begin{array}{c} \text{H} \\ | \\ \text{Cl} - \text{C} - \text{CH}_3 \\ | \\ \text{H}_3\text{C} - \text{C} - \text{Cl} \\ | \\ \text{H} \end{array}$
 - $\begin{array}{c} \text{H} \\ | \\ \text{H}_3\text{C} - \text{C} - \text{Cl} \\ | \\ \text{H}_3\text{C} - \text{C} - \text{Cl} \\ | \\ \text{H} \end{array}$ (d) none of these.
21. C_8H_{16} that can form *cis-trans* geometrical isomers and also has a chiral centre, is [2008]
- -
 - Both of these
 - None of these
22. $(\text{CH}_3)_2\text{C} = \text{CHCH}_3 + \text{NOBr} \longrightarrow \text{product.}$ The structure of the product is [2009]
- $(\text{CH}_3)_2\text{C}(\text{NO}) - \text{CH}(\text{Br})\text{CH}_3$
 - $(\text{CH}_3)_2\text{C}(\text{Br}) - \text{CH}(\text{NO})\text{CH}_3$
 - $(\text{CH}_3)_2\text{CH} - \text{C}(\text{NO})(\text{Br})\text{CH}_3$
 - $\begin{array}{c} \text{H} \\ | \\ \text{H}_3\text{C} - \text{C} - \text{CH} - \text{CH}_3 \\ | \quad | \\ \text{NO} \quad \text{CH}_3 \end{array}$
- 23.
- -
 -
 -

24. The pesticide DDT slowly changes to [2012]
 (a) $\text{CCl}_3\text{-CHO}$ and chlorobenzene
 (b) *p, p'*-Dichlorodiphenylethene
 (c) *p, p'*-Dichlorodiphenyldichloroethane
 (d) *p, p'*-Dichlorodiphenyldichloroethene
25. Rectified spirit is a mixture of [2012]
 (a) 95% ethyl alcohol + 5% water
 (b) 94% ethyl alcohol + 4.53 water
 (c) 94.4% ethyl alcohol + 5.43% water
 (d) 95.87% ethyl alcohol + 4.13% water
26. Which of the following is an example of $\text{S}_{\text{N}}2$ reaction? [2013]
 (a) $\text{CH}_3\text{Br} + \text{OH}^- \longrightarrow \text{CH}_3\text{OH} + \text{Br}^-$
 (b) $\text{CH}_3\text{-}\underset{\text{Br}}{\text{CH}}\text{-CH}_3 + \text{OH}^- \longrightarrow \text{CH}_3\text{-}\underset{\text{OH}}{\text{CH}}\text{-CH}_3$
 (c) $\text{CH}_3\text{CH}_2\text{OH} \xrightarrow{-\text{H}_2\text{O}} \text{CH}_2 = \text{CH}_2$
 (d) $(\text{CH}_3)_3\text{C-Br} + \text{OH}^- \longrightarrow (\text{CH}_3)_3\text{COH} + \text{Br}^-$
27. Identify Z in

$$\text{CH}_3\text{CH}_2\text{CH}_2\text{Br} \xrightarrow{\text{Aq. NaOH}} \text{X} \xrightarrow{\text{Al}_2\text{O}_3} \text{Y} \xrightarrow{\text{Cl}_2/\text{H}_2\text{O}} \text{Z}$$
 [2014]
 (a) Mixture of $\text{CH}_3\text{CHClCH}_2\text{Cl}$ and $\text{CH}_3\text{CHOHCH}_2\text{Cl}$
 (b) $\text{CH}_3\text{CHOHCH}_2\text{Cl}$
 (c) $\text{CH}_3\text{CHClCH}_2\text{OH}$
 (d) $\text{CH}_3\text{CHClCH}_2\text{Cl}$
28. Which of the following pairs is/are correctly matched? [2015]
Reaction	Product
I. $\text{RX} + \text{AgCN}$	RNC
II. $\text{RX} + \text{KCN}$	RCN
III. $\text{RX} + \text{KNO}_2$	$\text{R}-\text{N} \begin{array}{l} \nearrow \text{O} \\ \searrow \text{O} \end{array}$
IV. $\text{RX} + \text{AgNO}_2$	$\text{R}-\text{O}-\text{N}=\text{O}$
- (a) Only I (b) I and II
 (c) III and IV (d) I, II, III and IV
29. The solution of a chemical compound reacts with AgNO_3 solution to form a white precipitate of Y which dissolves in NH_4OH to give a complex Z. When Z is treated with dilute HNO_3 , Y reappears. The chemical compound X can be: [2015]
 (a) NaCl (b) CH_3Cl
 (c) NaBr (d) NaI
30. The synthesis of alkyl fluorides is best accomplished by : [2017]
 (a) Finkelstein reaction
 (b) Swarts reaction
 (c) Free radical fluorination
 (d) Sandmeyer's reaction

TYPE B : ASSERTION REASON QUESTIONS

Directions for (Qs. 31-33) : These questions consist of two statements, each printed as Assertion and Reason. While answering these questions, you are required to choose any one of the following five responses.

- (a) If both Assertion and Reason are correct and the Reason is a correct explanation of the Assertion.
 (b) If both Assertion and Reason are correct but Reason is not a correct explanation of the Assertion.
 (c) If the Assertion is correct but Reason is incorrect.
 (d) If both the Assertion and Reason are incorrect.
 (e) If the Assertion is incorrect but the Reason is correct.

31. **Assertion :** The presence of nitro group facilitates nucleophilic substitution reactions in aryl halides.

Reason : The intermediate carbanion is stabilized due to the presence of nitro group.

[2006]

32. **Assertion :** Chloral reacts with phenyl chloride to form DDT.

Reason : It is an electrophilic substitution reaction.

[2007]

33. **Assertion :** Alkyl iodide can be prepared by treating alkyl chloride/bromide with NaI in acetone.

Reason : NaCl/NaBr are soluble in acetone while NaI is not.

[2007]

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Topicwise AIIMS Solved Papers – CHEMISTRY

Directions for (Qs. 34-42) : Each of these questions contains an Assertion followed by Reason. Read them carefully and answer the question on the basis of following options. You have to select the one that best describes the two statements.

- (a) If both Assertion and Reason are correct and Reason is the correct explanation of Assertion.
 (b) If both Assertion and Reason are correct, but Reason is not the correct explanation of Assertion.
 (c) If Assertion is correct but Reason is incorrect.
 (d) If both the Assertion and Reason are incorrect.

34. Assertion : Phenol on oxidation with KMnO_4 gives *meso*-tartaric acid.

Reason : Pure phenol is colourless but turns pink due to oxidation to phenoquinone. [2009]

35. Assertion : $\text{S}_{\text{N}}2$ reactions always proceed with inversion of configuration.

Reason : $\text{S}_{\text{N}}2$ reaction of an optically active aryl halide with an aqueous solution of KOH always gives an alcohol with opposite sign of rotation. [2010]

36. Assertion : 4-Nitrochlorobenzene undergoes nucleophilic substitution more readily than chlorobenzene.

Reason : Chlorobenzene undergoes nucleophilic substitution by elimination-addition mechanism while 4-nitrochlorobenzene undergoes nucleophilic substitution by addition-elimination mechanism. [2010]

37. Assertion : Reimer-Tiemann reaction of phenol with CCl_4 in NaOH at 340 K gives salicylic acid as the major product.

Reason : The reaction occurs through intermediate formation of dichlorocarbene. [2010]

38. Assertion : Cyanide (CN^-) is a strong nucleophile.

Reason : Benzonitrile is prepared by the reaction of chlorobenzene with potassium cyanide. [2011]

39. Assertion : Iodide ion combines with smaller group to avoid steric hindrance.

Reason : With HI, anisole gives iodobenzene and methyl alcohol. [2011]

40. Assertion : CHCl_3 is stored in dark bottles.

Reason : CHCl_3 is oxidised in dark. [2015]

41. Assertion : Alkylbenzene is not prepared by Friedel-Crafts alkylation of benzene.

Reason : Alkyl halides are less reactive than acyl halides. [2011, 2012, 2013, 2016]

42. Assertion : $\text{S}_{\text{N}}2$ reaction of an optically active aryl halide with an aqueous solution of KOH always gives an alcohol with opposite sign of rotation.

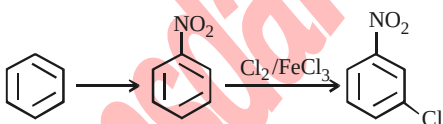
Reason : $\text{S}_{\text{N}}2$ reactions always proceed with retention of configuration. [2013, 2017]

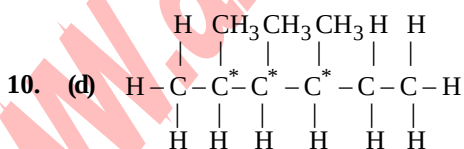
HINTS & SOLUTIONS

Type A : Multiple Choice Questions

- (c) Chloroform and HNO_3 react to produce CCl_3NO_2 which is also known as chloropicrin. It is used as insecticide.
- (b) $\text{C}_6\text{H}_5\text{N}_2\text{Cl} + \text{H}_3\text{PO}_2 + \text{H}_2\text{O} \longrightarrow$
 $\text{C}_6\text{H}_6 + \text{N}_2 + \text{HCl} + \text{H}_3\text{PO}_3$
- (a) B.H.C. is benzene hexachloride. It is used as an insecticide.
- (c) Acid can give acyl halide with PCl_5
 $\text{CH}_3\text{COOH} + \text{PCl}_5 \longrightarrow$
 $\text{CH}_3\text{COCl} + \text{POCl}_3 + \text{HCl}$
- (b) $\begin{array}{cc} \text{CHCl}_2 & \text{CH}_2\text{Cl} \\ | & | \\ \text{CH}_3 & \text{CH}_2\text{Cl} \end{array}$
gem-dihalide *vic*-dihalide
- (b) Gammexane is commercial name of benzene hexachloride (B.H.C.). It is an effective insecticide. It is also known as (6, 6, 6). Chemically it is $\text{C}_6\text{H}_6\text{Cl}_6$.
- (b) $\text{CH}_3 - \text{CH} = \text{CH}_2 + \text{HBr} \longrightarrow$
 $\begin{array}{c} \text{CH}_3 - \text{CH} - \text{CH}_3 \\ | \\ \text{Br} \end{array}$

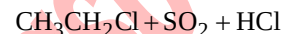
Here Markownikoff's rule is followed which states that negative part of addendum goes to that carbon which has least hydrogen.

- (b) 
- (a) BHC is also known as benzene hexachloride ($\text{C}_6\text{H}_6\text{Cl}_6$). It is an insecticide and sold under the brand name gammexane. It is also known as 6, 6, 6.



Carbon atoms marked star (*) are asymmetric. So it is a chiral compound.

- (c) Alkyl halides can be prepared by treating alcohol with SOCl_2 .
 $\text{CH}_3\text{CH}_2\text{OH} + \text{SOCl}_2 \longrightarrow$



This reaction is known as Darzen's procedure.

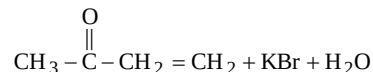
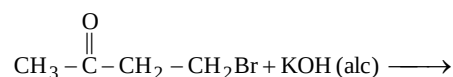
Note : SOBr_2 and SOI_2 are not used in this reaction because SOBr_2 is less stable and SOI_2 does not exist.

- (c) We can explain it on the basis of hyperconjugation.

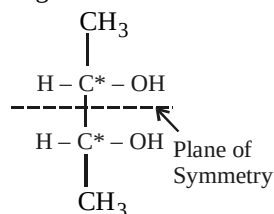
no. of α -H atoms

- $\text{CH}_3 - \text{CH}_2 - \text{CH} = \text{CH}_2$ 2
 - $\text{CH}_3 - \text{CH}_2 - \text{CH}_2 - \text{CH} = \text{CH}_2$ 2
 - $\text{CH}_3 - \text{CH} = \text{CH} - \text{CH}_3$ 6
 - $\text{CH}_3\text{CH}_2\text{CH} = \text{CHCH}_3$ 5
- (c) is most stable having largest no. of hyperconjugative structures as it has largest no. of α -H-atoms. (hyperconjugative H)

- (b) In $\begin{array}{c} \text{O} \\ || \\ \text{CH}_3 - \text{C} - \text{CH}_2 - \text{CH}_2\text{Br} \end{array}$, the elimination reaction by alcoholic KOH will be facilitated due to presence of $\text{C} = \text{O}$ group which is electron withdrawing group.



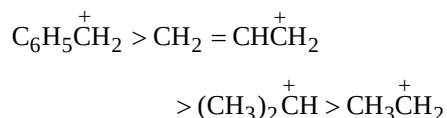
- (d) Dissociation constant will be highest for $\text{CH}_3\text{NH}_3^+\text{Cl}^-$ because it is ionic in nature.
- (b) A molecule having a plane of symmetry but having chiral carbons will have *meso* form



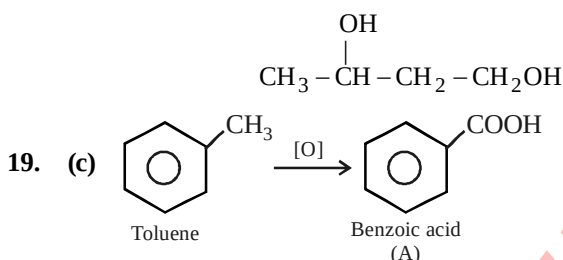
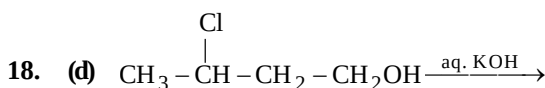
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Topicwise AIIMS Solved Papers – CHEMISTRY

16. (a) S_N1 reactions involve the formation of carbocations, so greater the stability of the carbocation formed by alkylhalide more will be its reactivity toward S_N1 reaction.

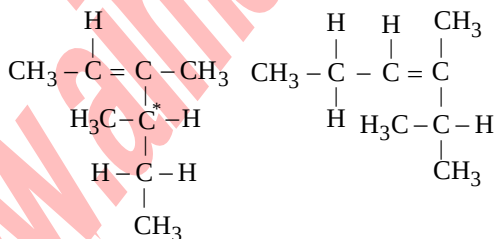


17. (b) Molecules having higher molecular weight and less branching have higher boiling point.



20. (c) It has centre of symmetry, so optically inactive.

21. (a) Redrawing the given structures we get,



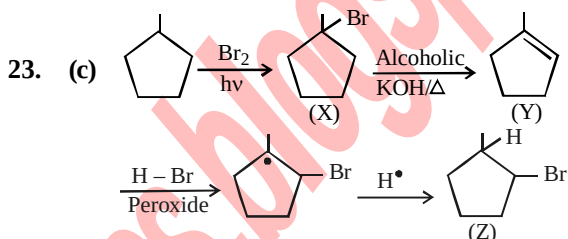
(a)

(b)

From the above structure, it is evident that structure (a) will show *cis-trans* isomerism

and it also has a chiral carbon. On the other hand, structure (b) although shows *cis-trans* isomerism, it has no chiral carbon.

22. (b) The reaction follows Markownikoff rule, namely the bromide ion adds on to the carbon having the least number of hydrogen and the more positive part namely the $-NO$ group adds to the other carbon of the double bond.

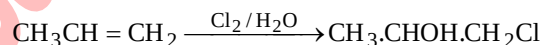
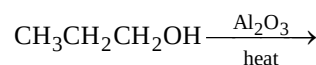


24. (d)

25. (d)

26. (a) Only 1° alkyl halides (i.e. CH_3Br) undergo S_N2 reaction.

27. (b) $CH_3CH_2CH_2Br \xrightarrow{aq. KOH}$

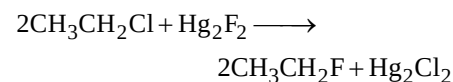
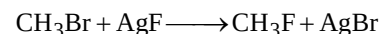


28. (b)

29. (a) $NaCl + AgNO_3 \longrightarrow AgCl$
(White)

CH_3Cl does not give ppt. $NaBr$ and NaI give yellow and dark yellow ppt. respectively.

30. (b) Alkyl fluorides are more conveniently prepared by heating suitable chloro- or bromo-alkanes with organic fluorides such as AsF_3 , SbF_3 , CoF_2 , AgF , Hg_2F_2 etc. This reaction is called **Swarts reaction**.

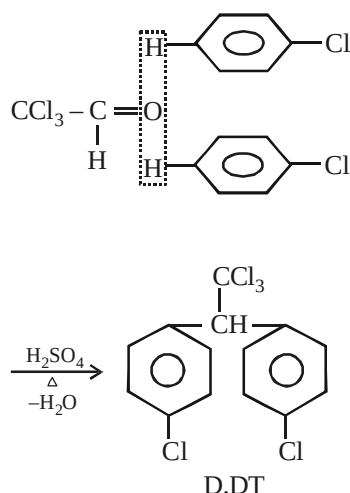


Type B : Assertion Reason Questions

31. (a) Nitro group is electron-withdrawing, hence it stabilises the carbanion by dispersing the negative charge on the carbon. So both the assertion as well as reason are true and

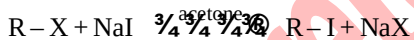
reason is correct explanation of the assertion.

32. (c) Chloral reacts with phenyl chloride to form D.D.T. in presence of conc. H_2SO_4 . A water molecule eliminates in this reaction.



Hence, assertion is true but reason is false.

33. (c) Alkyl halides on treatment with NaI in presence of acetone forms alkyl iodide. This is called Finkelstein reaction.



Here NaI is soluble in acetone but NaBr/NaCl are not soluble. Hence due to precipitation of salt, equilibrium is shifted to forward direction. Hence assertion is true but reason is false.

34. (b) Both assertion and reason are true and reason is not the correct explanation of assertion.

35. (c) Assertion is true, because aryl halides do not undergo nucleophilic substitution under ordinary conditions. This is due to resonance, because of which the carbon-halogen bond acquires partial double bond character, hence, it becomes shorter and stronger and thus, cannot be replaced by nucleophiles. However, Reason is false.

36. (b) As compared to chlorobenzene, the intermediate carbanion resulting from 4-nitrochlorobenzene is stabilized by $-\text{R}$ effect of the NO_2 group.

37. (c) Dichlorocarbene ($:\text{CCl}_2$) attacks on the *ortho*-position of the phenolate ion to form an intermediate which on hydrolysis gives salicylic acid.

38. (c) Aryl halides (chlorobenzene) do not undergo nucleophilic substitution with KCN because of the low reactivity of the Cl atom, which is because of resonance in chlorobenzene. So assertion is true. Reason is false.

39. (c)

40. (c) CHCl_3 is stored in dark bottles to prevent oxidation of CHCl_3 in presence of sunlight.

41. (c) Alkyl halides give polyalkylation products.

42. (d) Assertion is false, because aryl halides do not undergo nucleophilic substitution under ordinary conditions. This is due to resonance, because of which the carbon-chlorine bond acquires partial double bond character, hence it becomes shorter and stronger and thus cannot be replaced by nucleophiles. Also, Reason is false because $\text{S}_{\text{N}}2$ reactions proceed with inversion of configuration.

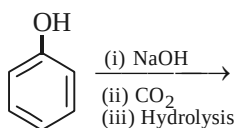
Chapter

25

Alcohols, Phenols and Ethers

TYPE A : MULTIPLE CHOICE QUESTIONS

1. The product obtained from the reaction is:

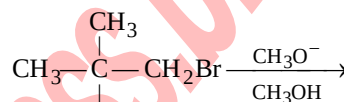


[1998]

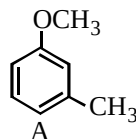
- (a) Benzene (b) Toluene
(c) Salicylic acid (d) Benzoic acid
2. Picric acid is: [2000]
(a) Trinitrophenol (b) Trinitrotoluene
(c) Trinitrobenzene (d) Tribromobenzene
3. Lucas reagent is: [2000]
(a) anhy. AlCl₃ + conc. HCl
(b) anhy. AlCl₃ + conc. HNO₃
(c) anhy. ZnCl₂
(d) anhy. ZnCl₂ + conc. HCl
4. Lucas test is used for the detection of [2002]
(a) alcohols (b) alkyl halides
(c) phenols (d) aldehydes
5. Intermolecular hydrogen bonding is strongest in: [2003]
(a) Methylamine (b) Phenol
(c) Formaldehyde (d) Methanol
6. Propan-1-ol can be prepared from propene by: [2003]
(a) H₂O / H₂SO₄
(b) Hg(OAc)₂ / H₂O followed by NaBH₄
(c) B₂H₆ followed by H₂O₂
(d) CH₃CO₂H / H₂SO₄
7. Among the following the one which reacts most readily with ethanol [2004]
(a) *p*-nitrobenzyl bromide
(b) *p*-chlorobenzyl bromide
(c) *p*-methoxybenzyl bromide
(d) *p*-methylbenzyl bromide
8. The most suitable reagent for the conversion of RCH₂OH → RCHO is: [2004]

- (a) KMnO₄
(b) K₂Cr₂O₇
(c) CrO₃
(d) PCC (pyridine chlorochromate)

9. The major product formed in the following reaction is: [2005]



- (a) $\text{CH}_3\text{—}\overset{\text{CH}_3}{\underset{\text{H}}{\text{C}}}\text{—CH}_2\text{OCH}_3$
(b) $\text{CH}_3\text{—}\underset{\text{OCH}_3}{\text{CH}}\text{—CH}_2\text{CH}_3$
(c) $\text{CH}_3\text{—}\overset{\text{CH}_3}{\text{C}}\text{=CH}_2$
(d) $\text{CH}_3\text{—}\underset{\text{OCH}_3}{\text{C}}\text{—CH}_3$
10. The major product obtained on the monobromination (with Br₂/FeBr₃) of the following compound A is: [2006]



- (a) (b)
(c) (d)

11. $\text{CH}_3\text{OC}_2\text{H}_5$ and $(\text{CH}_3)_3\text{C}-\text{OCH}_3$ are treated with hydroiodic acid. The fragments obtained after reactions are [2007]
- $\text{CH}_3\text{I} + \text{HOC}_2\text{H}_5$; $(\text{CH}_3)_3\text{CI} + \text{HOCH}_3$
 - $\text{CH}_3\text{OH} + \text{C}_2\text{H}_5\text{I}$; $(\text{CH}_3)_3\text{CI} + \text{HOCH}_3$
 - $\text{CH}_3\text{OH} + \text{C}_2\text{H}_5\text{I}$; $(\text{CH}_3)_3\text{COH} + \text{CH}_3\text{I}$
 - $\text{CH}_3\text{I} + \text{HOC}_2\text{H}_5$; $\text{CH}_3\text{I} + (\text{CH}_3)_3\text{COH}$
12. In which of the following reactions the product obtained is *t*-butyl methyl ether? [2008]
- $\text{CH}_3\text{OH} + \text{HO}-\text{CH}_2-\text{CH}_3 \xrightarrow{\text{conc. H}_2\text{SO}_4}$
 - $\text{CH}_3-\overset{\text{CH}_3}{\underset{\text{CH}_3}{\text{C}}}-\text{Br} + \text{CH}_3\text{OH} \xrightarrow{\text{HO}^-\text{Na}^+}$
 - $\text{CH}_3\text{Br} + \text{Na}^+\text{O}^--\overset{\text{CH}_3}{\underset{\text{CH}_3}{\text{C}}}-\text{CH}_3 \longrightarrow$
 - $\text{CH}_3-\text{O}^-\text{Na}^+ + \text{CH}_3-\overset{\text{CH}_3}{\underset{\text{CH}_3}{\text{C}}}-\text{Br} \longrightarrow$
13. Which of the following is a primary halide? [2008]
- Iso-propyl iodide
 - Secondary butyl iodide
 - Tertiary butyl bromide
 - Neohexyl chloride
14. An organic compound X on treatment with pyridinium chlorochromate in dichloromethane gives compound Y. Compound Y reacts with I_2 and alkali to form triiodomethane. The compound 'X' is [2008]
- $\text{C}_2\text{H}_5\text{OH}$
 - CH_3CHO
 - CH_3COCH_3
 - CH_3COOH
15. The formation of diethyl ether from ethanol is based on: [2009]
- Dehydrogenation reaction
 - Hydrogenation reaction
 - Dehydration reaction
 - Heterolytic fission reaction
16. Chloropicrin is obtained by the reaction of [2010]
- steam on carbon tetrachloride
 - nitric acid on chlorobenzene
 - chlorine on picric acid
 - nitric acid on chloroform
17. Ethanol can be prepared more easily by which reaction? [2011]
- $\text{CH}_3\text{CH}_2\text{Br} + \text{H}_2\text{O} \longrightarrow \text{CH}_3\text{CH}_2\text{OH}$
 - $\text{CH}_3\text{CH}_2\text{Br} + \text{Ag}_2\text{O}$ (in boiling water) $\longrightarrow \text{CH}_3\text{CH}_2\text{OH}$
- by (i) reaction
 - by (ii) reaction
 - Both reactions proceed at same rate
 - by none
18. An aromatic ether is not cleaved by HI even at 525 K. The compound is [2012]
- $\text{C}_6\text{H}_5\text{OCH}_3$
 - $\text{C}_6\text{H}_5\text{OC}_6\text{H}_5$
 - $\text{C}_6\text{H}_5\text{OC}_3\text{H}_7$
 - Tetrahydrofuran
19. The product of the following reaction is [2013]
- 
- 1-Pentanol
 - 2-Pentanol
 - Pentane
 - 1,2-Pentanediol
20. Ethanol when reacted with PCl_5 gives A, POCl_3 and HCl . A reacts with silver nitrite to form B (major product) and AgCl . A and B respectively are [2013]
- $\text{C}_2\text{H}_5\text{Cl}$ and $\text{C}_2\text{H}_5\text{OC}_2\text{H}_5$
 - C_2H_6 and $\text{C}_2\text{H}_5\text{OC}_2\text{H}_5$
 - $\text{C}_2\text{H}_5\text{Cl}$ and $\text{C}_2\text{H}_5\text{NO}_2$
 - C_2H_6 and $\text{C}_2\text{H}_5\text{NO}_2$
21. Polyvinylalcohol can be prepared by [2013]
- polymerization of vinyl alcohol
 - alkaline hydrolysis of polyvinyl acetate
 - polymerization of acetylene
 - reaction of acetylene with H_2SO_4 in presence of HgSO_4
22. Compound 'A' of molecular formula $\text{C}_4\text{H}_{10}\text{O}$ on treatment with Lucas reagent at room temperature gives compound 'B'. When compound 'B' is heated with alcoholic KOH, it gives isobutene. Compound 'A' and 'B' are respectively [2014]
- 2-methyl-2-propanol and 2-methyl-2-chloropropane
 - 2-methyl-1-propanol and 1-chloro-2-methylpropane
 - 2-methyl-1-propanol and 2-methyl-2-chloropropane
 - butan-2-ol and 2-chlorobutane

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Topicwise AIIMS Solved Papers – CHEMISTRY

23. Which of the following alcohols gives the best yield of dialkyl ether on being heated with a trace of sulphuric acid? [2014]
 (a) 2-Pentanol
 (b) Cyclopentanol
 (c) 2-Methyl-2-butanol
 (d) 1-Pentanol
24. Which of the following reagents convert propene to 1-propanol? [2015]
 (a) $\text{H}_2\text{O}, \text{H}_2\text{SO}_4$
 (b) Aqueous KOH
 (c) $\text{MgSO}_4, \text{NaBH}_4/\text{H}_2\text{O}$
 (d) $\text{B}_2\text{H}_6, \text{H}_2\text{O}_2, \text{OH}^-$
25. Which of the following fact(s) explain(s) as to why *p*-nitrophenol is more acidic than phenol?
 I. –I Effect of nitro group. [2015]
 II. Greater resonance effect of *p*-nitrophenoxy group
 III. Steric effect of bulky nitro group
 (a) I and II (b) I and III
 (c) II and III (d) II alone
26. $\text{ClCH}_2\text{CH}_2\text{OH}$ is stronger acid than $\text{CH}_3\text{CH}_2\text{OH}$ because of: [2016]
 (a) –I effect of Cl increases negative charge on O atom of alcohol
 (b) –I effect of Cl disperses negative charge on O atom to produce more stable cation
 (c) –I effect of Cl disperses negative charge on O atom to produce more stable anion
 (d) None of these
27. The ether that undergoes electrophilic substitution reactions is [2017]
 (a) $\text{CH}_3\text{OC}_2\text{H}_5$ (b) $\text{C}_6\text{H}_5\text{OCH}_3$
 (c) CH_3OCH_3 (d) $\text{C}_2\text{H}_5\text{OC}_2\text{H}_5$
28. A triglyceride can have how many different acyl groups? [2017]
 (a) 3 (b) 2
 (c) 1 (d) 4
29. In the reaction

$$\text{Phenol} \xrightarrow{\text{NaOH}} (\text{A}) \xrightarrow[140^\circ]{\text{CO}_2 + \text{HCl}} (\text{B}), \text{ here B is}$$
 [2017]
 (a) benzaldehyde (b) chlorobenzene
 (c) benzoic acid (d) salicylic acid
30. In the Victor-Meyer's test, the colour given by 1° , 2° and 3° alcohols are respectively. [2017]
 (a) red, colourless, blue
 (b) red, blue, colourless
 (c) blue, red, violet
 (d) red, blue, violet

TYPE B : ASSERTION REASON QUESTIONS

Directions for (Qs. 31-35) : These questions consist of two statements, each printed as Assertion and Reason. While answering these questions, you are required to choose any one of the following five responses.

- (a) If both Assertion and Reason are correct and the Reason is a correct explanation of the Assertion.
 (b) If both Assertion and Reason are correct but Reason is not a correct explanation of the Assertion.
 (c) If the Assertion is correct but Reason is incorrect.
 (d) If both the Assertion and Reason are incorrect.
 (e) If the Assertion is incorrect but the Reason is correct.

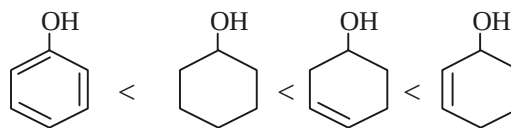
31. **Assertion :** Resorcinol turns FeCl_3 solution purple.
Reason : Resorcinol have phenolic group. [2000]

32. **Assertion :** Phenol is a strong acid than ethanol.
Reason : Groups with +M effect decreases acidity at *p*-position. [2002]

33. **Assertion :** Benzyl bromide when kept in acetone water, it produces benzyl alcohol.
Reason : The reaction follows $\text{S}_{\text{N}}2$ mechanism. [2003]

34. **Assertion :** The major products formed by heating $\text{C}_6\text{H}_5\text{CH}_2\text{OCH}_3$ with HI are $\text{C}_6\text{H}_5\text{CH}_2\text{I}$ and CH_3OH .
Reason : Benzyl cation is more stable than methyl cation. [2004]

35. **Assertion :** The ease of dehydration of the following alcohols is



Reason : Alcohols leading to conjugated alkenes are dehydrated to a greater extent. [2008]

Directions for (Qs.36-40) : Each of these questions contains an Assertion followed by Reason. Read them carefully and answer the question on the basis of following options. You have to select the one that best describes the two statements.

- (a) If both Assertion and Reason are correct and Reason is the correct explanation of Assertion.
- (b) If both Assertion and Reason are correct, but Reason is not the correct explanation of Assertion.
- (c) If Assertion is correct but Reason is incorrect.
- (d) If both the Assertion and Reason are incorrect.

36. Assertion: Phenyl is used as a household germicide.

Reason : Phenyl is phenol derivative and phenol is an effective germicide. [2010]

37. Assertion : *ter*-Butyl methyl ether is not prepared by the reaction of *ter*-butyl bromide with sodium methoxide.

Reason : Sodium methoxide is a strong nucleophile. [2010]

38. Assertion : Ethers behave as bases in the presence of mineral acids.

Reason : Due to the presence of lone pairs of electrons on oxygen. [2013]

39. Assertion : Phenol undergo Kolbe reaction, ethanol does not. [2014, 2015]

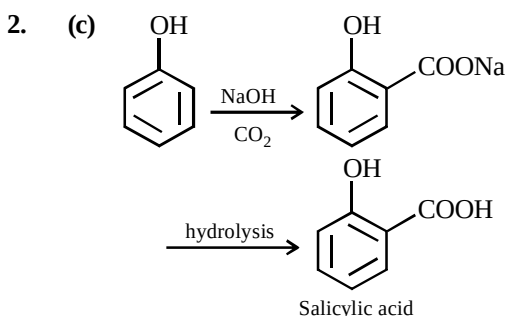
Reason : Phenoxide ion is more basic than ethoxide ion.

40. Assertion : Ethyl phenyl ether on reaction with HBr form phenol and ethyl bromide.

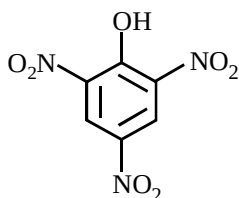
Reason : Cleavage of C–O bond takes place on ethyl-oxygen bond due to the more stable phenyl-oxygen bond. [2016]

HINTS & SOLUTIONS

Type A : Multiple Choice Questions



4. (a) Picric acid is *sym*-trinitrophenol

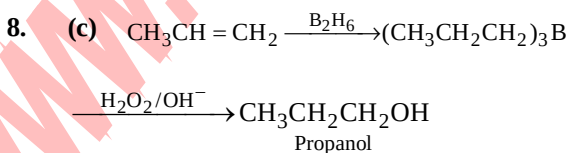


5. (d) Lucas reagent is anhydrous $\text{ZnCl}_2 + \text{HCl}$ which is used to distinguish between primary, secondary and tertiary alcohols.
6. (a) Lucas test is used for the determination of primary, secondary and tertiary alcohols.
7. (d) Hydrogen bonding is formed in compounds in which H is attached to highly electronegative element like F, O and N.

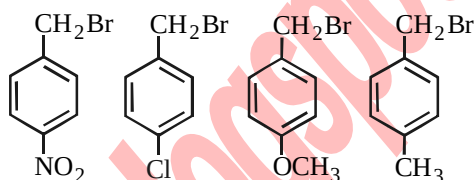
(i) In $\text{H}-\overset{\text{O}}{\parallel}{\text{C}}-\text{H}$, O is not having H atom so it shows very little H-bonding.

(ii) N is less electronegative than O, so H-bond formed by amines will be weak than that by alcohols.

(iii) $\text{C}_6\text{H}_5\text{OH}$ forms weak H-bonding due to steric hinderance due to bulky phenyl group.



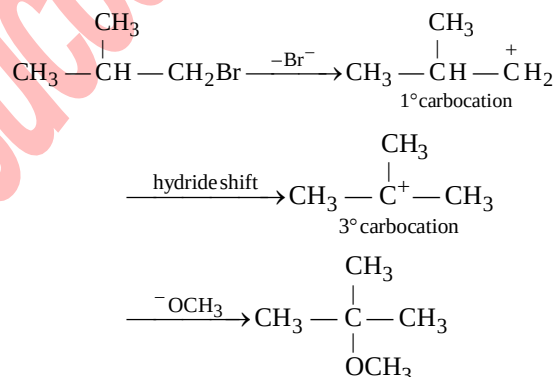
9. (a) Among the given compounds,



the first one can give carbonium ion most readily because the carbonium ion will be stabilised due to presence of NO_2 group on the ring.

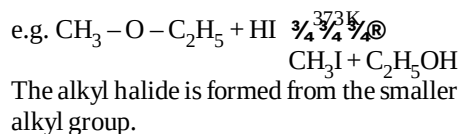
10. (d) The most suitable reagent for converting alcohol to acetaldehyde is PCC. Other reagent will convert alcohol to acid.

11. (d) The reaction is an example of $\text{S}_{\text{N}}1$ reaction

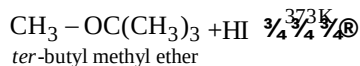


12. (b) The reaction is an example of electrophilic aromatic substitution. Although both OCH_3 and CH_3 groups are *o,p*-directing, the OCH_3 group dominates. Product (b) is favoured because the new coming group (Br) experiences least hindrance.

13. (a) In case of unsymmetrical ethers, the site of cleavage depends on the nature of alkyl group.



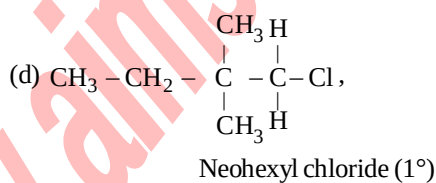
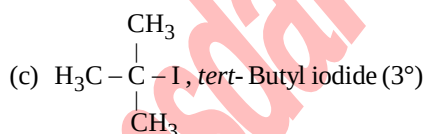
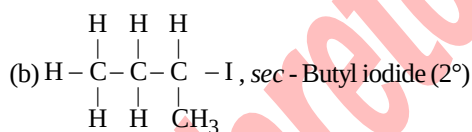
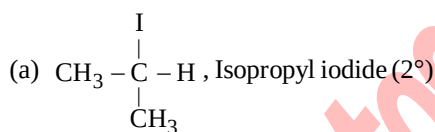
However, in case of tertiary alkyl ether following reaction occurs.



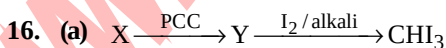
The alkyl halide is formed from the tertiary alkyl group and the cleavage of such ethers occurs by $\text{S}_{\text{N}}1$ mechanism as the product is controlled by the formation of more stable intermediate tertiary carbocation from protonated ether.

14. (c) It is *Williamson's synthesis*. It involves the nucleophilic attack of *alkoxide ion* on alkyl halide according to $\text{S}_{\text{N}}2$ mechanism. In order to prepare methyl tertiarybutyl ether, we must use methyl halide (primary) and sodium tertiary butoxide, but not sodium ethoxide and *t*-alkyl halide because the latter undergoes elimination reaction rather than substitution.

15. (d) Writing the structures, we get



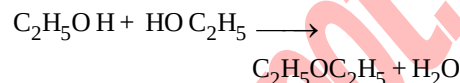
Thus, (d) is a primary (1°) halide.



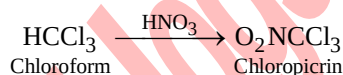
Compound Y must give iodoform test. Further since Y is obtained by the oxidation

of X which must be an alcohol ($\text{CH}_3\text{CH}_2\text{OH}$) and thus Y is CH_3CHO .

17. (c) Ethanol on dehydration forms diethyl ether.

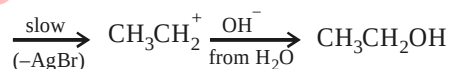
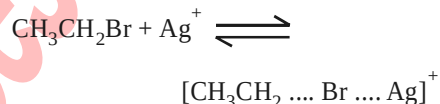


18. (d) Chloropicrin is nitrochloroform. It is obtained by the nitration of chloroform with HNO_3 .



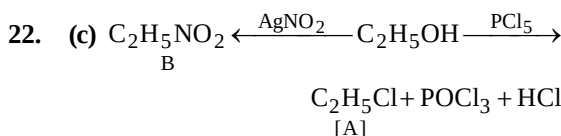
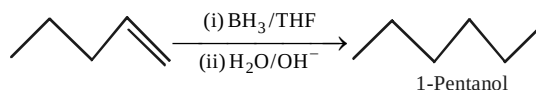
Chloropicrin is a liquid, poisonous and used as an insecticide and in war gas.

19. (b) Heavy metal ions, particularly Ag^+ , catalyse $\text{S}_{\text{N}}1$ reaction because of presence of empty orbital.



20. (b) Due to greater electronegativity of sp^2 -hybridized carbon atoms of the benzene ring, diaryl ethers are not attacked by nucleophiles like I^- .

21. (a) Hydroboration-oxidation leads to *anti*-Markownikoff's hydration, thus

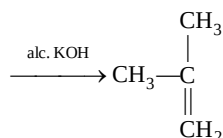
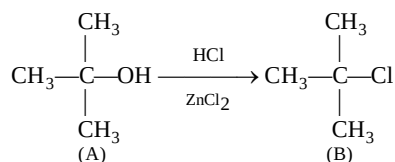


23. (b) Vinyl alcohol, $\text{CH}_2=\text{CHOH}$, monomer of polyvinyl alcohol exists mainly as CH_3CHO ; hence polyvinyl alcohol is best prepared by the alkaline hydrolysis of polyvinyl acetate which in turn is prepared by the polymerisation of vinyl acetate.

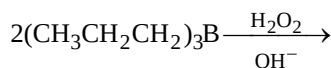
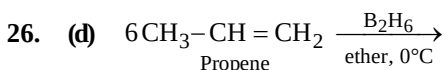
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Topicwise AIIMS Solved Papers – CHEMISTRY

24. (a) Reaction involved is given as :

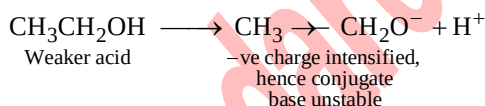
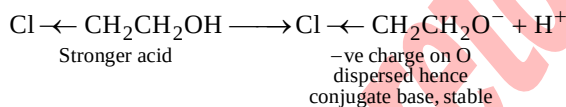


25. (d) 1-pentanol
Primary alcohols readily form ether when heated with conc. H_2SO_4 .



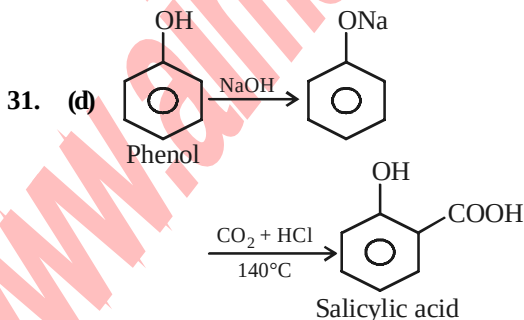
27. (a)

28. (c) $\text{ClCH}_2\text{CH}_2\text{OH}$ is stronger acid than $\text{CH}_3\text{CH}_2\text{OH}$ due to $-I$ effect of Cl.



29. (b)

30. (a) Since glycerol has three $-\text{OH}$ groups, it can have three acyl (similar or different) groups



32. (b)

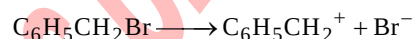
Type B : Assertion Reason Questions

33. (a) Phenols turn FeCl_3 solution purple
Resorcinol has phenolic group.

34. (b) Phenol is strong acid than ethanol because phenoxide ion is resonance stabilised.

When a group having $+M$ effect is at p -position (like halide group) it decreases the acidity of phenols. So assertion and reason are correct but reason is not the explanation of assertion. So correct option is (b).

35. (c) The reaction follows $\text{S}_{\text{N}}1$ mechanism for two reasons :

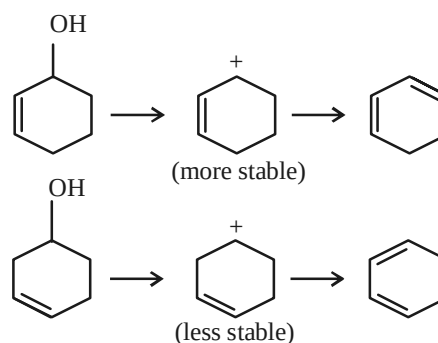


1. $\text{C}_6\text{H}_5\text{CH}_2^+$ is stabilised by resonance.
2. Steric hinderance of phenyl group.

36. (a) As benzyl cation ($\text{C}_6\text{H}_5\text{CH}_2^+$) is more stable than methyl cation (CH_3^+), so the product is $\text{C}_6\text{H}_5\text{CH}_2\text{I}$ and CH_3OH

37. (a) The given order of dehydration is correct due to following reasons.

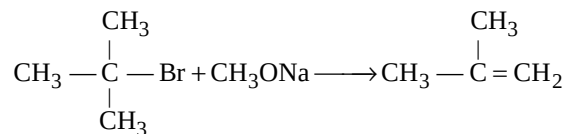
- (i) Alcohols leading to conjugated alkenes are dehydrated more readily.
- (ii) 2-Cyclohexenol is dehydrated more easily than 3-cyclohexenol because the carbocation from the former is more stable than the latter.



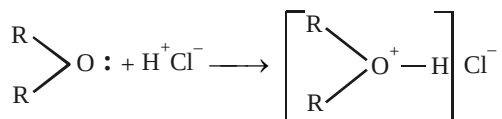
- (iii) Phenol is not dehydrated due to its highly stable character due to resonance.

38. (a) Phenol is an effective germicide. Phenyl is a derivative of phenol, that's why it also has germicidal property.

39. (b) On using *ter*-butyl bromide and sodium ethoxide as reactants, the major product would be 2-methylpropene and ethanol (elimination reaction).



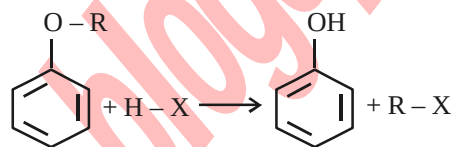
40. (a) Ethers have lone pair on oxygen, so they behave as Lewis base. It forms salt known as oxonium salt with acids.



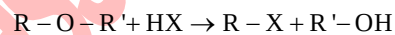
41. (c) It is correct that sodium phenoxide (sodium salt of phenol) and CO_2 on heating form

sodium salicylate. This is known as Kolbe's reaction. Ethanol does not respond to this reaction. Therefore, Assertion is true. But the Reason that phenoxide ion is more basic than ethoxide ion is not correct.

42. (c) Alkyl aryl ethers are cleaved at the alkyl-oxygen bond due to the more stable aryl-oxygen bond. The reaction yields phenol and alkyl halide



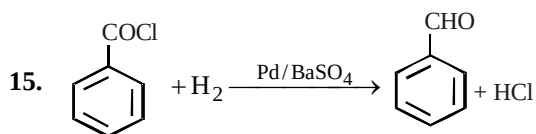
Ethers with two different alkyl groups are also cleaved in the same manner.



Aldehydes, Ketones and Carboxylic Acids

TYPE A : MULTIPLE CHOICE QUESTIONS

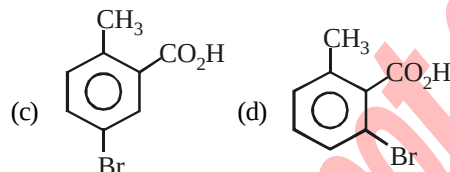
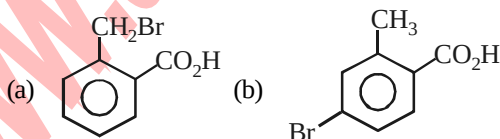
- Reduction of benzoyl chloride with Pd and BaSO_4 gives : [1997]
 - benzyl chloride
 - benzaldehyde
 - benzoic acid
 - benzene sulphonyl chloride
- Acetaldehyde does not respond to [1997]
 - Tollen's test
 - Benedict's test
 - Lucas test
 - Iodoform test
- $2\text{CH}_3\text{COOC}_2\text{H}_5 \xrightarrow{\text{C}_2\text{H}_5\text{ONa}}$
 $\text{CH}_3\text{COCH}_2\text{COOC}_2\text{H}_5$ [1997]
 The above reaction is known as :
 - Claisen condensation
 - Perkin reaction
 - Schotten-Baumann reaction
 - Curtius reaction
- In a ring substitution of $\text{C}_6\text{H}_5\text{Z}$, the main product obtained is meta, the group Z is [1997]
 - $-\text{COOH}$
 - $-\text{Cl}$
 - $-\text{NH}_2$
 - $-\text{CH}_3$
- Acetate ion contains: [1998]
 - One C – O bond and one C = O bond
 - Two C = O bonds
 - Two C – O bonds
 - Two C = O bonds and one C – O bond
- Phenol $\xrightarrow{\text{NaOH}}$ X $\xrightarrow{\text{CO}_2}$ Y $\xrightarrow{\text{H}^+}$ Z,
 Z is identified as: [1999]
 - Benzoic acid
 - Benzaldehyde
 - Sodium benzoate
 - Salicylic acid
- Benzaldehyde can be prepared by the hydrolysis of: [1999]
 - benzonitrile
 - benzotrichloride
 - benzyl chloride
 - benzal chloride
- Which produces ketone on treatment with Grignard reagent ? [1999]
 - methyl cyanide
 - acetaldehyde
 - methyl alcohol
 - acetic acid
- Which of the following compound is formed when $\text{CH}_2 = \text{CH}(\text{CH}_2)_2\text{COOH}$ reacts with HBr? [2000]
 - $\text{CH}_3\text{CH}_2\text{CH}_2\text{CH}_2\text{BrCOOH}$
 - $\text{CH}_3\text{CHBrCH}_2\text{CH}_2\text{COOH}$
 - $\text{CH}_2\text{BrCH}_2(\text{CH}_2)_2\text{COOH}$
 - $\text{CH}_3\text{CH}_2\text{CH}_2\text{BrCH}_2\text{COOH}$
- Ethyl alcohol reacts with chlorine to produce : [2000]
 - $\text{CH}_3\text{CH}_2\text{Cl}$
 - $\text{CH}_2\text{ClCH}_2\text{OH}$
 - $\text{CHCl}_2\text{CH}_2\text{OH}$
 - CCl_3CHO
- Aldol condensation does not take place in: [2000]
 - HCHO
 - CH_3CHO
 - $\text{CH}_3\text{CH}_2\text{CHO}$
 - CH_3COCH_3
- Acetic acid on heating with P_2O_5 produces : [2000]
 - CH_3COCH_3
 - CH_3CHO
 - $\text{CH}_3\text{COCH}_2\text{CH}_3$
 - $(\text{CH}_3\text{CO})_2\text{O}$
- Salol is : [2001]
 - acetylsalicylic acid
 - phenyl salicylate
 - methyl salicylate
 - none of the above
- Aldehydes and ketones can be distinguished by: [2001]
 - Ammonia
 - H_2SO_4
 - Alkaline KMnO_4
 - Fehling solution

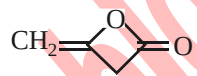
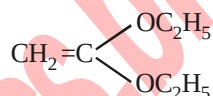


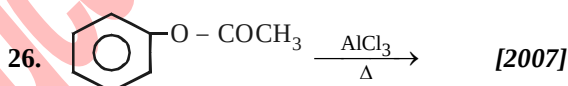
The above reaction is

[2001]

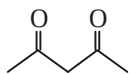
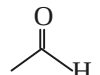
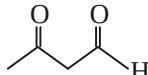
- (a) Clemmensen reduction
(b) Rosenmund reduction
(c) Birch reduction
(d) Walf-Kishner reduction
16. The intermediate formed in aldol condensation is [2002]
(a) aldol (b) carbanion
(c) alcohol (d) α -hydrogen ester
17. The compound most suitable for the preparation of cyanohydrin is [2002]
(a) $\text{C}_2\text{H}_5\text{COOH}$ (b) $\text{C}_6\text{H}_5\text{NH}_2$
(c) $\text{C}_2\text{H}_5\text{COC}_2\text{H}_5$ (d) $\text{C}_2\text{H}_5 - \text{C}_2\text{H}_5$
18. Action of acetylene on dilute H_2SO_4 gives [2002]
(a) acetic acid (b) acetaldehyde
(c) acetone (d) acetoacetic ester
19. CH_3COCH_3 can be converted to $\text{CH}_3\text{CH}_2\text{CH}_3$ by the action of [2002]
(a) HIO_3 (b) HNO_3
(c) HI (d) H_3PO_3
20. Among the following the strongest acid is [2003]
(a) CH_3COOH
(b) $\text{C}_6\text{H}_5\text{COOH}$
(c) $m\text{-CH}_3\text{OC}_6\text{H}_4\text{COOH}$
(d) $p\text{-CH}_3\text{OC}_6\text{H}_4\text{COOH}$
21. At higher temperature, iodoform reaction is given by the dilute solution of [2003]
(a) $\text{CH}_3\text{CO}_2\text{CH}_3$ (b) $\text{CH}_3\text{CO}_2\text{C}_2\text{H}_5$
(c) $\text{CH}_3\text{CO}_2\text{C}_6\text{H}_5$ (d) $\text{C}_2\text{H}_5\text{CO}_2\text{CH}_3$
22. The reagent used for the separation of acetaldehyde from acetophenone is [2004]
(a) NaHSO_3 (b) $\text{C}_6\text{H}_5\text{NHNH}_2$
(c) NH_2OH (d) $\text{NaOH} + \text{I}_2$
23. *o*-Toluic acid on reaction with $\text{Br}_2 + \text{Fe}$ gives [2004]



24. $\text{CH}_3\text{CO}_2\text{C}_2\text{H}_5$ on reaction with sodium ethoxide in ethanol gives A, which on heating in the presence of acid gives B. Compound B is: [2005]
(a) $\text{CH}_3\text{COCH}_2\text{COOH}$
(b) CH_3COCH_3
(c) 
(d) 
25. Isopropylbenzene on air oxidation in the presence of dilute acid gives: [2006]
(a) $\text{C}_6\text{H}_5\text{COOH}$ (b) $\text{C}_6\text{H}_5\text{COCH}_3$
(c) $\text{C}_6\text{H}_5\text{CHO}$ (d) $\text{C}_6\text{H}_5\text{OH}$



The product obtained is/are

- (a) *o*-product
(b) *m*-product
(c) *o*- and *p*-products
(d) *o*-, *m*- and *p*-products
27. Benzoic acid is treated with lithium aluminium hydride. The compound obtained is [2007]
(a) benzaldehyde (b) benzyl alcohol
(c) toluene (d) benzene.
28. Maximum enol content is in [2008]
(a)  (b) 
(c)  (d) 
29. $\text{CH}_3\text{CH}_2\text{C} \equiv \text{N} \xrightarrow{\text{X}} \text{CH}_3\text{CH}_2\text{CHO}$
The compound X is [2008]
(a) $\text{SnCl}_2/\text{HCl}/\text{H}_2\text{O}$, boil
(b) $\text{H}_2/\text{Pd}-\text{BaSO}_4$
(c) $\text{LiAlH}_4/\text{ether}$
(d) $\text{NaBH}_4/\text{ether}/\text{H}_3\text{O}^+$

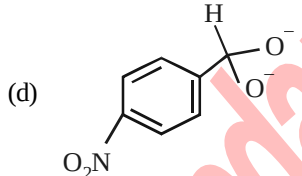
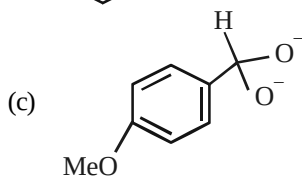
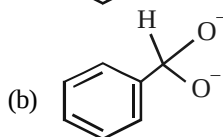
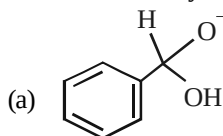
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Topicwise AIIMS Solved Papers – CHEMISTRY

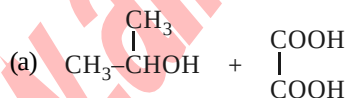
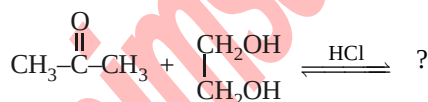
30. 3-Hydroxybutanal is formed when X reacts with Y in dilute Z solution. What are X, Y and Z?

[2008]

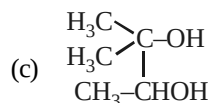
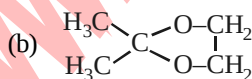
	X	Y	Z
(a)	CH ₃ CHO	(CH ₃) ₂ CO	NaOH
(b)	CH ₃ CHO	CH ₃ CHO,	NaCl
(c)	(CH ₃) ₂ CO,	(CH ₃) ₂ CO,	HCl
(d)	CH ₃ CHO,	CH ₃ CHO,	NaOH
31. Acid hydrolysis of which of the following compounds yields two different organic compounds? [2008]
- (a) CH₃COOH (b) CH₃CONH₂
 (c) CH₃COOC₂H₅ (d) (CH₃CO)₂O
32. In the Cannizzaro reaction the intermediate that will be the best hydride donor is [2009]



33. Identify the product for the following reaction



[2009]



- (d) No reaction
34. (CH₃)₃C—CHO does not undergo aldol condensation due to [2010]

- (a) three electron donating methyl groups
 (b) cleavage taking place between —C—CHO bond
 (c) absence of alpha hydrogen atom in the molecule
 (d) bulky (CH₃)₃C—group

35. Which of the following undergoes haloform reaction? [2011]

- (i) CH₃CH₂COCH₂Cl (ii) C₆H₅COCH₃
 (iii) C₆H₅COCHCl₂ (iv) CH₃CH₂COCCH₃
 (a) only (ii) (b) (ii) and (iv)
 (c) (i), (ii) and (iv) (d) all the four

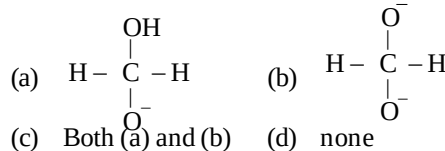
36. (CH₃)₃CCl $\xrightarrow{\text{NaCN}}$ A $\xrightarrow{\text{dil. H}_2\text{SO}_4}$ B.

Compound B is [2011]

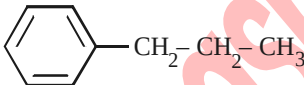
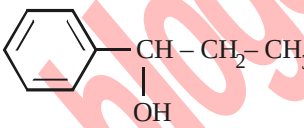
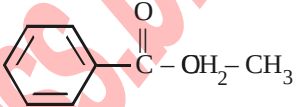
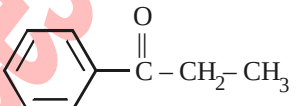
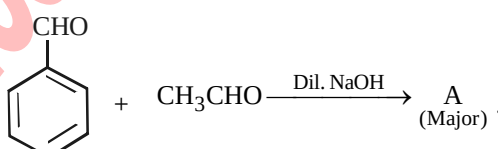
- (a) (CH₃)₃CCOOH (b) (CH₃)₃COH
 (c) (CH₃)₃COC(CH₃)₃ (d) All the three
37. When ethane-1, 2-dioic acid is heated with conc. H₂SO₄, it gives [2011]
- (a) CO + HCOOH (b) CO₂ + HCOOH
 (c) CO + CO₂ + HCOOH (d) CO + CO₂ + H₂O
38. Which of the following statement is not true? [2011]

- (a) At room temperature, formyl chloride is present in the form of CO and HCl
 (b) Acetamide behaves as a weak base as well as a weak acid.
 (c) CH₃CONH₂ $\xrightarrow{\text{LiAlH}_4}$ CH₃CH₂NH₂
 (d) None of the three.

39. Cannizzaro reaction between formaldehyde molecules involves the formation of [2011]



40. Carbonyl compounds undergo nucleophilic addition because of [2012]
 (a) electronegativity difference of carbon and oxygen atoms
 (b) electromeric effect
 (c) more stable anion with negative charge on oxygen atom and less stable carbonium ion
 (d) none of the above
41. Which of the following is correct order of acidity? [2012]
 (a) $\text{HCOOH} > \text{CH}_3\text{COOH} > \text{ClCH}_2\text{COOH} > \text{C}_2\text{H}_5\text{COOH}$
 (b) $\text{ClCH}_2\text{COOH} > \text{HCOOH} > \text{CH}_3\text{COOH} > \text{C}_2\text{H}_5\text{COOH}$
 (c) $\text{CH}_3\text{COOH} > \text{HCOOH} > \text{ClCH}_2\text{COOH} > \text{C}_2\text{H}_5\text{COOH}$
 (d) $\text{C}_2\text{H}_5\text{COOH} > \text{CH}_3\text{COOH} > \text{HCOOH} > \text{ClCH}_2\text{COOH}$
42. Which is not true about acetophenone? [2012]
 (a) It reacts with 2,4-dinitrophenylhydrazine to form 2,4-dinitrophenylhydrazone
 (b) It reacts with Tollen's reagent to form silver mirror
 (c) It reacts with I_2/NaOH to form iodoform
 (d) On oxidation with alkaline KMnO_4 followed by hydrolysis it gives benzoic acid
43. Which of the following products is formed when benzaldehyde is treated with CH_3MgBr and the addition product so obtained is subjected to acid hydrolysis? [2013]
 (a) A secondary alcohol
 (b) A primary alcohol
 (c) Phenol
 (d) tert-Butyl alcohol
44. Ethanoic acid on heating with ammonia forms compound A which on treatment with bromine and sodium hydroxide gives compound B. Compound B on treatment with $\text{NaNO}_2/\text{dil. HCl}$ gives compound C. The compounds A, B and C respectively are [2014]
 (a) ethanamide, methanamine, methanol
 (b) propanamide, ethanamine, ethanol
 (c) N-ethylpropanamide, methaneisocyanide, methanamine
 (d) ethanamine, bromoethane, ethanediazonium chloride
45. The final product (III) obtained in the reaction sequence –

$$\text{CH}_3 - \text{CH}_2 - \text{COOH} \xrightarrow{\text{PCl}_3} \text{I} \xrightarrow{\text{C}_6\text{H}_6/\text{AlCl}_3} \text{II} \xrightarrow[\text{base/heat}]{\text{NH}_2 - \text{NH}_2} \text{III}$$
 [2014]
 (a) 
 (b) 
 (c) 
 (d) 
46. 
 (A) will be – [2014]
 (a) $\text{C}_6\text{H}_5\text{CH}(\text{OH}) - \text{CH}_2\text{CHO}$
 (b) $\text{C}_6\text{H}_5\text{CH} = \text{CH} - \text{CHO}$
 (c) $\text{C}_6\text{H}_5\text{CH}_2\text{CH}_2\text{CHO}$
 (d) Both (b) & (c)
47. Which of the following represents the correct order of the acidity in the given compounds? [2015]
 (a) $\text{FCH}_2\text{COOH} > \text{CH}_3\text{COOH} > \text{BrCH}_2\text{COOH} > \text{ClCH}_2\text{COOH}$
 (b) $\text{BrCH}_2\text{COOH} > \text{ClCH}_2\text{COOH} > \text{FCH}_2\text{COOH} > \text{CH}_3\text{COOH}$
 (c) $\text{FCH}_2\text{COOH} > \text{ClCH}_2\text{COOH} > \text{BrCH}_2\text{COOH} > \text{CH}_3\text{COOH}$
 (d) $\text{CH}_3\text{COOH} > \text{BrCH}_2\text{COOH} > \text{ClCH}_2\text{COOH} > \text{FCH}_2\text{COOH}$

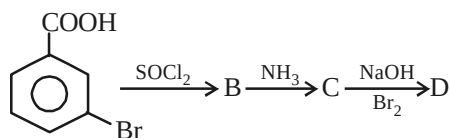
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Topicwise AIIMS Solved Papers – CHEMISTRY

48. An ester (A) with molecular formula, $C_9H_{10}O_2$ was treated with excess of CH_3MgBr and the complex so formed was treated with H_2SO_4 to give an olefin (B). Ozonolysis of (B) gave a ketone with molecular formula C_8H_8O which shows positive iodoform test. The structure of (A) is

[2015]

- (a) $C_6H_5COOC_2H_5$
 (b) $C_2H_5COOC_6H_5$
 (c) $H_3COCH_2COC_6H_5$
 (d) $p-H_3CO-C_6H_4-COCH_3$
49. In a set of reactions *m*-bromobenzoic acid gave a product D. Identify the product D. [2015]



- (a) (b)
 (c) (d)

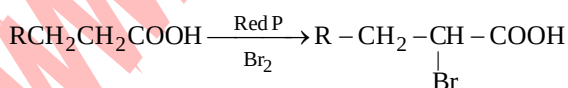
50. Aldehydes that do not undergo aldol condensation are
1. propanal
 2. trichloroethanal
 3. methanal
 4. ethanal
 5. benzaldehyde

[2016]

- (a) 3 and 4 only (b) 3 and 5 only
 (c) 1, 2 and 3 only (d) 2, 3 and 5 only
51. Aldol condensation will not be observed in
- (a) chloral (b) phenylacetaldehyde
 (c) hexanal (d) nitromethane

[2017]

52. The reaction



is called as

[2013, 2017]

- (a) Reimer-Tiemann reaction
 (b) Hell-volhard Zelinsky reaction
 (c) Cannizzaro reaction
 (d) Sandmeyer reaction

TYPE B : ASSERTION REASON QUESTIONS

Directions for (Qs. 53-58) : These questions consist of two statements, each printed as Assertion and Reason. While answering these questions, you are required to choose any one of the following five responses.

- (a) If both Assertion and Reason are correct and the Reason is a correct explanation of the Assertion.
 (b) If both Assertion and Reason are correct but Reason is not a correct explanation of the Assertion.
 (c) If the Assertion is correct but Reason is incorrect.
 (d) If both the Assertion and Reason are incorrect.
 (e) If the Assertion is incorrect but the Reason is correct.

53. **Assertion :** Acetaldehyde on treatment with alkali gives aldol.

Reason : Acetaldehyde molecule contains α -hydrogen atom. [1997]

54. **Assertion :** Acetylene on treatment with alkaline $KMnO_4$ produces acetaldehyde.

Reason : Alkaline $KMnO_4$ is a reducing agent. [2000]

55. **Assertion :** Hydroxyketones are not directly used in Grignard reaction.

Reason : Grignard reagents react with hydroxyl group. [2003]

56. **Assertion :** Isobutanal does not give iodoform test.

Reason : It does not have α -hydrogen [2004]

57. **Assertion :** The pK_a of acetic acid is lower than that of phenol.

Reason : Phenoxide ion is more resonance stabilised. [2004]

58. **Assertion :** Acetamide has more polar >C=O group than ethyl acetoacetate.

Reason : $\ddot{N}H_2$ is more electron donating than $\ddot{O}C_2H_5$. [2007]

Directions for (Qs.59-69) : Each of these questions contains an Assertion followed by Reason. Read them carefully and answer the question on the basis of following options. You have to select the one that best describes the two statements.

- (a) If both Assertion and Reason are correct and Reason is the correct explanation of Assertion.
(b) If both Assertion and Reason are correct, but Reason is not the correct explanation of Assertion.
(c) If Assertion is correct but Reason is incorrect.
(d) If both the Assertion and Reason are incorrect.

59. **Assertion :** RCOCl , $(\text{RCO})_2\text{O}$ and RCOOR' all react with Grignard reagents to form 3° alcohols.
Reason : RCOCl reacts with R_2Cd to form ketones but $(\text{RCO})_2\text{O}$ and RCOOR' do not react at all.

[2009]

60. **Assertion :** Protonation of a carbonyl group increases its electrophilic character.

Reason : Protonation of a carbonyl group involves addition of an electrophile on nucleophilic oxygen.

[2009]

61. **Assertion :** Nitration of benzoic acid gives *m*-nitrobenzoic acid.

Reason : Carboxyl group increases the electron-density at *meta*-position.

[2009]

62. **Assertion :** β -Keto carboxylic acids lose CO_2 when heated at about 370 K.

Reason : An enol is first formed by loss of CO_2 , but it readily tautomerises to the more stable ketone.

[2010]

63. **Assertion :** The acetate ion is resonance stabilized.

Reason : Acetate ion is more basic than the methoxide ion.

[2011]

64. **Assertion:** CH_3COCl is converted to CH_3CONH_2 on reaction with NH_3 .

Reason : Cl is a stronger nucleophile and better leaving group.

[2011]

65. **Assertion :** Aldol condensation can be catalysed both by acids and bases.

Reason : β -Hydroxyaldehydes or ketones readily undergo acid-catalysed dehydration.

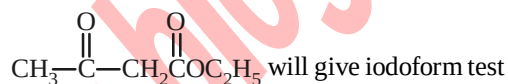
[2011]

66. **Assertion :** 2, 2-Dimethylpropanal undergoes Cannizzaro reaction with conc. NaOH .

Reason : Cannizzaro reaction is a disproportionation reaction.

[2012]

67. **Assertion :** Acetoacetic ester,



Reason : It does not contain $\text{CH}_3-\overset{\text{O}}{\parallel}{\text{C}}-$ group.

[2013]

68. **Assertion :** Benzaldehyde is more reactive than ethanol towards nucleophilic attack.

Reason : The overall effect of $-\text{I}$ and $+\text{R}$ effect of phenyl group decreases the electron density on the carbon atom of $>\text{C}=\text{O}$ group in benzaldehyde.

[2014, 2015]

69. **Assertion :** The boiling points of aldehydes and ketones are higher than hydrocarbons and ethers of comparable molecular masses.

Reason : There is a weak molecular association in aldehydes and ketones arising out of the dipole-dipole interactions.

[2016]

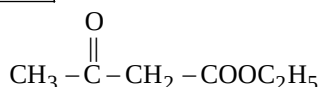
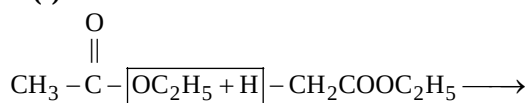
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HINTS & SOLUTIONS

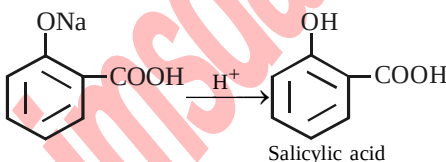
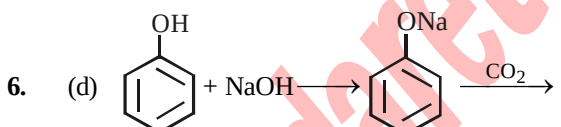
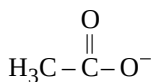
Type A : Multiple Choice Questions

- (b) $C_6H_5COCl \xrightarrow{Pd/BaSO_4} C_6H_5CHO$
This reaction is known as Rosenmund's reduction.
- (c) Lucas test is for primary, secondary and tertiary alcohols and not for acetaldehyde
- (a)

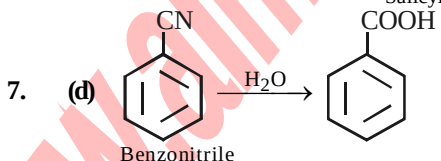


Self condensation of ester takes place in presence of strong base such as $C_2H_5O^-$. The reaction is known as Claisen condensation.

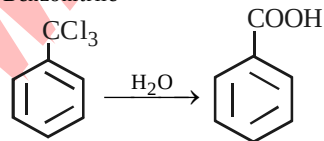
- (a) Group Z is meta directing. Among the given groups, $-COOH$ is the only meta directing group.
- (a) Acetate ion (CH_3COO^-) has one C-O and one C=O bond.



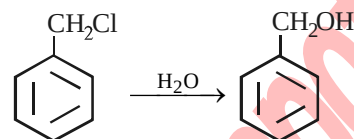
Salicylic acid



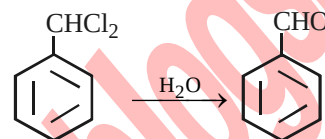
Benzonitrile



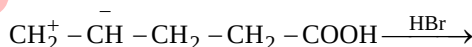
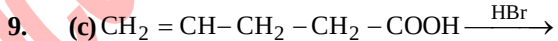
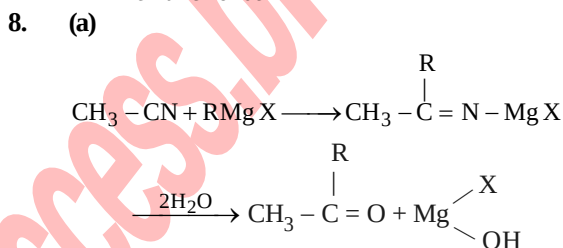
Benzotrichloride



Benzyl chloride

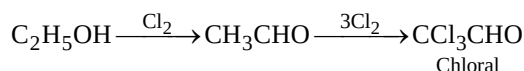


Benzal chloride



So, the addition is anti-Markovnikov.

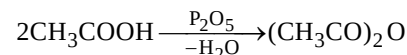
- (d) Ethyl alcohol reacts with chlorine to produce CCl_3CHO



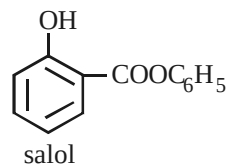
Chloral

- (a) Aldol condensation does not take place in HCHO as it has no α -carbon.

- (d) Acetic anhydride is produced.



- (b) Salol is phenyl salicylate.



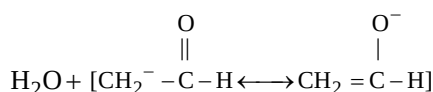
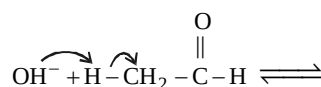
salol

It is used as intestinal antiseptic.

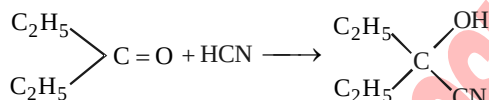
14. (d) Aldehydes and ketones can be distinguished by Fehling solution. Aldehydes can reduce it, whereas ketones cannot reduce it.

15. (b)

16. (b) Aldol condensation is carried out on aldehydes or ketones having α -hydrogen atom in presence of base which abstracts α -H atom from aldehyde/ketone to form corresponding carbanion which is stabilised by resonance.

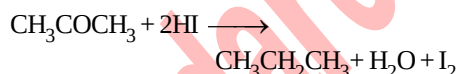


17. (c) Ketones reacts with HCN to form addition product, known as cyanohydrin compounds.



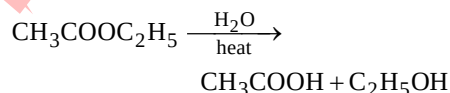
18. (b) Acetylene is hydrolysed by dil. H_2SO_4 to form acetaldehyde.

19. (c) CH_3COCH_3 can be reduced by HI to alkanes. HI is very strong reducing agent.

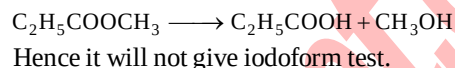


20. (b) Benzoic acid is the strongest acid. Benzoate ion is stabilised by resonance. +I effect of $-\text{CH}_3$ or $-\text{OCH}_3$ group reduces the possibility of ionisation of H^+ from COOH .

21. (b) Formation of iodoform is commonly used as a test for alcohols having $-\text{CH}(\text{OH})\text{CH}_3$ grouping, acetaldehyde and ketones having at least one alkyl group as methyl group, i.e. for detecting the presence of $-\text{CHOHCH}_3$, $-\text{COCH}_3$ and CH_3CHO . The esters (as given in the options) are hydrolysed into alcohols or acids.

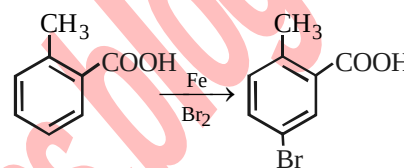


Ethyl alcohol, so formed, will give iodoform test.



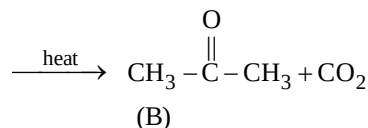
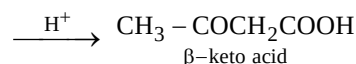
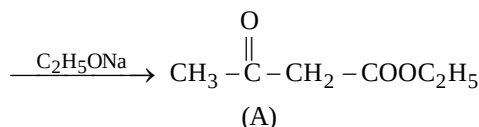
22. (a) NaHSO_3 does not react with acetophenone due to steric hindrance but it forms addition product with acetaldehyde.

23. (c) In *o*-toluic acid, $-\text{CH}_3$ group is *ortho-para* directing



and $-\text{COOH}$ group is *meta*-directing. So, the resulting product will be (c) in which Br is attached at *para* to $-\text{CH}_3$ and *meta* to $-\text{COOH}$ group.

24. (b) $\text{CH}_3\text{COOC}_2\text{H}_5 + \text{CH}_3-\overset{\text{O}}{\parallel}{\text{C}}-\text{OC}_2\text{H}_5$



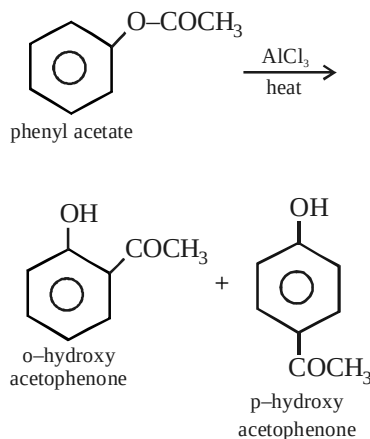
β -Keto acids, on heating, undergo decarboxylation.

25. (d)

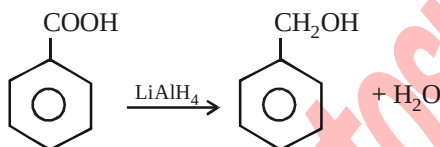
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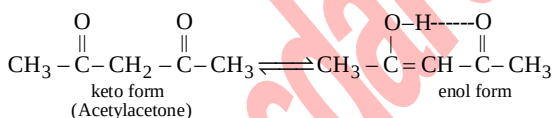
26. (c) The phenyl esters on treatment with AlCl_3 (anhy.) undergoes rearrangement to give *o*- and *p*- hydroxyketones (Fries rearrangement).



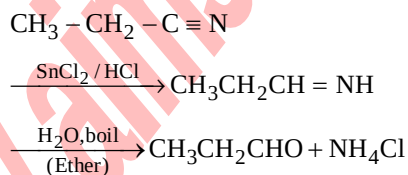
27. (b) When benzoic acid is treated with LiAlH_4 it reduces the $-\text{COOH}$ group of benzoic acid to $-\text{CH}_2\text{OH}$.



28. (b) Maximum enol content is in structure (b) because here the enol form is stabilised by H-bonding.

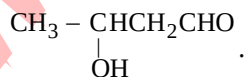


29. (a) Completing the given reaction

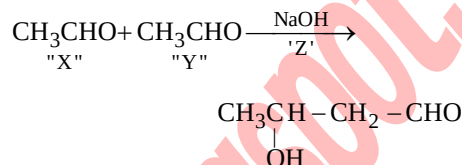


It is Stephen's reduction.

30. (d) The product obtained is

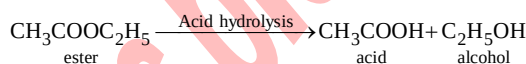


This product is obtained when 2 molecules of CH_3CHO are heated with concentrated alkali (NaOH)

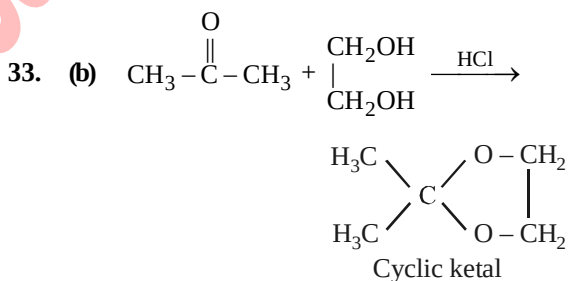


[Note ; The aldehydes having α -hydrogen atom on heating with concentrated alkali give brown resinous mass; aldol condensation]

31. (c)

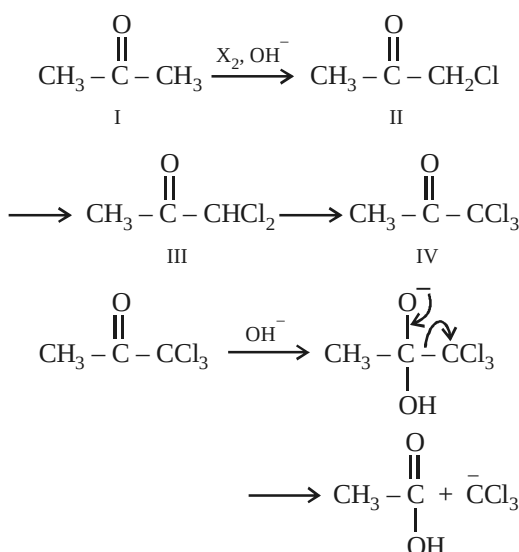


32. (a) In general, aldehydes containing no α -H atom undergo Cannizzaro's reaction. It follows the familiar pattern of carbonyl compounds i.e. nucleophilic addition and involves two successive additions. In step (i), a hydroxide ion is added to give intermediate compound (a). The presence of negative charge on compound (a) aids in loss of hydride ion.



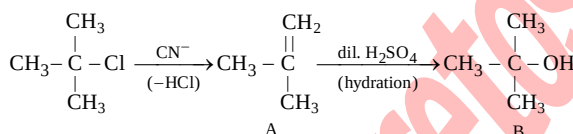
34. (c) Aldol condensation is given by the compounds which contain α -hydrogen atom.

35. (d) If we observe the haloform reaction carefully, we see that $-\text{COCH}_3$ group is first halogenated to the trihalo- $-\text{COCX}_3$ through monohalogeno and dihalogeno compound. It is the $-\text{COCX}_3$ part which then undergoes nucleophilic addition. The product easily loses $-\text{CX}_3$ since it is a very good leaving group.

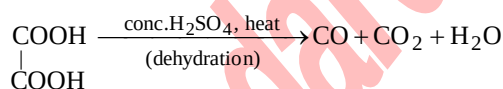


Thus all compounds (I to IV) are ultimately converted to CHCl_3 (chloroform).

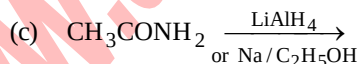
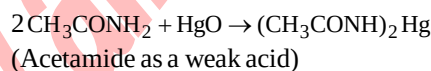
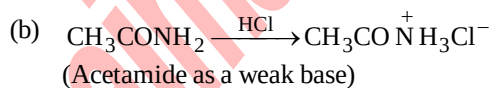
36. (b) CN^- is a strong base and since the substrate is a *tert*-halide, it mainly undergoes elimination reaction forming alkene (A). In presence of dil. H_2SO_4 , alkenes undergo hydration in Markovnikov's way.



37. (d)



38. (d) (a) $\text{H}-\overset{\text{O}}{\parallel}{\text{C}}-\text{Cl} \rightarrow \text{CO} + \text{HCl}$

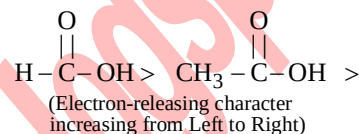
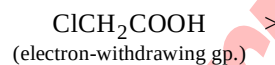


Thus all the three are correct.

39. (c)

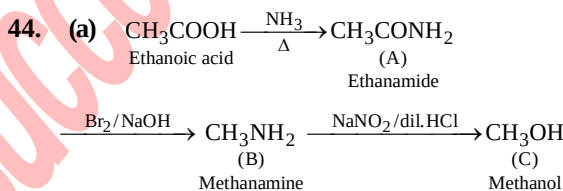
40. (c)

41. (b) Recall that presence of electron-withdrawing group increases, while presence of electron-releasing group decreases the acidity of carboxylic acids.

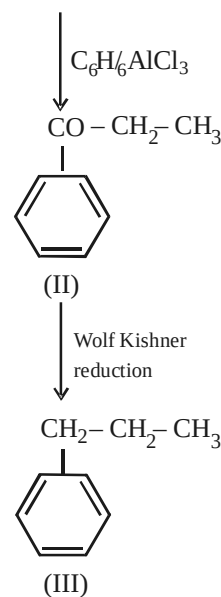
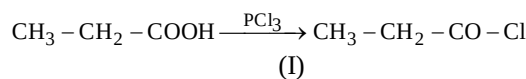


42. (b) Acetophenone ($\text{C}_6\text{H}_5\text{COCH}_3$) being a ketone, does not reduce Tollen's reagent.

43. (a) Aldehydes, other than formaldehyde, when treated with RMgX give 2° alcohols



45. (a)



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46. (b) Aldol formed in aromatic aldehydes itself loses water molecule without heating because double bond formed is more stable due to conjugation with benzene ring.

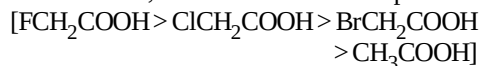
$C_6H_5CH=CHCHO$ is commonly known as cinnamaldehyde.

47. (c) Electron withdrawing substituent (like halogen, $-NO_2$, C_6H_5 etc.) would disperse the negative charge and hence stabilise the carboxylate ion and thus increase acidity of the parent acid. On the other hand, electron-releasing substituents would intensify the negative charge, destabilise the carboxylate ion and thus decrease acidity of the parent acid.

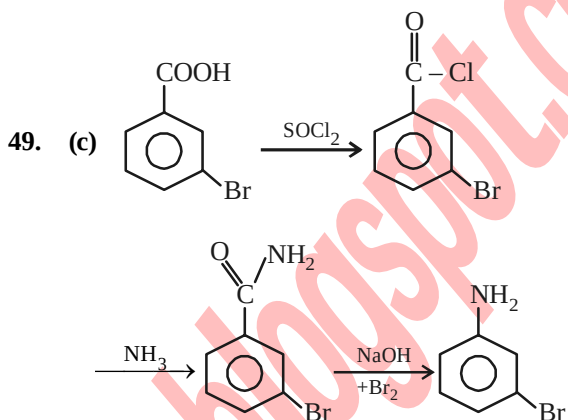
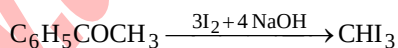
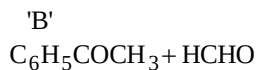
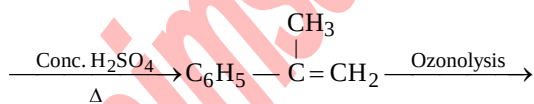
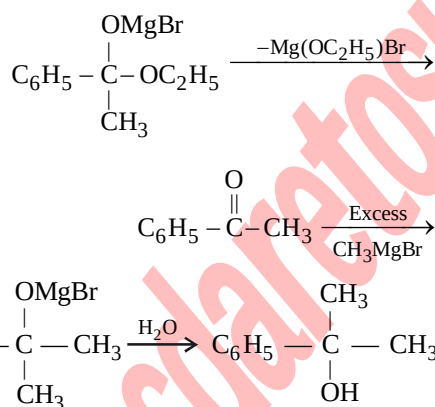
Electronegativity decreases in order



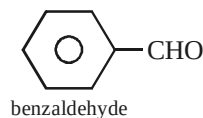
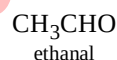
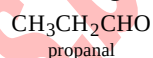
and hence $-I$ effect also decreases in the same order, therefore the correct option is



48. (a) $C_6H_5COOC_2H_5 \xrightarrow{CH_3MgBr}$

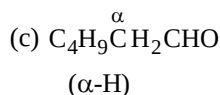
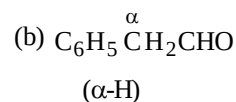
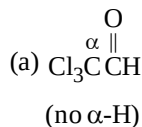


50. (d) Structures of given aldehydes



Trichloroethanal, methanal and benzaldehyde do not undergo aldol condensation. Aldol condensation is not given by aldehydes and ketones which do not contain α -hydrogen atom(s).

51. (a) only those compounds which have α -H give Aldol condensation



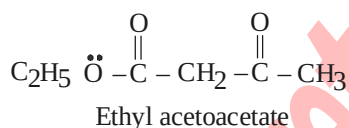
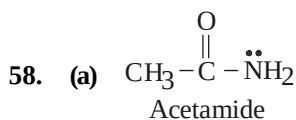
52. (b)

Type B : Assertion Reason Questions

53. (a) Acetaldehyde gives aldol condensation reaction because it contains α -hydrogen.
54. (d) Both are false. KMnO_4 is an oxidising agent and acetylene on treatment with alkaline KMnO_4 produces oxalic acid



55. (a) Grignard reagents are highly reactive, so react with the hydroxyl group.
56. (c) Isobutanal does not give iodoform test because it does not have $-\text{COCH}_3$ group.
57. (c) Low pK_a value corresponds to more acidic compound. Acetic acid ($\text{pK}_a = 4.0$) is more acidic than phenol ($\text{pK}_a = 9.0$). It is due to the fact that carboxylate ion is more stabilized due to resonance because its resonating structures are equivalent.



As $-\text{NH}_2$ is more basic than RO^- hence acetamide has more polar >C=O group than OC_2H_5 group in ethyl acetoacetate.

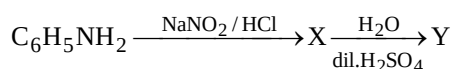
Hence assertion and reason both are true and reason is correct explanation of assertion.

59. (b) RCOCl , $(\text{RCO})_2\text{O}$ and RCOOR' all add two molecules of Grignard reagents to give 3° alcohols.
60. (b) Both assertion and reason are true and reason is not the correct explanation of assertion.
61. (c) The correct reason : Carboxyl group only marginally decreases the electron density at m -position relative to o - and p -positions.
62. (b)
63. (c) Assertion is correct as conjugate base of a strong acid is weak. Since CH_3COOH is a stronger acid than CH_3OH , CH_3COO^- is a weaker base than OCH_3^- .
64. (c)
65. (b) **Correct explanation :** Both carbanion (formed in presence of a base) and enol form (formed in presence of an acid) act as nucleophiles and hence add on the carbonyl group of aldehydes and ketones to give aldols.
66. (b) Aldehydes which do not contain α -hydrogen undergo Cannizzaro reaction.
67. (d)
68. (d) Benzaldehyde is less reactive than ethanol towards nucleophilic attack. The combined effect of $-I$ and $+R$ effect of phenyl group is electron donating which increases the electron density on the carbon atom of the $>\text{C}=\text{O}$ in benzaldehyde.
69. (a)

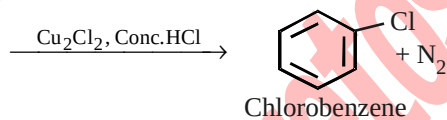
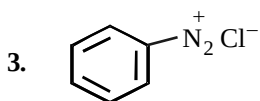
Amines

TYPE A : MULTIPLE CHOICE QUESTIONS

1. Identify Y in the reaction : [1998]



- (a) $\text{C}_6\text{H}_5\text{N}_2\text{Cl}$ (b) $\text{C}_6\text{H}_5\text{OH}$
 (c) $\text{C}_6\text{H}_5\text{NHOH}$ (d) C_6H_6
2. Dynamite is a mixture of: [1998]
- (a) Nitroglycerine + raw dust
 (b) Nitroglycerine + HCl
 (c) Hydrogen bomb + H_2SO_4
 (d) Glycerine + H_2SO_4



Above reaction is known as: [2000]

- (a) Strecker's reaction
 (b) Sandmeyer's reaction
 (c) Wohl-Ziegler reaction
 (d) Stephen's reaction
4. Reduction of nitrobenzene with Sn/HCl produces: [2001]
- (a) azobenzene (b) azoxybenzene
 (c) nitrobenzene (d) aniline
5. Hinsberg's reagent is : [2001]
- (a) COOC_2H_5
 $\quad \quad \quad |$
 $\quad \quad \quad \text{COOC}_2\text{H}_5$
 (b) $\text{C}_6\text{H}_5\text{SO}_2\text{Cl}$
 (c) $\text{C}_6\text{H}_5\text{SO}_2\text{NH}_2$
 (d) $\text{CH}_3\text{COCH}_2\text{COOC}_2\text{H}_5$

6. The product formed by the reaction of acetamide with bromine in presence of NaOH is : [2001]

- (a) CH_3CN (b) CH_3CHO
 (c) $\text{CH}_3\text{CH}_2\text{OH}$ (d) CH_3NH_2

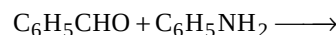
7. Primary amine reacts with carbon disulphide and HgCl_2 to produce alkyl isothiocyanate. This reaction is : [2001]

- (a) Carbylamine reaction
 (b) Hoffmann bromamide reaction
 (c) Perkin reaction
 (d) Hoffmann mustard oil reaction

8. Which of the following is involved in Sandmeyer's reaction? [2002]

- (a) ferrous salt
 (b) diazonium salt
 (c) ammonium salt
 (d) cuprammonium salt

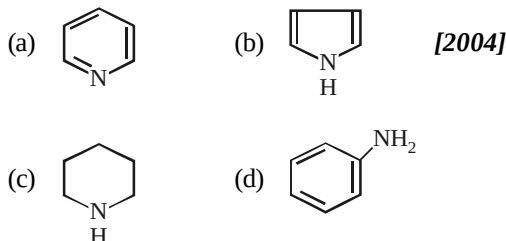
9. In the reaction :



The compound, $\text{C}_6\text{H}_5\text{N} = \text{CHC}_6\text{H}_5$ is known as [2002]

- (a) aldol (b) Schiff's base
 (c) Schiff's reagent (d) Benedict's reagent
10. The ortho/para directing group among the following is : [2003]
- (a) COOH (b) CN
 (c) COCH_3 (d) NHCONH_2
11. Among the following, the weakest base is [2003]
- (a) $\text{C}_6\text{H}_5\text{CH}_2\text{NH}_2$ (b) $\text{C}_6\text{H}_5\text{CH}_2\text{NHCH}_3$
 (c) $\text{O}_2\text{N.C}_6\text{H}_4\text{NH}_2$ (d) CH_3NHCHO
12. Nitrobenzene gives N-phenylhydroxylamine by : [2003]
- (a) Sn/HCl (b) $\text{H}_2/\text{Pd}-\text{C}$
 (c) Zn/NaOH (d) $\text{Zn}/\text{NH}_4\text{Cl}$

13. The strongest base among the following is



14. Aromatic nitriles (ArCN) are not prepared by reaction :

[2004]

- (a) $\text{ArX} + \text{KCN}$
(b) $\text{ArN}_2^+ + \text{CuCN}$
(c) $\text{ArCONH}_2 + \text{P}_2\text{O}_5$
(d) $\text{ArCONH}_2 + \text{SOCl}_2$

15. Melting points are normally highest for :

- (a) tertiary amides (b) secondary amides
(c) primary amides (d) amines [2004]

16. Which of the following chemicals are used to manufacture methyl isocyanate that caused "Bhopal Tragedy"?

[2005]

- (i) Methylamine (ii) Phosgene
(iii) Phosphine (iv) Dimethylamine
(a) (i) and (iii) (b) (iii) and (iv)
(c) (i) and (ii) (d) (ii) and (iv)

17. Among the following which one does not act as an intermediate in Hofmann rearrangement?

[2005]

- (a) RNCO (b) RCON
(c) RCONHBr (d) RNC

18. Pyridine is less basic than triethylamine because :

[2005]

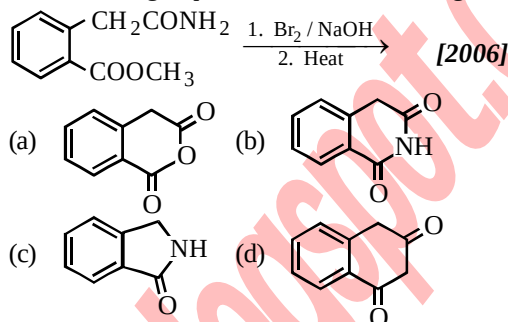
- (a) pyridine has aromatic character
(b) nitrogen in pyridine is sp^2 -hybridised
(c) pyridine is a cyclic system
(d) in pyridine, lone pair of electrons on nitrogen is delocalised

19. $\text{C}_6\text{H}_5\text{CONHCH}_3$ can be converted into $\text{C}_6\text{H}_5\text{CH}_2\text{NHCH}_3$ by :

[2005]

- (a) NaBH_4 (b) H_2 -Pd/C
(c) LiAlH_4 (d) Zn-Hg/HCl

20. The following sequence of reactions on A gives



21. Nitrobenzene on treatment with zinc dust and aqueous ammonium chloride gives:

[2006]

- (a) $\text{C}_6\text{H}_5\text{N} = \text{NC}_6\text{H}_5$
(b) $\text{C}_6\text{H}_5\text{NH}_2$
(c) $\text{C}_6\text{H}_5\text{NO}$
(d) $\text{C}_6\text{H}_5\text{NHOH}$

22. Which of the following statement is true?

[2007]

- (a) Trimethyl amine forms a soluble compound with Hinsberg reagent and KOH.
(b) Dimethyl amine reacts with KOH and phenol to form an azo dye.
(c) Methyl amine reacts with nitrous acid and liberates N_2 from aq. solution.
(d) None of these.

23. Which of the following amines will not give N_2 gas on treatment with nitrous acid ($\text{NaNO}_2 + \text{HCl}$)?

[2007]

- (a) $\text{C}_2\text{H}_5\text{NH}_2$ (b) CH_3NH_2
(c) $(\text{CH}_3)_2\text{CHNH}_2$ (d) All will give N_2 .

24. The compound which gives an oily nitrosoamine on reaction with nitrous acid at low temperature, is

[2008]

- (a) CH_3NH_2 (b) $(\text{CH}_3)_2\text{CHNH}_2$
(c) $\text{CH}_3\text{-NH-CH}_3$ (d) $(\text{CH}_3)_3\text{N}$

25. Diethyl oxalate is used for distinguishing primary, secondary and tertiary

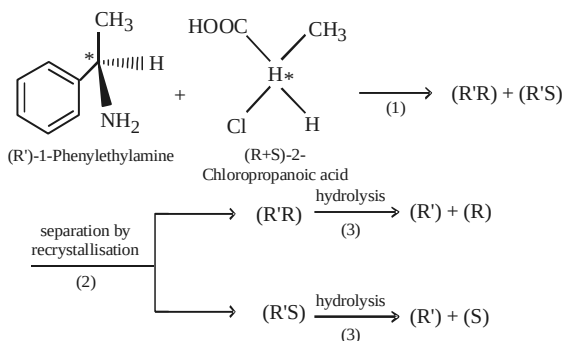
[2009]

- (a) alcohols
(b) amines
(c) alkyl halides
(d) hydrogens in hydrocarbons

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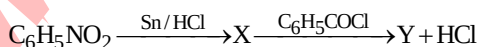
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26. Observe the following reaction : [2009]



Which statement is not correct about the above observation ?

- (a) The product mixture of step-1 is optically active
- (b) The product R'R and R'S have identical structural formula
- (c) R'R is nonsuperimposable on R'S
- (d) R'R and R'S have same solubility in water
27. Fluorescein is an example of [2009]
- (a) azo dyes
- (b) phthalein dyes
- (c) triphenylmethane dyes
- (d) nitro dyes
28. Urea upon hydrolysis yields: [2010]
- (a) acetamide
- (b) carbonic acid
- (c) ammonium hydroxide
- (d) NO_2
29. Benzamide and benzyl amine can be distinguished by [2011]
- (a) cold dil. NaOH
- (b) cold dil. HCl
- (c) both a & b
- (d) NaNO_2 , HCl, 0°C , then β -naphthol
30. The basic character of ethyl amine, diethyl amine and triethyl amine in chlorobenzene is [2011]
- (a) $\text{C}_2\text{H}_5\text{NH}_2 < (\text{C}_2\text{H}_5)_2\text{NH} < (\text{C}_2\text{H}_5)_3\text{N}$
- (b) $\text{C}_2\text{H}_5\text{NH}_2 < (\text{C}_2\text{H}_5)_3\text{N} < (\text{C}_2\text{H}_5)_2\text{NH}$
- (c) $(\text{C}_2\text{H}_5)_3\text{N} < (\text{C}_2\text{H}_5)_2\text{NH} < \text{C}_2\text{H}_5\text{NH}_2$
- (d) $(\text{C}_2\text{H}_5)_3\text{N} < \text{C}_2\text{H}_5\text{NH}_2 < (\text{C}_2\text{H}_5)_2\text{NH}$
31. Consider the following reaction [2012]



What is Y?

- (a) Acetanilide (b) Benzanilide
- (c) Azobenzene (d) Hydrazobenzene
32. Which of the following gives primary amine on reduction? [2013]
- (a) $\text{CH}_3\text{CH}_2\text{NO}_2$
- (b) $\text{CH}_3\text{CH}_2 - \text{O} - \text{N} = \text{O}$
- (c) $\text{C}_6\text{H}_5\text{N} = \text{NC}_6\text{H}_5$
- (d) $\text{CH}_3\text{CH}_2\text{NC}$
33. Which of the following compound will not undergo azo coupling reaction with benzene diazonium chloride. [2016]
- (a) Aniline (b) Phenol
- (c) Anisole (d) Nitrobenzene
34. Which of the following are intermediates in Sandmeyer reaction ? [2017]
- (i) $\text{C}_6\text{H}_5\text{N}^+ \equiv \text{NCl}^-$ (ii) $\text{C}_6\text{H}_5\text{N}^+ \equiv \text{N}$
- (iii) $\dot{\text{C}}_6\text{H}_5$ (iv) $\text{C}_6\text{H}_5\text{Cl}$
- (a) (ii) and (iii) (b) (i) and (iv)
- (c) (ii) and (iv) (d) (i) and (ii)

TYPE B : ASSERTION REASON QUESTIONS

Directions for (Qs. 35-41) : These questions consist of two statements, each printed as Assertion and Reason. While answering these questions, you are required to choose any one of the following five responses.

- (a) If both Assertion and Reason are correct and the Reason is a correct explanation of the Assertion.
- (b) If both Assertion and Reason are correct but Reason is not a correct explanation of the Assertion.
- (c) If the Assertion is correct but Reason is incorrect.
- (d) If both the Assertion and Reason are incorrect.
- (e) If the Assertion is incorrect but the Reason is correct.
35. **Assertion :** Amines are basic in nature
Reason : Presence of lone pair of electrons on nitrogen atom. [1999]
36. **Assertion :** Benzene diazonium chloride does not give test for nitrogen.
Reason : Loss of N_2 gas takes place during heating. [1999]

37. **Assertion :** $p\text{-O}_2\text{N. C}_6\text{H}_4.\text{COCH}_3$ is prepared by Friedel Craft's acylation of nitrobenzene.
Reason : Nitrobenzene easily undergoes electrophilic substitution reaction. [2005]
38. **Assertion :** Alkyl isocyanides in acidified water give alkyl formamides.
Reason : In isocyanides, carbon first acts as a nucleophile and then as an electrophile. [2005]
39. **Assertion :** Anilinium chloride is more acidic than ammonium chloride.
Reason : Anilinium ion is resonance stabilized. [2006]
40. **Assertion :** Benzene diazonium salt on boiling with water forms phenol.
Reason : C – N bond is polar. [2007]
41. **Assertion :** Nitrobenzene is used as a solvent in Friedel-Craft's reaction.
Reason : Fusion of nitrobenzene with solid KOH gives a low yield of a mixture of *o*- and *p*-nitrophenols. [2008]
- Directions for (Qs.42-46) :** Each of these questions contains an Assertion followed by Reason. Read them carefully and answer the question on the basis of following options. You have to select the one that best describes the two statements.
- (a) If both Assertion and Reason are correct and Reason is the correct explanation of Assertion.
- (b) If both Assertion and Reason are correct, but Reason is not the correct explanation of Assertion.
- (c) If Assertion is correct but Reason is incorrect.
- (d) If both the Assertion and Reason are incorrect.
42. **Assertion :** Nitration of aniline can be conveniently done by protecting the amino group by acetylation.
Reason : Acetylation increases the electron-density in the benzene ring. [2010]
43. **Assertion :** Acetamide reacts with Br_2 in presence of methanolic CH_3ONa to form methyl N-methylcarbamate.
Reason : Methyl isocyanate is formed as an intermediate which reacts with methanol to form methyl N-methylcarbamate. [2014]
44. **Assertion :** Acylation of amines gives a monosubstituted product whereas alkylation of amines gives polysubstituted product.
Reason : Acyl group sterically hinders the approach of further acyl groups [2016]
45. **Assertion :** Aniline does not undergo Friedel-Crafts reaction. [2017]
Reason : $-\text{NH}_2$ group of aniline reacts with AlCl_3 (Lewis acid) to give acid-base reaction.
46. **Assertion :** Aniline is better nucleophile than anilium ion. [2017]
Reason : Anilium ion have +ve charge.

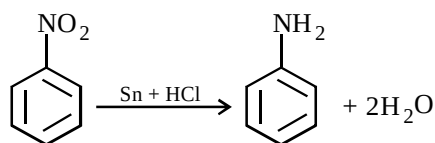
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Topicwise AIIMS Solved Papers – CHEMISTRY

HINTS & SOLUTIONS

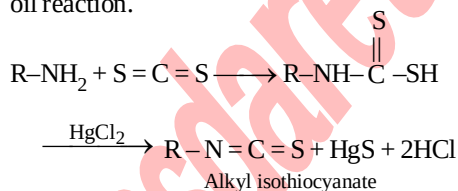
Type A : Multiple Choice Questions

1. (b) $\text{C}_6\text{H}_5\text{NH}_2 \xrightarrow{\text{NaNO}_2 + \text{HCl}} \underset{\text{X}}{\text{C}_6\text{H}_5\text{N}_2\text{Cl}} \xrightarrow{\text{H}_2\text{O}} \underset{\text{Y}}{\text{C}_6\text{H}_5\text{OH}}$
2. (a) Dynamite is a mixture of nitroglycerine and raw dust.
3. (b) The given reaction is known as Sandmeyer's reaction.
4. (d) Reduction of nitrobenzene with Sn/HCl produces aniline.

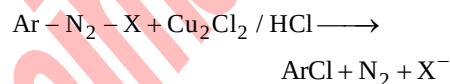


5. (b) Hinsberg's reagent is $\text{C}_6\text{H}_5\text{SO}_2\text{Cl}$ which is used to distinguish primary, secondary and tertiary amines.

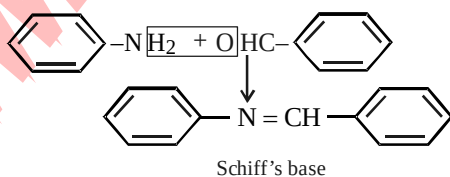
6. (d) $\text{CH}_3\text{CONH}_2 + 2\text{NaOH} + \text{Br}_2 \longrightarrow \text{CH}_3\text{NH}_2 + \text{Na}_2\text{CO}_3 + 2\text{NaBr} + \text{H}_2\text{O}$
7. (d) The reaction is known as Hoffmann mustard oil reaction.



8. (b) Diazonium salt is involved in Sandmeyer's reaction.

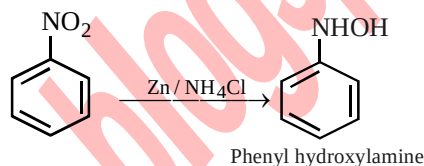


9. (b) Primary amines react with aldehydes or ketones to form compound known as Schiff's base



10. (d) $-\text{NH}-\text{CONH}_2$ group is ortho para directing. Nitrogen shares its lone pair with benzene ring and makes this group ortho para directing.

11. (c) As $-\text{NO}_2$ is strong electron withdrawing group.



13. (c) The lone pair of electrons on nitrogen is not involved in the formation of π -electron cloud of the ring.

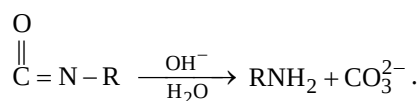
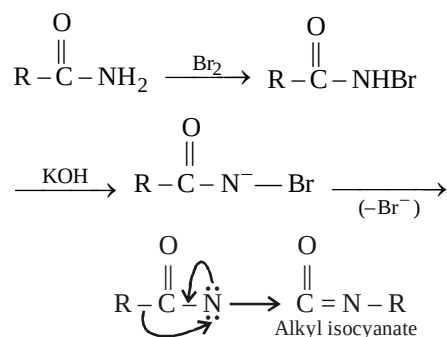
14. (a) Aryl halide (ArX) does not undergo nucleophilic substitution because they have strong $\text{C}-\text{X}$ bond due to resonance.

15. (d) Although amines as well as amides form intermolecular H-bonding, H-bonding in

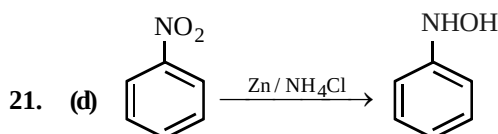
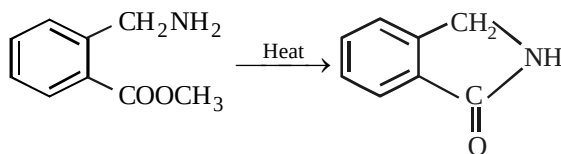
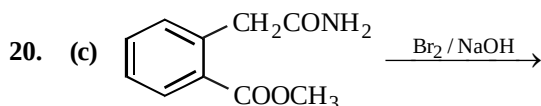
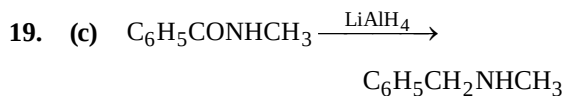
amides is less prominent because of $-\overset{\text{O}}{\parallel}{\text{C}}-$ group of $-\overset{\text{O}}{\parallel}{\text{C}}-\ddot{\text{N}}\text{H}_2$

16. (c) $\text{CH}_3\text{NH}_2 + \text{COCl}_2 \longrightarrow \text{CH}_3\text{NCO} + 2\text{HCl}$
Phosgene Methyl isocyanate

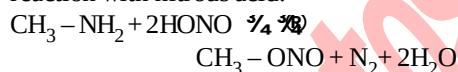
17. (d) Hofmann rearrangement



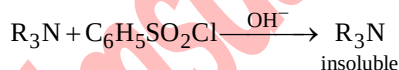
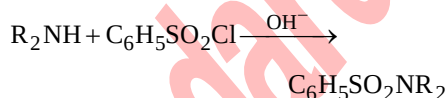
18. (b) Pyridine is less basic because nitrogen in pyridine is sp^2 hybridised, and sp^2 hybridised orbital is more acidic in character than sp^3 hybridised orbital in $(C_2H_5)_3N$.



22. (c) Among the given statements only (c) is true. As methyl amine liberates N_2 on reaction with nitrous acid.



While dimethyl amine and trimethyl amine form insoluble compound with Hinsberg reagent and KOH.

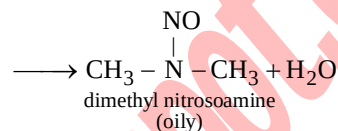
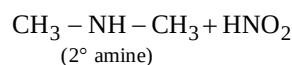


Azo dyes are not formed by secondary amines.

23. (d) All aliphatic primary amines liberate N_2 on treatment with nitrous acid ($NaNO_2 + HCl$)

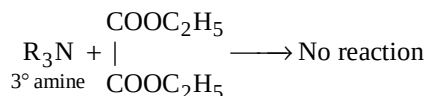
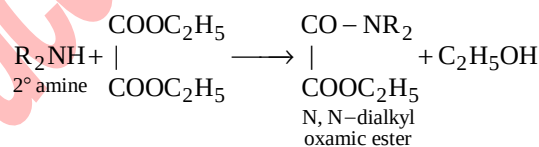
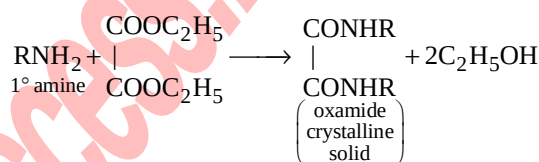


24. (c) Out of primary, secondary and tertiary amines, the secondary amines, on reaction with HNO_2 , produce yellow oily compounds called nitrosoamines.



25. (b) Diethyl oxalate is used for distinguishing 1° , 2° and 3° amines as three amines react differently as discussed below.

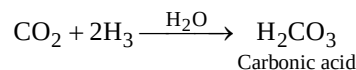
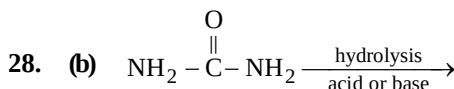
The 1° amine forms corresponding substituted oxamide which is a crystalline solid; while 2° amine forms a diethyl oxamic ester which is a liquid and 3° amine does not react with diethyl oxalate since it does not contain a replaceable hydrogen atom.



26. (d) R'R and R'S are diastereomers and have different physical properties like water solubility, B.P., M.P. etc.

Mixture of diastereomers is optically active hence the product mixture in step 1 is optically active.

27. (b) Fluorescein also called resorcinolphthalein is an example of phthalein dye. It is prepared by heating phthalic anhydride and resorcinol over a zinc catalyst, and it crystallizes as a deep red powder.



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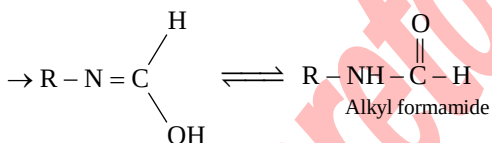
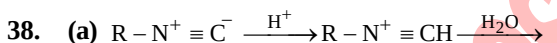
Topicwise AIIMS Solved Papers – CHEMISTRY

Note: The enzyme urease (occurs in soyabean) brings about the same change.

29. (b) Cold dil. NaOH does not attack to either of the compound, while cold dil. HCl reacts only with benzyl amine $C_6H_5CH_2NH_2$.
30. (a) In presence of chlorobenzene, hydrogen bonding is not possible between the protonated amine and the solvent and thus the stabilization factor (solvation effect) is absent. Hence basicity is explained on the basis of the number of electron releasing groups in an amine.
31. (b) 32. (a) 33. (d) 34. (a)

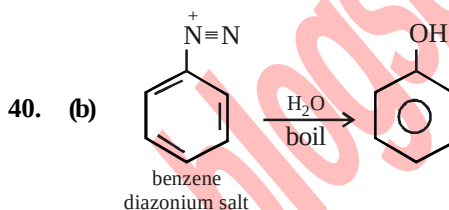
Type B : Assertion Reason Questions

35. (a) Amines are basic in nature due to presence of a lone pair of electrons on nitrogen.
36. (a) Benzene diazonium chloride does not give test of nitrogen as nitrogen gas is evolved on heating.
37. (d) Nitrobenzene undergoes electrophilic substitution reaction with difficulty because NO_2 group is electron withdrawing & therefore, it deactivates the benzene ring.



In the first step due to partial negative charge on carbon it acts as nucleophile and therefore attacked by H^+ of the acid. Once it acquires positive charge, it becomes electrophile as is shown in the next step.

39. (c) Anilinium chloride is more acidic than ammonium chloride because it liberates aniline (resonance stabilized) when heated with strong base. Anilinium ions does not show resonance because charge dispersion at ring may involve pentavalent nitrogen structure.



Although C-N bond is polar but it is not exact reason for the substitution.

41. (b) Nitrobenzene is used as a solvent in Friedel-Craft's reaction because its $-NO_2$ group deactivates benzene ring for electrophilic substitution.

Although the given statement of the reason is correct, it is not correct explanation of the given statement.

42. (c) Acetylation decreases the electron density in the benzene ring thereby preventing oxidation.

43. (a) 44. (c) 45. (a)

46. (a) It is fact that aniline is better nucleophile than anilium ion. Anilium ion contain +ve charge, which reduces the tendency to donate lone pair of electron $C_6H_5NH_3^+$ (Anilium ion).

MULTIPLE CHOICE QUESTIONS

- Which one of the following statements is true for protein synthesis (translation)? [2005]
 - Amino acids are directly recognized by *m*-RNA
 - The third base of the codon is less specific
 - Only one codon codes for an amino acid
 - Every *t*-RNA molecule has more than one amino acid attachment
- The pair in which both species have iron is :
 - Nitrogenase, cytochromes [2006]
 - Carboxypeptidase, haemoglobin
 - Haemocyanin, nitrogenase
 - Haemoglobin, cytochromes
- Lysine is least soluble in water in the pH range:
 - 3 to 4
 - 5 to 6 [2006]
 - 6 to 7
 - 8 to 9
- Thymine is : [2006]
 - 5-Methyluracil
 - 4-Methyluracil
 - 3-Methyluracil
 - 1-Methyluracil
- Which of the following statement is not correct? [2008]
 - Chlorophyll is responsible for the synthesis of carbohydrates in plants
 - The compound formed by the addition of oxygen to haemoglobin is called oxyhaemoglobin
 - Acetylsalicylic acid is known as aspirin
 - The metal ion present in vitamin B₁₂ is Mg²⁺
- The beta and alpha glucose have different specific rotations. When either is dissolved in water, their rotation changes until the same fixed value results. This is called [2008]
 - epimerisation
 - racemisation
 - anomerisation
 - mutarotation
- If one strand of DNA has the sequence ATCGTATG, the sequence in the complementary strand would be: [2009]
 - TAGCTTAC
 - TCACATAC
 - TAGCATAC
 - TACGATAC
- Fructose on reduction gives a mixture of two alcohols which are related as [2011]
 - diastereomers
 - epimers
 - both (a) and (b)
 - anomers.
- α -Amino acids are [2011]
 - acidic due to $-\text{COOH}$ group and basic due to $-\text{NH}_2$ group
 - acidic due to $-\text{NH}_3^+$ group and basic due to $-\text{COO}^-$ group.
 - neither acidic nor basic.
 - none is true.
- Denaturation of proteins leads to loss of its biological activity by [2012]
 - Formation of amino acids
 - Loss of primary structure
 - Loss of both primary and secondary structures
 - Loss of both secondary and tertiary structures
- Glucose molecule reacts with X number of molecules of phenylhydrazine to yield osazone. The value of X is [2013]
 - three
 - two
 - one
 - four
- For osazone formation, the effective structural unit necessary is [2014]
 - $$\begin{array}{c} \text{CH}_2\text{OCH}_3 \\ | \\ \text{CO} \\ | \end{array}$$
 - $$\begin{array}{c} \text{CH}_2\text{OH} \\ | \\ \text{CO} \\ | \end{array}$$
 - $$\begin{array}{c} \text{CH}_2\text{OH} \\ | \\ \text{CHOCH}_3 \\ | \end{array}$$
 - $$\begin{array}{c} \text{CHO} \\ | \\ \text{CHOCH}_3 \\ | \end{array}$$

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Topicwise AIIMS Solved Papers – CHEMISTRY

13. Which of the statements about "Denaturation" given below are correct ? [2015]
 (A) Denaturation of proteins causes loss of secondary and tertiary structures of the protein.
 (B) Denaturation leads to the conversion of double strand of DNA into single strand
 (C) Denaturation affects primary structure which gets distorted
 Options :
 (a) (B) and (C) (b) (A) and (C)
 (c) (A) and (B) (d) (A), (B) and (C)
14. Which one of the following statements is correct? [2016]
 (a) All amino acids except lysine are optically active
 (b) All amino acids are optically active
 (c) All amino acids except glycine are optically active
 (d) All amino acids except glutamic acids are optically active
15. α - D-(+)-glucose and β -D-(+)-glucose are [2017]
 (a) conformers (b) epimers
 (c) anomers (d) enantiomers

TYPE B : ASSERTION REASON QUESTIONS

Directions for (Qs. 16-25) : These questions consist of two statements, each printed as Assertion and Reason. While answering these questions, you are required to choose any one of the following five responses.

- (a) If both Assertion and Reason are correct and the Reason is a correct explanation of the Assertion.
 (b) If both Assertion and Reason are correct but Reason is not a correct explanation of the Assertion.
 (c) If the Assertion is correct but Reason is incorrect.
 (d) If both the Assertion and Reason are incorrect.
 (e) If the Assertion is incorrect but the Reason is correct.

16. **Assertion :** Hydrolysis of sucrose is known as inversion of cane sugar.

Reason : Sucrose is a disaccharide. [1997]

17. **Assertion :** Proteins on hydrolysis produce amino acids.

Reason : Amino acids contain $-\text{NH}_2$ and $-\text{COOH}$ groups. [1998]

18. **Assertion :** Sucrose undergoes mutarotation.

Reason : Sucrose is a disaccharide. [2000]

19. **Assertion :** DNA as well as RNA molecules are found in the nucleus of a cell.

Reason : On heating, the enzymes do not lose their specific activity. [2002]

20. **Assertion :** Haemoglobin is an oxygen carrier.

Reason : Oxygen binds as O_2^- to Fe of haemoglobin. [2003]

21. **Assertion :** Glycosides are hydrolyzed in acidic conditions

Reason : Glycosides are acetals. [2003]

22. **Assertion :** Carboxypeptidase is an exopeptidase.

Reason : It cleaves the N-terminal bond. [2004]

23. **Assertion :** Sucrose is a non-reducing sugar.

Reason : It has glycosidic linkage. [2004]

24. **Assertion :** Maltose is a reducing sugar which gives two moles of D-glucose on hydrolysis.

Reason : Maltose has 1, 4- β -glycosidic linkage [2005]

25. **Assertion :** Alpha (α)-amino acids exist as internal salt in solution as they have amino and carboxylic acid groups in near vicinity.

Reason : H^+ ion given by carboxylic group ($-\text{COOH}$) is captured by amino group ($-\text{NH}_2$) having lone pair of electrons. [2007]

Directions for (Qs.26-31) : Each of these questions contains an Assertion followed by Reason. Read them carefully and answer the question on the basis of following options. You have to select the one that best describes the two statements.

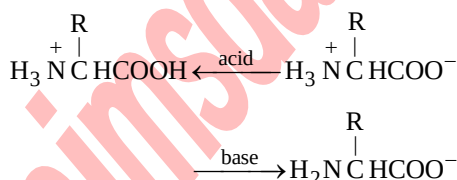
- (a) If both Assertion and Reason are correct and Reason is the correct explanation of Assertion.
 (b) If both Assertion and Reason are correct, but Reason is not the correct explanation of Assertion.

- (c) If Assertion is correct but Reason is incorrect.
(d) If both the Assertion and Reason are incorrect.
26. **Assertion :** Disruption of the natural structure of a protein is called denaturation.
Reason : The change in colour and appearance of egg during cooking is due to denaturation.
[2008]
27. **Assertion :** Proteins are made up of α -amino acids.
Reason : During denaturation, secondary and tertiary structures of proteins are destroyed.
[2011]
28. **Assertion :** At isoelectric point, the amino group does not migrate under the influence of electric field.
Reason : At isoelectric point, amino acid exists as a zwitterion.
[2012, 2013]
29. **Assertion :** Treatment of D-glucose with dilute alkali affords an equilibrium mixture consisting of D-mannose, D-fructose and starting substance D-glucose.
Reason : The reaction involves an intermediate in which hybridisation of C_2 changes from sp^3 to sp^2 .
[2013]
30. **Assertion :** Glucose and fructose give the same osazone.
Reason : During osazone formation stereochemistry only at C_1 and C_2 is destroyed.
[2014]
31. **Assertion :** Vitamin D cannot be stored in our body
Reason : Vitamin D is fat soluble vitamin and is excreted from the body in urine.
[2016]

HINTS & SOLUTIONS

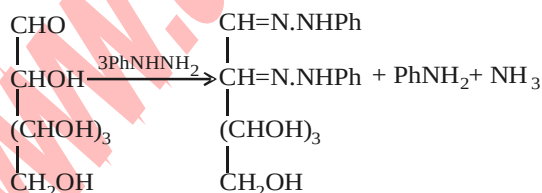
Type A : Multiple Choice Questions

1. (b) The triplet of nucleotides having a specific sequence of bases is known as codon. More than one codon can specify same amino acid. Specificity of a codon is determined by first two bases, the third base of a codon is not very important.
2. (d) Haemoglobin and cytochromes.
3. (c)
$$\text{H}_2\text{NCH}_2\text{CH}_2\text{CH}_2\text{CH}_2\overset{\text{NH}_2}{\underset{|}{\text{C}}}\text{HCOOH},$$
 Lysine is least soluble in water in the pH range 6–7.
4. (a) Thymine is 5-methyluracil.
5. (d) The statement is wrong or not correct. The metal ion present in vitamin B₁₂ (cyanocobalamine) is cobalt. All other statements are correct.
6. (d) This type of change in optical rotation is called mutarotation.
7. (c) One strand of DNA : A T C G T A T G
Complementary strand : T A G C A T A C
8. (c) Ketoses on reduction produce a new chiral carbon leading to the formation of two isomeric alcohols which are diastereomeric as well as C-2 epimers.
9. (b) Amino acids exist as Zwitterions in which acidic character is due to $-\text{NH}_3^+$ and basic due to $-\text{COO}^-$ group.



10. (d)

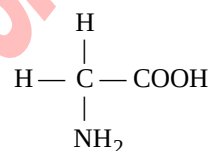
11. (a)



12. (b)

13. (c) When the proteins are subjected to the action of heat, mineral acids or alkali, the water soluble form of globular protein changes to water insoluble fibrous protein. This is called denaturation of proteins. During denaturation secondary and tertiary structures of protein destroyed but primary structures remains intact.

14. (c) With the exception of glycine all the 19 other common amino acids have a uniquely different functional group on the central tetrahedral alpha carbon.



Glycine

15. (c) Anomers are those diastereomers that differ in configuration at C-1 atom. Since $\alpha\text{-D-(+)-glucose}$ and $\beta\text{-D-(+)-glucose}$ differ in configuration at C-1 atom so they are anomers.

Type B : Assertion Reason Questions

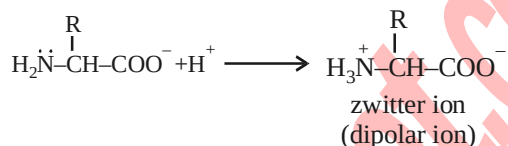
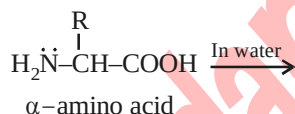
16. (b) Sucrose is a disaccharide with specific rotation of $+66.5^\circ$. On hydrolysis, it gives 1 mole of D-(+) glucose and 1 mole of D-(-) fructose. The hydrolysate is laevorotatory hence hydrolysis is known as inversion of sucrose.
17. (b) Proteins are polyamides so, on hydrolysis, give amino acids. Further it is a fact that amino acids contain both $-\text{NH}_2$ as well as $-\text{COOH}$ group. So assertion and reason, although both are correct but reason is not correct explanation of assertion.
18. (b) Sucrose which is a disaccharide undergoes mutarotation because it is converted into glucose and fructose on hydrolysis and the products have different optical activity from that of the reactant.
19. (d) DNA is found mainly in the nucleus of the cell and RNA occurs mainly in the

cytoplasm of the cell. So assertion given is false.

Enzymes are very good biological catalysts in certain temperature range but they lose their specific activity on heating.

Hence reason is also a wrong statement.

20. (c) The assertion is correct but the reason is incorrect because oxygen binds as O_2 (and not as O_2^-) to Fe of haemoglobin.
21. (d) Glycosides are formed by treating glucose with methanol in presence of dry HCl gas. They cannot be hydrolysed in acidic conditions. They are not acetals but they are hemiacetals.
22. (c) It is true that carboxypeptidase is an exopeptidase because it cleaves the peptide chain at carboxy terminal amino acids.
23. (a) Sucrose is a non-reducing sugar because it has glycosidic linkage which has no free aldehyde or ketonic group
24. (c) The two glucose units of maltose are linked through α -glycosidic linkage between C-1 of one glucose unit and C-4 of the other.
25. (a) All α -amino acids have $-NH_2$ and $-COOH$ groups. Since $-NH_2$ group is basic and $-COOH$ group is acidic, in neutral solution it exists as internal salt which is also called as zwitter ion. This zwitter ion is formed due to reason that proton of $-COOH$ group is transferred to $-NH_2$ group.



Hence assertion and reason both are true and reason is the correct explanation of assertion.

26. (b) During denaturation, the protein molecule uncoils, form a more random conformation and ultimately precipitates from the solution. Further during denaturation, a protein molecule loses its biological activity. Thus, reason is correct but it is not the correct explanation of assertion.
27. (c) **Correct explanation :** During formation of proteins, $-NH_2$ group of one amino acid condenses with $-CO_2H$ of the other with elimination of a water molecule to form a peptide bond.
28. (a) Reason is the correct explanation of Assertion.
29. (a) Reason is the correct explanation of Assertion.
30. (a) Reason is the correct explanation of Assertion.
31. (d) Vitamin D is a fat soluble vitamin and can be stored in the body since it is not excreted out of the body.

TYPE A : MULTIPLE CHOICE QUESTIONS

- Which of the following is a polymer containing nitrogen? [2008]
 (a) Polyvinyl chloride (b) Bakelite
 (c) Nylon (d) Terylene
- Synthetic detergents are more effective in hard water than soaps because [2009]
 (a) they are non-ionic
 (b) their Ca^{++} and Mg^{++} salts are insoluble in water
 (c) their Ca^{++} and Mg^{++} salts are water soluble
 (d) they are highly soluble in water
- Teflon, styron and neoprene are all [2012]
 (a) Copolymers
 (b) Condensation polymers
 (c) Homopolymers
 (d) Monomers
- Which compound/set of compounds is used in the manufacture of nylon-66? [2014]
 (a) $\text{HOOC}(\text{CH}_2)_4\text{COOH} + \text{H}_2\text{N}(\text{CH}_2)_6\text{NH}_2$
 (b) $\text{CH}_2 = \text{CH}-\text{C}(\text{CH}) = \text{CH}_2$
 (c) $\text{CH}_2 = \text{CH}_2$
 (d) $\text{HOOC}-\text{C}_6\text{H}_4-\text{COOH} + \text{HOCH}_2-\text{CH}_2\text{OH}$
- The repeating unit present in Nylon 6 is [2016]
 (a) $-\text{[NH}(\text{CH}_2)_6\text{NHCO}(\text{CH}_2)_4\text{CO]}-$
 (b) $-\text{[CO}(\text{CH}_2)_5\text{NH]}-$
 (c) $-\text{[CO}(\text{CH}_2)_6\text{NH]}-$
 (d) $-\text{[CO}(\text{CH}_2)_4\text{NH]}-$

- Which one of the following is not a condensation polymer? [2017]
 (a) Melamine (b) Glyptal
 (c) Dacron (d) Neoprene

TYPE B : ASSERTION REASON QUESTIONS

Directions for (Qs.7-8) : Each of these questions contains an Assertion followed by Reason. Read them carefully and answer the question on the basis of following options. You have to select the one that best describes the two statements.

- If both Assertion and Reason are correct and Reason is the correct explanation of Assertion.
 - If both Assertion and Reason are correct, but Reason is not the correct explanation of Assertion.
 - If Assertion is correct but Reason is incorrect.
 - If both the Assertion and Reason are incorrect.
- Assertion :** Bakelite is a thermosetting polymer.
Reason : Bakelite can be melted again and again without any change. [2015, 2016]
 - Assertion :** In vulcanisation of rubber, sulphur cross links are introduced.
Reason : Vulcanisation is a free radical initiated chain reaction. [2017]

HINTS & SOLUTIONS**Type A : Multiple Choice Questions**

1. (c) Nylon is a polymer of adipic acid and hexamethylenediamine thus it contains nitrogen. Polyvinyl chloride is a polymer of vinyl chloride. It does not contain nitrogen.

Bakelite is a resin of formaldehyde and phenol. It does not contain nitrogen.

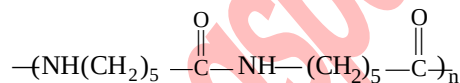
Terylene is a polymer of ethylene glycol and terephthalic acid. It does not contain nitrogen. It is also called *dacron*.

2. (c) Structural features of soaps and detergents are almost same except that the polar end in detergents is $-\text{OSO}_3^-\text{Na}^+$ while in soaps polar end is $-\text{COO}^-\text{Na}^+$. Detergents have an advantage over soaps that its polar end sulphate and sulphonate retain their efficiency in hard water, since the corresponding Ca and Mg salts are soluble. Being salts of strong acids, they yield neutral solution, in contrast, to the soaps, which being salts of weak acids yield slightly alkaline solutions.

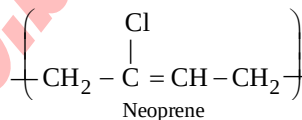
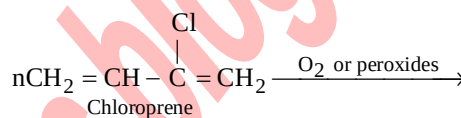
3. (c)

4. (a)

5. (b) Nylon 6 is



6. (d) Neoprene is an addition polymer of isoprene.

**Type B : Assertion Reason Questions**

7. (c) Bakelite can be heated only once.
8. (b) Vulcanisation is a process of treating natural rubber with sulphur or some compounds of sulphur under heat so as to modify its properties. This cross-linking give mechanical strength to the rubber.

MULTIPLE CHOICE QUESTIONS

1. Arsenicals are mainly used for treatment of: [1998]
(a) Cholera (b) Jaundice
(c) Syphilis (d) Typhoid
2. Which of the following is a local anaesthetic? [2009]
(a) Diazepam (b) Procaine
(c) Chloramphenicol (d) Penicillin-G
3. Which of the following is used as a 'morning after pill' [2010]
(a) Norethindrone (b) Ethynylestradiol
(c) Mifepristone (d) Bithional
4. Identify the wrong statement in the following: [2012]
(a) Chlorofluorocarbons are responsible for ozone layer depletion
(b) Greenhouse effect is responsible for global warming
(c) Acid rain is mostly because of oxides of nitrogen and sulphur
(d) Ozone layer does not permit infrared radiation from the sun to reach the earth
5. Which of the following is used for inducing sleep? [2012]
(a) paracetamol
(b) chloroquine
(c) bithional
(d) barbituric acid derivatives
6. Arsenic drugs are mainly used in the treatment of [2013]
(a) jaundice (b) typhoid
(c) syphilis (d) cholera
7. A broad spectrum antibiotic is [2014]
(a) paracetamol (b) penicillin
(c) aspirin (d) chloramphenicol
8. Which of the following is an antidiabetic drug? [2015]
(a) Insulin (b) Penicillin
(c) Chloroquine (d) Aspirin

9. Which of the following compounds is not an antacid? [2017]
(a) Phenelzine
(b) Ranitidine
(c) Aluminium hydroxide
(d) Cimetidine

TYPE B : ASSERTION REASON QUESTIONS

Directions for (Q. 10) : These questions consist of two statements, each printed as Assertion and Reason. While answering these questions, you are required to choose any one of the following five responses.

- (a) If both Assertion and Reason are correct and the Reason is a correct explanation of the Assertion.
- (b) If both Assertion and Reason are correct but Reason is not a correct explanation of the Assertion.
- (c) If the Assertion is correct but Reason is incorrect.
- (d) If both the Assertion and Reason are incorrect.
- (e) If the Assertion is incorrect but the Reason is correct.

10. **Assertion :** Activity of an enzyme is pH-dependent.

Reason : Change in pH affects the solubility of enzyme in water. [2003]

Directions for (Qs.11-14) : Each of these questions contains an Assertion followed by Reason. Read them carefully and answer the question on the basis of following options. You have to select the one that best describes the two statements.

- (a) If both Assertion and Reason are correct and Reason is the correct explanation of Assertion.
- (b) If both Assertion and Reason are correct, but Reason is not the correct explanation of Assertion.
- (c) If Assertion is correct but Reason is incorrect.
- (d) If both the Assertion and Reason are incorrect.

11. **Assertion :** Penicillin is an antibiotic.
Reason : The drugs which act on the central nervous system and help in reducing anxiety are called antibiotics. [2010]
12. **Assertion :** The addition of BHA to butter increases its storage life from months to years.
Reason : Butylated hydroxy anisole (BHA) is an antioxidant. [2014]
13. **Assertion :** Tetracycline is a broad spectrum antibiotic.
Reason : Tetracycline is effective against a number of types of bacteria, large viruses and typhus fever. [2016]
14. **Assertion :** Sedatives are given to patients who are mentally agitated and violent.
Reason : Sedatives are used to suppress the activities of central nervous system. [2017]

HINTS & SOLUTIONS**Type A : Multiple Choice Questions**

1. (c) Arsenicals are mainly used for the treatment of syphilis.
2. (b) Procaine is the only drug among the given options that is used as a local anaesthetic. Chloramphenicol and penicillin-G, both are antibiotics. Diazepam is a sedative.
3. (c)
4. (d) Ozone layer acts as a shield and does not allow ultraviolet radiation from sun to reach earth. It does not prevent infra-red radiation from sun to reach earth, thus option (d) is wrong statement and so it is the correct answer.
5. (d)
6. (c)
7. (d)
8. (a)
9. (a) Phenelzine is an antidepressant, while others are antacids.

Type B : Assertion Reason Questions

10. (b) The assertion that activity of an enzyme is pH dependent is true because with change in pH the enzymes are denatured. The statement that change in pH affects solubility of enzyme in water is also true.
11. (c) Assertion is true but Reason is false. The drugs which act on the central nervous system and help in reducing anxiety are called tranquilizers.
12. (a) Antioxidants are the compounds that retard the action of oxygen on the food and thereby help its preservation.
13. (a) Broad spectrum antibiotics are those medicines which are effective against several different types of harmful micro organisms.
14. (a) A small quantity of sedative produces a feeling of relaxation, calmness and drowsiness.

TYPE A : MULTIPLE CHOICE QUESTIONS

- Beilstein test is used for the detection of :
(a) N_2 (b) CO_2 [1999]
(c) Na (d) Cl
- When 8.3 g copper sulphate reacts with excess of potassium iodide then the amount of iodine liberated is: [2000]
(a) 42.3 g (b) 24.3 g
(c) 4.23 g (d) 2.43 g
- The compound used for gravimetric estimation of copper(II) is: [2003]
(a) $Cu(SCN)_2$ (b) Cu_2O
(c) Cu_2I_2 (d) Cu_2CO_3
- Dimethyl glyoxime gives a red precipitate with Ni^{2+} , which is used for its detection. To get this precipitate readily, the best pH range is : [2004]
(a) < 1 (b) 2 – 3
(c) 3 – 4 (d) 9 – 11
- Which of the following imparts green colour to the burner flame? [2004]
(a) $B(OMe)_3$ (b) $Na(OMe)$
(c) $Al(OPR)_3$ (d) $Sn(OH)_2$
- Nessler's reagent is used to detect [2010]
(a) PO_4^{3-} (b) MnO_4^-
(c) NH_4^+ (d) CrO_4^{2-}
- The reagent that can distinguish between silver and lead salt is [2012]
(a) H_2S gas
(b) Hot dilute HCl solution
(c) NH_4Cl (solid) + NH_4OH (solution)
(d) NH_4Cl (solid) + $(NH_4)_2CO_3$ solution
- A laboratory reagent imparts green colour to the flame. On heating with solid $K_2Cr_2O_7$ and conc. H_2SO_4 it evolves a red gas. Identify the reagent [2017]

- (a) $CaCl_2$ (b) $BaCl_2$
(c) $CuCl_2$ (d) None of these

TYPE B : ASSERTION REASON QUESTIONS

Directions for (Qs. 9-17) : These questions consist of two statements, each printed as Assertion and Reason. While answering these questions, you are required to choose any one of the following five responses.

- If both Assertion and Reason are correct and the Reason is a correct explanation of the Assertion.
 - If both Assertion and Reason are correct but Reason is not a correct explanation of the Assertion.
 - If the Assertion is correct but Reason is incorrect.
 - If both the Assertion and Reason are incorrect.
 - If the Assertion is incorrect but the Reason is correct.
- Assertion :** Potassium can be used in Lassaigne test
Reason : Potassium reacts vigorously. [1997]
 - Assertion :** During test for nitrogen with Lassaigne extract on adding $FeCl_3$ solution, sometimes a red precipitate is obtained.
Reason : Sulphur is also present [2001]
 - Assertion :** Sb (III) is not precipitated as sulphide when in its alkaline solution H_2S is passed.
Reason : The concentration of S^{2-} ion in alkaline medium is inadequate for precipitation. [2004]
 - Assertion :** Borax bead test is not suitable for Al(III).
Reason : Al_2O_3 is insoluble in water [2005]
 - Assertion :** In the iodometric titration, starch is used as an indicator.
Reason : Starch is a polysaccharide. [2006]

C-190

Topicwise AIIMS Solved Papers – CHEMISTRY

14. **Assertion :** $K_2Cr_2O_7$ is used as a primary standard in volumetric analysis.

Reason : It has a good solubility in water.

[2006]

15. **Assertion :** Sb_2S_3 is not soluble in yellow ammonium sulphide.

Reason : The common ion effect due to S^{2-} ions reduces the solubility of Sb_2S_3

[2006]

16. **Assertion :** Fe^{3+} can be used for coagulation of As_2S_3 sol.

Reason : Fe^{3+} reacts with As_2S_3 to give Fe_2S_3

[2006]

17. **Assertion :** Change in colour of acidic solution of potassium dichromate by breath is used to test drunk drivers.

Reason : Change in colour is due to the complexation of alcohol with potassium dichromate.

[2006]

Directions for (Q.18) : Each of these questions contains an Assertion followed by Reason. Read them carefully and answer the question on the basis of following options. You have to select the one that best describes the two statements.

- (a) If both Assertion and Reason are correct and Reason is the correct explanation of Assertion.
(b) If both Assertion and Reason are correct, but Reason is not the correct explanation of Assertion.
(c) If Assertion is correct but Reason is incorrect.
(d) If both the Assertion and Reason are incorrect.

18. **Assertion :** Cu^{2+} and Cd^{2+} are separated from each other by first adding KCN solution and then passing H_2S gas.

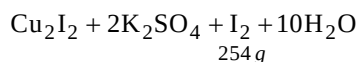
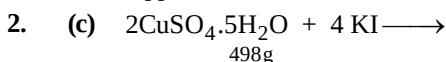
Reason : KCN reduces Cu^{2+} to Cu^+ and forms a complex with it.

[2013]

HINTS & SOLUTIONS

Type A : Multiple Choice Questions

1. (d) Beilstein test is used for the detection of halogens. A green or blue colour in flame indicates the presence of halogen. The colour is produced due to the formation of copper halides.

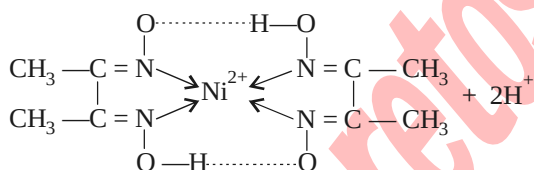
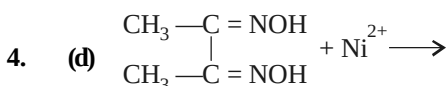


498 g of CuSO_4 liberate $\text{I}_2 = 254\text{g}$

$$8.3\text{ g of CuSO}_4 \text{ liberate } \text{I}_2 = \frac{254}{498} \times 8.3$$

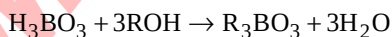
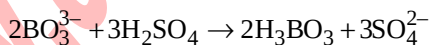
$$= 4.23\text{ g}$$

3. (a) Gravimetrically, Cu^{2+} ions are estimated as $\text{Cu}(\text{SCN})_2$, copper thiocyanate.



The reaction indicates that protons are released during reaction. Hence a basic medium is needed to facilitate the reaction. Thus the best pH range is 9-11. If medium is kept acidic then nitrogen atom of the ligand will start donating lone pair to H^+ ion of the acid and not to central metal ion.

5. (a) In the qualitative analysis of BO_3^{3-} , mixture is heated with conc. H_2SO_4 and little alcohol when trialkyl borate, R_3BO_3 or $\text{B}(\text{OR})_3$ is formed.



The vapours of trialkyl borate, $\text{B}(\text{OMe})_3$ impart green colour to the burner flame

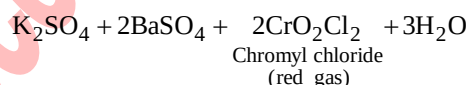
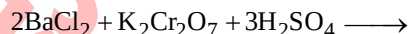
6. (c) Nessler's reagent ($\text{K}_2[\text{HgI}_4]$) is used for the detection and quantitative

determination of ammonia (or NH_4^+) in solution. It gives a yellow colour or brown precipitate of oxydimercuric ammonium

iodide $\left(\text{O} \begin{array}{c} \text{Hg} \\ \diagup \quad \diagdown \\ \text{Hg} \end{array} \text{NH}_2\text{I} \right)$ even with concentration as low as 1 part per million of NH_3 .

7. (b) Hot HCl will produce precipitate of AgCl with Ag^+ only. PbCl_2 will not precipitate because it is soluble in hot solution.

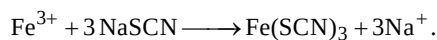
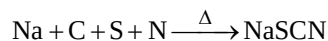
8. (b) The reagent is BaCl_2 which imparts green colour to flame. BaCl_2 forms chromyl chloride (which is red in colour), when treated with $\text{K}_2\text{Cr}_2\text{O}_7$ and conc. H_2SO_4 .



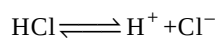
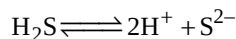
Type B : Assertion Reason Questions

9. (e) Potassium is not used in Lassaigne's test because of its higher reactivity.

10. (a) Due to presence of sulphur, sodium thiocyanate is produced which produces blood red coloured precipitate with Fe^{3+} ion.

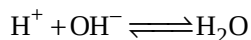
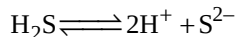


11. (d) $\text{Sb}(\text{III})$, placed in II group of qualitative analysis is precipitated as Sb_2S_3 by passing H_2S in presence of HCl which decreases ionisation of H_2S (due to common ion effect). This is done to avoid precipitation of metals of higher groups.



Thus when $\text{Sb}(\text{III})$ is precipitated by low concentration of H_2S , it will easily be

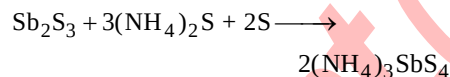
precipitated when concentration of S^{2-} is high, i.e., by H_2S in presence of alkali.



Thus here both assertion and reason are false.

12. (b) Metals form coloured compound (metaborates) with borax. On the basis of colour of metaborates, we can identify the metal. Aluminium does not form coloured metaborate, so this test is not valid for Al^{3+} ion. Al_2O_3 is insoluble in water but it is not explanation of A.
13. (b) Starch is used as an indicator because it forms blue coloured complex with iodine. Starch is a polysaccharide but this is not explanation of A.
14. (c) $K_2Cr_2O_7$ is used as primary standard in volumetric analysis because its standard solution can be prepared. A is true but R is wrong.
15. (d) Antimony sulphide (Sb_2S_3) is soluble in yellow ammonium sulphide forming

ammonium thioantimonate.



The common ion effect due to S^{2-} ion does not reduce the solubility of Sb_2S_3 . So both A as well as R, are false.

16. (c) Fe^{3+} can be used to coagulate As_2S_3 as sol of As_2S_3 is negatively charged due to adsorption of S^{2-} ions. The positive charge of Fe^{3+} ion neutralises the negative charge of sol particles. Reason as given in the question does not explain A.
17. (c) A is true but R is wrong because change in colour of potassium dichromate is due to oxidation of alcohol by dichromate.
- $$K_2Cr_2O_7 + 4H_2SO_4 \longrightarrow K_2SO_4 + Cr_2(SO_4)_3 + 4H_2O + 3O$$
- $$C_2H_5OH + O \longrightarrow CH_3COOH$$
18. (b) KCN forms complexes with Cu^+ and Cd^{2+} as $K_3[Cu(CN)_4]$ and $K_2[Cd(CN)_4]$ respectively. On passing H_2S , only Cd^{2+} complex is decomposed to give yellow CdS precipitate.

BIOLOGY

Chapter

1

The Living World

TYPE A : MULTIPLE CHOICE QUESTIONS

1. Linnaeus system of classification is [1999]
(a) Natural (b) Artificial
(c) Phylogenetic (d) Progressive
2. The basic unit of classification is [2000]
(a) genus (b) species
(c) variety (d) subspecies
3. Binomial nomenclature was introduced by [2000]
(a) Linnaeus
(b) Darwin
(c) Bentham and Hooker
(d) Aristotle
4. The usage of binomial names, for plant species was accepted by all after the publication of the work by [2001]
(a) Hooker (b) Linnaeus
(c) Bentham (d) Darwin
5. Which one of the following is correctly matched regarding an Institute and its location? [2004]
(a) National Institute of Virology - Pune
(b) National Institute of Communicable disease - Lucknow
(c) Central Drug Research Institute - Kasauli Institute
(d) National Institute of Nutrition - Mumbai
6. "Ordines Anomali" of Bentham and Hooker includes [2006]
(a) seed plants showing abnormal forms of growth and development.
(b) plants represented only in fossil state.
(c) plants described in the literature but which Bentham and Hooker did not see in original.
(d) a few orders which could not be placed satisfactory in the classification.
7. The system of classification based on evolutionary and genetic relationships among organisms, ignoring the morphological similarities or differences, is called [2009]
(a) cladistics
(b) phenetics
(c) classical systematics
(d) new systematics
8. Scientific name of Mango plant is *Mangifera indica* (Linn.) Santapau. In the above name Santapau refers to [2012]
(a) Variety of Mango
(b) A taxonomist who proposed the present nomenclature in honour of Linnaeus
(c) A scientist who for the first time described Mango plant
(d) A scientist who changed the name proposed by Linnaeus and proposed present name
9. The classification of Linnaeus was mainly based on [2012]
(a) Sepals (b) Carpels
(c) Petals (d) Stamens
10. Which of the following is less general in characters as compared to genus? [2013]
(a) Species (b) Division
(c) Class (d) Family
11. Read the following statements
(i) Lower the taxon, more are the characteristics that the members within the taxon share.
(ii) Order is the assemblage of genera which exhibit a few similar characters.
(iii) Cat and dog are included in the same family Felidae.

B-2

Topicwise AIIMS Solved Papers – BIOLOGY

(iv) Binomial Nomenclature was introduced by Carolus Linnaeus. [2014]

Which of the following statements are **NOT** correct?

- (a) (i), (ii) and (iii) (b) (ii), (iii) and (iv)
(c) (i) and (iv) (d) (ii) and (iii)

12. Choose the correct one [2015]

- (i) Growth cannot be taken as a defining property of living organism.
(ii) Dead organism does not grow.
(iii) Reproduction cannot be an all inclusive defining characteristic of living organisms.
(iv) No non-living object is capable of replicating itself.
(v) Metabolism in a test tube is non-living.
(vi) Metabolism is a defining feature of all living organisms.

- (a) (i) and (iii) (b) All except (v)
(c) All except (iii) (d) All of these

13. Match column I with column II and choose the correct option. [2017]

Column-I	Column-II
A. Family	I. <i>tuberosum</i>
B. Kingdom	II. Polymoniales
C. Order	III. <i>Solanum</i>
D. Species	IV. Plantae
E. Genus	V. Solanaceae
(a) A – IV; B – III; C – V; D – II; E – I	
(b) A – V; B – IV; C – II; D – I; E – III	
(c) A – IV; B – V; C – II; D – I; E – III	
(d) A – V; B – III; C – II; D – I; E – IV	

TYPE B : ASSERTION REASON QUESTIONS

Directions for (Qs. 14-15) : These questions consist of two statements, each printed as Assertion and Reason. While answering these questions, you are required to choose any one of the following five responses.

- (a) If both Assertion and Reason are correct and the Reason is a correct explanation of the Assertion.
(b) If both Assertion and Reason are correct but Reason is not a correct explanation of the Assertion.
(c) If the Assertion is correct but Reason is incorrect.
(d) If both the Assertion and Reason are incorrect.
(e) If the Assertion is incorrect but the Reason is correct.

14. **Assertion:** Living organisms are regarded as closed systems.

Reason: Energy of living organisms can not be lost or gained from external environment. [2002]

15. **Assertion:** Systematics is the branch of biology that deals with classification of living organisms.

Reason: The aim of classification is to group the organisms. [2002]

Directions for (Q. 16) : Each of these questions contains an Assertion followed by Reason. Read them carefully and answer the question on the basis of following options. You have to select the one that best describes the two statements.

- (a) If both Assertion and Reason are correct and Reason is the correct explanation of Assertion.
(b) If both Assertion and Reason are correct, but Reason is not the correct explanation of Assertion.
(c) If Assertion is correct but Reason is incorrect.
(d) If both the Assertion and Reason are incorrect.
16. **Assertion :** Taxon and category are different things.

Reason : Category shows hierarchical classification. [2013, 14]

HINTS & SOLUTIONS**Type A : Multiple Choice Questions**

1. (b) Carolus Linnaeus system of classification is artificial.
2. (b) The basic unit of classification is species which consists of a natural population of individuals having similar, morphological, anatomical, biochemical, cytological and reproductive characters so that they can interbreed freely and produce fertile offsprings.
3. (a) Carolus Linnaeus gave the binomial system of nomenclature.
4. (b) Carolus Von Linnaeus in his book *Genera Plantarum* made use of the artificial system of classification. He distinguished between the natural and artificial systems. He used the binomial nomenclature system and classified organisms into genus and species.
5. (a) National Institute of Virology is located in Pune.
The National Institute of Virology (NIV) is a premier virus research laboratory in India. It is one of the major Institutes of the Indian Council of Medical Research (ICMR). It was established at Pune.
6. (d) Bentham and Hooker system was published well before there were internationally accepted rules for botanical nomenclature. In this system, termination for families was not so as it is now.
7. (a) "Cladogram" emphasizes that the diagram represents a hypothesis about the actual evolutionary relationships of a group. This history is deduced on the basis of certain shares like homologous characters, that are thought to indicate common ancestry. While "phylogenies" represent true evolutionary history. To other biologists, "cladogram" suggests that the lengths of the branches in the diagram are arbitrary, while in a "phylogeny," the branch lengths indicate the amount of character change.
8. (d) Collection of rules regarding scientific nomenclature of plants is known as ICBN or International Code of Botanical Nomenclature. It was first accepted in 1961. According to ICBN, if any scientist has proposed wrong name then his name should be written in bracket and the scientist who corrected the name should be written after the bracket.
9. (d) Classification proposed by Linnaeus is artificial. Linnaeus classified plant kingdom on the basis of only two characters
(1) stamens (2) style
10. (a) Species is the lowest taxonomic category. Class is a category made of one or more related orders possessing similar correlated characters. Family is composed of one to many related genera. Division comprises of several related classes.
11. (d) Order being higher category is the assemblage of families which exhibit a few similar characteristics.
Dog (*Canis familiaris*) and Cat (*Felis domesticus*) belong to two different families—Cancideae and Felidae respectively.
12. (b) Metabolism takes place only inside the body of a living organism.
13. (b) A - V; B - IV; C - II; D - I; E - III

Type B : Assertion Reason Questions

14. (d) Living organisms are regarded as open system as energy flow is the key function of an ecosystem.

15. (b) Systematics is the science of identification, naming and classification of the organisms into groups.
16. (a) A category is a rank or level in the hierarchical classification of organisms. Taxon is a unit in classification which may

represent any level of grouping of organisms based on certain common characteristics. There is some confusion in the use of taxon and category, for example Bryophyta is a taxon while division is a category.

Biological Classification

TYPE A : MULTIPLE CHOICE QUESTIONS

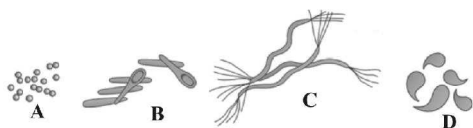
1. The symbiotic relationship of algae and fungus is found in [1997]
 - (a) lichen (b) mycorrhiza
 - (c) pneumatophore (d) bacteriophage
2. The virus that infects bacteria is called [1997]
 - (a) cyanophage (b) mycophage
 - (c) bacteriophage (d) none of these
3. Citrus canker is caused by [1997]
 - (a) bacterium (b) fungus
 - (c) alga (d) virus
4. Which of the following is a cyanobacterium ?
 - (a) *Nostoc* (b) *Chara* [1997]
 - (c) *E. coli* (d) *Polysiphonia*
5. Virus has [1998]
 - (a) DNA
 - (b) RNA
 - (c) both (a) and (b)
 - (d) either DNA or RNA
6. Hormogonia are vegetative reproductive structure of [1998]
 - (a) *Spirogyra* (b) *Ulothrix*
 - (c) *Oscillatoria* (d) Yeast
7. Which is a unicellular fungus ? [1998]
 - (a) Yeast (b) *E. coli*
 - (c) *Nostoc* (d) *Albugo*
8. Bacterial cell wall is made up of [1999]
 - (a) xylan (b) chitin
 - (c) cellulose (d) murein
9. Cell wall is absent in [2000]
 - (a) *Amoeba* (b) *Chara*
 - (c) yeast (d) *E. coli*
10. Which of the following is a fungus? [2000]
 - (a) *Nostoc* (b) *E. coli*
 - (c) Yeast (d) *Chara*
11. Powdery mildews of crops are caused by [2001]
 - (a) bacteria (b) ascomycetes
 - (c) basidiomycetes (d) phycomycetes
12. Pullorum disease of poultry is caused by [2001]
 - (a) *Mycobacterium* (b) *Salmonella*
 - (c) *Clostridium* (d) *Haemophilus*
13. Viroids have [2003]
 - (a) single stranded RNA not enclosed by protein coat.
 - (b) single stranded DNA not enclosed by protein coat.
 - (c) double stranded DNA enclosed by protein coat.
 - (d) double stranded RNA enclosed by protein coat.
14. Myxomycetes are [2006]
 - (a) saprobes or parasites, having mycelia, asexual reproduction by fragmentation.
 - (b) slimy mass of multinucleate protoplasm, having pseudopodia like structures for engulfing food, reproduction through fragmentation or zoospores.
 - (c) prokaryotic organisms, cellular or acellular, saprobes or autotrophic, reproduce by binary fission.
 - (d) eukaryotic, single-celled or filamentous, saprobes or autotrophic, asexual reproduction by division of haploid individuals, sexual reproduction by fusion of two cells or their nuclei.
15. Among rust, smut and mushroom all the three [2006]
 - (a) are pathogens (b) are saprobes
 - (c) bear ascocarps (d) bear basidiocarps
16. "Fairy rings" in lawns result from outward, spreading circles of mycelia of mushrooms producing, at their periphery, fruiting bodies called [2009]
 - (a) ascocarps (b) basidiocarps
 - (c) sorocarps (d) pseudocarps

B-6

Topicwise AIIMS Solved Papers – BIOLOGY

17. Which one of the following statements is correct? [2010]

- Prions are the smallest free-living cells.
 - The cell wall of *Mycoplasmas* is made up of amino sugars.
 - Viroids consist of single-stranded RNA molecule.
 - Rickettsiae lack cell wall.
18. Bacterial cell wall is composed of peptidoglycan, a complex of oligosaccharides and proteins. The oligosaccharide component consist of [2010]
- linear chain of alternating NAG and NAM linked by α (1 – 4) linkage.
 - linear chains of alternating NAG and NAM linked by β (1 – 4) linkage.
 - linear chain of glucose linked by β (1 – 4) linkage.
 - linear chain of glucose linked by α (1 – 4) linkage.
19. Choose the correct names of the different bacteria according to their shapes. [2013]



- A – Cocci, B – Bacilli, C – Spirilla, D – Vibrio
 - A – Bacilli, B – Cocci, C – Spirilla, D – Vibrio
 - A – Spirilla, B – Bacilli, C – Cocci, D – Vibrio
 - A – Spirilla, B – Vibrio, C – Cocci, D – Bacilli
20. Which pair of the following belongs to Basidiomycetes? [2013]
- Puffballs and *Claviceps*
 - Peziza* and *Alternaria*
 - Morchella* and mushrooms
 - Birds nest fungi and puffballs
21. Match column-I with column-II and select the option. [2014]

Column-I

(Classes of fungi)

- Phycomycetes
- Ascomycetes
- Basidiomycetes
- Deuteromycetes

Column-II

(Common name)

- Sac fungi
- Algal fungi
- Fungi imperfecti
- Club fungi

The correct combination is –

- A – II; B – I; C – IV; D – III
 - A – II; B – IV; C – I; D – III
 - A – IV; B – I; C – II; D – III
 - A – IV; B – III; C – II; D – I
22. Which of the following is correct about the slime mould? [2015]
- Its thalloid body, *Plasmodium* has pseudopodia for locomotion and engulfing organic matter.
 - During unfavourable conditions *Plasmodium* differentiates and produces fruiting bodies, sporangium.
 - Spores possess no true cell wall.
 - They are dispersed by air current.
 - Being extremely resistant, spores survive for many years.
 - Plasmodium* can grow upto several feet.
- Choose the answer from the following options
- (i),(ii), (iv), (v) and (vi)
 - (i),(ii) and (iii)
 - (i),(ii), (iii) and (vi)
 - (ii),(iii) and (vi)
23. (i) Green algae occur in fresh water, brackish water, salt water.
- (ii) Habitat of Brown algae-fresh water (rare), brackish water, salt water
- (iii) Some red algae are found in fresh water, mostly occur in salt water, some are in brackish water.
- (iv) Most of the red algae are multicellular.
- (v) Red alga may occur in both well lighted regions close to water-surface and also at great depths in oceans where light penetration is little.
- (vi) Cell wall of red algae consists of cellulose + agar.
- (vii) 2 – 8, equal and apical flagella in green algae [2015]
- All are correct
 - All are false
 - (i) and (vi) are correct
 - (ii), (iii) and (v) are correct

24. Fungi are filamentous with the exception of "X" which is unicellular. Identify X. [2017]
(a) Yeast (b) Albugo
(c) Mucor (d) Lichen
25. Which of the following statements is not correct for viruses? [2017]
(a) Viruses are obligate parasites.
(b) Viruses can multiply only when they are inside the living cells.
(c) Viruses cannot pass through bacterial filters.
(d) Viruses are made up of protein and DNA or RNA (never both DNA and RNA).
26. Which of the following statements regarding cyanobacteria is incorrect? [2017]
(a) It is also called blue green algae.
(b) They are chemosynthetic heterotrophs.
(c) It forms blooms in polluted water bodies.
(d) It is unicellular, colonial or filamentous, marine or terrestrial bacteria.
28. **Assertion :** Bacteria have three basic shapes, i.e., round, rod, spiral.
Reason : Cocci and Bacilli may form clusters or chain of a definite length. [2000]
29. **Assertion :** Aflatoxins are produced by *Aspergillus flavus*.
Reason : These toxins are useful to mankind. [2000]
30. **Assertion :** *Escherichia coli*, *Shigella* sp. and *Salmonella* sp. are all responsible for diarrhoeal diseases. [2006]
Reason : Dehydration is common to all types of diarrhoeal diseases and adequate supply of fluids and electrolytes should be ensured.
31. **Assertion :** Gram-negative bacteria do not retain the stain when washed with alcohol.
Reason : The outer face of the outer membrane of gram-negative bacteria contains lipopolysaccharides, a part of which is integrated into the membrane lipids. [2006]
32. **Assertion :** *Neurospora* is commonly called water mould.
Reason : It belongs to basidiomycetes fungi. [2007]

TYPE B : ASSERTION REASON QUESTIONS

Directions for (Qs. 27-32) : These questions consist of two statements, each printed as Assertion and Reason. While answering these questions, you are required to choose any one of the following five responses.

- (a) If both Assertion and Reason are correct and the Reason is a correct explanation of the Assertion.
(b) If both Assertion and Reason are correct but Reason is not a correct explanation of the Assertion.
(c) If the Assertion is correct but Reason is incorrect.
(d) If both the Assertion and Reason are incorrect.
(e) If the Assertion is incorrect but the Reason is correct.
27. **Assertion:** Viruses are not considered organism.
Reason: Viruses are nucleoproteins and lack cell organelle, etc. [1998]

Directions for (Qs. 33-34) : Each of these questions contains an Assertion followed by Reason. Read them carefully and answer the question on the basis of following options. You have to select the one that best describes the two statements.

- (a) If both Assertion and Reason are correct and Reason is the correct explanation of Assertion.
(b) If both Assertion and Reason are correct, but Reason is not the correct explanation of Assertion.
(c) If Assertion is correct but Reason is incorrect.
(d) If both the Assertion and Reason are incorrect.
33. **Assertion :** Chemosynthesis is an autotrophic nutrition.
Reason : Chemoautotrophs contain chlorophyll pigments. [2009]
34. **Assertion :** TMV is a virus which causes mosaic disease.
Reason : TMV has RNA as genetic material. [2001, 2017]

HINTS & SOLUTIONS

Type A : Multiple Choice Questions

1. (a) Lichens are the symbiotic association between algae and fungi. Fungi provides the raw material and algae manufacture the food.
2. (c) The virus which attacks bacteria is called bacteriophage, *e.g.* T II phage, M13, ϕ 174 *etc.*
3. (a) *Citrus canker* is caused by bacterium, *Xanthomonas citri*. Bacterium is rod shaped, motile, flagellate and gram negative.
4. (a) *Nostoc* is a cyanobacterium. Cyanobacteria are gram (–) ve prokaryotes which perform oxygenic photosynthesis like plants. Cyanobacteria can be unicellular (*e.g.* *Spirulina*), colonial. (*e.g.* *Nostoc*) or filamentous (*e.g.* *Oscillatoria*)
5. (d) Virus are obligate intracellular parasite which can reproduce only by invading and taking over other cells as they lack the cellular machinery for self reproduction. Virus has either DNA or RNA and never both.
6. (c) Hormogonia is a part of a filament of a cyanobacterium that detaches and grows by cell division into a new filament. Cyanobacteria mostly multiply by asexual means like binary fission, small fragments (hormogones), hormospores, akinetes, endospores *etc.* Common cyanobacteria are-*Nostoc*, *Anabaena*, *Oscillatoria* *etc.*
7. (a) Yeast is the only member in kingdom fungi which is unicellular.
Nostoc : Blue green algae
E. coli : Bacterium
Albugo : Parasitic fungi
8. (d) Bacterial cell wall consists of peptidoglycan/murein/mucopeptide which contains polymers of modified sugars (N-acetyl glucosamine and N-acetylmuramic acid) cross linked by short peptides.
9. (a) Cell wall is a characteristic of bacteria, plants and fungi.
10. (c) Heterotrophs were the first to be evolved and fungi in the plant kingdom are heterotrophs. Yeast with its characteristic absence of chlorophyll and its vegetative propagation through budding and saprophytic nature shows it is a fungus.
11. (b) Powdery mildews are caused by fungi belonging to the family Erysiphaceae (class-Ascomycetes). Ascomycetes spores are harmful and it makes the crop vulnerable to its toxin. The stem becomes a powdery mass.
12. (b) Pullorum disease (Salmonellosis), a contagious disease of young birds, is caused by bacteria *Salmonella pullorum*. It is usually transmitted by infected hens through their eggs. Its symptoms are loss of appetite and thirst, diarrhoea with white faeces, drooping of wings *etc.*
13. (a) Viroids are the smallest known agents of infectious diseases comprising of small single stranded molecule of RNA. Viroids lack capsid and have no proteins associated with them.
14. (b) Myxomycetes are acellular plasmodial slime molds *i.e.* a group of 4 fungus which reproduces through fragmentation or zoospore.
15. (d) Rust, smut and mushroom bear short lived reproductive bodies called basidiocarps.

- ### Type B : Assertion Reason Questions

27. (a) Virus is a small infectious agent that can

TYPE A : MULTIPLE CHOICE QUESTIONS

1. Meiosis in *Dryopteris* takes place during [1997]
 - (a) spore formation
 - (b) gametic formation
 - (c) spore germination
 - (d) zygote formation
2. Sometimes a ladder like structure in *Spirogyra* is formed due to [1998]
 - (a) lateral conjugation
 - (b) asexual reproduction
 - (c) scalariform conjugation
 - (d) direct conjugation
3. In which group of the following would you place the plants having vascular tissue and lacking seeds? [1998]
 - (a) Algae
 - (b) Fungi
 - (c) Bryophytes
 - (d) Pteridophytes
4. Largest ovule in plant kingdom are found in
 - (a) *Pinus*
 - (b) *Cycas*
 - (c) *Thuja*
 - (d) *Gnetum*
5. Plant material, which is used in culture medium is obtained from [1998]
 - (a) *Cycas*
 - (b) coconut milk
 - (c) *Pinus*
 - (d) mango
6. Which is a saprophytic angiosperm? [1998]
 - (a) *Cuscuta*
 - (b) *Neottia*
 - (c) *Agaricus*
 - (d) Yeast
7. Bryophytes do not possess [1999]
 - (a) vascular tissue
 - (b) gametophyte
 - (c) alternation of generation
 - (d) spores
8. The heart shaped fern prothallus is [1999]
 - (a) gametophyte
 - (b) sporophyte
 - (c) saprophyte
 - (d) gamete
9. In *Dryopteris*, the opening mechanism of sporangium is effectively operated by [1999]
 - (a) stalk
 - (b) stomium
 - (c) annulus
 - (d) peristome
10. 13 celled male gametophyte of *Selaginella* has [2000]
 - (a) 12 cells of antheridium + 1 prothallial cell
 - (b) 10 cells of antheridium + 3 prothallial cell
 - (c) 9 cells of antheridium + 4 prothallial cell
 - (d) 8 cells of antheridium + 6 prothallial cell
11. Which of the following is found in algal zone of *Cycas* coralloid roots? [2000]
 - (a) Blue green algae
 - (b) Red algae
 - (c) Diatoms
 - (d) Brown algae
12. Sex organs in *Funaria* develop [2001]
 - (a) in protonema.
 - (b) outside capsule.
 - (c) in the axil of leaf.
 - (d) at the tip of gametophore.
13. In which portion of *Cycas* diploxylic vascular bundles are found ? [2001]
 - (a) Root
 - (b) Stem
 - (c) Leaflet
 - (d) Rachis and leaflet
14. *Funaria* gametophyte is [2001]
 - (a) dioecious
 - (b) heteroecious
 - (c) autoecious
 - (d) monoecious and autoecious
15. Sometimes, the fern plant arises from fern prothallus without fertilization. This is an example of [2001]
 - (a) apospory
 - (b) apogamy
 - (c) parthenocarp
 - (d) gametogenesis
16. Zygospore of *Spirogyra* at the time of meiosis is divided into 4 nuclei. How many nuclei degenerate out of these four ? [2001]
 - (a) One
 - (b) Two
 - (c) Three
 - (d) Four

17. *Cycas* is [2001]
 (a) monoecious (b) bisexual
 (c) dioecious (d) hermaphrodite
18. The drug belladonna is obtained from [2001]
 (a) *Atropa* (b) *Opium*
 (c) *Rauwolfia* (d) *Solanum*
19. Algae are useful because they [2002]
 (a) purify the atmosphere
 (b) are large in number
 (c) are used in fermentation
 (d) are used to study respiration
20. The plant body of *Funaria* is [2002]
 (a) sporophyte
 (b) gametophyte
 (c) predominantly sporophyte with independent gametophyte
 (d) predominantly gametophyte with dependent sporophyte.
21. Elaters help in dispersal of spores of [2002]
 (a) *Riccia* (b) *Marchantia*
 (c) *Dryopteris* (d) *Funaria*
22. The nature of megasporophyll of *Cycas* is similar to [2002]
 (a) stamen (b) carpel
 (c) sepal (d) petal
23. Which of the following helps in respiration of lichens? [2002]
 (a) *Isidia* (b) *Soredia*
 (c) *Cyphella* (d) *Cephalodia*
24. In *Ulothrix*, meiosis takes place in [2004]
 (a) cells of the filament
 (b) holdfast
 (c) zygote
 (d) zoospores
25. Mosses and ferns are found in moist and shady places because both [2004]
 (a) require presence of water for fertilization.
 (b) do not need sunlight for photosynthesis.
 (c) depend for their nutrition on micro-organisms which can survive only at low temperature.
 (d) cannot compete with sun-loving plants.
26. In the following table identify the correct matching of the crop, its disease and the corresponding pathogen [2006]
- | | Crop | Disease | Pathogen |
|-----|------------|-------------|---------------------------------|
| (a) | Citrus | Canker | <i>Pseudomonas rubrilineans</i> |
| (b) | Potato | Late blight | <i>Fusarium udum</i> |
| (c) | Brinjal | Root-knot | <i>Meloidogyne incognita</i> |
| (d) | Pigeon pea | Seed gall | <i>Phytophthora infestans</i> |
27. Plants of which one of the following groups of genera are pollinated by the same agency? [2006]
 (a) *Triticum*, *Cocos*, *Mangifera*
 (b) *Ficus*, *Kigelia*, *Casuarina*
 (c) *Salvia*, *Morus*, *Euphorbia*
 (d) *Bombax*, *Butea*, *Bauhinia*
28. Which of the following match is correct? [2007]
- | Disease | Pathogen |
|--------------------------|--------------------|
| (a) Wilt disease | <i>Synchytrium</i> |
| (b) Citrus canker | <i>Xanthomonas</i> |
| (c) Red rot of sugarcane | <i>Ustilago</i> |
| (d) Powdery mildew | <i>Fusarium</i> |
29. People recovering from long illness are often advised to include the alga *Spirulina* in their diet because it [2003, 2008]
 (a) makes the food easy to digest.
 (b) is rich in proteins.
 (c) has antibiotic properties.
 (d) restores the intestinal microflora.
30. Botanical name of Sanjeevani is [2009]
 (a) *Selaginella chrysocaulos*
 (b) *Selaginella bryopteris*
 (c) *Selaginella chrysorrhiza*
 (d) None of the above
31. In *Pinus*, the third tier of embryonal cells from below is known as [2009]
 (a) rosette tier (b) suspensor tier
 (c) embryonal tier (d) free-nuclear tier
32. Which of the following is found in algal zone of *Cycas* coralloid roots? [2007, 2011]
 (a) Blue green algae (b) Red algae
 (c) Diatoms (d) Brown algae

B-12

33. Which among the following is a rootless plant? [2007, 2011]

- (a) *Nymphaea* (b) *Sagittaria*
(c) *Ceratophyllum* (d) *Vallisneria*

34. Sporocarp is a reproductive structure of

- (a) Some algae [2012]
(b) Some aquatic ferns having sori
(c) Angiosperms having spores
(d) Bryophytes

35. Coralloid roots of *Cycas* is distinguished from angiosperm roots by [2013]

- (a) absence of pith
(b) having xylem tissue
(c) absence of algal zone
(d) presence of algal zone

36. If the cells of root in wheat plant have 42 chromosomes, then the no. of chromosome in the cell of pollen grain is [2014]

- (a) 14 (b) 21
(c) 28 (d) 42

37. Match the following

Column-I (Classes)	Column-II (Examples)
A. Psilotopsida	I. <i>Dryopteris</i> , <i>Pteris</i> , <i>Adiantum</i>
B. Lycopsidea	II. <i>Equisetum</i>
C. Sphenopsida	III. <i>Selaginella</i>
D. Pteropsida	IV. <i>Lycopodium</i>
	V. <i>Psilotum</i>

- (a) A – V; B – III; C – II; D – I
(b) A – I; B – II; C – III; D – IV
(c) A – IV; B – III; C – II; D – I
(d) A – III; B – V; C – I; D – II

38. Consider the following statements regarding the major pigments and stored food in the different groups of algae and choose the correct option

- (i) In chlorophyceae, the stored food material is starch and the major pigments are chlorophyll-*a* and *d*.
(ii) In phaeophyceae, laminarian is the stored food and major pigments are chlorophyll-*a* and *b*.
(iii) In rhodophyceae, floridean starch is the stored food and the major pigments are chlorophyll-*a*, *d* and phycoerythrin.

[2017]

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- (a) (i) is correct, but (ii) and (iii) are incorrect
(b) (i) and (ii) are correct, but (iii) is incorrect
(c) (i) and (iii) are correct, but (ii) is incorrect
(d) (iii) is correct, but (i) and (ii) are incorrect

TYPE B : ASSERTION REASON QUESTIONS

Directions for (Qs. 39-43) : These questions consist of two statements, each printed as Assertion and Reason. While answering these questions, you are required to choose any one of the following five responses.

- (a) If both Assertion and Reason are correct and the Reason is a correct explanation of the Assertion.
(b) If both Assertion and Reason are correct but Reason is not a correct explanation of the Assertion.
(c) If the Assertion is correct but Reason is incorrect.
(d) If both the Assertion and Reason are incorrect.
(e) If the Assertion is incorrect but the Reason is correct.

39. **Assertion :** Mosses are evolved from algae.

Reason : Protonema of mosses is similar to some green algae. [2001]

40. **Assertion :** Coconut tree is distributed in coastal areas over a large part of the world.

Reason : Coconut fruit can float and get dispersed over thousands of kilometers before losing viability. [2004]

41. **Assertion :** The fungi are widespread in distribution and they even live on or inside other plants and animals.

Reason : Fungi are able to grow anywhere on land, water or on other organisms because they have a variety of pigments, including chlorophyll, carotenoids, fucoxanthin and phycoerythrin. [2005]

42. **Assertion :** Algae and fungi are classified as thallophytes.

Reason : They both are autotrophs. [2007]

43. Assertion : Conifer trees produce a large quantity of wind borne pollen grains.

Reason : The pollen grains have wings. [2007]

Directions for (Qs. 44-46) : Each of these questions contains an Assertion followed by Reason. Read them carefully and answer the question on the basis of following options. You have to select the one that best describes the two statements.

- (a) If both Assertion and Reason are correct and Reason is the correct explanation of Assertion.
- (b) If both Assertion and Reason are correct, but Reason is not the correct explanation of Assertion.
- (c) If Assertion is correct but Reason is incorrect.
- (d) If both the Assertion and Reason are incorrect.

44. Assertion : Red algae contributes in producing coral reefs. [2004, 2011]

Reason : Some red algae secrete and deposit calcium carbonate over their walls.

45. Assertion: The peristome is a fringe of teeth-like projections found at the mouth of the capsule. [2004, 2011]

Reason: It may be of two types nematodontous and orthodontous.

46. Assertion : Members of phaeophyceae vary in colour from olive green to various shades of brown

Reason : Phaeophyceae possess chlorophyll a, c, carotenoids and xanthophysis. [2016]

HINTS & SOLUTIONS

Type A : Multiple Choice Questions

1. (a) In sporangium,
 Spore mother cell ($2n$) $\xrightarrow{\text{Meiosis}}$
 spores (n) $\xrightarrow{\text{dispersed by}}$ germination
 $\longrightarrow$ Prothallus(n) $\longrightarrow$ gamete fusion
 $\longrightarrow$ zygote $\longrightarrow$ Main plant body ($2n$).
2. (c) **Conjugation** is exchange of genetic material i.e. mode of sexual reproduction in lower organisms. Conjugation occurs by two methods–
 (i) **Scalariform conjugation**
 It takes place during the night and between the recently divided cells of the conjugating participating filaments. Opposite cells of two filaments develop conjugation tube by lying side by side and parallel to each other. The conjugation tube between two filament looks like a ladder, through which gamete from one gametangia passes through to fuse with the passive gamete of another filament.
 (ii) **Lateral conjugation**
 Two adjacent cells of same filament function as male and female cells. It is commonly reported in *S. affinis* and *S. fenuissima*.
3. (d) Pteridophytes are seedless vascular plants. They are also called vascular cryptogams as they possess xylem and phloem.
4. (b) Largest ovule in plant kingdom is found in *Cycas*. Female cone consists of megasporophylls. Each megasporophyll bears 2-12 reddish ovules in the middle fertile part. Ovules of *Cycas* are the largest, 6-7 cm in diameter.
 The sperms of *Cycas* are also the largest ($300\ \mu\text{m}$) in the biological world.
5. (b) Coconut milk is rich in compounds chemically similar to cytokinin and promote callus growth by inducing cell division.
6. (b) *Neottia* grows on soil rich humus. It has an underground stem with a cluster of roots. The roots are associated with endotrophic mycorrhiza. The fungus absorbs its food from humus and the cortical cells of the roots of *Neottia* absorb food from humus. *Neottia* is actually a parasite on fungus.
7. (a) Bryophytes are terrestrial plants found in moist places and shady localities. They are rightly called the amphibians of the plant kingdom. Since fertilization does not occur without water. Being in moist places, water and mineral salts are being absorbed by rhizoids that have the main function of fixing the plant. Absorption also occurs due to diffusion. Moreover, these plants are very small. Hence, Bryophytes do not possess the vascular tissue.
8. (a) The heart shaped prothallus is the characteristic feature of ferns and mainly belong to polypodiaceae. They show polarity and dorsoventrality. The prothallus contains both the antheridia and archegonia which are embedded in the prothallus. Since it forms the male and female gametes the prothallus is considered as the gametophyte.
9. (b) When the capsule of the sporangium in *Dryopteris* matures, about 4 lower median cells of the jacket stretch tangentially. The two median ones identify the place from where the capsule opens. This is called as stomium. The other cells of the jacket develop a thickening. At maturity, the indusium dries exposing the sorus. Due to loss of water in the annulus, the upper walls contract and inner ones straighten, the annulus coils. This feature exerts pressure

- on the wall resulting in the breaking of the capsule, between the cells of the stomium, thereby, releasing the spores.
10. (a) The structure and development of male gametophyte was described by Slagg (1932). The 13 celled male gametophyte has 12 antheridial cells and one prothallial cell as a result of segmentation. This is to increase the number of biflagellate antherozoids.
11. (a) The algal zone consists of blue green algae in the coralloid roots. The relationship is a mutual relationship. The algae get the dwelling place, while *Cycas* can use the food produced by the algae.
12. (d) Sex organs in *Funaria* develop at the tip of gametophore since the plant itself constitutes the gametophytic phase. After fertilization develops the capsule from which protonema develops from the spores that dehisces from the capsule. The capsule constitutes the sporophytic phase. The plant shows an alternation of generation, between the sporophytic and gametophytic phase.
13. (d) The rachis and leaflet have diploxylic vascular bundles. At the region of the stem cortex, the leaf trace has only centrifugal xylem, hence, it is endarch. These traces enter the leaf as the rachis separates, the centripetal xylem appears and it is in the exarch condition. The leaflet has a single midrib bundle and is in the diploxylic condition.
14. (d) *Funaria* is both monoecious and autoecious. The antheridium (male sex organ) are born on different heads of the same plant. Hence, it is both autoecious and monoecious.
15. (b) Apogamy is the formation of sporophyte from a gametophytic cell other than egg without fertilization. The prothallus is only a part of gametophytic cell. Hence, the development is apogamy.
16. (c) The united protoplasmic mass of two gametes is called zygote or zygospore. Prior to germination, the diploid zygospore nucleus undergoes meiosis and forms four nuclei. Three of the four nuclei degenerate since they are smaller in size. The last cell is bigger and grows using the reserve food substances.
17. (c) *Cycas* is dioecious in nature since it produces micro and megaspores in the micro and megasporangia. The micro and megasporangia are born on microsporophyll and megasporophyll respectively.
18. (a) *Atropa belladonna* produces the drug belladonna. It is an alkaloid which is atropine and hyoscyamine. The leaves and root contain the alkaloid. It is used to cure and relieve pain.
19. (a) Algae is a collective term for all those chlorophyll bearing organisms which are thalloid. So, during photosynthesis by taking in CO_2 and giving out O_2 , they purify the atmosphere.
20. (d) In the life cycle of *Funaria*, two distinct individuals occur. One of these is haploid and is independent leafy plant. The other is diploid, leafless sporogonium. It is partially dependent on the leafy gametophyte for its nutrition.
21. (b) The diploid bispiral elaters are hygroscopic and they help in the dispersal of spores.
22. (b) Megasporophyll of *Cycas* bears ovules similar to carpel.
23. (c) Cyphella are aerating organs in the form of organised breaks, which occur in the lower cortex and appear as concave circular depression where white medulla is exposed.
24. (c) *Ulothrix* being an haploid organism, shows zygotic meiosis. Zygote is the only diploid structure which undergoes meiosis to form four cells. Each develops into *Ulothrix*.
25. (a) Mosses and ferns are called the amphibians of plants which are land plants but require a film of water for antherozoids to reach archegonium.

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26. (c) Root knot/root gall in brinjal is caused by nematode *Meloidogyne incognita*.
27. (c) *Salvia*, *Morus*, *Euphorbia* are pollinated by insects (entomophily).
28. (b) Citrus canker is the disease caused by an aerobic, rod shaped bacterium, *Xanthomonas citri*.
29. (b) Some dieters say that blue green algae helps satisfy appetite and supplies good nutrition while dieting. Some dieters say that blue-green algae *Spirulina*, a well-known example, is a group of 1,500 species of microscopic aquatic plants. The two most common species used for human consumption are *Spirulina maxima* and *Spirulina platensis*. *Spirulina* is particularly rich in protein and also contains carotenoids, vitamins, minerals, and essential fatty acids. Blue-green algae (*Spirulina*) is a concentrated source of nutrients compared to most foods, but it is expensive compared to other supplemental sources of protein, vitamins, and minerals.
30. (b) *Selaginella bryopteris* (L.), popularly known as Sanjeevani, is a plant with medicinal properties. Sanjeevani grows on the hills of tropical areas, particularly the Arawali mountain terrains from east to west in India. Traditionally plants have been used to: (i) relief from heat stroke and the burning sensation during urination; (ii) restoring menstrual irregularities to normal and applied topically to pregnant women, aids easy delivery; and (iii) for treating jaundice.
31. (a) In *Pinus*, the third tier of embryonal cells from below is known as rosette tier. The four lower most cells which are far from the micropolar end are called the embryonal tier. These develop into an embryo. The cells above the embryonal tier called the suspensor tier and the third tier from below is called the rosette tier. The free nuclei tier are formed of 4 nuclei. It is the fourth upper most tier.
32. (a) The algal zone consists of blue green algae in the coralloid roots. The relationship is a mutual relationship. The algae get the dwelling place, while cycas can use the food produced by the algae.
33. (c) *Nymphaea*, *Sagittaria*, *Ceratophyllum* and *Vallisneria* are hydrophytes which grow in water. *Nymphaea*, *Sagittaria* and *Vallisneria* are rooted hydrophytes while *Ceratophyllum* is a submerged floating hydrophyte. It remains completely under water but is not rooted in mud. *Ceratophyllum* lacks roots even in embryonic stage.
34. (b) Sporocarp is a reproductive structure of some aquatic ferns like *Marsilea*. Sporocarps are functionally and developmentally modified leaf which bears several sori. Each sori consists of sporangia of two types -megasporeangia producing simple large female megaspore and microsporangia producing many small male microspore.
35. (d) In *Cycas*, coralloid roots are bluish green in colour and have blue-green algae in their cortex. This character distinguishes them from angiosperms.
36. (b) Number of chromosome in root cells of wheat plant is
 $2n = 42$
 $n = \frac{42}{2} = 21$
 The number of chromosome in the cell of pollen grain is 21 because pollen grains are haploid (n) in nature.
37. (a)
38. (d) In chlorophyceae, the stored food material is starch and the major pigments are chlorophyll- *a* and *b*. In phaeophyceae, laminarian is the stored food and major pigments are chlorophyll *a*, *c* and fucoxanthin.

Type B : Assertion Reason Questions

39. (a) Mosses that belong to the bryophytes have evolved from algae. The fact that protonema has a thallus like body shows that mosses have evolved from algae.
40. (a) Coconut tree is distributed in coastal areas since it floats on saline water because salt is more denser than freshwater, so it floats.
41. (c) Fungi lack pigments and are therefore, heterotrophic. The mode of nutrition is either parasitic/saprophytic.
42. (c) Thallophyte includes plants in which body is not differentiated into root, stem and leaves. Algae and fungi have thallose plant body. Algae are autotrophs *i.e.* they can prepare their own food by *photosynthesis*. while fungi are heterotrophs.
43. (a) In pinus, a conifer tree, the microspores are produced by microsporogenesis in microsporangium. Each microsporangium has an inner nourishing layer known as tapetum. A large number of dusty and two winged microspores are present. On maturity the microsporangium wall bursts and microspores are released in the air which is called "shower of sulphur." They are dispersed by wind due to presence of wings.
44. (a) Red algae generally grow attached to rocky stones. Some deep water red algae are calcareous and build up hard stony thallii responsible for the production of lime stones and coral reefs.
45. (b) The peristome teeth are present at the mouth of capsule. The teeth may be solid cellular tissue or composed only of the thickened portions of the cell walls of adjacent cells. When the teeth of peristome are solid structures composed of bundles of dead cells, it is termed *nematodontous* peristome are solid structures composed of bundles of dead cells, it is termed *nematodyntous* peristome. It is found in *polytrichum*, *Pogonatum* and *Tetraphis*. If peristome composed of thin, membranous, transversely barred teeth, each tooth is made up of the thickened portions of the cell walls of adjacent cells. Such a peristome is called orthodontous.
46. (a) Phaeophyceae possesses chlorophyll a, c, carotenoids and xanthophylls. Members of phaeophyceae show variations in colour from olive green to different shades of brown depending upon the amount of xanthophyll pigments.

Chapter

4

Animal Kingdom

TYPE A : MULTIPLE CHOICE QUESTIONS

1. Pouched mammals are known as [1997]
(a) prototherians (b) metatherians
(c) eutherians (d) therians
2. Sponges capture food with the help of [1997]
(a) pinacocytes (b) choanocytes
(c) trophocytes (d) theocytes
3. Chloragogen cells of earthworm are similar to which organ of vertebrates ? [1997]
(a) Liver (b) Lung
(c) Kidney (d) Spleen
4. Haemocoel is found in [1997]
(a) *Hydra and Aurelia*
(b) *Taenia and Ascaris*
(c) *Cockroach and Pila*
(d) *Herdmania and Balanoglossus*
5. Aquatic reptiles are [1997]
(a) ureotelic
(b) ureotelic on land
(c) ammonotelic
(d) uricotelic in water
6. Larva of house-fly lacks [1997]
(a) eyes (b) wings
(c) spiracles (d) none of these
7. Single filament of *Nostoc* without mucilage sheath is called as [1998]
(a) colony (b) mycelium
(c) trichome (d) hyphae
8. Organisms, attached to substratum generally possess [1998]
(a) radial symmetry
(b) asymmetrical body
(c) single opening of digestive canal
(d) cilia to create water current
9. *Hydra* recognizes its prey by [1998]
(a) nematocyst
(b) special organ
(c) chemical stimulus
(d) mechanical stimulus
10. The long bones are hollow and connected by air passage. They are characteristic of [1998]
(a) aves (b) mammalia
(c) reptilia (d) sponges
11. Aristotle's lantern is found in [1998]
(a) Asteroidea (b) Echinoidea
(c) Holothuroidea (d) Ophiuroidea
12. Sympathetic nerves in mammals arise from [1998]
(a) sacral region
(b) cervical region
(c) 3rd, 7th, 9th, 10th cranial nerves
(d) thoracico-lumbar region
13. Which of the following statement is true regarding corals ? [1999]
(a) Form branch colonies.
(b) Solitary or colonial.
(c) Grow as massive bodies.
(d) All of the above
14. Water current in *Leucosolenia* is produced by [1999]
(a) pinacocytes (b) choanocytes
(c) archaeocytes (d) collencytes
15. Which is the example of platyhelminthes ? [1999]
(a) *Entamoeba* (b) *Plasmodium*
(c) *Wuchereria* (d) *Schistosoma*
16. Paired spermathecae occur in *Pheretima* in which of the following segments ? [1999]
(a) 4, 5, 6, 7 (b) 5, 6, 7, 8
(c) 6, 7, 8, 9 (d) 3, 4, 5, 6
17. Weberian ossicles are found in [1999]
(a) frog (b) snakes
(c) fishes (d) birds
18. The vertebrae in birds are mostly [1999]
(a) procoelous (b) heterocoelous
(c) amphicoelous (d) acoelous
19. Basket star belongs to class [1999]
(a) Ophiuroidea (b) Echinoidea
(c) Crinoidea (d) Asteroidea

20. The egg case in female cockroach is formed by secretion of [2000]
(a) collateral gland (b) mushroom gland
(c) conglobate gland (d) prothoracic gland
21. Power of regeneration in sponges is due to [2000]
(a) theocytes (b) archaeocytes
(c) amoebocytes (d) sclerocytes
22. The poisonous fluid present in nematocyst of *Hydra* is [2000]
(a) toxin (b) venom
(c) hematin (d) hypnotoxin
23. Life cycle of *Taenia* is [2000]
(a) monogenetic (b) digenetic
(c) polygenetic (d) hexogenetic
24. Pigment haemocyanin is found in [2000]
(a) chordata (b) annelida
(c) porifera (d) mollusca
25. *Antedon* belongs to which of the following class? [2000]
(a) Asteroidea (b) Ophiuroidea
(c) Crinoidea (d) Echinoidea
26. Scales in Chondrichthyes are [2000]
(a) placoid (b) ctenoid
(c) cycloid (d) all of these
27. Which of the following snake is not poisonous? [2000]
(a) *Naja-Naja* (b) *Python*
(c) *Hydrophis* (d) *Bungarus*
28. Birds are [2000]
(a) cold blooded (b) homeothermal
(c) poikilothermal (d) homeopoesis
29. Which of the following substances is at its lowest level in fish food? [2000]
(a) Actin (b) Myosin
(c) Cholesterol (d) Tissue fluid
30. How many ovaries are found in birds? [2000]
(a) One (b) Two
(c) Three (d) Many
31. Gemmule formation in sponges are useful in [2001]
(a) asexual reproduction
(b) sexual reproduction
(c) parthenogenesis
(d) parthenocarp
32. The places of first, second and third moulting of *Ascaris* larva are [2002]
(a) soil, alveoli, lung
(b) liver, soil, stomach
(c) soil, lung, liver
(d) soil, intestine, lung
33. What is left, when bath sponges dries up? [2002]
(a) Spicules (b) Hold fast
(c) Spongin fibres (d) Tentacles
34. *Hydra* receives impulses and stimuli through [2002]
(a) nerve cells (b) sensory cells
(c) neuron cell (d) nematocysts
35. Which of the following are uricotelic animals? [2002]
(a) Rohu, Frog
(b) Camel, Frog
(c) Lizard, Crow
(d) Eagles, Earthworm
36. In *Entamoeba histolytica*, the presence of chromatid bodies is characteristic of [2002]
(a) precystic stage
(b) trophozoite stage
(c) mature binucleate stage
(d) both (a) and (b)
37. Just as *Xenopsylla* is a *Yersenia pestis*, so is [2003]
(a) *Glossina palpalis* to *Wuchereria bancrofti*
(b) *Culex* to *Plasmodium falciparum*
(c) *Homo sapiens* to *Taenia solium*
(d) *Phlebotomus* to *Leishmania donovani*
38. Which of the following feature is common to leech, cockroach and scorpion? [2004]
(a) Nephridia (b) Ventral nerve cord
(c) Cephalization (d) Antennae
39. Which one of the following statements is correct with respect to salt water balance inside the body of living organisms? [2005]
(a) When water is not available camels do not produce urine but store urea in tissues.
(b) Salmon fish excretes lot of stored salt through gill membrane in fresh water.
(c) *Paramecium* discharges concentrated salt solution by contractile vacuoles.
(d) The body fluids of fresh water animals are generally hypotonic to surrounding water.
40. Which one of the following groups of structures/organs have similar function? [2005]
(a) Typhlosole in earthworm, intestinal villi in rat and contractile vacuole in *Amoeba*.
(b) Nephridia in earthworm, Malpighian tubules in cockroach and urinary tubules in rat.
(c) Antennae of cockroach, tympanum of frog and clitellum of earthworm.
(d) Incisors of rat, gizzard (proventriculus) of cockroach and tube feet of starfish.

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41. Which one of the following features is common in silverfish, scorpion, dragonfly and prawn?

[2005]

- (a) Three pairs of legs and segmented body.
- (b) Chitinous cuticle and two pairs of antennae.
- (c) Jointed appendages and chitinous exoskeleton.
- (d) Cephalothorax and tracheae.

42. Which one of the following animals is correctly matched with its one characteristic and the taxon?

[2006]

Animal	Characteristic	Taxon
(a) Millipede	Ventral nerve cord	Arachnida
(b) Duckbill	Oviparous	Mammalia
(c) platypus Silverfish	Pectoral & Pelvic fins	Chordata
(d) Sea anemone	Triploblastic	Cnidaria

43. All mammals without any exception are characterized by

[2006]

- (a) viviparity and biconcave red blood cells.
- (b) extra-abdominal testes and a four-chambered heart.
- (c) heterodont teeth and 12 pairs of cranial nerves.
- (d) a muscular diaphragm and milk producing glands.

44. Which of the following does not come under the class mammals?

[2007]

- (a) Flying fox
- (b) Hedgehog
- (c) Manatee
- (d) Lamprey

45. Which one feature is common to leech, cockroach and scorpion?

[2008]

- (a) Nephridia
- (b) Ventral nerve cord
- (c) Cephalization
- (d) Antennae

46. Based on cellular mechanisms there are two major types of regeneration found in the animals. Which one of the following is the correct example of the type mentioned?

[2008]

- (a) Morphallaxis - Regeneration of two transversely cut equal pieces of a *Hydra* into two small hydras
- (b) Epimorphosis - Replacement of old and dead erythrocytes by the new ones.

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(c) Morphallaxis - Healing up of a wound in the skin.

(d) Epimorphosis - Regeneration of crushed and filtered out pieces of a *Planaria* into as many new *Planarians*.

47. Which statement best explains why invertebrates regenerate lost tissue more readily than most vertebrates do?

[2009]

- (a) Invertebrates contain specialized cells that produce the hormones necessary for this process.
- (b) Invertebrate cells exhibit a higher degree of uncontrolled cell division than vertebrate cells do.
- (c) Invertebrate animals reproduce asexually, but vertebrate animals reproduce sexually.
- (d) Invertebrate animals have more undifferentiated cells than vertebrate animals have.

48. Which of the following is correctly matched?

[2009]

- (a) Human - Renal portal system
- (b) Earthworm - Closed circulatory system
- (c) Cockroach - Nephridia
- (d) None of the above

49. Which set of terms would most likely be used in a description of the nervous system of chordates?

[2009]

- (a) Brain, dorsal nerve cord, highly developed receptors
- (b) Brain, fused ganglia, ventral nerve cord
- (c) No brain, fused ganglia, tympana
- (d) No brain, nerve net, modified neurons

50. Which one of the following statements is **not** correct?

[2010]

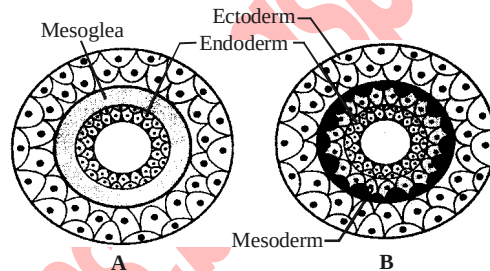
- (a) All echinoderms are viviparous.
- (b) Roundworm has no circulatory system.
- (c) In bony fishes, swim bladder is usually present.
- (d) In cartilaginous fishes, fertilization is internal.

51. Ticks and mites are actually

[2010]

- (a) arachnids
- (b) crustaceans
- (c) insects
- (d) myriapods

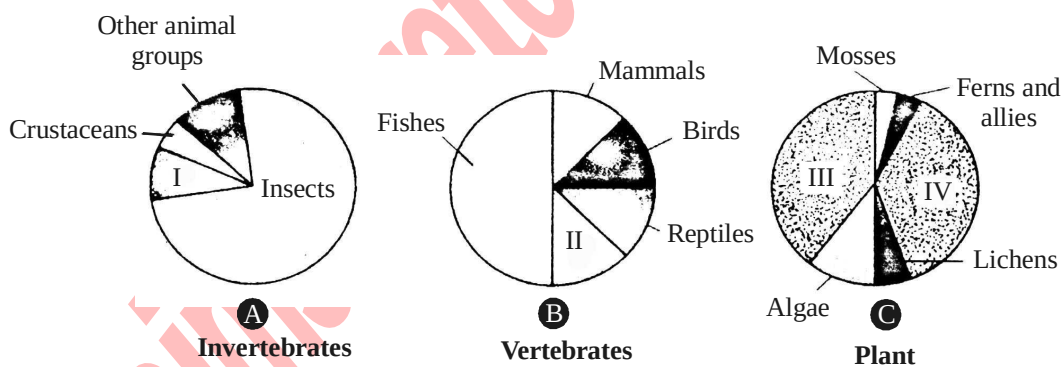
52. "Portuguese man of war" is [2012]
 (a) Soldier of world war I
 (b) Portuguese soldier
 (c) A sponge
 (d) A polymorphic, colonial, coelenterata
53. Which are exclusively viviparous ? [2012]
 (a) Bony fishes
 (b) Cartilaginous fishes
 (c) Sharks
 (d) Whales
54. Given are the four matches of phyla with their characteristic cells [2013]
 A. Coelenterata - Nematocytes
 B. Porifera - Choanocytes
 C. Ctenophora - Solenocytes
 D. Platyhelminthes - Nephrocytes
 Mark the option that has both correct matches
 (a) A and B (b) B and C
 (c) C and D (d) B and D
55. Cockroaches are brown or black bodied animals that are included in class _____ of phylum _____. [2014]
 (a) Reptilia; Annelida
 (b) Insecta; Arthropoda
 (c) Insecta; Annelida
 (d) Reptilia; Arthropoda
56. [2014]



The above diagram shows the germ layer. The animals having structures shown in the figures A and B are respectively called [2014]

- (a) Diploblastic, Triploblastic
 (b) Triploblastic, Diploblastic
 (c) Diploblastic, Diploblastic
 (d) Triploblastic, Triploblastic

57. Given below are pie diagrams A, B and C related to proportionate number of species of major taxa of invertebrates, vertebrates and plants respectively. Critically study and fill in the blanks I, II, III and IV



- (a) I- Molluscs, II-Amphibians, III-Fungi, IV-Angiosperms
 (b) I- Molluscs, II-Amphibians, III-Angiosperms, IV-Fungi
 (c) I- Hexapoda, II-Amphibians, III-Fungi, IV-Angiosperms
 (d) I- Turtles, II-Amphibians, III-Fungi, IV-Angiosperms

[2015]

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58. Which of the following statements are true/false?

- (i) In Torpedo, the electric organs are capable of generating strong electric shock to paralyze the prey.
- (ii) Bony fishes use pectoral, pelvic, dorsal anal and caudal fins in swimming.
- (iii) Amphibian skin is moist and has thick scales.
- (iv) Birds are poikilothermic animals.
- (v) The most unique mammalian characteristic is the presence of milk producing mammary glands by which the young ones are nourished.

[2015]

- (a) (i), (ii) and (iii) are true; (iv), (v) are false
- (b) (i), (ii) and (v) are true; (iii) and (iv) are false
- (c) (i), (iv) and (v) are true; (ii) and (iii) are false
- (d) (i), (ii) and (iv) are false; (iii) and (v) are true

59. Column-I contains organisms and column-II contains their excretory structures. Choose the correct match from the options given below.

**Column-I
(Organism)****Column-II
(Excretory
structures)**

A. Cockroach	I. Nephridia
B. Cat fish	II. Malpighian tubules
C. Earthworm	III. Kidneys
D. <i>Balanoglossus</i>	IV. Flame cells
E. Flatworm	V. Proboscis gland

[2017]

- (a) A – I; B – III; C – II; D – IV; E – V
- (b) A – III; B – I; C – II; D – V; E – IV
- (c) A – II; B – I; C – III; D – V; E – IV
- (d) A – II; B – III; C – I; D – V; E – IV

60. In which one of the following the genus name, its two characters and phylum are not correctly matched?

	Genus name	Two characters	Phylum
(a)	Pila	(i) Body segmented Mouth with radula	Mollusca
(b)	Asterias	(ii) Spiny skinned Water vascular system	Echinodermata
(c)	Sycon	(iii) Pore bearing Canal system	Porifera
(d)	Periplaneta	(iv) Jointed appendages Chitinous exoskeleton	Arthropoda

[2017]

TYPE B : ASSERTION REASON QUESTIONS

Directions for (Qs. 61-69) : These questions consist of two statements, each printed as Assertion and Reason. While answering these questions, you are required to choose any one of the following five responses.

- (a) If both Assertion and Reason are correct and the Reason is a correct explanation of the Assertion.
- (b) If both Assertion and Reason are correct but Reason is not a correct explanation of the Assertion.
- (c) If the Assertion is correct but Reason is incorrect.
- (d) If both the Assertion and Reason are incorrect.
- (e) If the Assertion is incorrect but the Reason is correct.

61. **Assertion :** Cold blooded animals do not have fat layer.**Reason :** Cold blooded animals use their fat for metabolic process during hibernation. [1997]62. **Assertion :** Birds have one ovary.**Reason :** This reduces the body weight for flight. [1999]63. **Assertion:** Lateral line system is found in fishes and aquatic larval amphibians.**Reason:** Lateral line system has receptor of sensory cells derived from ectoderm. [2002]64. **Assertion :** Bats and whales are classified as mammals.**Reason :** Bats and whales have four-chambered heart. [2003]65. **Assertion :** Holoblastic cleavage with almost equal sized blastomeres is a characteristic of placental animals.**Reason :** Eggs of most mammals, including humans, are of centrolecithal type. [2003]66. **Assertion :** All birds, except the ones like koel (cuckoo) build nests for retiring and taking rest during night time (day time for nocturnal).**Reason :** Koel lays its eggs in the nests of tailor bird. [2003]

67. **Assertion :** The honey bee queen copulates only once in her life time.

Reason : The honey bee queen can lay fertilized as well as unfertilized eggs. [2004]

68. **Assertion :** Torsion can be seen in ctenidium.

Reason : Ctenidium acts as the respiratory organ. [2007]

69. **Assertion :** Tapeworm, roundworm and pinworm are endoparasites of human intestine.

Reason : Improperly cooked food is the source of intestinal infections. [2004, 2008]

Directions for (Qs. 70-76) : Each of these questions contains an Assertion followed by Reason. Read them carefully and answer the question on the basis of following options. You have to select the one that best describes the two statements.

(a) If both Assertion and Reason are correct and Reason is the correct explanation of Assertion.

(b) If both Assertion and Reason are correct, but Reason is not the correct explanation of Assertion.

(c) If Assertion is correct but Reason is incorrect.

(d) If both the Assertion and Reason are incorrect.

70. **Assertion :** Sponges have body organization of "cellular level".

Reason : There is some physiological division of labour. [2009]

71. **Assertion :** Acraniata is a group of organisms which do not have distinct cranium.

Reason : It includes small marine forms without head. [1997, 2012]

72. **Assertion :** Sponges belong to Porifera.

Reason : Sponges have canal system. [1998, 2014]

73. **Assertion :** The duck-billed Platypus and the spiny ant-eater, both are egg-laying animals yet they are grouped under mammals.

Reason : Both of them have seven cervical vertebrae and 12 pairs of cranial nerves. [2005, 2015]

74. **Assertion :** Typhlosole increases the effective area of absorption in the intestine.

Reason : Typhlosole, present in the intestine, is the characteristic feature of cockroach. [2016]

75. **Assertion :** Ambulacral system plays a major role in locomotion of echinoderm.

Reason : Hydraulic pressure of fluid and contraction of muscle of tube feet make possible movement of echinoderm. [2010, 2017]

HINTS & SOLUTIONS

Type A : Multiple Choice Questions

1. (b) Pouched mammals are metatherians or marsupials because their female has a pouch or marsupium containing the teats for rearing the young ones. *e.g.*, Kangaroo and Wallaby.
2. (b) Sponges capture food with the help of flagellated cells/collar cells/choanocytes. These cells maintain a flow of water through the body and improves both respiratory and digestive functions, pulling in oxygen and nutrients and allowing a rapid expulsion of CO₂ and other waste products.
3. (a) Chloragogen cells of earthworm are similar to the liver of vertebrates because of the connection with storage and synthesis of glycogen and fat, deamination and urea formation.
4. (c) Presence of haemocoel (a blood filled body cavity) is a characteristic of arthropods and molluscs, *e.g.* cockroach and *Pila*.
5. (c) Aquatic reptiles are ammonotelic. Their main excretory product is nitrogenous ammonia. Availability of water makes them ammonotelic.
6. (b) Larva of housefly is legless, headless and wingless maggot.
7. (c) *Nostoc* is a colonial cyanobacterium. It contains a number of intertwined filaments on the periphery, a mucilage filled hollow interior and a dense mucilage covering on the outside.
8. (a) The organisms attached to substratum generally possess radial symmetry. Radial animals are usually sessile, freely floating or weakly swimming.
9. (c) *Hydra* recognizes its prey by a chemical stimulus.
10. (a) Presence of air passages in the bones (pneumatic bones) is a characteristic of birds.
11. (b) Aristotle's lantern is a chewing toothed apparatus in class echinoidea of phylum echinodermata.
12. (d) Sympathetic nerves in mammals arise from thoracico-lumbar region. Sympathetic nervous system is represented by a chain of 21 sympathetic ganglion on either side of spinal cord. It receives preganglionic sympathetic fibres from the spinal cord which make these exit along with thoracic and lumbar region.
13. (b) Corals belong to class anthozoa which exist as solitary or colonial. Corals is the rock like external skeletons. Coral animals secrete external skeletons of calcium carbonate.
14. (b) Water current in *Leucosolenia* is produced by flagellated choanocytes.
15. (d) Platyhelminthes are flat worms, *e.g.* blood fluke, *Schistosoma*.
16. (c) Four pairs of small spermathecae are present on the intersegmental groove of 5 & 6, 6 & 7, 7 & 8 and 8 & 9 segments. They receive sperms from another worm during copulation.
17. (c) Weberian ossicles are the chain of 4 small bones that connect air bladder and internal ear of teleost fishes. They serve to enhance hearing by conducting pressure changes produced by externally originating sound waves from the swim bladder to the ear.
18. (b) The vertebrae in birds are of heterocoelous type.
19. (a) Basket star (*Astropecten*) belongs to class ophiuroidea of phylum echinoderm.
20. (a) A pair of unequal, branched collateral glands (opening separately into genital chamber) form an egg case ootheca.
21. (b) In sponges, archaeocytes are totipotent cells which can transform into sclerocytes, spongocytes or collencytes. They also have a role in nutrient transport and sexual reproduction.
22. (d) Penetrant, the largest nematocysts in *Hydra* produce hypnotoxin.

23. (b) Life cycle of *Taenia* is digenetic. Their primary host is pig and secondary is man.
24. (d) Copper containing pigment, hemocyanin is found in molluscs.
25. (c) *Antedon* (sea lily/feather star) is found in the class crinoidea of phylum echinodermata.
26. (a) Chondrichthyes have placoid scales and teleosts have cycloid and ctenoid type of scales.
27. (b) *Python* is the largest non-poisonous snake.
28. (b) Birds are warm blooded/homeothermal animals. Their body temperature is independent of that of their external environment.
29. (c) Fish meal has good nutritive value because it contains easily digestive proteins (55 – 77%), minerals (10 – 20%) and moisture (6 – 12%).
30. (a) Birds have only one ovary (left) which reduces their body weight. It is an adaptation for flight.
31. (a) Gemmule is a type of internal bud formed in sponges to pass the unfavourable season. It is helpful in asexual reproduction.
32. (a) The rhabditoid larva moults within egg shell in soil to form second stage rhabditoid (capable of infection). Egg hatches in the intestine, bores through epithelium of intestine to enter the circulatory system and then it reaches alveoli where it moults for the second time. After its 3rd moult, it leaves the lungs through trachea.
33. (c) Spongin is an organic horny elastic substance. They are fibres insoluble, chemically inert and resistant to protein digesting enzymes.
34. (b) *Hydra* has diffused type of nervous system. It receives stimulus through sensory cells scattered in epitheliomuscular layer.
35. (c) Animals excreting uric acid are called uricotelic. It is least toxic and causes least loss of body water, e.g. land reptiles, birds etc.
36. (a) Chromatid bodies are present in the precystic stage in *Entamoeba histolytica*. These bodies disappear as the cyst mature.
37. (d) *Phlebotomus* (sand fly) transmits *Leishmania donovani* which causes dum dum fever/kala azar.
38. (b) In leech, cockroach and scorpion, double ventral nerve cord is present.
39. (a) When water is not available, the camels produce dry faeces and concentrated urine. One of the best sources of metabolic water in camels is oxidation of food in the hump.
40. (b) Nephridia in earthworm, malpighian tubules in cockroach and urinary tubules in the rat are excretory in function.
41. (c) Silverfish, scorpion, dragonfly and prawn are arthropods. They are characterised by jointed appendages and chitinous exoskeleton.
42. (b) Millipede is myriapod, silver fish is insecta and sea anemone is diploblastic.
- Duck bill platypus is a small semiaquatic oviparous mammal.
- Ornithorhynchus anatinus*, the Duckbill platypus, is a unique mammal native to Queensland, New South Wales, Victoria, South Australia, and Tasmania. This animal is about the size of a house cat and is covered by thick waterproof hair. It has a beak like a duck, webbed forelimbs for swimming, clawed hind feet for aid in burrowing, a common opening for the reproductive, excretory and digestive systems, and a broad, flat tail. In addition, the males have a single spur on each hind ankle that contains venom, and the females lay eggs.
43. (d) Mammals are characterised by muscular diaphragm and milk producing glands.
44. (d) A lamprey (sometimes also called as lamprey eel) is a jawless fish that belongs to the class cyclostomata. Lampreys possess toothed funnel-like sucking mouth, having scaleless slimy skin with seven pairs of circular gill slits on each side. They are well known as those species which bore into the flesh of other fish to suck their blood.

45. (a) Nephridia are invertebrate organs which function similarly to kidneys. They remove metabolic wastes from an animal's body. They are of two basic types, metanephridia and protonephridia. A metanephridium is a type of excretory gland or nephridium found in annelids, arthropods and molluscs. A protonephridium is a network of dead-end tubules lacking internal openings. The ends are called *flame cells* or *solenocytes*; they functions in osmoregulation.
46. (a) Morphallaxis refers to the type of regeneration in which lost body parts are replaced by the remodeling of the remaining tissue. In this type of regeneration, little or no cellular proliferation takes place during the regeneration process. A classic example of an organism that regenerates using this mechanism is the *Hydra*. When a *Hydra* is cut into two pieces, two *Hydra* as will be regenerated, both smaller than the parental *Hydra*. Once regeneration is completed, the two *Hydra* can continue to grow and reach the size of their original parent. Growth requires cellular proliferation but during the regenerative process very little cellular proliferation takes place.
47. (d) Invertebrates, animals without a backbone such as an earthworm, are simpler than vertebrates such as a human. Therefore, their cells are not as complex and they may be able to regenerate or grow lost body parts easier than a more complex animal.
48. (b) Earthworm has closed circulatory system. The blood circulates in definite walled blood vessels. Renal portal system is characteristic of reptiles. In reptiles, renal portal system brings blood from internal organs to the kidneys because their digestive tract and urinary tract only have cloaca to eliminate wastes. Humans have hepatic portal system that brings all the venous flow from digestive system into the liver. In cockroach, the excretory organs are malpighian tubules not nephridia.
49. (a) Chordates are a group of animals such as fish, frogs, snakes, birds, dogs, monkeys and humans. We all have central nervous systems made up of a brain and a dorsal (back) nerve cord. We all have highly developed receptors to detect changes in the environment for us to respond to. Fused ganglia is a primitive brain found in earthworms, tympana are primitive ears found in grasshoppers, and nerve nets are branched nerves without direction found in the *Hydra*.
50. (a) The animals of phylum echinodermata are oviparous. They have the ability of regeneration.
51. (a) Scorpion, spider, tick and mites comes under class arachnida of phylum arthropoda.
52. (d) Portuguese man of war is a polymorphic, colonial coelenterate *Physalia physalis*. It is named so due to its appearance which resembles with portuguese vessels sailing in sea in 15th and 16th centuries
53. (d) Whales are exclusively viviparous. In viviparous animals (majority of mammals including human beings), the zygote develops into a young one inside the body of the female organism. After attaining a certain stage of growth, the young ones are delivered out of the body of the female organism.
54. (a) 55. (b)
56. (a) Diploblastic animals have two germinal layers, outer ectoderm and inner endoderm, e.g., Porifera and Coelenterate. Triploblastic animals have three germinal layers – outer ectoderm, middle mesoderm and inner endoderm, e.g., Platyhelminthes, Aschelminthes, Annelida, Arthropoda, Molluscs, Echinodermata and Chordata.
57. (a)
58. (c) The amphibian skin is moist.
59. (d)
60. (a) Molluscs are soft bodied animals. Their body is unsegmented with a distinct head, muscular foot and visceral hump. In *Pila*, the buccal cavity contains a rasping organ, the radula with transverse rows of teeth.

Type B : Assertion Reason Questions

61. (a) Cold blooded organisms utilize their stored food at the time of hibernation and aestivation.
62. (a) Birds have only left ovary which is an adaptation to reduce the weight for flight.
63. (b) Lateral line system is made up of sensory cells of ectodermal origin. It is meant for balancing the body while swimming. So, is found in fishes and larval forms of amphibians.
64. (b) Bats and whales are classified as mammals. They have milk secreting mammary glands. Whales and bats are mammals. Whales are warm blooded, breathe air through lungs and give birth to live young that are suckled on milk secreted from the mother's mammary glands. Bats have hair, give birth to live young and feed these young on milk produced in mammary glands. They are the only true flying mammals and are so unique that they have been placed in an order of their own chiroptera. 4-chambered hearts in mammals and birds keep fully oxygenated.
65. (c) Cleavage in placental mammals is holoblastic because of microlecithal eggs.
66. (c) Koel (*Eudynamis*) lays eggs in crow's nest for incubation and rearing.
67. (a) Honey bee queen copulates only once in her life span (nuptial flight) and stores all the sperms in her seminal receptacles. It depends on her whether she releases sperms while laying eggs or not, so there are both fertilized and unfertilized eggs.
68. (b) Ctenidium is a gill situated on the right side of the branchial chamber. It helps in respiration by beating cilia. During development, ctenidium shifts from left side to right side which is called "torsion". It is characteristic feature of gastropods.
69. (b) Tapeworm, roundworm & pinworm are all endoparasites. The main cause of the intestinal infection is improperly cooked food. However, tapeworm infection occurs by eating improperly cooked food, roundworm is transmitted by contaminated food & water and pinworm or ringworm is transmitted through food or improper sanitary condition.
70. (b) Sponges are multicellular but they have cellular level of body organization i.e., true tissue, movable parts, or appendages are not formed. Although, there is some physiological division of labour, accompanied with structural differentiation amongst body cells. But here, similar cells are arranged neither in permanent layer nor masses to form tissues.
71. (b) Cephalochordates and urochordates are acraniates. These are marine animals without cranium, jaws, vertebral column and paired appendages. Notochord is present and they are less developed than craniates.
72. (b) Sponges belong to Porifera and they have characteristic canal system.
73. (b) Both duck billed platypus and spiny ant eaters are mammals because of their constant body temperature and presence of diaphragm.
74. (d) Typhlosole is the characteristic feature of earthworm. It can be defined as an extra flap of tissue or an infolding along the inner wall of intestine. The typhlosole in earthworm increases the surface area of the intestine for efficient secretion and absorption during digestion.
75. (a) The water vascular system is a unique organ system that functions in locomotion, feeding, respiration and excretion. Ambulacral canal is connected to outside through external tube feet. Hydraulic pressure of fluid and contraction of muscle of tube feet make possible movement of Echinoderm.

Chapter

5

Morphology of Flowering Plants

TYPE A : MULTIPLE CHOICE QUESTIONS

1. Fern character of *Cycas* is [1997]
 - (a) coralloid root
 - (b) tap root
 - (c) parallel venation
 - (d) circinate venation
2. The desert plants in order to tolerate water stress show [1997]
 - (a) sunken stomata
 - (b) reduced leaves
 - (c) well developed root system
 - (d) all of these
3. Perisperm is [1997]
 - (a) remnant of endosperm
 - (b) persistent nucellus
 - (c) remnant of embryo
 - (d) part of endosperm
4. In moss capsule, the number of peristome whorls are [1998]
 - (a) 1
 - (b) 2
 - (c) 3
 - (d) 4
5. A mature ligule, having a prominent basal portion, is called [1998]
 - (a) glossopodium
 - (b) rhizophore
 - (c) trichome
 - (d) None of these
6. Inflorescence of *Ficus* is [1999]
 - (a) spike
 - (b) hypanthodium
 - (c) raceme
 - (d) verticillaster
7. The edible part of cauliflower is [2000]
 - (a) inflorescence
 - (b) leaf
 - (c) flower
 - (d) stem
8. Most reduced form of stem is found in [2000]
 - (a) bulb
 - (b) rhizome
 - (c) tree
 - (d) stem
9. In *Opuntia*, spines are modification of [2000]
 - (a) stem
 - (b) root
 - (c) leaf
 - (d) flower
10. Clove is [2001]
 - (a) flower bud
 - (b) axillary bud
 - (c) thalamus
 - (d) ovule
11. Pollinia are found in [2001]
 - (a) wheat
 - (b) madar
 - (c) mango
 - (d) banana
12. Monocarpic plants flower [2001]
 - (a) once
 - (b) twice
 - (c) many times
 - (d) never
13. Nodules with nitrogen fixing bacteria are found in [2001]
 - (a) cotton
 - (b) gram
 - (c) mustard
 - (d) wheat
14. In which family (9) + 1 androecium condition is found ? [2001]
 - (a) Malvaceae
 - (b) Papilionaceae
 - (c) Solanaceae
 - (d) Poaceae
15. Which of following type of anther is found in Malvaceae? [2002]
 - (a) Monothealous
 - (b) Dithealous
 - (c) Polythealous
 - (d) Without theca
16. Potato and sweet potato [2004]
 - (a) have edible parts which are homologous organs.
 - (b) have edible parts which are analogous organs.
 - (c) have been introduced in India from the same place.
 - (d) are two species of the same genus.
17. The sugarcane plant has [2004]
 - (a) dumb-bell shaped guard cells
 - (b) pentamerous flowers
 - (c) reticulate venation
 - (d) capsular fruits

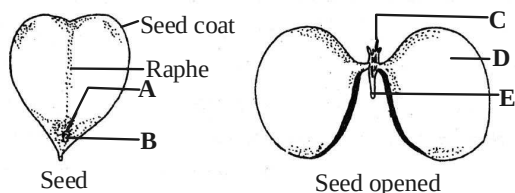
18. The family containing mustard and its main characters are [2005]
(a) Brassicaceae - Tetramerous flowers, six stamens, bicarpellary gynoecium, silique type fruit
(b) Brassicaceae - Pentamerous flowers, many stamens, pentacarpellary gynoecium, capsule type fruit
(c) Solanaceae - Pentamerous flowers, five stamens, bicarpellary gynoecium, berry type fruit
(d) Poaceae - Trimerous flowers, three stamens, monocarpellary gynoecium, caryopsis type of fruit
19. Velamen present in orchids help in [2007]
(a) absorbing water from support
(b) respiration
(c) absorption of moisture from air
(d) synthesizing food
20. Composite fruit develops from [2007]
(a) single ovary (b) inflorescence
(c) apocarpous ovary (d) pericarp
21. If the anthers are fused together forming a tubular structure while the filaments remain free, the condition is found in which one of the following family? [2009]
(a) Malvaceae (b) Cucurbitaceae
(c) Solanaceae (d) Asteraceae
22. Floral diagram fails to indicate [2009]
(a) epiphyly and epipetaly
(b) aestivation and placentation
(c) position of ovary on the thalamus
(d) cohesion of carpels and stamens
23. Aggregate fruit develops from [2009]
(a) syncarpous ovary
(b) multicarpellary, syncarpous ovary
(c) unilocular ovary
(d) multicarpellary, apocarpous ovary
24. The presence of cilia, an oral groove, and food vacuoles, and the absence of chloroplasts in a unicellular organism indicate that the organism carries on [2009]
(a) sexual reproduction
(b) autotrophic nutrition
(c) extracellular digestion
(d) heterotrophic nutrition
25. Of the following, which instrument is most commonly used to observe the external features of a grasshopper's abdomen? [2009]
(a) Ultracentrifuge
(b) Microdissection instrument
(c) Dissecting microscope
(d) Electron microscope
26. In a bisexual flower, if androecium and gynoecium mature at different times, the phenomenon is known as a [2010]
(a) dichogamy (b) herkogamy
(c) heterogamy (d) monogamy
27. Which of following type of anther is found in Malvaceae? [2011]
(a) Monothealous (b) Dithealous
(c) Polythealous (d) Without theous
28. Parachute type dispersal occurs in [2011]
(a) tomato (b) mustard
(c) pea (d) cotton
29. Prickles of rose are [2012]
(a) Modified leaves
(b) Modified stipules
(c) Exogenous in origin
(d) Endogenous in origin
30. Which of the following are not characteristic features of fabaceae? [2013]
(a) Tap root system, compound leaves and raceme inflorescence.
(b) Flowers actinomorphic, twisted aestivation and gamopetalous.
(c) Stamens 10, introrse, basifixed, ditheous.
(d) Monocarpellary, ovary superior and bent stigma.
31. Which one of the following is correctly matched? [2014]
(a) Onion – Bulb
(b) Ginger – Sucker
(c) *Chlamydomonas* – Conidia
(d) Yeast – Zoospores
32. Read the following statements.
(i) Gynoecium is situated in the centre and other parts of the flower are located on the rim of the thalamus almost at the same level.

B-30

- (ii) Ovary is half-inferior.
 (iii) Examples are plum, rose and peach.
 Which condition of flowers is being described by the above statements ? [2014]

- (a) Hypogyny (b) Perigyny
 (c) Epigyny (d) None of these

33. Which one of the option is correct?



[2015]

- (a) A - Hilum, B - Micropyle, C - Radicle, D - Cotyledon, E - Plumule
 (b) A - Hilum, B - Micropyle, C - Plumule, D - Cotyledon, E - Radicle
 (c) A - Micropyle, B - Hilum, C - Plumule, D - Cotyledon, E - Radicle
 (d) A - Hilum, B - Micropyle, C - Plumule, D - Radicle, E - Cotyledon

34. Seeds are adaptively important because [2015]

- they maintain dormancy
 - they protect young plants during vulnerable stages
 - they store food for young plants, and facilitate dispersal
- (a) 1 and 3 (b) 2 and 3
 (c) 1 and 2 (d) All of these

35. Match the following-

List-I

A. Coleorhiza

List-II

- I. Development of sporophyte directly from gametophyte without intervention of gametes
 B. Apogamy II. Development of gametophyte directly from sporophyte without the involvement of reduction division.

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- C. Indusium III. An unbranched columnar stem with a crown of leaves.
 D. Caudex IV. Protective covering of radicle
 V. Protective structure of a sorus. [2016]

- (a) A - V; B - II; C - IV; D - I
 (b) A - IV; B - I; C - V; D - III
 (c) A - III; B - V; C - II; D - IV
 (d) A - II; B - III; C - I; D - V

36. Which of the following is a modified stem for the protection of plants from browsing animals?

- (a) Tendrils (b) Thorns
 (c) Rhizome (d) Tuber

[2017]

37. Leaves of dicotyledonous plants possess _____ venation, while _____ venation is the characteristic of most monocotyledons. [2017]

- (a) reticulate and parallel
 (b) parallel and reticulate
 (c) reticulate and perpendicular
 (d) obliquely and parallel

TYPE B : ASSERTION REASON QUESTIONS

Directions for (Qs. 38-40) : These questions consist of two statements, each printed as Assertion and Reason. While answering these questions, you are required to choose any one of the following five responses.

- (a) If both Assertion and Reason are correct and the Reason is a correct explanation of the Assertion.
 (b) If both Assertion and Reason are correct but Reason is not a correct explanation of the Assertion.
 (c) If the Assertion is correct but Reason is incorrect.
 (d) If both the Assertion and Reason are incorrect.
 (e) If the Assertion is incorrect but the Reason is correct.

38. Assertion : In hemianatropous ovule, the funicle lies parallel to body of ovule.

Reason : Here, body of ovule is rotated by 90° .
[1999]

39. Assertion : Many plants are propagated vegetatively even though they bear seeds.

Reason : Potatoes multiply by tubers, apple by cutting etc.
[2001]

40. Assertion : Ginger has a prostrate growing rhizome.

Reason : Shoot growth is not effected by gravity.
[2004]

Directions for (Qs. 41-43) : Each of these questions contains an Assertion followed by Reason. Read them carefully and answer the question on the basis of following options. You have to select the one that best describes the two statements.

- (a) If both Assertion and Reason are correct and Reason is the correct explanation of Assertion.
(b) If both Assertion and Reason are correct, but Reason is not the correct explanation of Assertion.

- (c) If Assertion is correct but Reason is incorrect.
(d) If both the Assertion and Reason are incorrect.

41. Assertion : In fabaceae family monocarpellary, unilocular ovary is present. [2010]

Reason : In fabaceae, placentation is parietal.

42. Assertion : Apical meristem of root is subterminal.

Reason : At the terminal end of root, root cap is present. [2014]

43. Assertion : A simple leaf has undivided lamina.

Reason : Leaves showing pinnate and palmate venation have various types of incisions.
[2016]

HINTS & SOLUTIONS

Type A : Multiple Choice Questions

1. (d) In circinate venation, leaves are coiled when immature and gradually rolled with maturity. This coiling protects the growing point.
2. (d) Desert plants have well developed root system so that they can absorb water from the deeper layers of soil. They have sunken stomata and reduced leaves which reduce the rate of water loss through transpiration.
3. (b) The nucellus is generally used up during the development of embryo but in some cases it remains outside the endosperm in the form of a thin layer, called perisperm.
4. (b) In moss, peristome consists of 32 acellular teeth arranged in 2 whorls, outer hygroscopic and inner hygroscopic.
5. (a) Glossopodium is a mature ligule. It is generally present in grasses. The ligule is an outgrowth between leaf base and lamina. Leaves with ligule are called ligulates.
6. (b) *Ficus* has hypanthodium type of inflorescence i.e. cup shaped, fleshy receptacle bearing flowers on the inner wall of the cavity.
7. (a) Cauliflower is a crossbreed between 2 varieties of cabbage. It is evident that the edible part is the inflorescence due to the presence of small florets.
8. (a) Bulb has the most reduced form of stem since the stem is discoid in nature – a flattened disc. e.g. *Allium cepa*, *Allium sativum*.
9. (c) In *Opuntia*, the entire leaf is modified into the spine, to reduce water loss due to transpiration as *Opuntia* is a xerophyte.
10. (a) The structure of clove itself resembles the bud where we are, in fact, able to see the calyx also. Clove that is used as a condiment and spice has more of the medicinal property at the bud stage.
11. (b) Pollinia is generally seen in fused anthers. Each anther has pollinia. Madar shows the characteristic feature of pollinia.
12. (a) Monocarpic flowers have a single carpel that can mature only once in their life time. Hence, they flower only once.
13. (b) Grams are leguminous plants. Nitrogen fixing bacteria is seen in leguminous plants. They convert atmospheric N_2 to nitrate that can easily be absorbed by plants.
14. (b) In papilionaceae- the androceium is seen in diadelphous condition. 10 stamens are seen in two bundles- 9 + 1. 9 together form one bundle whereas the single stamen forms another bundle.
15. (a) The filament of stamen bears one celled anther.
16. (b) Potato is the modified underground stem whereas sweet-potato is the modified root for storage of food. These are analogous organs which have different origin but serve the same functions.
17. (a) Sugarcane being a monocot plant is characterized by the presence of dumb-bell shaped guard cells. In dicots, guard cells are kidney shaped.



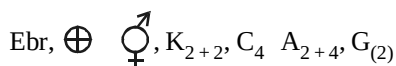
Stomata
Dicot



Stomata
Monocot

18. (a) Brassicaceae (cruciferae)
Other members are : Raddish, cabbage, cauliflower.

Floral formula :



19. (c) Orchids are the epiphytes that possess aerial roots. These roots contain a spongy tissue called velamen whose main function is to absorb moisture from the air.
20. (b) Composite fruits develop from the complete inflorescence and are also known as multiple fruit. These are of 2 types - sorosis and syconus. Sorosis develops from spike, spadix or catkin inflorescence, e.g. *Ananas*, *Arto carpus*. Syconus develops from hypanthodium inflorescence, e.g. *Ficus*.
21. (d) This condition is called syngenesious. It is found in members of family asteraceae (or compositae), e.g., disc florets of sunflower.
22. (c) Floral diagram illustrates the whorls and number of parts in each of the sets of organs comprising a flower. It shows the position of floral parts in relation to mother axis but although position of ovary on the thalamus is not shown by it.
23. (d) A multicarpellary ovary may be syncarpous (when carpels are fused) or apocarpous (when the carpels are free). A syncarpous ovary gives rise to a simple fruit while in an apocarpous ovary, each carpel changes into a fruitlet. The collection or aggregate of these fruitlets is known as etaerio.
24. (d) Cilia are hair-like bristles on a *Paramecium* used in locomotion and to find food. An oral groove is a mouth for a *Paramecium*, and food vacuoles store food in the cell body of the *Paramecium*. All of these are cell organelles used to ingest, digest, and egest preformed food, which is heterotrophic nutrition. An autotroph can make its own food using chloroplasts.
25. (c) The dissecting microscope allows to view 3D images up to 50x magnification. It is commonly used in dissections. The ultracentrifuge spins liquids and separates the contents by their density, micro-dissection instruments are used to manipulate microscopic organelles (such as transferring nuclei), and electron microscopes can magnify an image up to 250,000x and are used to see microscopic details.
26. (a) In a bisexual flower, if androecium and gynoecium mature at different times, the phenomenon is known as dichogamy.
27. (a) The filament of stamen bears one celled anther.
28. (b) Dispersal is a universal biological need. For non-aquatic, terrestrial plants, the wind is an obvious supplier of energy for movement, and many plant adaptations exist that clearly take advantage of this fact. This type of seed dispersal is not efficient, but very effective. Appendages of some fruits & seeds act as parachute like seeds of cotton possess hair that help in dispersal of these seeds. Another well-known example is the dandelion.
29. (c) Prickles of rose develop only from cortex and epidermis and found at the nodes or internodes. It helps in climbing. It is exogenous in origin.
30. (b)
31. (a) Onion - Bulb - Underground stem, Ginger - Rhizome, *Chlamydomonas* - Zoospore, Yeast - Ascospores
32. (b)
33. (b)
34. (d) Seeds perform all the given functions.
35. (b)
36. (b) Thorn is a stiff, sharp-pointed woody projection on the stem or other part of a plant. Thorns are found in many plants such as *Citrus*, *Bougainvillea*. They protect plants from grazing animals.
37. (a) Leaves of dicotyledonous plants possess reticulate venation while parallel venation is the characteristics of most monocotyledonous. In reticulate venation, the main veins of leaf form numerous irregular branches and as a result a net like arrangements is formed. Reticulate

venation is the most common vein formation in leaves. It can be found in the leaves of maple trees, oak trees and rose bushes. In parallel venation, veins are arranged parallel to each other.

Type B : Assertion Reason Questions

38. (e) In hemianatropus ovule, the funicle lies at right angles to the body of the ovule. The body of the ovule is rotated by 90°.
39. (c) Plants do propagate more by vegetative means since they multiply faster vegetatively.
40. (b) Ginger is an example of rhizome (*e.g.* prostrate stem creeping horizontally under soil surface). There is no effect of gravity. Rhizome of ginger contains nodes, internodes and scaly leaves. Buds are
- emerges from axils of scaly leaves. Response to light by plants is called phototropism. In this sense, shoot shows positive phototropism and root shows negative phototropism.
41. (c) In fabaceae, ovary is present. Placentation is marginal with many ovules.
42. (a)
43. (b) A leaf having a single or undivided lamina is called simple leaf, the lamina can have different types of incisions, which may reach upto half, more than half or near the base or midrib. Depending upon the pinnate or palmate venation, the incisions are known as pinnatifid, palmatifid, pinnatipartite, palmatipartite, pinnatisect and palmatisect, etc.

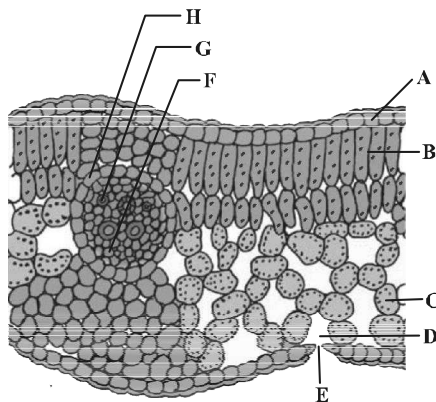
TYPE A : MULTIPLE CHOICE QUESTIONS

1. *Cycas* stem shows [1997]
 - (a) porous wood (b) manoxylic wood
 - (c) pycnoxylic wood (d) ring porous wood
2. Aerenchyma is found in [1997]
 - (a) parenchyma (b) xylem
 - (c) phloem (d) sclerenchyma
3. Which of the following tissue is absent in vascular bundles of monocot stem ? [1997]
 - (a) Xylem (b) Phloem
 - (c) Cambium (d) All of these
4. Cork cambium is a [1999]
 - (a) lateral meristem
 - (b) apical meristem
 - (c) intercalary meristem
 - (d) primitive meristem
5. Endodermis is a part of [1999]
 - (a) cortex (b) pericycle
 - (c) medulla (d) epidermis
6. Lateral root in higher plants arise from [1999]
 - (a) cortex (b) pericycle
 - (c) epidermis (d) endodermis
7. Cambium of root is an example of [2000]
 - (a) apical meristem
 - (b) intercalary meristem
 - (c) primary meristem
 - (d) secondary meristem
8. Which of the following is enucleate at maturity? [2000]
 - (a) Companion cell (b) Meristematic cell
 - (c) Parenchyma (d) Sieve tube cell
9. Porous wood contains [2001]
 - (a) vessels (b) tracheids
 - (c) fibres (d) parenchyma
10. Passage cells are found in [2002]
 - (a) endodermis (b) pericycle
 - (c) cortex (d) epiblema
11. Fascicular cambium is the cambium of vascular bundle of [2002]
 - (a) monocot stem (b) dicot stem
 - (c) monocot leaf (d) dicot leaf
12. Mesophyll is usually differentiated in [2002]
 - (a) monocot leaf (b) isobilateral leaf
 - (c) dorsiventral leaf (d) both 'a' and 'b'
13. In a dicotyledonous stem, the sequence of tissues from the outside to the inside is [2003]
 - (a) phellem-pericycle-endodermis-phloem
 - (b) phellem-phloem-endodermis-pericycle
 - (c) phellem-endodermis-pericycle-phloem
 - (d) pericycle-phellem-endodermis-phloem
14. The quiescent centre in root meristem serves as a
 - (a) site for storage of food which is utilized during maturation. [2003]
 - (b) reservoir of growth hormones.
 - (c) reserve for replenishment of damaged cells of the meristem.
 - (d) region for absorption of water.
15. In a plant organ which is covered by periderm and in which the stomata are absent, some gaseous exchange still takes place through [2004]
 - (a) aerenchyma (b) trichomes
 - (c) pneumatophores (d) lenticels
16. Companion cells in plants are associated with [2004]
 - (a) vessels (b) sperms
 - (c) sieve elements (d) guard cells

B-36

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17. Cork cambium results in the formation of cork which becomes impermeable to water due to the accumulation of [2004]
 (a) resins (b) suberin
 (c) lignins (d) tannins
18. Which one of the following statements pertaining to plant structure is correct? [2005]
 (a) Cork lacks stomata but lenticels carry out transpiration.
 (b) Passage cells help in transfer of food from cortex to phloem.
 (c) Sieve tube elements possess cytoplasm but no nuclei.
 (d) The shoot apical meristem has a quiescent centre.
19. In which one of the following would you expect to find glyoxysomes? [2005]
 (a) Endosperm of wheat
 (b) Endosperm of castor
 (c) Palisade cells in leaf
 (d) Root hairs
20. Grafting is successful in dicots but not in monocots because the dicots have [2006]
 (a) vascular bundles arranged in a ring
 (b) cambium for secondary growth
 (c) vessels with elements arranged end to end
 (d) cork cambium
21. In the sieve elements, which one of the following is the most likely function of P-proteins? [2006]
 (a) Deposition of callose on sieve plates.
 (b) Providing energy for active translocation.
 (c) Autolytic enzymes.
 (d) Sealing mechanism on wounding.
22. Two cross-sections of stem and root appear simple, when viewed by naked eye. But under microscope, they can be differentiated by [2009]
 (a) exarch condition of root and stem
 (b) endarch condition of stem and root
 (c) endarch condition of root and exarch condition of stem
 (d) endarch condition of stem and exarch condition of root
23. If a stem is girdled [2012]
 (a) Root dies first
 (b) Shoot dies first
 (c) Both die together
 (d) None of the above would die
24. Which of the following statement(s) is/are true? [2013]
 (A) Uneven thickening of cell wall is characteristic of sclerenchyma.
 (B) Periblem forms cortex of the stem and the root.
 (C) Tracheids are the chief water transporting elements in gymnosperms.
 (D) Companion cell is devoid of nucleus at maturity.
 (E) The Commercial cork is obtained from *Quercus suber*.
 (a) A and D only (b) B and E only
 (c) C and D only (d) B, C and E only
25. Sclerenchyma usually _____ and _____ protoplasts. [2014]
 (a) live, without (b) dead, with
 (c) live, with (d) dead, without
26. T.S. of dicot leaf passing through the midrib is given below, certain parts have been indicated by alphabets. Choose the correct option.



- [2015]
 (a) A – Epidermis, B – Spongy parenchyma, C – Palisade parenchyma, D – Stomata, E – Guard cells, F – Phloem, G – Metaxylem, H – Protoxylem

- (b) A – Epidermis, B – Palisade parenchyma, C – Spongy parenchyma, D – Sub-stomatal cavity, E – Stoma, F – Phloem, G – Metaxylem, H – Bundle sheath
- (c) A – Epidermis, B – Palisade parenchyma, C – Spongy parenchyma, D – Stomata, E – Guard cells, F – Epidermis, G – Xylem, H – Phloem
- (d) A – Epidermis, C – Palisade parenchyma, C – Spongy parenchyma, D – Stomata, E – Guard cells, F – Phloem, G – Metaxylem, H – Protoxylem
27. Contractile tissues have the following features
- Mesodermal in origin
 - They contain stretch receptors.
 - Rhythmic contractions are seen in them
 - They do not fatigue during the life of the animal
- Which of the above are characteristics of sphincters? [2015]
- All the four
 - Only (i), (ii) and (iii)
 - Only (i), (ii) and (iv)
 - Only (i), (iii) and (iv)
28. Meristematic tissue responsible for increase in girth of tree trunk is [2016]
- Apical meristem
 - Intercalary meristem
 - Lateral meristem
 - Phellogen
29. In stems, the protoxylem lies towards the _____ and the metaxylem lies towards the _____ of the organ.
- centre; periphery
 - periphery; centre
 - periphery; periphery
 - centre; centre
- [2017]
- (a) If both Assertion and Reason are correct and the Reason is a correct explanation of the Assertion.
- (b) If both Assertion and Reason are correct but Reason is not a correct explanation of the Assertion.
- (c) If the Assertion is correct but Reason is incorrect.
- (d) If both the Assertion and Reason are incorrect.
- (e) If the Assertion is incorrect but the Reason is correct.
30. **Assertion :** Thick cuticle is mostly present in disease resistant plants.
Reason : Disease causing agents cannot grow on cuticle and cannot invade the cuticle. [1997]
31. **Assertion:** Cambium is a lateral meristem and cause growth in width.
Reason: Cambium is made up of fusiform and ray initials in stem. [1998]
32. **Assertion :** Higher plants have meristematic regions for indefinite growth.
Reason : Higher plants have root and shoot apices. [1999]
33. **Assertion :** In collateral vascular bundles, phloem is situated towards inner side.
Reason : In monocot stem, cambium is present. [2000]
34. **Assertion :** Collenchyma is thick walled dead tissue.
Reason : Collenchymatous cells show thickenings of pectin. [2002]
35. **Assertion:** The two cotyledons in seed are embryonic leaves.
Reason: The embryo contains radicle and plumule. [2002]
36. **Assertion :** In angiosperms, the conduction of water is more efficient because their xylem has vessels. [2006]
Reason : Conduction of water by vessel elements is an active process with energy supplied by xylem parenchyma rich in mitochondria.

TYPE B : ASSERTION REASON QUESTIONS

Directions for (Qs. 30-38) : These questions consist of two statements, each printed as Assertion and Reason. While answering these questions, you are required to choose any one of the following five responses.

B-38

37. **Assertion :** In woody stems, the amount of heart wood continues to increase year after year.

Reason : The cambial activity continues uninterrupted. [2007]

38. **Assertion :** Petroplants produce large amount of latex.

Reason : The latex contains long chain hydrocarbons. [2007]

Directions for (Qs. 39-41) : Each of these questions contains an Assertion followed by Reason. Read them carefully and answer the question on the basis of following options. You have to select the one that best describes the two statements.

(a) If both Assertion and Reason are correct and Reason is the correct explanation of Assertion.

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(b) If both Assertion and Reason are correct, but Reason is not the correct explanation of Assertion.

(c) If Assertion is correct but Reason is incorrect.

(d) If both the Assertion and Reason are incorrect.

39. **Assertion :** Vessels are more efficient for water conduction as compared to tracheids. [2010]

Reason : Vessels are dead lignified.

40. **Assertion:** Bulliform cells are useful in the unrolling of leaf.

Reason: Bulliform leaves store water. [2011]

41. **Assertion :** In stem, pericycle take active part in secondary growth.

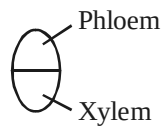
Reason : In dicots, pericycle has the capacity to produce lateral roots. [2013]

HINTS & SOLUTIONS

Type A : Multiple Choice Questions

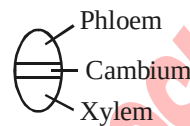
1. (b) *Cycas* stem shows monoxyletic wood with broad parenchymatous rays and often contain abundant resinous cells and resin canals. Towards the periphery of the stem, cycads produce a 'leaf armour' consisting of the tightly packed, helically arranged leaf bases.
2. (a) Aerenchyma is the modification of parenchyma tissue in which cells are arranged in such a way that - large air filled spaces are formed. Aerenchyma is found in aquatic plants to produce buoyancy.
3. (c)

Monocot vascular bundle



No secondary growth, cambium absent
i.e. V.B. is closed

Dicot vascular bundle

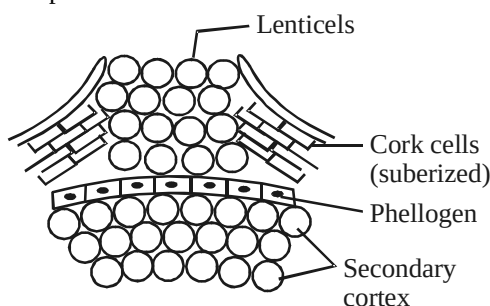


secondary growth, V.B. is open.

4. (a) Cork cambium (phellogen) is a secondary lateral meristem which develops from permanent tissues in the region of epidermis, hypodermis, cortex and even in outer layers of phloem.
5. (a) Endodermis is the inner most layer of cortex. The cells are characterized by the presence of casparian strips.
6. (b) The lateral roots arise from the cell of pericycle and hence, the root branches are said to be endogenous in origin (arising from a layer inner to endodermis). The lateral roots help in absorption of water and mineral salts from the soil. The meristematic cells of the lateral root push through the endodermis and cortex and then pierce through the epidermis to come out to form the lateral root.

7. (d) The cambium is secondary in its functional aspect since it forms secondary tissues like the secondary xylem and secondary phloem. It is, however, primary in origin.
8. (d) Sieve tube cell is enucleate at maturity due to the degeneration of its nucleus during its developmental process. The companion cell-that develops from the same initial as the sieve tube cell, possesses the nucleus throughout its life. The companion cell carries out the function of the sieve tube cell in the event of its degeneration.
9. (a) Porous wood contains vessels, with sieve cells, which contains passages for movement of substances.
10. (a) Passage cells are found in endodermis which allow a limited transfer of materials between the cortex and the vascular cylinder.
11. (b) In dicot stem, fascicular cambium and interfascicular cambium join to form a complete ring which helps in secondary growth.
12. (c) In a dorsiventral leaf, mesophyll is differentiated into two layers i.e. palisade parenchyma and spongy parenchyma.
13. (c) In a dicotyledonous stem, the sequence of tissues from outside to the inside is phellem-endodermis-pericycle-phloem.
14. (c) The concept of Quiescent Centre was proposed by Clowes in 1961. On the basis of autoradiographic studies of DNA synthesis in the root tip of *zea*, he found a reservoir of cells having low DNA, RNA and protein concentration. He called it as Quiescent Centre. They may or may not divide. It is resistant to damages.
15. (d) During secondary growth, where epidermis is replaced by tough and hard periderm, the cracked/ruptured epidermis forms the small holes called lenticels which help in gaseous exchange.

16. (c) Companion cells are long elongated living cells, that lie on the sides of the sieve tubes in phloem. Companion cells control the activities of the sieve tube through plasmodesmata.
17. (b) Phellogen produces cork or phellem on the outer side. It consists of dead and compactly arranged rectangular cells that possess suberised cell walls.



18. (c) Sieve tube elements possess cytoplasm but lack nucleus at maturity. Its metabolic activities are regulated by the nucleus of a closely associated cell called companion cell.
19. (b) Glyoxysomes are found in the plant cells particularly in the cells of germinating fatty seeds, *e.g.* endosperm of castor.
20. (b) Grafting is a horticultural technique whereby tissues from one plants are inserted into those of another so that the sets of vascular tissues may join together. Grafting is successful in dicots because vascular bundles are arranged in a ring and have cambium for secondary growth.
21. (a) In the sieve elements, P-proteins deposit callose on sieve plates.
22. (d) The cross sections of stem and root appear simple, when viewed by naked eye but under microscope they can be differentiated as endarch condition in stem and exarch condition in root. In endarch, protoxylem is present towards the center of stem while metaxylem towards the pericycle. In the exarch condition, protoxylem is present towards pericycle and metaxylem towards the center of the root.

23. (a) If a stem is girdled, root dies first, as the food synthesized by leaves is not able to reach to the roots.
24. (d)
25. (d) Sclerenchyma consists of long, narrow cells with thick and lignified cell walls having a few or numerous pits. They are usually dead and without protoplasts.
26. (b) 27. (b) 28. (c)
29. (a) The first formed primary xylem elements are called protoxylem and the later formed primary xylem is called metaxylem. In stems, the protoxylem lies towards the centre (pith) and the metaxylem lies towards the periphery of the organ. This type of primary xylem is called endarch.

Type B : Assertion Reason Questions

30. (e) Plant cuticles are a protective waxy covering produced only by the epidermal cells of leaves, young shoots and all other aerial plant organs. In addition to its function as a permeability barrier for water and other molecules, the micro and nano-structure of the cuticle confer specialized surface properties that prevent contamination of plant tissues with external water, dirt and micro-organisms. The waxy sheet of cuticle also functions in defence, forming a physical barrier that resists penetration by virus particles, bacterial cells, and the spores or growing filaments of fungi.
31. (b) Fusiform initials are vertically elongated cells that produce xylem and phloem elements. Ray initials are isodiametric and produce parenchymatous rays in secondary xylem and phloem.
32. (a) The root apex and shoot apex are meristematic in nature. These meristematic tissues are embryonic in origin. They are primary in origin because it develops from embryonic tissues and primary in function

- because they form the primary structure of the plant cell, the root apex and shoot apex, that live till the death of the whole plant. Hence, plants have the feature of indefinite growth.
33. (d) Collateral vascular bundles have the xylem pointing towards the inner side of the phloem. In the same way in monocots, cambium is absent. Collateral vascular bundles are present in stems and leaves of angiosperms and gymnosperms.
34. (e) Collenchyma is made up of living cells with unevenly thickened cell wall. Their cell wall is made up of cellulose and pectin. Collenchyma are present beneath the epidermis of young stem, petioles and midrib of leaves *etc.* These are absent in underground tissues and leaves and stems of monocots.
35. (b) During epigeal germination, cotyledons come out of the soil. The green cotyledons function as leaves of the seedling. They manufacture food and sustain the young seedling till the plumule gives rise to new leaves.
36. (d) Xylem is the water conducting tissue. It consists of living cells like parenchyma and dead cells like tracheary elements.
37. (a) In woody trees, the central portion of stem is dark in colour. It is hard and tough due to deposition of resins, tannins, gums and formation of tyloses. This central hard portion is called heart wood. It is formed by secondary growth. Due to cambial activity secondary xylem becomes non-functional and forms heart wood or duramen. It is more durable and little susceptible to attack of pathogens. The cambial activity continues in this region.
38. (a) Petroplants are plants having large amount of latex with long chain hydrocarbons. Latex of these plants are a good substitute for liquid fuels or petroleum. Cultivation of petroplants is a part of energy- cropping. Dr. Calvin was the scientist who identified petrocrops. They have property of converting large amount of their photosynthates into latex along with hydrocarbons. Some important petrocrops are *Euphorbia antisyphilitica*, *E. lathyris* *Calotropis procera etc.*
39. (b) Vessels are more efficient for water conduction as compared to tracheids. Vessels resemble tracheids very much in structure and function. But unlike tracheids these are like long tubes arranged in vertical row formed of cylindrical cells arranged to end with their end walls completely dissolved. These are also dead and lignified.
40. (b) In isobilateral leaves, the upper epidermis contains specialized cells, *i.e.*, bulliform or motor cells. They are highly vacuolate and can store water, if available. However, in case of water deficiency, the bulliform cells lose water and become flaccid. As a result, the leaf gets rolled up to reduce the exposed surface. The bulliform cells are also useful in the unrolling of leaf during its development.
41. (c) Pericycle is the outermost layer of stele. In dicot stems, pericycle strengthens the stem and provides protection to the vascular bundles. In angiosperms (dicots), pericycle gives rise to lateral roots and contribute to the vascular cambium often diverging into a work cambium.

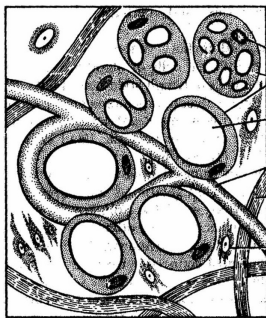
Chapter

7

Structural Organisation in Animals

TYPE A : MULTIPLE CHOICE QUESTIONS

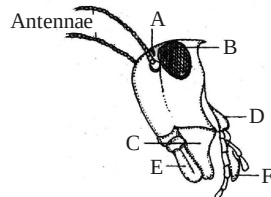
1. In frog, gastrulation process involves [1997]
 - (a) epiboly (b) emboly
 - (c) invagination (d) all of these
2. Structure which remains unchanged during metamorphosis of frog's tadpole is [1997]
 - (a) lung (b) heart
 - (c) nervous system (d) intestine
3. Which gland plays a key role in metamorphosis of frog ? [1999]
 - (a) Adrenal (b) Thyroid
 - (c) Thymus (d) Pancreas
4. Major protein of connective tissue is [2001]
 - (a) myosin (b) collagen
 - (c) melanin (d) keratin
5. Outer covering of cartilage is called [2001]
 - (a) perichondrium (b) periosteum
 - (c) endosternum (d) peritoneum
6. The protoplasmic segment of a striated muscle fibre is termed as [2001]
 - (a) sarcoplasm (b) sarcomere
 - (c) neuromere (d) metamere
7. Sharpey's perforating fibres are related with [2002]
 - (a) heart contraction
 - (b) muscle relaxation
 - (c) fixing of teeth
 - (d) none of these
8. The type of epithelial cells which line the inner surface of fallopian tubes, bronchioles and small bronchi are known as [2006]
 - (a) squamous epithelium
 - (b) columnar epithelium
 - (c) ciliated epithelium
 - (d) cubical epithelium
9. Tadpoles of frog can be made to grow as giant sized tadpoles, if they are [2006]
 - (a) administered antithyroid substance like thiourea.
 - (b) administered large amounts of thyroxine.
 - (c) reared on a diet rich in egg yolk.
 - (d) reared on a diet rich in both egg yolk and glucose.
10. Which of the following type of cell junction is not found in animal tissues ? [2013]
 - (a) Adhering junction (b) Tight junction
 - (c) Gap junction (d) Plasmodesmata
11. Identify the figure with its correct function



 - (a) Areolar connective tissue – Serves as a support framework for epithelium
 - (b) Adipose tissue – Store fats and act as heat insulators
 - (c) Dense regular tissue – Provide flexibility
 - (d) Dense irregular tissue – Provide strength and elasticity [2014]
12. Which of the following statement about cell junctions is false? [2015]
 - (i) All the cells of the epithelium are held together with little intercellular materials.
 - (ii) In almost all animal tissues specialized junction provide both structural and functional link between its individual cells.
 - (iii) Tight junctions help to stop substances from leaking across a tissue.
 - (iv) Adhering junctions provide cementing to keep neighbouring cells together.

- (v) Gap junctions provide cytoplasmic channels between cells for passage of ions, small molecules and sometimes big molecules.
- (a) (ii) and (iii) (b) (i) and (ii)
(c) Only (v) (d) None of these
13. i. The shape of the cells may vary with the function they perform
ii. Human RBC is about $7.0\text{ }\mu\text{m}$ in diameter
iii. Cytoplasm is the main arena of cellular activities
iv. Various chemical reactions occur in cytoplasm to keep the cell in the living state [2015]
- (a) All are correct
(b) Only I and II are correct
(c) Only IV is correct
(d) All are wrong

14. The figure given below shows the head region of cockroach. Identify A to F.



- [2016]
- (a) A- Compound eye, B-Ocellus, C-Maxilla, D-Mandible, E-Labrum, F-Labium
(b) A- Ocellus, B-Compound eye, C-Mandible, D-Maxilla, E-Labrum, F-Labium
(c) A- Ocellus, B-Compound eye, C-Mandible, D-Maxilla, E-Labium, F-Labrum
(d) A- Ocellus, B-Compound eye, C-Maxilla, D-Mandible, E-Labrum, F-Labium
15. Male cockroach can be identified from the female by the presence of [2017]
- (a) long antennae
(b) wingless body
(c) elongated abdomen
(d) anal styles
16. The sensory papillae in frogs are associated with [2017]

- (a) smell (b) hearing
(c) respiration (d) touch
17. In earthworms, setae are present in all segments except [2017]
- (a) first and the last segments
(b) first segment and the clitellum
(c) first segment
(d) clitellum and last segments

TYPE B : ASSERTION REASON QUESTIONS

Directions for (Q. 18) : These questions consist of two statements, each printed as Assertion and Reason. While answering these questions, you are required to choose any one of the following five responses.

- (a) If both Assertion and Reason are correct and the Reason is a correct explanation of the Assertion.
(b) If both Assertion and Reason are correct but Reason is not a correct explanation of the Assertion.
(c) If the Assertion is correct but Reason is incorrect.
(d) If both the Assertion and Reason are incorrect.
(e) If the Assertion is incorrect but the Reason is correct.

18. **Assertion :** Cartilage and bone are rigid connective tissues.

Reason : Blood is a connective tissue [2001]

Directions for (Q. 19) : Each of these questions contains an Assertion followed by Reason. Read them carefully and answer the question on the basis of following options. You have to select the one that best describes the two statements.

- (a) If both Assertion and Reason are correct and Reason is the correct explanation of Assertion.
(b) If both Assertion and Reason are correct, but Reason is not the correct explanation of Assertion.
(c) If Assertion is correct but Reason is incorrect.
(d) If both the Assertion and Reason are incorrect.

19. **Assertion :** The squamous epithelium is made of a single thin layer of flattened cells with irregular boundaries.

Reason : They are found in walls of blood vessels and air sacs of wings. [2017]

HINTS & SOLUTIONS

Type A : Multiple Choice Questions

1. (d) Gastrulation is the process of formation of three layers *i.e.* ectoderm, endoderm and mesoderm. In frog, these layers are formed by the processes of epiboly, emboly and invagination.
2. (c) Frog's nervous system once differentiated remains as such throughout life.
3. (b) Thyroxine hormone produced by thyroid gland plays a very important role in the metamorphosis of frog.
4. (b) Collagen is the major protein of connective tissue. Collagen, in the form of elongated fibrils is mostly found in fibrous tissues such as tendon, ligament and skin, and is also abundant in cornea cartilage, bone, blood vessels, the gut, and intervertebral disc. Collagen performs a very important role in ageing processes.

Myosin, commonest protein in muscle cells, is responsible for the elastic and contractile properties of muscle. It combines with actin to form actomyosin. Melanin is a black or dark brown pigment that is responsible for the dark colour of the skin, hair, scales, feathers and eyes of animals. Keratin is a fibrous scleroprotein that occurs in the outer layer of the skin and in horny tissues such as hair, feathers, nails and hooves.
5. (a) Cartilage is a type of connective tissue consisting of cells (called chondrocytes) and tough flexible matrix made of collagen, protein, and sugar. The cartilage is covered on the outside by layer of white fibrous connective tissue called perichondrium.

Periosteum is a membrane that lines the outer surface of all bones, except at the joints of long bones. It contains the blood vessels and nerves that provide nourishment and sensation.

Endosternum is a collective name for the apodemes or interior processes of the sternum in the thoracic of an insect. The peritoneum is thin membrane that lines the abdominal and pelvic cavities and covers most abdominal viscera.

6. (b) Sarcomere is the smallest contractile unit of striated muscle fibre. Sarcomere occurs as repeating units along the length of a myofibril, occupying the region between Z lines of the myofibril.

Sarcoplasm is the cytoplasm of a muscle fibre. It is a water solution containing ATP and phosphogens, as well as the enzymes of intermediate and product molecules involved in many metabolic reactions.

Neuromeres is a metameric segment of CNS. Metamere is a linear series of primitively similar segments into which the body of higher invertebrate and vertebrate is divisible.

7. (c) Sharpey's fibres are collagenous fibres that pass from the periodontal membrane into the cementum and the jaw bones, fixing the teeth firmly in the sockets.
8. (c) Columnar ciliated epithelium possesses fine hair like outgrowths, cilia on their free surfaces. This epithelium lines the nasal passages, oviduct (fallopian tube), terminal bronchiole *etc.* Its major function is protection and movement of mucus, urine and egg in a particular direction.

Squamous epithelium forms the lining of cavities such as the mouth, blood vessels, heart and lungs and make up the outer layers of the skin. Columnar epithelium forms the lining of the stomach and intestines. Some columnar cells are specialized for sensory reception such as in the nose, ears and the taste buds of the

tongue. Cubical epithelium is found in glands and in the lining of the kidney tubules as well as in the ducts of the glands. They also constitute the germinal epithelium which produces the egg cells in the female ovary and the sperm cells in the male testes.

9. (b) Thyroxine helps in the metamorphosis of tadpole.
10. (d)
11. (b) Adipose tissue is another type of connective tissue located mainly beneath the skin. The cells of this tissue are specialised to store fats.
12. (d) All the given statements about cell functions are true.
13. (a) All the given statements are correct.
14. (b) A - Ocellus; B - Compound eye; C - Mandible; D - Maxilla; E - Labrum; F - Labium.
15. (d) Both the sexes of cockroach have anal cerci which are jointed structures. But in the male, in addition, there is a paired unjointed needle-like anal style, which serve to distinguish between the male and the female.

16. (d) Frog has different types of sense organs like organs of touch (sensory papillae), taste (taste buds), smell (nasal epithelium), vision (eyes) and hearing (tympanum with internal ears).
17. (d) Except the first, the last and clitellar segment in each segment bear a ring of tiny curved, chitinous structure known as setae. Setae helps in locomotion and copulation.

Type B : Assertion Reason Questions

18. (e) Cartilage is a semi rigid connective tissue that is weaker than bone, but more flexible resilient. Cartilage serves to provide structure and support to the body's other tissues and also provide a cushioning effect in joints. Bone is rigid connective tissue and forms the skeleton of the body. It is composed chiefly of calcium phosphate and calcium carbonate. It also serves as a storage area for calcium, playing a large role in calcium balance in the blood. Blood is a fluid connecting tissue. Blood delivers necessary substances, such as nutrients and oxygen, to the body's cells (in animals) and transports waste products away from those same cells.
19. (b)

Chapter

8

Cell : The Unit of Life

TYPE A : MULTIPLE CHOICE QUESTIONS

1. In many bacteria, cell membrane is invaginated and folded to form [1997]
 - (a) pili
 - (b) cristae
 - (c) flagella
 - (d) mesosome
2. Cristae helps in [1998]
 - (a) respiration
 - (b) photosynthesis
 - (c) transpiration
 - (d) guttation
3. In nucleoplasm, a spherical body attached to a particular chromosome on a definite position is called [1998]
 - (a) nucleolus
 - (b) karyolymph
 - (c) plasmid
 - (d) reticulum
4. Which of the following is responsible for mechanical support and enzyme transport ? [1999]
 - (a) Dictyosome
 - (b) Cell membrane
 - (c) E. R.
 - (d) Mitochondria
5. Which of the following is present between cell walls of the plant cells ? [1999]
 - (a) Lomasome
 - (b) Microsome
 - (c) Lysosome
 - (d) Middle lamella
6. Rough E. R. differs from smooth E. R. due to the presence of [2000]
 - (a) DNA
 - (b) nucleus
 - (c) ribosome
 - (d) enzyme
7. Electron microscope was invented by [2000]
 - (a) Robert Hooke
 - (b) Knoll and Ruska
 - (c) Pasteur
 - (d) Schwann and Schleiden
8. Double membrane structure of cell are [2000]
 - (a) nucleus
 - (b) chloroplast
 - (c) mitochondria
 - (d) all of these
9. Hydrolytic enzymes are found in [2000]
 - (a) peroxisomes
 - (b) lysosomes
 - (c) lepdosomes
 - (d) lomasomes
10. Chromosomes with equal arms are called [2000]
 - (a) metacentric
 - (b) telocentric
 - (c) acentric
 - (d) polycentric
11. A prokaryotic cell lacks [2001]
 - (a) true nucleus
 - (b) nuclear membrane
 - (c) membrane bound organelles
 - (d) all of the above
12. Which of the following is a single membranous structure ? [2001]
 - (a) Lysosome
 - (b) Nucleus
 - (c) Mitochondria
 - (d) Chloroplast
13. In bacteria, site of respiration is [2001]
 - (a) mesosome
 - (b) episome
 - (c) plasmid
 - (d) cytoplasm
14. Which of the following organelle is related with photorespiration? [2002]
 - (a) Peroxisome
 - (b) Nucleus
 - (c) Cell wall
 - (d) Lysosome
15. The phagocytosis was first of all seen by [2002]
 - (a) Huxley
 - (b) Haeckel
 - (c) Metchnikoff
 - (d) Darwin
16. A chromosome with centromere at one end is called [2002]
 - (a) telocentric
 - (b) metacentric
 - (c) excentric
 - (d) apocentric
17. Plasmodesmata connections help in [2003]
 - (a) cytoplasmic streaming.
 - (b) synchronous mitotic divisions.
 - (c) locomotion of unicellular organisms.
 - (d) movement of substances between cells.
18. DNA is present in [2004]
 - (a) chromosomes and dictyosomes
 - (b) chloroplasts and lysosomes
 - (c) mitochondria and chloroplasts
 - (d) mitochondria and endoplasmic reticulum

19. Three of the following statements regarding cell organelles are correct while one is wrong. Which one is wrong? [2005]
- (a) Lysosomes are double membraned vesicles budded off from Golgi apparatus and contain digestive enzymes.
 - (b) Endoplasmic reticulum consists of a network of membranous tubules and helps in transport, synthesis and secretion.
 - (c) Leucoplasts are bound by two membranes, lack pigment but contain their own DNA and protein synthesizing machinery.
 - (d) Sphaerosomes are single membrane bound and are associated with synthesis and storage of lipids.
20. What is common between chloroplasts, chromoplasts and leucoplasts? [2006]
- (a) Presence of pigments.
 - (b) Possession of thylakoids and grana.
 - (c) Storage of starch, proteins and lipids.
 - (d) Ability to multiply by a fission-like process.
21. In prokaryotes, chromatophores are [2006]
- (a) specialized granules responsible for colouration of cells.
 - (b) structures responsible for organizing the shape of the organism.
 - (c) inclusion bodies lying free inside the cells for carrying out various metabolic activities.
 - (d) internal membrane systems that may become extensive and complex in photosynthetic bacteria.
22. Which of the following is responsible for the mechanical support, protein synthesis and enzyme transport? [2007]
- (a) Cell membrane
 - (b) Mitochondria
 - (c) Dictyosome
 - (d) Endoplasmic reticulum
23. "Omnis-cellula-e-cellula" was given by [2007]
- (a) Virchow (b) Hooke
 - (c) Leeuwenhoek (d) Brown
24. Genes present in the cytoplasm of eukaryotic cells, are found in [2005, 2008]
- (a) mitochondria and inherited via egg cytoplasm
 - (b) lysosomes and peroxisomes
 - (c) Golgi bodies and smooth endoplasmic reticulum
 - (d) plastids and inherited via male gamete
25. What is common between chloroplasts, chromoplasts and leucoplasts? [2008]
- (a) Presence of pigments.
 - (b) Possession of thylakoids and grana.
 - (c) Storage of starch, proteins and lipids.
 - (d) Ability to multiply by a fission-like process.
26. Molecules that are too large to pass through the pores of a cell membrane may enter the cell by a process known as [2009]
- (a) hydrolysis (b) pinocytosis
 - (c) cyclosis (d) synthesis
27. Three morphological forms of golgi complex are [2012]
- (a) Lamellae, tubules and vesicles
 - (b) Cisternae, tubules and vesicles
 - (c) Cisternae, tubules and lamellae
 - (d) Granum, thylakoids and vesicles
28. Which chromosome may lost during cell division? [2012]
- (a) Giant chromosome
 - (b) Acentric chromosome
 - (c) Polycentric chromosome
 - (d) Telocentric chromosome
29. Choose the incorrect match [2013]
- (a) Nucleus — RNA
 - (b) Lysosome — Protein synthesis
 - (c) Mitochondria — Respiration
 - (d) Cytoskeleton — Microtubules
30. Which of the following statements are correct?
- (i) In prokaryotic cells, a special membranous structure formed by the extension of the plasma membrane into the cell is known as polysome.
 - (ii) The smooth endoplasmic reticulum is the major site for synthesis of glycoproteins.
 - (iii) RuBisCO is the most abundant protein in the whole biosphere.
 - (iv) Mitochondria, chloroplasts and peroxisomes are not considered as part of endomembrane system. [2016]
- (a) (iii) and (iv) (b) (i) and (ii)
 - (c) (ii) and (iii) (d) (i) and (iv)

TYPE B : ASSERTION REASON QUESTIONS

Directions for (Qs. 31-38) : These questions consist of two statements, each printed as Assertion and Reason. While answering these questions, you are required to choose any one of the following five responses.

- (a) If both Assertion and Reason are correct and the Reason is a correct explanation of the Assertion.
- (b) If both Assertion and Reason are correct but Reason is not a correct explanation of the Assertion.
- (c) If the Assertion is correct but Reason is incorrect.
- (d) If both the Assertion and Reason are incorrect.
- (e) If the Assertion is incorrect but the Reason is correct.

31. **Assertion :** Power house of cell is mitochondria.
Reason : ATP is produced in mitochondria.

[2001]

32. **Assertion :** Cell wall is not found in animal cell.
Reason : Animal cells are covered by cell membrane.

[2001]

33. **Assertion:** Organisms are made up of cells.
Reason: Cells are structural unit of living organisms. A cell keeps its chemical composition steady within its boundary.

[2002]

34. **Assertion:** Specialization of cells is useful for organism.
Reason: It increases the operational efficiency of an organism.

[2002]

35. **Assertion:** The number of cells in a multicellular organism is inversely proportional to size of body.

Reason: All cells of biological world are alive.

[2002]

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36. **Assertion :** Eukaryotic cells have the ability to adopt a variety of shapes and carry out directed movements.

Reason : There are three principal types of protein filaments-microfilaments, microtubules and intermediate filaments, which constitute the cytoskeleton.

[2006]

Directions for (Qs. 37-40) : Each of these questions contains an Assertion followed by Reason. Read them carefully and answer the question on the basis of following options. You have to select the one that best describes the two statements.

- (a) If both Assertion and Reason are correct and Reason is the correct explanation of Assertion.
- (b) If both Assertion and Reason are correct, but Reason is not the correct explanation of Assertion.
- (c) If Assertion is correct but Reason is incorrect.
- (d) If both the Assertion and Reason are incorrect.

37. **Assertion :** Lipids present in the outer and inner side of the bilayer membrane are commonly different.

Reason : Oligosaccharides are attached to external surface as well as inner surface of a biomembrane.

[2009]

38. **Assertion :** Mitochondria and chloroplasts are semi autonomous organelles.

Reason : They are formed by division of pre-existing organelles as well as contain DNA but lack protein synthesizing machinery.

[2005, 2014]

39. **Assertion :** A cell membrane shows fluid behaviour.

Reason : A membrane is a mosaic or composite of diverse lipids and proteins.

[2003, 2008, 2015]

40. **Assertion :** Centrosomes and centrioles are related to each other.

Reason : Centrosome usually contains two cylindrical structures called centrioles.

[2016]

HINTS & SOLUTIONS**Type A : Multiple Choice Questions**

1. (d) In prokaryotic cell, cell membrane invaginate to form mesosomes. They have enzymes, which are useful for respiration.
2. (a) Cristae form a part of mitochondria which helps in cellular respiration.
3. (a) A small spherical body attached to the particular chromosome (nucleolar chromosome) in the nucleoplasm is nucleolus. Nucleolus is the principal or active site for the development of ribosomal RNAs & it is essential for spindle formation of ribosomes.
4. (c) ER provides mechanical support and enzyme transport in a cell.
5. (d) Adjacent cells in a plant tissue are held together by a thin, sticky, amorphous layer of cementing tissue called middle lamella. It is made up of Ca and Mg pectate.
6. (c) Rough endoplasmic reticulum is rough due to the presence of ribosomes at its surface. Their attachment to the ER is by means of protein ribophorin I and II.
7. (b) Electron microscope was invented by Knoll and Ruska in 1932.
8. (d) Double membrane organelles of the cell are mitochondria, chloroplast and nucleus.
9. (b) Lysosomes are spherical, single membrane limited vesicles, containing hydrolytic enzymes working at acidic pH. Lysosome is also known as suicidal bag/sac as they contain hydrolytic enzymes.
10. (a) Metacentric chromosomes have equal sized chromatids *i.e.* they have centromere in the centre.
11. (d) Prokaryotic cells, among the tiniest of all cells, has one envelope system with no membrane lined internal organelles except thylakoid if present. A prokaryotic cell lacks membrane bound organelles, nuclear membrane and histone proteins.
12. (a) Lysosome consists of hydrolytic enzymes, enclosed in a unit membrane.
13. (a) In bacteria, mesosome helps in cell respiration.
14. (a) Leaf peroxisomes are associated with endoplasmic reticulum, chloroplast and mitochondria and are involved in photorespiration. Photorespiration is light induced CO_2 liberation from a C_2 compound (glycolic acid) of dark phase of photosynthesis.
15. (c) The phagocytosis was first of all seen by Metchnikoff in 1893. Phagocytosis is a process whereby certain cells & unicellular organisms are capable of ingesting and digesting solid material.
16. (a) When centromere is located at the tip of the chromosome, it is said to be telocentric.
17. (d) Plasmodesmata are small fuses that connect plant cells to each other, providing living bridges between cells. Plasmodesmata brings the exchange of substances between cells.
18. (c) DNA is present in mitochondria and chloroplasts (extranuclear DNA). So these organelles are self replicating.
19. (a) Lysosomes are single membrane bound organelles rich in hydrolytic enzymes.
20. (a) C_4 pathway/Hatch and Slack pathway ensures the Calvin cycle to be operated only in bundle sheath cell. It is an adaptation to photorespiratory loss. Therefore, C_4 plants are adapted to photorespiratory loss.
21. (d) In prokaryotes, chromatophores are internal membrane system that may become extensive and complex in photosynthetic bacteria. It is structurally and functionally similar to eukaryotic chloroplast.

22. (d) Endoplasmic reticulum (ER) is a system of flattened membranes running through the cytoplasm. Rough ER containing ribosomes is mainly concerned with protein synthesis and transport of enzymes. It also functions as cytoskeleton by giving mechanical support to the cytoplasm.
23. (a) The cell is the basic structural and functional unit of living organisms. In 1855, Rudolf Virchow showed that all cells arise from the pre-existing cells by cell division or *Omnis-cellula-e-cellula*. Robert Hooke was the first one to find out the basic units of life and termed them as cells. Anton van Leeuwenhoek was the one who observed unicellular organisms including bacteria. Robert Brown described the nucleus as a characteristic spherical body in plant cells.
24. (a) Genes present in the cytoplasm of eukaryotic cells are found in mitochondria and inherited *via* egg cytoplasm.
25. (c) Chromoplasts are plastids responsible for pigment synthesis and storage. They, like all other plastids (including chloroplasts and leucoplasts), are organelles found in specific photosynthetic eukaryotic species. Chloroplasts conduct photosynthesis. Chloroplasts absorb light and use it in conjunction with water and carbon dioxide to produce sugars. Leucoplasts are non-pigmented, in contrast to other plastids such as the chloroplast. Lacking pigments, leucoplasts are not green, so they are predictably located in roots and non-photosynthetic tissues of plants. They may become specialized for bulk storage of starch, lipid or protein and are then known as amyloplasts, elaioplasts, or proteinoplasts respectively.
26. (b) Pinocytosis, or pinching in of the cell membrane, allows cells, such as the *Paramecium*, to capture larger food molecules. Hydrolysis, is the process of using water to split molecules apart. Cyclosis is a mechanism for transporting materials within a cell, by the cytoplasm swirling. Synthesis is the process of building up molecules within the cell.
27. (b) Three morphological forms of golgi complex are cisternae, tubules and vesicles. Varied number of cisternae are present in a Golgi complex.
The Golgi cisternae are concentrically arranged near the nucleus with distinct convex cis or the forming face and concave trans or the maturing face.
Tubules are long flattened structure while vesicles are round or oval structure.
28. (b) Acentric chromosome may be lost during cell division as centromere is absent in them. During metaphase and anaphase, spindle fibres are not attached with them and so they are not able to reach to the poles.
29. (b) Protein synthesis takes place in ribosomes, which are attached to surface of endoplasmic reticulum by ribophorin-I and ribophorin-II. About 50 hydrolytic enzymes are found in the lysosome. They include proteases, nucleases, glycosidases, lipases, phospholipases, phosphatases and sulphatases. All lysosomal enzymes are acid hydrolases and optimally active at pH-5.0
30. (a) The special membranous structure formed by the extension of prokaryotic plasma membrane is known as mesosome while polysome is structure formed by combination of many ribosomes.
SER is the major site of synthesis of lipids. The site of protein synthesis is RER.

Type B : Assertion Reason Questions

31. (b) Mitochondria are called power house of a cell because they produce large amount of energy in the form of ATP.

32. (a) Animal cells are covered by semipermeable plasma membrane. Cell wall is absent in animal because cell wall is incompatible with the way in which an animal moves and grows.
33. (a) Cells are the basic structural and functional unit of organism.
34. (a) Specialization of the cell increases the efficiency of the cell for a particular function.
35. (d) The size and shape of the cell in multicellular organism depends upon the location and function performed by them.
36. (b) Eukaryotic cells contain three types of filaments as microtubules, microfilament and intermediate filament which give definite shape to the cell and also helps in directional movement.
37. (c) Lipids present in the outer and inner side of the bilayer are commonly different, *e.g.*, lecithin on the outer side and cephalin on the inner side of erythrocyte membrane. Oligosaccharides are attached to external surface of lipids and proteins of a bio-membrane. They are absent on the inner side.
38. (c)
39. (a) The cell membrane also called the plasma membrane, plasmalemma, or "phospholipid bilayer" is a selectively permeable lipid bilayer found in all cells. It contains a wide variety of biological molecules, primarily proteins and lipids, which are involved in a vast array of cellular processes such as cell adhesion, ion channel conductance and cell signaling. The plasma membrane also serves as the attachment point for both the intracellular cytoskeleton and, if present, the extracellular cell wall.
40. (a) The centrosome is the main place where cell microtubules get organized. Centrosome usually contains two cylindrical structure called centrioles. Centrioles are composed of grouping of microtubules arranged in 9 + 3 pattern. The pattern is so named because a ring of 9 microtubule "triplets" are arranged at right angles to one another. Centrioles, found in animal cells, help to organize the assembly of microtubules during cell division. Centrioles replicate during the interphase stage of mitosis and meiosis.

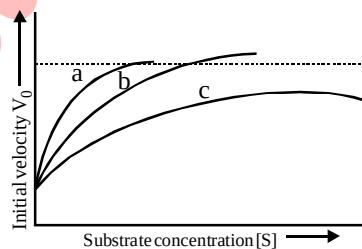
Chapter

9

Biomolecules

TYPE A : MULTIPLE CHOICE QUESTIONS

- Which is the derivative of amino acid ? [1999]
(a) Epinephrine (b) Estrogen
(c) Progesterone (d) All of these
- High energy bond of ATP are present in between [1999]
(a) C – C (b) C – O
(c) C – N (d) O – P
- Who coined the term zymase? [1999]
(a) Pasteur (b) Buchner
(c) Kuhne (d) Sumner
- Apoenzyme is [2000]
(a) protein (b) lipid
(c) sugar (d) vitamin
- Gamma globulins are synthesized inside [2000]
(a) liver
(b) kidney
(c) bone marrow
(d) lymph and lymphoid tissues
- Proteins are [2002]
(a) polysaccharides (b) polyamides
(c) polynucleotides (d) polyglycol
- Which of the following gives Fehling's test? [2002]
(a) Pectin (b) Sucrose
(c) Cellulose (d) Glucose
- The nicotinamide is synthesized in our body from [2002]
(a) tryptophan (b) tryosine
(c) valine (d) alanine
- An example of competitive inhibition of an enzyme is the inhibition of [2003]
(a) succinic dehydrogenase by malonic acid
(b) cytochrome oxidase by cyanide
(c) hexokinase by glucose-6-phosphate
(d) carbonic anhydrase by carbon dioxide
- Which of the following set of three items are not true as each set belongs to the category mentioned against them [2005]
(a) Lysine, glycine, thiamine - Amino acids
(b) Myosin, oxytocin and gastrin - Hormones
(c) Rennin, helicase and hyaluronidase - Enzyme
(d) Optic nerve, oculomotor, vagus - Sensory nerves
- The figure given below show three velocity-substrate concentration curves for an enzyme reaction. What do the curves a, b and c depict respectively? [2006]



- a - normal enzyme reaction,
b - competitive inhibition,
c - non-competitive inhibition.
 - a - enzyme with an allosteric modulator added,
b - normal enzyme activity,
c - competitive inhibition.
 - a - enzyme with an allosteric stimulator,
b - competitive inhibitor added,
c - normal enzyme reaction.
 - a - normal enzyme reaction,
b - non-competitive inhibitor added,
c - allosteric inhibitor added.
- Which of the following contain β -1, 4 linkage? [2007]
(a) Maltose (b) Sucrose
(c) Lactose (d) Fructose

13. Which statement is true? [2007]

- (a) Adenine has 4 nitrogen atoms.
- (b) Cytosine has 3 nitrogen atoms.
- (c) Guanosine has 3 nitrogen atoms.
- (d) Uracil has 5 nitrogen atoms.

14. Michaelis constant K_m is equal to [2010]

- (a) $\frac{K_1}{K_2 - K_3}$
- (b) $\frac{K_2 + K_3}{K_1}$
- (c) $\frac{K_2 - K_3}{K_1}$
- (d) $\frac{K_1 \times K_2}{K_3}$

15. Alpha-keratin is a protein present in [2010]

- (a) blood
- (b) skin
- (c) lymph
- (d) eggs

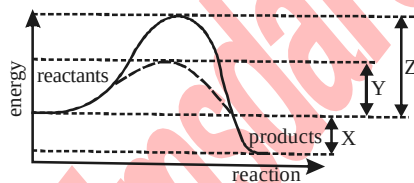
16. Which one of the following statements regarding starch and cellulose is not correct? [2010]

- (a) Both of them are of plant origin.
- (b) Both of them are polymers.
- (c) Both of them give colour with iodine.
- (d) Both of them are made up of glucose molecules.

17. Which of the following type of enzyme is not matched correctly with the molecule that it breaks down? [2013]

- (a) Amylase–starch
- (b) Lipase–starch
- (c) Protease–proteins
- (d) Disaccharidase–sugars

18. The diagram illustrates energy changes in an enzyme controlled reaction. [2013]



Which of the following represents the lowering of the activation energy?

- (a) X
- (b) Y
- (c) Z
- (d) Z – Y

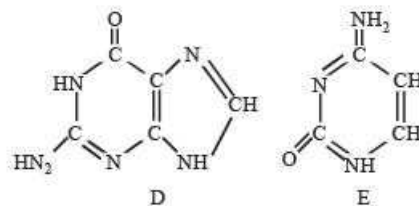
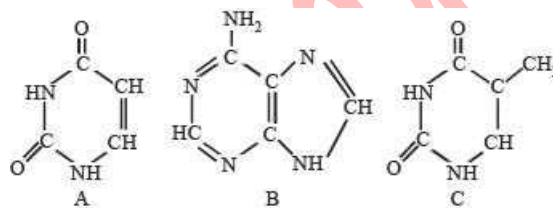
19. Which one of the following is a non-reducing carbohydrate? [2014]

- (a) Maltose
- (b) Sucrose
- (c) Lactose
- (d) Ribose 5-phosphate

20. The K_m value of the enzyme is the value of the substrate concentration at which the reaction reaches to [2014]

- (a) Zero
- (b) $2V_{max}$
- (c) $\frac{1}{2}V_{max}$
- (d) $\frac{1}{4}V_{max}$

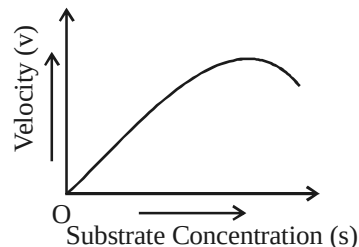
21. The following diagrams represent the nitrogenous bases of nucleic acid molecules. Identify the correct combination



[2015]

- (a) A-uracil, B-adenine, C-thymine, D-guanine, E-cytosine
- (b) A - uracil, B-guanine, C-cytosine, D-adenine, E-thymine
- (c) A-uracil, B - guanine, C-thymine, D-adenine, E-cytosine
- (d) A-thymine, B-guanine, C-uracil, D-adenine, E-cytosine.

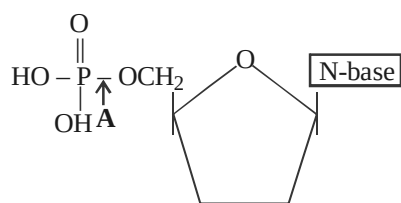
22. The given graph shows the effect of substrate concentration on the rate of reaction of the enzyme green -gram -phosphatase. What does the graph indicate ?



[2015]

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- (a) The rate of enzyme reaction is directly proportional to the substrate concentration
 (b) Presence of an enzyme inhibitor in the reaction mixture
 (c) Formation of an enzyme-substrate complex
 (d) At higher substrate-concentration the pH increases.
23. Inorganic catalyst work efficiently at _____ temperature and _____ pressure. [2016]
 (a) high, low (b) low, low
 (c) low, high (d) high, high
24. Refer the given structure of adenylic acid. In this identify A.



- [2016]
 (a) Glycosidic bond (b) Phosphate bond
 (c) Ester bond (d) Ionic bond
25. Nucleotides are building blocks of nucleic acids. Each nucleotide is a composite molecule formed by [2017]
 (a) base-sugar-phosphate.
 (b) base-sugar-OH.
 (c) (base-sugar-phosphate)_n.
 (d) sugar-phosphate.

TYPE B : ASSERTION REASON QUESTIONS

Directions for (Qs. 26-27) : These questions consist of two statements, each printed as Assertion and Reason. While answering these questions, you are required to choose any one of the following five responses.

- (a) If both Assertion and Reason are correct and the Reason is a correct explanation of the Assertion.
 (b) If both Assertion and Reason are correct but Reason is not a correct explanation of the Assertion.

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- (c) If the Assertion is correct but Reason is incorrect.
 (d) If both the Assertion and Reason are incorrect.
 (e) If the Assertion is incorrect but the Reason is correct.

26. **Assertion :** Enzymes have active sites and substrates have reactive sites on their surface respectively.

Reason : Active and reactive sites push the enzyme and substrate molecules away from each other. [1999]

27. **Assertion :** Vegetable oils are fats which are present in plant cells in soluble form.

Reason : Vegetable oils occur only in cells of embryo. [2007]

Directions for (Qs. 28-37) : Each of these questions contains an Assertion followed by Reason. Read them carefully and answer the question on the basis of following options. You have to select the one that best describes the two statements.

- (a) If both Assertion and Reason are correct and Reason is the correct explanation of Assertion.
 (b) If both Assertion and Reason are correct, but Reason is not the correct explanation of Assertion.
 (c) If Assertion is correct but Reason is incorrect.
 (d) If both the Assertion and Reason are incorrect.

28. **Assertion :** Human diet should compulsorily contain glycine, serine and tyrosine. [2010]

Reason : Essential amino acids can not be synthesized in the human body.

29. **Assertion :** Unsaturated fats are more reactive compared with the saturated fats. [2010]

Reason : Unsaturated fats have only single bonds in their structure.

30. **Assertion :** The amino acid glycine comes under the category of nonessential amino acids.

Reason : This is due to the fact that it can not be synthesised in the body. [2011]

31. **Assertion :** Allosteric enzymes show feed back inhibition.

Reason : The inhibitor is competitive. [2012]

32. **Assertion :** Coenzymes serve as co-factors in a number of different enzyme catalyzed reactions.
Reason : Coenzymes and prosthetic groups are cofactors. [2013]
33. **Assertion :** Enzymes lower the activation energy.
Reason : A substrate molecule can be acted upon by a particular enzyme. [2014]
34. **Assertion :** Comparative biochemistry provides a strong evidence in favour of common ancestry of living beings.
Reason : Genetic code is universal. [2015]
35. **Assertion :** A co-enzymes or metal ions that is very tightly bound to enzyme protein is called prosthetic group.
Reason : A complete, catalytically active enzyme together with its bound prosthetic group is called apoenzyme. [2016]
36. **Assertion :** Glycosidic bonds are formed by dehydration.
Reason : In polysaccharides, individual monosaccharide is linked by glycosidic bond. [2016]
37. **Assertion :** In a DNA molecule, A–T rich parts melt before G–C rich parts.
Reason: In between A and T there are three H-bond, whereas in between G and C there are two H-bonds. [2017]

HINTS & SOLUTIONS

Type A : Multiple Choice Questions

1. (a) Epinephrine is derived from tyrosine amino acid.
2. (d) High energy bonds of ATP are between O~P.
3. (b) Buchner coined the term zymase for the complex of biocatalysts extracted from yeast and taking part in alcoholic fermentation.
4. (a) Apoenzyme is the protein part of holoenzyme.
5. (a) Gamma globulins (γ) are synthesized by B-lymphocytes and stem cells found in the liver during foetal stage and bone marrow cells in the adult stage.
6. (b) Proteins are the polymers of basic units amino acids and hence are polyamides.
7. (d) Glucose is an aldehydic sugar and their free $-CHO$ part converts Cu^{+2} to Cu^{+1} (Fehling's reagent).
8. (a) The enzyme nicotinamide can be synthesized in small quantities from amino acid, tryptophan.
9. (a) Enzyme inhibition caused by a substance resembling substrate molecule through blocking its active site is competitive inhibition. Malonate closely resembles succinate in structure that inhibits the action of succinic dehydrogenase.
10. (c) Thiamine is a nitrogen base; myosin is a muscle protein; oculomotor nerve is motor and vagus is mixed type.
11. (a) The effect of a competitive inhibitor is reversed by increasing substrate concentration. At a sufficiently high substrate concentration, the reaction velocity reaches the v_{max} observed in the absence of inhibitor whereas non-competitive inhibitor decreases the v_{max} of the reaction *i.e.* it can not be overcome by increase in substrate concentration.
12. (c) Lactose or milk sugar, found exclusively in milk, contain β -1,4 linkage. It is a disaccharide formed by combination of galactose and glucose by means of a chemical reaction called as condensation reaction.
13. (a) Nucleotides contain carbon, hydrogen, oxygen, nitrogen and phosphorous. Nucleotides are either purines or pyrimidines. Adenine and guanine are the two purines which are the 9-membered double ringed compound where each ring possesses four nitrogen atoms. Thymine, uracil, and cytosine are the pyrimidines which are single ringed nitrogenous compounds.
14. (b) Michaelis constant K_m is equal to
$$\frac{K_2 + K_3}{K_1}.$$
15. (b) Alpha-keratin is present in high quantity in skin and epidermal appendages like hair and nail.
16. (c) Starch is the reserve substance in plant cells whereas cellulose is the most important structural component of the cell wall of plants. Both starch and cellulose are polymers of glucose. Starch is a branched polymers of α -D glucose units which are linked by α -1, 4 glycosidic bonds (but at branching, by α -1, 6 glycosidic bonds). Cellulose is a linear polymer of β -D-glucose units connected through β -1, 4 glycosidic bonds. In contrast to starch and glycogen, cellulose is insoluble in ordinary solvents and is not hydrolysed by boiling dilute acids. It gives no colour with iodine.

17. (b) Lipases are enzymes found in the small intestine of humans that help in the breakdown of fats.
18. (d) The energy required to initiate a reaction is known as the activation energy, E_a . The bold curve shows the uncatalysed reaction with $E_a = Z$, whilst Y represents the E_a of the catalysed reaction (dotted curve). The E_a is thus lowered by $(Z - Y)$.
19. (b) Sucrose is classified under non-reducing sugar because it does not have any free aldehyde or keto group.
20. (c) The concentration of substrate at which velocity of enzymatic action reaches half of its maximum value, is called **K_m** value or **Michaelis constant**.
21. (a)
22. (b) Even though the substrate concentration increases the velocity is decreasing there by showing a presence of inhibitor.
23. (d) Inorganic catalyst work efficiently at high temperature and high pressure. Inorganic catalysts speed up reactions, but they do not have carbon-hydrogen atoms. An example of this is magnesium sulphate, which is a compound used to speed up some reactions in the chemistry lab.
24. (c) Phosphate is bound to pentose sugar by ester bond.
25. (a) Nucleotides are the building blocks of nucleic acid. Each nucleotide consists of three parts: a sugar (ribose for RNA and deoxyribose for DNA), a phosphate, and a nitrogenous base.
27. (d) Vegetable oils and fats are present in plants in insoluble form. They are extracted mostly from seeds. In several cereals, they are obtained from embryo. Olive and palm oils are obtained from fleshy pericarp of the fruit. Sometimes oils are also extracted from roots, stem and leaves.
28. (d) Essential amino acids are those which are taken from food and not synthesized in the body whereas non-essential amino acids need not be supplied in the diet and are synthesized in the body. Glycine, serine and tyrosine are non-essential amino acids.
29. (c) Compound having double bond in their structure are more unstable compound in comparison to single bond holder compounds. Unsaturated fats those have double bonds in their structures are more reactive than saturated fats.
30. (c) Non-essential amino acids are those amino acids which need not be supplied in the diet because they can be synthesised by the body, particularly from carbohydrate metabolites, Glycine is one such non essential amino acid. On the contrary, essential amino acids are those amino acids which can not be synthesised in the animal body and must be supplied with food in adequate amounts. Out of twenty amino acids, eight are considered essential in human diet.
31. (c) Feed back inhibition is a type of reversible inhibition found in allosteric enzymes. The inhibitor is noncompetitive and is usually a low molecular intermediate or product of metabolic pathway having a chain of reactions involving a number of enzymes.
32. (b) Cofactor may be inorganic or organic in nature. Organic cofactors are of two types, coenzymes and prosthetic groups. Coenzymes are easily separable nonprotein organic cofactors. Prosthetic groups are

Type B : Assertion Reason Questions

26. (d) Enzymes are biocatalyst that increases the speed of a chemical reaction without themselves undergoing any permanent chemical change. Enzymes have active sites to bind the substrate during catalyzed reaction.

non-protein organic cofactors firmly attached to apoenzymes (protein part of enzyme).

33. (b) Activation energy is an external supply of energy which is needed for the initiation of the chemical reaction. Activation energy required for such a large number of reactions cannot be provided by living systems. Enzymes lower the activation energy required for a reaction. Enzymes are generally specific for their substrates.
34. (b) Comparative biochemistry provides a strong evidence for common ancestors of living beings (*e.g.* proteins lymph, enzymes, hormones, blood groups *etc.*)
35. (c) Prosthetic group is an organic substance which is thermostable and firmly attached to the protein or apoenzyme portion during the complete catalytic cycle. Apoenzyme is

a protein that forms an active enzyme system by combination with a coenzyme and determines the specificity of this system for a substrate.

36. (b) In polysaccharides, individual monosaccharide is linked by glycosidic bond. This bond is formed between two carbon atoms of two adjacent monosaccharides. A glycosidic bond is a type of covalent bond that joins a carbohydrate molecule to another group, which may or may not be another carbohydrate. Glycosidic bonds are formed by dehydration.
37. (c) In a DNA molecule, A-T rich parts melt before G-C rich parts because there are two H-bond between A and T whereas in between G and C, there are three H-bond.

Cell Cycle and Cell Division

TYPE A : MULTIPLE CHOICE QUESTIONS

- The correct sequence in cell cycle is [1999]
 - S - G₁ - G₂ - M
 - S - M - G₁ - G₂
 - G₁ - S - G₂ - M
 - M₁ - G₁ - G₂ - S
- Colchicine prevents the mitosis of cells at which of the following stage? [2000]
 - Anaphase
 - Metaphase
 - Prophase
 - Interphase
- Spindle fibres of mitotic cells are made up of
 - tubulin
 - actin
 - myosin
 - collagen [2001]
- When synapsis is complete all along the chromosome, the cell is said to have entered a stage called [2005]
 - zygotene
 - pachytene
 - diplotene
 - diakinesis
- Which one of the following precedes re-formation of the nuclear envelope during M-phase of the cell cycle? [2008]
 - Decondensation from chromosomes and reassembly of the nuclear lamina.
 - Transcription from chromosomes and reassembly of the nuclear lamina.
 - Formation of the contractile ring and formation of the phragmoplast.
 - Formation of the contractile ring and transcription from chromosomes.
- During which stages (or prophase I substages) of meiosis do you expect to find the bivalents and DNA replication respectively? [2009]
 - Pachytene and interphase (between two meiotic divisions)
 - Pachytene and interphase (just prior to prophase I)
 - Pachytene and S phase (of interphase just prior to prophase I)
 - Zygotene and S phase (of interphase prior to prophase I)
- Many cells function properly and divide mitotically even though they do not have [2011]
 - plasma membrane
 - cytoskeleton
 - mitochondria
 - plastids
- The stage of meiosis where centromere separate [2013]
 - metaphase I
 - metaphase II
 - anaphase I
 - anaphase II
- During meiosis I, the chromosomes start pairing at [2014]
 - Leptotene
 - Zygotene
 - Pachytene
 - Diplotene
- How many mitotic divisions are needed for a single cell to make 128 cells? [2016]
 - 7
 - 14
 - 28
 - 64
- Match the description (given in column I) with correct stage of prophase I (given column II) and choose the correct option. [2017]

Column I	Column II
A. Chromosomes are moved to spindle equator	I. Pachytene
B. Centromere splits and chromatids move apart	II. Zygotene
C. Pairing between homologous chromosomes takes place	III. Anaphase
D. Crossing between homologous chromosomes	IV. Metaphase

 - A - I; B - II; C - III; D - IV
 - A - II; B - III; C - IV; D - I
 - A - IV; B - III; C - II; D - I
 - A - III; B - I; C - IV; D - II

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TYPE B : ASSERTION REASON QUESTIONS

Directions for (Q. 12) : These questions consist of two statements, each printed as Assertion and Reason. While answering these questions, you are required to choose any one of the following five responses.

- (a) If both Assertion and Reason are correct and the Reason is a correct explanation of the Assertion.
- (b) If both Assertion and Reason are correct but Reason is not a correct explanation of the Assertion.
- (c) If the Assertion is correct but Reason is incorrect.
- (d) If both the Assertion and Reason are incorrect.
- (e) If the Assertion is incorrect but the Reason is correct.

12. Assertion: Meiosis results in production of haploid cells.

Reason: Synapses occurs during leptotene.

[1998]

Directions for (Qs. 13-17) : Each of these questions contains an Assertion followed by Reason. Read them carefully and answer the question on the basis of following options. You have to select the one that best describes the two statements.

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- (a) If both Assertion and Reason are correct and Reason is the correct explanation of Assertion.
- (b) If both Assertion and Reason are correct, but Reason is not the correct explanation of Assertion.
- (c) If Assertion is correct but Reason is incorrect.
- (d) If both the Assertion and Reason are incorrect.

13. Assertion : Meiosis II is known as equational or homotypic division. [2010]

Reason : Meiosis II produces same number of chromosome in cell.

14. Assertion : Interphase is resting stage.

Reason : The interphase cell is metabolically inactive. [2012]

15. Assertion : During zygotene, chromosomes show bivalent stage.

Reason : Bivalent is half the number of chromosomes. [2013]

16. Assertion : The stage between two mitotic divisions is called interkinesis.

Reason : Interkinesis is generally short lived.

[2016]

17. Assertion : Diplotene is characterized by the presence of chiasmata.

Reason : Diplotene can last for months and years in oocytes of some vertebrates. [2016]

HINTS & SOLUTIONS**Type A : Multiple Choice Questions**

1. (c) The correct sequence of cell cycle is G_1 , S, G_2 and M.
2. (c) Colchicine is an alkaloid derived from (*colchicum autumnale*) arrests the spindle formation at the end of prophase. Hence, it is also called 'Mitotic Poison'.
3. (a) Spindle fibres of mitotic cells are made up of microtubules. It consists of protein tubulin that maintain cell shape, serve as tracks for organelle movement & help in cell division by getting attached to the centromeres of bivalents. They are arranged on equator due to congression movements. The movement of bivalents or chromosomes occur towards the poles as a result of spindle fibres contraction.
4. (b) Synapse stabilizes the paired condition of chromosomes in zygotene stage. After this the cell enters the pachytene stage.
5. (a) In most eukaryotes, the nuclear envelope that separates the DNA from the cytoplasm disassembles. The chromosomes align themselves in a line spanning the cell. Microtubules, essentially miniature strings, pull out from opposite ends of the cell and shorten, pulling apart the sister chromatids of each chromosome. As a matter of convention, each sister chromatid is now considered a chromosome, so they are renamed to sister chromosomes. As the cell elongates, corresponding sister chromosomes are pulled toward opposite ends. A new nuclear envelope forms around the separated sister chromosomes.
6. (d) In bivalent formation of chromosomes during meiosis, the homologous chromosomes are arranged in pairs. The phenomenon is called synapsis and it occurs during zygotene stage. DNA replication occurs during S phase or synthetic phase which is the second phase of interphase.
7. (d) Many cells function properly and divide mitotically even in the absence of plastids.
8. (d)
9. (b) During zygotene, a substage of Prophase I of meiosis I, where chromosomes start pairing together is called synapsis. Such paired chromosomes are called as homologous chromosomes. A complex structure *i.e.*, synaptonemal complex is formed by a pair of synapsed homologous chromosomes called a bivalent or a tetrad.
10. (a) In mitosis, a single cell divides to form two daughter cells. So, the number of mitotic divisions can be calculated by 2^n .
where, n is the number of division of cell.
 $2^n = 128$
 $2^n = 2^7$
 $n = 7$
Thus, 7 mitotic divisions are needed for a single cell to make 128 cells.
11. (c) A – IV; B – III; C – II; D – I
Metaphase – Chromosomes are moved to spindle fibre.
Anaphase – Centromere splits and chromatids move apart.
Zygotene – Pairing between homologous chromosomes takes place.
Pachytene – Crossing between homologous chromosomes occurs.

Type B : Assertion Reason Questions

12. (c) Synapsis occurs during zygotene stage. Synapsis is the pairing of homologous chromosomes which leads to formation of bivalents.
13. (a) Meiosis II is known as equational or homotypic division like mitosis. It ensures the maintenance of constant number of chromosomes from generation to generation on a species.
14. (c) Previously interphase is called resting stage because there is no apparent activity related to cell division. The interphase cell is metabolically quite active. Interphase consist of three subphases (G_1 , G_2 and S). Synthesis of DNA occurs in S phase. G_1 is the period between the end of mitosis and the start of S phase. G_2 is the phase between S phase and the next mitosis. As the synthesis of DNA and proteins occurs in interphase so, it is considered as metabolically active phase.
15. (b) During zygotene, because of the pairing of the homologues, the nucleus contains half the number of chromosomes. Each unit is a bivalent composed of two homologous chromosomes.
16. (d) Interkinesis or interphase II is a period of rest that cells of some species enter during meiosis, between meiosis I and meiosis II. No DNA replication occurs during interkinesis however it does occur during the interphase I stage of meiosis. Interkinesis is generally short lived.
17. (b) Diplotene is the longest and most active subphase of prophase I of meiosis. The beginning of diplotene is recognized by the dissolution of synaptonemal complex and the tendency of the recombined homologous chromosomes of the bivalents to separate from each other except at the sites of crossovers. These X-shaped structures are called chiasmata. Diplotene can last for months and years in oocytes of some vertebrate.

Transport in Plants

TYPE A : MULTIPLE CHOICE QUESTIONS

- Translocation of organic materials in plants is explained by [1997]
 - active transport
 - transpiration pull
 - inhibition theory
 - mass flow hypothesis
- The main function of phloem is translocation of [1998]
 - food
 - water
 - mineral
 - air
- In rainy season, door gets swelled due to [2001]
 - imbibition
 - diffusion
 - transpiration
 - respiration
- Which of the following helps in ascent of sap? [2007]
 - Root pressure
 - Transpiration
 - Capillarity
 - All of these
- Hydroponics is [2007]
 - nutrient less culture
 - water less culture
 - soilless culture
 - none of these
- During $\text{Na}^+ - \text{K}^+$ pump [2010]
 - 3Na^+ and 2K^+ are transported
 - 1Na^+ and 2K^+ are transported
 - 3Na^+ and 3K^+ are transported
 - Depends on requirement of cell
- Excessive loss of water causes wilting of leaves, it can be prevented by : [2012]
 - Keeping the plant in bright light
 - Spraying the plant with alcohol
 - Applying vaseline on the leaf surface
 - Adding high amounts of fertilizers to the soil
- Water potential of pure water and its solution are [2013]
 - 0 and 1
 - 0 and 0
 - 0 and more than one
 - 0 and less than 1.
- In which method of transport in plasma membrane does not require carrier molecule? [2014]
 - Active transport
 - Facilitated diffusion
 - Simple diffusion
 - $\text{Na}^+ - \text{K}^+$ pump
- Seed increase in its volume by the adsorption of water through [2014]
 - Osmosis
 - Plasmolysis
 - Imbibition
 - Diffusion
- Minerals are known to enter the plant root by means of a number of mechanisms, including all except one of the following. Which one of the following is NOT a mechanism for moving minerals into roots? [2015]
 - Foliar feeding
 - Active transport
 - Proton (H^+) pump
 - Cation exchange
- A botanist discovered a mutant plant that was unable to produce materials that form casparian strip. This plant would be [2015]
 - unable to transport water or solutes to the leaves.
 - unable to use its sugar as a sugar sink.
 - able to exert greater root pressure than the normal plant.
 - unable to control amounts of water and solutes it absorbs.
- If a cell A with D.P.D. 4 bars is connected to cell B, C, D whose O.P. and T.P. are respectively 4 and 4, 10 and 5 and 7 and 3 bars, the flow of water will be [2015]
 - A and D to B and C
 - A to B, C and D
 - B to A, C and D
 - C to A, B and D

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14. A boy is studying transport of a certain type of molecules into cell. He finds that transport slows down when the cells are poisoned with a chemical that inhibits energy production. Under normal circumstances, the molecules studied by the boy is probably transported by [2016]
- simple diffusion
 - osmosis
 - active transport
 - facilitated diffusion
15. Which of the following statements is/are not incorrect? [2017]
- Water and minerals, and food are generally moved by a mass or bulk flow system.
 - Bulk flow can be achieved either through a positive hydrostatic pressure gradient or a negative hydrostatic pressure gradient.
 - The bulk movement of substances through the conducting tissues of plants is called translocation.
 - Xylem translocates organic and inorganic solutes, mainly from roots to the aerial parts of the plants.
 - Phloem translocates water, mineral salts, some organic nitrogen and hormones, from the leaves to other parts of the plants.
- (ii), (iii) and (v)
 - (ii), (iii) and (iv)
 - (iv) and (v)
 - (ii) and (v)
- (d) If both the Assertion and Reason are incorrect.
- (e) If the Assertion is incorrect but the Reason is correct.
16. **Assertion :** Waxy and cutin coating on plant parts reduce the transpiration.
Reason : These adaptation are found in xerophytes. [1999]
17. **Assertion :** Water and mineral uptake by root hairs from the soil occurs through apoplast until it reaches endodermis.
Reason : Casparian strips in endodermis are suberized. [2003]
18. **Assertion :** When the ambient temperature is high and soil contains excess of water, the plants tend to lose water in the form of droplets from lenticels.
Reason : Root pressure regulates the rate of loss of water form lenticels. [2006]

Directions for (Qs.19-21) : Each of these questions contains an Assertion followed by Reason. Read them carefully and answer the question on the basis of following options. You have to select the one that best describes the two statements.

TYPE B : ASSERTION REASON QUESTIONS

Directions for (Qs. 16-18) : These questions consist of two statements, each printed as Assertion and Reason. While answering these questions, you are required to choose any one of the following five responses.

- If both Assertion and Reason are correct and the Reason is a correct explanation of the Assertion.
 - If both Assertion and Reason are correct but Reason is not a correct explanation of the Assertion.
 - If the Assertion is correct but Reason is incorrect.
 - If both the Assertion and Reason are incorrect.
 - If the Assertion is incorrect but the Reason is correct.
19. **Assertion :** Upward movement of water is called ascent of sap.
Reason : Upward movement of water occurs through xylem and phloem. [2013]
20. **Assertion :** Long distance flow of photo assimilates in plants occurs through sieve tubes.
Reason : Mature sieve tubes have parietal cytoplasm and perforated sieve plates. [2012, 2015]
21. **Assertion :** Light is very important factor in transpiration.
Reason : Light induces stomatal opening and darkness closing of stomata. Therefore, transpiration increases in light and decreases in dark. [1999, 2015]

HINTS & SOLUTIONS**Type A : Multiple Choice Questions**

1. (a) Active transport is the mediated transport of biochemicals, and other atomic/molecular substances, across membranes. Unlike passive transport, this process requires chemical energy in the form of adenosine triphosphate(ATP). In this form of transport, molecules move against either an electrical or concentration gradient (collectively termed an electrochemical gradient).
2. (a) Phloem is the chief food conducting tissue of vascular plants responsible for translocation of organic solutes.
3. (a) In rainy season, door gets swelled due to the phenomenon of imbibition. It is the process of absorption of water without forming a solution.
4. (d) Upward movement of water (sap) through xylem against the force of gravity is called ascent of sap. All three help in ascent of sap.
5. (c) Cultivation of plants by placing the roots in the nutrient solution without any soil is called hydroponics. It is also known as soilless culture/ water culture/ solution culture. It is used to determine which elements are essential for plant growth and what symptoms are produced by the absence or deficiency of essential elements.
6. (a) During sodium-potassium pump, the concentration of sodium ions will be about 14 times more in extra cellular fluid (outside) and concentration of potassium ions will be about 28-30 times more in axoplasm (inside). Thus, 3Na^+ and 2K^+ are transported during the process.
7. (c) Excessive loss of water from the leaves can be prevented by applying vaseline on leaf surface. It will close the stomata and check transpiration.
8. (d)
9. (c)
10. (c) Imbibition is the process of adsorption of water by hydrophilic surfaces of a substance without forming a solution. It is a type of diffusion by which movement of water takes place along a diffusion gradient. The solid particles which adsorb water or any other liquid are called Imbibants. The liquid which is imbibed is known as Imbibate. Examples are absorption of water by seeds and dry wood.
11. (a) Potassium is accumulated by passive transport. Some solutes are pumped across membranes using active transport. The role of proton pumps in the transport process of plant cells is a specific application of chemiosmosis, a transmembrane proton gradient that links energy-releasing processes to energy-consuming ones like active transport.
12. (d) The casparian strips function in regulation of the flow of water between outer tissues and the vascular cylinder.
13. (c) $\text{DPD} = \text{OP} - \text{TP}$.
 $\text{DPD (A)} = 4 \text{ bar}$.
 $\text{DPD (B)} = 0 \text{ bar}$.
 $\text{DPD (C)} = 10 - 5 = 5 \text{ bars}$.
 $\text{DPD (D)} = 7 - 3 = 4 \text{ bars}$.
Water always flows from lower DPD (Diffusion Pressure Deficit) to higher DPD. Since the DPD of cell B is the lowest (0) the water will flow from B to A and then to C.
14. (c) Active transport uses energy (ATP) to pump molecules against a concentration gradient. Cells undergoing active transport bear abundant mitochondria to provide ATP, needed to power active transport. So, the production of ATP is blocked or decreased and active transport is blocked or slow down.
15. (c) Statements (iv) and (v) are not correct.

- (iv) Xylem is associated with the translocation of mainly water, mineral salts, some organic nitrogen and hormones from roots to the aerial parts of the plants.
- (v) Phloem translocates a variety of organic and inorganic solutes mainly from the leaves to other parts of the plants.

Type B : Assertion Reason Questions

16. (a) Waxy and cutin coating does reduce transpiration. This adaptive feature is seen in xerophytic and in plants of semi-arid region. This adaptive feature is seen to reduce water loss by transpiration.
17. (a) The radial and the inner walls of the cells of the endodermis are greatly thickened. These are called as casparian strips and these are impervious to water. Apart from the casparian strips, and suberization also does not allow the water to reach the endodermis. Hence, water moves through the apoplast which are passage cells.
18. (d) Root pressure is a pressure produced in the roots of plants, causing exudation of sap from cut stems and guttation of water from leaves. The pressure is generated by the concentration of solutes in the xylem of the root and stem which is then causes water to move into the xylem by osmosis.
19. (c) Sap is water with dissolved ingredients. The upward movement of water from roots towards the tips of stem branches and their leaves is called ascent of sap. It occurs through the tracheary elements of xylem.
20. (a) The parietal cytoplasm and perforated sieve plates help in the transport of photoassimilates that are required for photosynthesis. The parietal cytoplasm is the streaming of cytoplasm. The streaming cytoplasm moves throughout the cell, thus, helping in the transport of photoassimilates from one cell to another through the sieve plates.
21. (a) Light is an important factor in transpiration. The stomata opens well on days when light is brighter. It is also evident on cloudy days that the stomata does not open well. Hence, light induces stomatal opening and darkness closing.

TYPE A : MULTIPLE CHOICE QUESTIONS

- Leghaemoglobin helps in [2007]
 - nitrogen fixation
 - protecting nitrogenase from O_2
 - destroys bacteria
 - transport of food in plants
- Which of the following is correct set of micronutrient for plants? [2007, 2011]
 - Mg, Si, Fe, Cu, Ca
 - Cu, Fe, Zn, B, Mn
 - Mg, Fe, Zn, B, Mn
 - Mo, Zn, Cl, Mg, Ca
- In glycolysis, glucose molecule is converted into: [2011]
 - PEP
 - RuBP
 - Acetyl CoA
 - Pyruvic acid
- Which one of the following elements is not an essential micronutrient for plant growth? [2012]
 - Ca
 - Mn
 - Zn
 - Cu
- Which element plays an important role in nitrogen fixation? [2012]
 - Mn
 - Mo
 - Zn
 - Cu
- Match column-I and Column-II and choose the correct option given below the columns. [2013]

Column-I (Element)	Column-II (Function)
A. Calcium	I. Required for ionic-balance.
B. Boron	II. Essential for constitution of nucleic acid
C. Phosphorus	III. Required for absorption of calcium.
- Chlorine
 - A-1; B-2; C-3; D-4; E-5
 - A-5; B-4; C-3; D-2; E-1
 - A-4; B-1; C-5; D-3; E-2
 - A-5; B-3; C-2; D-1; E-4
- Which of the following is an **INCORRECT** match of essential element and function? [2014]
 - Manganese - structural component of chlorophyll.
 - Calcium - component of the middle lamella.
 - Zinc - enzyme activator.
 - Iron - component of ferredoxin.
- Which of the following is the mismatched pair?

Mineral elements	Form that is absorbed by plant
(a) Nitrogen	NO_3^-
(b) Phosphorus	$H_2PO_4^-$
(c) Sulphur	H_2SO_4
(d) Iron	Fe^{3+}

[2016]

TYPE B : ASSERTION REASON QUESTIONS

Directions for (Qs. 9-10) : These questions consist of two statements, each printed as Assertion and Reason. While answering these questions, you are required to choose any one of the following five responses.

- If both Assertion and Reason are correct and the Reason is a correct explanation of the Assertion.

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- (b) If both Assertion and Reason are correct but Reason is not a correct explanation of the Assertion.
- (c) If the Assertion is correct but Reason is incorrect.
- (d) If both the Assertion and Reason are incorrect.
- (e) If the Assertion is incorrect but the Reason is correct.

9. **Assertion :** Plants lack excretory organs.

Reason : Plant usually absorb essential nutrients and lead a passive life. [1997]

10. **Assertion :** Plants absorb sulphur in the form of sulphate ions.

Reason : Sulphur bacteria are required for the formation of sulphate. [2007]

Topicwise AIIMS Solved Papers – BIOLOGY

Directions for (Q.11) : Each of these questions contains an Assertion followed by Reason. Read them carefully and answer the question on the basis of following options. You have to select the one that best describes the two statements.

- (a) If both Assertion and Reason are correct and Reason is the correct explanation of Assertion.
- (b) If both Assertion and Reason are correct, but Reason is not the correct explanation of Assertion.
- (c) If Assertion is correct but Reason is incorrect.
- (d) If both the Assertion and Reason are incorrect.

11. **Assertion :** Deficiency of sulphur causes chlorosis in plants.

Reason : Sulphur is a constituent of chlorophyll, protein and nucleic acids. [2004, 2014]

HINTS & SOLUTIONS**Type A : Multiple Choice Questions**

1. (b) The root nodules of leguminous plants contain a symbiotic nitrogen fixing bacteria *Rhizobium*. Root nodules are small irregular outgrowth of the roots which are pinkish internally due to presence of a pigment called leghaemoglobin. It is related to blood pigment haemoglobin. The cells of root nodules are tetraploid and contain polyhedral bacteria called bacteroids. Leghaemoglobin is an oxygen scavenger and protects the nitrogen fixing enzyme nitrogenase of bacteroids.
2. (b) The essential elements are divided into macroelements and microelements based on the quantity in which they are required by the plants. Mn, Cu, Mo, Zn, B, and Cl are the micronutrients needed in very small quantities by the plants. C, H, O, N, P, S, K, Ca, Mg, Fe are the macronutrients required in more quantity.
3. (d) In this process, one molecule of glucose undergoes partial oxidation to form 2 molecules of pyruvic acid.
4. (a) Micronutrient elements are those element which is required in less quantity. These are Cu, Zn, Mn, B, Cl, Mo and Ni. Some physiologist consider Fe as micronutrient.
5. (b) Molybdenum (Mo) is required for symbiotic nitrogen fixation by legumes. Plants requires molybdenum 0.1 to 2.5 ppm in their tissue for normal growth.

Molybdenum availability varies with soil type, being highest in organic soil, less in clay, least in sandy soil.

6. (d)
7. (a) Magnesium is a constituent of the ring structure of chlorophyll. Function of manganese is to activate many enzymes involved in photosynthesis, respiration and nitrogen metabolism. The best defined function of manganese is in the splitting of water to liberate oxygen during photosynthesis.
8. (c) Plants obtain sulphur in the form of sulphate (SO_4^{2-}).

Type B : Assertion Reason Questions

9. (b) Plants do lack excretory organs, but it is not due to absorption pattern or passive life. The carbon dioxide during respiration passes out through the stomata. The other waste materials comes out in the form of alkaloids, gums and resins.
10. (a) Sulphur is a constituent of amino acids (cystein and cystine and methionine). Sulphur is present in the soil in the form of oxides. Sulphur bacteria convert them into sulphate ions. The plants absorb sulphur in the form of sulphate ions.
11. (c) Due to deficiency of sulphur plant shows chlorosis (*i.e.*, yellowing due to degradation of chlorophyll) followed by anthocyanin development. The younger leaves show chlorosis before older ones. Sulphur is not the constituent of chlorophyll. The main constituent of chlorophyll is magnesium.

Chapter

13

Photosynthesis in Higher Plants

TYPE A : MULTIPLE CHOICE QUESTIONS

1. In C_4 plants, the first carbon dioxide acceptor is
(a) pyruvate (b) phosphoenol pyruvate (c) ribulose biphosphate (d) ribulose 5, phosphate [1997]
2. In photosynthesis, splitting of water and release of oxygen occurs during
(a) photolysis (b) red drop (c) Pasteur effect (d) Calvin cycle [1998]
3. Blackman's law of limiting factor is applied to
(a) respiration (b) transpiration (c) photorespiration (d) photosynthesis [2001]
4. Hill reaction occurs in
(a) high altitude plants (b) total darkness (c) absence of water (d) presence of ferricyanide [2003]
5. Which one of the following categories of organisms do not evolve oxygen during photosynthesis?
(a) Red algae (b) Photosynthetic bacteria (c) C_4 plants with Kranz anatomy (d) Blue green algae [2004]
6. What is PAR range?
(a) 200 nm - 800 nm (b) 400 nm - 700 nm (c) 350 nm - 550 nm (d) 600 nm - 100 nm [2007]
7. Through the use of oxygen-18 (heavy oxygen), scientists have found that the oxygen released during photosynthesis comes from molecules of
(a) carbon dioxide (b) water (c) glucose (d) chlorophyll [2009]
8. Select the incorrect statement
(a) C_4 pathway for CO_2 fixation were discovered by Hatch and Slack (b) CO_2 is essential for photosynthesis (c) Addition of sodium carbonate in water retards photosynthetic rate in vallisneria (d) Phloem is the principal pathway for translocation of solutes [2011]
9. The family in which many plants are C_4 type
(a) Malvaceae (b) Solanaceae (c) Crucifereae (d) Graminae [2012]
10. In the electron transport chain during terminal oxidation, the cytochrome, which donates electrons to O_2 is
(a) Cytochrome-b (b) Cyto-C (c) Cyto- a_3 (d) Cyto-f [2012]
11. Which one does not differ between a C_3 and a C_4 plant?
I. Initial CO_2 acceptor.
II. Extent of photorespiration.
III. Enzyme catalyzing reaction that fixes CO_2 .
IV. Presence of Calvin cycle.
V. Leaf anatomy.
(a) I and V (b) IV (c) II and III (d) II [2013]
12. The total requirement of ATP & NADPH for each molecule of CO_2 fixed & reduced in photosynthesis in the Calvin cycle is
(a) 2 ATP & 2 NADPH (b) 2 ATP & 3 NADPH (c) 3 ATP & 2 NADPH (d) 4 ATP & 3 NADPH [2014]
13. Consider the following statements regarding photosynthesis.
(A) ATP formation during photosynthesis is termed as photophosphorylation. [2015]

- (B) Kranz anatomy pertains to leaf.
- (C) Reduction of NADP^+ to NADPH occurs during Calvin cycle.
- (D) In a chlorophyll molecule, magnesium is present in phytol tail. Of the above statements [2015]
- (a) A and B are correct
- (b) C and D are correct
- (c) A and C are correct
- (d) A and D are correct

TYPE B : ASSERTION REASON QUESTIONS

Directions for (Qs. 14-23) : These questions consist of two statements, each printed as Assertion and Reason. While answering these questions, you are required to choose any one of the following five responses.

- (a) If both Assertion and Reason are correct and the Reason is a correct explanation of the Assertion.
- (b) If both Assertion and Reason are correct but Reason is not a correct explanation of the Assertion.
- (c) If the Assertion is correct but Reason is incorrect.
- (d) If both the Assertion and Reason are incorrect.
- (e) If the Assertion is incorrect but the Reason is correct.

14. **Assertion:** C_4 pathway of CO_2 fixation is found in some tropical plants.

Reason: In this pathway, CO_2 is fixed by 3C compound. [1998]

15. **Assertion :** Mitochondria helps in photosynthesis

Reason : Mitochondria have enzymes for dark reaction. [1999]

16. **Assertion:** Bacterial photosynthesis occurs by utilizing wavelength longer than 700 nm.

Reason: Here reaction centre is B-890. [2002]

17. **Assertion :** *Rhoeo* leaves contain anthocyanin pigments in epidermal cells.

Reason : Anthocyanins are accessory photosynthetic pigments. [2003]

18. **Assertion :** Cyclic pathway of photosynthesis first appeared in some eubacterial species.

Reason : Oxygen started accumulating in the atmosphere after the non-cyclic pathway of photosynthesis evolved. [2004]

19. **Assertion :** C_4 photosynthetic pathway is more efficient than the C_3 pathway.

Reason : Photorespiration is suppressed in C_4 plants. [2005]

20. **Assertion :** The atmospheric concentration of CO_2 at which photosynthesis just compensates for respiration is referred to as CO_2 compensation point.

Reason : The CO_2 compensation point is reached when the amount of CO_2 uptake is less than that generated through respiration because the level of CO_2 in the atmosphere is more than that required for achieving CO_2 compensation point. [2005]

21. **Assertion :** Under conditions of high light intensity and limited CO_2 supply, photorespiration has a useful role in protecting the plants from photo-oxidative damage.

Reason : If enough CO_2 is not available to utilize light energy for carboxylation to proceed, the excess energy may not cause damage to plants. [2006]

22. **Assertion :** Photosynthetically C_4 plants are less efficient than C_3 plants. [2006]

Reason : The operation of C_4 pathway requires the involvement of only bundle-sheath cells.

23. **Assertion :** Dark reaction is purely enzymatic reaction. [2007]

Reason : It occurs only in absence of light.

Directions for (Qs.24-30) : Each of these questions contains an Assertion followed by Reason. Read them carefully and answer the question on the basis of following options. You have to select the one that best describes the two statements.

- (a) If both Assertion and Reason are correct and Reason is the correct explanation of Assertion.
 - (b) If both Assertion and Reason are correct, but Reason is not the correct explanation of Assertion.
 - (c) If Assertion is correct but Reason is incorrect.
 - (d) If both the Assertion and Reason are incorrect.
24. **Assertion :** Dark reaction occurs only at night in the stroma of chloroplast.

Reason : CO_2 fixation occurs only during C_3 cycle. [2009]

25. **Assertion :** *Amaranthus* and sugarcane are called as Hatch & Slack plants.

Reason : One glucose is formed by fixation of 6 CO_2 in the plants. [2010]

26. **Assertion :** D.C.M.U. is a photosynthetic inhibitor. [2010]

Reason : D.C.M.U. inhibits a photolysis of water.

27. **Assertion:** The stromal thylakoids are rich in both PS I and PS II.

Reason: The stroma membranes are rich in ATP synthetase. [2011]

28. **Assertion :** Cyclic pathway of photosynthesis first appeared in some eubacterial species.

Reason : Oxygen started accumulating in the atmosphere after the non-cyclic pathway of photosynthesis evolved. [2012]

29. **Assertion :** Each molecule of ribulose-1, 5-bisphosphate fixes one molecule of CO_2 .

Reason : Three molecules of NADPH and two ATP are required for fixation of one molecule of CO_2 . [2013]

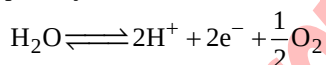
30. **Assertion:** Six molecules of CO_2 and twelve molecules of $\text{NADPH}^+ + \text{H}^+$ and 18 ATP are used to form one hexose molecule.

Reason: Light reaction results in formation of ATP and NADPH_2 . [2002, 2015]

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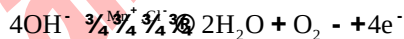
Type A : Multiple Choice Questions

1. (b) In C_4 plants, the first CO_2 acceptor is 3C compound, phosphoenol pyruvate.
2. (a) In photosynthesis, release of oxygen occurs during photolysis of water in light reaction.
3. (d) Blackman's law is applicable to photosynthesis. It states that when a process is conditioned as to its rapidity by number of factors, its rate is limited to the pace of slowest factor. Taking temperature into consideration, rate of photosynthesis is maximum at optimum temperature.
4. (a) Hill reaction or light reaction depends upon light. It involves photolysis of water and production of assimilatory power in the form of NADPH and ATP.
5. (b) Photosynthetic bacteria do not use H_2O as electron donor but some other compound like Fe^{2+} , H_2S .
In photosynthesis, splitting of water and liberation of O_2 by chlorophyll in presence of light and hydrogen acceptor is called photolysis of water.



[Photolysis of water]

6. (b) PAR (Photosynthetically active radiations) ranges between the wavelength 400-700nm.
7. (b) Oxygen which is liberated during photosynthesis comes from water. In photosynthesis, the light energy is captured by chlorophyll in the chloroplasts in plant leaves. This energy is used to split water apart in a process called photolysis.



8. (c) C_4 pathway for CO_2 fixation were discovered by Hatch and Slack. This pathway has more effective method of CO_2 fixation and is seen in plants like sugarcane. CO_2 is essential for photosynthesis. It is the source of carbon. The phloem or leptome is the pathway for movement of solutes.

9. (d) C_4 cycle occurs in 1500 species of 19 angiospermic families but most of the plants are monocots which belong to gramineae and cyperaceae family.
10. (c) In ETS or respiratory chain, there are five cytochromes cyto-b, cyto- c_1 , cyto-c, cyto-a, cyto- a_3 . Cytochrome a_3 is last cytochrome of ETS which denotes electrons to O_2 due to this metabolic water is formed.
11. (b)
12. (c) For every CO_2 molecule entering the Calvin cycle, 3 molecules of ATP and 2 molecules of NADPH are required.
13. (a) During Calvin cycle, NADPH is oxidised to NADP. In a chlorophyll molecule, magnesium is present in the porphyrin ring.

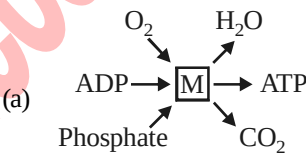
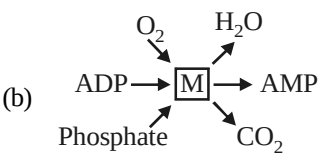
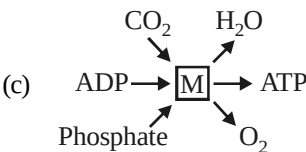
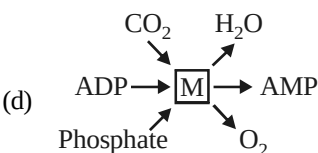
Type B : Assertion Reason Questions

14. (b) C_4 pathway is an adaptation of tropical plants to reduce/avoid the photorespiratory loss. In C_4 pathway, first acceptor of CO_2 is a 3 carbon compound - phosphoenol pyruvate.
15. (d) Mitochondria helps in cellular respiration by transferring energy from organic compounds to ATP. Chloroplast helps in photosynthesis. Dark reaction takes part in the stroma of the chloroplast.
16. (b) In bacteria, photosynthesis utilizes light wavelength more than 700 nm and their reaction centre is B-890.
17. (c) Anthocyanin pigments only give colouration since the epidermal cells mainly have potential colouring pigments. It is responsible of blue, red, pink and purple colours, observed in different parts of plants such as petals, stamens and fruits etc.
Anthocyanin are also important for attracting insects for pollination and seed dispersal. Hence, Anthocyanin pigments are not accessory photosynthetic pigments.
18. (b) Photosynthetic bacteria have a substance called bacteriochlorophyll. The bacteriochlorophyll pigment absorbs light in the extreme UV and infra-red parts of the

- spectrum which is outside the range used by normal chlorophyll, seen in plants.
19. (a) C_4 pathway/Hatch and Slack pathway ensures the Calvin cycle to be operated only in bundle sheath cell. It is an adaptation to photorespiratory loss. Therefore, C_4 plants are adapted to photorespiratory loss.
 20. (c) Compensation point is that value or point in the light intensity and atmospheric CO_2 concentration when the rate of photosynthesis is just equivalent to the rate of respiration in the photosynthetic organ. So that there is not net gaseous exchange.
 21. (c) Photorespiration is the uptake of O_2 and release of CO_2 in light and results from the biosynthesis of glycolate in chloroplasts and subsequent metabolism of glycolate acid in the same leaf cell. During photorespiration loss of carbon takes place in the form of CO_2 .
 22. (d) C_4 plants are more efficient in picking up CO_2 even when it is found in low concentration because of its high affinity for PEP. They show kranz anatomy i.e. vascular bundle is surrounded by bundle sheath and mesophyll cells.
 23. (e) During photosynthesis, assimilatory power ATP and $NADPH_2$ are produced which require light. This reaction is called light reactions or Hill's reaction. Assimilatory powers are required for the reduction of CO_2 . This reaction is enzymatic and independent of light. It is called dark reaction which takes place in stroma of chloroplast. So, dark reaction is independent of presence or absence of light.
 24. (d) Dark reaction is also known as light-independent phase. Unlike, light reaction, it does not require light as an essential factor. Thus, can take place both in the presence or absence of light. The term dark reaction does not mean that it takes place only in dark period or at night. CO_2 fixation occurs in both C_3 and C_4 cycle. In C_3 cycle, CO_2 is added by the enzyme, RuBisCo to a 5 carbon compound RuBP that is converted to 2 molecules of 3-carbon PGA. In C_4 cycle, the first product of CO_2 fixation (takes place in mesophyll) is a 4-carbon compound, oxaloacetic acid. It is seen in some tropical plants.
 25. (b) *Amaranthus* sp and sugarcane are known as Hatch and Slack plants. In Hatch and Slack pathway, one glucose molecule is formed by fixation of $6CO_2$ in the plants.
 26. (a) DCMU (Dichlorophenyl dimethyl urea) is a herbicide that can prevent non cyclic photophosphorylation and oxygen production. It inhibits photolysis of water.
 27. (d) The grana stacks of membranes are enriched in PS II and LHC (Light harvesting centre), while there is little ATP synthetase. On the other hand, a fraction of stroma thylakoids is rich in PS I and ATPase and poor in PS II and LHC.
 28. (b) Cyclic pathway of photosynthesis is appeared first in some eubacterial species. It is supposed to be the first evidence of production of ATP in the presence of light. During non-cyclic photophosphorylation photolysis of water takes place. Under the influence of light energy and the catalytic action of chlorophyll, water is split up into oxygen and hydrogen. Non-cyclic photophosphorylation is the only natural process which adds molecular oxygen to the atmosphere.
 29. (c) Each molecule of ribulose-1, 5-biphosphate fixes one molecule of carbon dioxide with the addition of water, thereby resulting in the formation of two molecules of 3-phosphoglyceric acid (3-PGA). The fixation and reduction of one molecule of CO_2 requires three molecules of ATP and two of $NADPH$, coming from the photochemical reactions.
 30. (b) Light reaction or Hill reaction results in the formation of ATP and $NADPH_2$, $6CO_2$, $6H_2O$, ATP and $NADPH_2$ are utilised to produce one molecule of glucose.

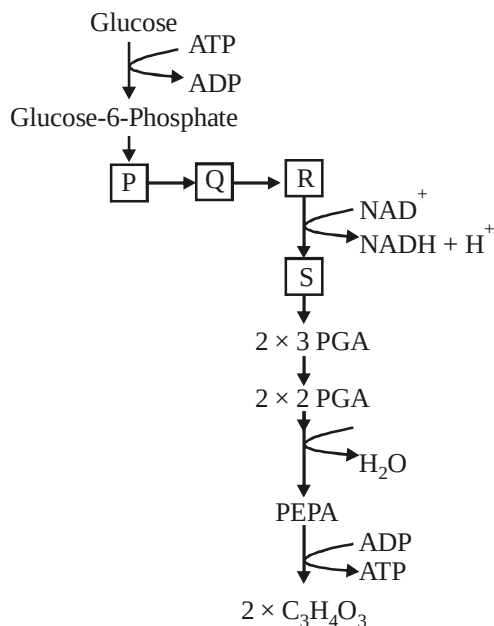
Respiration in Plants

TYPE A : MULTIPLE CHOICE QUESTIONS

- Glycolysis occurs in [2000]
 - mitochondria
 - chloroplast
 - cytoplasm
 - peroxisome
- Anaerobic respiration, after glycolysis is also called as [2002]
 - fermentation
 - fragmentation
 - restoration
 - multiplication
- In glycolysis, glucose molecule is converted into [2002]
 - PEP
 - RuBP
 - acetyl CoA
 - pyruvic acid
- Photorespiration in C_3 plants starts from [2003]
 - phosphoglycerate
 - phosphoglycolate
 - glycerate
 - glycine
- Which of the following is the connecting link between glycolysis and Krebs cycle? [2007]
 - Acetyl CoA
 - Oxalosuccinic acid
 - Pyruvic acid
 - Citric acid
- Pyruvate kinase enzyme catalyses [2010]
 - first irreversible step of glycolysis
 - second irreversible step of glycolysis
 - third irreversible step of glycolysis
 - fourth irreversible step of glycolysis
- An enzymes of TCA cycle are located in the mitochondrial matrix except one which is located in inner mitochondrial membrane in eukaryotes and in cytosol in prokaryotes. This enzyme is [2012]
 - Succinate dehydrogenase
 - Lactate dehydrogenase
 - Isocitrate dehydrogenase
 - Malate dehydrogenase
- Which of the metabolites is common to respiration mediated breakdown of fats, carbohydrates and proteins? [2014]
 - Fructose 1, 6 - biphosphate
 - Pyruvic acid
 - Acetyl CoA
 - Glucose - 6 - phosphate
- Which of the following representation correctly explain the function of mitochondrion? [2015]
 - 
 - 
 - 
 - 

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10. Refer the figure and answer the question.



Choose the correct names of P, Q, R, and S.

[2015]

	P	Q	R	S
(a)	1,3 di PGA	3 PGAl d	Fr.1,6 di P	Fr. 6 P
(b)	3 PGA1 d	1,3 di PGA	Fr. 1,6 di P	Fr.6 P
(c)	Fr. 1,6 di P	Fr. 6 P	3 PGAl d	1,3 di PGA
(d)	Fr.6 P	Fr. 1,6 di P	3 PGAl d	1,3 di PGA

11. By which of the following complex, proton is pumped to reach ATP synthase to participate in ATP synthesis?

- Cytochrome b_6f
- Cytochrome c oxidase
- Cytochrome $a - a_3$
- Cytochrome bc

[2016]

12. Which of the following statements (i to v) regarding glycolysis are correct.

- It is ten enzymatic reactions that convert a six-carbon molecule to a three carbon pyruvate and result in a net gain of 2 ATP molecules.
- Glucose undergoes partial oxidation to form one molecule of pyruvic acid.

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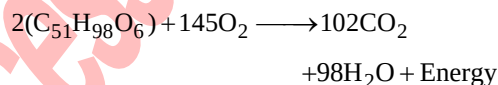
(iii) Glucose is phosphorylated to give rise to glucose - 6 - phosphate by the activity of the enzyme phosphofructokinase.

(iv) The scheme of glycolysis was given by Gustav Embden, Otto Morrison, and J. Parnas and is often referred to as the EMP pathway.

(v) ATP is utilized at two steps: first in the conversion of glucose into glucose 6-phosphate & second in the conversion of fructose - 6- phosphate to fructose 1, 6-disphosphate. [2016]

- (i), (iv) and (v)
- (iii) and (v)
- (iv) and (v)
- (ii) and (iv)

13. Refer the given equation and answer the question.



The R.Q of above reaction is [2017]

- 1
- 0.7
- 1.45
- 1.62

14. In alcoholic fermentation, NAD⁺ is produced during the [2017]

- reduction of acetyldehyde to ethanol.
- oxidation of glucose.
- oxidation of pyruvate to acetyl coA.
- hydrolysis of ATP to ADP.

TYPE B : ASSERTION REASON QUESTIONS

Directions for (Q. 15) : These questions consist of two statements, each printed as Assertion and Reason. While answering these questions, you are required to choose any one of the following five responses.

- If both Assertion and Reason are correct and the Reason is a correct explanation of the Assertion.
- If both Assertion and Reason are correct but Reason is not a correct explanation of the Assertion.
- If the Assertion is correct but Reason is incorrect.
- If both the Assertion and Reason are incorrect.
- If the Assertion is incorrect but the Reason is correct.

15. Assertion : Stomata are absent in submerged hydrophytes.

Reason : Respiration occurs by means of air chambers in submerged plants. **[1997]**

Directions for (Qs.16-18) : Each of these questions contains an Assertion followed by Reason. Read them carefully and answer the question on the basis of following options. You have to select the one that best describes the two statements.

- (a) If both Assertion and Reason are correct and Reason is the correct explanation of Assertion.
- (b) If both Assertion and Reason are correct, but Reason is not the correct explanation of Assertion.
- (c) If Assertion is correct but Reason is incorrect.
- (d) If both the Assertion and Reason are incorrect.

16. Assertion : Glycolysis is the first step of respiration in which glucose completely breaks into CO_2 and H_2O .

Reason : In this process, there is net gain of twenty four molecules of ATP. **[2009]**

17. Assertion : The inner membrane of mitochondria contains systems involving electron transport.

Reason : The mitochondrial matrix contains enzymes of Kreb's cycle. **[2013]**

18. Assertion : Glycolysis occurs in cytoplasm.

Reason : Enzymes for glycolysis are found in cytoplasm. It is common in aerobic/anaerobic respiration. **[2002, 2014]**

HINTS & SOLUTIONS

Type A : Multiple Choice Questions

1. (c) All the enzymes required for the different steps of glycolysis (1st step in cellular respiration) are present in the cytoplasm.
2. (a) Glycolysis is a common step for both aerobic and anaerobic respiration. Next step after glycolysis is fermentation in anaerobic respiration which leads to the formation of ethanol or lactic acid.
3. (d) In glycolysis, one molecule of glucose undergoes partial oxidation to form 2 molecules of pyruvic acid.
4. (a) In C_3 plants, photorespiration starts from 3-phosphoglycerate. Photorespiration is also called glycolate pathway.
5. (a) Acetyl CoA is the connecting link between glycolysis and Krebs cycle. Acetyl CoA combines with oxalo acetic acid to form citric acid during Krebs cycle.
6. (c) Pyruvate kinase enzyme catalyses third irreversible step of glycolysis.

$$2 \text{ Phosphoenol pyruvic acid} + 2\text{ADP} \xrightarrow[\text{Mg}^{2+}, \text{K}^+]{\text{Pyruvate kinase}} \text{Pyruvic acid} + \text{ATP}.$$
7. (a) All the oxidative enzymes of TCA are located in matrix except succinic dehydrogenase. This enzyme catalysed the conversion of succinic acid into fumaric acid. The enzyme is an integral protein complex that is tightly bound to the inner mitochondrial membrane. Infact this enzyme is the preferred marker enzyme for inner membranes when doing mitochondrial fractionations.
8. (c) Acetyl CoA is common to respiration mediated breakdown of fats, carbohydrates and proteins. Fats are broken down to fatty acid and glycerol and again fatty acid degraded to acetyl CoA. Protein first degraded by proteases to individual amino acids which deaminated to pyruvic acid and further decarboxylised to acetyl CoA.
9. (a) The main function of mitochondrion is the generation of ATP from ADP and inorganic phosphate during cellular respiration.
10. (d)
11. (a) With the help of cytochrome b_6f , proton is pumped to reach ATP synthetase to participate in ATP synthesis.
12. (a) Glucose undergoes partial oxidation to form two molecules of pyruvic acid, Glucose is phosphorylated to give rise to glucose-6-phosphate by the activity of the enzyme hexokinase. The scheme of glycolysis was given by Gustav Embden, Otto Meyerhof, and J. Parnas, and is often referred to as the EMP pathway.
13. (b) The ratio of the volume of CO_2 liberated to the volume of oxygen absorbed per molecule during respiration is called Respiratory Quotient (RQ). The value of RQ indicates the types of respiratory substrate.

$$\text{RQ} = \frac{\text{Volume of } \text{CO}_2 \text{ evolved}}{\text{Volume of } \text{O}_2 \text{ consumed}}$$

$$\text{RQ} = \frac{102}{145} = 0.7$$
14. (a) Alcoholic fermentation is a process in which molecules such as glucose etc. are converted into cellular energy and thereby produce ethanol and carbon dioxide as metabolic waste products. During alcoholic fermentation, NAD^+ is produced when acetaldehyde is reduced to ethanol.

Type B : Assertion Reason Questions

15. (b) Stomata are absent since gaseous exchange takes place through diffusion in submerged plants.
16. (d) Glycolysis is the process of breakdown of glucose or similar hexose sugar into two molecules of pyruvic acid through a series of enzyme mediated reactions, releasing

energy (ATP) and reducing power (NADH_2). It is the first step of respiration, which occurs inside the cytoplasm and is independent of O_2 . In glycolysis, two molecules of ATP are consumed during double phosphorylation of glucose to form fructose 1, 6 diphosphate. Four molecules of ATP are produced in the conversion of 1, 3-diphosphoglycerate to 3-phosphoglycerate and phosphoenol pyruvate to pyruvate whereas, two molecules of NADH_2 are formed during oxidation of glyceraldehyde 3-phosphate to 1,3-diphosphoglycerate. Since, each NADH is equivalent to 3 ATP, so net gain in glycolysis is 8 ATP.

17. (b) Electron transport system is a series of co-enzymes and cytochromes that takes part in the passage of electrons from a chemical to its ultimate receptor. The mitochondrial matrix contains all the soluble enzymes of the citric acid or Krebs' cycle and those involved in the oxidation of fatty acids.
18. (a) Glycolysis occurs in cytoplasm as all necessary enzymes are found in it. This process is common in aerobic/anaerobic respiration. In this process, one glucose molecule is converted into 2 molecules of pyruvic acid.

Chapter

15

Plant Growth and Development

TYPE A : MULTIPLE CHOICE QUESTIONS

1. In plant, auxin synthesis occurs in [1997]
 - (a) cortex
 - (b) xylem
 - (c) phloem
 - (d) root and shoot tips
2. Which of the following hormone induces cell division? [1997]
 - (a) Auxin
 - (b) Gibberellin
 - (c) Cytokinin
 - (d) Trypsin
3. Which is a weedicide? [1998]
 - (a) IAA
 - (b) 2,4-D
 - (c) IBA
 - (d) NAA
4. Which of the following is gaseous hormone?
 - (a) Auxin
 - (b) Ethylene [1998]
 - (c) Cytokinin
 - (d) GA
5. A plant cell has potential to develop into a full plant. This is called [1998]
 - (a) totipotency
 - (b) gene cloning
 - (c) tissue culture
 - (d) regeneration
6. Which of the following induces dormancy?
 - (a) Auxin
 - (b) Cytokinin [1999]
 - (c) Both (a) and (b)
 - (d) Absciscic acid
7. The plant hormone controlling fruit ripening is
 - (a) IAA
 - (b) GA [1999]
 - (c) ABA
 - (d) Ethylene
8. Induction of cell division and delay in senescence is done by [2001]
 - (a) cytokinins
 - (b) auxins
 - (c) GA
 - (d) CoA
9. Curling of tendrils is due to [2001]
 - (a) thigmotropism
 - (b) phototropism
 - (c) chemotropism
 - (d) nyctinasty
10. Bud dormancy can be induced by [2002]
 - (a) IAA
 - (b) GA
 - (c) ABA
 - (d) ethylene
11. *Avena* curvature test is a bioassay for examining the activity of [2006]
 - (a) auxins
 - (b) gibberellins
 - (c) cytokinins
 - (d) ethylene
12. Induction of cell division and delay in senescence is done by [2011]
 - (a) Cytokinins
 - (b) Auxins
 - (c) GA
 - (d) CoA
13. Gibberellins can promote seed germination because of their influence on [2005, 2012]
 - (a) Rate of cell division
 - (b) Production of hydrolyzing enzymes
 - (c) Synthesis of absciscic acid
 - (d) Absorption of water through hard seed coat.
14. Study the following statements. [2013]
 - I. "X" hormone promotes root growth and root hair formation thus helping the plants to increase their absorption surface.
 - II. "Y" hormone induces flowering in mango and also promotes rapid internode/petiole elongation in deep plants and hence helping leaves or upper parts of shoot above water.
 - III. "Z" hormone inhibits the seed germination, increase the tolerance of plant to various stresses, play import in seed development, maturation and dormancy.

Identify the correct names of hormones marked as 'X', 'Y' & 'Z'.

 - (a) Y = ABA; X = Auxin; Z = GA
 - (b) Z = GA; X = Auxin; Y = C_2H_4
 - (c) Y = Auxin; X = C_2H_4 ; Z = GA
 - (d) Y = C_2H_4 ; X = C_2H_4 ; Z = ABA
15. Identify the correct and incorrect statements from the following.
 - (i) 17,500 new cells are produced per hour by a single maize root apical meristem.
 - (ii) With the help of length, growth of pollen tube is measured.
 - (iii) The growth of the leaf is measured in term of volume.
 - (iv) Cells in a watermelon may increase in size by upto 3,50,000 times. [2016]

- (a) (i), (ii), (iii) are correct and (iv) is incorrect.
- (b) (i), (ii), (iv) are correct and (iii) is incorrect.
- (c) (ii), (iii) are correct and (i), (iv) are incorrect.
- (d) (i), (iv) are correct and (ii), (iii) are incorrect.

TYPE B : ASSERTION REASON QUESTIONS

Directions for (Qs. 16-19) : These questions consist of two statements, each printed as Assertion and Reason. While answering these questions, you are required to choose any one of the following five responses.

- (a) If both Assertion and Reason are correct and the Reason is a correct explanation of the Assertion.
- (b) If both Assertion and Reason are correct but Reason is not a correct explanation of the Assertion.
- (c) If the Assertion is correct but Reason is incorrect.
- (d) If both the Assertion and Reason are incorrect.

16. **Assertion :** Dark period plays more important part in flowering than light period.

Reason : Flowering occurs in short-day plant if the dark period is interrupted by light break.

[2013]

17. **Assertion :** Photomodulation of flowering is a phytochrome regulated process.

Reason : Active form of phytochrome (P_{FR}) directly induces floral induction in shoot buds.

[2015]

18. **Assertion (A) :** Vernalization is acceleration of subsequent flowering by low temperature treatment.

Reason (R) : Site of vernalization is apical meristem.

[2015]

19. **Assertion :** Auxins help to prevent fruit and leaf drop at early stages.

Reason : Auxins promote the abscission of older mature leaves and fruits.

[2017]

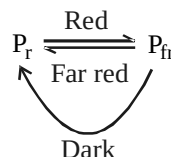
HINTS & SOLUTIONS

Type A : Multiple Choice Questions

1. (d) Auxin is a plant hormone which promote and regulate its growth and development. Auxin are produced in the meristem of shoot tips and move down the plant causing various effects.
2. (c) Cytokinins are substances which act primarily on cell division and have little or no effect on extension/growth. It delays the senescence of leaves.
3. (b) 2, 4-D (dichlorophenoxyacetic acid) is a common systemic pesticide/herbicide. It is a synthetic auxin (plant hormone) and is used for killing broad leaved weeds (generally dicot).
4. (b) Ethylene is the only gaseous natural plant growth regulator produced by all plant organs but its maximum production occurs in ripening fruits and during senescence.
5. (a) Any cell which has an ability to develop into a complete organism is totipotent.
6. (d) Absciscic acid (ABA) induces dormancy. Robinson and Warming (1964), isolated a substance responsible for dormancy in *Acer pseudoplatanus*, and named it as dormin. This hormone was similar to abscissin. It is a naturally occurring hormone that is present in all vascular plants and some mosses but is not present in bacteria, algae, fungi and liverworts. This hormone is responsible for dormancy.
7. (d) Fruit ripening is controlled by hormone, ethylene. Ethylene is a gaseous hormone. It affects the growth, development, ripening and senescence (aging) of all plants.
8. (a) Cytokinins promote cell division and inhibit the degradative reactions in detached leaves and slow down senescence in intact leaves. The effect of cytokinin in retarding ageing is called the Richmond Lang Effect.
9. (a) The curling of tendrils is a growth movement induced due to contact or touch. Such a movement is called thigmotropic movement. When the tip of the tendril comes in contact with an uneven surface, it coils around the support. This is due to the differential growth in the tendril.
10. (c) Absciscic acid (ABA) is a plant hormone which promotes dormancy in seeds and buds.
11. (a) Went (1928) performed *Avena* curvature test for auxins.
12. (a) Cytokinins promote cell division and inhibit the degradative reactions in detached leaves and slow down senescence in intact leaves. The effect of cytokinin in retarding ageing is called the Richmond Lang Effect.
13. (b) Gibberellins can promote seed germination in cereals due to production of hydrolyzing enzymes like α amylase and proteases.
14. (d) Gibberellins stimulate the production of some mRNAs and then hydrolytic enzymes like amylase, lipase ribonuclease and proteases. The enzymes solubilise the reserve food of the seeds and the same is transferred to embryo axis for its growth.
15. (b) The growth of the leaf is measured in term of surface area.

Type B : Assertion Reason Questions

16. (c) It has been demonstrated that flowering in plant is more of a response to the dark period than to the light period. In short day plants, the plants can flower in complete darkness if supplied with exogenous nutrients. Flowering is prevented in them if dark period below the critical level is interrupted by a flash of light. Interruption of light by dark inhibits flowering under normal photoperiods.
17. (a) Active form of PFR is responsible for inducing flowering. Phytochrome, protein pigment, exists in two inter convertible forms.



18. (b) The physiological mechanism of flowering in plants is controlled by two factors—light period and low temperature. The cold treatment of plants to induce flowering is called vernalization. Term vernalization was first given by T.D.Lysenko(1928). As a result of vernalization a flowering hormone called vernaline is formed. Site of vernalization is apical meristem.
19. (b) Auxin delays abscission of young leaves and fruits. Its effect is through non-formation of abscission zone below a leaf or fruit. Abscission zone cuts off nutrients and water supply. However, auxin promotes the abscission of mature or older leaves and fruits.

Chapter

16

Digestion and Absorption

TYPE A : MULTIPLE CHOICE QUESTIONS

1. Tocopherol stands for [1997]
 - (a) Vitamin A (b) Vitamin E
 - (c) Vitamin C (d) Vitamin K
2. Scurvy is caused due to deficiency of vitamin [1997]
 - (a) A (b) B
 - (c) E (d) C
3. The contraction of gall bladder is due to [1998]
 - (a) gastrin (b) secretin
 - (c) cholecystokinin (d) enterokinase
4. The function of rennin is [1999]
 - (a) vasodilation
 - (b) reduce blood pressure
 - (c) degradation of angiotensinogen
 - (d) none of the above
5. Liver in our body stores [1999]
 - (a) Vitamin A (b) Vitamin D
 - (c) Vitamin B₁₂ (d) All of these
6. Vitamin C is also called as [2000]
 - (a) ascorbic acid (b) glutamic acid
 - (c) aspartic acid (d) enolic acid
7. Brunner's glands are present in [2001]
 - (a) duodenum (b) oesophagus
 - (c) ileum (d) stomach
8. Curdling of milk in small intestine takes place due to [2002]
 - (a) rennin (b) trypsin
 - (c) chymotrypsin (d) ptyalin
9. Which of the following has minimum pH? [2002]
 - (a) Bile (b) Saliva
 - (c) Gastric juice (d) Pancreatic juice
10. Which of following teeth are lophodont? [2002]
 - (a) Incisor and canine
 - (b) Premolar and molar
 - (c) Canine and premolar
 - (d) Premolar and incisor
11. Wharton's duct is the duct of [2002]
 - (a) Parotid gland
 - (b) Sublingual gland
 - (c) Submaxillary gland
 - (d) Pancreatic gland
12. Continued consumption of a diet rich in butter, red meat and eggs for a long period may lead to [2003]
 - (a) vitamin A toxicity
 - (b) kidney stones
 - (c) hypercholesterolemia
 - (d) urine laden with ketone bodies
13. Which one of the following pairs of the cells with their secretion is **correctly** matched? [2006]
 - (a) Oxyntic cells - A secretion with pH between 2.0 and 3.0
 - (b) Alpha cells of Islets of Langerhans - Secretion that decreases blood sugar level.
 - (c) Kupffer cells - A digestive enzyme that hydrolysis nucleic acids.
 - (d) Sebaceous glands - A digestive enzyme that hydrolysis nucleic acids
14. Which match is true? [2007]

Vitamin deficiency disease	Vitamin	Source
(a) Severe bleeding	Tocopherol	Milk, egg
(b) Anaemia	Ascorbic acid	Lemon, orange
(c) Night blindness	Retinol	Carrot, milk
(d) Sterility	Calciferol	Milk, butter
15. A child took sugar cane and sucked its juice. Regarding this which of the following match is correct? [2007]

Substrate of enzyme	Enzyme secretion	Site of formation	Products
(a) Proteins	Pepsin	Duodenum	Polypeptides
(b) Starch	Amylase glands	Salivary	Glucose
(c) Lipids	Lipase globules	Pancreas	Fat
(d) Sucrose	Invertase Fructose	Duodenum	Glucose +
16. Which one of the following pairs of the kind of cells and their secretion are correctly matched? [2008]
- (a) Oxyntic cells – A secretion with pH between 2.0 and 3.0
- (b) Alpha cells of (Nutrition) islets – Secretion of Langerhans that decreases blood sugar level
- (c) Kupffer cells – A digestive enzyme that hydrolyses nucleic acids
- (d) Sebaceous glands – A secretion that evaporates for cooling
17. Fat present below the skin surface in our body, acts as a barrier against [2010]
- (a) loss of heat from the body
- (b) loss of essential body fluids
- (c) loss of salts from the body
- (d) entry of harmful micro-organisms from the environment
18. The nutritional deficiency condition that needs to be given top priority for remedial action in India today is [2010]
- (a) scurvy (b) rickets
- (c) xerophthalmia (d) pellagra
19. What is the average fat content of buffalo milk? [2010]
- (a) 7.2% (b) 4.5%
- (c) 9.0% (d) 10.9%
20. Consumption of fish is considered to be healthy when compared to flesh of other animals because when compared to flesh of other animals, fish contains [2010]
- (a) polyunsaturated fatty acids
- (b) saturated fatty acids
- (c) essential vitamins
- (d) more carbohydrates and proteins
21. Endoscopy, a technique used to explore the stomach or other inner parts of the body, is based on the phenomenon of [2010]
- (a) total internal reflection
- (b) interference
- (c) diffraction
- (d) polarization
22. Lathyrism is caused by excessive consumption of [2010]
- (a) khesari dal (b) mustard oil
- (c) polished rice (d) mushrooms
23. The normal temperature of human body on the Kelvin scale is [2010]
- (a) 280 (b) 290
- (c) 300 (d) 310
24. Parotid salivary glands are present [2012]
- (a) Below the tongue
- (b) Below the cheeks
- (c) In the angle between two jaws
- (d) Below the eye orbits
25. If for some reason the parietal cells of the gut epithelium become partially non-functional, what is likely to happen? [2015]
- (a) The pancreatic enzymes and specially the trypsin and lipase will not work efficiently
- (b) The pH of stomach will fall abruptly
- (c) Steapsin will be more effective
- (d) Proteins will not be adequately hydrolysed by pepsin into proteoses and peptones
26. A healthy person eats the following diet - 5 gm raw sugar, 4 gm albumin, 10 gm pure buffalo ghee adulterated with 2 gm vegetable ghee (hydrogenated vegetable oil) and 5 gm lignin. How many calories he is likely to get? [2014, 2016]
- (a) 144 (b) 126
- (c) 164 (d) 112
27. Which of the following statement is true? [2017]
- (a) Pepsin cannot digest casein.
- (b) Trypsin can digest collagen.
- (c) Pepsin cannot digest collagen.
- (d) Chymotrypsin can digest casein.

TYPE B : ASSERTION REASON QUESTIONS

Directions for (Q. 28) : These questions consist of two statements, each printed as Assertion and Reason. While answering these questions, you are required to choose any one of the following five responses.

- If both Assertion and Reason are correct and the Reason is a correct explanation of the Assertion.
- If both Assertion and Reason are correct but Reason is not a correct explanation of the Assertion.
- If the Assertion is correct but Reason is incorrect.
- If both the Assertion and Reason are incorrect.
- If the Assertion is incorrect but the Reason is correct.

28. Assertion : Scurvy is caused by deficiency of vitamin.

Reason : Deficiency of ascorbic acid causes scurvy.

[2001]

Directions for (Qs.29-35) : Each of these questions contains an Assertion followed by Reason. Read them carefully and answer the question on the basis of following options. You have to select the one that best describes the two statements.

- If both Assertion and Reason are correct and Reason is the correct explanation of Assertion.
- If both Assertion and Reason are correct, but Reason is not the correct explanation of Assertion.
- If Assertion is correct but Reason is incorrect.
- If both the Assertion and Reason are incorrect.

29. Assertion : In the condition of obstructive jaundice, large amounts of unabsorbed fats are eliminated out of the body.

Reason : Entry of bile into the small intestine is prevented during obstructive jaundice. [2009]

30. Assertion : Pancreatic amylase digest starch to maltose. [2010]

Reason : Pancreatic amylase breaks the peptide bond of protein.

31. Assertion : Trypsin helps in blood digestion of predator animals.

Reason : Trypsin hydrolyzes fibrinogen.

[2011]

32. Assertion : Lipases of bile help in the emulsification of fats.

Reason : Lipases can break large fat droplets into smaller ones. [2011]

33. Assertion : In the condition of obstructive jaundice, large amounts of unabsorbed fats are eliminated out of the body.

Reason : Entry of bile into the small intestine is prevented during obstructive jaundice.

[2015]

34. Assertion : Starch is hydrolysed by ptyalin to maltose.

Reason : Sucrase hydrolyses sucrose to lactose.

[2016]

35. Assertion : Water and electrolytes are almost fully absorbed in the large intestine.

Reason : In large intestine, haustral contractions (slow segmenting movements) roll the forming faeces over and over, causing absorption of water and electrolytes. [2017]

HINTS & SOLUTIONS**Type A : Multiple Choice Questions**

1. (b) Tocopherol or vitamin E is fat soluble vitamin. It is antisterility factor and antioxidant for membrane lipids, skin, and hair *etc.* It reduces atherosclerosis and inhibits oxidation of vitamin A and unsaturated fatty acid. Retinol, ascorbic acid and phyloquinone stands for vitamin A, C and K respectively.
2. (d) Deficiency of vitamin C (which is necessary for collagen production and iron absorption) causes scurvy. It is characterised by bleeding of gums, disturbance of protein metabolism and increased susceptibility to infections.
Scurvy is most frequently seen in order, malnourished adults. Scurvy commonly is associated with sailors in the 16th to 18th centuries who navigated long voyages without enough vitamin C frequently perished from the condition.
Deficiency of vitamin A, B and E results in xerophthalmia, beri-beri and miscarriage respectively.
3. (c) The contraction of gall bladder occurs due to hormone, cholecystokinin.
Cholecystokinin is a gastrointestinal hormone that is secreted by cells in the duodenum. Its release is stimulated by the presence of fatty acids and amino acids in the small intestine. It stimulates the release of bile into the intestine by contracting gall bladder and the secretion of pancreatic enzymes. Gastrin and secretin are polypeptide hormones. Gastrin, secreted by certain cells of the pyloric glands, stimulates secretion of gastric juice into the bloodstream and churning movement of stomach. Secretin is secreted by the mucosa of the duodenum and jejunum. It stimulates secretion of water and bicarbonates in bile and activates pancreas to secrete pancreatic juice. Enterokinase of enteropeptidase is an enzyme, secreted from duodenum's glands, called the crypts of Lieberkuhn, it converts inactive trypsinogen into active trypsin.
4. (d) Rennin (also called rennet or chymosin) is an coagulating enzyme produced from stomach of human body. It catalyzes the coagulation of milk by converting milk with soluble protein caesin into insoluble semi fluid calcium paracaesinate. This is called curdling of milk. Rennin produced in the infants immediately after birth. As the child grows, rennin production goes down and is replaced by pepsin digestive enzymes.
Renin is an enzyme which acts as hormone secreted by juxtaglomerular cells. It converts angiotensinogen into angiotensin.
5. (d) Liver is the largest organ in the body. It helps in digestion and removes waste products and worn-out cells from the blood. Liver performs many functions, like it forms and secretes bile that contains bile acids to aid in the intestinal absorption (taking in) of fats and the fat-soluble vitamins as A, D, E, K and B₁₂. Hence, it stores vitamins as A, D, E, K and B₁₂.
6. (a) Vitamin C (also called as ascorbic acid) is a water soluble vitamin. It helps the body to make collagen, an important protein used to make skin, cartilage, tendons, ligaments and blood vessels. Vitamin C is essential for healing wounds, and for repairing and maintaining bones and teeth.
7. (a) Brunner's glands are compound tubular glands found only in the sub-mucosa of duodenum. They produce mucoid fluid which protects the duodenal mucosa from acidic chyme coming from the stomach.
8. (a) Trypsin changes chymotrypsinogen to chymotrypsin and procarboxypeptidase to carboxypeptidase. Chymotrypsin changes caesin of milk into paracaesin. Ptyalin or salivary amylase converts starch and glycogen into limit dextrins, maltose and isomaltose.

9. (c) pH of bile is 8; pH of saliva is 6.7, pH of pancreatic juice is 8.8 and that of stomach is 2.
10. (b) Premolar and molar are lophodont teeth. Lophodont teeth with the cusps elongated to form narrow ridges. The molars in elephants and horses have cusps fused by means of intermediate masses of dentine to form ridges or lophs.
11. (c) Wharton's duct is the duct of the submaxillary or submandibular gland that occurs in the mouth on a papilla at the side of the frenulum of the tongue. The purpose of this duct is to drain the saliva.
12. (c) Continued consumption of fat rich diet causes hypercholesterolemia. Hypercholesterolemia is the presence of high levels of cholesterol in the blood. High cholesterol raises your risk for heart disease, heart attack, and stroke. Kidney stones are solid mass made up of tiny crystals. There are different types of kidney stones. The exact cause depends on the type of stone like, calcium stones, uric acid stone *etc.* Vitamin A toxicity or hypervitaminosis A is having too much of vitamin A in the body. Ketonuria is condition in which ketone bodies are present in urine. Body produces excess ketone bodies as an alternate source of energy during starvation or diabetes mellitus (type 1).
13. (a) Oxyntic cells or Parietal cells, are the stomach epithelium cells that secrete gastric acid intrinsic factor. These cells secrete hydrochloric acid (HCl) which makes the gastric juice acidic. (pH = 2.0-3.0).
Alpha cells of islets of Langerhans secrete glucagon hormone which increase the glucose level in the blood by converting glycogen to glucose in liver cells. Kupffer's cells are specialized cells in the liver that destroy bacteria, foreign proteins, and worn-out blood cells. Sebaceous glands and microscopic glands in the skin that secrete an oily/waxy matter (called sebum) to lubricate the skin and hair of mammals.
14. (c) Retinol is the chemical name of the vitamin A, which is mostly found in carrots, milk, cheese, fish etc. Retinol is well adapted for light absorption in animals where it is converted into the light-absorbing molecule called retinal. Deficiency of vitamin A mostly affects the rods containing retinal and leads to a disease called as night blindness or poor night vision. Tocopherol is the chemical name of vitamin E, found mostly in wheat germ oil, brown flour etc. Its deficiency causes sterility in rats. Vitamin C, also called as ascorbic acid, is found mostly in citrus fruits, potatoes, tomatoes etc. Its deficiency causes painful disease of the joints and gums called scurvy.
15. (d) Sugarcane and sugarbeet are the richest sources of sucrose, a disaccharide. It is most commonly found in plants, where it is transported in large quantity by phloem tissue. In humans, enzyme invertase (sucrase) present in duodenum of the small intestine hydrolyses sucrose into one molecule of glucose and one molecule of fructose. Pepsin is proteolytic enzyme that hydrolyses many proteins into smaller molecules of peptones. Saliva of humans contains salivary amylase (ptyalin) that hydrolyses starch into maltose, isomaltose and small dextrins. Lipases hydrolyse triglyceride fat into diglycerides, and then into monoglycerides alongwith fatty acids at each step.
16. (a) Parietal cells also called oxyntic cells are the stomach epithelium cells that secrete gastric acid and intrinsic factor. A cell of the gastric glands that secretes hydrochloric acid.
17. (a) Fats present below the skin surface in our body, is called subcutaneous fat deposition. It acts as insulator of body and prevent loss of heat from the body.
18. (c) Xerophthalmia is caused by vitamin A deficiency. This generally occurs in poorer section of the society because often they do not have adequate amount of fruits in diet.
19. (a) The average fat content in buffalo milk is 7.2% which is higher than human milk. Lactose is higher in human milk than cow and buffalo's milk.

20. (a) Fish has more polyunsaturated fatty acids which act as natural antioxidant.
21. (a) Endoscopy, a technique used to explore the stomach or other inner parts of the body, is based on total internal reflection.
22. (a) Lathyrism is caused by excessive consumption of khesari dal.
23. (d) Normal body temperature is 37 degree centigrade but in Kelvin scale $0^{\circ}\text{C} = 0^{\circ}\text{C} + 273 = 273^{\circ}\text{K}$. When we convert 37°C into Kelvin, it becomes $37 + 273 = 310^{\circ}\text{K}$.
24. (b) There are three pairs of salivary glands. These are parotids (below the cheeks), sub maxillary/ or sub mandibular (lower jaw) and the sublinguals (below the tongue)
25. (d)
26. (a) Physiological value of carbohydrates is 4.0 kcal/g, proteins 4.0 kcal/g and of fats is 9.0 kcal/g. Hence,
5 g raw sugar will yield
 $5 \times 4.0 = 20.0$ kcal
4 g albumin (protein) will yield
 $4 \times 4.0 = 16.0$ kcal
10 + 2 g of fat will yield
 $12 \times 9.0 = 108.0$ kcal
Total yield = 144 kcal.
27. (d) Milk protein can be digested by pepsin and chymotrypsin
30. (c) Pancreatic amylase is a starch splitting enzymes similar to ptyalin by hydrolysing starch and glycogen to maltose, isomaltose and limit dextrins.
31. (a) Trypsin is protein digesting enzyme present in the intestine of animals. Though it cannot digest casein (a milk protein), in predator animals drinking the blood of their prey, trypsin hydrolyses fibrinogen of blood into fibrin, leading to blood coagulation thus help in blood digestion. It also activates other pancreatic proteases.
32. (d) It is not lipases but the bile salts which are responsible for the emulsification of fats. Bile salts are steroids secreted by the liver in the bile. In the intestinal lumen, they reduce the surface tension of fat droplets, causing their breakdown into many smaller ones. A stable fine emulsion of fat is thereby formed. On the other hand, lipases are the enzymes which hydrolyse fats and oils. Lipases can digest fat in significant amounts only when large fat droplets are broken into tiny droplets to form a fine emulsion. Emulsification of fats by bile salts thus, increases the lipase action on fats.
33. (a) In the condition of obstructive jaundice the entry of bile into the small intestine is prevented due to an obstruction in the bile duct. As we know that bile salts help in the digestion of fats by emulsification and also in their absorption by the formation of water soluble droplets called micelles from whom fatty acids, glycerides, sterols and fat soluble vitamins are absorbed into the intestinal cells. Therefore, in the absence of bile, the fats remain unabsorbed and consequently are eliminated out of the body in the faeces.
34. (c) Sucrase hydrolyses sucrose to glucose and fructose.
35. (a)

Type B : Assertion Reason Questions

28. (a) Deficiency of ascorbic acid/vitamin C causes scurvy.
29. (a) In the condition of obstructive jaundice the entry of bile into the small intestine is prevented due to an obstruction in the bile duct. As we know that bile salts helps in the digestion of fats by emulsification and also in their absorption by the formation of water soluble droplets called micelles from whom fatty acids, glycerides, sterols and fat soluble vitamins are absorbed into the intestinal cells. Therefore, in the absence of bile, the fats remain unabsorbed and consequently are eliminated out of the body in the faeces.

Chapter

17

Breathing and Exchange of Gases

TYPE A : MULTIPLE CHOICE QUESTIONS

- Oxidative breakdown of respiratory substrates with the help of O_2 is called as [1997]
 - fermentation
 - anaerobic respiration
 - R. Q.
 - aerobic respiration
- Severe Acute Respiratory Syndrome (SARS)
 - is caused by a variant of *Pneumococcus pneumoniae*. [2004]
 - is caused by a variant of the common cold virus (corona virus).
 - is an acute form of asthma.
 - affects non-vegetarians much faster than the vegetarians.
- The diagram below represents part of a capillary in a specific region of the human body. The region labeled X represents part of [2009]

 - a glomerulus
 - an alveolus
 - a villus
 - the liver
- In humans, the concentration of carbon dioxide in the plasma [2009]
 - causes increased production of hydrochloric acid.
 - regulates gastric acid production by forming carbonic acid.
 - regulates breathing rate by its effect on the medulla.
 - causes inflammation of the tissues of the bronchial tubes.
- If the respiratory rate of 'A' is 35 breaths/min and tidal volume 185 cc/breath and of 'B' is 25 breaths/min and tidal volume 259 cc/breath then [2009]
 - Pulmonary ventilation of 'A' and 'B' is same.
 - Alveolar ventilation of 'A' and 'B' is same.
 - Pulmonary ventilation of 'A' is greater than 'B'.
 - Alveolar ventilation of 'A' is greater than 'B'.

- Oxyhaemoglobin can transport [2010]
 - 8 ml of CO_2 /100 ml blood
 - 5 ml of CO_2 /100 ml blood
 - 3 ml of CO_2 /100 ml blood
 - 2 ml of CO_2 /100 ml blood
- Which of the following match is correct? [2011]
 - Emphysema: reduction of surface area of alveoli and bronchi
 - Pneumonia: occupational disease with asbestos
 - Silicosis: inflammation of alveoli
 - Asthma: excessive secretion of bronchial mucus
- Volume of air breathed in and out during normal breathing is called [2012]
 - Vital capacity
 - IRV
 - ERV
 - Tidal volume
- Much developed larynx of human male is called
 - Aristole's lantern
 - Syrinx [2012]
 - Adam's apple
 - Muller's organ
- The presence of CO_2 in blood will lower pH because CO_2 combines with____, with the rate of reaction increased by____. [2013]
 - H_2O to form H^+ and HCO_3^- , carbonic anhydrase
 - H_2O to form only HCO_3^- , carbonic anhydrase
 - H_2O to form only H^+ , carbonic ions
 - H^+ to form HCO_3^- , oxyhaemoglobin
- Approximately seventy percent of carbon-dioxide absorbed by the blood will be transported to the lungs [2014]
 - as bicarbonate ions
 - in the form of dissolved gas molecules
 - by binding to RBC
 - as carbamino - haemoglobin

12. During oxygen transport the oxyhaemoglobin at the tissue level liberates oxygen to the cells because in tissue [2016]
- (a) O_2 concentration is high and CO_2 is low
 - (b) O_2 concentration is low and CO_2 is high
 - (c) O_2 tension is high and CO_2 tension is low
 - (d) O_2 tension is low and CO_2 tension is high

TYPE B : ASSERTION REASON QUESTIONS

Directions for (Qs. 13-14) : These questions consist of two statements, each printed as Assertion and Reason. While answering these questions, you are required to choose any one of the following five responses.

- (a) If both Assertion and Reason are correct and the Reason is a correct explanation of the Assertion.
- (b) If both Assertion and Reason are correct but Reason is not a correct explanation of the Assertion.
- (c) If the Assertion is correct but Reason is incorrect.
- (d) If both the Assertion and Reason are incorrect.
- (e) If the Assertion is incorrect but the Reason is correct.

13. **Assertion :** Many visitors to the hills suffer from skin and respiratory allergy problems.

Reason : Conifer trees produce a large quantity of wind-borne pollen grains. [2003]

14. **Assertion :** Severe Acute Respiratory Syndrome (SARS) is originated in China.

Reason : China is the most populated country of the world. [2003]

Directions for (Qs.15-17) : Each of these questions contains an Assertion followed by Reason. Read them carefully and answer the question on the basis of following options. You have to select the one that best describes the two statements.

- (a) If both Assertion and Reason are correct and Reason is the correct explanation of Assertion.
- (b) If both Assertion and Reason are correct, but Reason is not the correct explanation of Assertion.
- (c) If Assertion is correct but Reason is incorrect.
- (d) If both the Assertion and Reason are incorrect.

15. **Assertion :** Oxyhaemoglobin dissociates near the organ tissue due to Bohr effect and oxygen is released. [2010]

Reason : Increased CO_2 concentration reduces the affinity of haemoglobin for oxygen.

16. **Assertion:** In mammals, complex respiratory system has developed. [2011]

Reason: Mammalian skin is impermeable to gases

17. **Assertion :** Inspiration occurs due to muscular relaxation.

Reason : During inspiration, the diaphragm and external intercostal muscle contract simultaneously. [2012]

HINTS & SOLUTIONS

Type A : Multiple Choice Questions

1. (d) The oxidative breakdown of respiratory substrates (like carbohydrates, fats, proteins) into CO_2 and water, occurs in the presence of oxygen. It is called aerobic respiration.
2. (b) Severe acute respiratory syndrome (SARS) is caused by mutant of Influenza/common cold virus (*Corona* virus).
3. (b) An alveolus is a tiny air sac in the lung. It is the actual part of the lung that exchanges atmospheric oxygen with carbon dioxide from the blood. A glomerulus is a ball of capillaries found in the nephrons of the kidneys (to filter nitrogenous wastes), a villus is a tiny projection of a capillary in the small intestine (to absorb digested food), and the liver is the site of bile production and breakdown of amino acids.
4. (c) The medulla oblongata at the base of the brain increases breathing rate if the amount of carbon dioxide increases. It does not regulate breathing rate by checking oxygen content.
5. (c) The process by which a continuous exchange of gases is maintained across respiratory surface is often called external respiration. The ventilation rate of an animal is the volume of air breathed per minute *i.e.* tidal volume $\times$ number of breathes per minute. It can be measured with the aid of a respirometer.
6. (c) Oxyhaemoglobin can transport about 3ml of carbon dioxide per 100 ml of blood.
7. (a) Cigarette smoking leads to the disease emphysema. In this disease, terminal bronchioles get obstructed. This reduces the ventilation of the alveoli connected to them. Many alveoli coalesce together to form large chambers due to destruction of their walls. This change of smaller alveoli to large chambers reducing the area of alveolar surface across which gases are exchanged. All these changes reduce both oxygen uptake and carbon dioxide elimination.

8. (d) Volume of air breathed in and out during normal breathing is called tidal volume. It is approximately 500 ml *i.e.*, a healthy person can expire or inspire approximately 6000 to 8000 ml of air per minute as breathing rate is 12-16 times/minute.
9. (c) Larynx is a cartilaginous box which helps in sound production and hence is called the sound box. Much developed larynx of human male is called Adam's apple.
10. (a) Carbon dioxide combines with H_2O in the plasma to form H^+ and HCO_3^- . The enzyme carbonic anhydrase catalyzes the reaction.
11. (a) CO_2 from the respiratory tissues to the lungs is transported by the blood in 3 ways:
 - (i) **In dissolved state or as a physical solution:** Very small amount is physically dissolved in plasma (7% *i.e.* 0.3 ml of CO_2 by each 100 ml of blood).
 - (ii) **Bicarbonate ions:** About 70% (*i.e.* @ 2.5 ml per 100 ml of blood) CO_2 diffuses in plasma & then into RBCs where it (in the presence of carbonic anhydrase) combines with H_2O to form carbonic acid which is almost spontaneously dissociated into hydrogen ion and bicarbonate ions.
 - (iii) **Carbaminohaemoglobin :** 23% (*i.e.* 1 ml of CO_2 per 100 ml of blood) combines with haemoglobin forming an unstable compound.

12. (d)

Type B : Assertion Reason Questions

13. (b) The skin problem could be due to pollen allergy and respiratory problem could be due to the decrease in oxygen content, since the atmosphere becomes thin as one goes up the hill.
14. (b) The first patient of SARS was reported in February 2003 in China. Its causing agent is human corona virus (type of Influenza virus) which spreads through contact, respiratory secretions and cockroaches.

15. (a) Bohr's effect is the effect of CO_2 on oxyhaemoglobin. Body tissues obtain oxygen from oxyhaemoglobin because of its dissociation caused by low O_2 and high CO_2 concentration. The increased CO_2 concentration reduces the affinity of haemoglobin for oxygen.
16. (b) Mammalian skin is impermeable so that water loss through it is minimised. But mammals need far more oxygen to maintain their high metabolic rates than lower animals; so they need a more extensive respiratory surface. Thus, a complex mammalian respiratory system consists of the nasal cavity, nasopharynx, larynx, trachea, bronchi, bronchiole and lungs.
17. (c) Inspiration is the result of muscular contraction. The diaphragm and external intercostal muscles contract simultaneously. The lateral thoracic wall moves outward and upward.

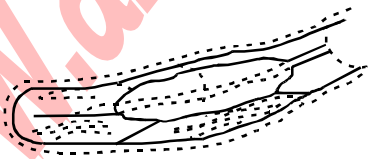
Chapter

18

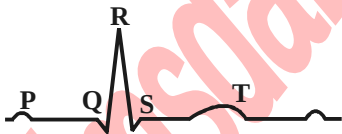
Body Fluids and Circulation

TYPE A : MULTIPLE CHOICE QUESTIONS

1. Anti-serum contains [1997]
 - (a) antigens (b) antibodies
 - (c) leucocytes (d) RBCs
2. Which enzyme induces lysis of fibrinogen to fibrin during fibrinolysis? [1997]
 - (a) Plasmin (b) Thrombin
 - (c) Fibrin (d) Trypsin
3. Which of the following blood group can be given to any patient? [1999]
 - (a) A (b) B
 - (c) O (d) AB
4. Which of the following chamber of heart has the thickest muscular wall? [1999]
 - (a) Left auricle (b) Left ventricle
 - (c) Right ventricle (d) Right auricle
5. In which of the following pairs the two items mean one and the same thing? [2004]
 - (a) Malleus - Anvil
 - (b) SA node - Pace maker
 - (c) Leucocytes - Lymphocytes
 - (d) Haemophilia - Blood cancer
6. An artificial pace maker is implanted subcutaneously and connected to the heart in patients [2004]
 - (a) having 90% blockage of the three main coronary arteries.
 - (b) having a very high blood pressure.
 - (c) with irregularity in the heart rhythm.
 - (d) suffering from arteriosclerosis.
7. The figure below shows an angioplasty of the coronary blood vessel. Which one of the following statements correctly describes, what is being done? [2006]



 - (a) It is coronary artery which has a cancerous growth that is being removed.
 - (b) It is coronary artery which is blocked by a plaque and the same is being cracked.
 - (c) It is coronary vein in which the defective valves are being opened.
 - (d) It is coronary vein blocked by a parasite (blood fluke) that is being removed.
8. Hirudin is [2006]
 - (a) A protein produced by *Hordeum vulgare*, which is rich in lysine.
 - (b) A toxic molecule isolated from *Gossypium hirsutum*, which reduces human fertility.
 - (c) A protein produced from transgenic *Brassica napus*, which prevents blood clotting.
 - (d) An antibiotic produced by a genetically engineered bacterium, *Escherichia coli*.
9. The component of blood which prevents its coagulation in the blood vessels is [2007]
 - (a) haemoglobin (b) plasma
 - (c) thrombin (d) heparin
10. Thickening of arteries due to cholesterol deposition is [2007]
 - (a) arteriosclerosis (b) rheumatic heart
 - (c) blood pressure (d) cardiac arrest.
11. Which one of the following is a matching pair? [2003, 2008]
 - (a) Lubb - Sharp closure of AV valves at the beginning of ventricular systole.
 - (b) Dup - Sudden opening of semilunar valves at the beginning of ventricular diastole.
 - (c) Pulsation of the radial artery valves in the blood vessels.
 - (d) Purkinje fibres-Initiation of the heart beat.
12. A malfunction of the lymph nodes would most likely interfere with the [2009]
 - (a) release of carbon dioxide into the lymph
 - (b) filtering of glucose from the lymph
 - (c) release of oxygen into the lymph
 - (d) filtering of bacteria from the lymph
13. Arteries supplying blood to the heart are called [2010]
 - (a) carotid arteries (b) hepatic arteries
 - (c) coronary arteries (d) pulmonary arteries

14. A man whose blood group is not known meets with a serious accident and needs blood transfusion immediately, which one of the blood groups readily available in the hospital will be safe for transfusion? [2010]
 (a) O, Rh⁻ (b) O, Rh⁺
 (c) AB, Rh⁻ (d) AB, Rh⁺
15. With reference to the blood in a normal person, which one of the following statements is correct? [2010]
 (a) Compared to arteries, veins are less numerous and hold less of the body's blood at any given time.
 (b) Blood cells constitute about 70 percent of the total volume of the blood.
 (c) White blood cells (WBC) are made by lymph nodes only.
 (d) The blood has more platelets than WBC.
16. Which of the following organs is the blood bank? [2011]
 (a) Heart (b) Lungs
 (c) Spleen (d) Liver
17. Which one of the following is a matching pair of a certain body feature and its value/count in a normal human adult? [2003, 2008, 2011]
 (a) Urea 5-10 mg / 100 ml of blood
 (b) Blood sugar (fasting) - 70-100 mg/100 ml
 (c) Total blood volume - 5-6
 (d) ESR in Wintrobe method - 9-15 mm in males and 20-34 mm in females
18. Given below is the ECG of a normal human. Which one of its components is correctly interpreted below? [2013]
- 
- (a) Peak P and Peak R together - systolic and diastolic blood pressures
 (b) Peak P - Initiation of left atrial contraction only
 (c) Complex QRS - One complete pulse
 (d) Peak T - Initiation of total cardiac contraction
19. Which of the following statements are wrong? [2013]
 (i) Leucocytes disintegrate in the spleen and liver.
 (ii) RBC, WBC and blood platelets are produced by bone marrow.
 (iii) Neutrophils bring about destruction and detoxification of toxins of protein origin.
 (iv) The important function of lymphocytes is to produce antibodies.
 (a) (i) and (ii) only (b) (i) and (iv) only
 (c) (i) and (iii) only (d) (ii) and (iii) only
20. The diagram given here is the standard ECG of a normal person, the P-wave represents the :
 (a) Initiation of the ventricular contraction
 (b) Beginning of the systole
 (c) End of systole
 (d) Contraction of both the atria [2014]
21. Bulk of carbon dioxide (CO₂) released from body tissues into the blood is present as [2015]
 (a) 70% carbamino-haemoglobin and 30% as bicarbonate
 (b) carbamino-haemoglobin in RBCs
 (c) bicarbonate in blood plasma and RBCs
 (d) free CO₂ in blood plasma
22. Given below is the ECG of a normal human. Which one of its components is correctly interpreted below? [2015]
- 
- (a) Peak P and Peak R together - systolic and diastolic blood pressures
 (b) Peak P - Initiation of left atrial contraction only
 (c) Complex QRS - One complete pulse
 (d) Peak T - Initiation of total cardiac contraction

TYPE B : ASSERTION REASON QUESTIONS

Directions for (Qs. 23-29) : These questions consist of two statements, each printed as Assertion and Reason. While answering these questions, you are

required to choose any one of the following five responses.

- (a) If both Assertion and Reason are correct and the Reason is a correct explanation of the Assertion.
- (b) If both Assertion and Reason are correct but Reason is not a correct explanation of the Assertion.
- (c) If the Assertion is correct but Reason is incorrect.
- (d) If both the Assertion and Reason are incorrect.
- (e) If the Assertion is incorrect but the Reason is correct.

23. **Assertion :** Muscle fibres of SA node possess the lowest rhythmicity among all cardiac muscles.

Reason : Due to this fact, it can initiate excitatory waves at the highest rate. [1999]

24. **Assertion :** Saline water is not given to patients of hypertension.

Reason : Saline water can cause vomiting and may drop blood pressure suddenly causing cardiac arrest. [2000]

25. **Assertion :** Blood pressure is arterial blood pressure.

Reason : Blood pressure is measured by sphygmomanometer. [2000]

26. **Assertion:** WBCs accumulate at site of wounds by diapedesis.

Reason: It is squeezing of leucocytes from endothelium. [2002]

27. **Assertion :** Persons suffering from haemophilia fail to produce blood clotting factor VIII.

Reason : Prothrombin producing platelets in such persons are found in very low concentration. [2005]

28. **Assertion (A) :** Blood coagulates in uninjured blood vessels.

Reason (R) : Uninjured blood vessels release an anticoagulant heparin. [2007]

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29. **Assertion :** Smaller the organism higher is the rate of metabolism per gram weight.

Reason : The heart rate of a six month old baby is much higher than that of an old person. [2007]

Directions for (Qs.30-34) : Each of these questions contains an Assertion followed by Reason. Read them carefully and answer the question on the basis of following options. You have to select the one that best describes the two statements.

- (a) If both Assertion and Reason are correct and Reason is the correct explanation of Assertion.
- (b) If both Assertion and Reason are correct, but Reason is not the correct explanation of Assertion.
- (c) If Assertion is correct but Reason is incorrect.
- (d) If both the Assertion and Reason are incorrect.

30. **Assertion :** Prothrombinase enzyme act as antiheparin. [2010]

Reason : Heparin prevent coagulation of blood in blood vessels.

31. **Assertion :** Blood is coloured in the insects.

Reason : Insect blood has no role in O₂ transport. [2012, 2013]

32. **Assertion :** When there is a fall in the blood pressure due to loss of blood volume, this is compensated by vasoconstriction of veins.

Reason : Veins hold the extra amount of blood which can be shifted to the arteries as required. [2010, 2015]

33. **Assertion :** Lub is a heart sound which is produced during each cardiac cycle.

Reason : It is associated with the closure of the tricuspid and bicuspid valves. [2016]

HINTS & SOLUTIONS**Type A : Multiple Choice Questions**

1. (b) Anti-serum is a blood serum that contains antibodies.
2. (b) During blood clotting, lysis of fibrinogen to fibrin occurs by plasma thrombin. Later on fibrin entangles corpuscles to form a clot. Thrombin is not normally found in circulating blood, but instead it is repressed by its inactive precursor prothrombin. The conversion of prothrombin to thrombin requires blood platelets, calcium ions and thromboplastin.
3. (c) Blood group 'O' is universal donor. Group 'O' blood, with no antigens, can be given to anyone.
4. (b) Left ventricle of the heart has the thickest wall because it has to pump the blood to the farthest end of the body.
5. (b) Malleus is hammer shaped; lymphocytes are type of leucocytes and hemophilia is bleeder's disease (genetic) disorder. SA node acts as pacemaker because it functions as originator of cardiac impulse.
6. (c) Artificial pace maker is implanted to the patients where heart beat level drops abnormally low (30-40) due to disease or operations.
7. (b) In this figure, coronary angioplasty is being done where atherosclerotic plaque, which builds up and clogs the coronary arteries, is compressed against the vessel wall by expanding a balloon like device inserted through a catheter that has been threaded through the artery.
8. (c) Hirudin is an anticlotting agent produced by transgenic *Brassica napus*.
9. (d) Blood contains an anticoagulant called heparin, which prevents the activation of prothrombin. The latter is an inactive globulin which is required during blood coagulation. Heparin is released from the mast-cell granules.
10. (a) High proportion of cholesterol in blood leads to deposition of cholesterol on the walls of blood vessels. This causes the arteries to lose their elasticity and get stiffened. This is called arteriosclerosis or hardening of arteries.
11. (a) Lubb sound is caused partly by the closure of the bicuspid and tricuspid valves and partly by the contraction of the muscles in the ventricles. Lubb is the first heart sound.
12. (d) The lymphatic system not only regulates fluid amounts in the blood but also helps to fight infection. The lymph nodes produce white blood cells and filter harmful bacteria, that is why they tend to enlarge when we have an infection.
13. (c) Coronary arteries supply the blood to the heart. Carotid arteries supply the blood to head region. Hepatic arteries supply the blood to liver while the pulmonary artery supplies blood to the lungs.
14. (b) According to ABO system of blood grouping, O type blood can be given to person of all types of blood, i.e., O, A, B and AB. Hence, a person with O type blood is called universal donor.
According to Rh system of blood grouping, most of the people have blood in which there is a substance called Rh factor. Rh stands for rhesus. This type of blood can be donated only in rarest of rare chances. In India, about 97% of people are Rh⁺. So, if an Rh⁺ person is transfused with Rh⁺ blood, then it is safe. But if an Rh negative (Rh⁻) person is transfused with Rh⁺ blood then he/she will develop anti-Rh factor i.e., antibodies in his/her blood, and there might be no harm is, but may kill the recipient if a second Rh⁺ transfusion is done.
15. (d) The number of blood platelets per cubic mm in human blood is 3 lacs while the number of WBCs are 5000/cubic mm of blood. Veins are as complex as the arteries. Veins and arteries both are types of blood vessels. Arteries carry blood from heart to different organs while vein carries blood from different organs to heart. At any given

time in a healthy human, the blood amount is same in both, as the circulation of blood never stops.

Blood consists of two parts:

The **plasma** (water, proteins, inorganic salts and other elements) constitutes 55-60% of blood while **cellular** part constitutes 40-45% of total blood. WBCs are produced in red bone marrow, lymph nodes and sometimes even in liver and spleen.

16. (c) Spleen is referred to as a blood bank of the body because it is the organ having the function of making and storing lymphocytes and red corpuscles. These are squeezed out into the blood-stream when the body needs more in circulation, as for instance in haemorrhage or shock.
17. (b) Fasting glucose level is 70-110 mg/decilitre. Total blood volume in normal adult human is 5-6 litres. Blood is a fluid connective tissues. Its cells consists of corpuscles. Plasma represents matrix of blood. Blood is mesodermal in origin and salty in taste. Its pH is 7.3 – 7.4.
18. (c) 19. (c)
20. (d) The P-wave represents the electrical excitation (or depolarisation) of the atria, which leads to the contraction of both the atria. The QRS complex represents the depolarisation of the ventricles, which initiates the ventricular contraction. The contraction starts shortly after Q and marks the beginning of the systole.
21. (c)
22. (c)

Type B : Assertion Reason Questions

23. (e) The sinoatrial or sinoauricular node determines the rate of heart beat by determining the rate of discharge of cardiac impulse. It is called the pace maker. It is formed of specialized cardiac muscles and is located in the right atrial wall near the opening of superior venacava. These muscles are self excitable. Since it is self excitable, it can produce waves at highest rate. Hence, the assertion is incorrect.

24. (c) Saline water increases the blood pressure due to the presence of NaCl in it. Hence, the reason for the assertion is false.
25. (b) Blood pressure is the arterial pressure of blood exerted on the wall of arteries with each heart beat. It is measured from the brachial artery in the elbow pit. It is expressed as

$$= \frac{\text{systolic pressure (mm/Hg)}}{\text{diastolic pressure (mm/Hg)}}$$

Arterial (superficial; arteries) blood pressure is measured by sphygmomanometer.

26. (b) WBC's are wandering cells capable of coming out of blood capillaries by amoeboid movement called diapedesis.
27. (a) Haemophilia is caused by lack of activity of blood clotting factor VIII or IX and they show platelet function disorder.
28. (d) When an injury is caused to a blood vessel, bleeding starts which is stopped by blood clotting. At the site of injury blood platelets release platelet factor - 3 and injured tissues release thromboplastin. The two combine to form prothrombinase enzyme which converts prothrombin to thrombin. The latter stimulates formation of fibrin thread or clot. Blood contains an anticoagulant heparin which prevents blood clotting in uninjured vessels.
29. (b) The basal metabolic rate is defined as the energy requirement of human body at rest. BMR of smallest animals are generally higher than larger animals. Peoples with higher metabolism means that they have higher heart rate. Heart rate of baby is 70-190 times/minute, whereas adults (including serious) is 60-100 times/ minute.
30. (b) Prothrombinase enzyme is necessary for blood clotting. It acts as antiheparin. Coagulation of blood in vessels is prevented by heparin, a quick acting anticoagulant. It inhibits conversion of prothrombin to thrombin and is used in open-heart surgery.

31. (b) Insect blood is colourless and does not play any role in transport of oxygen. Insects have tracheal respiration.
32. (a) When the blood pressure of an individual decreases due to loss of blood volume, then vasoconstriction of veins occurs. This shifts the little amount of blood from veins to arteries.
33. (b) Lub and dub are two heart sounds, which occurs due to the closure of cuspid valves and semilunar valves respectively. Lub is the first heart sound which is formed due to closure of atrioventricular valves at the beginning of ventricular systole. It is low pitched of long duration (0.15 sec).

Chapter

19

Excretory Products and their Elimination

TYPE A : MULTIPLE CHOICE QUESTIONS

- Podocytes occur in [1998]
 - large intestine
 - glomerulus of kidney
 - wall of capillaries
 - neck region
- The end product of ornithine cycle is [1999]
 - urea
 - uric acid
 - NH_3
 - CO_2
- Reabsorption in tubules of nephrons occurs by [2000]
 - osmosis
 - diffusion
 - active transport
 - both (b) & (c)
- Toxic substances are detoxified in human body in [2001]
 - kidney
 - lungs
 - liver
 - stomach
- In which of the following minimum content of urea is present ? [2012]
 - Hepatic portal vein
 - Portal vein
 - Renal vein
 - Vena cava
- Duct of Bellini is concerned with [2012]
 - Filtration of urine
 - Purification of urine
 - Conduction of urine
 - All the above
- Which one of the following statements in regard to the excretion by the human kidneys is correct? [2013]
 - Ascending limb of Loop of Henle is impermeable to electrolytes
 - Descending limb of Loop of Henle is impermeable to water
 - Distal convoluted tubule is incapable of reabsorbing HCO_3^-
 - Nearly 99 per cent of the glomerular filtrate is reabsorbed by the renal tubules

- If Henle's loop were absent from mammalian nephron which of the following is to be expected [2015]
 - there will be no urine formation
 - there will be hardly any change in the quality and quantity of urine formed
 - the urine will be more concentrated
 - the urine will be more dilute.
- Which blood vessel in mammals would normally carry the largest amount of urea? [2016]
 - Dorsal aorta
 - Hepatic vein
 - Hepatic portal vein
 - Renal vein
- In ornithine cycle, enzyme arginase breaks down arginine into [2016]
 - Citrulline and ammonia
 - Ornithine and ammonia
 - Ornithine and urea
 - Citrulline and urea.

TYPE B : ASSERTION REASON QUESTIONS

Directions for (Qs. 11-13) : These questions consist of two statements, each printed as Assertion and Reason. While answering these questions, you are required to choose any one of the following five responses.

- If both Assertion and Reason are correct and the Reason is a correct explanation of the Assertion.
 - If both Assertion and Reason are correct but Reason is not a correct explanation of the Assertion.
 - If the Assertion is correct but Reason is incorrect.
 - If both the Assertion and Reason are incorrect.
 - If the Assertion is incorrect but the Reason is correct.
11. **Assertion :** During physiology of excretion, deamination does not take place in liver.
Reason : Deamination is a process to make use of excess of amino acids which cannot be incorporated into protoplasm. [2001]

12. **Assertion :** Secreting hypotonic urine is effective in reducing urinary loss of water.
Reason : Hypotonic urine is more concentrated and higher in osmotic pressure than the blood. [2007]
13. **Assertion :** Aldosterone is a steroid hormone and is important in the control of sodium and potassium ion concentration in mammals.
Reason : It upgrades sodium ion concentration in the ECF by promoting reabsorption of sodium ions from renal tubules and excretion of potassium ions in urine. [2007]
- Directions for (Qs.14-18) :** Each of these questions contains an Assertion followed by Reason. Read them carefully and answer the question on the basis of following options. You have to select the one that best describes the two statements.
- (a) If both Assertion and Reason are correct and Reason is the correct explanation of Assertion.
(b) If both Assertion and Reason are correct, but Reason is not the correct explanation of Assertion.
(c) If Assertion is correct but Reason is incorrect.
(d) If both the Assertion and Reason are incorrect.
14. **Assertion :** Ultrafiltration takes place in presence of effective filtration pressure.
Reason : In ultrafiltration process, blood is filtered in Bowman's capsule, filtered fluid contain protein & blood corpuscles also. [2010]
15. **Assertion :** In vertebrates, the liver is also referred as an accessory excretory organ.
Reason : Liver helps kidneys in the secretion of urine. [2012]
16. **Assertion :** Main constituent of human urine is ammonia.
Reason : If human urine is allowed to stand for some time, it smells strongly of ammonia. [2013]
17. **Assertion :** Hemodialysis can save and prolong the life of uremic patients.
Reason : Waste products like urea can be removed from the blood by the process of hemodialysis. [2014]
18. **Assertion :** In the descending limb of loop of Henle, the urine is hypertonic, whereas in ascending limb of loop of Henle, the urine is hypotonic.
Reason : Descending limb is impermeable to sodium, while ascending limb is impermeable to water. [2016]

HINTS & SOLUTIONS

Type A : Multiple Choice Questions

1. (b) Podocytes are specialized visceral epithelial cell in the Bowman's capsule in the kidneys that wraps around the capillaries of the glomerulus. It helps filter blood in the glomerulus of the kidney.
2. (a) The ornithine cycle occurs in the mitochondria of liver cells. It is meant for urea formation.
3. (d) Tubular reabsorption is the second process in urine formation through filtrate. In this, most of the filtrate passes out of rephron tubule and returns to the blood through peritubular capillaries. Tubular reabsorption occurs by diffusion and active transport.
4. (c) Liver is the primary site of detoxification and elimination of body wastes and poisons. Liver detoxifies endotoxins, *e.g.* toxic NH_3 combined with CO_2 to form less toxic urea. It also detoxifies alcohol and convert them to acetaldehyde and then harmless acetyl CoA.
5. (c) Renal veins connects the kidney to inferior vena cava. They carry the blood purified by the kidney and carry minimum quantity of urea.
6. (c) Renal collecting tubules are also known as duct of bellini. These are the long narrow tubes in the kidney that conduct urine from the nephrons to larger ducts that leads to urinary bladder.
7. (d)
8. (d) Henle's loop is responsible for the reabsorption of water and sodium chloride from the urine. Hence, in the absence of Henle's loop the urine will become more dilute.
9. (b)
10. (c)

Type B : Assertion Reason Questions

11. (d) Deamination is the process of converting amino acid to keto acid with the release of NH_3 . It occurs in the liver.

12. (d) Hypotonic urine means concentration of urine is less than that of blood. Hypertonic urine is more concentrated than blood and has high osmotic pressure than the blood, therefore it helps in reducing the loss of water with urine. The urine is filtered by the Bowman's capsule. The tubules of nephrons reabsorb a large quantity of water making urine more concentrated.
13. (a) Aldosterone is one of the important mineralocorticoids in humans secreted by adrenal cortex. Its main function is to regulate sodium content of the body. It increases sodium ion concentration in the blood by absorbing sodium ions from renal tubules. Excessive production of aldosterone causes a disease aldosteronism. Its symptoms include high blood pressure, high blood volume.
14. (c) Ultrafiltration takes place in renal corpuscle of uriniferous tubule. It takes place in presence of effective filtration pressure. During the process, blood is filtered and contains only blood plasma – proteins. The filtered blood entering into Bowman's capsule is called glomerular filtrate. Glomerular filtrate = Blood – (Blood corpuscles + plasma proteins)
15. (c) In vertebrates, the lungs, liver & skin are referred as accessory excretory organs because besides the urinary system these organs also participate in the removal of waste products from the body. The liver is the principal organ for the excretion of cholesterol, bile pigments (bilirubin and biliverdin) and inactivated products of steroid hormones, some vitamins and many drugs. It secretes these substances in the bile and indirectly helps by formation of urea through amino acids in ornithine cycle. It has no role in secretion of urine.
16. (d) Urea is the chief nitrogenous constituent of human urine, though it possesses small amount of ammonia. But when the urine is allowed to stand for sometime, bacterial

degradation occurs and it leads to the production of ammonia from urea. And thus it smells strongly.

17. (a) The blood urea level rises abnormally (uremia) in patients suffering from renal failures. In uremia patients an artificial kidney is used for removing accumulated waste products like urea from the blood by a process called hemodialysis. In this way,

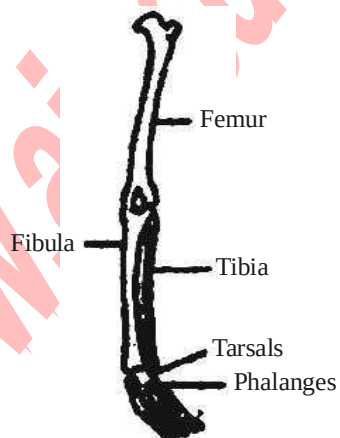
hemodialysis saves and prolongs the life of many uremic patients.

18. (a) Descending limb of Henle is permeable to water but not to sodium. Consequently water moves out into interstitium and concentration of sodium in tubular filtrate rises making filtrate hypertonic. Ascending loop is impermeable to water but permeable to sodium and makes the filtrate hypotonic.

Locomotion and Movement

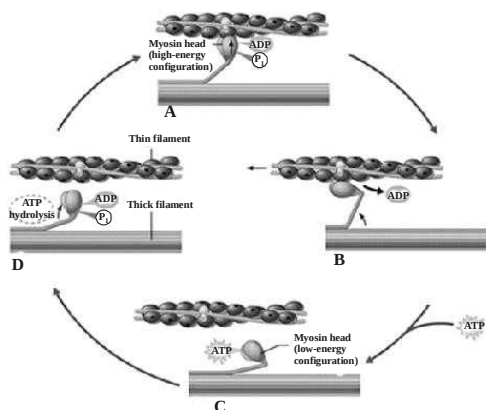
TYPE A : MULTIPLE CHOICE QUESTIONS

1. Cranium of human contains [2000]
(a) 12 bones (b) 8 bones
(c) 14 bones (d) 20 bones
2. Which of the following is made up of a single bone in mammal? [2001]
(a) Dentary (b) Hyoid
(c) Upper jaw (d) All of these
3. Sella turcica is found [2001]
(a) near pituitary (b) in bone
(c) in joints (d) near thyroid
4. Which one of the following is a sesamoid bone? [2003]
(a) Pelvis (b) Patella
(c) Pterygoid (d) Pectoral girdle
5. Two of the body parts which do not appear in MRI may be [2005]
(a) molar teeth and eye lens
(b) scapula and canines
(c) ligaments and ribs
(d) tendons and premolars
6. Given below is a diagram of the bones of the left human hindlimb as seen from front. It has certain mistakes in labelling. Two of the wrongly labelled bones are [2005]
7. A cricket player is fast chasing a ball in the field. Which one of the following groups of bones are directly contributing in this movement? [2006]
(a) Femur, malleus, tibia, metatarsals
(b) Pelvis, ulna, patella, tarsals
(c) Sternum, femur, tibia, fibula
(d) Tarsals, femur, metatarsals, tibia
8. The shoulder blade is made of [2007]
(a) clavicle (b) humerus
(c) ilium (d) scapula
9. The sensation of fatigue in the muscles after prolonged strenuous physical work, is caused by [2010]
(a) a decrease in the supply of oxygen
(b) minor wear and tear of muscle fibres
(c) the depletion of glucose
(d) the accumulation of lactic acid
10. Sesamoid bone is derived from- [2012]
(a) Cartilage (b) Areolar tissue
(c) Tendon (d) Ligament
11. Select the correct matching of the type of the joint with the example in human skeletal system: [2014]



Type of joint	Example
(a) Cartilaginous joint	between frontal and parietal
(b) Pivot joint	between third and fourth cervical vertebrae
(c) Hinge joint	between humerus and pectoral girdle
(d) Gliding joint	between carpals
12. Wish bone in birds is formed from the bones of [2016]
(a) Shoulder girdle (b) Hip girdle
(c) Keeled sternum (d) Skull bones

13. The given figure represents the cross bridge cycle in skeletal muscle. What does the step B in the figure represents? [2017]



- Attachment of myosin head to actin forming cross bridge.
- Release of phosphate. Myosin changes shape to pull actin.
- Attachment of new ATP to myosin head. The cross bridge detaches.
- Splitting of ATP into ADP and P_i . Myosin cocks into its high energy conformation.

TYPE B : ASSERTION REASON QUESTIONS

Directions for (Qs. 14-15) : These questions consist of two statements, each printed as Assertion and Reason. While answering these questions, you are required to choose any one of the following five responses.

- If both Assertion and Reason are correct and the Reason is a correct explanation of the Assertion.
- If both Assertion and Reason are correct but Reason is not a correct explanation of the Assertion.
- If the Assertion is correct but Reason is incorrect.
- If both the Assertion and Reason are incorrect.
- If the Assertion is incorrect but the Reason is correct.

14. **Assertion:** Fatigue is inability of muscle to relax.
Reason: It is due to lactic acid accumulation by repeated contractions. [1998]

Directions for (Qs.15-19) : Each of these questions contains an Assertion followed by Reason. Read them carefully and answer the question on the basis of following options. You have to select the one that best describes the two statements.

- If both Assertion and Reason are correct and Reason is the correct explanation of Assertion.
- If both Assertion and Reason are correct, but Reason is not the correct explanation of Assertion.
- If Assertion is correct but Reason is incorrect.
- If both the Assertion and Reason are incorrect.

15. **Assertion :** Ball and socket joints are the most mobile joints.

Reason : Synovial fluid is present here.

[2012]

16. **Assertion :** Intercalated discs are important regions of cardiac muscle cells.

Reason : Intercalated discs function as boosters for muscle contraction waves.

[2012]

17. **Assertion :** Arthritis or inflammation of a joint makes the joint painful.

Reason : Some toxic substances are deposited at the joint.

[2013]

18. **Assertion :** The phase of muscle contraction occurs when myosin binds and releases actin.

Reason : Muscle contraction is initiated by a signal sent by the peripheral nervous system via motor neuron.

[2016]

19. **Assertion :** Inflammation of a skeletal joint may immobilize the movements of the joint.

Reason : Uric acid crystals in the joint cavity and ossification of articular cartilage lead to this.

[2006, 2017]

HINTS & SOLUTIONS

Type A : Multiple Choice Questions

1. (b) Cranium of human body consists of 8 bones. There are 1 frontal, 2 parietal, 2 temporal, 1 occipital, 1 sphenoid and 1 ethmoid bone.
2. (b) Hyoid is a horse shoe shaped bone present in neck between lower jaw and voice box (larynx). It is not articulated to any bone, but is simply suspended, from temporal bones by means of ligaments. Hyoid provides surface for the attachment of tongue muscles.
3. (b) Sella turcica/turkish saddle/pituitary fossa is a depression in sphenoid bone of skull in which pituitary gland lies.
4. (b) Sesamoid bones are formed in the tendons at the joints, e.g. patella.
5. (b) MRI machine does not show image of bone and calcium, e.g. scapula, canine. It is also not suitable for patients with cardiac pace makers.
6. (c) Fibula and phalanges marked parts are actually tibia and metatarsals.
7. (d) In a fast chasing cricketer, foot and leg bones contribute directly in this movement e.g. femur, tibia, tarsal and metatarsals.
8. (d) Shoulder blade is made up of scapula. It is a flat, triangular-shaped largest bone present in each half of the pectoral (shoulder) girdle. It is joined to the clavicle in front. The clavicle is well developed in humans that links scapula to the sternum.
9. (d) The sensation of fatigue in the muscles after prolonged strenuous physical work is caused by the accumulation of lactic acid.
10. (c) Sesmoid bones are embedded in tendons. Sesmoids are found in locations where a tendon passes over a joint, such as the hand, knee and foot. Functionally they act to protect the tendon and its mechanical effect.
11. (d) A gliding joint is a common type of synovial joint formed between bones that meet at flat or nearly flat articular surfaces. Gliding

joints allow the bones to glide past one another in any direction along the plane of the joint - up and down, left and right, and diagonally. Many gliding joints are formed in the appendicular skeleton between the carpal bones of the wrist; between the carpals and the metacarpals of the palm; between the tarsal bones of the ankle; and between the tarsals and the metatarsals of the foot.

12. (a) Two clavicles fuse with one inter-clavicle to form 'Wish bone' or 'Bone of merry thought'.
13. (b) Step A: Attachment of myosin head to actin forming cross bridge.
Step B: Release of phosphate. Myosin changes shape to pull actin.
Step C: Attachment of new ATP to myosin head. The cross bridge detaches.
Step D: Splitting of ATP into ADP and Pi. Myosin cocks into its high energy conformation.

Type B : Assertion Reason Questions

14. (a) Due to the accumulation of lactic acid, muscles do not respond to a stimuli. After a prolonged previous activity.
15. (b) Synovial fluid is a thick sticky fluid secreted by synovial membranes into the synovial cavity. Though the presence of synovial fluid is one of the reasons behind the mobility of the joints, but the most accurate reason is the arrangement of the bones at the joint, the spheroidal ball-like end of one bone articulates here with the cup-shaped depression in another. This allows the bone with the ball head to be moved freely in many planes. Shoulder joints and hip joints are the ball-and-socket joints.
16. (a) Cardiac muscle cells are short cylindrical cells joined end to end and by side branching to form a network. Intercalated discs are the dense junctions formed in between the cardiac muscle cells where

they meet each other. Intercalated discs are the specialised regions of the cell membranes. As cardiac muscle possesses considerable rhythmicity and generates its own wave of excitation, these discs function as boosters for muscle contraction wave.

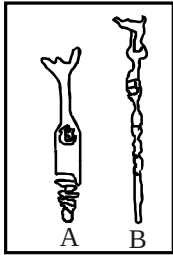
17. (c) Arthritis or inflammation of a joint makes the joint painful and may even immobilise the movements at the joint. This may result from a lack of the synovial fluid at the joint. The ossification of the articular cartilage, deposition of uric acid crystals in the joint cavity or other changes at the joint.

18. (c) The phase of muscle contraction occurs when myosin binds and releases actin. Muscle contraction is initiated by a signal sent by the central nervous system via a motor neuron. A motor neuron along with the muscle fibres connected to it constitutes a motor unit.

19. (a) Painful inflammation of the synovial membrane of the joints results in stiffening of joints and painful movement. Uric acid accumulation in the joints can lead to painful movement of joint.

TYPE A : MULTIPLE CHOICE QUESTIONS

1. The vagus nerve is the cranial nerve numbering [1997]
 - (a) 10th (b) 9th
 - (c) 5th (d) 8th
2. Sensation of stomach pain is due to [1998]
 - (a) interoceptors (b) exteroceptors
 - (c) teloreceptors (d) all of these
3. Which is the example of conditioned reflex ? [1999]
 - (a) Eyes closed when anything enter into it.
 - (b) Hand took up when piercing with needle.
 - (c) Salivation in a hungry dog in response to ringing of a bell.
 - (d) Digestion food goes forward in alimentary canal.
4. Otorhinolaryngology is the study of [1999]
 - (a) brain cells
 - (b) bird anatomy
 - (c) locomotary organs
 - (d) ENT
5. If frog's brain is crushed, even then its leg moves on pinpointing . It is called [2001]
 - (a) simple reflex
 - (b) conditional reflex
 - (c) neurotransmitter function
 - (d) autonomic nerve conditions
6. Which of the following is not a mental disorder?
 - (a) Epilepsy (b) Neurosis [2001]
 - (c) Psychosis (d) Plague
7. The 5th cranial nerve of frog is called [1998, 2001]
 - (a) optic nerve (b) vagus nerve
 - (c) trigeminal nerve (d) olfactory nerve
8. The crystal of lead zirconate is a key component of [2003]
 - (a) electroencephalography
 - (b) electrocardiography
 - (c) magnetoencephalography
 - (d) sonography
9. Excessive stimulation of vagus nerve in humans may lead to [2003]
 - (a) hoarse voice
 - (b) peptic ulcers
 - (c) efficient digestion of proteins
 - (d) irregular contraction of diaphragm
10. A person is wearing spectacles with concave lenses for correcting vision. While not using the glasses, the image of a distant object in his case will be formed [2003]
 - (a) on the blind spot
 - (b) behind the retina
 - (c) in front of the retina
 - (d) on the yellow spot
11. Unidirectional transmission of a nerve impulse through nerve fibre is due to the fact that [2004]
 - (a) nerve fibre is insulated by a medullary sheath.
 - (b) sodium pump starts operating only at the cyton and then continues into the nerve fibre.
 - (c) neurotransmitters are released by dendrites and not by axon endings.
 - (d) neurotransmitters are released by the axon endings and not by dendrites.
12. Examine the diagram of the two cell types A and B given below and select the correct option: [2006]



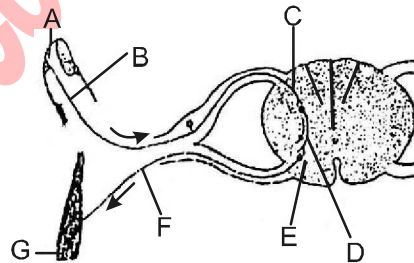
 - (a) Cell A is the rod cell found evenly all over retina.
 - (b) Cell A is the cone cell more concentrated in the fovea centralis.
 - (c) Cell B is concerned with colour vision in bright light.
 - (d) Cell A is sensitive to low light intensities.

13. A person, who shows unpredictable moods, outbursts of emotion, quarrelsome behaviour and conflicts with others, is suffering from
 (a) borderline personality disorder (BPD)
 (b) mood disorder [2006]
 (c) addictive disorder
 (d) schizophrenia
14. Which of the following is an eye disease?
 (a) hepatitis (b) measles
 (c) glaucoma (d) bronchitis
15. Given below is a table comparing the effects of sympathetic and parasympathetic nervous system for four features (1-4). [2006]
 Which one feature is correctly described?

	Feature	Sympathetic nervous system	Parasympathetic nervous system
(a)	Salivary glands	Stimulates secretion	Inhibits secretion
(b)	Pupil of the eye	Dilate	Constricts
(c)	Heart rate	Decrease	Increase
(d)	Intestinal peristalsis	Stimulates	Inhibits

16. Hearing impairment affects which part of brain? [2007]
 (a) Frontal lobe (b) Parietal lobe
 (c) Temporal lobe (d) Cerebellum
17. The black pigment in the eye which reduces the internal reflection is located in [2007]
 (a) retina (b) iris
 (c) cornea (d) sclerotic
18. Bipolar nerve cells are present in [2012]
 (a) Skin tactile corpuscles
 (b) Spinal cord
 (c) Retina of eye
 (d) All the above
19. Fenestra ovalis is the opening of [2012]
 (a) Cranium (b) Tympanum
 (c) Tympanic cavity (d) Brain

20. Multipolar nerve cells are present in [2012]
 (a) Cochlea
 (b) Dorsal root ganglia of spinal cord
 (c) Retina of eye
 (d) Brain
21. Neurons receive signals through their _____ and send signals to other neurons through their _____. [2013]
 (a) dendrites ... receptors
 (b) end feet ... cell bodies and dendrites
 (c) cell bodies and dendrites ... axons
 (d) transmitter vesicles ... axons
22. Which of the following ions are required for nerve conduction? [2016]
 (a) Ca^{++} , Na^{+} and K^{+} (b) Ca^{++} and Mg^{++}
 (c) Mg^{++} and K^{+} (d) Na^{+} and K^{+}
23. The following diagram indicates the reflex arc. Identify the parts labelled as A, B, C, D, E, F and G. Choose the correct option



- [2016]
- (a) A = sense organ; B = sensory nerve; C = dorsal horn; D = interneuron; E = ventral horn; F = motor nerve; G = effector
- (b) A = sense organ; B = sensory nerve; C = ventral horn; D = interneuron; E = dorsal horn; F = motor nerve; G = effector
- (c) A = effector; B = motor nerve; C = dorsal horn; D = interneuron; E = ventral horn; F = sensory nerve; G = effector
- (d) A = effector; B = motor nerve; C = ventral horn; D = interneuron; E = dorsal horn; F = sensory nerve; G = sense organ.

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TYPE B : ASSERTION REASON QUESTIONS

Directions for (Qs. 24-26) : These questions consist of two statements, each printed as Assertion and Reason. While answering these questions, you are required to choose any one of the following five responses.

- (a) If both Assertion and Reason are correct and the Reason is a correct explanation of the Assertion.
- (b) If both Assertion and Reason are correct but Reason is not a correct explanation of the Assertion.
- (c) If the Assertion is correct but Reason is incorrect.
- (d) If both the Assertion and Reason are incorrect.
- (e) If the Assertion is incorrect but the Reason is correct.

24. **Assertion :** Transmission of nerve impulse across a synapse is accomplished by neurotransmitters.

Reason : Transmission across a synapse usually requires neurotransmitters because there is a small space, *i.e.*, synaptic cleft, that separates one neuron from another. [1999]

25. **Assertion :** Tongue is a gustatoreceptor.

Reason : Receptors for gustatory sensations are located in taste buds. [2000]

26. **Assertion :** Astigmatism is due to uneven curvature of lens.

Reason : It is treated with cylindrical lenses. [2007]

Topicwise AIIMS Solved Papers – BIOLOGY

Directions for (Qs. 27-31) : Each of these questions contains an Assertion followed by Reason. Read them carefully and answer the question on the basis of following options. You have to select the one that best describes the two statements.

- (a) If both Assertion and Reason are correct and Reason is the correct explanation of Assertion.
- (b) If both Assertion and Reason are correct, but Reason is not the correct explanation of Assertion.
- (c) If Assertion is correct but Reason is incorrect.
- (d) If both the Assertion and Reason are incorrect.

27. **Assertion :** The brain stem contains centres for controlling activities.

Reason : Brain stem is very sensitive. [2012]

28. **Assertion :** The chemical stored in the synaptic vesicles are termed as neurotransmitters.

Reason : Synaptic vesicles release these chemicals in the synaptic cleft. [2013]

29. **Assertion:** The imbalance in concentration of Na^+ , K^+ and proteins generates resting potential.

Reason: To maintain the unequal distribution of Na^+ & K^+ , the neurons use electrical energy. [2002, 2015]

30. **Assertion :** The axonal membrane of the neuron is more permeable to sodium ion (Na^+) and nearly impermeable to potassium (K^+).

Reason : In a resting state neuron does not conduct any impulse. [2016]

31. **Assertion :** A cerebellum is related with skillful voluntary movement and involuntary activity like body balance, equilibrium, *etc.*

Reason : It is part of hind brain and it is situated behind the pons. [2010, 2017]

HINTS & SOLUTIONS**Type A : Multiple Choice Questions**

1. (a) Vagus is the 10th cranial nerve. Vagus is the longest cranial nerve. It has maximum branches and also called as wandering nerve.
2. (a) The sensation of stomach pain is due to enteroceptors (visceroreceptors).
3. (c) Conditioned reflexes are acquired reflexes and dependent on past experiences, training and learning I.R. Pavlov demonstrated conditioned reflexes in a hungry dog. He called food and salivation in response to it as unconditioned stimulus and sound of bell and salivation in response to bell as conditioned reflexes.
4. (d) Otorhinolaryngology is the study of ENT.
5. (a) The withdrawal of leg in a decapitated frog when pin pointed is a type of simple-reflex.
6. (d) Plague is a bacterial disease of rat, caused by *Pasteurella pestis*. Their vector is rat flea (*Xenopsylla cheopsis*). Bubonic plague affects lymph nodes. Pneumonic plague affects lungs and septicemic plague causes anaemia.
7. (c) The 5th cranial nerve in frog is trigeminal.
8. (d) Lead zirconate is a key component of sonography. These crystals are housed in a transducer which gets excited and starts vibrating when an electric potential is applied to it. These vibrations are the source of ultrasound.
9. (d) Vagus nerve is a mixed nerve. It controls the visceral sensations and visceral movements, e.g. respiratory movements.
10. (c) Concave lenses correct the eye condition of near sightedness i.e. myopia by bringing the light rays to a focus on retina. In such cases light rays converge at a point in front of the retina.
11. (d) Transmission of nerve impulse is always from axon of one neuron to the dendrite of another neuron i.e. unidirectional because neurotransmitters are produced by axons and not by dendrites.
12. (b) Cell A is the cone cell more concentrated in the fovea centralis/yellow spot of the eye. Cone cells are sensitive to bright light hence helps in differentiating colours and give high resolution. These cells are specialized for colour vision.
13. (a) Borderline personality disorder is an emotionally unstable personality disorder characterised by impulsivity, unpredictable moods, outburst of emotion, behavioural explosions, quarrelsome behaviour and conflicts with others.
14. (c) Glaucoma is an eye disease characterized by increased ocular pressure within the eye ball. Glaucoma is a group of diseases of the optic nerve involving loss of retinal ganglion cells in a characteristic pattern of optic neuropathy. Untreated glaucoma leads to permanent damage of the optic nerve and resultant visual field loss that can progress to blindness. Measles is a highly infectious viral disease that usually spread by droplet infection. Bronchitis is the inflammation of the membrane lining of the bronchial tubes.
15. (b) Sympathetic nervous system inhibits salivary gland secretion, accelerate heart rate, decreases intestinal peristalsis and dilate pupil of the eye. Whereas parasympathetic nervous system stimulates salivary gland secretion, slows heart rate, stimulates intestinal peristalsis and constricts pupil of the eye. The sympathetic and the parasympathetic nervous system are parts of what is commonly called the autonomic nervous

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system. These systems work in balance with each other and directly or indirectly affect almost every structure in the body (e.g. heart frequency, heart capacity, lumbar function, kidneys, blood vessels, stomach and intestines). The sympathetic nervous system has an active “pushing” function, the parasympathetic has mainly a relaxing function.

Sympathetic	Structure	Parasympathetic
Rate increased	Heart	Rate decreased
Force increased	Heart	Force decreased
Bronchial muscle relaxed	Lungs	Bronchial muscle contracted
Pupil dilation	Eye	Pupil constriction
Motility reduced	Intestine	Digestion increased
Sphincter closed	Bladder	Sphincter relaxed
Decreased urine secretion	Kidneys	Increased urine secretion

16. (c) Forebrain is the largest part of the brain consisting of two halves called cerebral hemispheres separated by longitudinal fissures. Each cerebral hemisphere is divided into four lobes-frontal lobe, parietal lobe, temporal lobe and occipital lobe. Temporal lobe has cells that bring to consciousness, the sensations of hearing and smell. The frontal lobe has centers that are concerned with voluntary movements and personality. The parietal lobe is concerned with general sensations like temperature, touch, pressure, pain, and proprioception. The occipital lobe has centers of visual sense.
17. (a) The inner layer of the posterior two-thirds of the eyeball consists of a light sensitive layer, called retina that possesses two types of photoreceptors called the rods and the cone cells. Retina reduces the internal reflection so any damage to it leads to greater internal reflection of light often causing an increase in light sensitivity.

Topicwise AIIMS Solved Papers – BIOLOGY

18. (c) Bipolar nerve cells are present in retina of eye. Bipolar nerve cell possesses one axon and one dendron.
19. (c) Fenestra ovalis is membrane covered opening leading from tympanic cavity into the vestibule of the internal ear.
20. (b) Multipolar nerve cells are present in dorsal root ganglia of spinal cord.
21. (c) Dendrites generally receive inputs and conduct signals toward the cell body, whereas axons conduct signals away from the cell body.

22. (a) 23. (a)

Type B : Assertion Reason Questions

24. (a) Transmission of nerve impulse across synapses is accomplished by neurotransmitter because synapses comprise of a synaptic cleft between the end of one nerve fibres and the beginning of the next.
25. (a) Gustatoreceptors are chemoreceptors, enclosed within taste buds.
26. (b) Astigmatism is a kind of defect of vision in which the image of an object is distorted. It is because all the light rays do not come to focus on retina. It is due to abnormal curvature of the lens. It can be corrected by wearing cylindrical lenses.
27. (b) The brain stem consists of pons varoli, medulla oblongata, mid brain and diencephalon. The brain stem is the connection between brain and spinal cord. It contains centres for controlling many vital activities like respiration, body temperature, urge for eating and drinking etc. It also carries nerve tracts between the spinal cord and the higher brain structure.
28. (b) The axon terminal of the neuron contains many membrane bound vesicles called synaptic vesicles, in its cytoplasm. Within these vesicles, chemical substances such as adrenaline and acetylcholine remain

stored. These chemicals are called neurotransmitters, because they help to transmit nerve impulses across the synapses. When a nerve impulse passes the axon terminal, its synaptic vesicles release their stored chemicals to the synaptic cleft. These diffuse through the cleft to reach the membrane of the next neuron, stimulating the latter. This causes the nerve impulse to be transmitted along the next neuron.

29. (c) Resting potential is due to differential distribution of ions on two sides of cell membrane.
30. (d) The axonal membrane of neuron is more permeable to potassium ions (K^+) and

nearly impermeable to sodium ions (Na^+). In a resting state neuron does not conduct any impulse. In the resting state the period during which a neuron is not conducting the fluids outside the cell membrane carry a relatively high positive charge. The fluids inside the cell membrane carry a less positive, or relatively negative, charge.

31. (b) Hind brain consists of cerebellum located dorsally to medulla oblongata and pons varolii. It contains centres for maintenance of posture and equilibrium of the body and for the muscle tone. All activities of the cerebellum are involuntary but may involve learning in their early stages.

TYPE A : MULTIPLE CHOICE QUESTIONS

- To yield more milk, cow is injected with [1997]
(a) sorbitol (b) prolactin
(c) gonadotrophs (d) stilbesterol
- Treatment with alloxan destroys [1998]
(a) stilt cells
(b) β -cells of Langerhans
(c) sertoli cells
(d) cells of Leydig
- Addison's disease result from [1998]
(a) hyposecretion of gonads
(b) hyposecretion of adrenal gland
(c) hypertrophy of kidney
(d) hyposecretion of pituitary gland
- The development of adult characteristics in a moulting insect is promoted by [1998]
(a) Thyroxine (b) Ecdysone
(c) Pheromone (d) None of these
- Heart beat increases at the time of interview because of [1999]
(a) renin (b) rennin
(c) adrenaline (d) Diuretic ADH
- Conn's disease is caused by the over secretion of [1999]
(a) ADH (b) ACTH
(c) Oxytocin (d) Aldosterone
- Acromegaly is due to hypersecretion of [2001]
(a) Insulin (b) Thyroxine
(c) Growth hormone (d) None of these
- Steroid hormones are similar in structure to [2001]
(a) Tryosine
(b) Cholesterol
(c) Coenzyme A
(d) Glycerol
- A person passes much urine and drinks much water put his blood glucose level normal. This condition may be the result of [2003]

- a reduction in insulin secretion from pancreas
- a reduction in vasopressin secretion from posterior pituitary
- a fall in the glucose concentration in urine
- an increase in secretion of glucagon

- The source of somatostatin is same as that of
(a) Thyroxine and calcitonin [2003]
(b) Insulin and glucagon
(c) Somatotropin and prolactin
(d) Vasopressin and oxytocin
- Which one of the following four secretions is **correctly matched** with its source, target and nature of action? [2005]

	Secretion	Source	Target	Action
(a)	Gastrin	Stomach lining	Oxyntic cells	Production of HCl
(b)	Inhibin	Sertoli cells	Hypothalamus	Inhibition of gonadotropin releasing hormone
(c)	Entero-kinase	Duodenum	Gall bladder	Release of bile juice
(d)	Atrial Natriuretic Factor (ANF)	Sinu atrial node (SAN) M-cells of Atria	Juxta-glomerular apparatus (JGA)	Inhibition of renin

- Which of the following match is correct?[2007]

Hormone	Effect
(a) Oxytocin	Milk ejection hormone
(b) Glucagon	Decreases blood sugar level
(c) Adrenaline	Decreases heart rate
(d) Thyroxine	Decreases BMR

13. Which of the following statements regarding glucagon is false? [2007]
 (a) It is secreted by α -cells of Langerhans.
 (b) It acts antagonistically to insulin.
 (c) It decreases blood sugar level.
 (d) The gland responsible for its secretion is heterocrine gland.
14. Which one of the following four gland is correctly matched with the accompanying description? [2005, 2008]
 (a) Thyroid - Hyperactivity in young children causes cretinism
 (b) Thymus - Starts undergoing atrophy after puberty
 (c) Parathyroid - Secrete para-thormone, which promotes movement of calcium ions from blood into bones during calcification
 (d) Pancreas - Delta cells of the 'islets of Langerhans' secrete a hormone, which stimulates glycolysis in liver
15. Which row in the chart contains the words that best complete this statement? The (I) glands produce (II), which are transported by the (III) system. [2009]
- | Row | I | II | III |
|-----|-----------|----------|-------------|
| A | digestive | hormones | circulatory |
| B | endocrine | enzymes | lymphatic |
| C | endocrine | hormones | circulatory |
| D | digestive | enzymes | lymphatic |
- (a) A (b) B
 (c) C (d) D
16. The blood glucose level is commonly expressed as [2010]
 (a) mm. of Hg
 (b) milligram per deci litre
 (c) parts per million
 (d) gram (mg/dl) per litre
17. Which one of the following hormones contains iodine? [2010]
 (a) Thyroxine (b) Testosterone
 (c) Insulin (d) Adrenaline
18. The pituitary gland by virtue of its tropic hormones controls the secretory activity of other endocrine glands. Which one of the following endocrine gland can function independently of the pituitary gland? [2010]
 (a) Thyroid (b) Gonads
 (c) Adrenals (d) Parathyroid
19. Match List-I (Endocrine glands) with List-II (Hormones secreted) and select the correct answer using the codes given below [2010]
- | List-I | List-II |
|--------------|----------------------|
| A. Gonads | I. Insulin |
| B. Pituitary | II. Progesterone |
| C. Pancreas | III. Growth hormones |
| D. Adrenal | IV. Cortisone |
- Codes :**
 (a) A – III; B – II; C – IV; D – I
 (b) A – II; B – III; C – IV; D – I
 (c) A – II; B – III; C – I; D – IV
 (d) A – III; B – II; C – I; D – IV
20. Which gland is concerned with salt equilibrium in body? [2012]
 (a) Anterior pituitary (b) Pancreas
 (c) Adrenal (d) Thyroid
21. Which of the following hormones have antagonistic (opposing) effects? [2013]
 (a) Thyroxine and calcitonin
 (b) Insulin and glucagon
 (c) Growth hormone and epinephrine
 (d) ACTH and glucocorticoids
22. Select the correct option describing gonadotropin activity in a normal pregnant female: [2014]
 (a) High level of FSH and LH stimulate the thickening of endometrium.
 (b) High level of FSH and LH facilitate implantation of the embryo.

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- (c) High level of hCG stimulates the synthesis of estrogen and progesterone.
 (d) High level of hCG stimulates the thickening of endometrium.
23. Which endocrine gland is called 'the Throne of immunity'? [2016]
 (a) Spleen (b) Thymus
 (c) Pineal (d) Adrenal medulla
24. Which of the following hormone acts upon the renal tubule and blood capillaries? [2017]
 (a) Glucagon (b) Aldosterone
 (c) Vasopressin (d) Glucocorticoids

TYPE B : ASSERTION REASON QUESTIONS

Directions for (Qs. 25-27) : These questions consist of two statements, each printed as Assertion and Reason. While answering these questions, you are required to choose any one of the following five responses.

- (a) If both Assertion and Reason are correct and the Reason is a correct explanation of the Assertion.
 (b) If both Assertion and Reason are correct but Reason is not a correct explanation of the Assertion.
 (c) If the Assertion is correct but Reason is incorrect.
 (d) If both the Assertion and Reason are incorrect.
 (e) If the Assertion is incorrect but the Reason is correct.
25. **Assertion:** The regulation of RBC production is accomplished by FSH.
Reason: Erythropoietin hormone circulates to red bone marrow where it increases stem cell mitosis and speed up development of RBCs. [2002]
26. **Assertion :** Diabetes insipidus is marked by excessive urination and too much thirst of water.

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Reason : Anti-diuretic hormone (ADH) is secreted by the posterior lobe of pituitary gland.

[2004]

27. **Assertion :** Our body secretes adrenaline in intense cold. [2006]

Reason : Adrenaline raises metabolic rate.

Directions for (Qs. 28-31) : Each of these questions contains an Assertion followed by Reason. Read them carefully and answer the question on the basis of following options. You have to select the one that best describes the two statements.

- (a) If both Assertion and Reason are correct and Reason is the correct explanation of Assertion.
 (b) If both Assertion and Reason are correct, but Reason is not the correct explanation of Assertion.
 (c) If Assertion is correct but Reason is incorrect.
 (d) If both the Assertion and Reason are incorrect.

28. **Assertion :** Mammary glands are apocrine glands. [2009]

Reason : The distal part containing secretory granules break down and leaves as a secretion.

29. **Assertion :** Hormone calcitonin has antagonistic effect to that of parathormone. [2009]

Reason : Calcitonin decreases blood calcium level while parathormone increases blood calcium level.

30. **Assertion :** The person with diabetes insipidus feels thirsty.

Reason : A person with diabetes insipidus suffers from excess secretion of vasopressin.

[2010]

31. **Assertion:** Failure of secretion of hormone vasopressin causes diabetes mellitus in the patient. [2011]

Reason: Vasopressin increases the volume of urine by increasing the reabsorption of water from the urine.

HINTS & SOLUTIONS**Type A : Multiple Choice Questions**

1. (b) Prolactin (also called leuteotrophic) hormone is associated with lactation (secretion of milk from the mammary gland). Therefore, to yield more milk cow is injected with prolactin hormone. Sorbitol is a sweetner found in some fruits (like apple, peers *etc.*). Gonadotrophs a type of basophil in the adenohypophysis (anterior pituitary gland) whose granules secrete FSH (follicle-stimulating hormone) and LH (luteinizing hormone). Stilbesterol is synthetic estrogen used in hormone therapy, as a post-coital contraceptive, and as a growth-promoting agent for livestock.
2. (b) Alloxan treatment damages β -cells of Islets of langerhans which leads to hyperglycaemia and glycosuria.
3. (b) Addisons disease occurs due to hyposecretion of both mineralocorticoids (aldosterone) and glucocorticoids (cortisol) from the layers of adrenal cortex called zona glomerulosa and zona fasciculata respectively. The disease is characterized by excessive loss of Na^+ , Cl^- and HCO_3^- increased K^+ level in blood, weight loss, muscle weakness, fatigue, low blood pressure, and sometimes darkening of the skin in both exposed and nonexposed parts of the body.
4. (b) Ecdysone is a moulting hormone of insects. Ecdysone is produced from prothoracic gland that triggers moulting and metamorphosis. Thyroxine is thyroid hormone that stimulates body metabolism and helps regulate body growth and development. Pheromone is a chemical screted by an animal that influences the behavior or development of other members of the same species.
5. (c) Adrenaline (amine hormone) is secreted by adrenal medulla on stimulation of sympathetic nervous system for meeting an emergency or stress condition like fear injury accident *etc.* Hence, it also called as emergency hormone. It increases blood pressure, respiration rate, sugar level in blood *etc.* It prepares the body to face stress at the time of interview by increasing heart beat. So it is also called stress hormone. Renin is proteolytic enzyme synthesized, stored, and secreted by the juxtaglomerular cells of the kidney. It plays a role in regulation of blood pressure by catalyzing the conversion of angiotensinogen to angiotensin I and II which in turn stimulates the release aldosterone from adrenal gland. Rennin, a coagulating enzyme produced from the stomach of human body, catalyzes the coagulation of milk by converting milk protein, caesin into paracaesinate. ADH (antidiuretic hormone) is secreted by the posterior portion of the pituitary gland that constricts blood vessels raises blood pressure, and reduces excretion of urine.
6. (d) Conn's syndrome/aldosteronism is due to hypersecretion of aldosterone. Aldosetrone is secreted from zona glomerulosa layer of adrenal cortex. The principle action of the aldosterone is retention of sodium. Conn's syndrome is characterized by rise in blood volume and blood pressure; muscular weakness; high sodium and low potassium level in the blood plasma resulting in kidney damage with polyuria and tetany and metabolic disorder.
7. (c) Acromegaly is due to hyposecretion of growth/somatotrophic hormone in adults after the closure of epiphysed plate at the end of long bones. Growth hormone is secreted by artesian pituitary gland.

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It is characterised by abnormal elongation of limbs and lower jaw giving gorilla like appearance. Hypersecretion of insulin results in hypoglycemia, hunger, sweating and double vision. Hypersecretion of thyroxine results in Grave's disease (also called exophthalmic goiter) which is characterised by increased BMR, heart rate, pulse rate; protrusion of eyes *etc.*

8. (b) Steroid hormones are fat soluble and have sterol group. They are derived from cholesterol, *e.g.* hormones of adrenal cortex, testis and ovaries. Amine hormones are derived from tyrosine amino acids and have amino group, *e.g.* thyroxine, epinephrine and nor epinephrine. Coenzyme A is essential to metabolism of carbohydrates and fats and some amino acids. Glycerol is a clear, colorless, viscous, sweet-tasting liquid organic compound of the alcohol family.
9. (b) When a person passes more urine and drinks more water, he is suffering from diabetes insipidus. It is caused by reduction in vasopressin (ADH) secretion from posterior pituitary gland.
10. (b) The source of somatostatin is same as that of insulin and glucagons. All these hormones are secreted from endocrine part (called Islets of Langerhans) of pancreas. These endocrine parts contain different types of endocrine cells which secrete different hormones.

Endocrine cells	Hormones
α cell	Glucagon
β cell	Insulin
γ cell	Gastrin
δ cell	Somatostatin
F cell	Pancreatic polypeptides

Thyroxine and calcitonin are secreted by thyroid gland. Somatotropin and prolactin are secreted from anterior pituitary gland.

Vasopressin and oxytocin are secreted from posterior pituitary gland.

11. (d) Atrial natriuretic factor (ANF) is produced by cardiocytes of atria of heart in response to an increased return of the deoxygenated blood. It inhibits the release of renin from juxta-glomerular apparatus and thereby, inhibits NaCl reabsorption by the collecting duct and reduces aldosterone release from the adrenal cortex. Inhibin is an endocrine hormone, produced from ovary and testes. When inhibin is secreted, it inhibits the production of follicle stimulating hormone (FSH). It also limits the release of gonadotropin releasing hormone. (For other hormones refer answer no. 4)
12. (a) Oxytocin is the hormone secreted by posterior pituitary that causes contraction of the smooth muscles of myometrium during child birth and ejection of milk from the mammary glands. Glucagon is secreted by the α -cells of islets of Langerhans of pancreas. Its main function is to increase blood glucose level. Adrenaline (epinephrine) is secreted by adrenal medulla. It increases the rate and force of heart beat. Thyroid gland secretes thyroxine that regulates basal metabolic rate.
13. (c) Pancreas is a heterocrine gland comprising both endocrine and exocrine parts. Its endocrine part consists of small masses of hormone secreting cells called islets of Langerhans. The α -cells of latter secrete glucagons and its β -cells secrete insulin. These two hormones have antagonistic effects on the glucose level in the blood which means that insulin decreases the blood glucose level while glucagon increases blood glucose level.
14. (b) The thymus is an organ located in the upper anterior portion of the chest cavity just behind the sternum. The thymus continues to grow between birth and puberty and then begins to atrophy. Proportional to thymic

size, thymic activity is most active before puberty. Upon atrophy, the size and activity are dramatically reduced, and the organ is primarily replaced with fat. The atrophy is due to the increased circulating level of sex hormones, and chemical or physical castration of an adult result in the thymus increasing in size and activity.

15. (c) The endocrine glands produce hormones, which are transported by the circulatory system. The digestive system makes enzymes that are secreted *via* ducts to the organ that needs them.
16. (b) Blood glucose level is commonly expressed as milligram per deci litre.
17. (a) The main secretion of thyroid gland is called thyroxine. Thyroxine contains iodine. When thyroid gland becomes inactive, the lack of iodine causes goitre.
18. (d) Parathyroid gland secretes parathormone hormone, which regulates Ca^{++} and PO_4^{2-} ion in body. This gland works independently to pituitary gland.
19. (c) Gonads, pituitary, pancreas & adrenal are all endocrine glands which secrete progesterone, growth hormone, insulin and cortisol hormone respectively.
20. (c) Adrenal glands are concerned with salt equilibrium in the body. Mineralocorticoids are secreted from adrenal cortex. Aldosterone is the main mineralocorticoid in our body. Aldosterone acts mainly at the renal tubules and stimulates reabsorption of Na^+ and water and excretion of K^+ and phosphate ions.
21. (b) Insulin lowers blood sugar levels. While Glucagon raises blood sugar levels.
22. (c) Synthesis of estrogen and progesterone due to high level of hCG is a normal gonadotropic activity in a normal pregnant female.
23. (b) Thymus stimulates T-cells which regulate the production of antibodies.

24. (c) ADH (or vasopressin) is secreted by posterior pituitary gland. It acts on kidney tubule and blood capillaries and concentrates the urine by promoting the reabsorption of water and salts into the cortical collecting ducts.

Type B : Assertion Reason Questions

25. (e) The regulation of RBC production is accomplished by erythropoietin hormone (EPO). Erythropoietin, a glycoprotein, is produced by the kidney when the oxygen level is low. EPO then stimulates the bone marrow to produce more red cells and thereby increase the oxygen-carrying capacity of the blood. Follicle-stimulating hormone (FSH) is a gonadotropic hormone that is secreted by the anterior pituitary gland. FSH causes gametogenesis and stimulates estrogen production from ovaries.
26. (b) Diabetes insipidus (DI) occurs when the kidneys are unable to conserve water as they perform their function of filtering blood. The amount of water conserved is controlled by antidiuretic hormone (ADH) also called vasopressin which is secreted by posterior lobe of pituitary gland. Diabetes insipidus is characterised by excessive urination and thirst. This problem appears due to the increase in permeability of collecting tubules.
27. (a) Adrenaline is an emergency hormone whose concentration increases under stress conditions. *e.g.* cold, stress. Adrenaline is secreted from adrenal medulla. It initiates many bodily responses, including the stimulation of heart action and an increase in blood pressure, metabolic rate, and blood glucose concentration.

28. (a) Based on the mode of secretion, the glands are of three types : mesocrine, apocrine and holocrine. Mammary glands that are present in mammals to feed the young ones with milk are the example of apocrine glands. In apocrine glands, the secretion accumulates as secretory granules in the distal part of the cell. This part later breaks down and leaves as a secretion.
29. (a) Calcitonin or thyrocalcitonin is secreted by parafollicular cells of thyroid stroma. It retards bone dissolution and stimulates excretion of calcium in urine. Thus, it lowers calcium level in extra cellular fluid (ECF). Parathormone is secreted by chief cells of parathyroid gland and is also known as Collip's hormone. It maintains blood calcium level by increasing its absorption from food in intestine and its reabsorption from nephrons in the kidney. Maintenance of proper calcium level is in fact, a combined function of parathormone and calcitonin. When calcium level falls below normal parathormone maintains it by promoting its absorption, reabsorption and also by demineralisation of bones. When blood calcium level exceeds above normal then calcitonin hormone increases excretion of calcium in urine.
30. (c) Vasopressin or antidiuretic hormone is secreted by posterior pituitary gland. The deficiency of vassopressin results in a disorder known as diabetes insipidus. The main symptoms of diabetes insipidus are increase in thirst and increase in urination.
31. (d) Vasopressin or anti-diuretic hormone (ADH) reduces the volume of urine by increasing the reabsorption of water from the urine in the distal convoluted tubules, collecting tubules and collecting ducts in the kidney. It does so by rendering the walls of these tubules leads to diabetes insipidus (increased urination). Although the volume of urine is increased. No glucose appears in the urine of such patients. Diabetes mellitus is a disease which is caused due to the failure of insulin hormone secretion by the pancreatic islets. The osmotic effect of glucose in the urine considerably increases the volume of urine, due to which thirst is also enhanced. In extreme cases, the patient suffers from coma and may die.

Reproduction in Organisms

TYPE A : MULTIPLE CHOICE QUESTIONS

1. Based on cellular mechanisms there are two major types of regeneration found in the animals. Which one of the following is the correct example of the type mentioned? [2005]

- (a) Morphallaxis - Regeneration of two transversely cut equal pieces of a Hydra into two small Hydrams.
- (b) Epimorphosis - Replacement of old and dead erythrocytes by the new ones.
- (c) Morphallaxis - Healing up of a wound in the skin.
- (d) Epimorphosis - Regeneration of crushed and filtered out pieces of a Planaria into as many new Planarians. from chapter 25

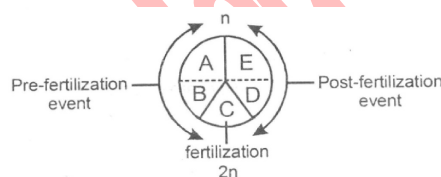
2. Which form of reproduction is correctly matched? [2007]

- (a) *Euglena* → transverse binary fission
- (b) *Paramecium* → longitudinal binary fission
- (c) *Amoeba* → multiple fission
- (d) *Plasmodium* → binary fission

3. Which reproductive adaptation is characteristic of most terrestrial vertebrates but not of most aquatic vertebrates? [2009]

- (a) External fertilization
- (b) Internal fertilization
- (c) Motile gametes
- (d) External development

4. Identify the events (A, B, D and E) in life of general reproduction-



[2015]

- (a) A-Gamete transfer, B-Gametogenesis, D-Zygote formation, E-Embryogenesis
 - (b) A-Gametogenesis, B-Gamete transfer, D-Zygote formation, E-Embryogenesis
 - (c) A-Gametogenesis, B-Zygote formation, D-Gamete transfer, E-Embryogenesis
 - (d) A-Gametogenesis, B-Gamete transfer, D-Embryogenesis, E-Zygote formation.
5. Which of the following statements is incorrect ?
- (i) Bamboo species flower only once in their life time, generally after 50-100 years and produce large number of fruits and die.
 - (ii) In animals, the juvenile phase is followed by morphological and physiological changes prior to active reproductive behaviour.
 - (iii) The reproductive phase is of same duration in all organisms.
 - (iv) Juvenile phase is the period of growth between the birth of an individual till it reaches reproductive maturity. [2016]
- (a) Only (i) (b) Only (ii)
 - (c) Only (iii) (d) Only (iv)

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6. In a practical test, a student has to identify the organisms in which syngamy does not occur. In those organisms the female gamete undergoes development to form new organisms without fertilization. This phenomenon is called "X". Identify the organisms and the phenomenon "X". [2017]

- (a) Frog, Parthenogenesis
- (b) Lizards, Gametogenesis
- (c) Rotifers, Embryogenesis
- (d) Honeybee, Parthenogenesis

TYPE B : ASSERTION REASON QUESTIONS

Directions for (Q. 7) : Each of these questions contains an Assertion followed by Reason. Read them

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carefully and answer the question on the basis of following options. You have to select the one that best describes the two statements.

- (a) If both Assertion and Reason are correct and Reason is the correct explanation of Assertion.
- (b) If both Assertion and Reason are correct, but Reason is not the correct explanation of Assertion.
- (c) If Assertion is correct but Reason is incorrect.
- (d) If both the Assertion and Reason are incorrect.

7. **Assertion :** Leaves of *Bryophyllum*, *Begonia* help in vegetative multiplication.

Reason : Leaves of these plants possess adventitious buds. [2014]

HINTS & SOLUTIONS**Type A : Multiple Choice Questions**

1. (a) Morphallaxis is the production of an entire animal from a small fragment whereas epimorphosis is the replacement of the lost part.
2. (c) Reproduction is the production of a new generation of individuals of the same species. It involves transfer of genetic material from one generation to the next.

Asexual and sexual are the two types of reproduction. Fission and budding are two most common forms of asexual reproduction in animals. During adverse conditions, amoeba reproduces by multiple fission that gives rise to many amoeba. *Euglena* reproduces by longitudinal binary fission, *Paramecium* reproduces by transverse binary fission and *Plasmodium* reproduces by multiple fission.
3. (b) Most vertebrate animals that live on land have an adaptation that allows internal fertilization, whereby the male penis inserts

sperm directly into the female body. This is advantageous since sperm need liquid to swim and the moist female reproductive tract provides this. Aquatic vertebrate animals live in water so sperm can easily be deposited in the water and swim to the female reproductive tract.

4. (b) Gametogenesis leads to production of gametes (sperm and ovum). Male gametes are then transferred to the site of fertilization. Fertilization results in zygote formation. The zygote then gives rise to embryo.
5. (c) Statement (iii) is not correct. The reproductive phase is not of same duration in all organisms.
6. (d) Parthenogenesis is a form of reproduction in which an unfertilized egg develops into a new individual, occurring commonly among insects and certain other arthropods.

Type B : Assertion Reason Questions

7. (a)

Sexual Reproduction in Flowering Plants

TYPE A : MULTIPLE CHOICE QUESTIONS

1. Asexual reproduction is called as [1997]
 - (a) apomixis (b) fragmentation
 - (c) self fertilization (d) cross fertilization
2. Pollination by snail and slug is called as [1998]
 - (a) entomophilous
 - (b) malacophilous
 - (c) ornithophilous
 - (d) chiropterophilous
3. In angiosperm, the endosperm is [1998]
 - (a) diploid (b) triploid
 - (c) haploid (d) polyploid
4. Female gametophyte of angiosperm is [1999]
 - (a) 7 celled (b) 8 celled
 - (c) 11 celled (d) 5 celled
5. Anemophilous flowers have [1999]
 - (a) sessile stigma
 - (b) small, smooth stigma
 - (c) coloured and scented flowers
 - (d) large feathery stigma
6. Growth of pollen tube towards embryo is [2000]
 - (a) geotropism (b) chemotaxis
 - (c) phototaxis (d) thigmotaxis
7. Which of the following statement is true? [2000]
 - (a) Spores are gametes
 - (b) Spores and gametes are diploid
 - (c) Gametes are always haploid
 - (d) Spores are always diploid
8. Which part of embryo comes out first during seed germination ? [2001]
 - (a) Radicle (b) Plumule
 - (c) Hypocotyl (d) Epicotyl
9. Xenia refers to [2002]
 - (a) effect of pollen on endosperm
 - (b) effect of pollen on stems
 - (c) effect of pollen on taste of fruits
 - (d) effect of pollen on vascular tissue
10. Ploidy of ovum of angiosperms is [2002]
 - (a) haploid (b) diploid
 - (c) triploid (d) polyploid
11. Pollen grains are able to withstand extremes of temperature and dessication because their exine is composed of [2003]
 - (a) cutin (b) suberin
 - (c) sporopollenin (d) callose
12. The pollen tube usually enters the embryo sac
 - (a) between the egg cell and synergid [2004]
 - (b) by directly penetrating the egg
 - (c) between one synergid and antipodal cell
 - (d) by knocking off the antipodal cells
13. Double fertilization involves [2005]
 - (a) fertilization of egg by two male gametes
 - (b) fertilization of two eggs in the same embryo sac by two sperms brought by one pollen tube
 - (c) fertilization of the egg and the central cell by two sperms brought by different pollen tubes
 - (d) fertilization of the egg and the central cell by two sperms brought by the same pollen tube
14. In which one of the following combinations (a - d) the number of chromosomes of the present day hexaploid wheat is correctly represented? [2006]

Comb- ination	Mono- somic	Haploid	Nulli- somic	Tri- somic
(a)	21	28	42	43
(b)	7	28	40	42
(c)	21	7	42	43
(d)	41	21	40	43

15. Apomixis is [2007]
(a) formation of seeds by fusion of gametes.
(b) formation of seeds without syngamy and meiosis.
(c) formation of seeds with syngamy but no meiosis.
(d) None of the above
16. The plant part which consists of two generations one within the other, is [2008]
(a) germinated pollen grain
(b) embryo
(c) unfertilized ovule
(d) seed
17. Chasmogamy refers to the condition where [2012]
(a) Flowers remains closed
(b) Flowers are absent
(c) Flowers are open
(d) Flower are gamopetalous
18. What is common between vegetative reproduction and apomixis? [2013]
(a) Both are applicable to only dicot plants
(b) Both bypass the flowering phase
(c) Both occur round the year
(d) Both produces progeny identical to the parent
19. Emasculation is not required when flowers are [2013]
(a) bisexual (b) intersexual
(c) unisexual (d) either (a) or (b)
20. Geitonogamy involves:
(a) fertilization of a flower by the pollen from another flower of the same plant.
(b) fertilization of a flower by the pollen from the same flower.
(c) fertilization of a flower by the pollen from a flower of another plant in the same population.
(d) fertilization of a flower by the pollen from a flower of another plant belonging to a distant population. [2014]
21. Which of the following statement is correct? [2016]
(a) Sporopollenin can withstand high temperatures but not strong acids.
(b) Sporopollenin can be degraded by enzymes.
(c) Sporopollenin is made up of inorganic materials.
(d) Sporopollenin can withstand high temperature as well as strong acids and alkalis.

TYPE B : ASSERTION REASON QUESTIONS

Directions for (Qs. 22-24) : These questions consist of two statements, each printed as Assertion and Reason. While answering these questions, you are required to choose any one of the following five responses.

- (a) If both Assertion and Reason are correct and the Reason is a correct explanation of the Assertion.
(b) If both Assertion and Reason are correct but Reason is not a correct explanation of the Assertion.
(c) If the Assertion is correct but Reason is incorrect.
(d) If both the Assertion and Reason are incorrect.
(e) If the Assertion is incorrect but the Reason is correct.

22. **Assertion :** If pollen mother cells has 42 chromosomes, the pollen has only 21 chromosomes.

Reason : Pollens are formed after meiosis in pollen mother cell. [1997]

23. **Assertion:** The megaspore mother cell divide mitotically to produce four spores.

Reason: Megaspore mother cells are diploid and megaspore is haploid. [2002]

24. **Assertion :** Insects visit flower to gather honey.

Reason : Attraction of flowers prevents the insects from damaging other parts of the plant. [2004]

Directions for (Qs. 25-28) : Each of these questions contains an Assertion followed by Reason. Read them carefully and answer the question on the basis of following options. You have to select the one that best describes the two statements.

- (a) If both Assertion and Reason are correct and Reason is the correct explanation of Assertion.
- (b) If both Assertion and Reason are correct, but Reason is not the correct explanation of Assertion.
- (c) If Assertion is correct but Reason is incorrect.
- (d) If both the Assertion and Reason are incorrect.

25. Assertion : Pollen mother cells (PMCs) are the first male gametophytic cells. [2009]

Reason : Each PMC gives rise to two pollens.

26. Assertion : Chasmogamous flowers require pollinating agents.

Reason : Cleistogamous flowers do not expose their sex organs. [2012]

27. Assertion : Double fertilization is characteristic feature of angiosperms.

Reason : Double fertilization involves two fusions. [2016]

28. Assertion : Endosperm is a nutritive tissue and it is triploid.

Reason: Endosperm is formed by fusion of secondary nucleus to second male gamete. It is used by developing embryo. [1998, 2017]

HINTS & SOLUTIONS**Type A : Multiple Choice Questions**

1. (c) In asexual reproduction, single parent is involved. It usually includes amitosis or mitotic division.
2. (b) Pollination by insects is entomophily, pollination by birds is ornithophily, pollination by bats is chiropterophily and pollination by molluscs (snail, slugs) is malacophily.
3. (b) Endosperm is formed as a result of triple fusion male gamete (n) + secondary nucleus ($2n$) = Primary endosperm nucleus ($3n$)
Secondary nucleus is formed by the fusion of 2 polar nuclei.
4. (a) The female gametophyte of angiosperms is eight nucleated and seven celled. The organized embryo sac comprises a 3 celled egg apparatus, three antipodal cells and a bipolar central cell. The embryo sac although eight nucleated has only seven cells.
5. (d) Anemophilous flowers have feathery stigma. It is the characteristic feature of Gramineae family (grass). In grasses, the stigma, that is plumose, works as an efficient pollen catcher. Hence, anemophilous flowers have feathery or plumose stigma.
6. (b) Growth of pollen tube towards embryo is chemotaxis due to the stimulus being chemical in nature. The chemical stimulus is supplied in the form of Ca^{++} ions.
7. (c) Gametes are always haploid in order to preserve the species genetically, anatomically and morphologically also. The embryo or zygote is formed due to the union of male and female gametes. ($n + n = 2n$). Hence, any species which is $2n$ is diploid in nature.
8. (a) The radicle comes out first since it grows towards the earth. During seed germination the radicle comes out first due to gravitational force and further more it results in a differential growth.
9. (a) Xenia is the effect of pollen genes on the development of the fruit or seed.
10. (a) Ovum is a female gamete and is always haploid.
11. (c) Sporopollenin, which is the hardest substance, helps the pollen grains to withstand extremes of temperatures. It avoids transpiration or water loss. This hard proteinaceous substance present in the exine makes it also spinous in nature.
12. (a) The synergids direct the growth of pollen tube by secreting some chemical substances. The tip of pollen tube enters into one synergid.
13. (d) Double fertilization involves fertilization of the egg/oosphere ($2n$) and that of secondary nucleus ($3N$) by two different sperms produced in the same pollen tube.
14. (d) $1n = 21$; monosomic ($2n - 1$) = $42 - 1 = 41$; nullisomic ($2n - 2$) = $42 - 2 = 40$. Trisomic ($2n + 1$) = $42 + 1 = 43$
15. (b) In plants, normal sexual reproduction includes meiosis and fertilization. It is called amphimixis. But in some plants abnormal sexual reproduction called apomixis has been observed. Apomixis includes abnormal sexual reproduction in which egg or other cells like synergids and antipodals develop into embryo without fertilization and meiosis. The term apomixis was given by Winkler (1908) eg. *Citrus*, *Ranunculus*.

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16. (b) The plant which consists of two generations one within the other is embryo. In botany, a seed plant *embryo* is part of a seed, consisting of precursor tissues for the leaves, stem and root as well as one or more cotyledons. Once the embryo begins to germinate, grow out from the seed, it is called a seedling. Plants that do not produce seeds, but do produce an embryo, include the bryophytes and ferns. In these plants, the embryo is a young plant that grows attached to a parental gametophyte.
17. (c) Chasmogamous flowers are always open. In same bisexual plants like *Commelina* & *Viola*. Chasmogamous and cleistogamous flowers (which never opens throughout the life) are found.
18. (d) Vegetative reproduction and apomixis both are asexual methods of reproduction, which gives the progeny genetically similar to parent.
19. (c) In unisexual flowers, the female flower buds are bagged before the flowers open. When the stigma become receptive, pollination is carried out using the desired pollen and the flower rebagged. Hence, there is no need of emasculation in these flowers.
20. (a) Geitonogamy is the transfer of pollen grains in different flowers of same plant.
21. (d) Pollen grains are generally spherical and prominent two-layered wall. The hard outer layer (called the exine) is made up of sporopollenin which is one of the most resistant organic material known. It can withstand high temperatures and strong acids and alkali.

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Type B : Assertion Reason Questions

22. (a) Pollen mother cells undergo meiosis and produce pollen grains. The pollen grains have haploid number of chromosomes.
23. (e) Megaspore mother cell is a prominent cell in the nucellus. It divides by meiosis and forms a row of four haploid megaspores.
24. (d) Honey bee visit flowers to gather nectar and turn it into honey. Visiting of insects for nectar helps in pollination.
25. (d) Primary sporogenous cell gives rise to microspore mother cells or pollen mother cells (PMCs). They are sporophytic in nature i.e., diploid. These cells undergo meiosis (reduction division) which gives rise to 4 microspores or pollens and this formation of microspores or pollens is called microsporo-genesis. Microspores represent the beginning of the gametophytic phase and they are haploid in nature.
26. (b) The majority of angiosperms bear chasmogamous flowers, which means the flowers expose their mature anthers and stigma to the pollinating agents. There is another group of plants which set seeds without exposing their sex organs. Such flowers are called cleistogamous and the phenomenon is cleistogamy.
27. (b) Double fertilization is a characteristic feature of angiosperms. It involves two fusions in which one female gametes fuse with egg cell to form zygote and other male gamete fuses with the diploid secondary nucleus to produce triploid primary endosperm nucleus.
28. (a) Male gamete (n) + secondary nucleus (2n) = primary endosperm nucleus which develops into endosperm (3n)
Endosperm is the reserve food used by developing embryo.

TYPE A : MULTIPLE CHOICE QUESTIONS

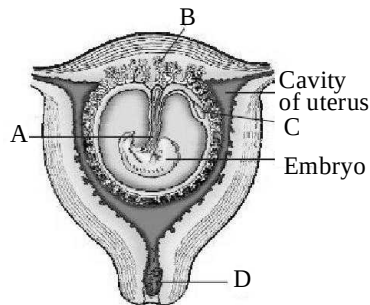
1. Prostate gland secretion helps in formation of
(a) larva (b) semen [1997]
(b) cocoon (c) none of these
2. Immediately after ovulation, the mammalian egg is covered by a membrane called as [1998]
(a) chorion (b) corona radiata
(c) zona pellucida (d) none of these
3. The extra-embryonic membranes of mammalian embryo are derived from [1999]
(a) trophoblast (b) follicle cells
(c) inner cell mass (d) formative cells
4. Acrosome of sperm is formed by [1999]
(a) nucleus (b) golgi bodies
(c) lysosome (d) E. R.
5. Cumulus covers [1999]
(a) ovary (b) ovum
(c) embryo (d) sperm
6. Cessation of menstrual cycle in women is called
(a) menopause (b) lactation [2001]
(c) ovulation (d) parturition
7. Both corpus luteum and macula lutea are [2003]
(a) found in human ovaries
(b) a source of hormones
(c) characterized by a yellow colour
(d) contributory in maintaining pregnancy
8. The early human embryo distinctly possesses [2003]
(a) gills
(b) gill slits
(c) external ear (pinna)
(d) eyebrows
9. The phase of menstrual cycle in humans that lasts for 7-8 days, is [2003]
(a) follicular phase (b) ovulatory phase
(c) luteal phase (d) menstruation
10. Which one of the following statements with regard to embryonic development in humans is correct? [2003]
(a) Cleavage divisions bring about considerable increase in the mass of protoplasm.
(b) In the second cleavage division, one of the two blastomeres usually divides a little sooner than the second.
(c) With more cleavage divisions, the resultant blastomeres become larger and larger.
(d) Cleavage division results in a hollow ball of cells called morula.
11. Women who consumed the drug thalidomide for relief from vomiting during early months of pregnancy gave birth to children with [2004]
(a) no spleen
(b) hare-lip
(c) extra fingers and toes
(d) under developed limbs
12. A cross section at the midpoint of the middle piece of a human sperm will show [2005]
(a) centriole, mitochondria and 9 + 2 arrangement of microtubules.
(b) centriole and mitochondria.
(c) mitochondria and 9 + 2 arrangement of microtubules.
(d) 9 + 2 arrangement of microtubules only.
13. Which one of the following events is correctly matched with the time period in a normal menstrual cycle? [2005]
(a) Release of egg : 5th day
(b) Endometrium regenerates : 5-10 days
(c) Endometrium secretes nutrients for implantation : 11-18 days
(d) Rise in progesterone level : 1-15 days

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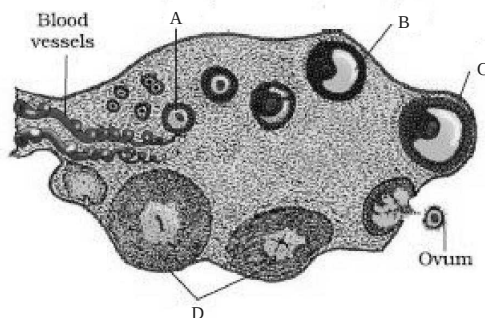
14. Which of the following is true regarding sperm? [2007]
 (a) Fertilizin: For penetrating egg membrane
 (b) Hyaluronidase: For penetrating egg membrane
 (c) Acrosin: Dissolves corona radiata
 (d) Capacitation: Takes place in penis
15. Both corpus luteum and macula lutea are [2008]
 (a) found in human ovaries
 (b) a source of hormones
 (c) characterized by a yellow colour
 (d) contributory in maintaining pregnancy
16. In humans, what is the ratio of the number of gametes produced from one male primary sex cell to the number of gametes produced from one female primary sex cell? [2009]
 (a) 1:3 (b) 1:4
 (c) 3:1 (d) 4:1
17. Corpus luteum is a mass of cells found in [2010]
 (a) brain (b) ovary
 (c) pancreas (d) spleen
18. Cells of leydig are found in [1997, 2011]
 (a) Testes of frog (b) Testes of rabbit
 (c) Kidney of frog (d) Kidney of rabbit
19. Meroblastic cleavage refers to which type of division of egg [2001, 2011]
 (a) Complete (b) Spiral
 (c) Incomplete (d) Horizontal
20. Which of the following organ is differentiated first during development? [2012]
 (a) Heart (b) Skin
 (c) Brain (d) Neural tube
21. The correct sequence of spermatogenetic stages leading to the formation of sperms in a mature human testis is: [2013]
 (a) spermatogonia-spermatid-spermatocyte-sperms
 (b) spermatocyte-spermatogonia-spermatid-sperms
 (c) spermatogonia-spermatocyte-spermatid-sperms
 (d) spermatid-spermatocyte-spermatogonia-sperms
22. All of the following statements concerning pregnancy are accurate EXCEPT [2015]
 (a) the detection of human chorionic gonadotropin in the urine forms the basis for pregnancy tests.
 (b) the cyclic release of pituitary gonadotropins and ovarian steroids is continued.
 (c) the mammary gland tissue of the pregnant woman is stimulated to develop by placental hormones.
 (d) the corpus luteum of pregnancy maintains the uterus until the placenta is well established.
23. The following graph of relative concentrations of the four hormones present in the blood plasma of a woman during her menstrual cycle. Identify the hormones. [2015]
-
	A	B	C	D
(a)	FSH	Progesterone	LH	Oestrogen
(b)	LH	Progesterone	FSH	Oestrogen
(c)	FSH	Oestrogen	LH	Progesterone
(d)	LH	Oestrogen	FSH	Progesterone
24. Ejaculation of human male contains about 200 – 300 million sperms, of which for normal fertility ____ % sperms must have normal shape and size and at least ____ % must show energetic motility. [2016]
 (a) 40, 60 (b) 50, 50
 (c) 60, 40 (d) 30, 70

25. The given figure shows the human foetus within the uterus with few structures marked as A, B, C and D.



Which of the following options shows the correct labeling? [2016]

- (a) A→Umbilical cord with its veins, B→Chorionic villi, C→Antrum, D→Plug of mucus in cervix
- (b) A→Umbilical cord with its vessels, B→Fimbriae, C→Oocyte, D→Plug of mucus in vagina
- (c) A→Umbilical cord with its vessels, B→Placental villi, C→Yolk sac, D→Plug of mucus in cervix
- (d) A→Umbilical cord with its veins, B→Placental villi, C→Trophoblast, D→Plug of mucus in vagina [2016]
26. The figure given below shows the sectional view of ovary. Select the option which gives correct identification of marked structure (A to D) and its feature. [2017]



- (a) A: Primary follicle, it is also called gamete mother cell.
- (b) B: Corpus luteum, it cannot be formed and added after birth.

- (c) C: Graafian follicle, mature follicle which ruptures to release secondary oocyte.
- (d) D: Tertiary follicle, a large number of this follicle degenerates during the phase from birth to puberty.

TYPE B : ASSERTION REASON QUESTIONS

Directions for (Qs. 27-31) : These questions consist of two statements, each printed as Assertion and Reason. While answering these questions, you are required to choose any one of the following five responses.

- (a) If both Assertion and Reason are correct and the Reason is a correct explanation of the Assertion.
- (b) If both Assertion and Reason are correct but Reason is not a correct explanation of the Assertion.
- (c) If the Assertion is correct but Reason is incorrect.
- (d) If both the Assertion and Reason are incorrect.
- (e) If the Assertion is incorrect but the Reason is correct.

27. **Assertion :** During fertilization only head of spermatozoa enters egg.

Reason : If several spermatozoa hit the egg at same time, all can enter the egg. [1997]

28. **Assertion :** In morula stage, cells divide without increase in size.

Reason : Zona pellucida remains undivided till cleavage is complete. [1997]

29. **Assertion :** Death is one of the important regulatory process on earth.

Reason : It avoids over-crowding caused by continuous reproduction. [2002]

30. **Assertion :** Old age is not an illness. It is a continuation of life with decreasing capacity for adaptation.

Reason : Cessation of mitosis is a normal genetically programmed event. [2003]

31. **Assertion :** Senescence is the time when age associated defects are manifested. [2005]

Reason : Certain genes may be undergoing sequential switching on and off during one's life.

Directions for (Qs. 32-38) : Each of these questions contains an Assertion followed by Reason. Read them carefully and answer the question on the basis of following options. You have to select the one that best describes the two statements.

- (a) If both Assertion and Reason are correct and Reason is the correct explanation of Assertion.
- (b) If both Assertion and Reason are correct, but Reason is not the correct explanation of Assertion.
- (c) If Assertion is correct but Reason is incorrect.
- (d) If both the Assertion and Reason are incorrect.

32. **Assertion :** Corpus luteum degenerates in the absence of fertilization. [2009]

Reason : Progesterone level decreases.

33. **Assertion :** Clitoris is not remnant of penis in females. [2009]

Reason : It also has high blood supply and erectile tissue.

34. **Assertion :** Mammalian ova produces hyaluronidase. [2009]

Reason : The eggs of mammal are microlecithal and telolecithal.

35. **Assertion :** Head of sperm consists of acrosome and mitochondria.

Reason : Acrosome contains spiral row of mitochondria. [2014]

36. **Assertion :** Females have less stature than males after puberty.

Reason : This happens because of the presence of hCG in the blood of females. [2014]

37. **Assertion :** Testicular lobules are the compartments present in testis.

Reason : These lobules are involved in the process of fertilization. [2016]

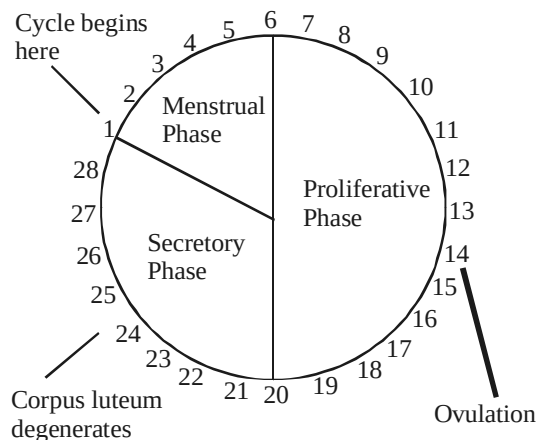
38. **Assertion :** Interstitial cell is present in the region outside the seminiferous tubule called interstitial spaces.

Reason : Interstitial cells provide nutrition to the sertoli cells. [2016, 2017]

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Type A : Multiple Choice Questions

1. (b) The prostate gland is a chestnut shaped gland which lies at the base of bladder and surrounds the first part of the urethra. This gland secretes a slightly alkaline fluid which forms the important component of semen. This fluid constitutes the major portion of seminal fluid which carries sperm and sperms move freely in this fluid. Prostate gland secretion contains lipids, small amount of citric acid, HCO_3^- ions and a few enzymes. They activate and provides nutrition to sperms and neutralise the acidity of urine which may kill the sperms. They form about 30% part of semen.
2. (d) Immediately after ovulation, mammalian eggs are covered by vitelline membrane.
3. (a) Trophoblast in mammalian embryo produces extra embryonic membranes which provide protection and nourishment to foetus. These are of 4 types – chorion, amnion, allantois & yolk sac embryonic membranes.
4. (b) Acrosome of sperm is formed from Golgi bodies and contains hydrolysing enzymes for sperm penetration.
5. (b) Cumulus covers the ovum. The ovum at the matured conditions has a massy cloud formed with a flat base and rounded outlines piled up like a mountain. A granulosa cell is a somatic cell found closely associated with the developing female gamete (oocyte or egg) in the ovary of mammals. Granulosa cells form a single flattened layer around the oocyte in the primordial ovarian follicle and later in follicle development they advance to form a multi layered cumulus surrounding the oocyte.
6. (a) Menopause is the period when ovulation and menstrual cycle stop in human females. The period of menopause is between 45-55 years.
7. (c) Corpus luteum is the fluid filled yellow body in the ovary and macula lutea is the yellow spot present in the eyes.
8. (c)
9. (b) In menstrual cycle, menstrual phase lasts for 4 days, proliferating/ovulating phase for about 10 days and secretory phase for 14 days.
10. (a) Repeated cleavage in the zygote brings about the distribution of the cytoplasm of the zygote among blastomere and increases mobility of the protoplasm which facilitates morphogenetic movements for cell differentiation.
11. (d) Woman who took the drug thalidomide in early pregnancy gave birth to children with severe birth defects such as missing or shortened limbs.
12. (c) A cross section at the midpoint of the middle piece of human sperm will show mitochondria and 9+2 arrangement of microtubules.
13. (b) The proliferative phase lasts for about 14 days in which the endometrium becomes thicker by rapid cell multiplication.



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14. (b) Sperm is the male gamete that fuses with female gamete and produce a diploid cell called zygote. During fertilization, acrosome of the sperm releases some enzymes, particularly hyaluronidase, that facilitates the penetration of the sperm into ovum. These enzymes dissolve the membrane enveloping the ovum and help the sperm head to enter the ovum.
15. (c) Both are characterized by a yellow colour. The corpus luteum is a temporary endocrine structure in mammals, involved in production of progesterone, which is needed to maintain pregnancy. The macula or macula lutea is an oval yellow spot near the center of the retina of the human eye.
16. (d) Four viable sperm cells are produced from one primary sex cell, whereby only one viable egg cell is produced, due to the unequal division of cytoplasm and the formation of polar bodies, which wither and die.
17. (b) Corpus luteum is a yellow coloured mass of cells found in ovary. Corpus luteum secretes progesterone hormone, which is essential for maintaining pregnancy and therefore also called as "pregnancy hormone."
18. (b) Leydig cells are the characteristic of mammalian testis. They produce hormone, testosterone meant for development of secondary sexual characters in males.
19. (c) Zygote divides partially in meroblastic cleavage.
20. (a) In human beings, after one month of pregnancy, the embryo's heart is formed. By the end of second month of pregnancy limbs and digits are developed. By the end of 12 weeks (first trimester) most of the major organ systems are formed.
21. (c)
22. (b) The high levels of estrogen and progesterone in the maternal circulation

Topicwise AIIMS Solved Papers – BIOLOGY

during pregnancy inhibit the cyclic release of pituitary gonadotropins and prevent the menstrual cycles. Pregnancy hormones include hCG, which maintains the corpus luteum of pregnancy and forms the basis for pregnancy diagnosis urine tests. Ovarian and placental estrogen and progesterone, human placental lactogen, and pituitary prolactin stimulate development of the ducts and alveoli in the mammary glands.

23. (c)
24. (c) Ejaculation of human male contains about 200 – 300 million sperms, of which for normal fertility 60 % sperms must have normal shape and size and at least 40 % must show energetic motility.
25. (c) A–Umbilical cord with its vessels, B–Placental villi, C–Yolk sac, D–Plug of mucus in cervix
26. (c) Oogonia are called as gamete mother cell. Corpus luteum is formed as a temporary endocrine structure after the ovulation. It is involved in the production of relatively high levels of progesterone and moderate levels of estradiol and inhibin A to maintain pregnancy. A large number of primary follicles degenerate during the phase from birth to puberty.

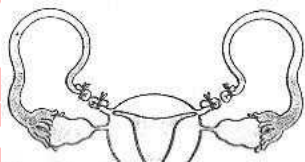
Type B : Assertion Reason Questions

27. (c) Fertilization is the fusion of male and female gametes to form zygote. During fertilization only head of the sperm enters egg. After that polyspermy is avoided by fertilization membrane.
28. (a) Morula involves cleavage of cells till 32 cell stage is formed. It is still surrounded by Zona pellucida.
29. (a) Death is the ultimate goal of every organism. This is caused by the wear and tear of organs which constitute the body of a living being.

30. (c) Old age is the progressive deterioration in the structure and functioning of cells, tissues and organs and cessation of immune system.
31. (a) According to programmed senescence theory of ageing, ageing is a result of switching on and off of certain genes. B and T- lymphocytes undergo programmed cell death called apoptosis.
32. (b) In female, Graafian follicle forms corpus luteum after ovulation. The cells of corpus luteum are called luteal cells. The cytoplasm of luteal cells have yellow granules called lutein which secrete the hormone progesterone to maintain pregnancy if fertilization takes place. In the absence of fertilization, corpus luteum degenerates and forms corpus albicans and there is decrease in progesterone level as well.
33. (c) Clitoris is a female reproductive organ. It is homologous to penis of males. It is not remnant of penis. It is devoid of erectile tissue and high blood supply as in penis, penis is the copulatory organ of males.
34. (d) Hyaluronidase, a hydrolytic enzyme is an acrosomal content in mammalian sperm. It helps at the time of fertilization during the penetration of the sperm into the ovum. Based on the amount of yolk mammalian eggs are alecithal means egg without yolk. Microlecithal eggs contain very little yolk *e.g.*, sea urchin, starfish. On the basis of distribution of yolk telolecithal eggs are those eggs in which the yolk is concentrated towards the vegetal pole and cytoplasm and nucleus lie near the animal pole, *e.g.*, birds and reptiles.
35. (c) Head of a sperm has acrosome but the spiral row of mitochondria are present in the mid (connecting) piece of the sperm.
36. (c) Males have more stature than females because of the action of male sex hormone-testosterone which is secreted by testis in males. Body starts secreting testosterone from the age of puberty. Its secretion is under the influence of Luteinizing Hormone (LH) of the anterior lobe of pituitary gland. Testosterone controls the development of secondary sexual characters in males like hoarseness of voice, development of facial hairs, bone growth, calcium retention, closing of epiphysial cartilage. The total quantity of bone matrix increases. The pelvic outlet is narrowed and lengthened. The strength of the pelvic bones increases to carry more loads. That is why, males have more stature than females after puberty when this hormone is present in the blood.
- hCG (Human Chorionic Gonadotropin) is the hormone secreted by human placenta during pregnancy. hCG enlarges the corpus luteum in the mother's ovary and stimulates it to secrete progesterone.
37. (d) Testicular lobules are the compartments present in the testes, are not involved in the process of fertilization as whole. Fusion of male and female gametes is called fertilization.
38. (c) Leydig cells, also known as interstitial cells, are found adjacent to the seminiferous tubules in the testicle. They produce testosterone in the presence of luteinizing hormone (LH).

TYPE A : MULTIPLE CHOICE QUESTIONS

- GIFT is [2009]
 - transfer of a sperm in fallopian tube of a female with the help of injections.
 - transfer of a zygote fertilized in vitro in the fallopian tube of female incapable to conceive.
 - transfer of an ovum collected from a donor into another females fallopian tube who can't produce an ovum but can provide a good environment for further development.
 - embryo is developed in vitro and then transferred into female's tract.
- What is the function of copper-T ? [2012]
 - Checks mutation
 - Stops fertilization
 - Stops zygote formation
 - Stops obliteration of blastocoel
- Progestasert and LNG-20 are [2013]
 - Implants
 - Copper releasing IUDs
 - Non-medicated IUDs
 - Hormone releasing IUDs
- What is the figure given below showing in particular ? [2014]



- Ovarian cancer
- Uterine cancer
- Tubectomy
- Vasectomy

- Match Column -I with Column - II. [2015]

Column I

Method

A. The pill

B. Condom

C. Vasectomy

D. Copper T

Column II

Mode of Action

I. Prevents sperms reaching cervix

II. Prevents implantation

III. Prevents ovulation

IV. Semen contains no sperms

(a) A – III; B – I; C – IV; D – II

(b) A – IV; B – I; C – II; D – III

(c) A – III; B – IV; C – I; D – II

(d) A – II; B – III; C – I; D – IV

- Select the correct match of the techniques given in column I with its feature given in column II.

	Column I		Column II
A.	ICSI	I	Artificially introduction of semen into the vagina or uterus.
B.	IUI	II	Transfer of ovum collected from a donor into the fallopian tube where fertilization occur
C.	IUT	III	Formation of embryo by directly injecting sperm into the
D.	GIFT	IV	Transfer of the zygote or early embryo (with upto 8 blastomeres) into a fallopian tube.
E.	ZIFT	V	Transfer of embryo with more than 8 blastomeres into the uterus

[2016, 2017]

- A – V; B – IV; C – I; D – III; E – IV
- A – I; B – II; C – III; D – IV; E – V
- A – III; B – V; C – II; D – IV; E – I
- A – III; B – I; C – V; D – II; E – IV

TYPE B : ASSERTION REASON QUESTIONS

Directions for (Qs. 7-9) : Each of these questions contains an Assertion followed by Reason. Read them carefully and answer the question on the basis of following options. You have to select the one that best describes the two statements.

- (a) If both Assertion and Reason are correct and Reason is the correct explanation of Assertion.
- (b) If both Assertion and Reason are correct, but Reason is not the correct explanation of Assertion.
- (c) If Assertion is correct but Reason is incorrect.
- (d) If both the Assertion and Reason are incorrect.

7. **Assertion :** Cu-T and Cu-7 do not suppresses sperm-motility.

Reason : Hormones released by them affect sperm motility. [2009]

8. **Assertion :** HIV infection can be avoided by use of condoms.

Reason : Condoms secrete anti-viral interferons. [2014]

9. **Assertion :** Copper-T is an effective contraceptive device in human females.

Reason : Copper-T prevents passage of sperms from vagina upwards into fallopian tubes. [2011, 2014]

HINTS & SOLUTIONS

Type A : Multiple Choice Questions

1. (c) GIFT is an ovum donation programme and its purpose is to provide ovum to the women who suffer from infertility due to primary and premature ovarian failure which is incurable. A woman in reproductive age denotes ova to a woman which cannot produce ova but she could provide good environment for embryo development. The ovum from donor mother is transferred to the recipient or would be mother's fallopian tube where it is fertilized by sperm and develops into embryo.
2. (b) Copper-T is copper releasing intra uterine devices (IUD). It increases phagocytosis of sperms within the uterus and suppress sperm motility and fertilising capacity of sperms.
3. (d)
4. (c) The figure shows the tubectomy. This is a surgical method to prevent pregnancy in women. In tubectomy, small part of the fallopian tube is removed or tied through a small cut in the abdomen or through vagina. It is very effective method but reversibility is very poor.
5. (a) A. The pill — Prevents ovulation
B. Condom — Prevents sperm reaching cervix
C. Vasectomy — Semen contains no sperms
D. Copper-T — Prevent implantation.
6. (d) ICSI (Intracytoplasmic sperm injection) - Formation of embryo by directly injecting sperm into the ovum

IUI (intrauterine insemination) - Artificial introduction of semen into the vagina or uterus

IUT (Intra uterine transfer) - Transfer of embryo with more than 8 blastomeres into the uterus

GIFT (Gamete intra fallopian transfer) - Transfer of ovum collected from a donor into the fallopian tube where fertilization occurs

ZIFT (Zygote intra fallopian transfer) - Transfer of the zygote or early embryo (with upto 8 blastomeres) into a fallopian tube.

Type B : Assertion Reason Questions

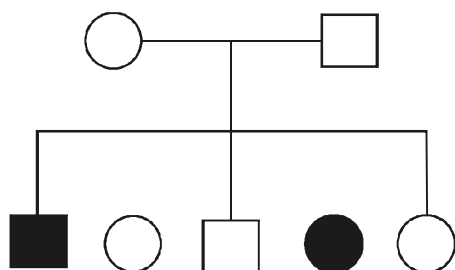
7. (c) Cu-7 and Cu-T are intrauterine contraceptive devices for females. They do not suppress sperm motility. Their mode of action is different. Cu-T and Cu-7 discharge 50-75 micrograms of ionic copper into the uterus daily. These copper ions interfere with life-sustaining functions that regulate implantation in the uterus. No any hormone is released by them.
8. (c) The use of condoms has been shown to decrease the transmission of AIDS because condoms is contraceptive.
9. (c) Intra-uterine device (IUD) Copper-T is plastic or metal object placed in the uterus by a doctor. Copper-T prevent the fertilization of the egg or implantation of the embryo.

Principles of Inheritance and Variation

TYPE A : MULTIPLE CHOICE QUESTIONS

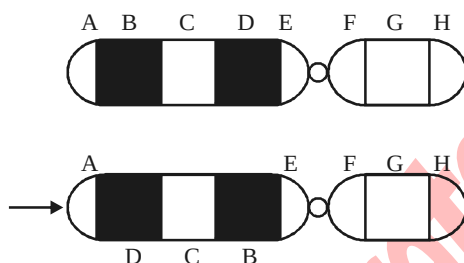
1. The formation of multivalents at meiosis in diploid organism is due to [1998]
 - (a) monosomy
 - (b) deletion
 - (c) inversion
 - (d) reciprocal translocation
2. If a homozygous tall plant is crossed with homozygous dwarf plant, the offsprings will be [1999]
 - (a) all tall plants
 - (b) all dwarf plants
 - (c) half tall plants
 - (d) half dwarf plants
3. XO chromosomal abnormality in humans causes [1999]
 - (a) Turner's syndrome
 - (b) Down's syndrome
 - (c) Patau's syndrome
 - (d) Klinefelter's syndrome
4. Polygenic genes show [2000]
 - (a) similar genotype
 - (b) different phenotype
 - (c) different karyotype
 - (d) different genotype
5. Which disease has XXY chromosome constitution? [2000]
 - (a) Down's syndrome
 - (b) Turner's syndrome
 - (c) Klinefelter's syndrome
 - (d) Okazaki syndrome
6. Barr-body in mammals represents [2001]
 - (a) One of the two X chromosomes in somatic cells of females.
 - (b) All heterochromatin of male & female cells.
 - (c) Y chromosomes of male.
 - (d) All heterochromatin of female cells
7. Discontinuous variations are [2001]
 - (a) essential features
 - (b) acquired characters
 - (c) non-essential changes
 - (d) mutations
8. *Mirabilis jalapa* shows [2001]
 - (a) codominance
 - (b) incomplete dominance
 - (c) dominance
 - (d) complementary genes
9. Frame shift mutation occurs when [2002]
 - (a) base is added
 - (b) base is deleted
 - (c) base is added or deleted
 - (d) none of the above
10. Pure line breed refers to [2002]
 - (a) homozygosity
 - (b) heterozygosity
 - (c) linkage
 - (d) both b & c
11. If a homozygous red flowered plant is crossed with a homozygous white flowered plant, the offsprings would be [2002]
 - (a) all red flowered
 - (b) half red flowered
 - (c) half white flowered
 - (d) all white flowered
12. Genes of which one of the following is present exclusively on the X-chromosome in humans? [2003]
 - (a) Baldness
 - (b) Red-green colour blindness
 - (c) Facial hair/moustaches in males
 - (d) Night blindness
13. Given below is a pedigree chart of a family with five children. It shows the inheritance of attached earlobes as opposed to the free ones. The squares represent the male individuals and circles the female individuals. Which one of the following conclusions drawn is correct? [2004]

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Free ○ Attached ●
 Ear-lobes □ Ear-lobes ■

- (a) The parents are homozygous recessive.
 (b) The trait is Y-linked.
 (c) The parents are homozygous dominant.
 (d) The parents are heterozygous.
14. Given below is a representation of a kind of chromosomal mutation. What is the kind of mutation represented?

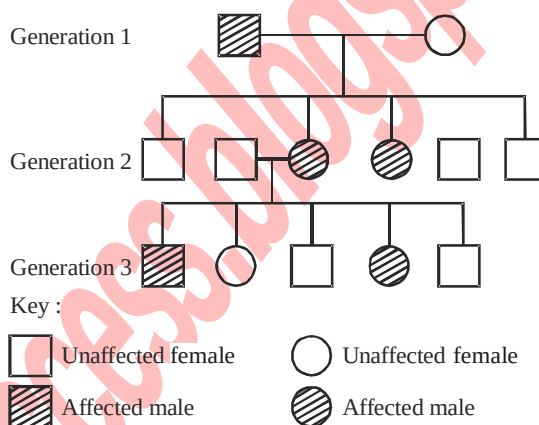


[2004]

- (a) deletion
 (b) duplication
 (c) inversion
 (d) reciprocal translocation
15. How many different types of gametes can be formed by F_1 progeny, resulting from the following cross $Tt \times Rr$? [2004]
 (a) 4 (b) 8
 (c) 27 (d) 64
16. Grain colour in wheat is determined by three pairs of polygene. Following the cross $AABBCC$ (dark colour) $\times$ $aabbcc$ (light colour), in F_2 generation what proportion of the progeny is likely to resemble either parent? [2005]
 (a) Half (b) Less than 5 percent
 (c) One third (d) None of these

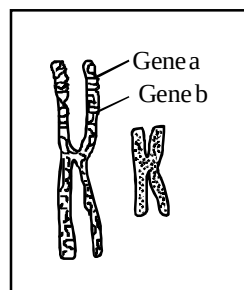
Topicwise AIIMS Solved Papers – BIOLOGY

17. Primary source of allelic variation is [2005]
 (a) independent assortment
 (b) recombination
 (c) mutation
 (d) polyploidy
18. Given below is a pedigree chart showing the inheritance of a certain sex-linked trait in humans.

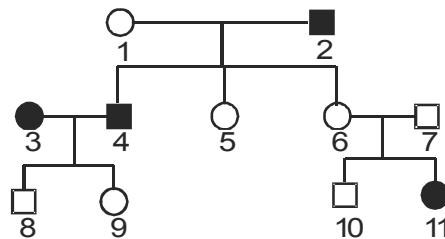


The trait traced in the above pedigree chart is [2005]

- (a) dominant X-linked
 (b) recessive X-linked
 (c) dominant Y-linked
 (d) recessive Y-linked
19. The "Cri-du-Chat" syndrome is caused by change in chromosome structure involving [2005]
 (a) deletion (b) duplication
 (c) inversion (d) translocation
20. Given below is a highly simplified representation of the human sex chromosomes from a karyotype. [2006]

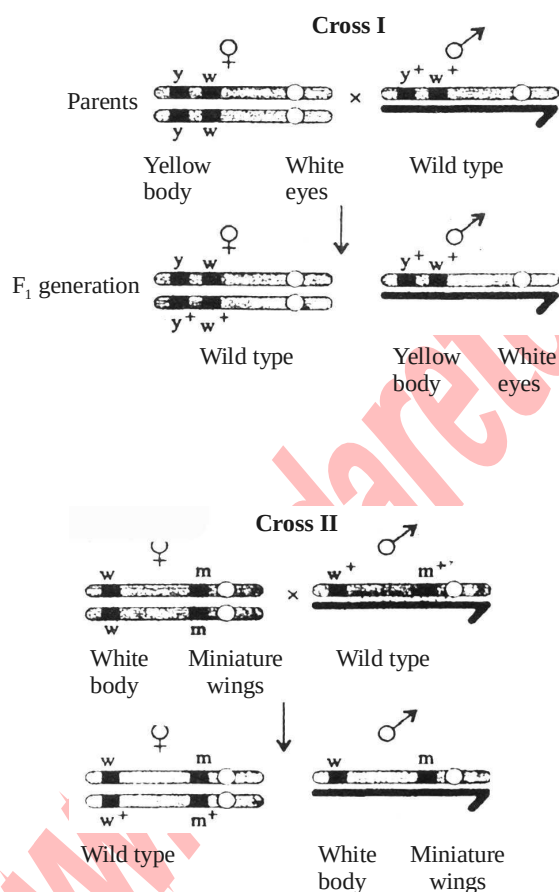


- The genes a and b could be of
- colour blindness and body height
 - attached ear lobe and Rhesus blood group
 - haemophilia and red-green colour blindness
 - phenylketonuria and haemophilia
21. In India, we find mangoes with different flavours, colours, fibre content, sugar content and even shelf-life. The large variation is on account of [2006]
- species diversity
 - induced mutations
 - genetic diversity
 - hybridization
22. Which one of the following pairs of features is a good example of polygenic inheritance? [2006]
- Human height and skin colour.
 - ABO blood group in humans and flower colour of *Mirabilis jalapa*.
 - Hair pigment of mouse and tongue rolling in humans.
 - Human eye colour and sickle cell anaemia.
23. Gene which suppresses other gene's activity but does not lie on the same locus is called as [2007]
- epistatic
 - supplementary
 - hypostatic
 - codominant
24. XO-chromosomal abnormality in human beings causes [2007]
- Turner's syndrome
 - Down's syndrome
 - Klinefelter's syndrome
 - none of the above
25. A normal woman whose father was colour blind, is married to a normal man. The sons would be [2008]
- 75% colour blind
 - 50% colour blind
 - all normal
 - all colour blind
26. Mating of an organism to a double recessive in order to determine whether it is homozygous or heterozygous for a character under consideration is called [2008]
- reciprocal cross
 - test cross
 - dihybrid cross
 - back cross
27. Bird females have chromosome arrangement as [2009]
- XY
 - XO
 - WZ
 - WW
28. Gene pool is referred to [2009]
- the genetic drift caused in a population
 - aggregate of all genes and their alleles in a population.
 - deletion of non essential genes.
 - induce cell division
29. Mother and father both have blood group 'A'. They have two children one with blood group 'O' and second one with blood group 'A'. They have [2009]
- mother has homozygous gene father has heterozygote $I^A I^A$.
 - both are homozygous ($I^A I^A$).
 - mother is heterozygous ($I^A i$) and father is homozygous ($I^A I^A$).
 - both are heterozygous ($I^A i$).
30. When one gene controls two or more different characters simultaneously, the phenomenon is called [2010]
- apomixis
 - pleiotropy
 - polyploidy
 - polyteny
31. Three children in a family have blood types O, AB and B respectively. What are the genotypes of their parents? [2013]
- $I^A i$ and $I^B i$
 - $I^A I^B$ and $i i$
 - $I^B I^B$ and $I^A I^A$
 - $I^A I^A$ and $I^B i$
32. If both parents are carriers for thalassemia, which is an autosomal recessive disorder, what are the chances of pregnancy resulting in an affected child? [2014]
- 50%
 - 25%
 - 100%
 - no chance
33. In Huntington's disease, the unaffected persons are homozygous for normal allele h. The following is erroneous because [2015]



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- (a) it shows both male and female affected by Huntingtons disease
- (b) either person 6 or 7 should have the disease, if individual 11 shows the disease.
- (c) at least one of the 2 children (8, 9) should have the disease
- (d) all of these
34. The experiment shown in the given figure has been carried out by Morgan to show the phenomenon of linkage and recombination. If in cross I, genes are tightly linked and in cross II, genes are loosely linked then what will be the percentage of recombinants produced in cross I and cross II respectively?



[2016]

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- (a) 98.7% and 62.8%
- (b) 1.3% and 37.2%
- (c) 37.2 and 1.3%
- (d) 62.8% and 98.7%

TYPE B : ASSERTION REASON QUESTIONS

Directions for (Qs. 35-38) : These questions consist of two statements, each printed as Assertion and Reason. While answering these questions, you are required to choose any one of the following five responses.

- (a) If both Assertion and Reason are correct and the Reason is a correct explanation of the Assertion.
- (b) If both Assertion and Reason are correct but Reason is not a correct explanation of the Assertion.
- (c) If the Assertion is correct but Reason is incorrect.
- (d) If both the Assertion and Reason are incorrect.
- (e) If the Assertion is incorrect but the Reason is correct.

35. **Assertion :** The genetic complement of an organism is called genotype.

Reason : Genotype is the type of hereditary properties of an organism. [1999]

36. **Assertion :** Phenylketonuria is a recessive hereditary disease caused by body's failure to oxidize an amino acid phenylalanine to tyrosine, because of a defective enzyme.

Reason : It results in the presence of phenylalanine acid in urine. [2000]

37. **Assertion :** In humans, the gamete contributed by the male determines whether the child produced will be male or female.

Reason : Sex in humans is a polygenic trait depending upon a cumulative effect of some genes on X-chromosome and some on Y-chromosome. [2005]

38. **Assertion :** Haemophilia is a recessive sex linked disease.

Reason : Haemophilia occurs due to mutation of a structural gene on chromosome 15. [2007]

Directions for (Qs.39-44) : Each of these questions contains an Assertion followed by Reason. Read them carefully and answer the question on the basis of following options. You have to select the one that best describes the two statements.

- (a) If both Assertion and Reason are correct and Reason is the correct explanation of Assertion.
- (b) If both Assertion and Reason are correct, but Reason is not the correct explanation of Assertion.
- (c) If Assertion is correct but Reason is incorrect.
- (d) If both the Assertion and Reason are incorrect.

39. Assertion : Persons suffering from haemophilia fail to produce blood clotting factor VIII.

Reason : Prothrombin producing platelets in such persons are found in very low concentration. [2008]

40. Assertion : In case of incomplete linkage, linked gene show new combination along with parental combination.

Reason : In case of incomplete linkage, linked genes are separated by crossing over. [2010]

41. Assertion: Aneuploidy may be of hypoploidy or hyperploidy type.

Reason: Monosomy lacks one pair of chromosomes. [2011]

42. Assertion : Cross of F_1 individual with recessive homozygous parent is test cross.

Reason : No recessive individual are obtained in the monohybrid test cross. [2012]

43. Assertion : In *Mirabilis*, selfing of F_1 pink flower plants produces same phenotypic & genotypic ratio.

Reason : Flower colour gene shows incomplete dominance. [2014]

44. Assertion : In humans, the gamete contributed by the male determines whether the child produced will be male or female.

Reason : Sex in humans is a polygenic trait depending upon a cumulative effect of some genes on X-chromosome and some on Y-chromosome. [2015, 2017]

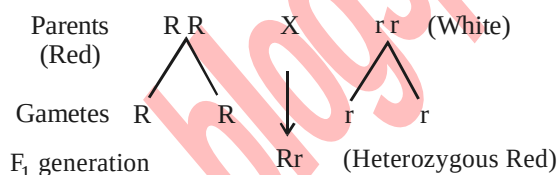
HINTS & SOLUTIONS

Type A : Multiple Choice Questions

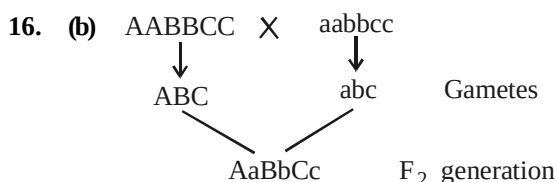
1. (d) Translocation is the separation of a chromosome segment and its union to a non homologous chromosome. In reciprocal translocation 2 non-homologous chromosomes exchange segments among themselves. Reciprocal translocation produces duplication.
2. (a) Homozygous Tall $\times$ Homozygous dwarf

$$\begin{array}{c}
 \text{TT} \quad \times \quad \text{tt} \\
 \downarrow \quad \quad \downarrow \\
 \text{Gametes } T \quad T \quad \quad t \quad t \\
 \quad \quad \quad \text{Tt} \\
 \quad \quad \quad \text{All Tall}
 \end{array}$$
3. (a) XO chromosomal abnormality in humans is due to monosomy of sex chromosome. Their total number of chromosomes are 45. This condition is found in Turner's syndrome.
4. (b) Polygenic genes show intermediate phenotypes, e.g. skin colour.
5. (c) Down's syndrome is due to trisomy of 21st chromosome; Turner's syndrome having XO genotype is caused by the absence of X chromosome in females; klinefelter's syndrome (XXY) is due to trisomy of sex chromosome.
6. (a) Barr body is the inactive one X-chromosome in somatic cells of female (Dosage compensation). The number of Barr bodies are always one less than the total number of X-chromosome.
7. (d) Discontinuous variations lead to mutations.
8. (b) *Mirabilis jalapa* (4O' clock plant) shows incomplete dominance because the genes for red and white colour do not mix in the F_1 pink hybrids as both the pure characters reappear in the F_2 plants.
9. (c) A mutation in which there is deletion or insertion of one or few nucleotides is called frameshift mutation.

10. (a) The self pollinated progeny of a homozygous plant constitutes a pure line.
11. (a) As per Mendel's law in F_1 generation only dominant phenotypes appear.

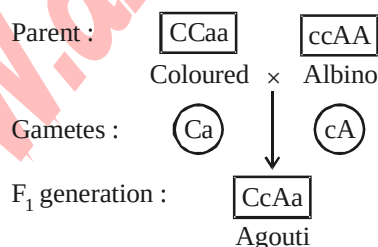


12. (b) Red and green colourblindness is a sex linked inheritance. Its genes are present on X-chromosome.
13. (d) Such types of results are obtained only if parents are heterozygous for the trait.
14. (c) The kind of mutation is paracentric inversion. In this a segment of a chromosome separates and rejoins in an inverted position.
15. (a) F_1 generation is always heterozygous, e.g. $TtRr$, so there are 4 types of gamete formation i.e. TR, Tr, tR, tr .



The F_2 generation will show the intermediate colour because of quantitative inheritance. In case of crossing between $AA BB CC$ (dark colour) and $aa bb cc$ (light colour), in F_2 generation seven phenotypes will be obtained with ratio $1 : 6 : 15 : 20 : 15 : 6 : 1$. The total number of progeny is 64, out of which only two will be likely resemble with either parents. Hence, their percentage in F_2 generation would be 3.12 i.e. less than 5%.

17. (c) Primary source of allelic variation is mutation.
18. (b) The genes for such traits are recessive and located on the X-chromosome. The character appears more often in males in hemizygous condition, but also in females with homozygous condition. Affected males receive their defective gene from carrier mothers who may have affected father. These exhibit criss- cross inheritance.
19. (a) Cri-du-chat/cat cry syndrome is due to the deletion of large part of the small or one of the 5th chromosome.
20. (c) Genes a and b lie very close to each other. So, they are representing linked genes. *e.g.* genes of haemophilia and colour blindness show sex linked inheritance.
21. (c) Genetic diversity describes an attribute which is commonly held to be advantageous for survival that there are many different versions of otherwise similar organisms, *e.g.* different varieties of mangoes.
22. (a) Polygenic inheritance is the trait under the control of more than one pair of genes, *e.g.* skin colour (trigenic) and human height.
23. (a) When one gene masks the effect or activity of another gene which does not lie on the same locus, it is called epistasis. Epistasis refers to non- allelic interactions. Like coat colour in mice is controlled by epistatic gene. When coloured (CCaa) mouse is crossed with albino (ccAA), agouti mice (CcAa) appeared in F₁ generation. Agouti, coloured and albino mice are obtained in 9 : 3 : 4 ratio in F₂ generation.

F₂ generation :

Gametes		♂ CA	♂ Ca	♂ cA	♂ ca
♀ CA		CCAA Agouti	CCAa Agouti	CcAA Agouti	CcAa Agouti
	♀ Ca	CCAa Agouti	CCaa Coloured	CcAa Agouti	Ccaa Coloured
	♀ cA	CcAA Agouti	CcAa Agouti	ccAA Albino	ccAa Albino
	♀ ca	CcAa Agouti	CcAa Coloured	ccAa Albino	ccaa Albino

Agouti - 9

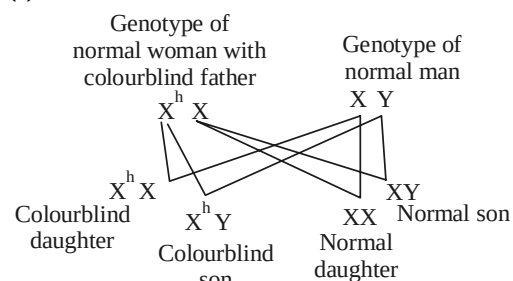
Coloured - 3

Albino - 4

Ratio - 9 : 3 : 4

24. (a) Turner's syndrome is caused due to the missing X chromosome. The genotype is therefore XO instead of the normal XX and the sufferer person possesses 45 chromosomes instead of 46. Patients with this condition can best be described as incompletely developed females, although there are often no obvious external differences compared with normal females. Affected females lack ovaries so they are infertile.

25. (b)



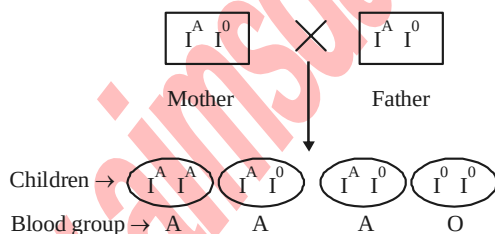
∴ 50% son would be colourblind.

26. (b) In genetics, a test cross, first introduced by Mendel, is used to determine if an individual exhibiting a dominant trait is homozygous or heterozygous for that trait. Test crosses involve breeding the individual in question with another individual that expresses a recessive version of the same trait. If all offspring display the dominant phenotype, the individual in question is homozygous

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dominant; if the offspring display both dominant and recessive phenotypes, then the individual is heterozygous. In some sources, the "test cross" is defined as being a type of back cross between the recessive homozygote and F_1 generation.

27. (c) In birds sex is determined by morphologically dissimilar pair of chromosomes called sex chromosomes. Z and W are two sex chromosomes of birds. A male bird has ZZ (homogenetic sex) arrangement while a female bird has ZW (heterogenetic sex) arrangement of chromosomes. Number of chromosomes in birds is 69.
28. (b) Gene pool is the sum total of genes and their alleles in the reproductive gametes of a population. The gene pool is transferred from one generation to the other using gametes from genetic pool. These gametes will form zygotes of next generation. Gene pool of a population will consist of a large number of genes which vary in their frequencies.
29. (d) In the mentioned case, one child with blood group 'O' and second with blood group 'A' are born to parents with heterozygous condition of genes for blood group A. i.e., $I^A I^0$. Both mother and father have blood group A but their genotypes indicate heterozygotic condition.



30. (b) Pleiotropy is the condition in which a single gene influences more than one trait. Polyploidy is a condition in which individuals have more than two complete sets of chromosomes. Apomixis is a reproductive process in plants

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that superficially resembles normal sexual reproduction but there is no fusion of gametes.

31. (a)
32. (b) Genotype of carrier parents is – Aa (male parent) $\times$ Aa (female parent)

	A	a
A	AA	Aa
a	Aa	aa

AA = normal child (25%)

Aa = carriers child (50%)

aa = affected child (25%)

33. (b) Since the offspring number 11 is affected (diseased) either of the two parents 6 or 7 have to be affected.
34. (b) The percentage of recombinants produced in cross I and cross II are respectively 1.3% and 37.2%.

Type B : Assertion Reason Questions

35. (a) Genotype of the organism include all dominant and recessive characters.
36. (b) Phenylketonuria is an recessive autosomal gene disorder. It occurs due to the absence of enzyme phenylalanine hydroxylase which changes phenylalanine to tyrosine.
37. (c) In humans, sex of a child depends upon the gametes produced by the male (X, Y).
38. (c) Haemophilia also known as bleeder disease is an example of recessive sex linked inheritance in human beings. It is masked in heterozygous condition. The person suffering from this disease lack factors VIII and IX responsible for blood clotting. A small cut may lead to bleeding till death. Men are affected by this disease while women are the carriers.

Mutation of a structural gene on chromosome number 15 causes Marfan syndrome. This disease results in formation of abnormal form of connective tissues and characteristic extreme looseness of joints.

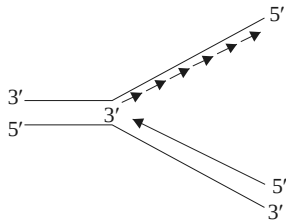
39. (c) Haemophilia bleeding disorder is a group of hereditary genetic disorders that impair the body's ability to control blood clotting or coagulation. In its most common form, Hemophilia A, clotting factor VIII is absent. In Haemophilia B, factor IX is deficient. Factor VIII participates in blood coagulation; it is a cofactor for factor IXa which, in the presence of Ca^{+2} and phospholipids forms a complex that converts factor X to the activated form Xa. Defects in this gene results in hemophilia A, a common recessive X-linked coagulation disorder. Prothrombin producing platelets in such persons are not found in very low concentration.
40. (a) In case of incomplete linkage, the linked gene shows new combination along with parental combination due to crossing over between chromatids.
41. (c) Aneuploidy can be either due to loss of one or more chromosomes (hypoploidy) or due to addition of one or more chromosomes to complete chromosome complement (hyperploidy). Hypoploidy is mainly due to loss of a single chromosomes, monosomes ($2n - 1$) or due to loss of one pair of chromosomes, nullisomes ($2n - 2$).
42. (c) In the monohybrid test-cross both dominant and recessive traits are obtained in 1 : 1 ratio.
43. (a) F_2 phenotypic and genotypic ratio in monohybrid cross involving incomplete dominance is
- | | | | | |
|-------|---|--------|---|---------|
| 1 | : | 2 | : | 1 |
| RR | | Rr | | rr |
| (red) | | (pink) | | (white) |
44. (c) In human, the gamete contributed by the male determines whether the child produced will be male or female. Sex in humans is a polygenic trait depending upon cumulative effect of some genes present on Y-chromosome. Only sex in human is amonogenic trait.

Molecular Basis of Inheritance

TYPE A : MULTIPLE CHOICE QUESTIONS

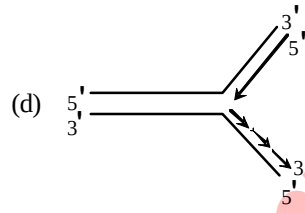
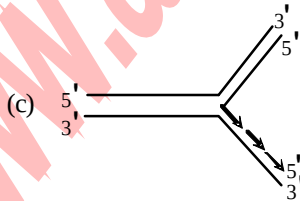
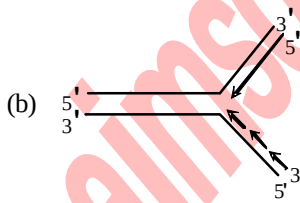
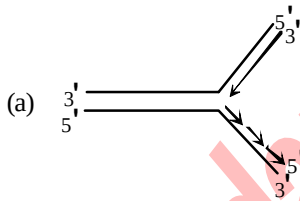
1. The process through which the amount of DNA, RNA and protein can be known at a time is called [1997]
 - (a) autoradiography
 - (b) tissue culture
 - (c) cellular fractioning
 - (d) phase contrast microscopy
2. Balbiani rings are found in [1997]
 - (a) polysomes
 - (b) polytene chromosomes
 - (c) autosomes
 - (d) nonsense chromosomes
3. In DNA helix, cytosine is paired with guanine by [1997]
 - (a) covalent bond
 - (b) phosphate bond
 - (c) three hydrogen bonds
 - (d) two hydrogen bonds
4. Which RNAs pick up specific amino acid from amino acid pool in the cytoplasm to ribosome during protein synthesis ? [1998]
 - (a) tRNA
 - (b) mRNA
 - (c) rRNA
 - (d) hnRNA
5. The structure of DNA is [1998]
 - (a) linear
 - (b) double helix
 - (c) single helix
 - (d) triple helix
6. Transposon was discovered by [1998]
 - (a) Sutton
 - (b) Strassburger
 - (c) Fischer
 - (d) B.Mc Clintock
7. Root cell of wheat has 42 chromosomes. What would be the number of chromosomes in the synergid cell ? [1999]
 - (a) 7
 - (b) 14
 - (c) 21
 - (d) 28
8. Okazaki fragments form [2000]
 - (a) leading strand
 - (b) lagging strand
 - (c) non-sense strand
 - (d) senseful strand
9. Wobble hypothesis was given by [2002]
 - (a) F.H.C. Crick
 - (b) Nirenberg
 - (c) Holley
 - (d) Khorana
10. Which one of the following pairs of terms/names mean one and the same thing? [2003]
 - (a) Gene pool-genome
 - (b) Codon-gene
 - (c) Cistron-triplet
 - (d) DNA fingerprinting - DNA profiling
11. What is true about t-RNA? [2003]
 - (a) It binds with an amino acid at it 3' end.
 - (b) It has five double stranded regions.
 - (c) It had a codon at one end which recognizes the anticodon on messenger RNA.
 - (d) It looks like clover leaf in the three dimensional structure.
12. Which one of the following codons codes for the same information as UGC? [2003]
 - (a) UGU
 - (b) UGA
 - (c) UAG
 - (d) UGG
13. During protein synthesis in an organism, at one point the process comes to a halt. Select the group of the three codons from the following, from which anyone of the three could bring about this halt. [2006]
 - (a) UUU, UCC, UAU
 - (b) UUC, UUA, UAC
 - (c) UAG, UGA, UAA
 - (d) UUG, UCA, UCG
14. The total number of nitrogenous bases in human genome is estimated to be about [2004, 2008]
 - (a) 3.5million
 - (b) 35 thousand
 - (c) 35million
 - (d) 3.1 billion
15. Which one of the following pairs is correctly matched with regard to the codon and the amino acid coded by it ? [2004, 2008]
 - (a) UUA-valine
 - (b) AM-lysine
 - (c) AUG-cysteine
 - (d) CCC-alanine

16.



What is the error in above diagram? [2009]

- (a) Arrows are wrongly depicted.
 - (b) Polarity is incorrect.
 - (c) Both arrows and polarity are incorrect.
 - (d) None of the above.
17. TATA box of eukaryotic promotor lies [2010]
- (a) about 25 bp upstream of the transcription start site.
 - (b) about 50 bp upstream of the transcription start site.
 - (c) about 75 bp upstream of the transcription start site.
 - (d) about 200 bp upstream of the transcription start site.
18. Which one of the following correctly represents the manner of replication of DNA ? [2003, 2012]

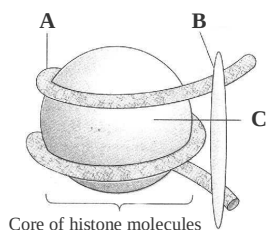


19. Select the correct option: [2014]

Direction of RNA synthesis	Direction of reading of the template DNA strand

(a) 5'—3'	3'—5'
(b) 3'—5'	5'—3'
(c) 5'—3'	5'—3'
(d) 3'—5'	3'—5'
20. Which one of the following represents a palindromic sequence in DNA? [2014]
- (a) 5' - GAATTC - 3'
3' - CTTAAG - 5'
 - (b) 5' - CCAATG - 3'
3' - GAATCC - 5'
 - (c) 5' - CATTAG - 3'
3' - GATAAC - 5'
 - (d) 5' - GATACC - 3'
3' - CCTAAG - 5'
21. Thirty percent of the bases in a sample of DNA extracted from eukaryotic cells is adenine. What percentage of cytosine is present in this DNA? [2015]
- (a) 10%
 - (b) 20%
 - (c) 30%
 - (d) 40%
22. There are three genes a, b, c. Percentage of crossing over between a and b is 20%, b and c is 28% and a and c is 8%. What is the sequence of genes on chromosome? [2015]
- (a) b, a, c
 - (b) a, b, c
 - (c) a, c, b
 - (d) None of these
23. Which one of the following group of codons is called as degenerate codons? [2016]
- (a) UAA, UAG and UGA
 - (b) GUA, GUG, GCA, GCG and GAA
 - (c) UUC, UUG, CCU, CAA and CUG
 - (d) UUA, UUG, CUU, CUC, CUA and CUG
24. The given figure shows the structure of nucleosome with their parts labelled as A, B & C. Identify A, B and C. [2017]

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- (a) A – DNA; B – H_1 histone;
C – Histone octamer
- (b) A – H_1 histone; B – DNA;
C – Histone octamer
- (c) A – Histone octamer; B – RNA;
C – H_1 histone
- (d) A – RNA; B – H_1 histone;
C – Histone octamer
25. Match the codons given in column I with their respective amino acids given in column II and choose the correct answer. [2017]

Column -I (Codons)		Column -II (Amino acids)	
A	UUU	I.	Serine
B	GGG	II.	Methionine
C	UCU	III.	Phenylalanine
D	CCC	IV.	Glycine
E	AUG	V.	Proline

- (a) A – III; B – IV; C – I; D – V; E – II
- (b) A – III; B – I; C – IV; D – V; E – II
- (c) A – III; B – IV; C – V; D – I; E – II
- (d) A – II; B – IV; C – I; D – V; E – III

TYPE B : ASSERTION REASON QUESTIONS

Directions for (Qs. 26-30) : These questions consist of two statements, each printed as Assertion and Reason. While answering these questions, you are required to choose any one of the following five responses.

- (a) If both Assertion and Reason are correct and the Reason is a correct explanation of the Assertion.
- (b) If both Assertion and Reason are correct but Reason is not a correct explanation of the Assertion.

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- (c) If the Assertion is correct but Reason is incorrect.
- (d) If both the Assertion and Reason are incorrect.
- (e) If the Assertion is incorrect but the Reason is correct.

26. **Assertion :** Histones are basic proteins of major importance in packaging of eukaryotic DNA. DNA and histones comprise chromatin forming the bulk of eukaryotic chromosome.

Reason : Histones are of five major types H_1, H_2A, H_2B, H_3 and H_4 . [2000]

27. **Assertion:** mRNA attaches to ribosome through its 3' end.

Reason: The mRNA has 5'-capsular nucleotide and bases of lagging sequence. [2002]

28. **Assertion :** Replication and transcription occur in the nucleus but translation in the cytoplasm.

Reason : m-RNA is transferred from the nucleus into the cytoplasm where ribosomes and amino acids are available for protein synthesis. [2005]

29. **Assertion:** An organism with lethal mutation may not even develop beyond the zygote.

[2006]

Reason: All types of gene mutations are lethal.

30. **Assertion:** Polytene chromosomes have a high amount of DNA.

Reason: Polytene chromosomes are formed by repeated replication. [2006]

Directions for (Qs.31-35) : Each of these questions contains an Assertion followed by Reason. Read them carefully and answer the question on the basis of following options. You have to select the one that best describes the two statements.

- (a) If both Assertion and Reason are correct and Reason is the correct explanation of Assertion.
- (b) If both Assertion and Reason are correct, but Reason is not the correct explanation of Assertion.
- (c) If Assertion is correct but Reason is incorrect.
- (d) If both the Assertion and Reason are incorrect.

31. **Assertion :** DNA is associated with proteins.

Reason : DNA binds around histone proteins that form a pool and the entire structure is called a nucleosome. [2013]

32. Assertion : The uptake of DNA during transformation is an active, energy requiring process.

Reason : Transformation occurs in only those bacteria, which possess the enzymatic machinery involved in the active uptake and recombination
[2014]

33. Assertion : UAA, UAG and UGA terminate protein synthesis.

Reason : They are not recognised by tRNA.
[2011, 2014]

34. Assertion : In a DNA molecule, A–T rich parts melt before G–C rich parts.

Reason : In between A and T there are three H-bond, whereas in between G and C there are two H-bonds.
[2010, 2015]

35. Assertion : Replication and transcription occur in the nucleus but translation takes place in the cytoplasm.

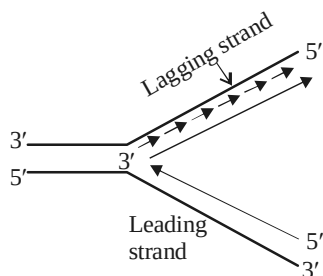
Reason : mRNA is transferred from the nucleus into cytoplasm where ribosomes and amino acids are available for protein synthesis.

[2008, 2015, 2017]

HINTS & SOLUTIONS

Type A : Multiple Choice Questions

1. (a) Autoradiography is the use of X-ray films to detect radioactive material. It produces a permanent record of positions and relative intensities of radiolabeled bands in a gel or slot. Typically, biomolecules are labeled with ^{32}P or ^{35}S , and detected by overnight film exposure.
 Autoradiography technique may be used to determine the tissue localization of a radioactive substance, either introduced into a metabolic pathway, bound to a receptor or enzyme, or hybridized to a nucleic acid.
2. (b) Balbiani rings are temporary swellings in polytene chromosome having uncoiled active DNA that transcribes RNA.
3. (c) In DNA helix, cytosine always pairs with guanine by three hydrogen bonds.
4. (a) There are specific types of tRNA (because of anticodon) for specific amino acid. They transport the amino acids from the cytoplasm to the site of protein synthesis.
5. (b) DNA is double helical in structure. Its both strands are complementary to each other.
6. (d) Mc Clintock discovered transposon or (jumping genes) in maize plants in 1983.
7. (c) The root cell in wheat is a somatic cell and, hence, has $2n$ number of chromosomes which is a diploid condition. The synergid cell that is formed after meiosis along with the ovum has 21 chromosomes which is the haploid condition.
8. (b) Okazaki fragments are short pieces of newly synthesized DNA, which are generated during the normal process of DNA replication. They are linked up by the enzyme DNA ligase after replacing RNA primers with deoxyribonucleotides. This will form lagging strand.
9. (a) Wobble hypothesis was given by F.H.C. Crick. It states that the first two positions of a triplet codon on mRNA have a precise pairing with the bases of the tRNA anticodon.
10. (d) Gene pool is the sum total of genes present in the inbreeding population whereas genome is a complete set of genes in the haploid case of chromosomes. Codon is a triplicate of nucleotide whereas gene is a linear segment of DNA. Cistron is a segment of the DNA molecule carrying information for the production of one polypeptide chain. DNA fingerprinting is also known as DNA profiling or DNA typing.
11. (d) t-RNA has a clover leaf like structure.
12. (a) UGC and UGU codes for cysteine.
13. (c) Protein termination occurs by nonsense codons i.e. UAA, UGA, UAG.
14. (d) Genome size is usually stated as the total number of base pairs; the human genome contains roughly 3.1 billion base pairs organized into 24 distinct, physically separate microscopic units called chromosomes. All genes are arranged linearly along the chromosomes. The complete set of instructions for making an organism is called its genome.
15. (a) Valine is one of 20 proteogenic amino acids. Its codons are GUU, GUC, GUA, and GUG. Cysteine codons are UGU and UGC. With a thiol side chain, cysteine is classified as a hydrophilic amino acid. Alanine codons are GCU, GCC, GCA, and GCG. It is classified as a non-polar amino acid. L-alanine is second only to leucine. Lysine codons are AAA and AAG. Lysine is a base, as are arginine and histidine.
16. (b) The figure below is the replicating fork of DNA. The DNA replication takes place in $5'$ to $3'$ direction always. On the leading strand DNA replication is continuous while on lagging strand DNA replication is discontinuous. The polarity of lagging strand is incorrect in the given figure. The correct figure should be



Both the strands are antiparallel. In one strand carbon of sugar are in 3' – 5' direction and in other the carbon of sugar are in 5' – 3' direction.

17. (a) TATA box of eukaryote promoter lies about 25 bp upstream of the transcription start site.
18. (d) The new strands of DNA are formed in the 5' → 3' direction from the 3' → 5' template DNA by the addition of deoxyribonucleotides to the 3' end of primer RNA.
19. (a) Synthesis of RNA exhibits several features that are synonymous with DNA replication. RNA synthesis requires accurate and efficient initiation, elongation proceeds in the 5'–3' direction (*i.e.* the polymerase moves along the template strand of DNA in the 3'–5' direction), and RNA synthesis requires distinct and accurate termination. Transcription exhibits several features that are distinct from replication.
20. (a) A palindromic sequence is a nucleic acid sequence (DNA or RNA) that is the same whether read 5' (five-prime) to 3' (three prime) on one strand or 5' to 3' on the complementary strand with which it forms a double helix.
 5 - GAATTC - 3
 3 - CTTAAG - 5
 It is a palindromic sequence of DNA cut by restriction enzyme *EcoRI*.
21. (b) If 30 percent of DNA is adenine, then by Chargaff's rule 30 percent will be thymine. The remaining 40 percent of the DNA is cytosine and guanine. Since the ratio of cytosine to guanine must be equal, then each accounts for 20 percent of the bases.

22. (a)
$$\frac{b \frac{20\%}{28\%} a \frac{8\%}{28\%} c}{28\%}$$

23. (a) Degenerate codons (also called as non-sense codons or terminator codons) do not code for any amino acids. Three types of degenerate codons are UAG (amber), UAA (ochre) and UGA (opal).
24. (a) Nucleosome is a structural unit of a eukaryotic chromosome which consists of a length of DNA coiled around a core of histones and are thought to be present only during interphase of the cell cycle. In the given figure of nucleosome structure, the parts marked as A, B and C are respectively DNA, H1 histones and histone octamer.
25. (a)
- | | | |
|-----|---|---------------|
| UUU | – | Phenylalanine |
| GGG | – | Glycine |
| UCU | – | Serine |
| CCC | – | Proline |
| AUG | – | Methionine |

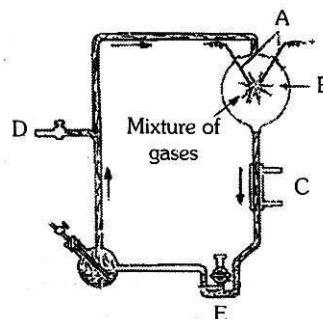
Type B : Assertion Reason Questions

26. (a) Histones are basic proteins found in the eukaryotic chromosomes. These are rich in the amino acids lysine and arginine. Histone proteins are basic proteins consisting of 5 types – H₁, H₂A, H₂B, H₃, H₄. DNA is coiled around it. It exists as octamers linked with H₁.
27. (d) mRNA is attached to the ribosome by means of protein ribophorin I & II. The sequence of nucleotides on mRNA is called codon.
28. (a) DNA is the master copy which transcribes to form working copy in the form of mRNA which translates in the form of peptide chain in the cytoplasm. It is also called central dogma.
29. (c) Organisms with lethal mutation bear lethal genes that result in the death of the individual which carries them. The completely lethal genes usually cause death of the zygote. Mutation is a sudden heritable change in the sequence of gene occurring on the chromosomes. Mutation may be beneficial, normal, sublethal or lethal.

30. (a) Polytene chromosomes show endomitosis and they have high DNA content.
31. (a) A chain of DNA has 140 base pairs, make $1\frac{3}{4}$ turns and twist around a histone octamer forming nucleosome. The core of nucleosome consists of 4 histones H_2A , H_2B , H_3 and H_4 .
32. (a) Transformation does not involve passive entry of DNA molecules through permeable cell walls and membranes. It does not occur 'naturally' in all species of bacteria, only in those species possessing the enzymatic machinery involved in the active uptake and recombination processes. Even in these species, all cells in a given population are not capable of active uptake of DNA. Only competent cells, which possess a so called competence factor are capable of serving as recipients in transformation.
33. (a) Synthesis of polypeptide terminates when a nonsense codon of mRNA reaches the A-site. There are three nonsense codons—UAA, UAG and UGA. These codons are not recognised by any of the tRNAs. Therefore, no more aminoacyl tRNA reaches the A site. The P-site tRNA is hydrolysed and the completed polypeptide is released in the presence of a release factor.
34. (c) In a DNA molecule, A-T rich parts melt before G-C rich parts because there are two H-bond between A and T whereas in between G and C, there are three H-bond.
35. (a) In eukaryotes, the replication and transcription takes place in the nucleus. mRNA comes out from the nucleus through the nuclear pore. In cytoplasm, translation occurs. In prokaryote, there is no nuclear membrane, so replication, transcription and translation all occur in the cytoplasm.

TYPE A : MULTIPLE CHOICE QUESTIONS

1. The branch of science dealing with process of improvement of human race by selective breeding is called [1997]
 - (a) Eugenics (b) Euthenics
 - (c) Euphenics (d) Obstetrics
2. The connecting link between annelida and mollusca is [1998]
 - (a) *Neoplinea* (b) *Nautilus*
 - (c) *Glochidium* (d) Velliger larva
3. Theory of Pangenesis was given by [1998]
 - (a) Lamarck (b) Oparin
 - (c) Darwin (d) De Vries
4. The cranial capacity was largest among the [2002]
 - (a) Peking man (b) African man
 - (c) Java Ape man (d) Neanderthal man
5. A baby has been born with a small tail. It is the case exhibiting [2004]
 - (a) retrogressive evolution
 - (b) mutation
 - (c) atavism
 - (d) metamorphosis
6. "*Homo sapiens*" implies [2007]
 - (a) human race (b) human beings
 - (c) modern man (d) none of these
7. The study of homologous structures in mature organisms provides evidence for the evolutionary relationships among certain groups of organisms. Which field of study includes this evidence of evolution? [2009]
 - (a) Comparative cytology
 - (b) Biochemistry
 - (c) Geology
 - (d) Comparative anatomy
8. Darwin's finches were a good example of [2009]
 - (a) convergent evolution
 - (b) adaptive radiation
 - (c) mutation
 - (d) none of the above
9. Wings of pigeon, mosquito and bat show [1999, 2007, 2011]
 - (a) divergent evolution
 - (b) atavism
 - (c) convergent evolution
 - (d) all of these
10. Which of the following cannot be explained by Lamarckism? [2012]
 - (a) Absence of lips in snakes
 - (b) Long neck of giraffe
 - (c) Degeneration of visual apparatus in cave dwellers
 - (d) Dull progeny of noble laureate
11. Thorn of *Bougainvillea* and tendril of *Cucurbita* are example of [2013]
 - (a) analogous organs
 - (b) homologous organs
 - (c) vestigial organs
 - (d) retrogressive evolution
12. Forelimbs of cat, lizard used in walking; forelimbs of whale used in swimming and forelimbs of bats used in flying are an example of [2014]
 - (a) Analogous organs
 - (b) Adaptive radiation
 - (c) Homologous organs
 - (d) Convergent evolution
13. The diagram represents Miller's experiment. Choose the correct combination of labelling. [2015]



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- (a) A–electrodes, B– $\text{NH}_3 + \text{H}_2 + \text{H}_2\text{O} + \text{CH}_4$, C–cold water, D–vacuum, E–U trap
 (b) A–electrodes, B– $\text{NH}_4 + \text{H}_2 + \text{CO}_2 + \text{CH}_3$, C–hot water, D–vacuum, E–U trap
 (c) A–electrodes, B– $\text{NH}_3 + \text{H}_2\text{O}$, C–hot water, D–tap, E–U trap
 (d) A–electrodes, B– $\text{NH}_3 + \text{H}_2 + \text{H}_2\text{O} + \text{CH}_4$, C–steam, D– vacuum, E–U trap
14. A population is in Hardy- weinberg equilibrium for a gene with only two alleles. If the gene frequency of an allele A is 0.7, the genotype frequency of Aa is [2014, 2016]
 (a) 0.21 (b) 0.42
 (c) 0.36 (d) 0.7
15. According to Hardy-Weinberg principle, allele and genotype frequencies in a population will remain constant from generation to generation in the absence of other evolutionary influences. It makes several assumptions which were given below. [2017]
 i. Random Mating
 ii. Sexual Reproduction
 iii. Non-overlapping Generations
 iv. Occurrence of Natural Selection
 v. Small size of population
 Identify two assumptions which do not meet for a population to reach Hardy-Weinberg Equilibrium?
 (a) iv and v (b) ii and iv
 (c) iii, iv and v (d) i, ii and iii
16. Which of the following was most similar to modern man? [2017]
 (a) Java man
 (b) Neanderthal man
 (c) Homo habilis
 (d) Cro-Magnon man
- (b) If both Assertion and Reason are correct but Reason is not a correct explanation of the Assertion.
 (c) If the Assertion is correct but Reason is incorrect.
 (d) If both the Assertion and Reason are incorrect.
 (e) If the Assertion is incorrect but the Reason is correct.
17. **Assertion:** We have lost all the direct evidence of origin of life.
Reason: The persons responsible for protecting evidences were not skilled. [1998]
18. **Assertion :** *Ginkgo biloba* is a living fossil.
Reason : Organism which have persisted and remain unchanged for the past several million years while their relatives disappeared. [2000]
19. **Assertion :** Among the primates, chimpanzee is the closest relative of the present day humans.
Reason : The banding pattern in the autosome numbers 3 and 6 of man and chimpanzee is remarkably similar. [2004]
20. **Assertion :** From evolutionary point of view, human gestation period is believed to be shortening.
Reason : One major evolutionary trend in humans has been the larger head undergoing relatively faster growth rate in the foetal stage. [2004]
21. **Assertion :** Coacervates are believed to be the precursors of life.
Reason : Coacervates were self-duplicating aggregates of proteins surrounded by lipid molecules. [2004]
22. **Assertion :** Human ancestors never used their tails and so the tail expressing gene has disappeared in them.
Reason : Lamarck's theory of evolution is popularly called theory of continuity of germ plasm. [2005]
23. **Assertion :** Comparative biochemistry provides a strong evidence in favour of common ancestry of living beings.
Reason : Genetic code is universal. [2005]
24. **Assertion :** Darwin's finches show a variety of beaks suited for eating large seeds, flying insects and cactus seeds.

TYPE B : ASSERTION REASON QUESTIONS

Directions for (Qs. 17-26) : These questions consist of two statements, each printed as Assertion and Reason. While answering these questions, you are required to choose any one of the following five responses.

- (a) If both Assertion and Reason are correct and the Reason is a correct explanation of the Assertion.

Reason : Ancestral seed-eating stock of Darwin's finches radiated out from South American mainland to different geographical areas of the Galapagos Islands, where they found competitor-free new habitats. [2005]

25. **Assertion :** The earliest organisms that appeared on the earth were non-green and presumably anaerobes.

Reason : The first autotrophic organisms were the chemoautotrophs that never released oxygen. [2006]

26. **Assertion :** The earliest fossil form in the phylogeny of horse is eohippus.

Reason : Eohippus lived during the early pliocene epoch. [2007]

Directions for (Qs.27-30) : Each of these questions contains an Assertion followed by Reason. Read them carefully and answer the question on the basis of following options. You have to select the one that best describes the two statements.

- (a) If both Assertion and Reason are correct and Reason is the correct explanation of Assertion.
- (b) If both Assertion and Reason are correct, but Reason is not the correct explanation of Assertion.
- (c) If Assertion is correct but Reason is incorrect.
- (d) If both the Assertion and Reason are incorrect.

27. **Assertion :** The primitive atmosphere was reducing one i.e., without oxygen. [2009]

Reason : In the primitive atmosphere, oxygen was involved in forming ozone.

28. **Assertion :** Java Ape-man, Peking man and Heidelberg man are the fossils of *Homo erectus*.

Reason : *Homo erectus* evolved from *Homo habilis*. [2009]

29. **Assertion :** Natural selection is the outcome of difference in survival and reproduction among individuals that show variation in one or more traits.

Reason : Adaptive forms of a given trait tend to become more common; less adaptive ones become less common or disappear. [2004, 2012]

30. **Assertion :** Organic compounds first evolved in earth required for origin of life were protein and nucleic acid.

Reason : All life forms were in water environment only. [2016]

HINTS & SOLUTIONS

Type A : Multiple Choice Questions

1. (c) Eugenics deals with factors related to the improvement of human race by controlled selective breeding. It is the improvement of human race by improving body functions and treatment of defective heredity by genetic engineering. Euthenics deals with the improvement of human race by providing better conditions of life. Obstetrics is the study of the reproductive process within the female body including fertilization, pregnancy and childbirth.
2. (a) *Neoplinea* is a connecting link between annelids and molluscs.
3. (c) The theory of Pangenesis was given by Darwin.
4. (d) The cranial capacity of Neanderthal man was the largest. The cranial capacity was about 1450 cc, roughly equal to that of modern man.
5. (c) Atavism is the reappearance of ancestral and not parental characters in an organisms which do not occur normally. A baby that has been born with a small tail it is exhibiting the case of atavism. Atavism is the sudden appearance of some ancestor characters which are lost during course of evolution.
6. (b) *Homo sapiens* imply human beings. Humans belong to an order of mammals called primates and placed in the family hominidae. Hominidae includes modern and archaic human beings and also consists of neanderthal, a sub species of *Homo sapiens*. Humans and their ancestors are more closely related to the apes.
7. (d) Comparative cytology is the field of study involving examination of similarities in cells of different organisms Biochemistry compares DNA and proteins made from DNA. Geology is the study of the earth.
8. (b) During voyage on the ship M.S. Beagle in 1931, Darwin visited Galapagos Islands of South America and studied the climate and birds of that Island. He studied the finches there, which were called Darwin's finches. The finches showed differences in their beaks based on their different feeding habits and are examples of natural selection. Darwin's Finches are good examples of adaptive radiation (also called divergent evolution). Different types of beaks in these Finches show adaptive radiation.
9. (c) Wings of birds, insects, mammals are analogous organs i.e. have same function and different structure. The similarity developed in distantly related groups is an adaptation for the same function. So it is analogy or convergent evolution.
10. (d) According to Lamarck, during the lifetime of an organism new characters are developed due to internal vital forces, effect of environment, new needs, use and disuse of organs. These acquired characters are inherited from one generation to another. According to him, intelligence should also be inherited and so it fails to explain dull progeny of nobel laureate.
11. (b) Thorn of *Bougainvillea* and tendril of *Cucurbita* are examples of homologous chromosomes.
12. (c) Organs which have a common fundamental anatomical plan and similar embryonic origin whatever various functions they may perform are regarded as homologous organs. For example, the flippers of a whale, a bat's wing, fore-limb of a horse, a bird's wing and forelimbs of human are structurally as well as functionally different.
13. (a)
14. (b) For a gene with two alleles, A (dominant) and a (recessive), if the frequency of A is p and the frequency of a is q, then the frequencies of the three possible genotypes (AA, Aa, and aa) can be expressed by the Hardy-Weinberg

equation :

$$p^2 + 2pq + q^2 = 1$$

where, p^2 = frequency of AA (homozygous dominant) individuals, $2pq$ = frequency of Aa (heterozygous) individuals and q^2 = frequency of aa (homozygous recessive) individuals. The equation can be used to calculate allele frequencies if the numbers of homozygous recessive individuals in the population is known.

Here, $p = 0.7$ and $q = 0.3$ (given)

$\therefore 2pq$ (frequency of heterozygote)
 $= 2 \times 0.7 \times 0.3 = 0.42$

15. (a) Occurrence of natural selection and small size of population do not meet the criteria for a population to reach Hardy-Weinberg Equilibrium. For Hardy-Weinberg equilibrium to be reached, natural selection should not be occurring. If populations are undergoing natural selection at the locus under consideration, allele frequencies will be continuously changing in a specific direction and Hardy-Weinberg Equilibrium predicts that allele frequencies will stay constant. It assumes that population size is very large.
16. (d) The skeleton of Cro-Magnon was almost identical to the modern man.

Type B : Assertion Reason Questions

17. (c) We have lost all the direct evidences of origin of life only due to destruction of fossils on account of climatic changes and not due to any person(s).
18. (a) *Ginkgo biloba*, belong to the Ginkgoales evolved during the Jurassic period and is still existing without any morphological or anatomical changes. Hence, both assertion and reason are correct.
19. (a) The banding pattern seen on stained chromosomes from humans and chimpanzee show striking similarities which indicates that they have evolutionary relationships (cytogenetic evidence).
20. (d) The human gestation period cannot be shortened unless there is really a problem.

Complete development will not take place before the gestation period of 270 – 290 days in humans.

21. (d) Coacervates are large colloidal aggregates formed due to intermolecular attraction from large organic molecules synthesized abiotically on primitive earth. It mainly consists of proteins, polysaccharides and water. They do not fulfil the requirement for probable precursors of life.

A coacervate is a tiny spherical droplet of assorted organic molecules which is held together by hydrophobic forces from a surrounding liquid. Coacervates possess osmotic properties and form spontaneously from certain dilute organic solutions. They were even once suggested to have played a significant role in the evolution of cells and, therefore, of life itself. They are interesting not only in that they provide a locally segregated environment but also in that their boundaries allow the selective absorption of simple organic molecules from the surrounding medium. Coacervates do not have lipid outer membrane, hence they cannot reproduce.

22. (c) According to Lamarck's theory, continuous disuse of organs makes them weak. The theory of continuity of germplasm was given by Weismann.

If humans share ancestry with other primates such as prosimian, monkeys etc, then remnants of that common ancestry should be present in our genes.

23. (b) Comparative biochemistry provides a strong evidence for common ancestors of living beings (e.g. proteins lymph, enzymes, hormones, blood groups etc.)
24. (a) Darwin finches found on Galapagos islands differ primarily in body size, feather colour, bill shape as adaptation to type of food available. It is a type of divergent evolution.
25. (b) The earliest organisms that appeared on the earth were heterotrophic because of

reducing atmosphere and the first autotrophs were chemoautotrophs.

An anaerobic organism does not require oxygen for growth and may even die in its presence. Chemotrophs are the first organisms that appeared on earth & obtain energy by the oxidation of electron donating molecules in their environments. These molecules can be organic (organotrophs) or inorganic (lithotrophs). The chemotrophs utilize solar energy and can be either autotrophic or heterotrophic.

26. (c) Eohippus is the earliest fossil form in the phylogeny of horse. Origin of horse took place in the eocene period. The first fossil of horse was found in North America which was named Eohippus or "Dawn Horse.", that later renamed as hyracotherium.

It was found during eocene period not during pliocene.

27. (c) The lightest atoms of nitrogen, carbon *etc.* formed the primitive atmosphere. Hydrogen atoms were most numerous and most reactive in primitive atmosphere. Hydrogen atoms combined with all oxygen atoms to form water leaving no free oxygen. Thus primitive atmosphere was reducing (without free oxygen) unlike the present oxidizing atmosphere (with free oxygen).

Formation of ozone layer is the consequence of modern oxidizing atmosphere having plenty of free oxygen. As more oxygen accumulated in the atmosphere (due to photosynthesis) ozone began to appear in the top layers.

28. (b) The fossil of Java Ape-man was discovered from pleistocene rocks in central Java. The fossil of Peking man was discovered from the lime stone caves of Choukoutou near Peking while that of Heidelberg man was discovered in mid pleistocene. All these three fossils come under the category of *Homo erectus*. *Homo erectus* appeared about 1.7 million years ago in the middle pleistocene. *H. erectus* evolved from *Homo habilis*. He was about 1.5-1.8 metres tall. He had erect posture. His skull was flat than that of the modern man. He had protruding jaws, projecting brow ridges, small canines and large molar teeth. He made more elaborate tools of stones and bones, hunted big animals and perhaps knew the use of fire.

29. (a) The Darwin's theory of Natural Selection can be generalised as the change in species by the survival of an organism exhibiting a natural variation that gives it an adaptive advantage in an environment. Thus, leading to a new environmental equilibrium. The idea of the survival of the fittest explains the above evolution by natural selection. According to survival of the fittest, some of the variations exhibited by living things make it easier for them to survive and reproduce. Thus, more adaptive forms increase. Those which are not fit (or less adaptive) are eliminated.

30. (b) Organic compounds that first evolved in earth which required for origin of life were protein and nucleic acid. All life forms were in aquatic environment only.

TYPE A : MULTIPLE CHOICE QUESTIONS

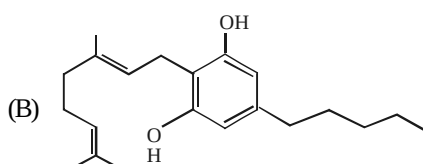
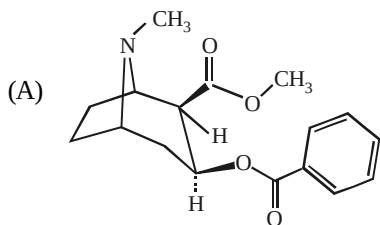
1. Gambusia fish has been introduced in lakes and ponds of India to control a deadly disease. It feeds on larva of [1997]
(a) nepenthes (b) *anopheles*
(c) dragon fly (d) house-fly
2. Anti-viral substance is [1997]
(a) antigen (b) antibody
(c) interferon (d) antibiotic
3. Which malarial parasite has longest incubation period? [1997]
(a) *Plasmodium vivax*
(b) *Plasmodium falciparum*
(c) *Plasmodium malariae*
(d) *Plasmodium ovale*
4. The type of antibodies present in colostrum secreted from mammary gland is [1997]
(a) IgM (b) IgD
(c) IgE (d) IgA
5. Which of the following disease is due to an allergic reaction ? [1998]
(a) Goitre (b) Hay fever
(c) Skin cancer (d) Rheumatic fever
6. Influenza is caused by [1998]
(a) virus (b) bacteria
(c) alga (d) fungus
7. Which type of cancer is found in lymph nodes and spleen? [1998]
(a) Carcinoma (b) Sarcoma
(c) Lymphoma (d) Leukemia
8. Amoebiasis is caused by [1999]
(a) *Entamoeba histolytica*
(b) *Taenia solium*
(c) *Plasmodium vivax*
(d) *E. coli*
9. Inflammatory response, in allergy is caused by the release of [1999]
(a) antigen (b) histones
(c) histamines (d) antibodies
10. Sporogony of malarial parasite occurs in [1999]
(a) liver of man
(b) RBCs of man
(c) stomach wall of mosquito
(d) salivary glands of mosquito
11. Malignant tertian malaria is caused by [2000]
(a) *P. vivax* (b) *P. malariae*
(c) *P. ovale* (d) *P. falciparum*
12. HIV has a protein coat and genetic material [2000]
(a) ss RNA (b) ds RNA
(c) ss DNA (d) ds DNA
13. Cyclosporine is used [2002]
(a) For allergy
(b) As immunodepressant
(c) Prophylactic for virus
(d) None of the above
14. Lysis of foreign cell is mediated through [2002]
(a) IgM (b) IgA
(c) IgE (d) IgM & IgG
15. The treatment of snake-bite by antivenom is an example of [2004]
(a) artificially acquired active immunity
(b) artificially acquired passive immunity
(c) naturally acquired passive immunity
(d) specific natural immunity
16. Electron beam therapy is a kind of radiation therapy to treat [2004]
(a) enlarged prostate gland
(b) gall bladder stones by breaking them
(c) certain types of cancer
(d) kidney stones
17. A young drug addict used to show symptoms of depressed brain activity, feeling of calmness, relaxation and drowsiness. Possibly he was taking [2005]
(a) Amphetamine (b) Marijuana
(c) Pethadine (d) Valium

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18. When children play bare footed in pools of dirty water and flood water, they may suffer from diseases like [2006]
 (a) leptospirosis and bilharizia
 (b) malaria, amoebic dysentery and leptospirosis
 (c) bilharizia, infective hepatitis and diarrhoea
 (d) guinea worm infection, elephantiasis and amoebic dysentery
19. Which one of the following is not a matching pair of a drug and its category? [2004, 2008]
 (a) Amphetamines - stimulant
 (b) Lysergic acid - narcotic dimethyl amide
 (c) Heroin - psychotropic
 (d) Benzodiazepam - pain killer
20. An insect bite may result in inflammation of that spot. This is triggered by the alarm chemicals such as [2005, 2008]
 (a) histamine and dopamine
 (b) histamine and kinins
 (c) interferons and opsonin
 (d) interferons and histones
21. Antigen binding site in an antibody is found between [2005, 2008]
 (a) two light chains
 (b) two heavy chains
 (c) one heavy and one light chain
 (d) either between two light chains or between one heavy and one light chain depending upon the nature of antigen
22. The antigen-binding site are present where on the antibody molecule [2009]
 (a) on light chain as well as on heavy chain.
 (b) on light chain only.
 (c) on variable region and constant region of light chain.
 (d) on heavy chain only.
23. Which one of the following antimicrobial drugs is suitable for treatment of both tuberculosis and leprosy? [2010]
 (a) Isoniazid
 (b) R-aminosalicylic acid
 (c) Streptomycin
 (d) Rifampicin
24. Antigen is a substance which [2010]
 (a) lowers body temperature
 (b) destroys harmful bacteria
 (c) triggers the immune system
 (d) is used as an antidote to poison
25. Which of the following is a pentameric immunoglobulin and is produced first in a primary response to an antigen? [2010]
 (a) I_gG (b) I_gM
 (c) I_gA (d) I_gE
26. Cattle fed with spoilt hay to sweet clover which contains dicumarol [2011]
 (a) are healthier due to a good diet
 (b) catch infections easily
 (c) may suffer vitamin K deficiency and prolonged bleeding
 (d) may suffer from beri-beri due to deficiency of vitamin-B
27. Opium is obtained from [2011]
 (a) *Oryza sativa*
 (b) *Coffea arabica*
 (c) *Thea sinensis*
 (d) *Papaver somniferum*
28. Match the following bacteria with the diseases
- | Column-I | Column-II |
|------------------------------|---------------|
| A. <i>Treponema pallidum</i> | I. Plague |
| B. <i>Yersinia pestis</i> | II. Anthrax |
| C. <i>Bacillus anthracis</i> | III. Syphilis |
| D. <i>Vibrio</i> | IV. Cholera |
- [2012]
- (a) A – III; B – I; C – II; D – IV
 (b) A – IV; B – I; C – II; D – III
 (c) A – III; B – II; C – I; D – IV
 (d) A – I; B – III; C – II; D – IV
29. Which one of the following is a correct match? [2013]
 (a) Bhang – Analgesic
 (b) Cocaine – Opiate narcotics
 (c) Morphine – Hallucinogen
 (d) Barbiturate – Tranquiliser
30. Which of the following is an autoimmune disorder? [2013]
 (a) Myasthenia gravis
 (b) Osteoporosis
 (c) Muscular dystrophy
 (d) Gout
31. Which of the following is based upon the principle of antigen-antibody interaction? [2014]
 (a) PCR
 (b) ELISA
 (c) r-DNA technology
 (d) RNA

32. Identify the molecules (A) and (B) shown below and select the right option giving their source and use. [2014,2015]



	Molecule	Source	Uses
(a)	(A) Cocaine	<i>Erythroxylum coca</i>	Accelerates the transport of dopamine
(b)	(B) Heroin	<i>Cannabis sativa</i>	Depressant and slows down body functions
(c)	(B) Cannabinoid	<i>Atropa belladonna</i>	Produces hallucinations
(d)	(A) Morphine	<i>Papaver somniferum</i>	Sedative and pain killer

33. *Pasteurella/Yersinia pestis* (causal agent of Bubonic Plague) is transmitted by [2016]
 (a) *Cimex* (b) *Xenopsylla*
 (c) *Pediculus* (d) *Aedes*
34. Which of the following pairs is not correctly matched? [2016]
 (a) Cholera – *Vibrio cholerae*
 (b) German measles – Rubella virus
 (c) Whooping cough – *Bordetella pertussis*
 (d) Tetanus – *Pasteurella pestis*
35. Human immuno deficiency virus (HIV) has a protein coat and a genetic material which is [2017]
 (a) Single stranded DNA.
 (b) Single stranded RNA.
 (c) Double stranded RNA.
 (d) Double stranded DNA.

36. Which one of the following pairs of diseases is viral as well as transmitted by mosquitoes? [2017]

- (a) Elephantiasis and dengue
 (b) Yellow fever and sleeping sickness
 (c) Encephalitis and sleeping sickness
 (d) Yellow fever and dengue

TYPE B : ASSERTION REASON QUESTIONS

Directions for (Qs. 37-44) : These questions consist of two statements, each printed as Assertion and Reason. While answering these questions, you are required to choose any one of the following five responses.

- (a) If both Assertion and Reason are correct and the Reason is a correct explanation of the Assertion.
 (b) If both Assertion and Reason are correct but Reason is not a correct explanation of the Assertion.
 (c) If the Assertion is correct but Reason is incorrect.
 (d) If both the Assertion and Reason are incorrect.
 (e) If the Assertion is incorrect but the Reason is correct.

37. **Assertion:** There is no chance of malaria to a man on the bite of male *Anopheles* mosquito.

Reason: It carries a non-virulent strain of *Plasmodium*. [1998]

38. **Assertion :** Rabies is an infection of mammals, it involves central nervous system which may result in paralysis and finally death.

Reason : This is caused by neurotropic bacteria in saliva of rabies animal. [2000]

39. **Assertion :** *Plasmodium vivax* is responsible for malaria.

Reason : Malaria is caused by polluted water. [2001]

40. **Assertion:** Histamine is related with allergic and inflammatory reactions.

Reason: Histamine is a vasodilator. [2002]

41. **Assertion :** Organ transplantation patients are given immunosuppressive drugs.

Reason : Transplanted tissue has antigens which stimulate the specific immune response of the recipient. [2005]

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42. **Assertion:** LSD and marijuana are clinically used as analgesics. [2006]

Reason: Both these drugs suppress brain function.

43. **Assertion :** A person who has received a cut and is bleeding needs to be given anti-tetanus treatment. [2006]

Reason : Anti-tetanus injection provides immunity by producing antibodies for tetanus.

44. **Assertion (A) :** Antigen can be easily recognized because it has antigenic determinants.

Reason (R) : The recognition ability is innate. [2007]

Directions for (Qs.45-57) : Each of these questions contains an Assertion followed by Reason. Read them carefully and answer the question on the basis of following options. You have to select the one that best describes the two statements.

- (a) If both Assertion and Reason are correct and Reason is the correct explanation of Assertion.
- (b) If both Assertion and Reason are correct, but Reason is not the correct explanation of Assertion.
- (c) If Assertion is correct but Reason is incorrect.
- (d) If both the Assertion and Reason are incorrect.

45. **Assertion :** *Escherichia coli*, *Shigella sp.* and *Salmonella sp.* are all responsible for diarrhoeal diseases.

Reason : Dehydration is common to all types of diarrhoeal diseases and adequate supply of fluids and electrolytes should be ensured.

[2008]

46. **Assertion :** Dope test is used to estimate the level of blood alcohol by analyzing the breath of persons drinking alcohol.

Reason : A drunken person usually feels tense and less talkative. [2004, 2008]

47. **Assertion :** Interferons are a type of antibodies produced by body cells infected by bacteria.

Reason : Interferons stimulate inflammation at the site of injury. [2004, 2008]

48. **Assertion :** Mast cells in the human body release excessive amounts of inflammatory chemicals, which cause allergic reactions.

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Reason : Allergens in the environment on reaching human body stimulate mast cells in certain individuals. [2003, 2008]

49. **Assertion :** *Cannabis sativa* is a powerful anti-depressant.

Reason : Hashish and Marijuana are derived from it. [2009]

50. **Assertion:** Epstein– Barr virus is an oncovirus.

Reason: It stimulates the growth of cancer. [2011]

51. **Assertion:** HIV infected person are prone to opportunistic diseases.

Reason: Immune system weakens during HIV infection. [2011]

52. **Assertion :** Histamine is involved in allergic and inflammatory reactions.

Reason : Histamine is a vasodilator. [2012]

53. **Assertion :** The antibodies separated from serum are homogenous.

Reason : Monoclonal antibodies are homogenous immunological reagents. [2013]

54. **Assertion :** Interferons are effective against viruses.

Reason : Proteins which can be synthesized only by genetic engineering are effective against viruses. [2013, 2014]

55. **Assertion :** Cancer cells are virtually immortal until the body in which they reside dies.

Reason : Cancer is caused by damage to genes regulating the cell division cycle. [2006, 2015]

56. **Assertion :** Cocaine has a potent stimulating action on central nervous system, producing a sense of euphoria and increased energy.

Reason : Injecting the microbes intentionally during immunisation or infectious organisms gaining access into body during natural infection induces active immunity. [2016]

57. **Assertion:** Artificially acquired passive immunity results when antibodies or lymphocytes produced outside the host are introduced into a host.

Reason: A bone marrow transplant given to a patient with genetic immunodeficiency is an example of artificially acquired passive immunity. [2017]

HINTS & SOLUTIONS**Type A : Multiple Choice Questions**

1. (b) *Gambusia* fish is larvicidal *i.e.* feed on insect larva. They are introduced into lakes and ponds to eat mosquito larvae (*e.g.* *Anopheles*) and control malaria.
2. (c) Interferons are glycoproteins produced by viral infected cell. They make the cells resistant to viral infection.
3. (c) Incubation period of *Plasmodium vivax* is 14 days, *P. malariae* is 30 days, *P. ovale* is 14 days, and *P. falciparum* is 12 days.
4. (d) Colostrum (also called first milk) is the thin yellowish fluid secreted by the mammary glands at the time of parturition and which precedes the production of true milk. It provides a nursing infant with essential nutrients and infection-fighting antibodies (called immunoglobulin). IgA is the major immunoglobulin in colostrum. It provides protection from inhaled and ingested pathogens.
5. (b) Hay fever is due to allergic reaction.
6. (a) Influenza is caused by virus *Myxovirus influenzae*. It is an acute respiratory tract infection.
7. (c) Cancer of lymphatic tissue *i.e.* lymph nodes, spleen, is lymphoma.
8. (a) Amoebiasis or amoebic dysentery is caused by *Entamoeba histolytica*.
9. (c) Inflammatory response is due to the release of histamines by the damaged mast cells. The vascular fluid comes out of the blood vessels causing swelling of the region.
10. (d) Sporogony of *Plasmodium* occurs in the salivary glands of female *Anopheles*.
11. (d) Malignant tertian malaria is caused by *Plasmodium falciparum*.
12. (a) HIV (AIDS virus) consists of glycoprotein coat, double layer of lipid membrane of two protein coats. It contains ss RNA and reverse transcriptase.
13. (b) Cyclosporin is used as immunodepressant especially for the patients having organ transplantation. It suppresses T-lymphocytes activity in the immune response.
14. (c) IgE immunoglobulin acts as mediator in allergic response.
15. (b) Artificial passive immunity is the resistance passively transferred to a recipient by administration of antibodies, *e.g.* administration of antivenom.
16. (c) Electron beam therapy is a kind of radiation therapy to treat certain types of cancer. It is used as a therapeutic treatment for cancer.
17. (d) Valium is the anti depressant used by addicts that produces feelings of calmness, relaxation and drowsiness.
18. (a) In leptospirosis and bilharziasis diseases, cercaria of the fluke penetrates the human body through the skin during bath in rivers and canals.
19. (d) Amphetamine is a stimulant drug which stimulates CNS. Lysergic acid diethylamide (LSD) is the most potent hallucinogen. Benzodiazepam is a sedative which switches off the CNS and is anti-anxiety. Heroin is a psychotropic drug which acts on the brain and alters behavior, consciousness and capacity of perception.
20. (b) An insect bite may result in inflammation of that spot. This is triggered by the alarm chemicals such as histamine and kinins. Histamine is a biogenic amine involved in local immune responses as well as regulating physiological function in the gut and acting as a neurotransmitter. It is found in virtually all animal body cells. New evidence also indicates that histamine plays an important role in chemotaxis of white blood cells. Kinin is any of various structurally related polypeptides, such as bradykinin and kallikrein. They are members of the autacoid family. They act locally to induce vasodilation and contraction of smooth muscles.
21. (c) Antigen binding site is Y-shaped showing lock and key pattern made up of one heavy and one light chain.
22. (a) The Y-shaped antibody molecule is composed of 4 polypeptide chains - two

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identical light chains and two heavy chains held together by disulphide bonds. Antigen-binding site is formed on antibody molecule where a heavy chain variable and a light chain variable come closer.

23. (d) Leprosy is caused by *Mycobacterium leprae*, while tuberculosis is caused by bacteria *Streptococcus* or *Staphylococcus*. Rifampicin is a common medicine in treatment of both the diseases.
24. (c) Antigen is the only foreign substance which triggers immune system by way of antibody formation. These antibodies neutralize antigen by antigen-antibody reaction.
25. (b) I_gM is a pentameric immunoglobulin that is produced first in a primary response to an antigen. I_gA , I_gD and I_gE consist of single monomers.
26. (c) Hemorrhagic syndrome of cattle are associated with the feeding of sweet clover hay containing dicumarol.
27. (d) Opium is a narcotic formed from the latex released by lacerating the immature seed pods of opium poppies (*Papaver somniferum*). Morphine is the most prevalent alkaloid in opium, about 10%-16% of the total alkaloids. It is responsible for most of the harmful effects such as lung edema, respiratory difficulties, coma, or cardiac or respiratory collapse.
28. (a) Plague is a deadly infectious disease that is caused by the enterobacteria *Yersinia pestis* (formerly known as *Pasteurella pestis*). Anthrax is an infectious bacterial disease which involves skin, gastrointestinal tract or lungs. Syphilis is a sexually transmitted infection caused by bacterium *Treponema pallidum*. Cholera is an infection in the small intestine caused by the bacterium *Vibrio cholerae* that causes a large amount of watery diarrhea and vomiting.
29. (d)
30. (a)
31. (b) The ELISA is a fundamental tool of clinical immunology, and is used as an initial screen for HIV detection. Based on the principle of antigen- antibody interaction, this test

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allows for easy visualization of results.

32. (d) Molecule (A) represents structure of morphine. Morphine is the most abundant alkaloid found in *Opium*, the dried sap (latex) derived from shallowly slicing the unripe seedpods of the *Opium*, or common and/or edible poppy *Papaver somniferum*. Morphine is a potent opiate analgesic drug that is used to relieve severe pain.
33. (b)
34. (d) Tetanus is caused by *Clostridium tetani* while plague is caused by *Pasteurella pestis*.
35. (b) The human immunodeficiency virus is a lentivirus that causes the acquired immunodeficiency syndrome, a condition in humans in which progressive failure of the immune system allows life-threatening opportunistic infections and cancers to thrive. HIV has a protein coat and a genetic material which is single stranded RNA.
36. (d) Yellow fever and dengue are viral diseases, and they are transmitted by mosquitoes.

Type B : Assertion Reason Questions

37. (c) Male *Anopheles* mosquito do not have piercing and sucking type of mouth parts. So, they can not inject malarial parasite into man.
38. (c) Rabies (hydrophobia) is caused by rabies virus. Its vectors are rabid animals especially dogs. It leads to encephalitis, fear of water (hydrophobia), high fever, severe headache, spasm of throat & chest, leading to death.
39. (b) Malaria is caused by *Plasmodium* whose sexual phase occurs in the mosquito *Anopheles*. When female *Anopheles* feed on blood, they can serve as vector host for malarial parasite.
40. (a) Histamine is produced by mast cells in response to the allergy and inflammatory reaction. When histamine is released from mast cells, it causes vasodilation and an increase in permeability of the blood vessel walls. These effects, in turn cause the common symptoms of allergy including a running nose and watering eyes.

41. (a) Success of organ transplant depends on proper matching of histocompatibility of antigens that occurs in all cells of the body. As there are antigens which are likely to be attacked by recipient's T-cells and antibodies, the recipient of organ transplant is always given immunosuppressants to prevent immune rejection of the transplanted tissue.
42. (c) LSD and marijuana are anti inflammatory, sedative, anticonvulsive and laxative in action.
43. (c) Anti tetanus is a disinfectant *i.e.* it prevents the infection due to the entry of bacteria through wounds.
44. (b) Antigen is a substance that when introduced in the body, stimulate the production of antibody. They are mostly proteins but may be carbohydrates, lipids, nucleic acids etc. One antigen can bind with many antibodies. Every antigen has many antigenic determinants called epitopes. The recognition ability of antibody is innate and develops without exposure to the antigen.
45. (b) Diarrhoeal disease conditions include frequent and excessive discharge of watery material from the bowel. Such diseases mostly result from ingestion of harmful germs with food and water. *E. coli*, *Shigella sp.* & *salmonella sp.* causes diarrhoea. Diarrhoea caused by virus, bacteria or parasites possesses two characteristics- firstly, the offending organisms colonise the intestine and as a consequence cause inflammation of the intestine or enteritis; and secondly, they upset the balance of intestinal fluid absorption and secretion mechanism, often enhancing the latter very considerably, which is then manifested as watery stool discharged frequently in large volumes. *Shigella sp*, *Salmonella sp.* are quite closely related genera that are responsible for diarrhoeal diseases. Dehydration is common to all types of diarrhoeal diseases & adequate supply of fluids & electrolytes that provides ions, should be ensured.
46. (d) Blood alcohol test measures the amount of alcohol (ethanol) in the body. Alcohol is quickly absorbed into the blood and can be measured within minutes of having an alcoholic drink. The amount of alcohol in the blood reaches its highest level about an hour after drinking. But food in the stomach may increase the amount of time it takes for the blood alcohol to reach its highest level. About 90% of alcohol is broken down in the liver. The rest of it is passed out of the body in urine and your exhaled breath. Symptoms of alcohol intoxication include confusion, lack of coordination, unsteadiness that makes it hard to stand or walk, or erratic or unsafe driving. Dope test is not related to alcohol. Dope test is a blood test to know whether a person used any drug to improve their performance.
47. (d) Interferons are natural proteins produced by the cells of the immune system in response to challenges by foreign agents such as viruses, parasites and tumor cells. Interferons belong to the large class of glycoproteins known as cytokines. Interferons are produced by a wide variety of cells in response to the presence of double-stranded RNA, a key indicator of viral infection. Interferons assist the immune response by inhibiting viral replication within host cells, activating natural killer cells and macrophages, increasing antigen presentation to lymphocytes, and inducing the resistance of host cells to viral infection. When the antigen is presented to matching T and B cells, those cells multiply and strategically and specifically wipe out the foreign substance. That is why antigen presentation is so important to the immune response.
48. (a) A mast cell contains many granules rich in histamine serotonin and heparin. Although best known for their role in allergy and anaphylaxis, mast cells play an important protective role as well, being intimately involved in wound healing and defense against pathogens. The symptoms of an allergic reaction develop in response to

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histamine. Mast cells release a large amount of histamine into the blood stream & it also act as initiator of the inflammatory response, which aids the arrival of leucocytes at a site of infection. Histamine stimulates capillary dilation increased capillary permeability, closure of bronchial tubes, mucus secretion, pain & swelling.

49. (d) *Cannabis sativa* or Hemp is an annual herb of cannabaceae family. It is mainly the source of fibre. *Cannabis sativa* is not an antidepressant. Antidepressant is a psychiatric medication used to alleviate mood disorders such as major depression. Hashish and Marijuana are drugs derived from it. Preparations of flowers of *Cannabis* is called marijuana while preparations of the resinous extract is called hashish. Both are consumed by smoking, vapourising and oral ingestion and are hallucinogen drugs that cause acute panic anxiety reaction.
50. (a) Oncoviruses are cancer – causing viruses and may be DNA or RNA virus *e.g.*, Epstein – Barr – Virus, Herpes simplex type 2 virus etc. This shows that the development of cancerous tumour is associated with certain genes.
51. (a) Usually, person shows symptoms of HIV infection within 2 to 6 weeks of exposure to the virus. But in some persons, the virus may remain silent for long periods (upto 10 years) before symptoms of full blown AIDS are observable. The symptoms of HIV infection include fever, lethargy, pharyngitis, nausea, headache, rashes etc. Persons suffering from AIDS have a weakened immune system due to depletion of T- helper cells. Such persons show *opportunistic infections*, *i.e.*, infection by those fungi, bacteria and viruses to which a person with normal immune system is expected to be resistant. Therefore, persons prone to opportunistic infections may be suspected to be infected by HIV, particularly, if the count of T helper cells in 200/ ml or lower.
52. (a) Histamine is a derivative of the amino acid histidine produced by damaged cells of

vertebrates. When released, it has the effect of dilating capillaries and lowering blood pressure. Histamine is involved in allergic and inflammatory reactions also.

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53. (d) From hyperimmunized animals, the blood serum may be taken and antibodies may be isolated from this serum. However, the antibodies, whenever separated from serum after induction due to an antigen, are usually heterogenous, because the cells keep on producing a variety of antibodies. Monoclonal antibodies (Mabs), on the other hand are homogeneous immunological reagents of defined specificity so that these can be utilized for diagnosis and screening of disease.
54. (c) Interferons are proteins that are effective against most viruses. They are naturally produced by virus infected cells. The proteins interact with adjacent cells and make them resistant to virus attack. Now interferons are also being manufactured through genetic engineering.

Interferons control the multiplication of virus particles by inhibiting their protein synthesis.
55. (b) Cancer cells divide and redive mitotically and is due to the activation of pro-oncogenes.
56. (c) Cocaine is obtained from the cocaplant, *erthyroxylum coca*. Cocaine is commonly called as coke or crack which is usually snored. It has a potent stimulating action of euphoria and increased energy. It interferes with the transport of the neurotransmitter dopamine. Its increased dosages cause hallucinations.
57. (b) Artificially acquired passive immunity results when antibodies or lymphocytes that have been produced outside the host are introduced into a host. This type of immunity is immediate short lived, lasting only a few weeks to a few months. An example is bone marrow transplant given to a patient with genetic immunodeficiency.

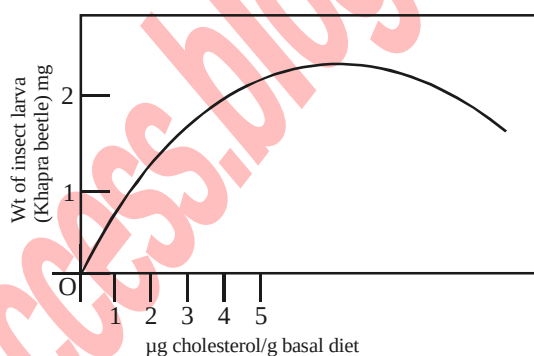
Strategies for Enhancement in Food Production

TYPE A : MULTIPLE CHOICE QUESTIONS

- The chemical which are produced by host plants due to infection as a defence reaction to pathogen, are called [1997]
 - phytotoxin
 - toxin
 - phytotron
 - phytoalexins
- Auxanometer is used to measure [1998]
 - length
 - respiration
 - transpiration
 - ascent of sap
- Crop rotation is used to increase [1999]
 - soil fertility
 - pore size and soil particle
 - organic content of soil
 - viscosity of soil water
- Haploid cultures can be obtained by culturing
 - pollen grains
 - embryo
 - shoot apex
 - root apex
- Azolla* is used as a biofertilizer because it [2003]
 - multiplies very fast to produce massive biomass
 - has association of nitrogen-fixing *Rhizobium*
 - has association of nitrogen-fixing Cyanobacteria
 - has association of mycorrhiza
- Pruning of plants promotes branching because the axillary buds get sensitized to [2004]
 - ethylene
 - gibberellin
 - cytokinin
 - indole acetic acid
- Somaclonal variation can be obtained by [2004]
 - application of colchicine
 - irradiation with gamma rays
 - tissue culture
 - hybridisation
- Somaclonal variation appears in [2005]
 - organisms produced through somatic hybridization.
 - plants growing in highly polluted conditions.
 - apomictic plants.
 - tissue culture raised plants.
- In an experiment freshly hatched larvae of an insect (Khapra beetle) were reared on a basal diet (complete diet without cholesterol) with

increasing amounts of cholesterol. Results obtained are shown in the given graph.

[2005, 2008]



The graph indicates

- cholesterol is an essential dietary requirement of khapra beetle.
 - growth of khapra beetle is directly proportional to cholesterol concentration.
 - cholesterol concentration of 2 µg/g diet is the optimum level.
 - growth of khapra beetle is inhibited when cholesterol concentration exceeds 5 µg/g diet.
- A scion is grafted to a stock. The quality of fruits produced will be determined by the genotype of [2006]
 - stock
 - scion
 - both stock and scion
 - neither stock nor scion
 - Cocoa is the plant from which chocolate is made. Which part is used to extract it? [2007]
 - Flower
 - Fruit
 - Seeds
 - Bark
 - Bean seeds were planted and put on a sunny windowsill. As the plants grew, their stems bent toward the window. This bending was most likely caused by an [2009]

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- (a) unequal distribution of auxin in the stem.
 (b) unequal distribution of a neurotransmitter in the stem.
 (c) equal distribution of auxin in the stem.
 (d) equal distribution of a neurotransmitter in the stem.
13. Phytotron is a facility to [2010]
 (a) grow plants under disease-free conditions.
 (b) conserve endangered species of plants.
 (c) grow plants under controlled conditions.
 (d) induce mutations.
14. Essential oils are those which [2011]
 (a) are essential to the plant itself
 (b) are used as lubricants
 (c) produce perfumes
 (d) are essential for human beings
15. Coconut water is rich in [2011]
 (a) auxins (b) gibberellins
 (c) abscisic acid (d) cytokinin
16. Which of the following is the pair of biofertilizers? [2014]
 (a) *Azolla* and BGA
 (b) *Nostoc* and legume
 (c) *Rhizobium* and grasses
 (d) *Salmonella* & *E. coli*
17. Hisardale is a new breed of sheep developed in Punjab by one of the breeding technique in which superior male of one breed is mated with superior females of another breed. Identify the breeding technique from the option given below. [2016]
 (a) Inbreeding (b) Out crossing
 (c) Out breeding (d) Cross breeding
18. Biodiversity loss occurs due to the reasons given below. [2017]
 (i) Habitat loss and fragmentation
 (ii) Co-extinction
 (iii) Over-exploitation
 (iv) Alien species invasion
 Identify the correct reasons.
 (a) (i) and (ii) (b) (i), (ii) and (iii)
 (c) (ii), (iii) and (iv) (d) (i), (ii), (iii) and (iv)
19. Explant is required to be disinfected before placing in culture. This is done by [2017]
 (a) autoclaving
 (b) ultra-violet rays
 (c) clorax or hypochlorite
 (d) X-rays

Topicwise AIIMS Solved Papers – BIOLOGY

20. Which of the following is a viral disease of poultry birds? [2017]
 (a) Anthrax (b) Ranikhet
 (c) Coccidiosis (d) None of these

TYPE B : ASSERTION REASON QUESTIONS

Directions for (Qs. 21-25) : These questions consist of two statements, each printed as Assertion and Reason. While answering these questions, you are required to choose any one of the following five responses.

- (a) If both Assertion and Reason are correct and the Reason is a correct explanation of the Assertion.
 (b) If both Assertion and Reason are correct but Reason is not a correct explanation of the Assertion.
 (c) If the Assertion is correct but Reason is incorrect.
 (d) If both the Assertion and Reason are incorrect.
 (e) If the Assertion is incorrect but the Reason is correct.

21. **Assertion :** In plant tissue culture somatic embryos can be induced from any plant cell.

Reason : Any viable plant cell can differentiate into somatic embryos. [2003]

22. **Assertion :** Use of fertilizers greatly enhances crop productivity.

Reason : Irrigation is very important in increasing crop productivity. [2003]

23. **Assertion :** Fish meal is a rich source of protein for cattle and poultry.

Reason : Fish meal is produced from non-edible parts of fishes like fins, tail etc. [2004]

24. **Assertion :** Cattle breeds can be improved by super ovulation and embryo transplantation.

Reason : Superovulation in high milk-yielding cows is induced by hormonal injection. [2004]

25. **Assertion (A) :** Vernalization is acceleration of subsequent flowering by low temperature treatment.

Reason (R) : Site of vernalization is apical meristem. [2007]

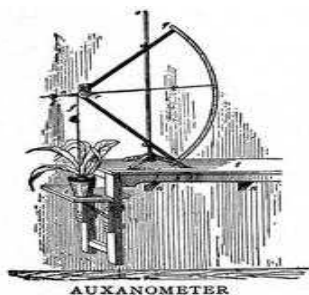
Directions for (Qs. 26-31) : Each of these questions contains an Assertion followed by Reason. Read them carefully and answer the question on the basis of following options. You have to select the one that best describes the two statements.

- (a) If both Assertion and Reason are correct and Reason is the correct explanation of Assertion.
- (b) If both Assertion and Reason are correct, but Reason is not the correct explanation of Assertion.
- (c) If Assertion is correct but Reason is incorrect.
- (d) If both the Assertion and Reason are incorrect.
26. **Assertion :** In plant tissue culture, somatic embryos can be induced from any plant cell.
Reason : Any viable plant cell can differentiate into somatic embryos. [2008]
27. **Assertion :** Cattle breeds can be improved by superovulation and embryo transplantation.
Reason : Superovulation in high milk-yielding cows is induced by hormonal injection. [2013]
28. **Assertion :** In case of vegetatively propagated crops, pure-line selection is not required.
Reason : Hybrid vigour is mostly used in vegetatively propagated plants. [2013]
29. **Assertion :** Yeasts such as *Saccharomyces cerevisiae* are used in baking industry.
Reason : Carbon dioxide produced during fermentation causes bread dough to rise by thermal expansion. [2015]
30. **Assertion :** Somatic embryos can be induced from any cell in plant tissue culture.
Reason : Any living plant cell is capable of differentiating into somatic embryos. [2017]
31. **Assertion :** A major advantage of tissue culture is protoplast fusion.
Reason : A hybrid is formed by the fusion of naked protoplasts of two plants. [2017]

HINTS & SOLUTIONS

Type A : Multiple Choice Questions

1. (d) Phytoalexins are produced by plants that are under attack. Phytoalexins produced in plants act as toxins to the attacking organism. They may puncture the cell wall, delay maturation, disrupt metabolism or prevent reproduction of the pathogen in question. However, phytoalexins are often targeted to specific predators; a plant that has anti-insect phytoalexins may not have the ability to repel a fungal attack.
2. (a) Auxanometer is an apparatus for measuring increase or rate of growth in plants. It automatically detects and measures plant growth and stores information in a data logger.



3. (a) Crop rotation increases the soil fertility by sowing different crops, usually legume and non-legume, in successive seasons on the same piece of land.
4. (a) Pollen grains are used for haploid cultures since they possess n-number of chromosomes that are required for haploid cultures.
5. (c) *Azolla*, has cyanobacteria which is the nitrogen fixing bacteria. Due to this *Azolla* is able to fix the nitrogen as nitrates, thereby making it available to plants in the soluble form of nitrogen.
6. (c) Pruning causes the cutting of plant apex which lowers the amount of auxin and relatively an increase in cytokinin content. In the plant, cytokinin promotes growth of axillary buds causing branching. Cytokinins are essential plant hormones

that control cell division, shoot meristem initiation, leaf and root differentiation, senescence.

7. (c) Somaclonal variations are differences in plants that are raised from the callus by tissue culture. If these variations are of economic value, e.g., induce tolerance of pests, diseases, etc, such plants are selected and multiplied. This technique has been used in wheat, rice, potato and tomato.
8. (d) Somaclonal variations refer to heritable changes which accumulate in callus (tissue culture) from a somatic explant and express in the progeny of *in vitro* regeneration obtained from callus. These variations have been used to develop several useful.
9. (a) According to graph, growth of Khapra beetle is directly proportional to cholesterol concentration.
10. (b) The quality of fruits produced by the grafted plant is determined by the genotype of scion.
11. (c) Cocoa is obtained from seeds of cocoa plant *Theobroma*. It belongs to family sterculiaceae. This plant is a native of tropical America and its seeds are used to prepare cocoa and chocolate.
12. (a) The plant hormone, auxin, is more distributed on the side away from the unilateral illumination causing cells to grow faster in the darkerside, which in turn, causes the plant to bend toward the light. If the distribution were equal, the plant would grow just upwards. Neuro-transmitters are chemicals secreted by multicellular animals and are used in transmitting impulses in the nervous system.
13. (c) Phytotron is a chamber in which plants can be grown in controlled condition.
14. (c) Essential oils-These are volatile oils and possess strong aromatic smell.

15. (d) Coconut water is rich in cytokinin. Cytokinin initiates cell division and is found in dividing tissues. So, coconut water is used as a medium in tissue culture of plant tissues where it initiates cell division. Coconut water is liquid endosperm.
16. (a) *Azolla* and BGA are biofertilizer which increases the fertility of soil.
17. (d) Hisardale is a new breed of sheep developed in Punjab by crossing Bikaneri ewes and Marino rams. Cross breeding is a method in which superior male of one breed is mated with superior females of another breed. It allows the desirable qualities of two different breeds to be combined.
18. (d) Biodiversity refers to the variety found in biota due to the genetic make-up of plants and animals to cultural diversity. The main cause of the loss of biodiversity can be attributed to the influence of human beings on the world's ecosystem. The important factors causing loss of biodiversity are - habitat loss, habitat fragmentation, disturbances, over exploitation of resources, pollution, exotic species, co-extinction, alien species invasion, intensive agriculture and forestry.
19. (c) Before transferring on the culture medium, the explant is first of all disinfected by surface sterilization using clorax water, sodium or calcium hypochlorite solution or methiolate. Too much care must be taken in this operation so that the cells do not die.
20. (b) Coccidiosis is a protozoan disease.
23. (a) Fish meal is made from nonedible parts of the fish and is rich source of protein. Fish is a rich source of protein and many of the vitamins and minerals which is required for good health. Fish also has many other benefits including helping to protect against heart disease and a range of other illnesses. Fish is also a source of zinc, which is needed for a healthy immune system, iodine, needed for a healthy metabolism and vitamins A and B₁₂. Oil-rich fish are an important source of omega 3 fats. Your body cannot make these special fats so you need to eat foods containing omega 3 everyday. Fish meal, is a commercial product made from the waste of fish oil and the bones from processed fish. It is a brown powder or cake obtained by pressing the whole fish or fish trimmings to remove the fish oil. The major use of fish meal is as a high-protein supplement in aquaculture feed.
24. (a) Superovulation is done by hormone injection. During artificial insemination, 4-10 embryos are transplanted into carrier cows. The seven days old embryos can be preserved at a temperature of -196°C for several years. The assertion & reason are true and the reason is the correct explanation for the assertion.
25. (b) The physiological mechanism of flowering in plants is controlled by two factors— light period and low temperature. The cold treatment of plants to induce flowering is called vernalization. Term vernalization was first given by T.D.Lysenko(1928). As a result of vernalization a flowering hormone called vernaline is formed. Site of vernalization is apical meristem.
26. (a) Any living plant cell which is viable can be used to culture somatic embryos. These embryos have the characteristic features of the parent plant. The somatic cultures are viable from the stem root, or leaves & the most viable part is the meristematic cell.

Type B : Assertion Reason Questions

21. (a) Any living plant cell which is viable can be used to culture somatic embryos. These embryos have the characteristic features of the parent plant. The somatic cultures are viable from the stem, root or leaves and the most viable part is the meristematic cell.
22. (b) Irrigation relates to the supply of water to the crops. Fertilizers which are mainly NPK are required to increase the harvest of crops.

27. (b) Cattle breeds can be improved by super ovulation and embryo transfer technique. It is also known as Multiple Ovulation Embryo Transfer Technology (MOET). In this method, a cow is administered hormones with FSH like activity, to induce super ovulation instead of one egg, which they normally yield per cycle they produce 6-8 eggs. The animal is either mated with an elite bull or artificially inseminated. The fertilised eggs at 8-32 cells stages are removed non surgically and transferred to surrogate mothers. The genetic mother is available for another round of super ovulation.
28. (b) In case of vegetatively propagated crops, pure line selection is not required. Pure-line selection is useful only for sexually reproducing plants. Hybrid vigour is most profitably used in vegetatively propagated crops because they do not involve sexual reproduction and hence no loss of hybrid superiority.
29. (a) Yeast is a fermentation agent. It is a known fact that yeast raises bread dough to rise and hence, yeast is also used to increase the volume, making the dough porous and the product soft. It is the carbon dioxide that is produced by the yeast that helps the dough to rise.
30. (a) Somatic embryos are non-zygotic embryo like structures that develop into from any type of tissue in plant tissue culture.
31. (b) An important technique of tissue culture, somatic hybridization results in the production of somatic hybrid plants. Two different plant varieties each with a desirable character can be made to undergo protoplast fusion, which further can be grown into a new plant.

TYPE A : MULTIPLE CHOICE QUESTIONS

- Which of the following antibiotic was discovered by Alexander Flemming ? [2000]
(a) Streptomycin (b) Tetracycline
(c) Penicillin (d) Terramycin
- Which one of the following pairs is correctly matched? [2003]
(a) *Rhizobium* - Parasite in the roots of leguminous plants.
(b) Mycorrhizae - Mineral uptake from soil.
(c) Yeast - Production of biogas.
(d) Myxomycetes - The ringworm diseases.
- The bacteria *Pseudomonas* is useful because of its ability to [2004]
(a) transfer genes from one plant to another.
(b) decompose a variety of organic compounds.
(c) fix atmospheric nitrogen in the soil.
(d) produce a wide variety of antibiotics.
- Chloramphenicol and erythromycin (broad spectrum antibiotics) are produced by [2014]
(a) *Streptomyces* (b) *Nitrobacter*
(c) *Rhizobium* (d) *Penicillium*
- A patient brought to a hospital with myocardial infarction is normally immediately given: [2014]
(a) Penicillin (b) Streptokinase
(c) Cyclosporin-A (d) Statins
- Microbes are used in [2015]
1. primary treatment of sewage
2. secondary treatment of sewage
3. anaerobic sludge digester
4. production of bioactive molecules
(a) 1, 3 and 4 (b) 1, 2, 3 and 4
(c) 2, 3 and 4 (d) 3 and 4
- Choose the right combination

Column-I	Column-II
A. <i>Escherichia coli</i>	I. Nif gene
B. <i>Rhizobium melilotae</i>	II. Digestive hydrocarbon of crude oil
- Bacillus thuringiensis* III. Production of human insulin
- Pseudomonas putida* IV. Biological control of fungal disease
V. Bio-decomposed insecticide [2016]
(a) A – III; B – I; C – V; D – IV
(b) A – I; B – II; C – III; D – IV
(c) A – II; B – I; C – III; D – IV
(d) A – III; B – I; C – V; D – II
- What would happen if oxygen availability to activated sludge flocs is reduced? [2016]
(a) It will slow down the rate of degradation of organic matter.
(b) The centre of flocs will become anoxic, which would cause death of bacteria and eventually breakage of flocs.
(c) Flocs would increase in size as anaerobic bacteria would grow around flocs.
(d) Protozoa would grow in large numbers.
- Which one of the following statement regarding BOD is true? [2017]
(a) The greater the BOD of waste water, more is its polluting potential.
(b) The greater the BOD of waste water, less is its polluting potential.
(c) The lesser the BOD of waste water, more is its polluting potential.
(d) The lesser the BOD of waste water, less is its polluting potential.
- The free-living fungus *Trichoderma* can be used for [2017]
(a) killing insects
(b) biological control of plant diseases
(c) controlling butterfly caterpillars
(d) producing antibiotics

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TYPE B : ASSERTION REASON QUESTIONS

Directions for (Qs. 11-12) : These questions consist of two statements, each printed as Assertion and Reason. While answering these questions, you are required to choose any one of the following five responses.

- (a) If both Assertion and Reason are correct and the Reason is a correct explanation of the Assertion.
- (b) If both Assertion and Reason are correct but Reason is not a correct explanation of the Assertion.
- (c) If the Assertion is correct but Reason is incorrect.
- (d) If both the Assertion and Reason are incorrect.
- (e) If the Assertion is incorrect but the Reason is correct.

11. Assertion : Leguminous plants are nitrogen fixers.

Reason : Leguminous plants have *Rhizobium* in their root nodules. [1997]

12. Assertion : Nitrogen-fixing enzyme in legume root nodules function at low oxygen concentration.

Reason : Low oxygen concentration is provided by leghaemoglobin. [2004]

Topicwise AIIMS Solved Papers – BIOLOGY

Directions for (Qs.13-15) : Each of these questions contains an Assertion followed by Reason. Read them carefully and answer the question on the basis of following options. You have to select the one that best describes the two statements.

- (a) If both Assertion and Reason are correct and Reason is the correct explanation of Assertion.
- (b) If both Assertion and Reason are correct, but Reason is not the correct explanation of Assertion.
- (c) If Assertion is correct but Reason is incorrect.
- (d) If both the Assertion and Reason are incorrect.

13. Assertion : Lichen is important for chemical industries.

Reason : Litmus and Orcein are formed from lichens. [2009]

14. Assertion : Yeasts such as *Saccharomyces cerevisiae* are used in baking industry.

[2003, 2011]

Reason : Carbon dioxide produced during fermentation causes bread dough to rise by thermal expansion.

15. Assertion : Vitamins B₂ is found in cereals, green vegetables, brewer's yeast, egg white, milk and liver.

Reason : It can be commercially produced by some yeasts. [2014]

HINTS & SOLUTIONS**Type A : Multiple Choice Questions**

1. (c) Alexander Flemming discovered Penicillin from a fungus penicillium accidentally. It is a natural antibiotic.
2. (b) Mycorrhiza is a symbiotic relationship between fungi and roots of higher plants. Mycorrhizae present in the soil help in the uptake of minerals from soil. These organisms also help in the binding of roots to the soil. Since it is active transport in the roots, the mycorrhizae help in this active transport of minerals.
3. (b) *Pseudomonas* is a gram negative rod shaped bacteria. It is useful because of its ability to decompose a variety of organic compounds. Other bacteria which help in purification, decay are *Streptococci*, *Clostridium*, *Micrococcus*, *Proteus*, etc.
4. (a)
5. (b) Streptokinase is immediately given to dissolve the thrombus carrying myocardial infarction.
6. (c) Microbes are not used in the primary treatment of sewage which basically involves settling down of sludge through sedimentation.
7. (d)
8. (b) In the secondary treatment of sewage, if oxygen availability to activated sludge flocs (masses of bacteria associated with fungal filaments to form mesh like structure) is reduced; the centre of flocs will become anoxic, which would cause death of bacteria and eventually breakage of flocs.
9. (a) BOD is the method of determining the amount of oxygen required by microorganisms to decompose the waste present in the water supply. It is a measure of organic matter present in the water. If

the quantity of organic wastes in the water supply is high then the number of decomposing bacteria present in the water will also be high. As a result, BOD value will increase.

10. (b) *Trichoderma* is a free-living saprophytic fungi that most commonly lives on dead organic matter in the soil and rhizosphere (root ecosystem). It inhibits pathogens through release of gliotoxin, viridin, gliovirin and trichodermin like substances.

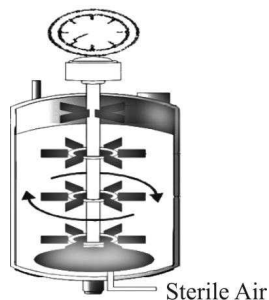
Type B : Assertion Reason Questions

11. (a) The *Rhizobium* bacteria converts the atmospheric nitrogen into soluble nitrates that is absorbed by the plants. Soybean root nodules, contain billions of *Bradyrhizobium* bacteria.
12. (a) Leghaemoglobin is the oxygen scavenger and it protects nitrogen fixing enzyme nitrogenase from oxygen.
13. (a) Litmus is an important and widely used dye in chemical laboratories as an acid-base indicator. It is obtained from *Rocella montaignei*. Orcein, a biological stain, is obtained from *Rocella tinctoria*.
14. (a) Yeast is a fermentation agent. It is a known fact that yeast raises bread dough to rise and hence, Yeast is also used to increase the volume, making the dough porous and the product soft. It is the yeast that helps the dough to rise.
15. (b) Besides cereals, green vegetables, brewer's yeast, egg white, vitamin B₂ is also produced by intestinal bacteria. The vitamin was first obtained in 1938 using wild strain of mould *Ashbya gossypii*. Vitamin B₂ is essential for normal growth and reproduction in a number of laboratory animals.

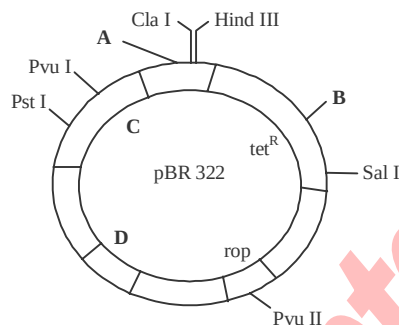
Biotechnology: Principles and Processes

TYPE A : MULTIPLE CHOICE QUESTIONS

- Restriction endonucleases are used as [1998]
 - molecular build up at nucleotides.
 - molecular degradation to DNA breakup.
 - molecular knives for cutting DNA at specific sites.
 - molecular cement to combine DNA sites.
- In genetic engineering, which of the following is used ? [2001]
 - Plasmid
 - Plastid
 - Mitochondria
 - E.R.
- Introduction of foreign gene for improving genotype is called [2002]
 - tissue culture
 - vernalization
 - genetic engineering
 - eugenics
- An example of gene therapy is [2004]
 - production of injectable hepatitis B vaccine.
 - production of vaccines in food crops like potatoes which can be eaten.
 - introduction of gene for adenosine deaminase in persons suffering from Severe Combined Immuno Deficiency (SCID).
 - production of test tube babies by artificial insemination and implantation of fertilized eggs.
- c-DNA probes are copied from the messenger RNA molecules with the help of [2005]
 - restriction enzymes
 - reverse transcriptase
 - DNA polymerase
 - adenosine deaminase
- Electroporation procedure involves [2005]
 - fast passage of food through sieve pores in phloem elements with the help of electric stimulation.
 - opening of stomatal pores during night by artificial light.
 - making transient pores in the cell membrane to introduce gene constructs.
 - purification of saline water with the help of a membrane system.
- What is the first step in the Southern blot technique? [2004, 2008]
 - Denaturation of DNA on the gel for hybridization with specific probe.
 - Production of a group of genetically identical cells.
 - Digestion of DNA by restriction enzyme.
 - Denaturation of DNA from a nucleated cell such as the one from the scene of crime.
- The polymerase chain reaction (PCR) technology was discovered by [2009]
 - Karry Mullis
 - Saiki *et al*
 - Craig Venter
 - Maxam and Gilbert
- After 4 PCR cycles how many DNA molecules are formed from one DNA template molecule ? [2012]
 - 4
 - 32
 - 16
 - 8
- Human Genome Project (HGP) is closely associated with the rapid development of a new area in biology called as [2013]
 - biotechnology
 - bioinformatics
 - biogeography
 - bioscience
- Identify the correct match for the given apparatus. [2013]



Apparatus	Function
(a) Gene gun	Vectorless direct gene transfer
(b) Column chromatograph	Separation of chlorophyll pigments
(c) Stirred tank bioreactor	Carry out fermentation process
(d) Respirometer	Finding out rate of respiration
12. Genes of interest can be selected from a genomic library by using [2014]
- (a) Restriction enzymes
(b) Cloning vectors
(c) DNA probes
(d) Gene targets
13. Choose the correct option. [2015]



A	B	C	D
(a) Hind I	EcoR I	amp ^R	ori
(b) Hind I	BamHI	kan ^R	amp ^R
(c) BamHI	Pst I	ori	amp ^R
(d) EcoRI	BamHI	amp ^R	ori
14. Which one of the following palindromic base sequences in DNA can be easily cut at about the middle by some particular restriction enzyme? [2016]
- (a) 5'.....CGTTTCG.....3'
3'.....ATGGTA.....5'
- (b) 5'.....GATATG.....3'
3'.....CTACTA.....5'
- (c) 5'.....GAATTC.....3'
3'.....CTTAAG.....5'
- (d) 5'.....CACGTA.....3'
3'.....CTCAGT.....5'
15. Which of the following statement is not correct about cloning vector ? [2017]

- (a) 'Ori' is a sequence responsible for controlling the copy number of the linked DNA.
- (b) Selectable marker selectively permitting the growth of the non-transformants.
- (c) In order to link the alien DNA, the vector needs to have single *recognition site* for the commonly used restriction enzymes.
- (d) The ligation of alien DNA is carried out at a restriction site present in one of the two antibiotic resistance genes.

TYPE B : ASSERTION REASON QUESTIONS

Directions for (Qs. 16-20) : These questions consist of two statements, each printed as Assertion and Reason. While answering these questions, you are required to choose any one of the following five responses.

- (a) If both Assertion and Reason are correct and the Reason is a correct explanation of the Assertion.
- (b) If both Assertion and Reason are correct but Reason is not a correct explanation of the Assertion.
- (c) If the Assertion is correct but Reason is incorrect.
- (d) If both the Assertion and Reason are incorrect.
- (e) If the Assertion is incorrect but the Reason is correct.
16. **Assertion :** Plasmids are extrachromosomal DNA.
Reason : Plasmids are found in bacteria and are useful in genetic engineering. [2001]
17. **Assertion:** Plasmids are single-stranded extra chromosomal DNA.
Reason: Plasmids are usually present in eukaryotic cells. [2002]
18. **Assertion:** Clones are produced by sexual reproduction.
Reason: These are prepared by group of cells descended from many cells or by inbreeding of a heterozygous line. [2002]
19. **Assertion :** In recombinant DNA technology human genes are often transferred into bacteria (prokaryotes) or yeast (eukaryote).
Reason : Both bacteria and yeast multiply very fast to form huge population which expresses the desired gene. [2005]

20. **Assertion :** *Agrobacterium tumefaciens* is popular in genetic engineering because this bacterium is associated with the roots of all cereal and pulse crops.

Reason : A gene incorporated in the bacterial chromosomal genome gets automatically transferred to the crop with which the bacterium is associated. [2005]

Directions for (Qs. 21-24) : Each of these questions contains an Assertion followed by Reason. Read them carefully and answer the question on the basis of following options. You have to select the one that best describes the two statements.

- (a) If both Assertion and Reason are correct and Reason is the correct explanation of Assertion.
- (b) If both Assertion and Reason are correct, but Reason is not the correct explanation of Assertion.
- (c) If Assertion is correct but Reason is incorrect.
- (d) If both the Assertion and Reason are incorrect.

21. **Assertion :** Restriction enzymes cut the strand of DNA to produce sticky ends. [2009]

Reason : Stickiness of the ends facilitates the action of the enzyme DNA polymerase.

22. **Assertion :** “DNA finger printing” has become a powerful tool to establish paternity and identity of criminals in rape and assault cases. [2010]

Reason : Trace evidences such as hairs, saliva and dried semen are adequate for DNA analysis.

23. **Assertion :** In recombinant DNA technology, human genes are often transferred into bacteria (prokaryotes) or yeast (eukaryote).

Reason : Both bacteria and yeast multiply very fast to form huge population, which express the desired gene. [2008, 2015]

24. **Assertion :** Insertion of recombinant DNA within the coding sequence of β -galactosidase results in colourless colonies.

Reason : Presence of insert results in inactivation of enzyme β -galactosidase known as insertional inactivation. [2017]

HINTS & SOLUTIONS**Type A : Multiple Choice Questions**

1. (c) Restriction endonuclease cleaves DNA duplex at specific points in such a way that single stranded free ends project from each fragment of DNA duplex called sticky ends. These sticky ends can join similar complementary ends of DNA fragment from some other source.
2. (a) Plasmid (extrachromosomal part in bacteria) plays important role in recombinant DNA technology.
3. (c) The process of introduction of foreign gene for obtaining the desirable trait is called genetic engineering.
4. (c) Gene therapy is a new system of medicine. Excellent example of gene therapy is SCID. They have defective gene for the enzyme adenosine deaminase (ADA). They lack T-lymphocytes which fail to combat the infecting pathogen. Lymphocytes are extracted from the patients bone marrow and normal functioning copy of gene coding for ADA is introduced into these lymphocytes with the help of retrovirus. The cells so treated are reintroduced into patients bone marrow which reactivate patients immune system for life.
5. (b) c DNA probes are copied from the mRNA molecules with the help of reverse transcriptase.
6. (c) Electroporation is the method of making cell membrane permeable for the entry of recombinant DNA into the bacteria.
7. (c) The Southern blot is used to detect and identify certain DNA sequences in a sample of bodily fluid. It uses single-stranded DNA to search out their complementary strands. When a Southern blot is performed on DNA, the first step is digestion of DNA with restriction enzymes. Restriction enzymes cut DNA at known sequences, and produces DNA fragments of a certain length. Once the DNA is cut into pieces, scientists conduct electrophoresis to separate them by size.
8. (a) Developed in 1984 by Kary Mullis, PCR is now a common and often indispensable technique used in medical and biological research labs for a variety of applications. These include DNA cloning for sequencing, DNA-based phylogeny, or functional analysis of genes; the diagnosis of hereditary diseases; the identification of genetic fingerprints (used in forensic sciences and paternity testing); and the detection and diagnosis of infectious diseases. In 1993, Mullis won the Nobel Prize in Chemistry for his work on PCR.
9. (c) From a single DNA template molecule, it is possible to generate 2^n DNA molecules after n number of cycles in polymerase chain reaction.
10. (b) Human Genome Project (HGP) is closely associated with the rapid development of a new area in biology called Bioinformatics which is used for storage and analysis of enormous amount of data.
11. (c)
12. (c) A hybridization probe is a fragment of DNA of variable length which is used in DNA samples to detect the presence of nucleotide sequence (the DNA target) that are complementary to the sequence in the probe. The probe hybridize to single-stranded DNA whose base sequence allow probe target base-pairing due to complementary between the probe and target.
13. (d)
14. (c) Palindromic sequences in DNA molecule are group of bases that forms the same sequence when read in both forward and backward direction. In the given question, only option (c) represent a palindromic sequence.
15. (b) Selectable marker selectively permitting the growth of the transformants.

Type B : Assertion Reason Questions

16. (b) Plasmids are the extrachromosomal part in the bacteria and are useful in recombinant DNA technology.
17. (c) Plasmid is a extra chromosomal DNA present in prokaryotes e.g., bacteria.
18. (d) Cloning is shortcut method to amplify the number of organisms with a desirable constitution. No sex is involved in their production. Members of clone are genetically identical as they are derived from single parent.
19. (a) In recombinant DNA technology, recombinants DNA are usually transferred to *E. coli*, yeast because of their rapid multiplication. This technology is employed for combining DNA from two different organisms to produce recombinant DNA.
20. (d) A soil inhabiting, plant pathogenic bacteria *Agrobacterium tumefaciens* infects broad leaved crops including tomato, soyabean, sunflower and cotton but not the cereals. Tumour formation (crown galls) is induced by its plasmid (Ti) into the chromosomal DNA of its host plant. The T-DNA causes tumors. As gene transfer occurs without human efforts the bacteria is known as natural genetic engineer of plants.
21. (c) Restriction enzyme, a type of endonuclease, functions by "inspecting" the length of a DNA sequence. Once it finds a recognition sequence, it binds and cut each of the two strands of the double helix at specific point leaving single stranded portions at the ends. This results in overhanging stretches called sticky ends. These are named so because they form hydrogen bonds with their complementary counter parts i.e., they can join similar complementary ends of DNA fragment from some other source with the help of DNA ligase. This stickiness of the ends facilitates the action of the enzyme DNA ligase, not DNA polymerase.
22. (a) DNA finger printing has become a powerful tool due to its ability in tracing evidences of crime and to establish the paternity. These evidences can be collected from hairs, semen and saliva.
23. (a) Recombinant DNA is a form of synthetic DNA that is engineered through the combination or insertion of one or more DNA strands, thereby combining DNA sequences that would not normally occur together. In terms of genetic modification, recombinant DNA is produced through the addition of relevant DNA into an existing organismal genome, such as the plasmid of bacteria, to code for or alter different traits for a specific purpose, such as immunity. It differs from genetic recombination, in that it does not occur through processes within the cell or ribosome, but is exclusively engineered. Recombinant protein is protein that is derived from recombinant DNA.
24. (a) Alternative markers have been developed that can differentiate recombinants from non-recombinants based upon their ability to produce colour in presence of a chromogenic substrate. The plasmid in the bacteria, lacking an insert produces blue coloured colonies, while those plasmids with an insert do not produce any colour due to insertional inactivation of the enzyme, β -galactosidase.

TYPE A : MULTIPLE CHOICE QUESTIONS

- A tumour inducing plasmid widely used in the production of transgenic plant is that of [2005]
 - Escherichia coli*
 - Bacillus thuringiensis*
 - Staphylococcus aureus*
 - Agrobacterium tumefaciens*
- Which one of the following is a correct statement? [2005]
 - "Bt" in "Bt-cotton" indicates that it is a genetically modified organism produced through biotechnology.
 - Somatic hybridization involves fusion of two complete plant cells carrying desired genes.
 - The anticoagulant 'hirudin' is being produced from transgenic *Brassica napus* seeds.
 - "Flavr Savr" variety of tomato has enhanced the production of ethylene which improves its taste.
- Cultivation of *Bt cotton* has been much in the news. The prefix *Bt* means [2008]
 - barium-treated cotton seeds
 - bigger thread variety of cotton with better tensile strength
 - produced by biotechnology using restriction enzymes and ligases
 - carrying an endotoxin gene from *Bacillus thuringiensis*
- Golden rice is a transgenic crop of the future with the following improved trait [2012]
 - High lysine (essential amino acid) content
 - Insect resistance
 - High protein content
 - High vitamin-A content
- How many varieties of rice has been estimated to be present in India? [2013]

(a) 2,000	(b) 20,000
(c) 200,000	(d) 2,000,000
- The scientific process by which crop plants are enriched with certain desirable nutrients is called [2013]
 - crop protection
 - breeding
 - bio-fortification
 - bio-remediation
- Which of the following is a variety of *Brassica* resistance to white rust disease? [2014]
 - Himgiri
 - Pusa Kamal
 - Pusa Swarnim (Karan rai)
 - Pusa Sadabahar
- The first clinical gene therapy was given in 1990 to a 4 years old girl with enzyme deficiency of [2014]
 - Adenosine deaminase (ADA)
 - Tyrosine oxidase
 - Monamine oxidase
 - Glutamate dehydrogenase
- Select the correct statement(s)- [2015]
 - IARI has released a mustard variety rich in vitamin C.
 - Pusa Sawani variety of Okra is resistant to aphids.
 - Hairiness of leaves provides resistance to insect pests.
 - Agriculture accounts for approximately 33% of India's GDP and employs nearly 62% of the population.
 - (1) and (2)
 - (2) and (3)
 - (1), (3) and (4)
 - None of these
- Read the following four statements (1-4) about certain mistakes in two of them
 - The first transgenic buffalo, Rosie produced milk which was human alpha-lactalbumin enriched.
 - Restriction enzymes are used in isolation of DNA from other macro-molecules.
 - Downstream processing is one of the steps of R-DNA technology.

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4. Disarmed pathogen vectors are also used in transfer of R-DNA into the host.

Which are the two statements having mistakes?

[2015]

- (a) Statement 2 and 3 (b) Statement 3 and 4
(c) Statement 1 and 3 (d) Statement 1 and 2

11. A transgenic food crop which may help in solving the problem of night blindness in developing countries is

[2016]

- (a) golden rice (b) *Bt* soyabean
(c) *flavr - savr* tomato (d) starlink maize

12. Which variety of rice was patented by a U.S. company even though the highest number of varieties of this rice is found in India ?

[2017]

- (a) Sharbati Sonara (b) Co-667
(c) Basmati (d) Lerma Roja

Topicwise AIIMS Solved Papers – BIOLOGY

TYPE B : ASSERTION REASON QUESTIONS

Directions for (Q. 13) : Each of these questions contains an Assertion followed by Reason. Read them carefully and answer the question on the basis of following options. You have to select the one that best describes the two statements.

- (a) If both Assertion and Reason are correct and Reason is the correct explanation of Assertion.
(b) If both Assertion and Reason are correct, but Reason is not the correct explanation of Assertion.
(c) If Assertion is correct but Reason is incorrect.
(d) If both the Assertion and Reason are incorrect.

13. **Assertion :** Insect resistant transgenic cotton has been produced by inserting Bt gene. [2010]

Reason : The Bt gene is derived from a bacterium.

HINTS & SOLUTIONSType A : Multiple Choice Questions

1. (d) A tumour (crown gall) inducing plasmid widely used in the production of transgenic plant is *Agrobacterium tumefaciens*.
2. (c) Hirudin is a protein that stops blood clotting. The gene encoding hirudin was chemically synthesized. This gene was then transferred into *Brassica napus* where hirudin accumulates in seeds. This hirudin is purified & used as a medicine.
3. (d) *Bacillus thuringiensis*, or Bt, is a bacterium that occurs naturally in the soil, produces a protein that is toxic to certain insect pests, and is widely used as a pest control agent. It is also extremely host-specific.
4. (d) Golden rice is a variety of rice produced through genetic engineering to biosynthesize beta-carotene, a precursor of pro-vitamin A.
5. (c)
6. (c)
7. (c)
8. (a) Gene therapy is an experimental technique that uses genes to treat or prevent disease. The first clinical gene therapy was given for treating adenosine deaminase deficiency. A four-year old girl became the first gene therapy patient on September 14, 1990 at the NIH Clinical Center. Adenosine deaminase deficiency, also called ADA deficiency or ADA-SCID is an autosomal recessive metabolic disorder that causes immunodeficiency. ADA deficiency is due to a lack of the enzyme adenosine deaminase.
9. (c)
10. (d) Transgenic Rosie is actually cow. Restriction enzymes cut the DNA at specific sites.
11. (a) A transgenic food crop which may help in solving the problem of night blindness in developing countries is golden rice. Golden rice is genetically modified rice that has been engineered to have elevated levels of beta carotene in it. It is a precursor of vitamin A, which gives it a characteristic golden colour.
12. (c) Basmati rice was patented by a US company even though the highest number of varieties of this rice is found in India.

Type B : Assertion Reason Questions

13. (b) Bt-cotton is a transgenic crop. Transgenic plants are those plants, which have foreign gene incorporated in their DNA. This insect resistant gene is derived from a bacterium, *Bacillus thuringiensis*.

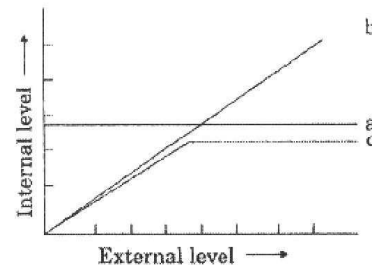
Organisms and Populations

TYPE A : MULTIPLE CHOICE QUESTIONS

1. Territoriality occurs as a result of [1998]
 - (a) competition (b) parasitism
 - (c) predation (d) co-operation
2. Obligate parasites live on [1999]
 - (a) living host only
 - (b) living host and dead organic matter
 - (c) dead organic matter only
 - (d) artificial liquid medium
3. Mycorrhiza help in absorption of [1999]
 - (a) calcium (b) nutrients
 - (c) metals (d) none of these
4. The plants which can withstand narrow range of temperature tolerance are called [2000]
 - (a) stenothermal (b) eurythermal
 - (c) mesothermal (d) monothermal
5. Abundance of a species in a population, within habitat is called [2001]
 - (a) niche density
 - (b) absolute density
 - (c) relative density
 - (d) geographic density
6. The maintenance of internal favourable conditions, by a self regulated mechanisms inspite of the fact that there are changes in environment, is known as [2001]
 - (a) entropy (b) enthalpy
 - (c) homoeostasis (d) steady state
7. July 11 is observed as [2003]
 - (a) World Population Day
 - (b) No Tobacco Day
 - (c) World Environment Day
 - (d) World Health Day
8. Which one of the following is a matching pair of certain organism(s) and the kind of association? [2003]
 - (a) Shark and sucker fish - Commensalism
 - (b) Algae and fungi in lichens - Mutualism
 - (c) Orchids growing on trees - Parasitism
 - (d) *Cuscuta* (dodder) growing on other - flowering plants - Epiphytism
9. The great barrier reef along the east coast of Australia can be categorised as [2004]
 - (a) population (b) community
 - (c) ecosystem (d) biome
10. Which one of the following correctly represents an organism and its ecological niche ? [2005]
 - (a) *Vallisneria* and pond
 - (b) Desert locust (*Schistocerca*) and desert
 - (c) Plant lice (aphids) and leaf
 - (d) Vultures and dense forest
11. Keystone species deserve protection because these [2006]
 - (a) are capable of surviving in harsh environmental conditions.
 - (b) indicate presence of certain minerals in the soil.
 - (c) have become rare due to overexploitation.
 - (d) play an important role in supporting other species.
12. A lizard-like member of reptila is sitting on a tree with its tail coiled around a twig. This animal could be [2006]
 - (a) *Hemidactylus* showing sexual dimorphism
 - (b) *Varanus* showing mimicry
 - (c) Garden lizard (*Calotes*) showing camouflage
 - (d) *Chamaeleon* showing protective colouration

13. Carrying capacity is [2009]
 (a) the capacity of an individual to produce young ones.
 (b) availability of resources in a given habitat to support a certain no of individuals of population, beyond which no further growth is possible.
 (c) gene frequency from one generation to next.
 (d) gene frequency in same generation.
14. Within biological communities, some species are important in determining the ability of a large number of other species to persist in the community. Such species are called [2010]
 (a) keystone species
 (b) allopatric species
 (c) sympatric species
 (d) threatened species
15. Presence of flagellated protozoans in the gut of termites are the example [2012]
 (a) Symbiosis (b) Parasitism
 (c) Antibiosis (d) Commensalism
16. The formula for exponential population growth is [2013]
 (a) $dN/rN = dt$ (b) $rN / dN = dt$
 (c) $dN / dt = rN$ (d) $dt / dN = rN$
17. The rate of formation of new organic matter by rabbit in a grassland, is called [2014]
 (a) Net productivity
 (b) Secondary productivity
 (c) Net primary productivity
 (d) Gross primary productivity
18. If 4 individuals in a laboratory population of 40 fruitflies died during a specified time interval (i.e., a week), the death rate in the population during that period is [2014]
 (a) 1 (b) 0.1
 (c) 0.01 (d) 0.4
19. A population of 500 that experiences 55 births and 5 deaths during a one-year period. What is the reproductive rate for the population during the one-year period ? [2015]
 (a) 0.01/year (b) 0.05/year
 (c) 0.1/year (d) 50/year

20. The figure given below is a diagrammatic representation of response of organisms to abiotic factors. What do A, B and C represent respectively? [2015]



	A	B	C
(a)	conformer	regulator	partial regulator
(b)	regulator	partial	conformer
(c)	partial	regulator	conformer
(d)	regulator	conformer	partial regulator
21. The salinity in sea water in parts per thousand (ppt) ranges between [2016]
 (a) 5-15% (b) 30-35%
 (c) 50-75% (d) more than 100%
22. In Urn shaped age pyramid of the population the trend of growth is [2017]
 (a) Rapid (b) Stable
 (c) Declining (d) Stationary

TYPE B : ASSERTION REASON QUESTIONS

Directions for (Qs. 23-25) : These questions consist of two statements, each printed as Assertion and Reason. While answering these questions, you are required to choose any one of the following five responses.

- (a) If both Assertion and Reason are correct and the Reason is a correct explanation of the Assertion.
 (b) If both Assertion and Reason are correct but Reason is not a correct explanation of the Assertion.
 (c) If the Assertion is correct but Reason is incorrect.
 (d) If both the Assertion and Reason are incorrect.
 (e) If the Assertion is incorrect but the Reason is correct.

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23. **Assertion :** Leaf butterfly and stick insect show mimicry to dodge their enemies.

Reason : Mimicry is a method to acquire body colour blending with the surroundings. [2003]

24. **Assertion :** Animals adopt different strategies to survive in hostile environment.

Reason : Praying mantis is green in colour which merges with plant foliage. [2004]

25. **Assertion :** The sex ratio of Kerala is highest in India.

Reason : In countries like India the population is increasing at a rapid rate. [2005]

Directions for (Qs. 26-30) : Each of these questions contains an Assertion followed by Reason. Read them carefully and answer the question on the basis of following options. You have to select the one that best describes the two statements.

- (a) If both Assertion and Reason are correct and Reason is the correct explanation of Assertion.
- (b) If both Assertion and Reason are correct, but Reason is not the correct explanation of Assertion.
- (c) If Assertion is correct but Reason is incorrect.
- (d) If both the Assertion and Reason are incorrect.

26. **Assertion :** Thick cuticle is mostly present in disease resistant plants.

Reason : Disease causing agents cannot grow on cuticle and cannot invade the cuticle. [2012]

27. **Assertion :** In sigmoid growth curve, population finally stabilizes itself.

Reason : Finally, the death rate increases than the birth rate. [2013]

28. **Assertion :** Tropical rain forests are disappearing fast from developing countries such as India.

Reason : No value is attached to these forests because these are poor in biodiversity. [2015]

29. **Assertion :** Flora contains the actual account of habitat and distribution of plants of a given area.

Reason : Flora helps in correct identification. [2016]

30. **Assertion :** Species are groups of potentially interbreeding natural populations which are isolated from other such groups.

Reason : Distinctive morphological characters are displayed due to reproductive isolation. [2017]

HINTS & SOLUTIONS**Type A : Multiple Choice Questions**

1. (a) Competition exists between individuals of the same or different species for food, light, space, shelter and mate. Establishment of territories by animals is meant for ensuring availability of their needs.
2. (a) Obligate parasites lead only parasitic life and are host specific.
3. (b) The roots of higher plants possess symbiotic mycorrhizae. It is a symbiotic, non-pathogenic association between the roots and soil fungi. Several conifers lack root hair and here the mycorrhizae perform this function. The mycorrhizae are of two types : ectomycorrhizae and endomycorrhizae with an intermediate category as ectendomycorrhizae. The most common endomycorrhizae are Vesicular Arbuscular Mycorrhizae (VAM), generally present in herbaceous plants. Mycorrhizae perform the function of root hair, i.e. they absorb essential ions.
4. (a) The climatic conditions in the stenothermal plants have made them to get adapted to a small variations in temperature.
5. (a) Density of a population is the number of individual species in a given area. Niche is a suitable habitat of a species. Niche density is the number of a particular species in a given area or suitable habitat.
6. (c) For metabolic processes to continue, the living things need to remain in a steady state maintained by self regulatory mechanism called *homeostasis*.
7. (a) July 11 has been observed as World Population Day.
8. (b) Algae and fungi in lichens show mutualism. Fungi provide fixation, water, minerals and shelter to the algae. The algae manufactures food for itself and for fungi.
9. (c) Coral reefs occur in clear, shallow, warm water where temperature rarely falls below 20°C and there is enough light for photosynthesis.
10. (c) Ecological niche is the status of an organism within its environment and community (affecting its survival as a species).
11. (d) Keystone species has disproportionate effects on its environment relative to its biomass. Such species play a critical role in maintaining the structure of an ecological community and help to determine the types and numbers of various other species in the community.
12. (d) *Chamaeleon* (girgit) shows protective colouration with its surrounding e.g. twig.
13. (b) Carrying capacity is the maximum number of individuals of population that can be sustained by available resources in a given habitat beyond which there is no further growth. When population reaches the carrying capacity then mortality < natality.
14. (a) Within biological communities, some species may be important in determining the ability of large number of other species to persist in the community. These crucial species are known as key stone species. Allopatric species are species having exclusive areas of geographic distribution. Sympatric species are species having overlapping area of geographical distribution.
15. (a) Presence of flagellated protozoans in the gut of termites are the example of symbiosis. In this type of association both partners are mutually benefited from each other. Termites are dependent on protozoa for breaking down their food stuff and the protozoa are dependent on the termites as host organisms.

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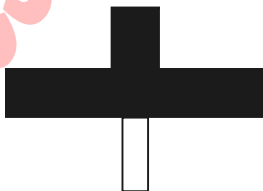
Topicwise AIIMS Solved Papers – BIOLOGY

Type B : Assertion Reason Questions

16. (c) The formula of exponential growth is $\frac{dN}{dt} = rN$ where $\frac{dN}{dt}$ is the rate of change in population size, r is the biotic potential and N is the population size.
17. (b) At the trophic level of consumers the rate at which food energy is assimilated is called secondary productivity. Rabbit is a consumer.
18. (b) Mortality or Death rate refers to the death of individuals in a population.
- $$\text{Death rate} = \frac{\text{No. of deaths}}{\text{Total population}}$$
- $$= \frac{4}{40} = 0.1 \text{ individuals per fruitfly per week}$$
19. (c) The rate of growth, r , equals (55 births – 5 deaths)/ 500 per year, or 0.1/year.
20. (d) In the graph, the line **A** represents regulator, line **B** represents conformer and line **C** represents partial regulator. Organisms that are able to maintain homeostasis by physiological means that ensures constant body temperature are called regulators. Organism that are not able to maintain a constant internal temperature are called conformers. Partial regulators are organisms that have the ability to regulate, but only over a limited range of environmental conditions, beyond which they simply conform.
21. (b) Sea water typically has a salinity of around 35 g/kg although lower values are typical near coasts where river enter the ocean. Rivers and lakes can have a wide range of salinities, from less than 0-0.1 g/kg to a few g/kg, although there are many places where even higher salinities are found. The dead sea has a salinity of more than 200 g/kg.
22. (c) In Urn Shaped pyramid the individuals below the reproductive age are fewer in number than the individuals of reproductive age.
23. (a) Leaf butterfly is green in colour and stick insect also mimics in order to escape from the enemies and also to catch prey. The camouflaging mechanism helps the organism to get adapted to its surroundings. The Leaf butterfly is seen more near the leaves while the stick insect camouflages with its surroundings by living on the branches.
24. (a) Animals blend with the surroundings or back ground to remain unnoticed for protection and aggression.
25. (b) Kerala has a sex ratio of 1058 Indian population is growing with 1.2% annual change.
26. (a) Disease resistant plants possess thick cuticle. Infectious organisms can not grow or invade cuticle.
27. (c) In sigmoid growth curve, finally, growth rate becomes stable because mortality and natality rates become equal to each other and finally the population shows zero growth rate as birth rate equals death rate.
28. (c) Tropical rain forests have disappeared mainly due to man's activities. Due to over population in countries like India, rain forests are cut to make place available for man to live and build houses. To build buildings and factories man has incessantly cut down trees. This has caused the depletion of rain forests.
29. (b) Flora contains the actual account of habitat and distribution of plants of a given area. It provides the index to the plant species found in particular area.
30. (b) A group of individuals resembling each other in morphological, physiological, biochemical and behavioural characters constitute a species. Such individuals can breed among themselves but cannot breed with members other than their own to produce fertile offsprings. New species are formed mainly due to reproductive isolation.

TYPE A : MULTIPLE CHOICE QUESTIONS

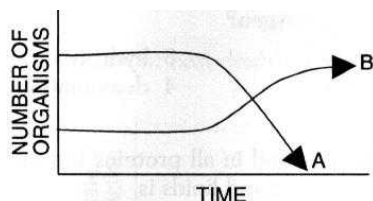
1. The food chain in which microbes breakdown energy rich compounds synthesized by producers is called [1999]
 - (a) ecosystem
 - (b) parasitic food chain
 - (c) detritus level chain
 - (d) predator food chain
2. 10 % law of energy transfer was given by
 - (a) Lindemann
 - (b) Tansley [2000]
 - (c) Stanley
 - (d) Darwin
3. Food chain starts with [2000]
 - (a) autotrophs
 - (b) herbivores
 - (c) carnivores
 - (d) decomposers
4. Flora and fauna in lake or ponds is [2000]
 - (a) lentic biota
 - (b) lotic biota
 - (c) abiotic biota
 - (d) field layer
5. The enzyme responsible for the reduction of molecular nitrogen to the level of ammonia in the leguminous root nodule is [2000]
 - (a) nitrogenase
 - (b) nitrate reductase
 - (c) nitrite reductase
 - (d) ammoniases
6. The role of bacteria in carbon cycle is [2000]
 - (a) photosynthesis
 - (b) chemosynthesis
 - (c) decomposition of organic compounds
 - (d) evolution of O_2
7. Trophic levels are formed by : [2001]
 - (a) plants
 - (b) animals
 - (c) organisms linked in food chain
 - (d) carnivores
8. Desert can be converted into green land by planting [2001]
 - (a) oxylophytes
 - (b) psammophytes
 - (c) halophytes
 - (d) trees
9. Mr. X is eating curd/yoghurt. For this food intake in a food chain Mr. X should be considered as occupying [2003]
 - (a) first trophic level
 - (b) second trophic level
 - (c) third trophic level
 - (d) fourth trophic level
10. Given below is one of the types of ecological pyramids. This type represents [2005]



 - (a) pyramid of numbers in a grassland
 - (b) pyramid of biomass in a fallow land
 - (c) pyramid of biomass in a lake
 - (d) energy pyramid in a spring
11. The function of leghaemoglobin during biological nitrogen fixation in root nodules of legumes is to [2006]
 - (a) convert atmospheric N_2 to NH_3
 - (b) convert ammonia to nitrite
 - (c) transport oxygen for activity of nitrogenase
 - (d) protect nitrogenase from oxygen
12. An ecosystem, such as an aquarium, is self-sustaining if it involves the interaction between organisms, a flow of energy, and the presence of [2009]
 - (a) equal numbers of plants and animals
 - (b) more animals than plants
 - (c) materials cycles
 - (d) pioneer organisms

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13. The graph below shows the changes in two populations of herbivores in a grassy field. A possible reason for these changes is that [2009]



- (a) all of the plant populations in this habitat decreased.
 (b) population B competed more successfully for food than population A did.
 (c) population A produced more offspring than population B did.
 (d) population A consumed the members of population B.
14. A scorpion stalks, kills, and then eats a spider. Based on its behavior, which ecological terms describe the scorpion? [2009]
 (a) producer, herbivore, decomposer
 (b) producer, carnivore, heterotroph
 (c) predator, carnivore, consumer
 (d) predator, autotroph, herbivore
15. In the vast marine ecosystem, certain sea develop red colouration. This red colour is due to the presence of large population of which one of the following organisms? [2009]
 (a) *Trichodesmium erythrium*
 (b) *Physarium*
 (c) Dinoflagellates
 (d) Diatoms and members of red algae
16. The xerophytic plants conserve water by storing it in [2009]
 (a) intercellular spaces
 (b) normal parenchymatous cells
 (c) intercellular spaces and parenchymatous cells
 (d) parenchymatous cells specialized for this purpose
17. Most of the desert plants bloom during night time because [2010]
 (a) their blooming is controlled by low temperature.
 (b) they are sensitive to the phases of moon.
 (c) the desert insects eat away flowers during day time.
 (d) the desert insects are active during night time.
18. Whale is [2012]
 (a) Primary producer
 (b) Carnivorous, secondary consumer
 (c) A decomposer
 (d) Herbivorous
19. Which one of the following is not a function of an ecosystem? [2013]
 (a) Energy flow (b) Decomposition
 (c) Productivity (d) Stratification
20. How much portion of the Photosynthetically Active Radiation (PAR) is captured by the plants? [2016]
 (a) 5–10% (b) 7–10%
 (c) 8–10% (d) 2–10%
21. Arrange the following ecosystems in increasing order of mean NPP (Tonnes / ha / year)
 A. Tropical deciduous forest
 B. Temperate coniferous forest
 C. Tropical rain forest
 D. Temperate deciduous forest [2017]
 (a) $B < A < D < C$
 (b) $D < B < A < C$
 (c) $A < C < D < B$
 (d) $B < D < A < C$

Topicwise AIIMS Solved Papers – BIOLOGY

TYPE B : ASSERTION REASON QUESTIONS

Directions for (Q. 22) : These questions consist of two statements, each printed as Assertion and Reason. While answering these questions, you are required to choose any one of the following five responses.

- (a) If both Assertion and Reason are correct and the Reason is a correct explanation of the Assertion.
 (b) If both Assertion and Reason are correct but Reason is not a correct explanation of the Assertion.
 (c) If the Assertion is correct but Reason is incorrect.
 (d) If both the Assertion and Reason are incorrect.
 (e) If the Assertion is incorrect but the Reason is correct.

22. **Assertion:** Insectivorous habitat of plants is to cope up O_2 deficiency.

Reason: Insectivorous plants are partly autotrophic and partly heterotrophic. [1998]

Directions for (Qs. 23-28) : Each of these questions contains an Assertion followed by Reason. Read them carefully and answer the question on the basis of following options. You have to select the one that best describes the two statements.

- (a) If both Assertion and Reason are correct and Reason is the correct explanation of Assertion.
- (b) If both Assertion and Reason are correct, but Reason is not the correct explanation of Assertion.
- (c) If Assertion is correct but Reason is incorrect.
- (d) If both the Assertion and Reason are incorrect.

23. **Assertion :** A network of food chains existing together in an ecosystem is known as food web.

Reason : An animal like kite cannot be a part of a food web. [2006, 2008, 2011]

24. **Assertion :** Pyramid of energy may be upright or inverted. [2011]

Reason: Only 20% of energy goes to next trophic level.

25. **Assertion :** Biotic community has higher position than population in ecological hierarchy.

Reason : Population of similar individuals remains isolated in the community. [2012]

26. **Assertion :** Net primary productivity is gross primary productivity minus respiration.

Reason : Secondary productivity is produced by heterotrophs. [2013]

27. **Assertion :** Net primary productivity is gross primary productivity minus respiration.

Reason : Secondary productivity is produced by heterotrophs. [2016]

28. **Assertion :** In a food chain, members of successive higher levels are fewer in number.

Reason : Number of organisms at any trophic level depends upon the availability of organisms which serve as food at the lower level. [2003, 2017]

HINTS & SOLUTIONS

Type A : Multiple Choice Questions

1. (c) In nature, detritus food chains are indispensable as the dead organic matter of grazing food chains is acted upon by the detritivores (bacteria, protozoa, nematodes) to recycle the inorganic elements into the ecosystem.
2. (a) 10 % law of energy transfer (pyramid of energy) was given by Lindemann.
In this, only 10% of total energy received by one trophic level is transferred to next trophic level.
3. (a) All trophic levels in an ecosystem are connected by transfer of food as energy. The transfer of food and its contained energy from one trophic level to the next trophic level is called food chain.
Food chain always starts with producers (autotrophs) → Herbivores → Carnivorous → Detrivores are placed at the top of the food chain.
4. (a) Lentic relates to still waters such as lakes and ponds. Hence, the flora and fauna constitute the lentic biota.
5. (d) The enzyme responsible for the reduction of nitrogen to ammonia is ammoniase and the process is ammonification. e.g. actinomycetes, *Bacillus ramosus*, *B. vulgaris* etc.
6. (c) The excretory wastes of living organisms have accumulated carbon compounds and they are decomposed after their death by micro-organisms in the soil to release CO₂ back into the environment for its recycling.
7. (c) The producers and consumers in ecosystem are arranged into several feeding groups/levels called trophic levels.
8. (b) Psammophytes are those plants that can grow in desert and mainly in sandy soil. Hence, psammophytes can be used to convert desert into a green land.
9. (c) Producers occupy first trophic level, primary consumers i.e. herbivores (cow produce milk forming curd) are placed at second trophic level and Mr. X will occupy third place (curd eater).
10. (c) The given figure shows the pyramid of biomass in a lake. An ecological pyramid of biomass shows the relationship between biomass and trophic level by quantifying the amount of biomass present at each trophic level of an ecological community at a particular moment in time.
11. (d) Leghaemoglobin is an oxygen scavenger. It combines with oxygen and protects nitrogenase which catalyses the fixation of nitrogen under anerobic conditions.
12. (c) If a ecosystem is to be self-sustaining, materials such as oxygen, carbon dioxide, water and nitrogen must to recycle between the organisms.
13. (b) If population B increased while population A decreased, these organisms were probably in competition for the same food (grass) and population B was better adapted. Hence, population A is competitively being excluded from the population.
14. (c) Because the scorpion stalks, kills and eats its food, it is a predator. Because it eats a spider it is a carnivore. Because it ingests food it is a consumer. A producer is an autotroph as it is an organism that makes its own food from inorganic substances. A decomposer breaks down dead matter and a herbivore eats only plants.
15. (a) *Trichodesmium erythreum* is a cyanobacteria (blue green alga). Although a blue green alga, it possesses a pigment, phycoerythrin, which is red in colour and imparts red colour to the water of the sea in which it is found, hence named Red Sea.
16. (d) The xerophytic plants conserve water by storing it in parenchymatous cells specialized for this purpose. Xerophytes plants are specially adapted to succeed in an arid climate. They are typically able to withstand long periods of drought and the drying effects of desert winds. Some plants have adapted to arid lands by developing the ability to store water.

17. (d) In desert condition, most of the activity of the plants and animals happens during night because of very high temperature in day time. As a result the desert insects make themselves active and pollinate the flowers at night. To attract the insects, most of the desert plants bloom during night.
18. (b) Whale is carnivorous and feeds on primary consumer and occupies the third trophic level of the ecosystem.
19. (d) Four important functional aspects of the ecosystem are
(i) Productivity
(ii) Decomposition,
(iii) Energy flow and
(iv) Nutrient cycling.
20. (d) The main source of energy for an ecosystem is the radiant energy or light energy derived from the sun. 50% of the total solar radiation that falls on earth is Photosynthetically Active Radiation (PAR).
The light energy is converted into chemical energy in the form of sugar by photosynthesis.
$$6\text{H}_2\text{O} + 6\text{CO}_2 + \text{Light} \rightarrow 6\text{C}_6\text{H}_{12}\text{O}_6 + 6\text{O}_2$$

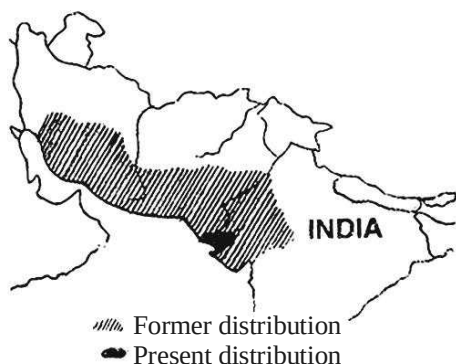
Plants utilize 2-10% of PAR in photosynthesis.
21. (d) Net primary productivity (NPP) is the biomass or storage of energy by green plants. It is equal to the gross primary productivity minus loss due to respiration. The productivity generally increases from polar regions toward the tropics, because of the increasing sunlight and temperature.
24. (d) Energy flow in the ecosystem is a unidirectional manner. There is a decline in the amount of energy passing from one trophic level to the next. Thus the pyramid of energy is always upright. According to Lindemann, only 10% of energy goes to next trophic level.
25. (c) The organisms of all the species that live in a particular area and interact in various ways with one another form biotic community. Biotic community is a grouping that is higher than population in ecological hierarchy. It is an assemblage of all the populations of different organisms occurring in an area. The different populations of a community do not remain isolated. They show interactions and inter-dependence.
26. (b) Net primary productivity is the rate of organic matter built up or stored by producers in their bodies per unit time and area. Net productivity is equal to gross primary productivity minus loss due to respiration and other reasons. Rate of increase in energy containing organic matter or biomass by heterotrophs or consumers per unit time and area is known as secondary productivity.
27. (b) Net primary productivity is the rate of organic matter build up or stored by producers in their bodies per unit time and area. Net productivity is equal to gross primary productivity minus loss due to respiration and other reasons. Rate of increase in energy containing organic matter or biomass by heterotrophs or consumers per unit time and area is known as secondary productivity.

Type B : Assertion Reason Questions

22. (e) Insectivorous plants are those plants which capture and digest live prey (normally insects) to obtain nitrogen compounds that are lacking in its usual marshy habitat. These plants are partly autotrophic and partly heterotrophic.
23. (c) In the food web, different food chains are interconnected. Each chain is interconnected and consists of different trophic levels i.e. producers, consumers and detritivorous. So, kite can also be a part of food web.
28. (d) When food is made available, automatically the next higher level of organism in the hierarchy should increase. This is because when the forest cover got depleted it led to the increase in the number of endangered species. If the deer population is more, it automatically leads to an increase in the tiger population.

TYPE A : MULTIPLE CHOICE QUESTIONS

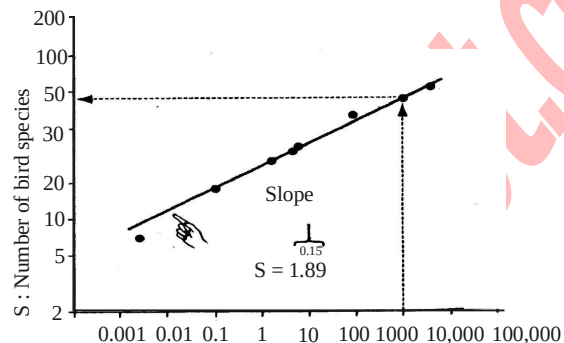
- Heavy rainfall during summer produces [1998]
(a) desert (b) grassland
(c) forest (d) wetland
- The trees occurring in two seasons is the characteristic feature of [1998]
(a) temperate deciduous forest
(b) tropical savannah
(c) grassland
(d) coniferous forest
- The map given below indicates the former and the present distribution of an animal. [2003]



Which animal could it be?

- Wild ass (b) Nilgai
(c) Black buck (d) Lion
- If the high altitude birds become rare or extinct, the plants which may disappear along with them are [2004]
(a) pine (b) oak
(c) orchids (d) *Rhododendrons*
 - Which one of the following is a pair of endangered species? [2004]
(a) Garden lizard and Mexican poppy
(b) Rhesus monkey and sal tree
(c) Indian peacock and carrot grass
(d) Hornbill and Indian aconite
- Which one of the following is correct matching of a plant, its habit and forest type where it normally occurs? [2005]
(a) *Prosopis*, tree, scrub
(b) *Saccharum officinarum*, grass, forest
(c) *Shorea robusta*, herb, tropical rain forest
(d) *Acacia catechu*, tree, coniferous forest
 - One of the *ex-situ* conservation methods for endangered species is [2005]
(a) wildlife sanctuaries
(b) biosphere reserves
(c) cryopreservation
(d) national parks
 - Genetic diversity in agricultural crops is threatened by [2005]
(a) introduction of high yielding varieties.
(b) intensive use of fertilizers.
(c) extensive intercropping.
(d) intensive use of biopesticides.
 - The Montreal protocol refers to [2006]
(a) persistent organic pollutants
(b) global warming and climate change
(c) substances that deplete the ozone layer
(d) biosafety of genetically modified organisms
 - Biosphere reserves differ from National parks and Wildlife sanctuaries because in the former [2006]
(a) human beings are not allowed to enter.
(b) people are an integral part of the system.
(c) plants are paid greater attention than the animals.
(d) living organisms are brought from all over the world and preserved for posterity.
 - Which part of the world has a high density of organism? [2007]
(a) Deciduous forests
(b) Grasslands
(c) Tropical rain forests
(d) Savannahs

12. Beta diversity is diversity [2007]
 (a) in a community
 (b) between communities
 (c) in a mountain gradient
 (d) on a plain
13. Which one of the following pairs of geographical areas show maximum biodiversity in our country? [2008]
 (a) Sunderbans and Rann of Kutch
 (b) Eastern Ghats and West Bengal
 (c) Eastern Himalaya and Western Ghats
 (d) Kerala and Punjab.
14. A tree species in Mauritius failed to reproduce because of the extinction of a fruit-eating bird. Which one of the following was that bird? [2010]
 (a) Dove (b) Dodo
 (c) Condor (d) Skua
15. Tectonic is the study of [2011]
 (a) volcanos (b) earth's crust
 (c) sand dunes (d) Sun
16. If the Bengal tiger becomes extinct [2004, 2012]
 (a) Hyenas and wolves will become scare
 (b) The wild area will be safe for man and domestic animals
 (c) Its gene pool will be lost for ever
 (d) The population of beautiful animals like deers will be stabilized.
17. Which of the following is considered a hot-spot of biodiversity in India? [2013]
 (a) Indo-Gangetic Plain
 (b) Eastern Ghats
 (c) Aravalli Hills
 (d) Western Ghats
18. The largest Tiger reserve in India is [2014]
 (a) Nagarhole
 (b) Valmiki
 (c) Nagarjunsagar-Srisailem
 (d) Periyar
19. Using the figure, determine the percentage of bird species that will be lost if the island's inhabitable land area is reduced from 100,000 km² to 1 km².



A : Island land area (km²) [2016]

- (a) 17 percent of the bird species will be lost.
 (b) 20 percent of the bird species will be lost.
 (c) All of bird species will be lost.
 (d) 93 percent of the bird species will be lost.

TYPE B : ASSERTION REASON QUESTIONS

Directions for (Q. 20) : These questions consist of two statements, each printed as Assertion and Reason. While answering these questions, you are required to choose any one of the following five responses.

- (a) If both Assertion and Reason are correct and the Reason is a correct explanation of the Assertion.
 (b) If both Assertion and Reason are correct but Reason is not a correct explanation of the Assertion.
 (c) If the Assertion is correct but Reason is incorrect.
 (d) If both the Assertion and Reason are incorrect.
 (e) If the Assertion is incorrect but the Reason is correct.

20. **Assertion :** In tropical rain forests, O-horizon and A-Horizon of soil profile are shallow and nutrient-poor.

Reason : Excessive growth of micro-organisms in the soil depletes its organic content. [2006]

Directions for (Qs. 21-24) : Each of these questions contains an Assertion followed by Reason. Read them carefully and answer the question on the basis of following options. You have to select the one that best describes the two statements.

- (a) If both Assertion and Reason are correct and Reason is the correct explanation of Assertion.
- (b) If both Assertion and Reason are correct, but Reason is not the correct explanation of Assertion.
- (c) If Assertion is correct but Reason is incorrect.
- (d) If both the Assertion and Reason are incorrect.

21. **Assertion :** Tropical rain forests are disappearing fast from developing countries such as India.

Reason : No value is attached to these forests because these are poor in biodiversity.

[2012, 2013]

22. **Assertion :** Diversity observed in the entire geographical area is called gamma diversity.

Reason : Biodiversity decreases from high altitude to low altitude. [2014]

23. **Assertion :** A sanctuary is formed for the conservation of animals only.

Reason : Restricted human activities are allowed in sanctuaries. [2014]

24. **Assertion:** Communities that comprise of more species tend to be more stable.

Reason: A higher number of species results in less animal variation in total biomass. [2017]

HINTS & SOLUTIONS**Type A : Multiple Choice Questions**

1. (b) During summer the land becomes dry and rainfall induces formation of grass and hence, heavy rainfall during summer produces grasslands.
2. (a) In the deciduous forests, the leaves generally fall off during autumn. These trees are seen in temperate lands.
3. (a) This animal which had a wide distribution has now considerably decreased in number. This is due to the depletion of forest areas due to man's intrusion. This area has now become a protected area and hence, this animal is now considered an endangered species.
4. (b) The oak plant may disappear since they are seen at a high altitude and their dispersal is dependant on these birds.
5. (d) Endangered species are species with low population numbers that are in considerable danger of becoming extinct. Hornbill and Indian Aconite are endangered species.
6. (a) *Prosopis fuliflora* is a shrub or small tree native to Mexico, South America and the Caribbean. Its uses include forage, wood and environmental management.
7. (c) *Ex situ* conservation is the method of selecting plants or animals in places outside their natural homes, *e.g.* cryopreservation, tissue culture *etc.* They are the sources of genetic material for breeders and genetic engineering.
8. (d) Genetic diversity is liable to undergo degradation and prone to mass scale destruction due to fungal and insects attacks and intensive use of biopesticides.
9. (c) Montreal protocol (1987) was a landmark international agreement to protect the stratospheric ozone by agreeing to limit the production and use the ozone-depleting substances.
10. (b) Biosphere reserves are a special category of protected areas of land or coastal environments where people are an integral component of the system.
11. (c) Tropical rain forests have a high density of organisms. Tropical rain forests are mainly found in America, South America, Congo river basin of Africa, South East Asia. In this biome, rainfall and warmth are abundant. Plant growth is luxuriant. This biome possess more than half of the flora and fauna of the world. Productivity is very high. Diversity of life is so high that a hectare of the forest may have 200 species of trees. 70–80% of all insects and 80 – 85% of all birds are known from tropical forests.
12. (b) α , β , γ are the three types of ecosystem diversities where diversity is the diversity operating between communities.
13. (c) The Eastern Himalayas Region includes Bhutan, north-eastern India, and southern, central, and eastern Nepal. It is home to 163 globally threatened species, including Asia's three largest herbivores—the Asian elephant (*Elephas maximus*), the greater one-horned rhinoceros (*Rhinoceros unicornis*), and the wild water buffalo (*Bubalus bubalis*)—and its largest carnivore, the tiger (*Panthera tigris*), as well as several large birds such as vultures, adjutant storks, and hornbills. The Western Ghats are amongst the world's biodiversity Hotspots. The various human-induced threats to the rich biodiversity and the large number of endemic species have been identified and highlighted by the recently completed National Biodiversity Strategy and Action Plan; Western Ghats Ecoregion.
14. (b) *Dodo* became extinct in 14th century from Mauritius because of large-scale hunting. *Dodo* was helpful in pollinating and propagating seed of this tree species.

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15. (b) Tectonic is the study of the earth's crust. It was considered that earth was made up of tectonic plates.
16. (c) If bengal tiger becomes extinct, its gene pool will be lost forever. There are various methods for conservation of biodiversity like formation of botanical gardens, zoological park, sperm bank, gene bank etc.
17. (d) Hot spot are those areas which were rich in biodiversity but now under threat due to direct or indirect interference of human activities. These regions are on the edge to get some of their species extinct due to humans. Western Ghats in India are under threat due to continuous developmental activities and Doon valley is under threat due to continuous mining activities.
18. (c) Nagarjunsagar-Srisailem Tiger Reserve is the largest Tiger reserve in India and the only Tiger Reserve in Andhra Pradesh state.
19. (d)
- Type B : Assertion Reason Questions**
20. (c) O-horizon occupies the topmost soil and is rich in mineral and decomposed organic matter (humus). A-horizon is dark coloured and has abundant minerals mixed with humus.
21. (c) Tropical rain forests are located in the equatorial regions where the annual rainfall exceeds 140 cm. They are also called jungles and cover one twelfth of earth's surface but contain more than half of the earth's flora and fauna (i.e., rich in biodiversity). Now-a-days these forests are disappearing due to excessive cutting of forests for domestic purposes like fuel, furnitures, accomodations, cloths, resin, gum, etc.
22. (a)
23. (a) A sanctuary is an area which is reserved for the protection of wild animals only. The activities like harvesting of timber, collection of minor forest products and private ownership rights are allowed, however, such activities should not have any adverse effect on animals.
24. (a) Communities with higher number of species are more stable as it can resist occasional disturbances. A stable community should show less variation in productivity from year to year and resistance towards alien species.

TYPE A : MULTIPLE CHOICE QUESTIONS

1. Which of the following is biodegradable pollutant? [1997]
(a) Plastic (b) Asbestos
(c) Sewage (d) Polythene
2. Positive pollution of soil is due to [1997]
(a) reduction in soil productivity
(b) addition of waste to soil
(c) excessive use of fertilizers
(d) all of the above
3. Which of the following metal pollution causes sterility in human beings? [1998]
(a) Mercury (b) Arsenic
(c) Manganese (d) Chromium
4. Which of the following is dissolved in water to make Bordeaux mixture? [1998]
(a) Calcium chloride (b) Copper sulphate
(c) Sodium chloride (d) None of these
5. Acid rain is due to pollution of [2000]
(a) dust (b) pesticides
(c) SO_2 and NO_2 (d) carbon particle
6. Deforestation causes [2001]
(a) soil erosion (b) soil pollution
(c) noise pollution (d) air pollution
7. Green muffler is useful against [2002]
(a) air pollution
(b) noise pollution
(c) soil pollution
(d) radioactive pollution
8. In almost all Indian metropolitan cities like Delhi, the major atmospheric pollutant(s) is / are [2003]
(a) suspended particulate matter (SPM)
(b) oxides of sulphur
(c) carbon dioxide and carbon monoxide
(d) oxides of nitrogen
9. Photochemical smog formed in congested metropolitan cities mainly consists of [2003]
(a) ozone, peroxyacetyl nitrate and NO_x
(b) smoke, peroxyacetyl nitrate and SO_2
(c) hydrocarbons, SO_2 and CO_2
(d) hydrocarbons, ozone and SO_x
10. Biological Oxygen Demand (BOD) is a measure of [2003]
(a) industrial wastes poured into water bodies
(b) extent to which water is polluted with organic compound
(c) amount of carbon monoxide inseparably combined with haemoglobin
(d) amount of oxygen needed by green plants during night
11. Drinking of mineral water with very low level of pesticides (about 0.02 ppm) for long periods may [2003]
(a) produce immunity against mosquito
(b) cause leukemia (blood cancer) in most people
(c) cause cancer of the intestine
(d) lead to accumulation of pesticide residues in body fat
12. Minimata disease is pollution related disease. It results from [2001, 2004]
(a) oil spills in sea
(b) DDT pollution
(c) release of industrial waste containing mercury in fishing water
(d) accumulation of arsenic
13. A lake with an inflow of domestic sewage rich in organic waste may result in [2004]
(a) drying of the lake very soon due to algal bloom
(b) an increased production of fish due to lot of nutrients
(c) death of fish due to lack of oxygen
(d) increased population of aquatic food web organisms

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14. Nitrogen oxides, produced from the emission of automobiles and power plants, are the source of fine air borne particles which lead to [2004]
 (a) photochemical smog
 (b) dry acid deposition
 (c) industrial smog
 (d) wet acid deposition
15. Formation of non-functional methaemoglobin causes blue-baby syndrome. This is due to [2005]
 (a) excess of arsenic concentration in drinking water
 (b) excess of nitrates in drinking water
 (c) deficiency of iron in food
 (d) increased methane content in the atmosphere
16. Pollution from animal excreta and organic waste from kitchen can be most profitably minimized by [2006]
 (a) storing them in underground storage tanks
 (b) using them for producing biogas
 (c) vermiculture
 (d) using them directly as biofertilizers
17. Which one of the following is an environment-related disorder with the correct main cause? [2006]
 (a) Black lung disease (pneumoconiosis) found mainly in workers in stone quarries and crushers.
 (b) Blue baby disease (methaemoglobinaemia) due to heavy use of nitrogen rich fertilizers in the area.
 (c) Non-Hodgkin's Lymphoma found mainly in workers involved in manufacture of neem based pesticides.
 (d) Skin cancer mainly in people exposed to benzene and methane.
18. Ozone in stratosphere extends [2007]
 (a) 10-20 km (b) 20-25 km
 (c) 15-30 km (d) 25-40 km
19. Which one of the following organisms is likely to show the highest concentration of DDT, once it has been introduced into the ecosystem? [2010]
 (a) Grasshopper (b) Toad
 (c) Snake (d) Cattle
20. Which one of the following statement pertaining to pollutants is correct? [2011]
 (a) DDT is a non-biodegradable pollutant
 (b) Excess fluoride in drinking water causes osteoporosis hardening of bones, stiff joints
 (c) Excess cadmium in drinking water causes black foot disease
 (d) Methylmercury in water may cause "Itai Itai" disease
21. In the environment, ozone is known for its [2012]
 (a) Harmful effects
 (b) Useful effects
 (c) Both (a) and (b)
 (d) Inert nature
22. Which one of the following statement is true? [2013]
 (a) The greater the BOD of waste water, more is its polluting potential.
 (b) The greater the BOD of waste water, less is its polluting potential.
 (c) The lesser the BOD of waste water, more is its polluting potential.
 (d) The lesser the BOD of waste water, less is its polluting potential.
23. Which one of the following pairs is mismatched? [2013]
 (a) Fossil fuel burning - release of CO_2
 (b) Nuclear power - radioactive wastes
 (c) Solar energy - green house effect
 (d) Biomass burning - release of CO_2
24. The two gases making the highest relative contribution to the greenhouse gases are [2014]
 (a) CO_2 and CH_4 (b) CH_4 and N_2O
 (c) CFC and N_2O (d) CO_2 and N_2O
25. A lake near a village suffered heavy mortality of fishes within a few days. Consider the following reasons for this:
 1. Lots of urea and phosphate fertilizer were used in the crops in the vicinity
 2. The area was sprayed with DDT by an aircraft
 3. The lake water turned green and stinky

4. Phytoplankton populations in the lake declined initially thereby greatly reducing photosynthesis.
Which two of the above were the main causes of fish mortality in the lake? [2015]
(a) 2 and 3 (b) 3 and 4
(c) 1 and 3 (d) 1 and 2
26. DDT residues are rapidly passed through food chain causing biomagnification because DDT is [2015]
(a) moderately toxic
(b) non-toxic to aquatic animals
(c) water soluble
(d) lipo soluble
27. Two lakes, A and B are identical in all aspects except that lake A has higher temperature. Which of the following is true? [2016]
(a) A has higher rate of oxygen dissolution.
(b) B has higher rate of oxygen dissolution.
(c) Oxygen dissolution of both is the same.
(d) Both the lakes have same BOD.
28. Euro II norms stipulate that sulphur be controlled at _____ ppm in diesel and _____ ppm in petrol. [2017]
(a) 350; 150 (b) 150; 350
(c) 350; 250 (d) 150; 250
29. **Assertion** : Inhabitants close to very busy airports are likely to experience health hazards.
Reason : Sound level of jet aeroplanes usually exceeds 160 dB. [2003]
30. **Assertion** : Organochlorine pesticides are organic compounds that have been chlorinated.
Reason : Fenitrothion is one of the organochlorine pesticides. [2003]
31. **Assertion** : Agricultural output increased several times after introduction of DDT.
Reason : DDT was the first insecticide used on a wide scale. [2004]
32. **Assertion** : A suspended particulate matter (SPM) is an important pollutant released by diesel vehicles.
Reason : Catalytic converters greatly reduce pollution caused by automobiles. [2005]
33. **Assertion** : Presently, the global atmosphere is warming up.
Reason : The depletion of stratospheric ozone layer has resulted in increase in ultraviolet radiations reaching the earth. [2005]
34. **Assertion** : Deforestation is one main factor contributing to global warming.
Reason : Besides CO_2 , two other gases methane and CFCs are also included under green house gases. [2006]
35. **Assertion** : UV radiation causes photo-dissociation of ozone into O_2 and O , thus causing damage to the stratospheric ozone layer.
Reason : Ozone hole is resulting in global warming and climate change. [2006]
36. **Assertion** : The concentration of methane in the atmosphere has more than doubled in the last 250 years.
Reason : Wetlands and rice fields are the major sources of methane. [2006]
37. **Assertion (A)** : Pollution is always caused by human activities.
Reason (R) : Pollution is not different from contamination. [2007]
38. **Assertion (A)** : Chlorofluorocarbons are responsible for ozone depletion.
Reason (R) : Ozone level decreases by as much as 67% every year. [2007]

TYPE B : ASSERTION REASON QUESTIONS

Directions for (Qs. 29-38) : These questions consist of two statements, each printed as Assertion and Reason. While answering these questions, you are required to choose any one of the following five responses.

- (a) If both Assertion and Reason are correct and the Reason is a correct explanation of the Assertion.
(b) If both Assertion and Reason are correct but Reason is not a correct explanation of the Assertion.
(c) If the Assertion is correct but Reason is incorrect.
(d) If both the Assertion and Reason are incorrect.
(e) If the Assertion is incorrect but the Reason is correct.

Directions for (Qs. 39-43) : Each of these questions contains an Assertion followed by Reason. Read them carefully and answer the question on the basis of following options. You have to select the one that best describes the two statements.

- (a) If both Assertion and Reason are correct and Reason is the correct explanation of Assertion.
- (b) If both Assertion and Reason are correct, but Reason is not the correct explanation of Assertion.
- (c) If Assertion is correct but Reason is incorrect.
- (d) If both the Assertion and Reason are incorrect.

39. Assertion : Secondary succession takes place in recently denuded area. [2009]

Reason : It is caused due to barring of an area.

40. Assertion : Excess of nitrates in drinking water are harmful for infants. [2009]

Topicwise AIIMS Solved Papers – BIOLOGY

Reason : Nitrates are responsible for blue baby syndrome.

41. Assertion : Water pollutants are measured by BOD.

Reason : If BOD is more, the water is polluted.

[2013]

42. Assertion : Methane, component of green house gases, contributing to global warming is about 20 percent.

Reason : Introduction of multi-point fuel injection engines in automobiles has decreased methane content in the exhausts.

[2005, 2015]

43. Assertion : Eutrophication shows increase in productivity in water. [2013, 2017]

Reason : With increasing eutrophication, the diversity of the phytoplankton increases.

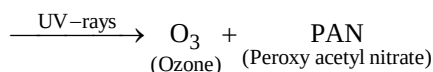
HINTS & SOLUTIONS**Type A : Multiple Choice Questions**

1. (c) Sewage is a biodegradable pollutant *i.e.* capable of being removed by microbial action.
2. (d) Soil pollution is of two types : positive soil pollution and negative soil pollution.
When there is addition of undesirable substance in the soil then it is called as positive pollution.
3. (c) Manganese causes sterility in human beings. It enters the food chain and finally reaches human beings & has an effect on the reproductive system.
4. (b) Bordeaux mixture is a combination of copper sulphate and hydrated lime. It is used mainly to control garden, vineyard and farm infestations of fungus.
5. (c) Acid rain is rainfall and other form of precipitation with a pH of less than 5. It is due to the excess of SO_2 and NO_2 in the air which along with water form sulphurous and nitric acid.
6. (a) In India, deforestation is the main cause of soil erosion. The quality of top soil loss in India is about 18.5% of the total global loss.
7. (b) Green muffler or green belt vegetation is rows of trees and shrubs grown and maintained to serve as noise absorbers.
8. (a) Suspended particulate matter (SPM) is maximum in metropolitan cities.
9. (c) Photochemical smog or oxidizing type of pollution is characterized by the presence of large concentration of ozone, oxides of nitrogen and various hydrocarbons. It occurs in Los Angeles.
10. (b) BOD is the measure of degree of impurity of water due to organic matter.
11. (d) Pesticides in a drinking water pass into food chain and they increase in amount per unit weight of organisms with the rise in trophic level due to their accumulation in fat (biomagnification).
12. (c) Mercury compounds in waste water are converted by bacterial action into extremely toxic compound, methyl mercury. Biomagnification of mercury into fishes through the food chain is responsible for large number of deaths due to Minamata diseases. It is characterised by numbers of limbs, lips and tongue, deafness, blurred vision, mental retardation *etc.*
13. (c) A lake rich in (domestic sewage) nutrients accelerates the growth of algae which use oxygen at night and deoxygenate the water enough to kill the fish and other animals (eutrophication).
14. (a) Nitrogen oxides form peroxyacyl nitrate (PAN) by reacting with hydrocarbons. It leads to photochemical smog formation.
15. (b) Excess nitrate in drinking water, leaves and fruits, changes into nitrite in alimentary canal. It reacts with haemoglobin and produces non-functional met haemoglobin. This reduces O_2 carrying capacity of blood. The disorder is called methaemoglobinaemia. It causes blue baby syndrome and breathlessness in adults.
16. (c) Vermiculture means artificial seating of worms whose excreta is rich in humus. These worms eat farmyard manure along with other farm wastes and pass out it through their bodies and the process converts it into vermicompost for the betterment of human beings.
17. (b) Blue baby disease is caused by nitrate poisoning (presence of methaemoglobin) resulting in organs & cell tissues that are deprived of oxygen & skin with the characteristic bluish tint.

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Topicwise AIIMS Solved Papers – BIOLOGY

18. (b) Stratosphere extends from 20-25 km above troposphere. It is also called ozonosphere due to presence of ozone. Temperature increases in this zone (upto 90°C) due to ozone formation. Ozone protects Earth from harmful ultraviolet radiations of the sun.
Oxides of Nitrogen + Unburnt Hydrocarbons



19. (c) Biomagnification is phenomenon of increasing concentration of a compound in the tissues of chain, usually as a result of food intake. In this case, the concentration of compound increases with increasing trophic level.

Pollutant increases in concentration from Producers → Primary consumers → Secondary consumers → Tertiary consumers → Top consumer. In the given question, only snake represents the tertiary consumer, so the concentration of DDT will be highest in snake.

20. (a) Excess fluorine in drinking water causes hardening of bones and stiffness of joints, black foot disease is due to arsenic and itai-itai disease is due to cadmium in contaminated water.
21. (c) In the environment, ozone is known for its both harmful and useful effects. Ozone present in stratosphere is useful as it act like shield and protect the earth from harmful UV-rays. Ozone present in troposphere act as pollutant and have many deleterious effects.

22. (a)

23. (c) Solar energy coming to the earth is not responsible for green house effect. It is the increase in green house gases in atmosphere like CO₂ which is released by complete combustion of fossil fuels or biomass in industries or transportation vehicles that prevent the reradiation of infrared radiation from the earth and result in increase in temperature of the earth.

24. (a) The gases that makes highest relative contribution to the green house gases are carbon dioxide (CO₂) and methane (CH₄).

25. (c) Lots of urea and phosphate fertilizer were used in the crops in the vicinity and the lake water turned green and stinky. Due to this, lake near a village suffered heavy mortality of fishes within a few days.

26. (d) DDT residues are rapidly passed through food chain causing biomagnification because DDT is soluble in lipids. Biomagnification, also known as bioamplification or biological magnification, is the increase in concentration of a substance, such as the pesticide DDT, that occurs in a food chain as a consequence of:

- Persistence (slow to be broken down by environmental processes)
- Food chain energetics
- Low (or non-existent) rate of internal degradation/excretion of the substance (often due to water-insolubility)

27. (b) Lake A and B are identical in all aspects except that Lake A has higher temperature. On the basis of this difference, it is clear that Lake B has higher rate of oxygen dissolution

28. (a) The Govt. of India through a new auto fuel policy has laid out a roadmap to cut down the vehicular pollution in Indian cities. For example, Euro II norms stipulate that sulphur be controlled at 350 ppm in diesel and 150 ppm in petrol.

Type B : Assertion Reason Questions

29. (a) Sound level of jet aeroplanes is about 150 dB beyond the level of human audible capacity (80 dB). It affects the hearing and general health of man.
30. (c) Organochlorine are persistent pesticides (e.g. DDT) which pass into food chain and increase in amount per unit weight of organisms with the rise in trophic level. Fenitrothion is organophosphate.

31. (a) DDT (dichloro diphenyl trichloroethane) is a organochlorine contact insecticide that kills by acting as a nerve poison. DDT was originally used during world war II to control typhus which was spread by body louse. Since then it has been used to control mosquito borne malaria and was used extensively as a general agricultural insecticide.
32. (b) Catalytic converters are involved in reducing gaseous pollutions by converting $\text{CO} \longrightarrow \text{CO}_2$, $\text{NO}_2 \longrightarrow \text{N}_2$ etc. Thus, decrease the amount of pollutant. They can not reduce emission of SPM.
33. (b) Global warming is due to the increase in concentration of green house gases resulted in increase in global temperature. These global gases prevent the escape of long wave radiations into space.
34. (b) Deforestation results in increase in green house gases which retains more and more UV radiations and leads to global warming. Global warming is the warming/heating up of the earth's atmosphere due to depletion of ozone in the stratosphere.
35. (c) Ozone in stratosphere is responsible for the protection of earth from high energy UV rays *i.e.* it acts as life saving screen. Ozone layer found in troposphere protects from warming effect of earth. Due to human activities, the ozone layer in the stratosphere starts thinning, which is also called ozone hole. Ozone hole is resulting in rain failure, increase in radiation, cancer (skin) and reduction in crop production.
36. (a) Wetland and rice fields are the major sources of methane. It is a green house gas whose concentration is double now than it was 250 years ago.
37. (d) Pollution may be defined as an undesirable change in physical, chemical or biological characteristics of air, water and land causing harmful effects on living organisms. Pollution can be natural or man made. Natural pollution includes volcanic eruptions, soil erosion, UV- rays *etc.* Pollution is different from contamination. Contamination is the presence of harmful organisms causing disease.
38. (b) Stratosphere zone of Earth's atmosphere contains a layer of ozone which protects us from harmful ultraviolet radiations of the sun. A group of chlorine containing compounds called chlorofluoro carbon (CFCs) used as coolants in air conditioners and refrigerators are primary chemicals responsible for ozone depletion. After their release into troposphere, CFCs go to stratosphere where they are broken down by UV radiations releasing chlorine. In presence of sunlight, chlorine breaks O_3 into O_2 . Due to ozone depletion, its levels decreases by 67% every year causing higher levels of UV radiations reaching earth which may cause eye cataracts, skin cancer etc.
39. (a) Biotic or ecological succession is the formation of a series of biotic communities at the same site over a period of time one after the other, till a stable climax community develops over the area. It occurs generally in bare areas. Primary succession takes place on a biological sterile soilless primary barren area. Secondary succession takes place in a recently denuded area which still contains a lot of organic debris, remains and propagules of previous living organisms. The area has become bared due to destruction of the community previously present. The baring of an area can be caused due to forest fire, deforestation for wood, timber and habitat, overgrazing, landslides or earthquakes, excessive and repeated droughts, following a cropland and repeated floods.
40. (a) Excess of nitrates in drinking water are harmful for human health and may be fatal for infants. Excessive use of fertilizers often leads to accumulations of nitrates in water. In infants, excess nitrate reacts with

haemoglobin to form nonfunctional methaemoglobin that impairs oxygen transport. This condition is termed as methaemoglobinemia or blue baby syndrome. This disease can damage respiratory and vascular systems and even cause suffocation.

41. (a) Water pollutants are commonly measured by their main common denominator, called BOD (Biochemical Oxygen Demand), *i.e.*, the amount of free oxygen absorbed by extraneous substances from water. If water is polluted, it will consume more oxygen, thereby enhancing the BOD of water.
42. (b) Methane is produced by incomplete biomass combustion, incomplete decomposition mostly by anaerobic methanogens.
Carbon dioxide contributes about 60% of the total global warming and share of

methane (CH_4) and chlorofluoro carbons (CFCs) is 20% and 14% respectively. N_2O also contributes 6% in total global warming. Efficient engine such as multi point fuel injection engine can reduce the unburnt hydrocarbon (methane) in auto-emissions.

43. (b) Eutrophication is a natural process which literally means well nourished or enriched. It is a natural state in many lakes and ponds which have a rich supply of nutrients. Eutrophication becomes excessive, when abnormally high amount of nutrient from sewage, fertilizers, animal wastage and detergent, enter streams and lakes causing excessive growth or blooms of microorganisms. With increasing eutrophication, the diversity of the phytoplankton community of a lake increases and the lake finally becomes dominated by blue - green algae.

GENERAL KNOWLEDGE

Chapter

1

G.K. – History

1. Doctors before starting their service take oath in the name of a scientist to work honestly :
(a) Hippocrate (b) Darwin [1997]
(c) Plato (d) Socrates
2. Confucianism is famous in : [1997]
(a) Japan (b) China
(c) Myanmar (d) Malaysia
3. The tomb of Qutub Shahi is situated in : [1997]
(a) Aligarh (b) Agra
(c) Hyderabad (d) Allahabad
4. "Statue of Liberty" was gifted to USA by : [1997]
(a) Germany (b) Canada
(c) Greece (d) France
5. The dynasty of Bahadur Shah (II) Jafar was in : [1998]
(a) 1658 to 1707 A.D. (b) 1837 to 1857 A.D.
(c) 1857 to 1862 A.D. (d) 1800 to 1829 A.D.
6. Swami Vivekanand was born in which one of the following year ? [1998]
(a) 1860 (b) 1882
(c) 1897 (d) 1863
7. The Simon Commission had come in which of the following year ? [1998]
(a) 1937 (b) 1938
(c) 1927 (d) 1942
8. The Fifth Day commission was headed by justice : [1999]
(a) Verma (b) Ahmadi
(c) Anand (d) Vadhwa
9. Grand Trunk road was built by : [2000]
(a) Sher Shah Suri (b) Shah Jahan
(c) Lord Bentic (d) Lord Mount Battan
10. At the first time, the song Vande Mataram was sung in : [2001]
(a) Indian National Congress session 1986
(b) Indian National Congress session 1896
(c) Quit India Movement 1942
(d) Congress session 1911
11. From where did Mahatma Gandhi start the famous Dandi March? [2001]
(a) Surat (b) Mumbai
(c) Bardoli (d) Ahmedabad
12. In which year was English recommended as the medium of instruction for higher education in India by Lord Macaulay? [2001]
(a) 1833 (b) 1835
(c) 1859 (d) 1825
13. 'Gayatri Mantra' is related with : [2002]
(a) Athar Veda (b) Rig Veda
(c) Yajur Veda (d) Sam Veda
14. The founder of 'Khalsa' was : [2002]
(a) Guru Gobind Singh
(b) Guru Nanak Dev
(c) Guru Ram Das
(d) Guru Tegh Bahadur
15. Who was the last Viceroy of India : [2002]
(a) Lard David
(b) Lord Wavell
(c) Lord Mountbattern
(d) Wellington
16. Euthanasia (mercy killing) was first legalized in : [2003]
(a) Switzerland
(b) Netherlands (Holland)
(c) France
(d) Italy
17. Which city was gifted to Charles II by the Portuguese when he married the sister of the King of Portugal in 1662? [2003]
(a) Bombay (b) Paris
(c) Lisoon (d) Castille
18. Who is the mother of Bharat in the epic 'Ramayana'? [2003]
(a) Kaushalya (b) Sumitra
(c) Urmila (d) Kaikayee
19. Which of the 'Nawab of Bengal' is supposed to be responsible for 'Back Hole Tragedy' of Calcutta (Kolkata)? [2003]
(a) Mir Jafer (b) Sirajuddaula
(c) Alivardi Khan (d) Sarfaraj Khan
20. Who among the following is known as Fuehrer? [2003]
(a) Stalin (b) Lenin
(c) Hitler (d) Bismarck

c-2

Topicwise AIIMS Solved Papers – GENERAL KNOWLEDGE

21. Since the Britishers wanted India to produce and supply raw materials to feed English factories, they pushed a policy that encouraged cultivation of : **[2004]**
 (a) jute (b) indigo
 (c) cotton (d) commercial crop
22. 'Brahmo Samaj' was founded by : **[2005]**
 (a) Devendra Nath Tagor
 (b) Keshv Chandra Sen
 (c) Raja Ram Mohan Roy
 (d) Annie Besant
23. Who was the first woman ruler of India? **[2005]**
 (a) Raziya Sultan (b) Noor Jahan
 (c) Chand Biwi (d) Durga Devi
24. Who were the first to issue gold coins in India? **[2005]**
 (a) The Kushan's (b) The Gupta's
 (c) The Mauryan's (d) The Indo Greeks
25. Which sea is referred to in our National Anthem? **[2006]**
 (a) Bay of Bengal
 (b) Indian ocean
 (c) Arabian sea
 (d) No sea is mentioned in it
26. The national calendar of India is based on : **[2006]**
 (a) Gragorian calendar
 (b) Hizzr Era
 (c) Saka- Era
 (d) one of the old Indian Era
27. Gaya is associated with Lord buddha, where he **[2007]**
 (a) was born
 (b) attained enlightenment
 (c) died
 (d) delivered his first sermon
28. Which of the following places was known as a centre of learning in ancient India? **[2007]**
 (a) Nalanda (b) Ujjain
 (c) Allahabad (d) none of these
29. In violation of the Salt Laws, Gandhiji started a movement called **[2008]**
 (a) Non-Cooperation Movement
 (b) Swadeshi Movement
 (c) Civil Disobedience Movement
 (d) None of the above
30. The Cabinet Mission came to India in **[2008]**
 (a) 1943 (b) 1944
 (c) 1945 (d) 1946
31. Who was the founder-editor of the famous newspaper 'Kesari' during the national struggle? **[2009]**
 (a) Mahatma Gandhi
 (b) Jawaharlal Nehru
 (c) Lokmanya Tilak
 (d) Muhammad Iqbal
32. The earliest Iron Age in India has been associated with **[2010]**
 (a) Painted grey ware
 (b) Black and red ware
 (c) Ochre Coloured Pottery (OCP)
 (d) Northern black polished ware
33. Who among the following was the ruler of Delhi at the time of the invasion of Nadir Shah? **[2010]**
 (a) Muhammad Shah
 (b) Raj Raj I, the Chola
 (c) Bahadur Shah
 (d) Alamgir II
34. Most of the Ajanta Paintings were done during the period of :
 (a) Harshavardhana (b) Guptas
 (c) Mauryas (d) Kushan
35. Who was the first Indian ruler to face the Mahmud Ghaznavi ? **[2011]**
 (a) Prithviraj Chauhan (b) King Jaipal
 (c) Jaichand (d) Firdausi
36. Which one of the following countries is "Orange Revolution" associated ? **[2012]**
 (a) Brazil (b) Sudan
 (c) Turkey (d) Ukraine
37. Who was the Governor General of India during the Revolt of 1857 ? **[2012]**
 (a) Lord Canning (b) Lord Dalhousie
 (c) Lord Dufferin (d) Lord Hardinge
38. Who founded the Brahma Samaj? **[2012]**
 (a) Debendranath Tagore
 (b) Keshab Chandra Sen
 (c) Raja Rammohan Roy
 (d) Ishwar Chandra Vidyasagar
39. Consider the following Mughal Emperors:
 i. Farrukhshiyar ii. Jahandar Shah
 iii. Muhammad Shah iv. Shah Alam II
 What is the correct chronological sequence of their ascending the throne ? **[2012]**
 (a) i, ii, iii, iv (b) ii, i, iii, iv
 (c) i, ii, iv, iii (d) ii, i, iv, iii
40. Match the following : **[2013]**
 A. Sarojini Naidu 1. Muslim League
 B. M.A. Jinnah 2. Indian National Congress

- C. Sir Tej Bahadur Sapru 3. Hindu Mahasabha
D. V.D. Savarkar 4. Liberal Party
- A B C D A B C D
- (a) 2 1 4 3 (b) 2 1 3 4
(c) 2 4 1 3 (d) 4 1 3 2
41. Identify the medical trio of Ancient India from the following names. [2013]
(a) Charaka, Susruta and Vagbhata
(b) Charaka, Vatsyayana and Vagbhata
(c) Charaka, Susruta and Bharata
(d) Charaka, Susruta and Patanjali
42. Who among the following first propounded the idea of Basic Education? [2014]
(a) Jawahar Lal Nehru
(b) Raja Ram Mohan Roy
(c) Mahatma Gandhi
(d) Dayanand Saraswati
43. 'Tebhega' movement is associated with which state? [2015]
(a) Maharashtra (b) Tamil Nadu
(c) Karnataka (d) Bengal
44. When was our national song sung for the first time? [2015]
(a) 1896 session of Indian National Congress
(b) 1857 revolt
(c) 1919 - Jallianwala Bagh Massacre
(d) None of the above
45. The first meeting of Indian National Congress was held in Bombay in 1885 A.D. under the leadership of ___? [2015]
(a) Dadabhai Naoroji
(b) Sir C. Sankaran Nair
(c) Womesh Chandra Banerjee
(d) Badruddin Tyabji
46. When did Vasco-da-Gama come to India? [2016]
(a) 1492 (b) 1494
(c) 1496 (d) 1498
47. The Qutub Minar at Delhi was built by? [2016]
(a) Qutbuddin Aibak (b) Shahjhan
(c) Aleu-din-khilji (d) Chandragupta
48. Who was the first Governor - General of India [2016]
(a) Robert Clive
(b) Sir Charles Metcalfe
(c) William Bentinck
(d) Warren Hastings
49. 'Do or Die' (Karo ya Maro) slogan was given by which freedom fighter in 1942? [2017]
(a) Mahatma Gandhi
(b) Subhash Chand Bose
(c) Bal Gangadhar Tilak
(d) Bhagat Singh

ANSWER KEY

1	(a)	2	(b)	3	(c)	4	(d)	5	(b)	6	(d)	7	(c)	8	(a)	9	(a)	10	(b)
11	(d)	12	(a)	13	(b)	14	(a)	15	(c)	16	(b)	17	(a)	18	(d)	19	(b)	20	(c)
21	(b)	22	(c)	23	(a)	24	(d)	25	(d)	26	(c)	27	(b)	28	(a)	29	(c)	30	(d)
31	(c)	32	(a)	33	(a)	34	(b)	35	(b)	36	(d)	37	(a)	38	(c)	39	(b)	40	(a)
41	(d)	42	(c)	43	(d)	44	(a)	45	(c)	46	(d)	47	(a)	48	(d)	49	(a)		

Chapter

2

G.K. – Indian Polity

1. Sixty five year plan to promote significant expansion of employment opportunities was scheduled in the year of : **[1998]**
 (a) 1980-1985 (b) 1669-1674
 (c) 1974-1979 (d) 1961-1966
2. Sixty first amendment in the Constitution states about **[1998]**
 (a) Extended President rule in Punjab
 (b) Increasing the ceiling of profession tax
 (c) Reservation of seats for scheduled castes and scheduled tribes in parliament
 (d) Reducing the voting age from 21 years to 18 years
3. Which of the following state, becomes the 22nd state of Indian union ? **[1998]**
 (a) Tripura (b) Sikkim
 (c) Meghalaya (d) Assam
4. At present, the total membership of Lok Sabha : **[1998]**
 (a) 552 (b) 525
 (c) 527 (d) 545
5. Fundamental duties were introduced in the constitution by : **[1999]**
 (a) 42nd amendment (b) 40th amendment
 (c) 48th amendment (d) 53rd amendment
6. The person who served as the President of India twice, was : **[1999]**
 (a) Radha Krishnan
 (b) Dr. Rajendra Prasad
 (c) Zakir Hussain
 (d) V.V.Giri
7. President of India gives his resignation to the : **[1999]**
 (a) Chief Justice (b) Parliament
 (c) Vice President (d) Prime Minister
8. The contribution of Sarkaria commission was related between : **[2000]**
 (a) state and centre
 (b) centre and union territories
 (c) one state to other state
 (d) none of these
9. Who was appointed as the first governor general of India ? **[2000]**
 (a) C. Raj Gopalachari (b) Radha Krishana
 (c) Y. C. Grace (d) V.V.Giri
10. National Anthem "Jana Gana Mana" was adopted on **[2001]**
 (a) 26 Jan. 1950 (b) 26 July 1947
 (c) 15 August 1947 (d) 24 Jan. 1950
11. Who is the chairman of Rajya Sabha? **[2001]**
 (a) Speaker of Lok Sabha
 (b) Home Minister
 (c) President
 (d) Vice President
12. Which one of the following determines the salary of attorney General? **[2001]**
 (a) Speaker of Lok Sabha
 (b) Home Minister
 (c) President of India
 (d) Prime Minister
13. The oath of office to a Supreme Court Judge is administered by : **[2001]**
 (a) The Chief Justice
 (b) The President of India
 (c) The Chief Justice of India
 (d) The Law minister
14. Who addressed the U. N. General Assembly for the first time in Hindi? **[2001]**
 (a) Rajendra Prasad (b) Atal Bihari Vajpai
 (c) Jawahar Lal Nehru (d) Swarn Singh
15. How many languages are recognised by the constitution of India in the 8th schedule? **[2002]**
 (a) 12 (b) 14
 (c) 16 (d) 18
16. Who is known as the 'Iron Man of India'? **[2002]**
 (a) Jawaharlal Nehru
 (b) Bal Gangadhar Tilak
 (c) Sardar Vallabhbhai Patel
 (d) Mahatma Gandhi
17. The design of the National Flag was adopted by the constituent assembly of India on : **[2002]**
 (a) 26 January, 1949 (b) 26 January, 1950
 (c) 22 July, 1947 (d) 15 August, 1947

18. When was the golden jubilee of Indian Parliament celebrated ? [2002]
(a) 1st January, 1997 (b) 26th January, 2002
(c) 13th may, 2002 (d) 15th August, 1997
19. Dravida Munnetra Kargam (DMK) was founded by : [2004]
(a) M.G. Ramachandran
(b) C.N. Annadurai
(c) Kumar Swami Kamraj
(d) Lalithambika Antharjanam
20. The Planning Commission was set up in : [2005]
(a) January, 1950 (b) March, 1950
(c) January, 1952 (d) March, 1952
21. How many spokes are in Indian National Flag? [2005]
(a) 22 (b) 24
(c) 26 (d) 28
22. Who was elected as the permanent President of constituent assembly ? [2005]
(a) Dr. Sachchidanand Sinha
(b) Dr. Rajendra Prasad
(c) Dr. B. R. Ambedkar
(d) C. Rajgopalachari
23. How many articles and schedule are there in originally constitution ? [2005]
(a) 391 articles and 7 schedules
(b) 395 articles and 8 schedules
(c) 400 articles and 10 schedules
(d) 444 articles and 12 schedules
24. The Tenure of first planning holiday was [2005]
(a) 1964-1967 (b) 1965-1968
(c) 1966-1969 (d) 1978-1981
25. World Trade Organisation established in : [2005]
(a) 1954 (b) 1988
(c) 1994 (d) 1995
26. The supreme command of the defence forces is vested with the : [2006]
(a) Field Marshal
(b) Commander-in-chief
(c) Prime minister
(d) President of India
27. India's first battle field missile is : [2006]
(a) Akash (b) Prithvi
(c) Agni (d) Nag
28. Who conducts the State assembly elections? [2007]
(a) Chief Justice of the High Court concerned
(b) Chief Justice of the Supreme Court
(c) Chief Election Commissioner
(d) Governor of the state concerned
29. Who is the constitutional head of the Government of India ? [2008]
(a) President
(b) Prime Minister
(c) Chief Justice of India
(d) Attorney General
30. Which part of Indian Constitution has been described as the soul of the Constitution ? [2008]
(a) Fundamental Rights
(b) Directive Principle of State Policy
(c) The Preamble
(d) Right to Constitutional Remedies
31. The President of India can nominate [2008]
(a) 10 members to Rajya Sabha
(b) 2 members to Rajya Sabha
(c) 15 members to Rajya Sabha
(d) 12 members to Rajya Sabha
32. The Constitution of India was adopted by the Constituent Assembly on [2008]
(a) August 15, 1947
(b) June 30, 1948
(c) November 26, 1949
(d) January 26, 1950
33. Who is the Chairman of the Planning Commission ? [2008]
(a) President
(b) Prime Minister
(c) Finance Minister
(d) Governor of Reserve Bank
34. Which Plan give emphasis on removal of poverty for the first time? [2009]
(a) Fourth (b) Fifth
(c) Sixth (d) Seventh
35. The Council of Ministers does not include [2009]
(a) Cabinet Ministers
(b) Ministers of State
(c) Cabinete Secretary
(d) Ministers without portfolio
36. Attorney -General of India is appointed by [2010]
(a) Chief Justice of Supreme Court
(b) Parliament
(c) Law Minister
(d) President
37. Which one of the following Article provide 'Right to equality'? [2010]
(a) Article - 14
(b) Article -19
(c) Article - 20
(d) Article - 18

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Topicwise AIIMS Solved Papers – GENERAL KNOWLEDGE

38. First speaker of Lok Sabha was : [2011]
 (a) Sardar Hukum Singh
 (b) G. V. Mavlankar
 (c) Neelam Sanjeevan Reddy
 (d) Bali Ram Bhagat
39. What is the intermediate tier of the Panchayati Raj System called? [2012]
 (a) Zilla Parishad (b) Taluka Panchayat
 (c) Panchayat Samiti (d) Gram Sabha
40. Which of the following is associated with Panchayati Raj ? [2013]
 (a) Nanavati Commission
 (b) Balwant Rai Mehta Committee
 (c) Librahan Commission
 (d) Shah Commission
41. How many articles are there in the Indian constitution? [2014]
 (a) 395 (b) 396
 (c) 398 (d) 399
42. The Vice President of India is elected by the electoral collage consisting of the members of _____? [2015]
 1. Rajya Sabha
 2. Lok Sabha
 3. State Legislatures
- Choose the correct option from the codes given below:
 (a) Only 1 (b) Only 2
 (c) Only 1 & 2 (d) Only 1 & 3
43. In Lok Sabha of India, the "Leader of the House" is nominated by ____: [2015]
 (a) President (b) Lok Sabha Speaker
 (c) Prime Minister (d) Deputy Speaker
44. The President of India can nominate how many members to Rajya Sabha and Lok Sabha respectively? [2015]
 (a) 10, 3 (b) 12, 2
 (c) 10, 2 (d) 12, 3
45. Supreme Court judge retires upon attaining the age of [2016]
 (a) 65 years (b) 60 years
 (c) 55 years (d) 50 years
46. How many times has National Emergency been declared? [2016]
 (a) Six times (b) Three times
 (c) Five times (d) Four times
47. A Municipal Corporation is set up in a city with how much population of not less than? [2016]
 (a) 2 lakhs (b) 5 lakhs
 (c) 10 lakhs (d) 15 lakhs

ANSWER KEY

1	(b)	2	(a)	3	(c)	4	(a)	5	(a)	6	(b)	7	(b)	8	(a)	9	(a)	10	(d)
11	(d)	12	(c)	13	(c)	14	(b)	15	(d)	16	(c)	17	(c)	18	(c)	19	(b)	20	(b)
21	(b)	22	(b)	23	(b)	24	(c)	25	(d)	26	(d)	27	(b)	28	(c)	29	(a)	30	(d)
31	(d)	32	(c)	33	(b)	34	(a)	35	(c)	36	(d)	37	(a)	38	(b)	39	(c)	40	(b)
41	(a)	42	(c)	43	(c)	44	(b)	45	(a)	46	(b)	47	(c)						

1. Dachigan Wild life sanctuary in Kashmir is associated with which of the following animal ?
(a) Hangul (b) Panther [1997]
(c) Horned toed Deer (d) Sagui
2. 'Principality of Liechtenstion' is situated between Switzerland and [1997]
(a) Austria (b) France
(c) Italy (d) Germany
3. The largest producer of rubber is : [1997]
(a) Sri Lanka (b) India
(c) Japan (d) Malaysia
4. Kalpakkam in Tamilnadu is known for its : [1997]
(a) temples
(b) textiles mills
(c) handicrafts
(d) atomic power plants
5. OPEC is : [1997]
(a) Organisation of petroleum Exporting Companies
(b) Oil and Petroleum exporting Corporation
(c) Oil and petroleum Exporting Countries
(d) Organisation of Petroleum Exporting Countries
6. Sambalpur is situated on the bank in which of the following river ? [1998]
(a) Jammu (b) Saraswati
(c) Sagar (d) Mahandi
7. Seoul is the capital of : [1999]
(a) Japan (b) South Korea
(c) Afganistan (d) Philippines
8. Hirakund dam is constructed on which of the following river ? [1999]
(a) Mahanadi (b) Ganga
(c) Yamuna (d) Kosi
9. 'Sun city' is in : [2000]
(a) USA (b) South Africa
(c) France (d) Denmark
10. Which one of the least populated state in India? [2000]
(a) Nagaland (b) Himachal Pradesh
(c) Orissa (d) Sikkim
11. Shakti sthal is the name given to : [2000]
(a) The factory where India's newly designed battle tanks are being manufactured
(b) The samadhi of Indira Gandhi
(c) The nuclear reactor at KalpaKam at Chennai
(d) none of these
12. Khushi Nagar, the famous Buddhist pilgrimage centre in the state of : [2000]
(a) U.P. (b) M.P
(c) Bihar (d) Orissa
13. Nasic is situated on the bank of : [2000]
(a) Narmada (b) Krishna
(c) Kauvery (d) Godavari
14. Which city is known as Pink city ? [2000]
(a) Jaipur (b) Paris
(c) New York (d) London
15. An indian river, that does not form any delta is :
(a) Cauvery (b) narmada [2002]
(c) Yamuna (d) Singh
16. How many islands are there in lakshadweep?
(a) 47 (b) 36 [2002]
(c) 27 (d) 17
17. From which of the following places the international dateline crosses? [2003]
(a) Atlantic ocean
(b) Pacific ocean
(c) Greenwich
(d) Gape of Good Hope
18. A man-made tunnel in India transfers water from which one river to another? [2004]
(a) Narmada to Tapti
(b) Betwa to Sone
(c) Beas to Sutlej
(d) Godawari to Krishna
19. The grand Fisher Bank is situated off : [2004]
(a) the coast of New Foundland
(b) the Chilean coast
(c) the Spanish coast
(d) the coast of Great Britain
20. Which one of the following organisation's iron and steel plant was build to use charcoal as a source of power, to start with, but later switched over to hydroelectricity ? [2004]

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Topicwise AIIMS Solved Papers – GENERAL KNOWLEDGE

- (a) The Tata Iron Steel Company
(b) The Indian Iron and Steel Company
(c) Mysore Iron and Steel Company
(d) Hindustan Steel Limited
21. Rishikesh is famous for the production of
(a) antibiotics [2004]
(b) heavy electricals
(c) fertilizers
(d) transistorized radios
22. Nepanagar is famous for : [2004]
(a) paper board industries
(b) craft paper industries
(c) carbon paper industries
(d) newsprint paper industries
23. Where is 'Indira Gandhi Rashtriya Uran Akademi' situated? [2004]
(a) Dehradun (b) Raebareli
(c) Allahabad (d) Mussoorie
24. Where is 'National Defence Academy' situated? [2005]
(a) New Delhi (b) Khadakvasla
(c) Dehradun (d) Pune
25. Which river is called 'Bengal's Sorrow'? [2005]
(a) Hughli (b) Ganga
(c) Damodar (d) Koshi
26. 'Maoris' are : [2005]
(a) inhabitants of New Zealand
(b) inhabitants of Hungary
(c) inhabitants of North America
(d) inhabitants of North-West Asia
27. 'Chittaranjan' is famous for the [2005]
(a) railway coaches (b) locomotives
(c) iron and steel (d) heavy machinery
28. Sardar Sarovar Dam is built on the river [2006]
(a) Jhelam (b) Narmada
(c) Tapi (d) Vyas
29. Lagoon refers to : [2006]
(a) A full moon
(b) The sea breaking into the land and then separated by the sand dunes
(c) A spot in a desert made fertile by presence of water
(d) Horse shoe shaped coral reef
30. Ecology deals with : [2006]
(a) The earth and planets
(b) The relationship between organisms and environment
(c) The life under the sea
(d) Economical growth of poor people
31. 'Equinox' means [2007]
(a) days are longer than nights
(b) days and nights are equal
(c) days are shorter than nights
(d) none of the above
32. Which country leads in production of aluminium and aluminium goods ? [2007]
(a) Australia (b) U.S.
(c) Russia (d) Japan
33. Which is an ore of aluminium? [2007]
(a) chromite (b) cuprite
(c) bauxite (d) siderite
34. The southern tip of India is [2008]
(a) Cape Comorin (Kanyakumari)
(b) Point Calimere
(c) Indira Point in Nicobar Islands
(d) Kovalam in Thiruvananthapuram
35. The major coffee producing state in India is [2008]
(a) Kerala (b) Karnataka
(c) Tamil Nadu (d) West Bengal
36. Bauxite is an ore of [2008]
(a) Aluminium (b) Boron
(c) Lead (d) Silver
37. Which of the following methods is used to determine the age of the earth ? [2008]
(a) Carbon dating (b) Germanium dating
(c) Uranium dating (d) All of the above
38. The coastal tract of Andhra Pradesh and Tamil Nadu is called [2009]
(a) Konkan (b) Coromandel
(c) East Coast (d) Malabar Coast
39. Diamond bearing rocks occur in [2010]
(a) Panna of Madhya Pradesh
(b) Mysore of Karnataka
(c) Waltair of Andhra Pradesh
(d) Ajmer of Rajasthan
40. Highest mustard seed producing state is [2010]
(a) Maharashtra (b) Rajasthan
(c) U.P. (d) Gujarat
41. The highest city of the world is- [2011]
(a) Wan Chan (China) (b) La Paz (Bolivia)
(c) Tokyo (Japan) (d) New York (USA)
42. Kalahari desert is in [2011]
(a) North Africa (b) South Africa
(c) South America (d) Australia
43. Which of the following latitudes passes through India ? [2011]
(a) Equator
(b) Arctic Circle
(c) Tropic of Capricorn
(d) Tropic of Cancer

44. Ghataprabha is a tributary of which one of the following rivers ? [2012]
 (a) Ganga (b) Indus
 (c) Godavari (d) Krishna
45. Kiel Canal connects [2012]
 (a) Baltic Sea and North Sea
 (b) Red Ocean and Mediterranean Sea
 (c) Caribbean Sea and Pacific Sea
 (d) Atlantic Ocean and Pacific Ocean
46. The Victoria Falls in Africa is located on which river? [2012]
 (a) Zaire (b) Orange
 (c) Zambezi (d) Niger
47. The project similar to T.V.A. (Tennessee Valley Authority) of U.S.A. in India is [2013]
 (a) Damodar Valley Project
 (b) Mahanadi Delta Project
 (c) Ramganga Multipurpose Project
 (d) Idukki Project
48. Catch crops are [2013]
 (a) crops palnted to attract certain insect pests to be destroyed
 (b) crops planted to attract certain useful insects to be used for biological control of pests
 (c) crops to be cut and fed green to the cattle
 (d) substitute crops planted after the regular crop has failed.
49. Which one of the following National Park/ Sanctuary is not in Rajasthan ? [2013]
 (a) Sariska National Park
 (b) Sambar Wildlife Sanctuary
 (c) Rajaji National Park
 (d) Rhanthambore National Park
50. The black part of the moon is always calm and dark which is called [2014]
 (a) Sea of tranquility (b) Ocean of storms
 (c) Area of storms (d) None of these
51. The earth's magnetic field always has a vertical component except at the [2014]
 (a) magnetic equator
 (b) magnetic poles
 (c) geographic north pole
 (d) latitude 45°
52. Which place in India is called "The Golden Mine of Liverworts"? [2014]
 (a) Eastern Himalayas
 (b) Western Himalayas
 (c) Western Ghats
 (d) Eastern Ghats
53. As per data, which two Indian cities are at highest risk of being devastated by an earthquake? [2015]
 (a) Guwahati and Nagpur
 (b) Guwahati and Srinagar
 (c) Jamnagar and Guwahati
 (d) Nagpur and Srinagar
54. Which is the hottest planet of the solar system. [2016]
 (a) Mercury (b) Venus
 (c) Jupiter (d) Saturn
55. Which one of the following zones of the atmosphere is rich in Ozone gas [2016]
 (a) Mesosphere (b) Troposphere
 (c) Stratosphere (d) Ionosphere
56. A sand deposit extending into the mouth of a bay is a ? [2016]
 (a) Headland (b) Sea Stack
 (c) Split (d) Berm
57. Which is the Highest milk producer in India? [2016]
 (a) Madhya Pradesh (b) Andhra Pradesh
 (c) Uttar Pradesh (d) Rajasthan
58. Which is the longest bridge in India? [2017]
 (a) Bandra Worli Sea Link
 (b) Mahatma Gandhi Setu
 (c) Dhola-Sadia Bridge
 (d) Arrah-Chhapra Bridge
59. Asia's longest bi-direction road tunnel is located in———. [2017]
 (a) Jammu & Kashmir
 (b) Sikkim
 (c) Maharashtra
 (d) Himachal Pradesh

ANSWER KEY

1	(a)	2	(a)	3	(d)	4	(d)	5	(d)	6	(a)	7	(b)	8	(a)	9	(b)	10	(a)
11	(b)	12	(a)	13	(d)	14	(a)	15	(b)	16	(b)	17	(b)	18	(c)	19	(a)	20	(a)
21	(a)	22	(d)	23	(b)	24	(b)	25	(c)	26	(a)	27	(b)	28	(b)	29	(b)	30	(b)
31	(b)	32	(c)	33	(c)	34	(a)	35	(b)	36	(a)	37	(c)	38	(b)	39	(a)	40	(b)
41	(b)	42	(b)	43	(d)	44	(d)	45	(a)	46	(c)	47	(a)	48	(d)	49	(c)	50	(a)
51	(a)	52	(b)	53	(b)	54	(b)	55	(c)	56	(c)	57	(c)	58	(c)	59	(a)		

Chapter

4

G.K. – General Science

1. Halley's comet will be seen in : [1997]
 (a) 2062 (b) 2060
 (c) 2068 (d) 2066
2. Skylab was launched into space by the US in : [1997]
 (a) 1975 (b) 1974
 (c) 1973 (d) 1979
3. Which one of the following is responsible for the disease 'dropsy' ? [1999]
 (a) *Argemone maxicana*
 (b) *Brassica oleracea*
 (c) *Oenothera lamarckiana*
 (d) *Brassica campestris*
4. Which of the following vitamin is required in bone formation ? [1999]
 (a) D (b) B
 (c) C (d) A
5. Ecology is the branch of science which deals with : [1999]
 (a) cell structure (b) soils surface
 (c) balance of nature (d) human anatomy
6. The disease rheumatism affects : [1999]
 (a) legs (b) ears
 (c) lungs (d) joints
7. Weight of blood in the body is : [2000]
 (a) about 7 litres in normal body or 7% of the total body weight
 (b) about 5 litres in normal body or 5% of the total body weight
 (c) about 10 litres in normal body or 10% of the body weight
 (d) none of these
8. The earthquake is measured by : [2001]
 (a) Lactometer (b) Seismograph
 (c) Hygrometer (d) Barometer
9. AIDS is caused by : [2001]
 (a) Helminth (b) Protozoa
 (c) Virus (d) Bacteria
10. Which one of the following functions of the platelets occurs in our body? [2001]
 (a) It helps in breathing
 (b) It helps in strengthening of gums
 (c) It helps in circulation of blood
 (d) It helps in clotting of blood
11. Which one of the following vitamins can be most easily synthesised in the human body? [2001]
 (a) Vitamin B (b) Vitamin C
 (c) Vitamin A (d) Vitamin D
12. The spinning of the earth on its imaginary axis is known as : [2002]
 (a) rotation (b) circulation
 (c) orbiting (d) revolution
13. Which organ of the body purifies the blood ? [2002]
 (a) Heart (b) Lungs
 (c) Kidneys (d) Pancreas
14. Positron Emission Tomography (PET) is one of the best methods of functional imaging because [2003]
 (a) isotopes of basic body elements are used for imaging
 (b) isotopes with long half-lives are used
 (c) isotopes with short half-lives are used
 (d) positrons are directly involved in imaging
15. Magnetic Resonance (MR) images are derived from the proton-bearing species present principally from water and [2003]
 (a) long alkane chain protons of the fatty acid moieties
 (b) short alkane chain protons of the fatty acid moieties
 (c) long alkene chain protons of the fatty acid moieties
 (d) short alkene chain protons of the fatty acid moieties

16. The following separation technique depends on the molecular size of the protein : [2003]
(a) chromatography on a carboxymethyl (CM) cellulose column
(b) iso-electric focusing
(c) gel filtration chromatography
(d) chromatography on a diethylaminoethyl (DEAE) cellulose column
17. The approximate number of genes contained in the genome of Kalpana Chawala was : [2003]
(a) 40,000 (b) 30,000
(c) 80,000 (d) 1,00,000
18. Thanatology is the science that deals with [2003]
(a) death in all its aspects
(b) solving paternity of child
(c) identification of living
(d) detection of lie
19. The disease, Tetanus also known as [2003]
(a) Gangrene (b) Shingles
(c) Lockjaw (d) Whooping cough
20. It lives underwater for up to three years as nymph before emerging as a flying insect, Fossils of this insect dating back about 300 million years have been found : [2004]
(a) scorpion fly (b) stone fly
(c) caddis fly (d) May fly
21. Rayon fibre is manufactured from : [2004]
(a) petroleum (b) wood and pulp
(c) chemicals (d) naphtha
22. Maria Montessori's name is associated with : [2004]
(a) Christian mission
(b) Child education
(c) Women's rights
(d) Mission hospitals
23. The noise produced in office is normally at the level of : [2004]
(a) 20 db (b) 30 db
(c) 40 db (d) 60 db
24. Ascorbic acid is the chemical name of : [2005]
(a) vitamin A (b) vitamin B
(c) vitamin C (d) vitamin D
25. The chemical formulae of Plaster of Paris' is [2005]
(a) $\text{CaSO}_4 \cdot 2\text{H}_2\text{O}$ (b) $\text{Ca}(\text{OH})_2$
(c) $\text{CaSO}_4 \cdot 1/2\text{H}_2\text{O}$ (d) $\text{C}_2\text{H}_5\text{OH}$
26. Biometry refers to : [2006]
(a) Identification of humans by scanning face and fingerprints
(b) Measurement of mechanical displacement in humans
(c) A method of lie detection
(d) Body length relationships across the evolutionary scale
27. Which one of the following is one of the two days when the sun rises exactly in the east? [2006]
(a) 14th January (b) 21st March
(c) 21st June (d) 23rd December
28. X-rays were discovered by : [2006]
(a) Wilhelm K. Roentgen
(b) H. Kissinger
(c) Sir C.V. Raman
(d) Meghnad Saha
29. One ream of paper equal to : [2006]
(a) 100–110 sheets
(b) 256 sheets
(c) 180–500 sheets
(d) 1000 sheets
30. Which of the following gases is most toxic? [2006]
(a) Carbon dioxide (b) Carbon monoxide
(c) Sulphur dioxide (d) None of these
31. The gas used in the manufacture of vanaspati ghee is : [2006]
(a) Helium (b) Oxygen
(c) Nitrogen (d) Hydrogen
32. Which mirror is used as a rear view mirror in vehicles? [2007]
(a) plain (b) convex
(c) concave (d) spherical
33. Chemical change does not take place in [2007, 2011]
(a) souring of milk into curd
(b) rusting of iron in atmosphere
(c) burning of magnesium ribbon in air
(d) emitting of light by a red hot platinum wire
34. The process of transfer of heat by matter but without actual movement of the particles themselves is called [2007]
(a) conduction (b) convection
(c) radiation (d) none of these

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Topicwise AIIMS Solved Papers – GENERAL KNOWLEDGE

35. Only zero and one are used for operating [2007, 2011]
 (a) Calculator (b) Computer
 (c) Abacus (d) Type writer
36. Transistor is [2007]
 (a) semi conductor (b) inductor
 (c) modulator (d) demodulator
37. Computer cannot [2007]
 (a) send message (b) read files
 (c) abstract thought (d) play music
38. Which of the following is not a carbohydrate ? [2007]
 (a) wax (b) starch
 (c) sucrose (d) maltose
39. Which of the following is an eye disease? [2007]
 (a) hepatitis (b) measles
 (c) glaucoma (d) bronchitis
40. Which of the following is the vaccine for tuberculosis? [2007]
 (a) OPT (b) BCG
 (c) salk vaccine (d) rubella vaccine
41. Horns, nails and hair are [2007]
 (a) soluble fats
 (b) insoluble carbohydrates
 (c) keratin proteins
 (d) complex lipids
42. If the blood group of one parent is AB and that of the other O, the possible blood group of their child would be [2008]
 (a) A or B (b) A or B or O
 (c) A or AB or O (d) A or B or AB or O
43. The vitamin that helps to prevent infections in the human body is [2008]
 (a) vitamin A (b) vitamin B
 (c) vitamin C (d) vitamin D
44. The gas which turns into liquid at the lowest temperature among the following is [2008]
 (a) hydrogen (b) oxygen
 (c) helium (d) nitrogen
45. Which of the following disease is caused by a virus ? [2008]
 (a) Diphtheria (b) Malaria
 (c) Cholera (d) Hepatitis
46. An ECG shows the functioning of the [2009]
 (a) Brain (b) Heart
 (c) Lungs (d) Kidneys
47. The purest form of water is [2009]
 (a) Tap water (b) Rain water
 (c) Ground water (d) Distilled water
48. Which of the following means 'change' in Greek [2009]
 (a) Orangutam (b) Goat
 (c) Amoeba (d) Hydra
49. The velocity of light in a medium is maximum for that colour for which refractive index is [2010]
 (a) minimum (b) maximum
 (c) optimum (d) very high
50. Which of the following is/ are the law(s) of reflection of light? [2010]
 (a) The angle of incidence is equal to the angle of reflection.
 (b) The incident ray, the normal to the mirror at the point of incidence and the reflected ray, all lie in the same plane.
 (c) Both (a) and (b).
 (d) The angle of incidence is never equal to the angle of reflection.
51. Which of the following halo-organic compounds is used as insecticide, germicide, soil fumigant and deodorant? [2010]
 (a) Benzene hexachloride
 (b) Chlorobenzene
 (c) *p*-chlorobenzene
 (d) All of the above
52. Electronic configuration of deuterium atom is [2010]
 (a) $1s^2$ (b) $2s^1$
 (c) $1s^1$ (d) $2s^2$
53. Which of the material interactions will not promote co-evolution? [2010]
 (a) Commensalism (b) Parasitism
 (c) Heterothallism (d) All of these
54. Bence Jones protein is associated with
 (a) Lymphosarcoma
 (b) Leukaemia
 (c) Multiple myeloma
 (d) All of these
55. A MODEM is connected in between a telephone line and a [2010]
 (a) Serial port
 (b) Computer
 (c) Network
 (d) Communication adaptor

56. A sequence of precise and unambiguous instructions for solving a problem in a finite number of operations is referred as [2010]
(a) algorithm (b) address
(c) advice (d) all of these
57. Polio vaccine was first prepared by [2011]
(a) J. Salk (b) L. Pasteur
(c) G. J. Mendel (d) Watson
58. The Saturn rings were discovered by [2011]
(a) Copernicus (b) Newton
(c) Galileo (d) none of these
59. $\frac{4}{25}$ coulomb of charge contains _____ electrons. [2011]
(a) 10^{15} (b) 10^{18}
(c) 10^{20} (d) none of these
60. Fish can survive inside deep frozen ponds because [2011]
(a) Fish are cold blooded
(c) They hibernate
(c) Ice is a good conductor of heat
(d) There is water at 4°C below frozen ice
61. Which one of the following diseases is not caused by virus? [2012]
(a) Chicken pox (b) Measles
(c) Poliomyelitis (d) Tetanus
62. In the plant body, the water and minerals are transported by: [2012]
(a) Bast (b) Collenchyma
(c) Parenchyma (d) Xylem
63. What is the main constituent of natural gas ? [2012]
(a) Methane (b) Ethane
(c) Butane (d) Hydrogen
64. Which one among the following has the highest first ionisation energy ? [2012]
(a) Carbon (b) Fluorine
(c) Nitrogen (d) Oxygen
65. Chemical weathering is at its maximum in : [2012]
(a) hot and dry regions
(b) cold and humid regions
(c) hot and humid regions
(d) cold and dry regions
66. Grave's disease is caused due to: [2013]
(a) hyperactivity of thyroid
(b) hypoactivity of thymus
(c) hypoactivity of thyroid
(d) hyperactivity of thymus
67. Which one among the following is the correct order of power consumption for light of equal intensity ? [2014]
(a) CFL tube < Fluorescent tube < Incandescent bulb < Light emitting diode
(b) Light emitting diode < CFL tube < Fluorescent tube < Incandescent bulb
(c) CFL tube < Fluorescent tube < Light emitting diode < Incandescent bulb
(d) Incandescent bulb < Light emitting diode < Fluorescent tube < CFL tube
68. When a particle and an antiparticle come in contact with each other, they [2014]
(a) repel each other
(b) annihilate each other
(c) go undisturbed
(d) spin about a common axis
69. Photoelectric effect is [2014]
(a) an instantaneous process
(b) delayed process
(c) emission of protons
(d) emission of neutrons
70. Candles contains a mixture of [2014]
(a) Bees wax and paraffin wax
(b) Bees wax and stearic acid
(c) Paraffin wax and stearic acid
(d) Higher fatty acid
71. In chemical terms, what are alums used for purifying water for drinking purposes ? [2014]
(a) Hydrated chlorides
(b) Double nitrate
(c) Double sulphates
(d) Nitrates of aluminium
72. Each body segment of Earthworm is called [2014]
(a) Proglottid (b) Metamere
(c) Scolex (d) Rostellum
73. The hydraulic brake used in automobiles is a direct application of [2014]
(a) Archimedes' principle
(b) Torricellian law
(c) Bernoulli's Theorem
(d) Pascal's law

1. In which of the following year Olympic Games were not played ? **[1997]**
 (a) 1936 (b) 1925
 (c) 1916 (d) 1932
2. The male cricketer who scored maximum runs in one day cricket match : **[1997]**
 (a) Azharuddin (b) Vivian Richards
 (c) Sachin Tendulkar (d) Sayeed Anwar
3. Writer of Future Shock is **[1997]**
 (a) Bernad shaw (b) Bertrand
 (c) Sewitzer (d) Alwyn Toffler
4. Deep Blue is a : **[1997]**
 (a) computer which gives weather report
 (b) computer operating system
 (c) blue whale
 (d) computer which plays chess
5. The 'AIDS' day is observed on : **[1997]**
 (a) 10th Dec. (b) 21st Dec.
 (c) 20 Dec. (d) 1st Dec.
6. Asian Games were held in India : **[1997]**
 (a) 1961 and 1984 (b) 1956 and 1986
 (c) 1962 and 1984 (d) 1957 and 1982
7. Ruble is the currency of : **[1997]**
 (a) USSR (b) Denmark
 (c) Germany (d) Japan
8. The trade name IBM associated with : **[1997]**
 (a) scooters (b) refrigerators
 (c) cars (d) computers
9. Which plant was responsible for Bhopal Gas Tragedy? **[1997]**
 (a) BHEL
 (b) Union Carbide
 (c) Hindustan Insecticides
 (d) None of these
10. Libra is the currency of which of the following country? **[1998]**
 (a) Spain (b) Vietnam
 (c) Philippines (d) Turkey
11. Which one of the following is the biggest cave temple in India ? **[1998]**
 (a) Ajanta (b) Tuljapur
 (c) Ellora (d) Parli
12. The largest airport in the world is situated in
 (a) Saudi (b) USSR **[1998]**
 (c) Russia (d) Denmark
13. Martyr day is observed on : **[1998]**
 (a) 18 April (b) 12 May
 (c) 29 August (d) 30 January
14. National Housing Bank is subsidiary of : **[1998]**
 (a) R.B.I. (b) I.D.B.I.
 (c) I.C.I.C.I. (d) S.B.I.
15. What is Nikkie? **[1998]**
 (a) Index of shares in Tokyo stock exchange
 (b) Rate of interest by Bank of Tokyo
 (c) A private firm situated in Japan
 (d) Currency of Korea
16. 'Frank Worrel was associated with which of the following sport ? **[1998]**
 (a) Hockey (b) Football
 (c) Swimming (d) Cricket
17. India's multi largest surface to air missile is known as : **[1998]**
 (a) Nag (b) Agni
 (c) Prithvi (d) Akash
18. Beighton cup in India is associated with : **[1998]**
 (a) Cricket (b) Foot ball
 (c) Volleyball (d) Hockey
19. Which one of the following book is written by Sarojini Naidu ? **[1998]**
 (a) Gandevata (b) Chitra
 (c) Broken wing (d) Great Tragedy
20. The common wealth games of 1998 were hosted by
 (a) Singapore (b) England **[1998]**
 (c) Malaysia (d) Australia
21. The old name of Thailand is : **[1998]**
 (a) Combodia (b) Siam
 (c) Zaire (d) Persia
22. Which one of the following country is not the member of SAARC ? **[1999]**
 (a) Maldeiv (b) Bangladesh
 (c) Nepal (d) Myanmar
23. Hari Prasad Chaurasia is related to which of the following instrument ? **[1999]**
 (a) Tabla (b) Flute
 (c) Violin (d) Santoor

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Topicwise AIIMS Solved Papers – GENERAL KNOWLEDGE

24. Which of the following missile of India has the longest range ? [1999]
 (a) Akash (b) Prithvi
 (c) Pinaka (d) Both (b) and (c)
25. Which one of the following is the cave temple in India ? [1999]
 (a) Ellora (b) Ajanta
 (d) Parli (d) Tuljapur
26. Which one of the following pair is incorrect ? [1999]
 (a) Kapil – Cricket
 (b) M. F. Husain – Actor
 (c) Abul Fazal – Author
 (d) Feroz Gandhi – Politics
27. The great poetry 'Madhushala' was composed by : [1999]
 (a) Mulk Raj Anand
 (b) Harivansh Rai Bachchan
 (c) Mahadevi Verma
 (d) Surender Sharma
28. Grand prix is a term associated with : [1999]
 (a) Chess (b) Table tennis
 (c) Hockey (d) Badminton
29. William's cup is related to : [2000]
 (a) basket ball (b) table tennis
 (c) volley ball (d) foot ball
30. Full form of H.T.T.P. is : [2000]
 (a) Hyper Terminal Transformation
 (b) Hyper Text Transfer Protocol
 (c) High Technology Test Principles
 (d) Hyper Text Training Program
31. Tallest tower in the world is : [2000]
 (a) C.N.Tower (b) Kutub Minar
 (c) Angel (d) None of these
32. 'The Satanic Verses' a controversial book is written by : [2000]
 (a) Gyani Jail Singh (b) Khuhwant Singh
 (c) Kuldeep Nayyar (d) Salman Rushdie
33. World Tourism day was declared on : [2000]
 (a) 1st October (b) 11th February
 (c) 27th September (d) none of these
34. Which one of first Indian missile (earth to earth) was tested successfully from Shri Hari Kota ? [2000]
 (a) Prithvi (b) Nag
 (c) Agni (d) none of these
35. "Divine" comedy was written by : [2000]
 (a) Goethe (b) Milton
 (c) Dante (d) Shakespears
36. 'Abhigyan shakuntalam' was written by : [2000]
 (a) Surdas (b) Tulsidas
 (c) R.N. Tagore (d) Kalidas
37. Who was known as the "Lady of the Lamp"? [2000]
 (a) Sarojini Naidu
 (b) Joan of Arc
 (c) Florence Nightingale
 (d) None of these
38. Rial is the currency of : [2000]
 (a) Afganistan (b) Iran
 (c) Saudi Arabia (d) Jordan
39. The writer of "Daughter of East" is : [2001]
 (a) Indira Gandhi (b) Benazier Bhutto
 (c) Amrita Pritam (d) Marget Thatcher
40. Which one of the following is the largest bridge? [2001]
 (a) Seawise (b) Petronas
 (c) Strahov (d) George
41. Teacher day is celebrated on : [2001]
 (a) 5th September (b) 16 August
 (c) 21 September (d) 1st April
42. Who discovered the sea route to India? [2001]
 (a) Vasco de Gama (b) Columbus
 (c) Magellan (d) Hopkins
43. Garba dance is a dance style of : [2001]
 (a) Gujrat (b) Uttar Pradesh
 (c) Nagaland (d) Bihar
44. A former cricketer after whose name no championship has been started in India : [2001]
 (a) G. K. Naidu (b) Daleep Singh
 (c) Lala Amarnath (d) Vijay Merchant
45. Currency note bearts the signature of the : [2001]
 (a) Finance Minister
 (b) Governor, Reserve Bank of India
 (c) Cabinet Secretary
 (d) President
46. When was the first football world cup held? [2002]
 (a) 1930 (b) 1950
 (c) 1954 (d) 1968
47. 'Human Organ Development Centre for Transplantation' is going to be established in India at : [2002]
 (a) Vellore (b) Mumbai
 (c) Hyderabad (d) Chennai
48. July 11 is celebrated as [2002]
 (a) Doctor's Day
 (b) Van Mahotsava Day
 (c) AIDS Day
 (d) World Population day
49. Which one of the classical dance forms originated in Andhar Pradesh? [2002]
 (a) Odissi (b) kathakali
 (c) Kuchipudi (d) Bharat Natyam
50. Who is called Nightingale of India [2002]
 (a) Indira Gandhi
 (b) Lata mangeshker
 (c) Asha Bhonsle
 (d) Sarojini Naidu

51. In Internet what does 'http' mean? [2003]
 (a) High Transfer Text Protocol
 (b) Highest Transfer Text Protocol
 (c) Hyper Text Transfer Protocol
 (d) Hyper Transfer Text Protocol
52. The India-born US physicist who was awarded the Nobel Prize in Physics for his work on astrophysics is : [2003]
 (a) H. G. Khorana
 (b) Subrahmanyam Chandrashekhara
 (c) Sivaramakrishna Chandrashekhara
 (d) C.V.Raman
53. Which German Physicist invented the electron microscope which won him the 1986 Nobel Prize in Physics ? [2003]
 (a) E. Ruska (b) Van't Hoff
 (c) J. H. D. Jensen (d) Eugene P. Wigner
54. Who was the first Indian to be awarded the world Food Prize in 1987? [2003]
 (a) M. S. Swaminathan
 (b) Sunderlal Bahuguna
 (c) Anna Hazare
 (d) B. R. Barwale
55. Israel's Prime Minister Yitzhak Rabin won the Nobel Prize for : [2003]
 (a) Peace (b) Literature
 (c) Chemistry (d) Economics
56. Who was the world's first space tourist? [2003]
 (a) Desmond Rickett (b) Dennis Tito
 (c) Igor Kajlnikov (d) Li Wang
57. How many "World Cultural Heritage Sites" are in India ? [2003]
 (a) 10 (b) 17
 (c) 14 (d) 15
58. Birbal Sahni was a : [2004]
 (a) zoologist
 (b) founder of Central Drug Research Institute
 (c) ornithologist
 (d) paleobotanist
59. Primary sector refers to : [2004]
 (a) industry (b) agriculture
 (c) trade (d) banks
60. All of the following won the title of 'Miss World' except : [2004]
 (a) Lara Dutta (b) Aishwarya Rai
 (c) Yukta Mukhi (d) Priyanka Chopra
61. All of the following are correct about 'Media Lab' except : [2004]
 (a) the third media lab is situated in india
 (b) it is supported by government funding
 (c) it is interdisciplinary i.e., involves sociologists, economist, computer sciences etc.
 (d) it plans to produce wearable computer
62. Who one of the following is a medical doctor ? [2004]
 (a) Samuel Taylor Coleridge
 (b) John Webster
 (c) Somerset Maugham
 (d) Thomas Gray
63. Who was the first Indian to win Nobel Prize? [2005]
 (a) Mother Teresa
 (b) C.V.Raman
 (c) Ravindra Nath Tagore
 (d) Amartya Sen
64. Oldest religious text in the world is : [2005]
 (a) Rig Veda (b) Sama Veda
 (c) Yajur Veda (d) Atharva Veda
65. Who is the inventor of 'Insulin'? [2005]
 (a) Loard Lister (b) Jonos Salk
 (c) Ronald Ross (d) Banting and Best
66. Who is the author of 'An Area of Darkness'? [2005]
 (a) Nirad C. Choudhari
 (b) Vikram Seth
 (c) V.S. Naipaul
 (d) B.C. Chatterjee
67. Which one of the following literary titles is correctly matched with its author? [2006]
 (a) Ramayan – Tulsidas
 (b) Mahabharat – Vedvyas
 (c) Kumarsambhav – Ravidas
 (d) Shakuntala – Bhushan
68. The jungle in Rudyard Kipling's Jungle book, describes which part of Indian forest ? [2006]
 (a) Central Indian forest near Satpura range
 (b) Uttranchal thick forest
 (c) Himalayan Forest in Himachal
 (d) Nilgiri Jungles
69. Which of the following honour is given by UNESCO? [2006]
 (a) The Kalinga Prize
 (b) Magasay Award
 (c) Pulitzer Prize
 (d) Order of the Golden Ark Award
70. 'Body line' in the cricket refers to : [2006]
 (a) Bowling that hits the body
 (b) The line of body chose to wicket line
 (c) The white line on ground within which the player sands
 (d) The line of moving ball
71. 'Hindu view of life' is written by : [2006]
 (a) S.Radhakrishnan (b) R.K. Narayan
 (c) V.D. Savarkar (d) John Ruskin

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Topicwise AIIMS Solved Papers – GENERAL KNOWLEDGE

72. The compilation "Meri Ekyawan Kavitaayen's is by [2007]
 (a) A.B. Vajpayee
 (b) Harivanshrai Bachchan
 (c) Dharam Vir Bharti
 (d) Shiv Mangal Singh Suman
73. Who was known as "Nightingale of India"? [2007]
 (a) Vijaylaxmi Pandit (b) Sarojini Naidu
 (c) Suraiya (d) None of these
74. Kalidas was [2007]
 (a) A poet during the Gupta period
 (b) A dramatist during Harshvardhana's reign
 (c) An astronomer during Gupta period
 (d) None of the above
75. India's first human DNA Bank has been setup in
 (a) Patna (b) New Delhi [2008]
 (c) Lucknow (d) Kolkata
76. What is the motto incorporated under our National Emblem? [2008]
 (a) Satyam Shivam
 (b) Satyam Shivam Sundaram
 (c) Satyameva Jayate
 (d) Jai Hind
77. Bhabha Atomic Research Centre is situated in
 (a) Delhi (b) Mumbai [2009]
 (c) Chennai (d) Hyderabad
78. FERA in India has been replaced by [2009]
 (a) FEPA (b) FEMA
 (c) FENA (d) FETA
79. The missile Agni II of India is a [2009]
 (a) Nuclear missile
 (b) Surface-to-air missile
 (c) Surface-to-surface missile
 (d) Surface-to-sea missile
80. Amjad Ali Khan is a maestro with which instrument? [2009]
 (a) Violin (b) Sitar
 (c) Sarod (d) Sarangi
81. With which sport do you associate the name of Geet Sethi? [2009]
 (a) Golf (b) Billiards
 (c) Lawn Tennis (d) Cricket
82. In which of the following games, left hand is not to be used? [2009]
 (a) Tennis (b) Hockey
 (c) Polo (d) cricket
83. Among countries given below, Albert Einstein had citizenship of which country along with Germany and US? [2009]
 (a) Sweden (b) Austria
 (c) Israel (d) Netherlands
84. Environment Day is celebrated on [2009]
 (a) 5th June (b) 11th Sep.
 (c) 20th Feb. (d) 5th Oct.
85. Among which of the below is a script? [2009]
 (a) Hindi (b) English
 (c) Gurumukhi (d) Sanskrit
86. On which cartoon character's name a gene is also named : [2009]
 (a) Tintin (b) Sonic
 (c) Asterix (d) Obedix
87. Which of the following river's name means 'Elephant-river' [2009]
 (a) Krishna (b) Errabadi
 (c) Godavari (d) Mahanadi
88. Reserve Bank of India's emblem carries the sketch of a tiger and a tree. What kind of tree is depicted in this emblem? [2010]
 (a) Palm tree (b) Cactus
 (c) Banyan (d) Banana
89. The term 'smash' in sports is associated with
 (a) Lawn Tennis (b) Badminton
 (c) Volleyball (d) Hockey
90. Match List-I (personality) with List-II (their field of activity) and select the correct combination/option : [2010]
- | List - I | List - II |
|--------------------------|-------------------|
| (A) Yamini Krishnamurthy | (1) Paintings |
| (B) Wasim Jaffer | (2) Politics |
| (C) Raja Ravi Verma | (3) Bharat Natyam |
| (D) Rahul Gandhi | (4) Cricket |
- Code :
 (A) (B) (C) (D)
 (a) 3 4 1 2
 (b) 3 4 2 1
 (c) 2 4 3 1
 (d) 4 2 1 3
91. Which of the following sites has been included in UNESCO's list of World Heritage sites? [2010]
 (a) Akbar's Tomb at Sikandara
 (b) Gateway of India (Mumbai)
 (c) Agra Fort
 (d) Bibi ka Maqbara (Aurangabad)
92. With which program, the slogan 'Do Boond Jindgi Ki' is associated? [2010]
 (a) Blood Donation (b) Save Water
 (c) Pulse Polio (d) Pollution Control
93. On whose birthday is Teacher's Day celebrated? [2011]
 (a) S. Radhakrishnan
 (b) Maulana Abul Kalam Azad
 (c) Rajendra Prasad
 (d) Jawaharlal Nehru

94. Dronacharya Award is given to [2011]
 (a) fire fighting operation
 (b) archery
 (c) outstanding coaching in sports and games
 (d) outstanding coaching in athletics
95. Yuan is the currency of [2011]
 (a) China (b) Indonesia
 (c) Thailand (d) Japan
96. National game of Australia is [2011]
 (a) base -ball (b) cricket
 (c) rugby football (d) hockey
97. Which one of the following pairs is not correctly matched ? [2012]
- | State/U.T. | High Court |
|---------------------------------|------------|
| (a) Goa | – Bombay |
| (b) Andaman and Nicobar Islands | – Calcutta |
| (c) Sikkim | – Guwahati |
| (d) Pondicherry | – Madras |
98. Who is the author of Das Kapital ? [2012]
 (a) Karl Marx (b) Friedrich Engels
 (c) Joseph Stalin (d) Vladimir Lenin
99. Which National Highway connects Delhi and Mumbai? [2012]
 (a) NH6 (b) NH8
 (c) NH10 (d) NH12
100. Who among the following advocated scientific socialism? [2012]
 (a) Robert Owen
 (b) Proudhon Pierre Joseph
 (c) Karl Marx
 (d) Saint Simon Henri Claude
101. Where are the headquarters of the UNO ? [2012]
 (a) Geneva (b) The Hague
 (c) New York (d) Paris
102. For controlling inflation, the central bank should [2013]
 (a) sell Government securities in the open market
 (b) lower the bank rate
 (c) purchase Government securities in the open market
 (d) lower the reserve ratio of the banks
103. United Nations Conference on Environment and Development is called [2013]
 (a) Earth Summit (b) Water Summit
 (c) Air Summit (d) Resource Summit
104. The five permanent members of the U.N. Security Council are [2013]
 (a) China, France, Russia, U.K. and U.S.A.
 (b) China, Canada, France, U.S.A and Germany
 (c) China, Germany, Russia, U.K. and U.S.A.
 (d) China, Germany, U.S.A., U.K and Canada
105. Which of the following is not correctly paired? [2013]
 (a) Jwala Gutta — Tennis
 (b) Virat Kohli — Cricket
 (c) Harbhajan Singh — Kabaddi
 (d) Saina Nehwal — Badminton
106. Which one of the following is an example for a non-economic good? [2013]
 (a) Doctor's service (b) Teacher's service
 (c) Mother's service (d) Banker's service
107. Which one of the following does not match? [2013]
 (a) Hindu Marriage Act : 1955
 (b) Medical Termination of Pregnancy Act : 1971
 (c) Domestic Violence on women Act : 1990
 (d) Cruelty against Women : 1995
108. Ward Cunningham is famous for developing for the first time [2013]
 (a) the free encyclopedia on Internet
 (b) a computer language called 'Java'
 (c) a digital camera
 (d) a software which can take Hebrew language as input
109. Which of the following is/are instance(s) of violation of human rights? [2013]
 1. A person was detained by the security forces while going for casting vote in Parliamentary Election.
 2. A civilian was killed by the army while undertaking combing operation.
 Select the correct answer using the code given below:
Code:
 (a) 1 only (b) 2 only
 (c) Both 1 and 2 (d) Neither 1 nor 2
110. Navroze is a festival celebrated in India by the [2013]
 (a) Hindus (b) Muslims
 (c) Parsis (d) Christians
111. Who is the author of the book 'Conquest of Self'? [2014]
 (a) Aurobindo Ghosh
 (b) Rabindra Nath Tagore
 (c) Mahatma Gandhi
 (d) S. Radhakrishnan
112. Who is known as the 'Picasso of India'? [2014]
 (a) Amrita Shergil (b) M.F. Hussain
 (c) Sudhir Vyas (d) Shafqat Hussain
113. Which is the capital of Mali ? [2014]
 (a) Mopti (b) Bamako
 (c) Cairo (d) Nairobi
114. Which one of the following though called a garden is infact, not a garden? [2014]
 (a) Vrindavan Garden of Mysore
 (b) Hanging Garden of Mumbai
 (c) Eden Garden of Kolkata
 (d) Shalimar Garden of Kashmir

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Topicwise AIIMS Solved Papers – GENERAL KNOWLEDGE

115. Who advocated the adoption of 'PURA' model to eradicate rural poverty? [2014]
 (a) Dr. A. P. J. Abdul Kalam
 (b) Sri Abhijit Sen
 (c) Maulana Abdul Kalam Azad
 (d) Prof. A. M. Patha
116. Who caught the wicket of Sachin Tendulkar in his last match? [2014]
 (a) Chris Gayle
 (b) Darren Sammy
 (c) Shiv Narayan Chandrapaul
 (d) Dwane Bravo
117. Gilt-edged market stands for.....? [2015]
 (a) bullion market
 (b) market of government securities
 (c) market of guns
 (d) market of pure metals
118. The best indicator of economic development of a country is _____? [2015]
 (a) Its agriculture
 (b) Its transport
 (c) Its gross production
 (d) Its per capita income
119. The data of estimation of India's National income is issued by? [2015]
 (a) Planning Commission
 (b) National Data Center
 (c) Central Statistical Organisation
 (d) None of above
120. First five year plan in India was from? [2015]
 (a) 1947–1952 (b) 1949–1954
 (c) 1950–1955 (d) 1951–1956
121. The banks are required to maintain a certain ratio between their cash in hand and total assets. This is called? [2015]
 (a) Statutory Liquid Ratio
 (b) Cash Reserve Ratio
 (c) Liquid Ratio
 (d) Statutory Ratio
122. Which movie has won maximum awards at the International Indian Film Awards? [2015]
 (a) Queen (b) Ek Villain
 (c) Haider (d) PK
123. Who has made the first attempt to initiate economic planning in India? [2016]
 (a) M. Visvesvaraya (b) Zakir Hussain
 (c) Amartya Sen (d) Narendra Modi
124. When was decimal coinage introduced in India? [2016]
 (a) 1949 (b) 1965
 (c) 1935 (d) 1957
125. Who founded the Ayurveda system of medicine? [2016]
 (a) Susruta (b) Thirumoolar
 (c) Atreya (d) Agasthiya
126. What is the full form of GST? [2017]
 (a) General Sales Tax
 (b) Goods and Sales Tax
 (c) Goods and Services Tax
 (d) General Services Tax
127. ICMR signs agreement to provide healthcare through solar based solutions. What is the full form of ICMR? [2017]
 (a) Indian Council of Medical Research
 (b) International Council of Medical Research
 (c) India Council of Medical Research
 (d) Indian Counciling of Medical Research
128. Which tiger reserve in Madhya Pradesh has become the first tiger reserve in India to officially introduce a mascot which has been named Bhoorsingh the Barasingha? [2017]
 (a) Kanha Tiger Reserve
 (b) Kaziranga Tiger Reserve
 (c) Buxa Tiger Reserve
 (d) Sunderbans Tiger Reserve

ANSWER KEY

1	(c)	2	(d)	3	(d)	4	(d)	5	(d)	6	(d)	7	(a)	8	(d)	9	(b)	10	(b)
11	(b)	12	(a)	13	(a)	14	(a)	15	(b)	16	(b)	17	(b)	18	(a)	19	(b)	20	(c)
21	(b)	22	(d)	23	(b)	24	(b)	25	(a)	26	(b)	27	(b)	28	(a)	29	(a)	30	(b)
31	(a)	32	(d)	33	(c)	34	(a)	35	(c)	36	(d)	37	(c)	38	(b)	39	(b)	40	(d)
41	(a)	42	(a)	43	(a)	44	(c)	45	(b)	46	(a)	47	(c)	48	(d)	49	(a)	50	(d)
51	(c)	52	(b)	53	(a)	54	(a)	55	(a)	56	(b)	57	(b)	58	(d)	59	(b)	60	(a)
61	(d)	62	(c)	63	(c)	64	(a)	65	(b)	66	(c)	67	(b)	68	(a)	69	(a)	70	(a)
71	(a)	72	(a)	73	(b)	74	(a)	75	(c)	76	(c)	77	(b)	78	(b)	79	(b)	80	(c)
81	(b)	82	(c)	83	(b)	84	(a)	85	(c)	86	(b)	87	(b)	88	(a)	89	(b)	90	(a)
91	(c)	92	(c)	93	(a)	94	(c)	95	(a)	96	(b)	97	(c)	98	(a)	99	(b)	100	(c)
101	(c)	102	(a)	103	(a)	104	(a)	105	(c)	106	(c)	107	(c)	108	(a)	109	(c)	110	(d)
111	(c)	112	(b)	113	(b)	114	(c)	115	(a)	116	(b)	117	(b)	118	(d)	119	(c)	120	(d)
121	(a)	122	(c)	123	(a)	124	(d)	125	(a)	126	(c)	127	(a)	128	(a)				

1. Noble Prize for physiology and medicine for the year 1998 was given for the discovery of :
(a) Prion (b) Viagra [1999]
(c) Streptomycin (d) Invading germs
2. How many countries adopted Euro currency?
(a) 11 (b) 6 [1999]
(c) 9 (d) 8
3. Present speaker in 12th Lok Sabha is : [1999]
(a) G. M. C. Balayogi
(b) Nazma Haptullah
(c) P. A. Sangama
(d) Murali Manohar Joshi
4. Miss Universe event 2000 was held at [2001]
(a) Puerto Rico
(b) London
(c) Paris
(d) Nicosia (Cyprus)
5. Who was chosen 'Time Magazines Person' for the year 2001? [2002]
(a) Collin Powel (b) Mike Monore
(c) George Bush (d) Rudolf Guilani
6. Which of the following Hindi Indian movies Language film for Oscar Award 2002? [2002]
(a) Mansoon Wedding
(b) Dil Chahata Hai
(c) Gadar Ek Prem Katha
(d) Lagaan
7. Men's Single US Open, 2001 Championship won by : [2002]
(a) Leyton Herwitt (b) Pete Sampras
(c) Safin (d) Stefan Edberg
8. Who is CEAT International Cricketer of the year 2000-2001? [2002]
(a) Sachin Tendulkar
(b) Muttiah Muralitharan
(c) Shane Warne
(d) Brayan Lara
9. When seen from earth, which of the following planet eclipsed (crossed a cross) of the sun on 7 May, 2003? [2003]
(a) Mercury (b) Uranus
(c) Saturn (d) Jupiter
10. In the year (2003) the chemistry Nobel Prize was awarded to the following work : [2004]
(a) aquaporins (b) Na⁺⁺ channels
(c) Ca⁺⁺ channels (d) methyl chavicol
11. Who is known as 'Deshbandhu'? [2004]
(a) Chandra Shekhar (b) C.R Das
(c) A.O. Hume (d) Annie Besant
12. The Ramakrishna Mission was established by
(a) Swami Vivekananda [2004]
(b) Ramakrishna Paramhansa
(c) Swami Dayanand Saraswati
(d) None of these
13. In which space Shuttle Kalpana Chawla killed
(a) Discovery (b) Columbia [2005]
(c) Sputnik (d) None of the above
14. A very much publicized treatment method "DOTS" is being adopted for the cure of :
(a) Dementia [2006]
(b) Tetanus
(c) Tuberculosis
(d) Sexually transmitted disease
15. Which of the following Indian cricket player after India-Pakistan ODI (one-day International) at Abudhabi became no. 1 ODI batsman in the ICC (international Cricket Club) ranking : [2006]
(a) Rahul Dravid (b) Yuvraj
(c) Sachin Tendulkar (d) M.S. Dhoni
16. Who is the highest wicket taker in Indian Cricket team ? [2007]
(a) Javagal Srinath (b) Anil Kumble
(c) Maninder Singh (d) Kapil Dev
17. India test-fired Agni III on [2008]
(a) May 7, 2008 (b) March 20, 2008
(c) May 20, 2008 (d) March 7, 2008
18. The train which was started on April 14, 2008 between Kolkata (India) and Dhaka (Bangladesh) has been named ? [2008]
(a) Shanti Express
(b) Maitri Express
(c) Aman Express
(d) Samjhauta Express

G-22

Topicwise AIIMS Solved Papers – GENERAL KNOWLEDGE

19. Which cricketer holds the record for scoring highest number of runs in a test match innings? [2008]
 (a) Gary Sobers (b) Vivian Richards
 (c) Sunil Gavaskar (d) Brian Lara
20. What is the name given to the common currency of the European Union? [2009]
 (a) Rupee (b) Euro
 (c) Rouble (d) Franc
21. Who has written "Two Lives"? [2010]
 (a) Vikram Seth (b) Kiran Desai
 (c) Arundhati Roy (d) Khushwant Singh
22. Who amongst the following is the ICC Cricketer of the year? [2011]
 (a) Sachin Tendulkar (b) Kevin Pietersen
 (c) M. S. Dhoni (d) Sanath Jayasuriya
 (e) None of these
23. 'Goodbye Shahzadi' is a book written by- [2011]
 (a) Shyam Bhatia (b) Ashok Mehra
 (c) Janardhan Thakur (d) Arun Gandhi
 (e) None of these
24. Who is Robert Zoelick? [2011]
 (a) IMF Chief
 (b) World Bank President
 (c) ADB President
 (d) Chief UNIDO
 (e) None of these
25. Which country's Parliament has banned 'Burqa' by passing a law of 14th September, 2010? [2011]
 (a) USA (b) France
 (c) Italy (d) Holland
26. Which among the following is not correct with regard to Sampoorna Grameen Rozgar Yojana?
 (1) The cash component of the programme is borne exclusively by the Central Government.
 (2) Foodgrains are provided free of costs to the States/Union Territories.
 Select the answer using the code given below:
 (a) (1) only (b) (2) only [2012]
 (c) Both (1) and (2) (d) Neither (1) nor (2)
27. Which of the following countries does not belong to the group of G-8 nations? [2012]
 (a) Italy (b) Canada
 (c) Germany (d) Australia
28. Who is author of *One Night @ the Call Centre*? [2013]
 (a) Vikram Seth (b) Chetan Bhagat
 (c) Anurag Mathur (d) Robin Sharma
29. Schemes run under the National Rural Employment Guarantee Act are sponsored [2013]
 (a) by the Central Government alone
 (b) partly by the Central Government and partly by the State Government
 (c) by Centre, State and Panchayat bodies together
 (d) on public-private partnership basis
30. 'Catch Me If You Can' is a Hollywood movie made on the life of Frank Abagnale who was [2013]
 (a) a famous lawyer
 (b) a famous swimmer
 (c) a famous sprinter
 (d) an infamous imposter
31. Who among the following was awarded the first Tagore Award for Cultural Harmony for the year 2012? [2013]
 (a) Jasraj (b) Ravi Shankar
 (c) Nikhil Banerjee (d) Bhimsen Joshi
32. Which team has won the Men's National Hockey Championship? [2015]
 (a) Karnataka (b) Telangana
 (c) Indian Railways (d) Madhya Pradesh
33. Which bank won the Asian Banker Achievement Award? [2015]
 (a) ICICI Bank
 (b) Bharatiya Mahila Bank
 (c) State Bank of Mysore
 (d) Axis Bank
34. Which among the following state does not implement the National Food Security Act recently empowers 87% of the priority households? [2016]
 (a) Manipur
 (b) Sikkim
 (c) Nagaland
 (d) Arunachal Pradesh
35. Smt. Maneka Sanjay Gandhi launched Beti Bachao Beti Padhao Scheme in additional how many districts of the country? [2016]
 (a) 66 (b) 67
 (c) 51 (d) 61
36. Which Government banned digging of bore wells beyond 200ft to prevent the declining of Ground water level? [2016]
 (a) Tamilnadu (b) B.Karnataka
 (c) Madhya Pradesh (d) Maharashtra

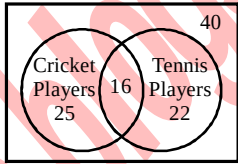
- ## ANSWER KEY

[illegible]

Chapter

7

G.K. – Logical Thinking

1. A duck, a goose, a goat, and a horse all entered the bar n at different times one day last week. [2017]
- (1) A mammal entered the bar n first.
 - (2) The duck entered before the goose.
 - (3) The goose entered ahead of the horse.
- Who entered the bar n first?
- (a) A goat (b) A duck
 - (c) A goose (d) A horse
2. Choose or find odd word [2017]
- (a) Piano (b) Guitar
 - (c) Sitar (d) Violin
3. If Ram lives east of a post office. In the north of post office is big bazar. Then what is the position of Ram's house with respect to the post office? [2017]
- (a) North-west (b) North-east
 - (c) South-west (d) South-east
4. Find out the number of students who play only cricket. [2017]
- 
5. Arrange the following words as per order in the dictionary [2017]
1. Eyelid 2. Eyeless 3. Eyesore 4. Eyesight
- (a) 2, 1, 4, 3 (b) 2, 1, 3, 4
 - (c) 4, 3, 1, 2 (d) 4, 2, 3, 1
6. If the day before yesterday was Thursday, when will Sunday be? [2017]
- (a) Today
 - (b) Two days after today
 - (c) Tomorrow
 - (d) Day after Tomorrow

ANSWER KEY

1	(d)	2	(a)	3	(d)	4	(a)	5	(a)	6	(c)

Mock AIIMS

Time : 3½ Hrs.

Questions : 200

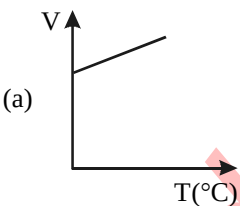
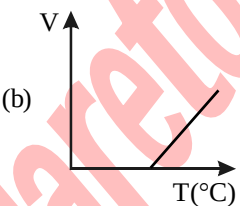
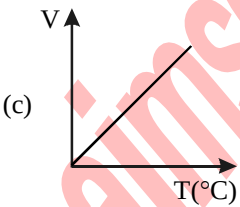
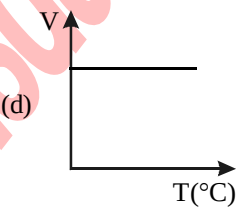
Maximum Marks : 200

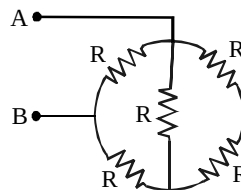
Negative Marking : $-1/3$ for each incorrect answer.

SECTION I - PHYSICS

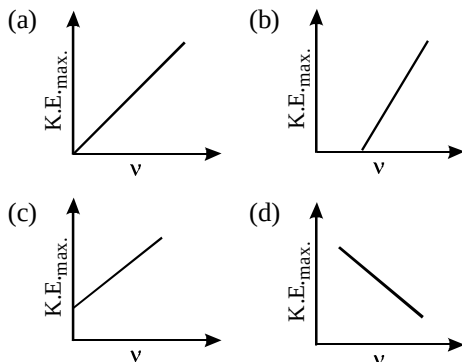
- A block is kept on an inclined plane of inclination θ of length ℓ . The velocity of particle at the bottom of inclined is (the coefficient of friction is μ)
 - $[2g\ell(\mu \cos \theta - \sin \theta)]^{1/2}$
 - $\sqrt{2g\ell(\sin \theta - \mu \cos \theta)}$
 - $\sqrt{2g\ell(\sin \theta + \mu \cos \theta)}$
 - $\sqrt{2g\ell(\cos \theta + \mu \sin \theta)}$
- If earth is supposed to be a sphere of radius R , if g_{30} is value of acceleration due to gravity at latitude of 30° and g at the equator, the value of $g - g_{30}$ is
 - $\frac{1}{4}\omega^2 R$
 - $\frac{3}{4}\omega^2 R$
 - $\omega^2 R$
 - $\frac{1}{2}\omega^2 R$
- An organ pipe open at one end is vibrating in first overtone and is in resonance with another pipe open at both ends and vibrating in third harmonic. The ratio of length of two pipes is
 - 1 : 2
 - 4 : 1
 - 8 : 3
 - 3 : 8
- A coil takes 15 min to boil a certain amount of water, another coil takes 20 min for the same process. Time taken to boil the same amount of water when both coils are connected in series,
 - 5 min
 - 8.6 min
 - 35 min
 - 30 min
- Two capillaries of length L and $2L$ and of radius R and $2R$ are connected in series. The net rate of flow of fluid through them will be (given rate to the flow through single capillary, $X = \frac{\pi P R^4}{8\eta L}$)
 - $\frac{8}{9}X$
 - $\frac{9}{8}X$
 - $\frac{5}{7}X$
 - $\frac{7}{5}X$
- A charge q is fixed. Another charge Q is brought near it and rotated in a circle of radius r around it. Work done during rotation is
 - zero
 - $\frac{Q \cdot q}{4\pi\epsilon_0 r}$
 - $\frac{Q \cdot q}{2\epsilon_0 r}$
 - None of these
- Advantage of optical fibre
 - high bandwidth and EM interference
 - low band width and EM interference
 - high band width, low transmission capacity and no EM interference
 - high bandwidth, high data transmission capacity and no EM interference.
- In an electromagnetic wave, direction of propagation is in the direction of
 - $\vec{E}$
 - $\vec{B}$
 - $\vec{E} \times \vec{B}$
 - None of these
- F_1 and F_2 are focal length of objective and eyepiece respectively of the telescope. The angular magnification for the given telescope is equal to
 - $\frac{F_1}{F_2}$
 - $\frac{F_2}{F_1}$
 - $\frac{F_1 F_2}{F_1 + F_2}$
 - $\frac{F_1 + F_2}{F_1 F_2}$
- Critical velocity of the liquid
 - decreases when radius decreases
 - increases when radius increases
 - decreases when density increases
 - increases when density increases

11. An organ pipe, open from both end produces 5 beats per second when vibrated with a source of frequency 200 Hz. The second harmonic of the same pipes produces 10 beats per second with a source of frequency 420 Hz. The fundamental frequency of organ pipe is
(a) 195 Hz (b) 205 Hz
(c) 190 Hz (d) 210 Hz
12. Two rings of radius R and nR made up of same material have the ratio of moment of inertia about an axis passing through centre as 1 : 8. The value of n is
(a) 2 (b) $2\sqrt{2}$ (c) 4 (d) $\frac{1}{2}$
13. One drop of soap bubble of diameter D breaks into 27 drops having surface tension σ . The change in surface energy is
(a) $2\pi\sigma D^2$ (b) $4\pi\sigma D^2$
(c) $\pi\sigma D^2$ (d) $8\pi\sigma D^2$
14. The gas having average speed four times as that of SO_2 (molecular mass 64) is
(a) He (molecular mass 4)
(b) O_2 (molecular mass 32)
(c) H_2 (molecular mass 2)
(d) CH_4 (molecular mass 16)
15. A container having 1 mole of a gas at a temperature 27°C has a movable piston which maintains at constant pressure in container of 1 atm. The gas is compressed until temperature becomes 127°C . The work done is (C_p for gas is 7.03 cal/mol-K)
(a) 703 J (b) 814 J (c) 121 J (d) 2035 J
16. An electron having mass ($9.1 \times 10^{-31}\text{ kg}$) and charge ($1.6 \times 10^{-19}\text{ C}$) moves in a circular path of radius 0.5 m with a velocity 10^6 m/s in a magnetic field. Find the strength of magnetic field.
(a) $1.13 \times 10^{-5}\text{ T}$ (b) $5.6 \times 10^{-6}\text{ T}$
(c) $2.8 \times 10^{-6}\text{ T}$ (d) None of these
17. A cylinder rolls down an inclined plane of inclination 30° , the acceleration of cylinder is
(a) $\frac{g}{3}$ (b) g (c) $\frac{g}{2}$ (d) $\frac{2g}{3}$
18. A period of a planet around Sun is 27 times that of Earth. The ratio of radius of planet's orbit to the radius of Earth's orbit is
(a) 4 (b) 9 (c) 64 (d) 27
19. 3 particles each of mass m are kept at vertices of an equilateral triangle of side L. The gravitational field at centre due to these particles is
(a) 1.5 V (b) 2.0 V (c) 2.5 V (d) 5 V
- (a) zero (b) $\frac{3GM}{L^2}$ (c) $\frac{9GM}{L^2}$ (d) $\frac{12}{\sqrt{3}} \frac{GM}{L^2}$
20. A solid sphere of radius R is rolling with velocity v on a smooth plane. The total kinetic energy of sphere is
(a) $\frac{7}{10}mv^2$ (b) $\frac{3}{4}mv^2$
(c) $\frac{1}{2}mv^2$ (d) $\frac{1}{4}mv^2$
21. A diode having potential difference 0.5 V across its junction which does not depend on current, is connected in series with resistance of 20Ω across source. If 0.1 A current passes through resistance then what is the voltage of the source?
(a) 1.5 V (b) 2.0 V (c) 2.5 V (d) 5 V
22. Potentiometer wire of length 1 m is connected in series with 490Ω resistance and 2 V battery. If 0.2 mV/cm is the potential gradient, then resistance of the potentiometer wire is
(a) 4.9Ω (b) 7.9Ω
(c) 5.9Ω (d) 6.9Ω
23. A dipole is placed parallel to the electric field. If W is the work done in rotating the dipole by 60° , then work done in rotating it by 180° is
(a) 2 W (b) 3 W (c) 4 W (d) $\frac{W}{2}$
24. An electron of charge e moves in a circular orbit of radius r around the nucleus at a frequency ν . The magnetic moment associated with the orbital motion of the electron is
(a) $\pi\nu r^2$ (b) $\frac{\pi\nu r^2}{e}$ (c) $\frac{\pi\nu e}{r}$ (d) $\frac{\pi e r^2}{\nu}$

25. A and B are two identically spherical charged bodies which repel each other with force F , kept at a finite distance. A third uncharged sphere of the same size is brought in contact with sphere B and removed. It is then kept at mid point of A and B. Find the magnitude of force on C.
- (a) $\frac{F}{2}$ (b) $\frac{F}{8}$ (c) F (d) Zero
26. A composite rod made of copper ($\alpha = 1.8 \times 10^{-5} \text{ K}^{-1}$) and steel ($\alpha = 1.2 \times 10^{-5} \text{ K}^{-1}$) is heated then it
- (a) bends with steel on convex side
(b) bends with copper on convex side
(c) does not expand
(d) data is insufficient
27. A wave has the equation $y = 0.1 \sin [100\pi t - kx]$ and wave velocity 100 m/s, its wave number is equal to
- (a) 1m^{-1} (b) 2m^{-1}
(c) πm^{-1} (d) $2\pi\text{m}^{-1}$
28. Volume temperature graph at atmospheric pressure for a monatomic gas (V in m^3 , T in $^\circ\text{C}$) is
- (a)  (b) 
- (c)  (d) 
29. In X-ray experiment K_α , K_β denotes
- (a) characteristic lines
(b) continuous wavelength
(c) α , β emissions respectively
(d) None of these
30. The ratio of frequencies of two pendulums are 2 : 3, then their length are in ratio
- (a) $\sqrt{\frac{2}{3}}$ (b) $\sqrt{\frac{3}{2}}$ (c) $\frac{4}{9}$ (d) $\frac{9}{4}$
31. The value of escape velocity on a certain planet is 2 km/s. Then the value of orbital speed for a satellite orbiting close to its surface is
- (a) 12 km/s (b) 1 km/s
(c) $\sqrt{2}$ km/s (d) $2\sqrt{2}$ km/s
32. The electrochemical equivalent of a metal is $3.3 \times 10^{-7} \text{ kg/C}$. The mass of metal liberated at cathode by 3 A current in 2 sec will be
- (a) $19.8 \times 10^{-7} \text{ kg}$ (b) $9.9 \times 10^{-7} \text{ kg}$
(c) $6.6 \times 10^{-7} \text{ kg}$ (d) $1.1 \times 10^{-7} \text{ kg}$
33. For a paramagnetic material, the dependence of the magnetic susceptibility, χ on the absolute temperature is given as
- (a) $\chi \propto T$ (b) $\chi \propto \frac{1}{T^2}$
(c) $\chi \propto \frac{1}{T}$ (d) Independent
34. An optically active compound
- (a) rotates the plane polarised light
(b) changes the direction of polarised light
(c) do not allow plane polarised light to pass through
(d) none of the above
35. Three particles A, B and C are thrown from the top of a tower with the same speed. A is thrown up, B is thrown down and C is horizontally. They hit the ground with speeds V_A , V_B and V_C respectively.
- (a) $V_A = V_B = V_C$ (b) $V_A = V_B > V_C$
(c) $V_B > V_C > V_A$ (d) $V_A > V_B = V_C$
36. The equivalent resistance between A and B is
- (a) $\frac{8R}{5}$ (b) $\frac{5R}{8}$ (c) $\frac{3R}{8}$ (d) $\frac{7R}{8}$



37. The variation of maximum kinetic energy photoelectrons with applied frequency (ν) is



38. The angle of projection θ for which range is equal to maximum height attained by projectile is

- (a) $\tan^{-1} 4$ (b) $\tan^{-1} 5$
(c) $\tan^{-1} 4/5$ (d) $\tan^{-1} 5/4$

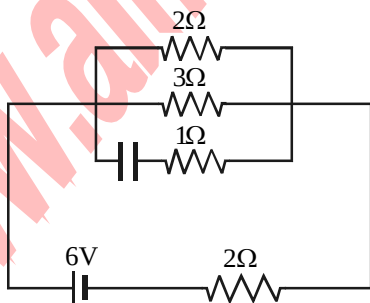
39. The range of projectile will be maximum, when angle of projection is

- (a) $\frac{\pi}{3}$ (b) $\frac{\pi}{2}$ (c) $\frac{\pi}{4}$ (d) None

40. Forces of 4 N and 5 N are applied at origin along x-axis and y-axis respectively. The resultant force will be

- (a) $\sqrt{41}\text{N}, \tan^{-1}\left(\frac{5}{4}\right)$
(b) $\sqrt{41}\text{N}, \tan^{-1}\left(\frac{4}{5}\right)$
(c) $-\sqrt{41}\text{N}, \tan^{-1}\left(\frac{5}{4}\right)$
(d) $-\sqrt{41}\text{N}, \tan^{-1}\left(\frac{4}{5}\right)$

41. Current in 2Ω resistor is (see given figure)



- (a) 1 A (b) 1.5 A (c) 0.9 A (d) 0.6 A

42. Which of the following is false ?

- (a) convex lens always forms image with $m < 1$
(b) a simple mirror produces virtual, erect and same-sized image
(c) a concave mirror produces virtual, erect and magnified image
(d) a convex lens can produce real and same-sized image.

43. A star having wavelength λ is reaching with velocity v_s from earth. The apparent shift in wavelength will be

- (a) $\frac{\lambda v_s}{c}$ (b) $-\frac{\lambda v_s}{c}$
(c) $-\frac{\lambda v_s^2}{c^2}$ (d) $\frac{\lambda v_s^2}{c^2}$

44. The deflection in a galvanometer decreases from 25 divisions to 5 divisions when a resistor of 20Ω is connected in series. Find resistance of galvanometer.

- (a) 4Ω (b) 5Ω (c) 6Ω (d) 7Ω

45. A current source drives a current in a coil of resistance R_1 for a time t . The same source drives current in another coil of resistance R_2 for same time. If heat generated is same, find internal resistance of source

- (a) $\frac{R_1 R_2}{R_1 + R_2}$ (b) $R_1 + R_2$
(c) zero (d) $\sqrt{R_1 R_2}$

46. The waves used by artificial satellites for communication is

- (a) microwaves (b) radio-waves, AM
(c) radio-waves, FM (d) X-rays

47. The ratio of de-Broglie wavelengths of proton and α -particle having same kinetic energy is

- (a) $\sqrt{2} : 1$ (b) $2\sqrt{2} : 1$
(c) $2 : 1$ (d) $4 : 1$

48. The dimensions of Planck's constant is
(a) $M^2L^2T^{-1}$ (b) M^2LT^{-2}
(c) ML^2T^{-1} (d) ML^2T^{-2}
49. Which of these requires quantum nature of light for their explanation?
(a) diffraction (b) polarisation
(c) interference (d) black body spectrum
50. If blue light is used in place of red light in a diffraction experiment
(a) diffraction pattern remains unchanged
(b) fringes come closer
(c) fringes become broader
(d) none of these

DIRECTION:**NOTE : Instructions for Q. 51 to Q. 60**

- (a) Both Assertion and Reason are true and 'Reason' is the correct explanation of 'Assertion'
(b) Both Assertion and R are true and Reason is not the correct explanation of 'Assertion'
(c) 'Assertion' is true but 'Reason' is false
(d) Both 'Assertion' and 'Reason' are false
(e) Assertion is false but 'Reason' is true

51. **Assertion :** The dominant mechanism for motion of charge carriers in forward and reverse biased silicon p-n junction are drift in both forward and reverse bias.

Reason : In reverse biased, no current flow through the junction

52. **Assertion :** The force of repulsion between atomic nucleus and α -particle varies with distance according to inverse square law.

Reason : Rutherford did α -particle scattering experiment.

53. **Assertion :** The unpolarized light and polarized light can be distinguished from each other by using polaroid.

Reason : A polaroid is capable of producing plane polarised beams of light.

54. **Assertion :** An induced current develop in a conductor moved in direction parallel to the magnetic field.

Reason : An induced current is developed when the number of magnetic lines of force associated with conductor is changed.

55. **Assertion :** If the length of the conductor is doubled, the drift velocity will become half of the original value (keeping potential difference unchanged).

Reason : At constant potential difference, drift velocity is inversely proportional to the length of the conductor.

56. **Assertion :** Circuits containing capacitors should be handled cautiously even when there is no current.

Reason : The capacitors are very delicate and so quickly breakdown.

57. **Assertion :** The absorbance of a perfect black body is unity.

Reason : A perfect black body when heated emits radiations of all possible wavelengths at that temperature.

58. **Assertion :** The phase difference between two medium particle having a path difference λ is 2π .

Reason : The phase difference is directly proportional to path difference of a particle.

59. **Assertion :** The impurities always decrease the surface tension of a liquid.

Reason : The change in surface tension of the liquid depends upon the degree of contamination of the impurity.

60. **Assertion :** Orbital velocity of a satellite is greater than its escape velocity.

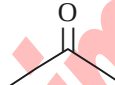
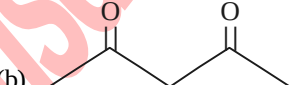
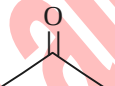
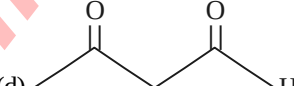
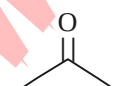
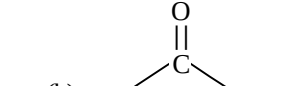
Reason : Orbit of a satellite is within the gravitational field of earth whereas escaping is beyond the gravitational field of earth.

SECTION II - CHEMISTRY

61. Arene diazonium salt results from reaction of nitrous acid with
 (a) 1° aliphatic amine
 (b) 2° aromatic amine
 (c) 1° aromatic amine
 (d) 1° aromatic amide
62. Colloidal system constituting the liquid as dispersed phase and solid as dispersion medium is
 (a) gel (b) emulsion
 (c) solution (d) suspension
63. Calculate number of valence electrons in complex $[\text{Cr}(\text{H}_2\text{O})_5\text{SCN}]^{2+}$
 (a) 17 (b) 15 (c) 16 (d) 19
64. The ground state valence shell electronic configuration of an element is $3d^5 4s^1$. The metal is
 (a) Cr (b) Fe (c) Mn (d) V
65. X reacts with acid chloride to give ester X is
 (a) Phenol (b) Benzoic acid
 (c) Methnol chloride (d) Acid anhydride
66. Aldehyde which do not show Cannizzaro reaction

$$\begin{array}{c} \text{O} \\ \parallel \\ \text{H}-\text{C}-\text{H} \end{array}$$

 (a) $\text{H}-\text{C}-\text{H}$ (b) $(\text{CH}_3)_3-\text{CHO}$
 (c) $\text{C}_6\text{H}_5\text{CHO}$ (d) CH_3CHO
67. Lucas test is used to distinguish between
 (a) 1°, 2° and 3° amines
 (b) 1°, 2° and 3° alcohol
 (c) Aromatic and aliphatic acids
 (d) 1°, 2° and 3° amides
68. The number of radial nodes in 5d is
 (a) 1 (b) 2 (c) 3 (d) 4
69. Increasing order of electronegativity of hybrid orbital is
 (a) $sp < sp^2 < sp^3$ (b) $sp > sp^2 > sp^3$
 (c) $sp > sp^3 > sp^2$ (d) $sp^3 > sp > sp^2$
70. Which is longest bond?
 (a) N_2 (b) O_2 (c) I_2 (d) Cl_2
71. Hinsberg's reagent is used to distinguish between
 (a) acids (b) alcohols
 (c) amides (d) amine
72. Ozonolysis is relation in which double bond is cleaved to give carboxyl group. Which of these will give formaldehyde as one of its product?
 (a) $\text{CH}_3\text{CH}=\text{CH}-\text{CH}_3$
 (b) $\text{CH}_3-\text{CH}_2-\text{CH}_2=\text{CH}_3$
 (c) $\begin{array}{c} \text{CH}_3 \\ \diagup \\ \text{C}=\text{CH}_2\text{CH}_3 \\ \diagdown \\ \text{CH}_3 \end{array}$
 (d) $\begin{array}{c} \text{CH}_3 \\ \diagup \\ \text{C}=\text{C} \\ \diagdown \quad \diagup \\ \text{CH}_3 \quad \text{CH}_3 \end{array}$
73. Which of these reacts with Grignard reagent to give carboxylic acid?
 (a) CO (b) CO_2
 (c) RCOOR (d) HCHO
74. Dehydration of tertiary alcohols in presence of an acid involves
 (a) Formation of carbocation
 (b) Formation of carbanion
 (c) Formation of free radical
 (d) Formation of Transition state
75. Reagent of Clemmensen's reduction is
 (a) NH_2-NH_2 (b) $\text{Zn}-\text{Hg}/\text{HCl}$
 (c) $\text{P}_{\text{red}}/\text{HI}$ (d) $\text{Pd}/\text{H}_2, \text{BaSO}_4$
76. The number of structural isomers of $\text{CrCl}_3 \cdot 6\text{H}_2\text{O}$ are
 (a) 4 (b) 2 (c) 3 (d) 1
77. How many atoms are present in bcc?
 (a) 3 (b) 4 (c) 2 (d) 1
78. Which of the following pairs present pseudohalide and polyhalide respectively?
 (a) OCN^- and BrI_2^- (b) RCOO^- and BrI_2^-
 (c) NNN^- and IF_5 (d) OCN^- and IF_5
79. Units of rate constant of a given chemical reaction is $\text{L mol}^{-1}\text{s}^{-1}$. What is order of reaction?
 (a) 0 (b) 1 (c) 2 (d) 3
80. Which of the following is least paramagnetic in nature?
 (a) Mn (b) Fe (c) Ni (d) Cu
81. Which among the following will have highest B.P at 1 atm. pressure?
 (a) 0.1 M NaCl (b) 0.1 M BaCl_2
 (c) 0.1 M Sucrose (d) 0.1 M urea
82. Which of the following has smallest ionic radii?
 (a) Na^+ (b) Mg^{2+} (c) F^- (d) Al^{3+}

83. Given compound is subjected to chemical analysis. Results are
 I. -ve test to Ninhydrin
 II. +ve test to Benedict's solution
 Compound is
 (a) Lipid (b) Monosaccharide
 (c) Protein (d) Amino acid
84. Iodoform test is shown by
 (a) Glycol (b) Propanaldehyde
 (c) Ethanol (d) Diethyl ether
85. The correct order of penetrating power is
 (a) $\gamma > \alpha > \beta$ (b) $\gamma < \alpha < \beta$
 (c) $\gamma < \alpha > \beta$ (d) $\gamma > \beta > \alpha$
86. Given electron would enter which of the following shells first
 (a) $n = 5, \ell = 0$ (b) $n = 3, \ell = 2$
 (c) $n = 6, \ell = 0$ (d) $n = 5, \ell = 1$
87. $[\text{Cr}(\text{SCN})(\text{H}_2\text{O})_5]^{+3}$ and $[\text{Cr}(\text{NCS})(\text{H}_2\text{O})_5]^{+3}$ show
 (a) Ionization isomerism
 (b) Hydration isomerism
 (c) Linkage isomerism
 (d) Co-ordination isomerism
88. Buna-S is polymer of
 (a) Butadiene
 (b) Butadiene and nitrile
 (c) Butadiene and styrene
 (d) Butadiene and isoprene
89. Which of the following has bond order zero?
 (a) CO (b) O_2 (c) F_2 (d) Be_2
90. Maximum enol content is in
 (a)  (b) 
 (c)  (d) 
91. Which of the following reduces Benedict's solution?
 (a)  (b) 
 (c) HCHO (d) $\text{R}-\text{O}-\text{R}$
92. Which of the following principle/experiment shows quantisations of energy in an atom?
 (a) Heisenberg's uncertainty principle
 (b) Aufbau's principle
 (c) Pauli's exclusion principle
 (d) H-spectrum
93. Conjugate acid of CH_3NH_2 is
 (a) CH_3NH^- (b) NH_2
 (c) CH_3OH (d) CH_3NH_3^+
94. Sublimation energy of $\text{I}_{2(s)}$ is 57.3 kJ/mol and enthalpy of fusion is 15.5 kJ/mol.
 The enthalpy of vaporisation of I_2 is
 (a) 41.8 kJ/mol (b) 72.8 kJ/mol
 (c) -72.8 kJ/mol (d) -41.8 kJ/mol
95. 2-butyne on reaction with Pd/BaSO_4 gives
 (a) Cis-2-butene (b) Trans-2-butene
 (c) 1-butene (d) 2-hydroxybutene
96. If ΔH is (-) and ΔS is (+) ΔG will be
 (a) (-)ve (b) (+)ion
 (c) Zero (d) $> \Delta H - T\Delta S$
97. The given reaction has reagent X as $\rightarrow$

$$\text{CH}_3 - \text{C} \equiv \text{C} - \text{CH}_3 \xrightarrow[\text{H}_2\text{O}/\text{Zn}]{\text{X}}$$

$$\text{CH}_3 - \underset{\text{O}}{\underset{\parallel}{\text{C}}} - \underset{\text{O}}{\underset{\parallel}{\text{C}}} - \text{CH}_3$$
 (a) O_2 (b) HNO_3
 (c) O_3 (d) KMnO_4
98. Which of the following is most reactive towards nucleophilic substitution reaction
 (a) $\text{CH}_2 = \text{CH} - \text{Cl}$
 (b) $\text{C}_6\text{H}_5 - \text{Cl}$
 (c) $\text{CH}_3\text{CH} = \text{CHCl}$
 (d) $\text{ClCH}_2 - \text{CH} = \text{CH}_2$
99. $\text{BaCO}_3 \rightleftharpoons \text{BaO} + \text{CO}_2$ is an endothermic reaction formation of BaO is favoured by
 (a) Decrease in temperature
 (b) Decrease in pressure
 (c) Increase in concentration
 (d) Increase in pressure

100. A is 0.5M solution of $\text{Ca}(\text{NH}_3)_2$ and B is 0.75 m solution of KOH
Depression in freezing point is
- Greater for b due to more concentration
 - equal in both A and B freezing point is less than zero
 - equal to 0°C in both as ionic concentration is negligible
 - Greater for a because number of ions is greater
101. Calculate the volume of H_2 gas at NTP obtained by passing 2 ampere through acidified water for 1 hour.
- 0.0836L
 - 0.0432L
 - 0.1672L
 - 0.836L
102. In an antifluorite structure cation occupies
- Octahedral void
 - Tetrahedral void
 - Centre of cube
 - Edges of cube
103. Which is not permissible ?
- $n = 3, \ell = 1, m = -1, s = \frac{1}{2}$
 - $n = 2, \ell = 2, m = -1, s = -\frac{1}{2}$
 - $n = 4, \ell = 2, m = -1, s = -\frac{1}{2}$
 - $n = 4, \ell = 2, m = 2, s = -\frac{1}{2}$
104. A $\xleftarrow[\text{reagent}]{\text{Lindlar's}}$ $\text{CH}_3 - \text{C} \equiv \text{CH}_3$
 $\xrightarrow{\text{Na/liq. NH}_3}$ B; A and B are
- Cis, trans 2 butene
 - Trans, trans 2 butene
 - Cis, cis 2 butene
 - Trans, cis 2 butene
105. Which is not true about hydrogen peroxide ?
- If acts as both oxidising and reducing agent
 - If is pale blue liquid
 - If can be oxidised by O_3
 - Two OH bonds lies in same plane
106. Which is a true peroxide ?
- CO_2
 - MnO_2
 - Na_2O
 - BaO_2
107. The conductance of Li salts is lowest of all group I metals
- easy diffusion of Li^+ ion
 - lower ability of Li^+ ion to polarise water molecules
 - lowest charge to radius ratio
 - high degree of hydration of Li^+
108. Which of following has highest protective power on lyophobic colloids ?
- gum arabic
 - sodium oleate
 - gelatin
 - starch
109. 0.1 M solution of $[\text{Ag}^+]$, $[\text{Ba}^{+}]$ and $[\text{Ca}^{+}]$ is added to solution of sodium sulphate. K_{sp} values for these salts are : $\text{BaSO}_4 = 10^{-11}$; $\text{CaSO}_4 = 10^{-6}$; $\text{Ag}_2\text{SO}_4 = 10^{-5}$
Which of those will precipitate first ?
- BaSO_4
 - Ag_2SO_4
 - CaSO_4
 - All the above
110. Which is not a reducing agent ?
- LiNH_4
 - Na/liq ammonia
 - Lindlar's reagent
 - SeO_2
- DIRECTIONS : In the following questions an Assertion (A) is given followed by a Reason (R). Mark your responses from the following options.**
- Both Assertion and Reason are true and Reason is the correct explanation of 'Assertion'
 - Both Assertion and Reason are true and Reason is not the correct explanation of 'Assertion'
 - Assertion is true but Reason is false
 - Assertion is false but Reason is true

111. **Assertion (A)** : A very dilute acidic solution of Cd^{2+} and Ni^{2+} gives yellow precipitate of CdS on passing hydrogen sulphide.
Reason (R) : Solubility product of CdS is more than that of NiS .
112. **Assertion (A)** : $[\text{Ni}(\text{CN})_4]^{2-}$ has square planar and $[\text{NiCl}_4]^{2-}$ has tetrahedral shape.
Reason (R) : $[\text{Ni}(\text{CN})_4]^{2-}$ is diamagnetic while $[\text{NiCl}_4]^{2-}$ is paramagnetic.
113. **Assertion (A)** : Rusting of an iron is an example of corrosion.
Reason (R) : Rusting of iron is decreased by acid and electrolytes.
114. **Assertion (A)** : Trihydroxyglutaric acid ($\text{HO}_2\text{C}-\text{CHOH}-\text{CHOH}-\text{CHOH}-\text{CO}_2\text{H}$) exists in four stereoisomeric forms; two of which are optically active while the other two are meso-forms.
Reason (R) : It contains two asymmetric and pseudo-asymmetric carbon atom.
115. **Assertion (A)** : The endothermic reactions are favoured at lower temperature and the exothermic reactions are favoured at higher temperature.
Reason (R) : When a system in equilibrium is disturbed by changing the temperature, it will tend to adjust itself so as to overcome the effect of change.
116. **Assertion (A)** : For each ten degree rise of temperature the specific rate constant is nearly doubled.
Reason (R) : Energy-wise distribution of molecules in a gas is an experimental function of temperature.
117. **Assertion (A)** : HNO_3 is a stronger acid than HNO_2 .
Reason (R) : In HNO_3 there are two nitrogen-to-oxygen bonds whereas in HNO_2 there is only one.
118. **Assertion (A)** : A metal having negative reduction potential when dipped in the solution of its own ions has a tendency to pass into the solution.
Reason (R) : Metal having negative reduction potential have large hydration energy.
119. **Assertion (A)** : If hydration energy is greater than lattice energy the solid dissolves in liquid.
Reason (R) : The solubility of a solid in a liquid depends upon lattice energy and hydration energy.
120. **Assertion (A)** : Reduction of *m*-dinitrobenzene with ammonium sulphide gives *m*-nitroaniline.
Reason (R) : *m*-Nitroaniline formed gets precipitated and hence further reduction is prevented.

SECTION III - BIOLOGY

121. Sequence of taxonomic categories is
 (a) Class – Phylum – Tribe – Order – Family – Genus – Species
 (b) Division – Class – Family – Tribe – Order – Genus – Species
 (c) Division – Class – Order – Family – Tribe – Genus – Species
 (d) Phylum – Order – Class – Tribe – Family – Genus – Species
122. Genophore/bacterial genome or nucleoid is made of
 (a) Histones and nonhistones
 (b) RNA and histones
 (c) A single double stranded DNA
 (d) A single stranded DNA
123. *Claviceps purpurea* is causal organism of
 (a) Smut of Barley
 (b) Rust of Wheat
 (c) Ergot of Rye
 (d) Powdery Mildew of Pea.
124. Chloroplast of *Chlamydomonas* is
 (a) Stellate (b) Cup-shaped
 (c) Collar-shaped (d) Spiral
125. Oxyosomes of $\text{F}_0 - \text{F}_1$ particles occur on
 (a) Thylakoids
 (b) Mitochondrial surface
 (c) Inner mitochondrial membrane
 (d) Chloroplast surface

126. Two linked genes a and b show 20% recombination. The individuals of a dihybrid cross between $++/++ \times ab/ab$ shall show gametes
 (a) $++80:ab:20$
 (b) $++50:ab:50$
 (c) $++40:ab40:++a10:++b10$
 (d) $++30:ab30:++a20:++b20$
127. In *Escherichia coli*, lac operon is induced by
 (a) Lactose (b) Promoter gene
 (c) β -galactosidase (d) I-gene
128. If a diploid cell is treated with colchicine then it becomes
 (a) triploid (b) tetraploid
 (c) diploid (d) monoploid
129. Syngenesious condition is found in
 (a) Asteraceae (b) Labiate
 (c) Solanaceae (d) Fabaceae
130. Floral formula of Tomato/Tobacco is
 (a) $\Theta \overline{\Psi} K_{4-5} A_{10} G_{(2)}$
 (b) $\Theta \overline{\Psi} K_{2+2} C_4 A_{2+4} G_1$
 (c) $\Theta \overline{\Psi} P_2 A_3 G_1$
 (d) $\Theta \overline{\Psi} K_{(5)} \widehat{C_{(5)}} A_5 G_{(2)}$
131. Ectophloic siphonostele is found in
 (a) *Osmunda* and *Equisetum*
 (b) *Marsilea* and *Botrychium*
 (c) *Adiantum* and *Cucurbitaceae*
 (d) *Dicksonia* and *Maidenhair fern*
132. If a cell A with DPD 4 bars is connected to cell B, C, D whose OP and TP are respectively 4 and 4, 10 and 5 and 7 and 3 bars, the flow of water will be
 (a) A and D to B and C
 (b) A to B, C and D
 (c) B to A, C and D
 (d) C to A, B and D
133. The size of chlorophyll molecule is
 (a) Head $15 \times 15 \text{ \AA}$, tail $25 \text{ \AA}$
 (b) Head $20 \times 20 \text{ \AA}$, tail $25 \text{ \AA}$
 (c) Head $15 \times 15 \text{ \AA}$, tail $20 \text{ \AA}$
 (d) Head $10 \times 12 \text{ \AA}$, tail $25 \text{ \AA}$
134. Terminal cytochrome of respiratory chain which donates electrons to oxygen is
 (a) Cyt. b (b) Cyt. c
 (c) Cyt. a_1 (d) Cyt. a_3
135. An ovule which becomes curved so that the nucellus and embryo sac lie at right angles to the funicle is
 (a) Hemitropous (b) Campylotropous
 (c) Anatropous (d) Orthotropous
136. Which of the following movement is not related to auxin level
 (a) Bending of shoot towards light
 (b) Movement of root towards soil
 (c) Nyctinastic leaf movements
 (d) Movement of sunflower head tracking the sun
137. An interesting modification of flower shape for insect pollination occurs in some orchids in which a male insect mistakes the pattern on the orchid flower for the female of his species and tries to copulate with it, thereby pollinating the flower. This phenomenon is called
 (a) Mimicry
 (b) Pseudopollination
 (c) Pseudocopulation
 (d) Pseudoparthenocarpy
138. The most common indicator organism that represents polluted water is
 (a) *E. coli* (b) *P. typhi*
 (c) *C. vibrio* (d) *Entamoeba*
139. In order to obtain virus-free plants through tissue culture the best method is
 (a) Embryo rescue (b) Anther culture
 (c) Meristem culture (d) Protoplast culture
140. Which one among the following chemicals is used for causing defoliation of forest trees?
 (a) Phosphon-D
 (b) Malic hydrazide
 (c) 2, 4 Dichlorophenoxy acetic acid
 (d) Amo-1618
141. Which of the following is **not** true for a species?
 (a) Members of a species can interbreed.
 (b) Gene flow does not occur between the populations of a species.
 (c) Each species is reproductively isolated from every other species.
 (d) Variations occur among members of a species.

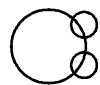
142. The catalytic efficiency of two different enzymes can be compared by the
(a) formation of the product
(b) pH optimum value
(c) K_m value
(d) molecular size of the enzyme
143. Fire bellied toad is
(a) *Amphiuma* (b) *Banbina*
(c) *Necturus* (d) *Salamandra*
144. American water plant that has become a troublesome water weed in India is
(a) *Cyperus rotundus*
(b) *Eichhornia crassipes*
(c) *Trapa latifolia*
(d) *Trapa bispinosa*
145. Characteristics of smooth muscle fibres are
(a) Spindle-shaped, unbranched, unstriated, uninucleate and involuntary
(b) Spindle shaped, unbranched, unstriped, multinucleate and involuntary
(c) Cylindrical, unbranched, unstriped, multinucleate and involuntary
(d) Cylindrical, unbranched, striated, multinucleate and voluntary
146. An adolescent human below 17 years of age normally has dental formula as
(a) $\frac{2,1,3,2}{2,1,3,2}$ (b) $\frac{2,2,3,2}{2,2,3,2}$
(c) $\frac{2,1,2,0}{2,1,2,0}$ (d) $\frac{2,1,2,2}{2,1,2,2}$
147. In alveoli of the lungs, the air at the site of gas exchange, is separated from the blood by
(a) alveolar epithelium only
(b) alveolar epithelium and capillary endothelium
(c) alveolar epithelium, capillary endothelium and tunica adventitia
(d) alveolar epithelium, capillary endothelium, a thin layer of tunica media and tunica adventitia
148. Splenic artery arises from
(a) Anterior mesenteric artery
(b) Coeliac artery
(c) Posterior mesenteric artery
(d) Intestinal artery
149. If Henle's loop were absent from mammalian nephron, which of the following is to be expected?
(a) The urine will be more dilute
(b) There will be no urine formation
(c) There will be hardly any change in the quality and quantity of urine formed
(d) The urine will be more concentrated
150. Number of cervical vertebrae in camel is
(a) More than that of Rabbit
(b) Less than that of Rabbit
(c) Same as that of Whale
(d) More than that of Horse
151. Which of the following cranial nerves can regulate heart beat?
(a) X (b) IX
(c) VIII (d) VII
152. Which one of the following pairs correctly matches a hormone with a disease resulting from its deficiency?
(a) Luteinizing - Failure of hormone ovulation
(b) Insulin - Diabetes insipidus
(c) Thyroxine - Tetany
(d) Parathyroid - Diabetes mellitus hormone
153. The growth of corpus luteum is initiated by
(a) Human chorionic gonadotropin
(b) Follicle stimulating hormone
(c) Luteinizing hormone
(d) Prolactin
154. Two opposite forces operate in the growth and development of every population. One of them relates to the ability to reproduce at a given rate. The force opposing it is called
(a) environmental resistance
(b) morbidity
(c) fecundity
(d) biotic potential
155. Red-green colour blindness in humans is governed by a sex-linked recessive gene. A normal woman whose father was colour-blind marries a colour blind man. What proportion of their daughters is expected to be colour-blind?
(a) $\frac{3}{4}$ (b) $\frac{1}{2}$
(c) $\frac{1}{4}$ (d) All

156. Genetic drift operates only in
 (a) Smaller Populations
 (b) Larger Populations
 (c) Mendelian Populations
 (d) Island Populations
157. Which one of the following statements about fossil human species is correct?
 (a) Fossils of *Homo neanderthalensis* have been found recently in South America
 (b) Neanderthal man and Cro-Magnon man did exist for sometime together
 (c) *Australopithecus* fossils have been found in Australia
 (d) *Homo erectus* was preceded by *Homo habilis*
158. In the silk worm, if no juvenile hormone (JH) is present when it moults, it will
 (a) die
 (b) moult into another larval stage
 (c) moult into pupa
 (d) moult into an adult
159. Which one of the following is correct match?
 (a) Reserpine — Tranquilizer
 (b) Cocaine — Opiate narcotic
 (c) Morphine — Hallucinogenic
 (d) Bhang — Analgesic
160. Test tube baby is one who
 (a) is born out of artificial insemination
 (b) has undergone development in a test tube
 (c) is born out of the technique of fertilization *in vitro*
 (d) has been developed without fertilization
- (d) **If both the Assertion and Reason are incorrect.**
 (e) **If the Assertion is incorrect but the Reason is correct.**
161. **Assertion :** Mango dipped in concentrated sodium chloride solution will contract.
Reason : Water goes out due to exosmosis in hypertonic solution.
162. **Assertion :** Nissl's granules that are basophilic are present in the cyton.
Reason : They are composed of RNA.
163. **Assertion :** Phycobilins are destroyed by heat.
Reason : They are protein linked and proteins are denatured due to heat.
164. **Assertion :** The inner mucosa coat has innumerable finger like projections.
Reason : Absorption increases due to infolds.
165. **Assertion :** Vital capacity is the total volume of air that can be breathed out with minimum effort.
Reason : Vital capacity represents the maximum capacity of an individual to renew air in the respiratory system.
166. **Assertion :** Heart wood is non functional.
Reason : Duramen is plugged due to in-growth of collenchyma.
167. **Assertion :** Glycogen is called animal starch.
Reason : Glycogen is stored in the liver and muscles of animals.
168. **Assertion :** Racemose Inflorescence is an indeterminate inflorescence.
Reason : The Inflorescence shows definite growth.
169. **Assertion :** Mouth parts of cockroach, honey bee & mosquito are analogous organs.
Reason : These organs follow the same basic plan of organization during development.
170. **Assertion :** Crossing over occurs at four strand or tetrad stage.
Reason : Parent strand and gene linkages disappear at two strand stage.
171. **Assertion :** Oncogenes transform normal cell into cancer cell.
Reason : They integrate their DNA with RNA of the host cells.

DIRECTIONS : These questions consist of two statements, each printed as Assertion and Reason. While answering these questions, you are required to choose any one of the following five responses.

- (a) **If both Assertion and Reason are correct and the Reason is a correct explanation of the Assertion.**
 (b) **If both Assertion and Reason are correct but Reason is not a correct explanation of the Assertion.**
 (c) **If the Assertion is correct but Reason is incorrect.**

172. **Assertion :** Human immuno deficiency Virus-III are retroviruses.
Reason : They exhibit reverse transcription.
173. **Assertion :** Genes are actual physical units of heredity.
Reason : Genes are in the chromosome in linear order.
174. **Assertion :** Viruses are obligatory parasites.
Reason : They show host specificity and multiply only inside living systems.
175. **Assertion :** Allergens are generally weak antigens, which are glycogen molecules.
Reason : Allergy means inappropriate reaction of a person.
176. **Assertion :** Interferons are antiviral proteins.
Reason : It is released from the infected and dying cells.
177. **Assertion :** Horticulture is the conscious raise of Cereal crop.
Reason : Growing of vegetables, fruits and ornamental plants is Horticulture.
178. **Assertion :** Viruses cannot metabolise outside host cells and use host machinery to produce own nucleic acids and proteins.
Reason : Viruses lack energy yielding and biosynthetic machinery.
179. **Assertion :** All aggregate and multiple fruits are false.
Reason : They develop from other floral parts instead of the ovary
180. **Assertion :** *Casuarina* and *Betula* show chalazogamy.
Reason : Pollen tube enters the ovule through micropyle end.
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- SECTION IV - G.K.**
-
181. On August 12, 2017, Dr Vishwanath Karad MIT World Peace University, considered to be the first of its kind in India was inaugurated in:
(a) Pune (b) Bhopal
(c) Jaipur (d) Chennai
182. On July 18, 2017, the Supreme Court has allowed the Centre to replace the oversight committee set up to supervise the functioning of the Medical Council of India (MCI) with a fresh panel of how many eminent doctors?
(a) 8 eminent doctors
(b) 7 eminent doctors
(c) 6 eminent doctors
(d) 5 eminent doctors
183. Who among the following is set to become the United Nations' youngest-ever 'Messenger of Peace'?
(a) Mark Zuckerberg
(b) Malala Yousafzai
(c) Selena Gomez
(d) Virat Kohli
184. Find out the correct sequence -
(a) Pain, Doctor, Hospital, Drug
(b) Hospital, Doctor, Drug, Pain
(c) Hospital, Doctor, Pain, Drug
(d) Pain, Hospital, Doctor, Drug
185. Human : Brain :: Computer : ?
(a) USB (b) Monitor
(c) CPU (d) Internet
186. Which of these is a dwarf planet?
(a) Neptune (b) Titan
(c) Eris (d) Hydra
187. M is son of P, Q is the grand-daughter of O, who is the husband of P. How is M related to O?
(a) Son (b) Daughter
(c) Mother (d) Father
188. How many meaningful English words can be formed with the letters URLE using each letter only once in each word?
(a) None (b) One
(c) Two (d) Three
189. Name the country that will host the 2018 Table Tennis Team World Cup.
(a) South Africa (b) China
(c) USA (d) England

190. Select the related word/letters/ number from the given alternatives.
Psychology : Human Being :: Ornithology : ?
(a) Birds (b) Volcanoes
(c) Insects (d) Reptiles
191. The 2017 International Day for the Remembrance of the Slave Trade and its Abolition is observed on which date?
(a) August 24 (b) August 25
(c) August 22 (d) August 23
192. Who is the head of the 9-judge Constitution bench of the Supreme Court (SC) to determine whether privacy is a fundamental right or not under the Constitution?
(a) Abhay Manohar Sapre
(b) J S Khehar
(c) Sanjay Kishan Kaul
(d) Fali Narima
193. Which of the following is the correct description of the term 'sex ratio' as used in context of the census?
(a) Number of females per 1000 persons
(b) Number of females in a sample of 1000 persons
(c) Number of males per 1000 females
(d) Number of females per 1000 males
194. In India, which city is also known as 'City of Palaces'?
(a) Jaipur (b) Kolkata
(c) Gwalior (d) Udaipur
195. Heena Sidhu, who recently won a World Cup Gold Medal for India, is associated with
(a) Shooting (b) Archery
(c) Weightlifting (d) Boxing
196. On July 21, 2017, Uttar Pradesh Assembly adopted two resolutions on naming the airport terminals of which two cities?
(a) Kanpur and Lucknow
(b) Lucknow and Bareilly
(c) Kanpur and Meerut
(d) Kanpur and Bareilly
197. Which country is accused of interfering and hacking the US 2016 presidential elections?
(a) Russia (b) China
(c) Germany (d) Japan
198. On July 23, 2017, Arun Jaitley inaugurated 315th Rest House of the Kendriya Sainik Board in:
(a) Shimla (b) Dehradun
(c) New Delhi (d) Amritsar
199. Arrange the following steps of AIIMS application form
(1) City Choice
(2) Payment
(3) Password received
(4) Registration
(a) 3,4,2,1 (b) 4,3,1,2
(c) 3,4,1,2 (d) 3,1,4,2
200. Which of the following diagrams indicates the best relation between Pluto, Planets, Sun and Earth ?
(a)  (b) 
(c)  (d) 

SOLUTIONS

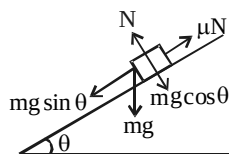
SECTION I - PHYSICS

1. (b) From the F.B.D.

$$N = mg \cos \theta$$

$$F = ma = mg \sin \theta - \mu N$$

$$\Rightarrow a = g(\sin \theta - \mu \cos \theta)$$



$$\text{Now using, } v^2 - u^2 = 2as$$

$$\text{or, } v^2 = 2 \times g(\sin \theta - \mu \cos \theta) \ell$$

(ℓ = length of incline)

$$\text{or, } v = \sqrt{2g\ell(\sin \theta - \mu \cos \theta)}$$

2. (b) Acceleration due to gravity at latitude ' λ '

$$\text{is given by } g_\lambda = g_e - R_e \omega^2 \cos^2 \lambda$$

$$\text{At equator, } \lambda = 90^\circ$$

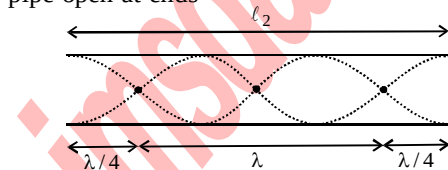
$$\Rightarrow \cos \lambda = \cos 90^\circ = 0$$

$$\text{or } g_\lambda = g_e = g \text{ (as given in question)}$$

$$\text{At } 30^\circ, g_{30} = g - R\omega^2 \cos^2 30 = g - \frac{3}{4}R\omega^2$$

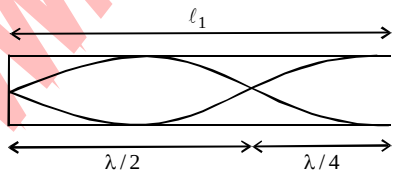
$$\text{or, } g - g_{30} = \frac{3}{4}R\omega^2$$

3. (a) For 3rd harmonic/2nd overtone of organ pipe open at ends



$$\Rightarrow n_2 = \frac{3V}{2\ell_2}$$

For 1st overtone of organ pipe open at one end



$$\Rightarrow n_1 = \frac{3V}{4\ell_1}$$

$$\text{Given } n_1 = n_2 \Rightarrow \frac{3V}{2\ell_2} = \frac{3V}{4\ell_1} \quad \text{or}$$

$$\frac{\ell_1}{\ell_2} = \frac{1}{2}$$

$$4. (c) H = \frac{V^2}{R} t \quad \text{or} \quad t = \frac{HR}{V^2}$$

The voltage, V remains same, H is also same

$$t_1 = \frac{HR_1}{V^2}; \quad t_2 = \frac{HR_2}{V^2}$$

$$\text{or } t = \frac{H(R_1 + R_2)}{V^2} = t_1 + t_2$$

$$= 15 + 20 = 35 \text{ min}$$

5. (a) Fluid resistance is given by $R = \frac{8\eta\ell}{\pi r^4}$

When two capillary tubes of same size are joined in parallel, then equivalent fluid resistance is

$$R_S = R_1 + R_2$$

$$= \frac{8\eta\ell}{\pi R^4} + \frac{8\eta \times 2L}{\pi(2R)^4} = \left(\frac{8\eta L}{\pi R^4} \right) \times \frac{9}{8}$$

Rate of flow

$$= \frac{P}{R_S} = \frac{\pi R^4}{8\eta L} \times \frac{8}{9} = \frac{8}{9} X \left[\text{as } X = \frac{\pi P R^4}{8\eta \ell} \right]$$

6. (a) The charge is moving in an equipotential line. So no work is done.
 7. (d) Optical fibers carry immense no. of signals as compared to other wires. There is no EM interference in these fibres.
 8. (c) An EMW is the one constituted by oscillating electric and magnetic field which oscillate in two mutually perpendicular planes. The wave itself propagates in a direction perpendicular to both of the directions of oscillations of electric ($\vec{E}$)

and magnetic fields ($\vec{B}$), i.e. $\vec{E} \times \vec{B}$.

9. (a) The angular magnification,

$$M = \frac{\text{angle subtended by the image at eye}}{\text{angle subtended at eye with object in actual position}}$$

For telescope, $M = \frac{f_o}{f_e} = \frac{F_1}{F_2}$

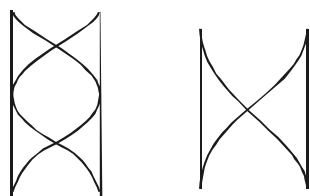
10. (c) As per Reynold's formula critical velocity of a liquid is defined as

$$v_c = \frac{K\eta}{\rho r} \Rightarrow v_c \propto \frac{1}{\rho} \text{ \& } v_c \propto \frac{1}{r}$$

Where η is coefficient of viscosity of the liquid, ρ its density and r is the radius of the tube. K is a dimensionless constant called the Reynold number. Thus critical velocity increases when density and radius of the tube decreases.

11. (b) Let the fundamental frequency of organ pipe be f

Case I : $f = 200 \pm 5 = 205 \text{ Hz or } 195 \text{ Hz}$



Case II : frequency of 2nd harmonic of organ pipe = $2f$ (as is clear from the second figure)

$$2f = 420 \pm 10 \text{ or } f = 210 \pm 5$$

$$\text{or } f = 205 \text{ or } 215$$

Hence fundamental frequency of organ pipe = 205 Hz

12. (a) The moment of inertia (I) of circular ring whose axis of rotation is passing through

its center, $I_1 = m_1 R^2$

$$\text{Also, } I_2 = m_2 (nR)^2$$

Since both rings have same density,

$$\Rightarrow \frac{m_2}{2\pi (nR) \times A_2} = \frac{m_1}{2\pi R \times A_1}$$

Where A is cross-section of ring,

$$A_1 = A_2 \text{ (Given) } \therefore m_2 = nm_1$$

$$\text{Given } \frac{I_1}{I_2} = \frac{1}{8} = \frac{m_1 R^2}{m_2 (nR)^2} = \frac{m_1 R^2}{nm_1 (nR)^2}$$

$$\Rightarrow \frac{1}{8} = \frac{1}{n^3} \quad \text{or } n = 2$$

13. (d) Volume of bigger bubble
= volume of 27 smaller bubbles

$$\Rightarrow \frac{4}{3} \pi D^3 = 27 \times \frac{4}{3} \pi d^3 \Rightarrow d = \frac{D}{3}$$

$$\text{Initial surface energy } S_i = 4\pi D^2 \sigma$$

$$\text{Final surface energy } S_f = 27 \times 4\pi D^2 \sigma$$

$$\Delta S = S_f - S_i \text{ and using } d = \frac{D}{3}$$

$$\Delta S = \sigma \times 4\pi \left[27 \times \frac{D^2}{9} - D^2 \right]$$

$$= 2D^2 \times 4\pi \times \sigma = 8\pi \sigma D^2$$

$$14. (a) \frac{V_1}{V_2} = \sqrt{\frac{M_1}{M_2}} \Rightarrow 4 = \sqrt{\frac{64}{M_1}}$$

or $M_1 = 4$ i.e. He

15. (b) At constant pressure

$$W = P(V_f - V_i) = nR\alpha(T_f - T_i)$$

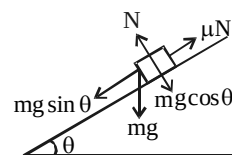
$$= 1 \times 8.14 (127 - 27) = 8.14 \times 100 = 814 \text{ J}$$

$$16. (a) \frac{mv^2}{r} = qvB$$

$$B = \frac{mv}{qr} = \frac{9.1 \times 10^{-31} \times 10^6}{1.6 \times 10^{-19} \times 0.5}$$

$$= 1.13 \times 10^{-5} \text{ T}$$

17. (a) Remember that acceleration of a cylinder down a smooth inclined plane is



$$a = \frac{g \sin \theta}{\left(1 + \frac{I}{mR^2}\right)} \text{ where } I = \frac{mR^2}{2} \text{ is the}$$

moment of Inertia for cylinder

$$a = \frac{g \sin 30^\circ}{\left(1 + \frac{mR^2}{2} \times \frac{1}{mR^2}\right)} = \frac{g \times \frac{1}{2}}{1 + \frac{1}{2}} = \frac{g}{3}$$

18. (b) According to Kepler's third law,

$$R^3 \propto T^2 = \frac{R}{R_e} = \left(\frac{T}{T_e}\right)^3 = \left(\frac{27 T_e}{T_e}\right) = 9$$

19. (a) The gravitational field intensity at the centre (of an equilateral triangle), equidistant from the three vertices due to 3 equal masses will be zero. The vector sum of the forces due to the 3 masses will be zero.

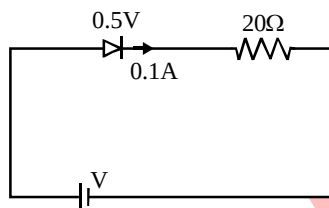
20. (a) Kinetic energy = translational kinetic energy + rotational kinetic energy

$$K.E. = \frac{1}{2}mv^2 + \frac{1}{2}I\omega^2$$

$$\text{Moment of inertia of sphere (I)} = \frac{2}{5}MR^2$$

$$\therefore K.E. = \frac{1}{2}mv^2 + \frac{1}{2} \times \frac{2}{5}MR^2 \left(\frac{v}{R}\right)^2 = \frac{7}{10}mv^2$$

21. (c) $V' = V \times IR = 0.5 + 0.1 \times 20 = 2.5 V$



22. (a) Pot. gradient = 0.2mV/cm

$$= \frac{0.2 \times 10^{-3}}{10^{-2}} = 2 \times 10^{-2} \text{ V/m}$$

$$\text{Emf of cell} = 2 \times 10^{-2} \times 1\text{m} = 2 \times 10^{-2} \text{ V} = 0.02 \text{ V}$$

As per the condition of potentiometer
 $0.02(R + 490) = 2(R)$ or $1.98R = 9.8$

$$\Rightarrow R = \frac{9.8}{1.98} = 4.9 \Omega$$

23. (c) Work done in rotating a dipole by an angle ' θ ' is

$$W = pE(1 - \cos \theta) = pE(1 - \cos 60) = \frac{pE}{2}$$

$$\text{Again, } W_{180} = pE(1 - \cos 180)$$

$$= pE[1 - (-1)] = 2pE = 4W$$

24. (a) Magnetic moment = $M = IA$, where A is the area of the orbit (πr^2) and I is the

current flowing due to charge e . Further orbital motion of electron is equivalent to a current

$$I = \frac{e}{T} = ev$$

$$\left(\text{where } T = \frac{1}{\nu} \text{ is the time period}\right)$$

$$\therefore M = IA = ev\pi r^2$$

25. (c) Initial force between the two spheres carrying charge (say q) is

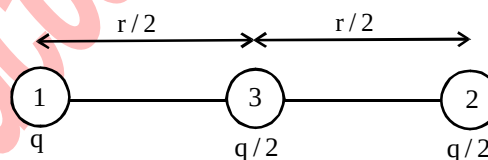
$$F = \frac{1}{4\pi\epsilon_0} \frac{q^2}{r^2}$$

(r is the distance between them)

Further when an uncharged sphere is kept in touch with the sphere of charge q , the

net charge on both become $\frac{q+0}{2} = \frac{q}{2}$.

Force on the 3rd charge, when placed in center of the 1st two



$$F_3 = \frac{1}{4\pi\epsilon_0} \frac{q\left(\frac{q}{2}\right)}{\left(\frac{r}{2}\right)^2} - \frac{1}{4\pi\epsilon_0} \frac{\left(\frac{q}{2}\right)}{\left(\frac{r}{2}\right)^2}$$

$$= \frac{1}{4\pi\epsilon_0} \frac{q^2}{r^2} [2 - 1] = F$$

26. (b) A bimetallic strip, on uniform heating, bends in the form of an arc and the metal with greater ' α ' lies on the convex side.

27. (c) General wave equation

$$y = A \sin(\omega t - kx)$$

On comparing, we get $\omega = 100\pi$

$$\therefore \text{Wave number, } k = \frac{\omega}{v} = \frac{100\pi}{100} = \pi \text{ m}^{-1}$$

28. (c) For constant pressure, $V \propto T$

29. (c) K_α and K_β are characteristics line in the X-ray line spectrum.

30. (d) $T = 2\pi\sqrt{\frac{\ell}{g}}$

$$\Rightarrow \text{Frequency, } n = \frac{1}{T} \propto \frac{1}{\sqrt{\text{length}}}$$

$$\frac{n_1}{n_2} = \frac{\sqrt{\ell_2}}{\sqrt{\ell_1}} \Rightarrow \frac{2}{3} = \frac{\sqrt{\ell_2}}{\sqrt{\ell_1}} \Rightarrow \frac{\ell_1}{\ell_2} = \frac{9}{4}$$

31. (c) $V_e = \sqrt{2gR}$ and $V_0 = \sqrt{gR}$

$$V_e = \sqrt{2}V_0 \quad V_0 \Rightarrow \frac{2}{\sqrt{2}} = \sqrt{2} \text{ km/s}$$

32. (a) $m = Zit$

$$\Rightarrow m = 3.3 \times 10^{-7} \times 3 \times 2 = 19.8 \times 10^{-7}$$

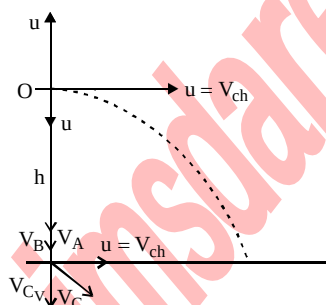
33. (c) $\chi = \frac{C}{T}$ (as per Curie's law)

Paramagnetic materials obey Curies law.
C = Curies constant

34. (a) When the plane polarised light passes through certain substance, the plane of polarisation of the light is rotated about the direction of propagation of light through a certain angle.

35. (a) For A: It goes up with velocity u will it reaches its maximum height (i.e. velocity becomes zero) and comes back to O and attains velocity u .

$$\text{Using } v^2 = u^2 + 2as \Rightarrow v_A = \sqrt{u^2 + 2gh}$$



For B, going down with velocity u

$$\Rightarrow v_B = \sqrt{u^2 + 2gh}$$

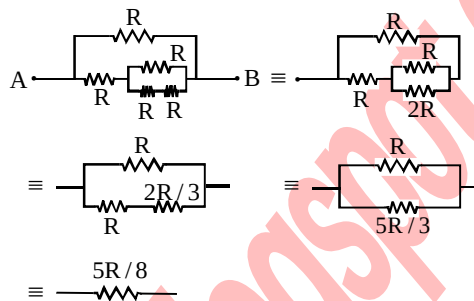
For C, horizontal velocity remains same, i.e. ' u '.

$$\text{Vertical velocity} = \sqrt{0 + 2gh} = \sqrt{2gh}$$

$$\text{The resultant } v_C = \sqrt{v_x^2 + v_y^2} = \sqrt{u^2 + 2gh}$$

$$\text{Hence } v_A = v_B = v_C$$

36. (b) The equivalent circuit can be redrawn as

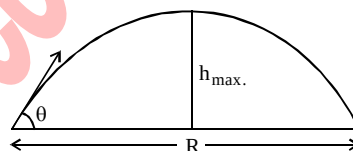


37. (b) As per Einstein's photoelectric equation :

$$E = h\nu = wF + KE_{\max}$$

i.e. till a certain value of ν , KE remains 0, it only starts increasing once the Work function (WF) of the metal surface is achieved.

38. (a) $R = \frac{u^2 \sin 2\theta}{g}$; $R_{\max} = \frac{u^2 \sin^2 \theta}{2g}$



$$\text{Equating we get } \sin 2\theta = \frac{\sin^2 \theta}{2}$$

$$\text{or } 4 \sin \theta \cos \theta = \sin^2 \theta$$

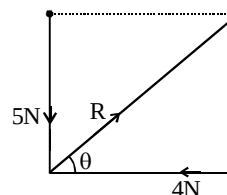
$$\Rightarrow \tan \theta = 4 \text{ or } \theta = \tan^{-1} 4$$

39. (c) $R = \frac{u^2 \sin 2\theta}{g}$ will be maximum for

$$\sin 2\theta = 1 \Rightarrow 2\theta = \frac{\pi}{2} \text{ or } \theta = \frac{\pi}{4} = 45^\circ$$

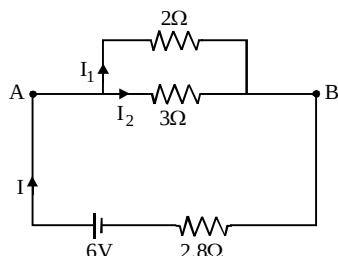
40. (a) $R = \sqrt{4^2 + 5^2} = \sqrt{41} \text{ N}$

$$\text{The angle } \theta \text{ will be given by } \tan \theta = \frac{5}{4}$$



$$\text{or } \theta = \tan^{-1} \frac{5}{4}$$

41. (c) At steady state the capacitor will be fully charged and thus there will be no current in the 1Ω resistance. So the effective circuit becomes



Net current from the 6V battery,

$$I = \frac{6}{\left(\frac{2 \times 3}{2+3}\right) + 2.8} = \frac{6}{1.2 + 2.8} = \frac{3}{2} = 1.5A$$

Between A and B, Voltage is same in both resistances,

$$2I_1 = 3I_2 \quad \text{where } I_1 + I_2 = I = 1.5$$

$$\Rightarrow 2I_1 = 3(1.5 - I_1) \Rightarrow I_1 = 0.9A$$

42. (a) Convex lens can form image with $m < 1$, $m > 1$ and $m = 1$ depending upon the position of the object. Convex lens forms magnified image ($m > 1$) when the object is pole and $2f$, same size as the object ($m = 1$) when the object is at $2f$ and smaller image ($m < 1$), when the object is beyond $2f$.

43. (a) When the source (star) is moving towards the observer (earth),
Apparent wavelength,

$$\lambda' = \frac{C - V_s}{C} \lambda = \left(1 - \frac{V_s}{C}\right) \lambda = \lambda - \frac{V_s}{C} \lambda$$

$$\Rightarrow \lambda - \lambda' = \text{apparent shift in wavelength}$$

$$= \frac{V_s}{C} \lambda \quad (C = \text{velocity of sound})$$

44. (b) **Case - I :** When resistor is not connected
Using $V = IR \Rightarrow V = 25(R_G) \dots\dots\dots (i)$

Case - II : When resistor is connected
 $V = 5(20 + R_G) = 100 + 5R_G \dots\dots\dots (ii)$

From (i) and (ii), $20R_G = 100$

$$\Rightarrow R_G = 5\Omega$$

45. (d) Let internal resistance of source = R
Current in coil of resistance

$$R_1 = I_1 = \frac{V}{R + R_1}$$

Current in coil of resistance

$$R_2 = I_2 = \frac{V}{R + R_2}$$

Further, as heat generated is same, so

$$I_1^2 R_1 t = I_2^2 R_2 t$$

$$\text{or } \left(\frac{V}{R + R_1}\right)^2 R_1 = \left(\frac{V}{R + R_2}\right)^2 R_2$$

$$\Rightarrow R_1(R + R_2)^2 = R_2(R + R_1)^2$$

$$\Rightarrow R^2 R_1 + R_1 R_2^2 + 2RR_1 R_2$$

$$= R^2 R_2 + R_1^2 R_2^2 + 2RR_1 R_2$$

$$\Rightarrow R^2(R_1 - R_2) = R_1 R_2(R_1 - R_2)$$

$$\Rightarrow R = \sqrt{R_1 R_2}$$

46. (a) Microwaves are used for communication in artificial satellites.

47. (c) de Broglie wavelength, $\lambda = \frac{h}{\sqrt{2mE_{K.E}}}$

$$\therefore \frac{\lambda_p}{\lambda_\alpha} = \sqrt{\frac{m_\alpha}{m_p}} = \sqrt{\frac{4m_p}{m_p}}$$

$$[\because E_{K.E(\alpha)} = E_{K.E(p)}]$$

$$\therefore \frac{\lambda_p}{\lambda_\alpha} = \frac{2}{1}$$

48. (c) $h = \frac{E}{\nu} = \frac{ML^2T^{-2}}{T^{-1}} = ML^2T^{-1}$

49. (d) Black body spectrum

50. (b) Fringe width $\propto \lambda$. Also $\lambda_{\text{blue}} > \lambda_{\text{red}}$
Therefore, fringes come closer when blue light is replaced by red light in diffraction pattern.

51. (d) In p-n junction, the diffusion of majority carriers takes place when junction is forward biased and drifting of minority carriers takes place across the junction, when reverse biased. The reverse bias opposes the majority carriers but makes the minority carriers to cross the p-n junction. Thus the small current in μA flows during reverse bias.

52. (b) In Rutherford's α -particle scattering experiments, some of α -particles was found to be scattered at very large angles, inspite

of having very high kinetic energy. This shows that there are the α -particle which will be passing very close to nucleus. Rutherford's confirmed the repulsive force on α -particle due to nucleus varies with distance according to inverse square law and that the positive charges are concentrated at the center and not distributed throughout the atom. This is the nuclear model of Rutherford.

53. (a) When a polaroid is rotated in the path of unpolarised light, the intensity of light transmitted from polaroid remains undiminished (because unpolarised light contains waves vibrating in all possible planes with equal probability). However, when the polaroid is rotated in path of plane polarised light, its intensity will vary from maximum (when the vibrations of the plane polarised light are parallel to the axis of the polaroid) to minimum (when the direction of the vibrations becomes perpendicular to the axis of the crystal). Thus using polaroid we can easily verify that whether the light is polarised or not.

54. (e) An induced current develop in a conductor cannot moved in a direction parallel to magnetic field. This is because when the conductor moved in a direction parallel to magnetic field, amount of flux linked with the conductor does not change. Thus the induced current develops only when conductor cuts the lines of magnetic force. The direction of flow of induced current can also be found by applying Fleming's right hand rule, when the direction of motion of conductor inside the magnetic field and the direction of magnetic field action on it are known.

55. (a) Drift velocity of free electrons is given by,

$$v_d = \frac{eE}{m} \tau$$

$$\text{Where, } E = \frac{\text{Potential difference}}{\text{length}} = \frac{V}{\ell}$$

$$\therefore v_d = \frac{eV}{m\ell} \tau$$

$$\text{i.e., } v_d \propto \frac{1}{\ell} \text{ where } \frac{eV\tau}{m} \text{ is constant.}$$

56. (c) A charged capacitor, after removing the battery, does not discharge itself. If this

capacitor is touched by someone, he may feel shock due to large charge still present on the capacitor. Hence it should handled cautiously otherwise this may cause a severe shock.

57. (b) A perfect black body is one which absorbs heat radiation of all wavelengths, which fall on it. Such a body neither reflects nor transmits any part of the incident heat radiation and hence appears black irrespective of the colour of the incident radiation. Obviously the absorbance of a perfect black body is unity. The radiation given out by a perfect black body are called black body radiations or full radiation or total radiations.

58. (b) As we know, $\Delta\phi = \left(\frac{2\pi}{\lambda}\right) \times \Delta x$. This is

phase difference between two particles whose path difference is Δx . If $\Delta x = \lambda$, then $\Delta\phi = 2\pi$. Thus, the phase difference between two medium particles having a path difference λ is 2π , i.e., the particles are in the same phase of oscillations.

59. (a) The presence of impurities either on the liquid surface or dissolved in it, considerably affect the force of surface tension, depending upon the degree of contamination. A highly soluble substance like sodium chloride when dissolved in water, increased the surface tension of water. But the sparingly soluble like phenol when dissolved in water reduces the surface tension of water.

60. (c) The orbital velocity, if a satellite close to earth is $V_0 = \sqrt{gR_e}$, While the escape velocity for a body thrown from the earth's surface is $V_e = \sqrt{2gR_e}$.

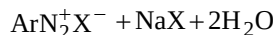
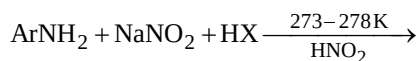
$$\text{Thus } \frac{V_0}{V_e} = \frac{\sqrt{gR_e}}{\sqrt{2gR_e}} = \frac{1}{\sqrt{2}}$$

$$\text{or } V_e = \sqrt{2}V_0$$

i.e., if the orbital velocity of a satellite revolving close to the earth happens to increase to $\sqrt{2}$ times, the satellite would escape.

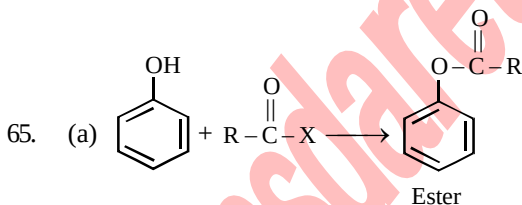
SECTION II - CHEMISTRY

61. (a) Aromatic diazonium salts are generally prepared by adding cold aqueous solution of sodium nitrite to solution/suspension of 1° aromatic amine at 273 - 278 K



62. (a) Some sols have a high concentration of dispersed solid and change spontaneously into semisolid form on cooling these are called gels thus they form liquid as dispersed phase and solid as dispersion medium.

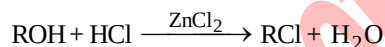
63. (c) Cr has valance shell $3d^5 4s^1$
 $\therefore$ Number of valance electrons = 6
 H_2O is monodentate
 $\therefore$ 2 electrons from each H_2O
 $\therefore$ Total electrons contributed by H_2O
 $= 2 \times 5 = 10$
 SCN gives 2 electrons
 Total valance electrons = $6 + 10 + 2 = 18$
 Over all charge on complex is + 2
 $\therefore$ Valance electrons in complex are 16
64. (a) Valance shell is $3d^5 4s^1$, It means inner shells are $1s^2 2s^2 2p^6 3s^2 3p^6$
 $\therefore$ At no. = 24. Hence element is Cr.



66. (d) Aldehyde which do not contain α -H atom on treatment with alkali solution undergo self oxidation - reduction reaction (Cannizaro reaction) $^{\alpha}\text{CH}_3 - \text{CHO}$ has α -H
 $\therefore$ Cannot show Cannizaro reaction.
 e.g. of Cannizaro reaction :
 $\text{HCHO} + \text{NaOH}$



67. (b) $(\text{HCl}_{(\text{conc.})} + \text{ZnCl}_2)$ is Lucas reagent.
 Different alcohols react at different rate with this reagent.



1° alc. $\xrightarrow{\text{HCl} / \text{ZnCl}_2}$
 do not react at room temp.

2° alc. $\xrightarrow{\text{HCl} / \text{ZnCl}_2}$ turbidity appears in 5 min.

3° alc. $\xrightarrow{\text{HCl} / \text{ZnCl}_2}$ turbidity appears at once.

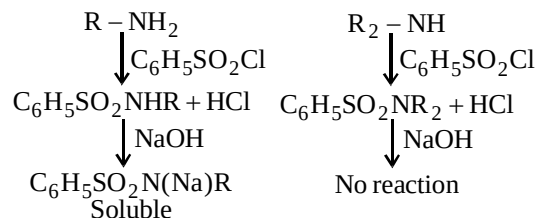
68. (b) No. of nodes = $n - \ell - 1$
 For 5d = $5 - 2 - 1 = 2$
69. (b) More is s-character more is electronegativity of hybrid orbital..
 sp has 50 % s-character
 sp^2 has 33 % s-character
 sp^3 has 25 % s-character
 $\therefore$ Order of electronegativity
 $sp > sp^2 > sp^3$

70. (c) Bond length is in order as given
 Single bond > double bond > triple bond
 N_2 has triple bond; O_2 has double bond
 I_2 and Cl_2 have single bond
 Out of these I_2 has longer bond length as, due to big atoms the inter nuclear distance is large.

71. (d) $\text{C}_6\text{H}_5\text{SO}_2\text{Cl}$ is Hinsberg reagent

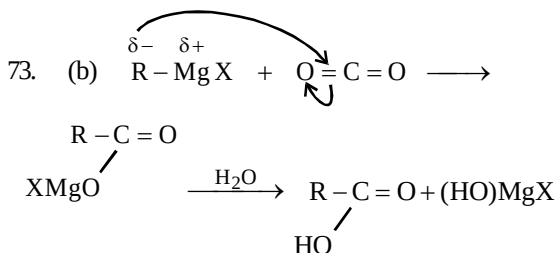
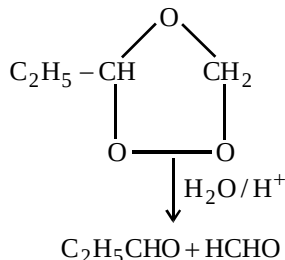
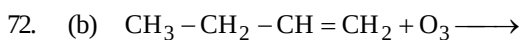
1° amine

2° amine

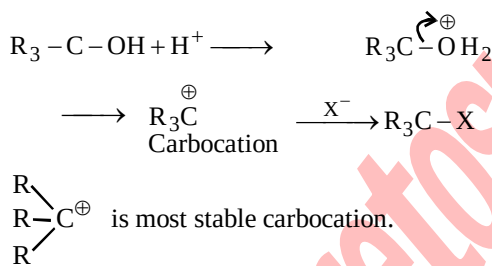


3° amine

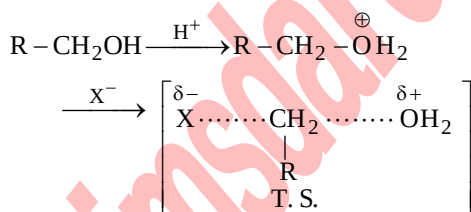
↓
Do not react at all



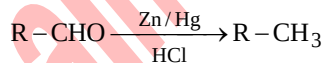
74. (a) 3° alcohols undergo reaction with $\text{S}_{\text{N}}1$ mechanism



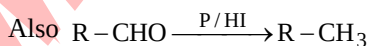
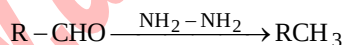
Note :- 1° alcohol show $\text{S}_{\text{N}}2$ mechanism



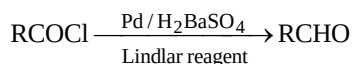
75. (b) Clemmenson's reaction



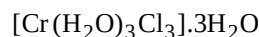
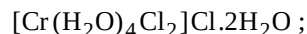
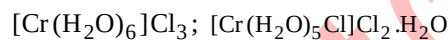
Note :- Wolf Kishner reduction is



Rosenmund reaction :-



76. (a) 4 Isomers are



77. (c) Contribution by 8 atoms present at corner
 $= 1/8 \times 8 = 1$

Contribution by atom present within the body = 1

Numbers of atoms present per unit cell
 $= 1 + 1 = 2$

78. (a) A few ions, consisting of two or more electro negative atoms of which at least one is N and properties similar to halide ions are called pseudohalides of NNN^- , OCN^- , CN^- etc.

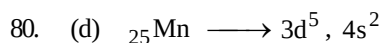
Halide ions often react with molecules of halogens or interhalogen to form poly halides like BrI_2^- , where as IF_5 is an inter halogen compound. Note - RCOO^- is not pseudohalide

79. (c) $\frac{dx}{dt} = K [\text{Conc}]^n$

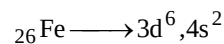
$k = \frac{dx}{dt} \times \frac{1}{[\text{Conc.}]^n} = \frac{1}{\text{Time}} \times \frac{1}{[\text{Conc.}]^{n-1}}$

For 2nd order reaction,

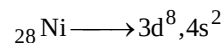
$k = \frac{1}{\text{sec}} \times \frac{1}{[\text{mol/L}]^{2-1}} = \text{sec}^{-1} \text{mol}^{-1} \text{L}$



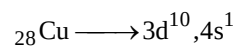
Number of unpaired electrons = 5



Number of unpaired electrons = 4



Number of unpaired electrons = 2



Number of unpaired electrons = 1

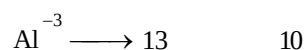
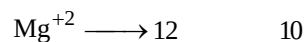
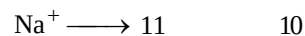
More is number of unpaired electrons higher is paramagnetism.

81. (b) Elevation in B.P. is colligative property which depends upon number of particles.

Each BaCl_2 ion gives Ba^{+2} and 2Cl^- . Thus number of particles is highest out of given compounds.

82. (d) Size of ion depends upon nuclear charge. More is nuclear charge compared to number of electrons, tightly are electrons held and thus smaller is size

Nuclear charge **No. of electrons**



In Al^{+3} 13 units of positive charge tend to attract 10 electrons more towards nucleus thus reducing sphere of electron cloud around the nucleus i.e. size.

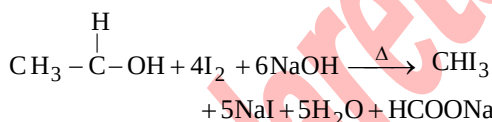
83. (b) Ninhydrin test is shown by proteins and amino acid. Negative result shows absence of these two.

Benedict's solution test is for aldehyde group which is present in monosaccharides and not lipids.

84. (c) Iodoform test is shown by compounds of aldehyde, ketone or alcohol which have

CH_3 gp at α position like $\overset{\alpha}{\text{C}}\text{H}_3\text{CHO}$,

$\overset{\alpha}{\text{C}}\text{H}_3-\text{COR}$, $\text{CH}_3\text{CR}(\text{OH})$ etc. Ethyl alcohol has $\text{CH}_3\text{CH}(\text{OH})$ thus shows iodoform test



85. (d) Penetration power is more when particle is small in size and is moving with high speed. $\therefore$ order of penetrating power is $\gamma > \text{X-ray} > \beta > \alpha$

86. (b) Order of filling follows $(n + \ell)$ rule, small is $(n + \ell)$ lower is energy so filling is first.

If $(n + \ell)$ values are same then lower n is given preference for

(a) $n = 5, \ell = 0, n + \ell = 5$

(b) $n = 3, \ell = 2, n + \ell = 5$

(c) $n = 6, \ell = 0, n + \ell = 6$

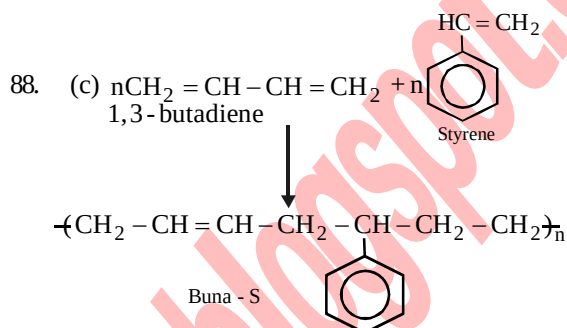
(d) $n = 5, \ell = 1, n + \ell = 6$

$n = 3, \ell = 2$, i.e. 3d is filled 1st

87. (c) When more than one atom in a monodentate ligand can act as donor

linkage isomerism occurs.

In this case SCN has S and N as donor atom which can link with the central atom.

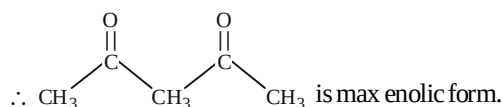


89. (d) CO has triple bond; $\therefore$ B.O. must be 3
 O_2 has double bond, $\therefore$ B.O. must be 2
 F_2 is single bonded, $\therefore$ B.O. must be 1
 Be_2 does not exist, $\therefore$ B.O. = 0
 Alternatively B.O.

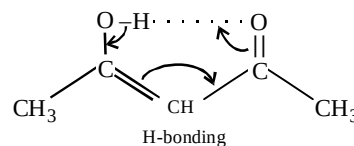
$$= \frac{\text{Number of bonding} - \text{No. of antibonding } e^-}{2}$$

$$\text{Be}_2 \Rightarrow \sigma 2s^2, \sigma^* 2s; \text{B.O.} = \frac{2-2}{2} = 0$$

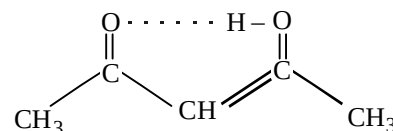
90. (b) enolic form increases when there is H-bonding. If this H-bonding is further stabilised by conjugation enolic form further increases.



$\rightleftharpoons$ Tautomerism



Conjugation $\rightarrow$



91. (c) Benedict's sol. test is shown by aldehydes. Reason for easy oxidation of aldehyde to acid is presence of H-atom on carboxyl gp. Due to which it acts as strong reducing

agent and can thus reduce weak oxidising reagents like Tollens, Benedict and Fehling solution.

Note :- Benedict's solution is alkaline solution of Cu^{+2} complexed with citrate ions.

Fehling solution is alkaline solution of Cu^{+2} complexes with Rochelle salt (is Sod. potassium tartrate). Tollens solution is ammonical silver nitrate ($\text{AgNO}_3/\text{NH}_4\text{OH}$).

92. (d) H – Spectrum confirms quantisation of energy within an atom.

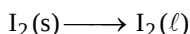
93. (d) Conjugate acid and base differ by one hydrogen only

CH_3NH_2 is a base its conjugate acid is

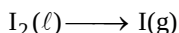
CH_3NH_3^+ (Which is +ve, electrons deficient species)

94. (a) Given $\text{I}_2(\text{s}) \longrightarrow \text{I}(\text{g})$,

$$\Delta H_{\text{sublimation}} = +57.3 \text{ kJ/mol}$$



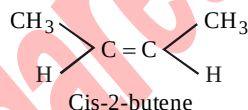
$$, \Delta H_{\text{fusion}} = +15.5 \text{ kJ/mol}$$



$$, \Delta H_{\text{vap}} = \Delta H_{\text{sub}} - \Delta H_{\text{fusion}}$$

$$= 57.3 - 15.5 = 41.8 \text{ kJ/mol}$$

95. (a) $\text{HC} \equiv \text{C} - \text{CH}_3 \xrightarrow[\text{Lindlar's reagent}]{\text{Pb/BaSO}_4}$



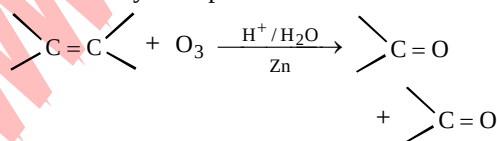
96. (a) $\Delta H = (-)$ i.e. exothermic reaction
 $\Delta S = (+)$ i.e. entropy factor also favours.
 Thus for a spontaneous reaction ΔG is always negative.

$$\Delta G = (-\Delta H) - T\Delta S = -(ve)$$

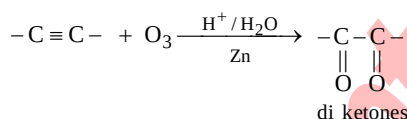
Note : $\Delta G = +(ve)$, reaction is non spontaneous

$\Delta G = 0$, reaction is in equilibrium.

97. (c) Ozone changes π bond compound to carbonyl compounds



Carbonyl compounds



98. (d) More easily Nucleophilic can replace halide ion more is reactivity. In case of vinyl $\text{C} = \text{C}$, $\text{C}-\text{Cl}$ bond acquires some double bond character and become strong thus is not easily replacable.

$\therefore$ order is Allyl chloride > Vinyl > Chloro Benzene



99. (b) According to Le Chatelier's principal
 (1) Increase in concentration of any reactant being consumed during the reaction favours the reaction.

- (2) For an endothermic reaction increase in temperature favours reaction in forward direction.

- (3) High pressure is favourable for the reaction in which there is decrease in volume.
 In given case faourable conditions are :

- (a) Increase in conc. of BaCO_3

- (b) Increase in temprature

- (c) Decrease in pressure

100. (b) Ionic concentration of A i.e.

$$\text{Ca}(\text{NO}_3)_2 = 0.5 \times 3 = 1.5$$

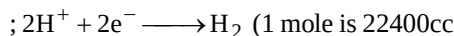
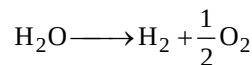
Ionic concentration of B i.e.

$$\text{KOH} = 0.75 \times 2 = 1.5$$

Ionic concentration is same for A and B

$\therefore$ depression in freezing point will also be same.

101. (d) Change $Q = \text{Current (Ampere)} \times \text{time (sec)}$
 $\therefore Q = 2 \times 60 \times 60$



at NTP) For 1 mol of H_2 liberated 2 faradays

are required $2F = 2 \times 96500$

$0.2 \times 60 \times 60$ will give H_2

$$= \frac{22400 \times 2 \times 60 \times 60}{2 \times 96500} = 835.64 \text{ cc}$$

$$= 0.836 \text{ L}$$

102. (b) In fluorite structure, cations form face centered cubic a array and anions fit into tetrahedral void.
In antfluorite structure case is reversed, the oxide ions fill half tetrahedral holes.

103. (b) For any n ; $\ell = n - 1$, $m = -\ell$ to 0 to $+\ell$
and $s = \pm \frac{1}{2}$ $\therefore$

for $n = 2$, $\ell \neq 2$

104. (a) Lindlar catalyst is Pd/H_2 , BaSO_4 poisoned with sulphur or quinoline $\longrightarrow$ It gives us product $\text{Na} / \text{liq. NH}_3$ (Birch reduction) gives trans alkenes.

Note there are variety of other reducing agents which gives trans or cis products according to mechanism they follow. Some are listed below

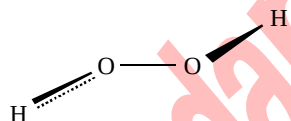
1. Wilkinson's catalyst $\longrightarrow$

$\text{RhCl}(\text{H}_2)(\text{PPh}_3) \longrightarrow$ cis addition

2. Hydroboration
 $\text{B}_2\text{H}_6 \longrightarrow$ cis addition

Note : LiAlH_4 and NaBH_4 normally donot reduce olefinic bonds. They are selective towards carbonyl $\text{C} = \text{O}$ double bond.

105. (d) Value of dipole moment is not zero thus
 $\text{H} - \text{O} - \text{O} - \text{H}$ is not supposed structure where both OH are in same plane.
Dipole moment is some what near 2.1 D
 $\therefore$ Struture comes out to be



106. (d) In CO_2 O has -2 valency
In MnO_2 O has -2 valency
In Na_2O O has -2 valency

In BaO_2 O is O_2^{2-}
 $\therefore$ it is true peroxide

[Note: $\text{Ba}^{+2}\text{O}^{2-} \rightarrow \text{BaO}$ is Barium oxide]

107. (d) Li^+ due to small size have high degree of hydration.
108. (c) Gelatin has maximum protective power
starch has minimum protective power

109. (a) Conc. of SO_4 is $[\text{SO}_4^{2-}]$ in BaSO_4

$$= \frac{10^{-11}}{0.1} = 10^{-10}$$

Conc. of SO_4 is $[\text{SO}_4^{2-}]$ in Ag_2SO_4

$$= \frac{10^{-5}}{0.1 \times 0.1} = 10^{-3}$$

Conc. of SO_4 is $[\text{SO}_4^{2-}]$ in CaSO_4

$$= \frac{10^{-6}}{0.1} = 10^{-5}$$

Ionic product is minimum for BaSO_4
 $\therefore$ it must precipitate 1st.

110. (d) SeO_2 in alkaline/acidic medium

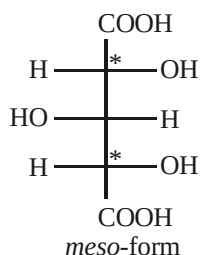
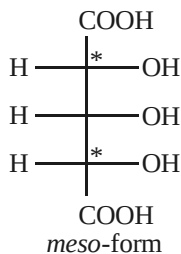
dehydrogenates ketones to give α, β unsaturated ketone. (Removal of hydrogen is oxidation).

111. (b) Cd^{2+} is a 2nd group radical and Ni^{2+} is a 4th group radical. So solubility product of NiS has to be more than CdS . Further Cd^{2+} gives yellow colour of CdS with H_2S , but Ni^{2+} gives black colour of NiS with H_2S . So both assertion and statement are wrong.
(d) is correct choice.

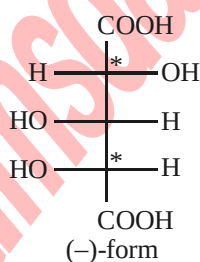
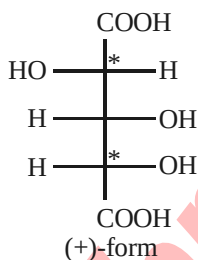
112. (b) In $[\text{NiCl}_4]^{2-}$ the Cl^- ligands present in the complex ion are less basic than CN^- . As such no pairing of electrons in the 3d-subshell takes place. This results in sp^3 hybridisation and the complex so formed is tetrahedral. On the other hand in case of $[\text{Ni}(\text{CN})_4]^{2-}$ the CN^- ligands present in the complex ion are more basic than Cl^- . As such pairing of electrons can take place in the 3d subshell. Due to pairing of electrons in 3d subshell, one of the d-orbital becomes vacant. This results in dsp^2 hybridisation and the complex so formed in square planar.

113. (c) Rusting involves reduction of absorbed oxygen to OH^- ions and oxidation of iron to Fe^{2+} ions. The two ions and oxidation of iron to Fe^{2+} ions. The two ions combine to yield $\text{Fe}(\text{OH})_2$ which gets oxidised to give $\text{Fe}_2\text{O}_3 \cdot n\text{H}_2\text{O}$ (rust). The presence of acid helps dissolution of pure iron to ferrous ions while electrolytes increase the conductivity and assist cell action.

- 114.(a) R is the correct explanation of A.



MIRROR



The central carbon atom is pseudochiral carbon atom.

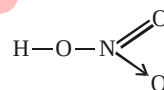
- 115.(d) The statement is clearly wrong in context to Le-chateliers principle, which states that "increase in temperature shifts the

equilibrium in the forward direction of those reactions which proceed with absorption of heat (**endothermic reactions**), and in the backward direction of those reactions which proceed with the evolution of heat (**exothermic reactions**).” E is clearly true again according to Le-chatelier principle.

- 116.(a) Assertion is correct as for every 10°C raise in temperature, the specific rate constant, K nearly doubles. (Although it is not correct for all reactions. For some reactions K even gets tripled for 10°C raise). The statement is clearly true and it explains the assertion, as the rate of collision among the molecules doubles for 10°C rise in temperature. So the answer is (a).

- 117..(c) Among oxyacids, the acidic character increases with increase in oxidation state of the central atom. Hence assertion is correct.

Structure of HNO_2 : $\text{O}-\text{H}-\text{N}=\text{O}$; Structure of HNO_3 :



The assertion is true but the reason is wrong as can be clearly seen from the above structures.

- 118.(b) Metal having negative reduction potential or positive standard oxidation potential has a tendency to get itself oxidised and pass into the solution.

- 119.(a) Lattice energy is the amount of energy required to dissociate one mole of an ionic crystal into its ions and hydration energy is the amount of energy released when one mole of ions undergo hydration. So for the solubility of a solid in liquid hydration energy must be greater than lattice energy

- 120.(c) The correct reason is : The overall electron deficiency in *m*-nitroaniline is much less (due to -R-effect of NO_2 group and +R-effect of NH_2 group) than in *m*-dinitrobenzene (-R-effect of the two NO_2 groups) and hence does not accept additional electrons from a weak reducing agent such as $(\text{NH}_4)_2\text{S}$ and thus further reduction is prevented.

SECTION III - BIOLOGY

121. (c) With the discovery of more and more organisms, sometimes, it becomes difficult to adjust an organism to the traditional categories. Therefore to make taxonomic position of a species more precise. The various obligate categories in hierarchical classification are explained below
Division $\longrightarrow$ Class $\longrightarrow$ order $\longrightarrow$ family $\longrightarrow$ Genus $\longrightarrow$ Species $\longrightarrow$ Tribe
122. (c) The bacterial genome/nucleoid is made of double stranded DNA without histone protein. The bacterial genome thus represented by a single circular double helical DNA. The genome contains some 100 chemical sites or loci. Each locus contains many genes. E coli contains about 4000 genes.
123. (c) The fungus that causes the disease 'Ergot of Rye' is *Claviceps purpurea*. It contains many poisonous alkaloids. The hallucinogenic drug LSD is extracted from this fungi.
- Rust of wheat is used by *Puccinia graminis*
 - Powdery Mildew of Pea is caused by *Erysiphe*.
124. (b) Shape and number of chloroplast in different member of algae is different
Chlamydomonas – cup shaped, 1/cell
Zygnema – Stellate, 2/cell
Spiral – *Spirogyra* 1/ cell
Collar shaped - *Ulothrix* 1/cell
125. (c) The inner membrane of mitochondria possess small tennis like particles called elementary particles, $F_0 - F_1$ particles or **oxysomes**. There are $1 \times 10^4 - 1 \times 10^5$ oxysomes in a mitochondria.
126. (c) $++40$; **a** 40 ; **a** 10 ; **b** 10
127. (a) Lac operon is an inducible operon system which regulates genetic material. The genetic material remains switched off normally but becomes operational in the presence of inducer.
128. (b) Certain mitotic and meiotic irregularities such as formation of restitution nucleus, fusions of spindles lead to doubling of the chromosomes in a cell. Chromosome doubling is introduced by high temperature, X-ray treatments, callus formation hybridisation and chemical treatment like chloroform, chloral hydrate colchicine, auxins, gibberellins and nicotine sulphate etc. induce polyploidy.
129. (a) Asteraceae constitutes the most advanced family among dicots. The syngenesious condition of the stamen is an adaptation for entomophily
130. (d) Tomato and tobacco both belong to the family Solanaceae.
131. (a) The central pith is surrounded by xylem, phloem, pericycle and endodermis. The phloem occurs only outside the xylem e.g. *Equisetum*, *Osmunda*
132. (c) D.P.D. or suction pressure (S.P.)
 $= O.P. - T.P.$
Hence D.P.D. for A = 4 bars, B = 0 bars, C = 5 bars, D = 4 bars
We know that direction of movement of water is from lower D.P.D. (S.P.) to higher D.P.D. (S.P.).
 $\therefore$ flow will be from B to A, C, and D.
133. (c) Chlorophyll has a tetrapyrrole porphyrin head ($15 \times 15 \text{ \AA}$) and a long chain alcohol called phytol ($20 \text{ \AA}$).
134. (d) Cyt a_3 possesses two copper centers. The latter help in transfer of electron to oxygen.
135. (a) In campylotropous ovule, the body is curved but the embryo sac is straight eg. *Capsella*. In Anatropous, the body of the ovule is inverted and gets fused with funiculus along its whole length on one side (most of the angiosperms). In orthotropous condition the body of ovule lies straight and upright over the funicle. e.g. Piperaceae, Polygonaceae.
136. (c) Nyctinastic (sleeping) movements : The diurnal (changes in day & night) movements of leaves cause sleeping movements during night which are called nyctinastic movements. It may be photonastic as in oxalis or thermonastic as in tulip flower.

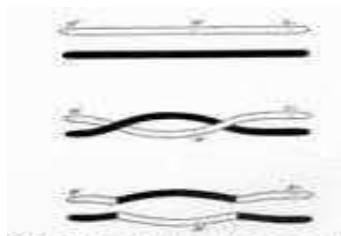
137. (a) Mimicry is the resemblance of an organism to its natural surroundings, like imitating a non-living object or another organism for conceding itself from its enemies. Flowers of *Ophrys muscifera* resemble the female wasps of *Colpa aurea* so that the male wasp tries to copulate with the flowers and pollinate them.
138. (a) *E. coli* are found in the human intestine. If they are present in water it indicates that the water is polluted.
139. (c) Meristem culture is done for the development of virus free plants. Meristematic tissue cells can be taken either from shoot or root tip.
140. (c) 2, 4 Dichlorophenoxy acetic acid is used for causing defoliation of forest trees.
141. (b) Species is the basic unit of classification. The term was coined by John Ray. Most taxonomists define species as morphologically distinct and reproductively isolated natural population or groups of populations where individuals resemble one another more closely than with the members of other species, interbreed freely and form a genetically closed system. Gene transfer occurs between populations of a species by gene flow i.e. emigration and immigration.
142. (c) K_m (Michealis Menten constant). It is defined as that substrate concentration at which under optimum conditions the rate of an enzyme catalysed reaction reaches half the maximum rate. K_m is inversely proportional to the affinity of enzyme for its substrate.
143. (b) Fire bellied toad (*Bombina*) is a member of order – Anura of the class Amphibia.
144. (b) *Eichhornia crassipes* is an American origin plant and now a troublesome water weed in India.
145. (a) Characteristics of smooth muscle cells
- range from 5 to 10 μm in diameter and 30 to 200 μm in length
 - spindle-shaped
 - single, centrally located nucleus
- Smooth muscle tissue occurs within almost every organ, forming sheets, bundles or sheaths around other tissues.
- Smooth muscle differs from both skeletal and cardiac muscle tissues in structure and function. Sarcomeres or myofibrils are not present and are therefore not striated, i.e. smooth.
146. (d) The permanent teeth appear completely by the age of 12 years, except for the last molars, which, if present, are formed after the age of 18 years. The dental formula before the wisdom teeth appear would be
- $$i \frac{2}{2}, c \frac{1}{1}; pm \frac{2}{2}, m \frac{2}{2}$$
- after wisdom teeth appear
- $$i \frac{2}{2}, c \frac{1}{1}; pm \frac{2}{2}, m \frac{3}{3}$$
147. (b) Alveoli are the site of the respiratory exchange of gases. Oxygen from the alveolar air diffuses through the alveolar epithelium and the capillary endothelium into the capillary blood and carbon dioxide diffuses in the opposite direction.
148. (b)
- ```

 Hepatic artery → Liver
 ↑
Heart → Carotico systemic arch → Dorsal aorta → Coeliac artery
 ↓
 Splenic (spleen) ← Lienogastric
 ↓
 Gastric (stomach)

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149. (a) Henle's loop is associated with concentration of the urine and production of hypertonic urine.
150. (c) All mammals have 7 cervical vertebrae in their neck (it is one of the typical mammalian characters). Though they become long in camel & giraff but the number is 7 only. As whale is also a mammal it must possess the same 7 cervical vertebrae.
151. (a) Xth pair of cranial nerves (vagus nerves) has a motor branch called cardiac nerve which innervate cardiac muscles.

152. (a) Luteinizing hormone (LH) stimulates ovulation. Deficiency of insulin causes diabetes mellitus. Deficiency of ADH or vasopressin causes diabetes insipidus. Deficiency of parathormone causes tetany. Deficiency of thyroxine causes cretinism in infants and myxoedema in adults.
153. (c) Follicle stimulating hormone (FSH) stimulates maturation of ovarian follicles. Luteinizing hormone stimulates testes to secrete testosterone. Prolactin stimulates development of mammary glands during pregnancy. Human chorionic gonadotropin released from the placenta also maintains the corpus luteum during pregnancy.
154. (a) Biotic potential is the inherent ability of an organism to reproduce. Resistance refers to the sum total of all the limiting factors that inhibit further growth of population.
155. (b) Normal woman whose father was colour blind would have received the  $X^{cX}$  chromosome from her father  $\rightarrow X^{cX}$ , marries a colour blind man  $-X^{cY}$ , their progeny would be:
- $$X^{cX} \times X^{cY}$$
- |         |                                       |                             |                              |                    |
|---------|---------------------------------------|-----------------------------|------------------------------|--------------------|
| progeny | $X^{cX^{c}}$<br>colour blind daughter | $X^{cX}$<br>normal daughter | $X^{cY}$<br>colour blind son | $XY$<br>normal son |
|---------|---------------------------------------|-----------------------------|------------------------------|--------------------|
156. (a) Genetic drift can operate only in smaller population where in fluctuation can be observed in the proportion of allele distribution in the presence of external disturbances.
157. (c) Cro-Magnon succeeded Neanderthal. Fossils of Neanderthal man have been found from Eroupe, Asia and north Africa. Fossils of Australopithecus have been found in Africa.
158. (b) The presence of juvenile hormone is necessary for metamorphosis in to adult
159. (a) Morphine is an opiate narcotic, Bhang is a hallucinogen, Reserpine derived from *Rauwolfia*, is used a tranquilizer, cocaine is a stimulant.
160. (c) In test tube baby, fertilization of the sperm and the ova is carried out in lab conditions (in vitro) and when the embryos have reached the 32-celled stage, it is implanted back into the uterus of the surrogate mother.
161. (a) Due to the process of exosmosis, plasmolysis takes place. Hence water goes out of the mango and the mango shrinks. Hence, the reason is the correct explanation for the assertion.
162. (b) Nissl's granules are both basophilic and also contain RNA. They are basophilic since they stain with basic dyes. The reason is therefore not the correct explanation of the assertion.
163. (a) Phycobilins are accessory photosynthetic pigments present in algae. These pigments are present along with chlorophyll  $- \alpha$  and help in capturing light for photosynthesis. Phycobilins are pigments which contain proteins and proteins are easily denatured by heat. Hence, the reason is the correct explanation for the assertion.
164. (d) The inner mucosa is mainly meant to increase the surface area and not for absorption. Hence, both assertion and reason are false.
165. (e) Vital capacity is the total volume of air that can be breathed out with maximum effort. The assertion in this case is false.
166. (c) Heart wood is non functional but it is plugged due to the growth of parenchyma that thickens later on. The reason in this case is false, but the assertion is true.
167. (a) Glucose which is the final product of carbohydrate digestion is converted to glycogen in the liver and stored both in the liver and muscles of animals. This process takes place only in animals and hence it is called as animal starch. Hence the reason is the correct explanation for the assertion.
- Electron micrograph of a section of a liver cell showing glycogen.**
168. (c) Racemose inflorescence shows an indefinite growth, which is why it is said to be an indeterminate inflorescence. The reason given is false.
169. (e) Mouth parts of cockroach, honey bee & mosquito are homologous organs. Therefore the assertion is false.

170. (b) The crossing over takes place at the four strand stage so that recombinations can take place when the chromosomes separate as chromatids. The gene linkages do disappear if crossing over takes place at two strand stage. The reason is therefore not the correct explanation of the assertion.



**A double crossing over.**

171. (c) Oncogenes integrate their DNA with DNA of the host cells and not their RNA. The reason in this case is false.
172. (a) HIV is found in body fluids like blood & semen. It is a retrovirus which has RNA as its genetic material. It hence shows reverse transcription. Hence the reason is the correct explanation for the assertion.
173. (b) Genes although show a linear order but are arranged in the DNA as a helical coiled structure. Hence the reason is not the correct explanation for the assertion given.
174. (a) The virus cannot multiply outside living systems. They require a host in order to multiply. Hence the reason is true for the assertion.
175. (e) The allergens are actually not glycogen molecules but are protein molecules. Hence the assertion is false.
176. (b) The interferons are a special defensive mechanism produced by the infected cells. On reaching the nearby uninfected cells they help in the formation of certain proteins that prevent the multiplication of the virus. Hence the reason is not the correct explanation of the assertion.
177. (e) Horticulture is the conscious raise of Vegetables, fruits & Ornamental plants and not of cereal crops. Hence the assertion is false.
178. (a) Viruses are bodies which have either DNA or RNA as a genetic material. For multiplication, it is the genetic material that enters into the host cells which then with the help of the DNA of the host cell prepare their protein shield. The reason is the correct explanation for the assertion.
179. (a) All aggregate and multiple fruits develop from other floral parts like the thalamus, calyx, etc. Hence the reason is the correct explanation for the assertion.
180. (c) In Casuarina & Betula the pollen tube enters through the Chalaza and not the microphyle. Hence the reason is false.

#### SECTION IV - G.K.

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|----------|----------|----------|
| 181. (a) | 182. (d) | 183. (b) |
| 184. (d) | 185. (c) | 186. (c) |
| 187. (a) | 188. (b) | 189. (d) |
| 190. (a) | 191. (d) | 192. (b) |
| 193. (d) | 194. (b) | 195. (a) |
| 196. (d) | 197. (a) | 198. (c) |
| 199. (b) | 200. (d) |          |