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ENGINEERING ENTRANCE

SOLVED PAPER 2005

Mathematics

1. The equation of a parabola which passes through the intersection of a straight line $x + y = 0$ and the circle $x^2 + y^2 + 4y = 0$ is :

(a) $y^2 = 4x$ (b) $y^2 = x$
(c) $y^2 = 2x$ (d) none of these

2. The point $(4, -3)$ with respect to the ellipse $4x^2 + 5y^2 = 1$ is :

(a) lies on the curve
(b) is inside the curve
(c) is outside the curve
(d) is focus of the curve

3. If $\vec{\mathbf{a}} = \hat{\mathbf{i}} + 2\hat{\mathbf{j}} - 3\hat{\mathbf{k}}$ and $\vec{\mathbf{b}} = 3\hat{\mathbf{i}} - \hat{\mathbf{j}} + 2\hat{\mathbf{k}}$ then the angle between the vectors $\vec{\mathbf{a}} + \vec{\mathbf{b}}$ and $\vec{\mathbf{a}} - \vec{\mathbf{b}}$ is:

(a) 60° (b) 90°
(c) 45° (d) 55°

4. Let S be a set containing n elements and we select two subsets A and B of S at random, then the probability that $A \cup B = S$ and $A \cap B = \phi$, is :

(a) 2^n (b) n^2
(c) $1/n$ (d) $1/2^n$

5. $$\begin{vmatrix} 1+\sin^2\theta & \sin^2\theta & \sin^2\theta \\ \cos^2\theta & 1+\cos^2\theta & \cos^2\theta \\ 4\sin 4\theta & 4\sin 4\theta & 1+4\sin 4\theta \end{vmatrix} = 0,$$

then $\sin 4\theta$ equals to :

(a) 1/2 (b) 1
(c) − 1/2 (d) −1

6. The value of the constant α and β such that $\lim_{x \to \infty} \left(\frac{x^2+1}{x+1} - \alpha x - \beta \right) = 0$ are respectively :

(a) (1, 1) (b) (−1, 1)
(c) (1, −1) (d) (0, 1)

7. Let the homogeneous system of linear equations $px + y + z = 0$, $x + qy + z = 0$, and $x + y + rz = 0$, where $p, q, r \neq 1$, have a non-zero solution, then the value of $\frac{1}{1-p} + \frac{1}{1-q} + \frac{1}{1-r}$ is :

(a) −1 (b) 0
(c) 2 (d) 1

8. A point (α, β) lies on a circle $x^2 + y^2 = 1$, then locus of the point $(3\alpha + 2, \beta)$ is a/an :

(a) straight line (b) ellipse
(c) parabola (d) none of these

9. If θ is an acute angle and $\sin \frac{\theta}{2} = \sqrt{\frac{x-1}{2x}}$, then $\tan\theta$ is equal to :

(a) $x^2 - 1$ (b) $\sqrt{x^2-1}$
(c) $\sqrt{x^2+1}$ (d) $x^2 + 1$

10. The value of

$$\left[\int_0^{\sin^2\theta} \sin^{-1}\sqrt{\phi}\, d\phi + \int_0^{\cos^2\theta} \cos^{-1}\sqrt{\phi}\, d\phi \right]$$

is equal to :

(a) π (b) $\pi/2$
(c) $\pi/3$ (d) $\pi/4$

11. $\int_0^{2n\pi} \left\{ |\sin x| - \left| \frac{1}{2} \sin x \right| \right\} dx$ equals :

(a) n
(b) $2n$
(c) $-2n$
(d) none of the above

12. Range of the function $f(x) = \frac{x^2}{x^2+1}$ is :

(a) (−1, 0) (b) (−1, 1)
(c) [0, 1] (d) (1, 1)

13. If $\sin^{-1}(1-x) - 2\sin^{-1}x = \pi/2$, then x is equals :
(a) $\{0, -1/2\}$ (b) $\{1/2, 0\}$
(c) $\{0\}$ (d) $(-1, 0)$

14. $\sin A$, $\sin B$, $\cos A$ are in GP. Roots of $x^2 + 2x \cot B + 1 = 0$ are always :
(a) real (b) imaginary
(c) greater than 1 (d) equal

15. If $\int_{\log 2}^{x} \frac{du}{(e^u - 1)^{1/2}} = \frac{\pi}{6}$, then e^x is equal to :
(a) 1 (b) 2
(c) 4 (d) -1

16. Total number of books is $2n + 1$. One is allowed to select a minimum of the one book and a maximum of n books. If total number of selections if 63, then value of n is :
(a) 3 (b) 6
(c) 2 (d) none of these

17. $x^2 = xy$ is a relation which is :
(a) symmetric (b) reflexive
(c) transitive (d) none of these

18. Let the determinant of a 3×3 matrix A be 6, then B is a matrix defined by $B = 5A^2$. Then determinant of B is :
(a) 180 (b) 100
(c) 80 (d) none of these

19. Let $f(x) = \begin{cases} 1 & \forall \quad x < 0 \\ 1 + \sin x & \forall \quad 0 \le x \le \pi/2 \end{cases}$
then what is the value of $f'(x)$ at $x = 0$?
(a) 1 (b) -1
(c) ∞ (d) does not exist

20. The length intercepted by the curve $y^2 = 4x$ on the line satisfying $dy/dx = 1$ and passing through point (0, 1), is given by:
(a) 1 (b) 2
(c) 0 (d) none of these

21. Area bounded by curve $y = x^2$ and $y = 2 - x^2$ is:
(a) 8/3 sq units (b) 3/8 sq units
(c) 3/2 sq units (d) none of these

22. $\lim_{\theta \to 0} \frac{4\theta(\tan\theta - 2\theta\tan\theta)}{(1 - \cos 2\theta)}$ is :
(a) $1/\sqrt{2}$ (b) 1/2
(c) 1 (d) 2

23. The largest value of $2x^3 - 3x^2 - 12x + 5$ for $-2 \le x \le 4$ occurs at x is equal to :
(a) -4 (b) 0
(c) 1 (d) 4

24. The number of solutions for the equations $|z-1| = |z-2| = |z-i|$ is :
(a) one solution (b) 3 solutions
(c) 2 solutions (d) no solution

25. Let A and B are two events and $P(A') = 0.3$ $P(B) = 0.4$, $P(A \cap B') = 0.5$ then $P(A \cup B')$ is:
(a) 0.5 (b) 0.8
(c) 1 (d) 0.1

26. $(10101101)_2 = (\ldots\ldots\ldots\ldots)_{10}$:
(a) 137 (b) 173
(c) 170 (d) none of these

27. Given function $f(x) = \left(\frac{e^{2x} - 1}{e^{2x} + 1}\right)$ is :
(a) increasing (b) decreasing
(c) even (d) none of these

28. The solution of $x^2 + y^2 - 2xy\frac{dy}{dx} = 0$ is :
(a) $x^2 - y^2 = cx$ (b) $x^2 + y^2 = cx$
(c) $2(x^2 - y^2) = cx$ (d) none of these

29. $f(x) = ax^2 + bx + c$ and $g(x) = px^2 + qx$ with $g(1) = f(1)$, $g(2) - f(2) = 1$, $g(3) - f(3) = 4$, then $g(4) - f(4)$ is :
(a) 0 (b) 5
(c) 6 (d) none of these

30. If the vectors $\alpha\hat{\mathbf{i}} + \hat{\mathbf{j}} + \hat{\mathbf{k}}$, $\hat{\mathbf{i}} + \beta\hat{\mathbf{j}} + \hat{\mathbf{k}}$, $\hat{\mathbf{i}} + \hat{\mathbf{j}} + \lambda\hat{\mathbf{k}}$ $(\alpha, \beta, \gamma \ne 1)$ are coplanar, then the value of $\frac{1}{1-\alpha} + \frac{1}{1-\beta} + \frac{1}{1-\gamma}$ is :
(a) -1 (b) 0
(c) 1 (d) 1/2

31. The circumcentre of a triangle formed by the line $xy + 2x + 2y + 4 = 0$ and $x + y + 2 = 0$ is :
(a) $(-1, -1)$ (b) $(0, -1)$
(c) $(1,1)$ (d) $(-1, 0)$

32. The number of common tangents to circle $x^2 + y^2 + 2x + 8y - 23 = 0$ and $x^2 + y^2 - 4x - 10y + 9 = 0$, is :
(a) 1 (b) 3
(c) 2 (d) none of these

33. If $\frac{x}{\alpha} + \frac{y}{\beta} = 1$ touches the circle $x^2 + y^2 = a^2$, then point $(1/\alpha, 1/\beta)$ lies on a/an:
(a) straight line (b) circle
(c) parabola (d) ellipse

34. The point of intersection of the line $\frac{x-1}{3}=\frac{y+2}{4}=\frac{z-3}{-2}$ and plane $2x-y+3z-1=0$ is :

(a) $(10, -10, 3)$ (b) $(10, 10, -3)$
(c) $(-10, 10, 3)$ (d) none of these

35. The tangents from a point $(2\sqrt{2}, 1)$ to the hyperbola $16x^2 - 25y^2 = 400$ include an angle equal to :

(a) $\pi/2$ (b) $\pi/4$
(c) π (d) $\pi/3$

36. Let α, β, γ and δ are four positive real number such that their product is unity, then the least value of $(1+\alpha)(1+\beta)(1+\gamma)(1+\delta)$ is:

(a) 6 (b) 16
(c) 0 (d) 32

37. Value of $\sum_{k=1}^{6}\left(\frac{2k\pi}{7}\right)-i\cos\left(\frac{2k\pi}{7}\right)$ is equal to:

(a) -1 (b) 1
(c) 0 (d) none of these

38. The degree of the differential equation

$$y(x)=1+\frac{dy}{dx}+\frac{1}{1\cdot 2}\left(\frac{dy}{dx}\right)^2+\frac{1}{1\cdot 2\cdot 3}\left(\frac{dy}{dx}\right)^3+\ldots$$

is:

(a) 2 (b) 3
(c) 1 (d) none of these

39. Let $P(x_1, y_1)$ and $Q(x_2, y_2)$ are two points such that their abscissa x_1 and x_2 are the roots of the equation $x^2+2x-3=0$ while the ordinate y_1 and y_2 are the roots of the equation $y^2+4y-12=0$. The centre of the circle with PQ as diameter is :

(a) $(-1, -2)$ (b) $(1,2)$
(c) $(1, -2)$ (d) $(-1, 2)$

40. The equation of plane passing through a point $A(2, -1, 3)$ and parallel to the vectors $\vec{\mathbf{a}}=(3, 0, -1)$ and $\vec{\mathbf{b}}=(-3, 2, 2)$ is :

(a) $2x-3y+6z-25=0$
(b) $2x-3y+6z+25=0$
(c) $3x-2y+6z-25=0$
(d) $3x-2y+6z+25=0$

41. The equation of a straight line drawn through the focus of the parabola $y^2=-4x$ at an angle of 120° to the x-axis is :

(a) $y+\sqrt{3}(x-1)=0$
(b) $y-\sqrt{3}(x-1)=0$
(c) $y+\sqrt{3}(x+1)=0$
(d) $y-\sqrt{3}(x+1)=0$

42. Let $x=\alpha+\beta$, $y=\alpha\omega+\beta\omega^2$, $z=\alpha\omega^2+\beta\omega$, ω is an imaginary cube root of unity. Product of xyz is :

(a) $\alpha^2+\beta^2$ (b) $\alpha^2-\beta^2$
(c) $\alpha^3+\beta^3$ (d) $\alpha^3-\beta^3$

43. If $r=[2\phi+\cos^2(2\phi+\pi/4)]^{1/2}$, then what is the value of the derivative of $dr/d\phi$ at $\phi=\pi/4$?

(a) $2\left(\frac{1}{\pi+1}\right)^{1/2}$ (b) $2\left(\frac{2}{\pi+1}\right)^{2}$
(c) $\left(\frac{2}{\pi+1}\right)^{1/2}$ (d) $2\left(\frac{2}{\pi+1}\right)^{1/2}$

44. If a vector $\vec{\alpha}$ lie in the plane of $\vec{\beta}$ and $\vec{\gamma}$, then which is correct?

(a) $[\vec{\alpha}\ \vec{\beta}\ \vec{\gamma}]=0$ (b) $[\vec{\alpha}\ \vec{\beta}\ \vec{\gamma}]=1$
(c) $[\vec{\alpha}\ \vec{\beta}\ \vec{\gamma}]=3$ (b) $[\vec{\beta}\ \vec{\gamma}\ \vec{\alpha}]=1$

45. If $\vec{\alpha}=2\hat{\mathbf{i}}+3\hat{\mathbf{j}}-\hat{\mathbf{k}}$, $\vec{\beta}=-\hat{\mathbf{i}}+2\hat{\mathbf{j}}-4\hat{\mathbf{k}}$, $\vec{\gamma}=\hat{\mathbf{i}}+\hat{\mathbf{j}}+\hat{\mathbf{k}}$, then what is the value of $(\vec{\alpha}\times\vec{\beta})\cdot(\vec{\alpha}\times\vec{\gamma})$?

(a) 47
(b) 74
(c) -74
(d) none of the above

Physics

46. If M is the mass of the earth and R its radius, the ratio of the gravitational acceleration and the gravitational constants is:

(a) $\frac{R^2}{M}$ (b) $\frac{M}{R^2}$
(c) MR^2 (d) $\frac{M}{R}$

47. A student unable to answer a question on Newton's laws of motion attempts to pull himself up by tugging on his hair. He will not succeed :

(a) as the force exerted is small
(b) the frictional force while gripping, is small

(c) Newton's law of inertia is not applicable to living beings
(d) as the force applied is internal to the system

48. Which one of the following is not a unit of Young's modulus?
(a) Nm^{-1}
(b) Nm^{-2}
(c) dyne cm^{-2}
(d) mega pascal

49. A piece of blue glass heated to a high temperature and a piece of red glass at room temperature, are taken inside a dimly lit room, then:
(a) the blue piece will look blue and red will look as usual
(b) red looks brighter red and blue looks ordinary blue
(c) blue shines like brighter red compared to the red piece
(d) both the pieces will look equally red

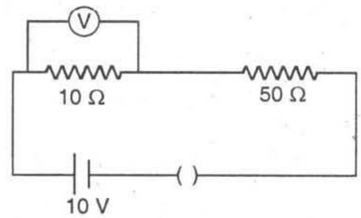
50. A 5.0 A current is setup in an external circuit by a 6.0 V storage battery for 6.0 min. The chemical energy of the battery is reduced by:
(a) 1.08×10^4 J
(b) 1.08×10^{-4} J
(c) 1.8×10^4 J
(d) 1.8×10^{-4} J

51. The current in a simple series circuit is 5.0 A. When an additional resistance of 2.0 Ω is inserted, the current drops to 4.0 A. The original resistance of the circuit in ohms was :
(a) 1.25 (b) 8
(c) 10 (d) 20

52. Two resistances are connected in two gaps of a metre bridge. The balance point is 20 cm from the zero end. A resistance of 15 Ω is connected in series with the smaller of the two. The null point shifts to 40 cm. The value of the smaller resistance in ohms is :
(a) 3 (b) 6
(c) 9 (d) 12

53. By using only two resistance coils-singly, in series or in parallel one should be able to obtain resistances of 3, 4, 12 and 16 Ω. The separate resistances of the coil are :
(a) 3 and 4 (b) 4 and 12
(c) 12 and 16 (d) 16 and 3

54. In the given circuit, the voltmeter records 5 V. The resistance of the voltmeter in ohms is :



(a) 200 (b) 100
(c) 10 (d) 50

55. The wavelength of the radiation emitted by a body depends upon :
(a) the nature of the surface
(b) the area of the surface
(c) the temperature of the surface
(d) all of the above factors

56. Which mirror is to be used to obtain a parallel beam of light from a small lamp?
(a) Plane mirror
(b) Convex mirror
(c) Concave mirror
(d) Any one of the above

57. Which of the following is a wrong statement?
(a) $D = 1/f$ where f is the focal length and D is called the refractive power of a lens.
(b) Power is expressed in a diopter when f is in metres
(c) Power is expressed in diopter and does not depend on the system of unit used to measure f
(d) D is positive for convergent lens and negative for divergent lens

58. An electric field of 1500 V/m and a magnetic field of 0.40 Wb/m^2 act on a moving electron. The minimum uniform speed along a straight line the electron could have is:
(a) 1.6×10^{15} m/s (b) 6×10^{-16} m/s
(c) 3.75×10^3 m/s (d) 3.75×10^2 m/s

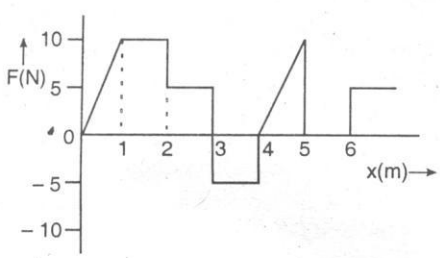
59. In an ammeter 10% of main current is passing through the galvanometer. If the resistance of the galvanometer is G, then the shunt resistance, in ohms is:
(a) $9G$ (b) $\frac{G}{9}$
(c) $90G$ (d) $\frac{G}{90}$

60. Among the following properties describing diamagnetism identify the property that is wrongly stated:
(a) Diamagnetic material do not have permanent magnetic moment
(b) Diamagnetism is explained in terms of electromagnetic induction
(c) Diamagnetic materials have a small positive susceptibility
(d) The magnetic moment of individual electrons neutralize each other

61. The induction coil works on the principle of :
(a) self-induction
(b) mutual induction
(c) Ampere's rule
(d) Fleming's right hand rule

62. The square root of the product of inductance and capacitance has the dimension of :
(a) length (b) mass
(c) time (d) no dimension

63. The relationship between the force F and position x of a body is as shown in figure. The work done in displacing the body from $x = 1$ m to $x = 5$ m will be :



(a) 30 J (b) 15 J
(c) 25 J (d) 20 J

64. From the top of a tower of two stones, whose masses are in the ratio 1 : 2 are thrown on straight up with an initial speed u and the second straight down with the same speed u. Then neglecting air resistance:
(a) the heavier stone hits the ground with a higher speed
(b) the lighter stone hits the ground with a higher speed
(c) both the stones will have the same speed when they hit the ground
(d) the speed cannot be determined with the given data

65. Infrared radiation was discovered in 1800 by :
(a) William Wollaston
(b) William Herschel
(c) Wilhelm Roentgen
(d) Thomas Young

66. A particle on the trough of a wave at any instant will come to the mean position after a time : (T = time period)
(a) $T/2$ (b) $T/4$
(c) T (d) $2T$

67. The disc of a siren containing 60 holes rotates at a constant speed of 360 rpm. The emitted sound is in unison with a tuning fork of frequency :
(a) 10 Hz (b) 360 Hz
(c) 216 Hz (d) 60 Hz

68. The ratio of velocity of sound in hydrogen and oxygen at STP is :
(a) 16 : 1 (b) 8 : 1
(c) 4 : 1 (d) 2 : 1

69. In an experiment with sonometer a tuning fork of frequency 256 Hz resonates with a length of 25 cm and another tuning fork resonates with a length of 16 cm. Tension of the string remaining constant the frequency of the second tuning fork is :
(a) 163.84 Hz
(b) 400 Hz
(c) 320 Hz
(d) 204.8 Hz

70. The wave theory of light, in its original form, was first postulated by:
(a) Isaac Newton
(b) Christian Huygens
(c) Thomas Young
(d) Augustin Jean Fresnel

71. If a liquid does not wet glass, its angle of contact is :
(a) zero (b) acute
(c) obtuse (d) right angle

72. Electron of mass m and charge q is travelling with a speed v 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:
(a) $2r$ (b) $4r$
(c) $r/4$ (d) $r/2$

73. Two coherent light beams of intensity I and $4I$ are superposed. The maximum and minimum possible intensities in the resulting beam are :

(a) $9I$ and I (b) $9I$ and $3I$

(c) $5I$ and I (d) $5I$ and $3I$

74. The electron in a hydrogen atom makes a transition form $n = n_1$ to $n = n_2$ state. The time period of the electron in the initial state (n_1) is eight times that in the final state(n_2). The possible values of n_1 and n_2 are :

(a) $n_1 = 8, n_2 = 1$

(b) $n_1 = 4, n_2 = 2$

(c) $n_1 = 2, n_2 = 4$

(d) $n_1 = 1, n_2 = 8$

75. If the forward voltage in a diode is increased, the width of the depletion region :

(a) increases

(b) decreases

(c) fluctuates

(d) no change

76. Two nucleons are at a separation of one Fermi. Protons have a charge of $+1.6 \times 10^{-19}$ C. The net nuclear force between them is F_1, if both are neutrons, F_2 if both are protons and F_3 if one is proton and the other is neutron. Then :

(a) $F_1 = F_2 > F_3$

(b) $F_1 = F_2 = F_3$

(c) $F_1 < F_2 < F_3$

(d) $F_1 > F_2 > F_3$

77. The potential to which a conductor is raised, depends on :

(a) the amount of charge

(b) geometry and size of the conductor

(c) both (a) and (b)

(d) only on (a)

78. The work done in carrying a charge q once round a circle of radius r with a charge Q at the centre is :

(a) $\frac{qQ}{4\pi\varepsilon_0 r}$

(b) $\frac{qQ}{4\pi\varepsilon_0^2 r^2}$

(c) $\frac{qQ}{4\pi\varepsilon_0 r^2}$

(d) none of the above

79. An air filled parallel plate condenser has a capacity of 2pF. The separation of the plates is doubled and the interspace between the plates is filled with wax. If the capacity is increased to 6 pF, the dielectric constant of wax is :

(a) 2 (b) 3

(c) 4 (d) 6

80. The energy that should be added to an electron to reduce its de-Broglie wavelength from 1 nm to 0.5 nm is :

(a) four times the initial energy

(b) equal to the initial energy

(c) twice the initial energy

(d) thrice the initial energy

81. Mean life of a radioactive sample is 100 s. Then its half-life (in minutes) is:

(a) 0.693 (b) 1

(c) 10^{-4} (d) 1.155

82. Consider two nuclei of the same radioactive nuclide. One of the nuclei was created in a supernova explosion 5 billion years ago. The probability of decay during the next time is :

(a) different for each nuclei

(b) nuclei created in explosion decays first

(c) nuclei created in the reactor decays first

(d) independent of the time of creation

83. Bohr's atom model assumes :

(a) the nucleus is of infinite mas and is at rest

(b) electrons in a quantized orbit will not radiate energy

(c) mass of electron remains constant

(d) all the above conditions

84. Identify the wrong statement in the following. Coulomb's law correctly described the electric force that :

(a) binds the electrons of an atom to its nucleus

(b) binds the protons and neutrons in the nucleus of an atom

(c) binds atoms together to form molecules

(d) binds atoms and molecules to form solids

85. When unpolarised light beam is incident from air onto glass ($n = 1.5$) at the polarising angle:

(a) reflected beam is polarised 100 percent

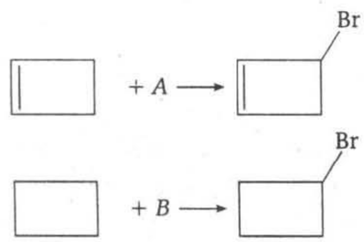
(b) reflected and refracted beams are partially polarised

(c) the reason for (a) is that almost all the light is reflected

(d) all of the above

86. Which of the following silver salts is insoluble in water ?
(a) $AgClO_4$ (b) Ag_2SO_4
(c) AgF (d) $AgNO_3$

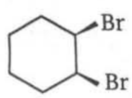
87. Suitable reagents A and B for the following reactions are:

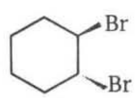


(a) Br, Br_2 (b) Br_2, NBS
(c) NBS, NBS (d) NBS, Br_2

88. KF combines with HF to form KHF_2. The compound contains the species:
(a) K^+ , F^- and H^+ (b) K^+ , F^- and HF
(c) K^+ and $[HF_2]^-$ (d) $[KHF]^+$ and F_2

89.  + $Br_2 \rightarrow A$, A will have configuration :

(a) 

(b) 

(c) both (a) and (b) (d) none of these

90. Among the following sets of quantum numbers. Which one is incorrect for 4d electron ?
(a) 4, 3, 2, $+\frac{1}{2}$ (b) 4, 2, 1, 0
(c) 4, 2, −2, $+\frac{1}{2}$ (d) 4, 2, 1, $-\frac{1}{2}$

91. Raffinose is :
(a) trisaccharide
(b) monosaccharide
(c) disaccharide
(d) none of the above

92. The molecular electronic configuration of Be_2 is :
(a) $\sigma 1s^2 \sigma^* 1s^2 \sigma 2s^2 \sigma^* 2p^2$
(b) $KK\sigma 2s^2$
(c) $\sigma 1s^2 \sigma^* 1s^2 \sigma 2s^2 \sigma^* 2s^2$
(d) none of the above

93. Which of the following is deliquescent ?
(a) $ZnCl_2$ (b) Hg_2Cl_2
(c) $HgCl_2$ (d) $CdCl_2$

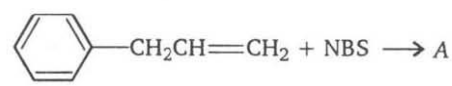
94. The velocity of electron in first orbit of H-atom as compared to the velocity of light is :
(a) $\frac{1}{10}$th (b) $\frac{1}{100}$th
(d) $\frac{1}{1000}$th (d) same

95.  $\xrightarrow[H_2O_2]{OsO_4}$ A, A is :
(a) *meso* diol
(b) racemic diol
(c) both (a) and (b)
(d) none of the above

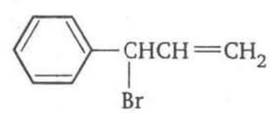
96. In which of the following reactions is $K_p < K_c$?
(a) $I_2\,(g) \rightleftharpoons 2I(g)$
(b) $2BrCl(g) \rightleftharpoons Cl_2\,(g) + Br_2\,(g)$
(c) $CO(g) + 3H_2(g) \rightleftharpoons CH_4(g) + H_2O(g)$
(d) All of the above

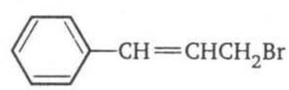
97. For the reaction (at 1240 K and 1 atm.)
$$CaCO_3(s) \longrightarrow CaO(s) + CO_2\,(g)$$
$\Delta H = 176$ kJ/mol; ΔE will be :
(a) 160 kJ (b) 165.6 kJ
(c) 186.4 kJ (d) 180 kJ

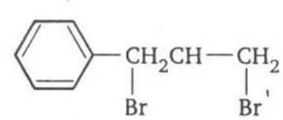
98. Following compound is treated with NBS

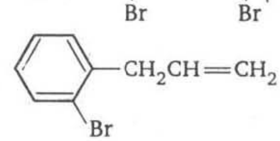


Compound formed A is :

(a) 

(b) 

(c) 

(d) 

99. The standard reduction potential of the reation, $H_2O + e^- \longrightarrow \frac{1}{2}H_2 + OH$ at 298 K is:

(a) $E° = \frac{RT}{F}\ln K_w$

(b) $E° = -\frac{RT}{F}\ln [P_{H_2}]^{1/2}[OH^-]$

(c) $E° = -\frac{RT}{F}\ln \frac{[P_{H_2}]^{1/2}}{[H^+]}$

(d) $E° = -\frac{RT}{F}\ln K_w$

100. Glycerol is oxidised by bismuth nitrate to produce:

(a) oxalic acid (b) mesooxalic acid
(c) glyceric acid (d) glyoxalic acid

101. Unit of frequency factor (A) is :

(a) mol/L
(b) mol/L × s
(c) depends upon order
(d) it does not have any unit

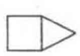
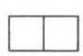
102. The change in pressure will not affect the equilibrium constant for :

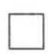
(a) $N_2 + 3H_2 \rightleftharpoons 2NH_3$
(b) $PCl_5 \rightleftharpoons PCl_3 + Cl_2$
(c) $H_2 + I_2 \rightleftharpoons 2HI$
(d) all of the above

103. The volume strength of 1.5 N H_2O_2 solution is :

(a) 4.8 (b) 8.4
(c) 4.2 (d) 2.4

104. Bicyclo (1, 1, 0) butane is :

(a)  (b) 

(c)  (d) 

105. How many hydrogen bonds are present between pair of thymine and adenine in DNA?

(a) 1-hydrogen bond
(b) 2-hydrogen bonds
(c) 3-hydrogen bonds
(d) No bonds occur

106. Graham's law deals with the relation between :

(a) pressure and volume
(b) density and rate of diffusion
(c) rate of diffusion and volume
(d) rate of diffusion and viscosity

107. The rms speed of hydrogen is $\sqrt{7}$ times the rms speed of nitrogen. If T is the temperature of the gas, then:

(a) $T_{H_2} = T_{N_2}$ (b) $T_{H_2} > T_{N_2}$
(c) $T_{H_2} < T_{N_2}$ (d) $T_{H_2} = \sqrt{7}T_{N_2}$

108. In P_4O_{10}, the :

(a) second bond in P=O is formed by $p\pi$-$d\pi$ back bonding
(b) P=O bond is formed by $p\pi$-$p\pi$ bonding
(c) P=O bond is formed by $d\pi$-$d\pi$ bonding
(d) P=O bond is formed by $d\pi$-$d\pi$-3σ back bonding

109. Grignard reagent reacts with HCHO to produce:

(a) secondary alcohol
(b) anhydride
(c) and acid
(d) primary alcohol

110. Dacron is polymer of :

(a) glycol and formaldehyde
(b) glycol and phenol
(c) glycol and phthalic acid
(d) glycol and terephthalic acid

111. The product obtained by heating diethyl ether with HI is :

(a) C_2H_5I
(b) C_2H_5OH
(c) $C_2H_5OH + C_2H_5I$
(d) $C_2H_5—C_2H_5$

112. For the gaseous reaction involving the complete combustion of isobutane:

(a) $\Delta H = \Delta E$ (b) $\Delta H > \Delta E$
(c) $\Delta H < \Delta E$ (d) none of these

113. Natural rubber is a polymer of :

(a) styrene (b) isoprene
(c) ethylene (d) butadiene

114. Charles' law is represented mathematically as :

(a) $V_t = KV_0 t$ (b) $V_t = \frac{KV_0}{t}$

(c) $V_t = V_0\left(1 + \frac{273}{t}\right)$ (d) $V_t = V_0\left(1 + \frac{t}{273}\right)$

115. Cyanohydrin of which of the following forms lactic acid:

(a) HCHO (b) CH_3CHO
(c) CH_3CH_2CHO (d) CH_3COCH_3

116. Dinitrogen pentoxide (N_2O_5), a colourless solid, is prepared by :

(a) heating NH_4NO_2 with an excess of oxygen
(b) dehydrating HNO_3 with CaO
(c) dehydrating HNO_3 with P_4O_{10}
(d) heating a mixture of HNO_2 and $Ca(NO_3)_2$

117. Which gas has the highest partial pressure in atmosphere?
(a) CO_2 (b) H_2O
(b) O_2 (d) N_2

118. Acetone and acetaldehyde can be distinguished by :
(a) Molisch test (b)Tollen's test
(c) Schiff's test (d) Iodoform test

119. Incorrect statement for pyrophosphorus acid $H_4P_2O_5$ is :
(a) contains P in +5 oxidation state
(b) it is dibasic acid
(c) it is strongly reducing in nature
(d) it contains one P—O—P bond

120. Which of the following compounds is not an "interpseudohalogen"?
(a) Cl_2N_3 (b) BrCN
(c) ClCN (d) ICN

121. The oxidation number of oxygen in hydrogen peroxide is :
(a) +1 (b) −1
(c) +2 (d) −2

122. Isopropyl bromide on Wurtz reaction gives:
(a) hexane
(b) propane
(c) 2, 3-dimethyl butane
(d) *neo*-hexane

123. Tetraethyl lead is a:
(a) solvent (b) petroleum additive
(c) oxidising agent (d) fire extinguisher

124. Solvay process is used for the manufacture of :
(a) NaOH (b) Na_2CO_3
(c) NH_3 (d) NaCl

125. Milk of magnesia is used as:
(a) antichlor (b) antacid
(c) antiseptic (d) food preservative

English

Directions : *Choose the correct meanings of Phrases/Idioms, out of the four responses given under each.*

126. To meet one's Waterloo :
(a) To meet a strong adversary
(b) To met with humiliation
(c) To die fighting
(d) To meet one's final defeat

127. Through thick and thin :
(a) Big and small
(b) Large object
(c) Under all conditions
(d) Thin and fat

128. An axe to grind :
(a) Difficult job
(b) Hard labour
(c) Private ends to serve
(d) Punishment

129. His wit's end :
(a) Finished
(b) Confused
(c) Comedy
(d) Very intelligent

Directions : *Find out the part which contains an error in the following sentences. If there is no error, the answer is (d).*

130. It is not advisable (a) to take heavy luggages (b) while on journey these days. (c) No error. (d)

131. Mr. Bose (a) accompanied by his wife and children (b) were present there. (c) No error. (d)

132. You must pay respect to (a) those who has (b) respect for you. (c) No error. (d)

Directions : *Choose the word that is most nearly opposite in meaning to the word given in capital letters at the question place.*

133. DREARY :
(a) Drab (b) Dangerous
(c) Beautiful (d) Bright

134. GREGARIOUS:
(a) Antisocial
(b) Horrendous
(c) Similar
(d) Glorious

135. MISERLY:
(a) Charitable (b) Spendthrift
(c) Liberal (d) Generous

Directions : *Choose the word that is most nearly the same in meaning to the word given in capital letters at the question place.*

136. DILIGENT:
(a) Industrious (b) Energetic
(c) Modest (d) Inteligent

137. RENOUNCE:
(a) Reform (b) Revoke
(c) Retain (d) Resign

138. PROLIFIC:
(a) Plenty (b) Competent
(c) Predominant (d) Fertile

Directions : *In each of the following questions four parts of a sentence are given as P, Q, R and S. Put them in proper order to produce the correct sentence.*

139. P: I decided to call on him
Q : at the earliest opportunity
R : having heard of the palmist
S : before I came into town
(a) RSPQ (b) PQRS
(c) SQPR (d) QPRS

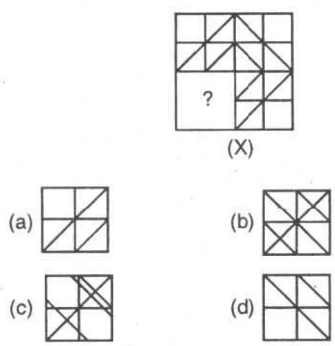
140. P : when a chemical substance
Q : the food poisoning occurred
R : in the food preparations
S : was mistaken for salt and used
(a) RQPS (b) SRQP
(c) QPSR (d) PSRQ

Reasoning

141. Victory is related to *Happiness* in the same way as *Failure* is related to :
(a) Defeat (b) Anger
(c) Frustration (d) Sadness

142. In the following question, four groups of letters are given. Three of them are alike in a certain way while one is different. Select the one which is different.
(a) RSXY (b) NOUV
(c) MNST (d) DEJK

143. Complete the pattern in fig (x) by selecting one of the figures from the four alternatives:

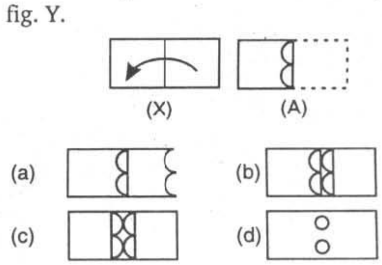


144. In the following question, a statement/ group of statements is given followed by some conclusions. Choose the conclusion which logically follows from the given statement.

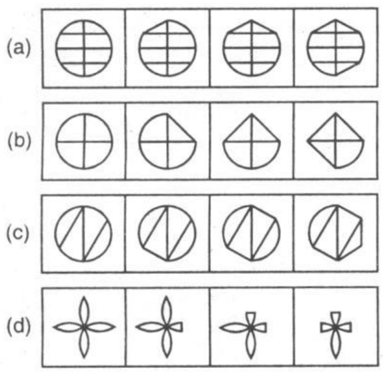
Statements :
1. Only students can participate in the race.
2. Some participants in the race are females.
3. All female participants in the race are invited for coaching.

Conclusions :
(a) All participants in the race are invited for coaching.
(b) All participants in the race are males.
(c) All students are invited for coaching.
(d) All participants in the race are students.

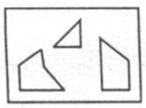
145. Consider the figures *X* and *Y* showing a rectangular sheet of paper folded in fig. *X* and punched in fig. *Y*. From amongst the answer figures *a, b, c* and *d*, select the figure, which will most closely resemble the unfolded position of fig. Y.



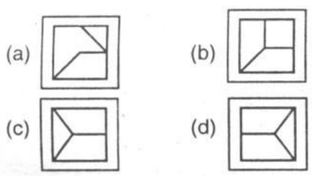
146. Which one of the given sets of figures follows the following rule.
Rule : "Sectors get converted to triangles one by one".



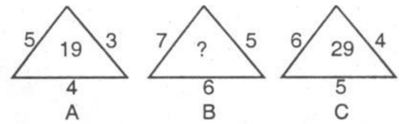
Direction : *In the following question find out which of the figures (a), (b), (c) and (d) can be formed from the pieces given in (X).*

147. 

(X)



Direction : *Find the missing character from among the given alternatives.*

148. 

(a) 25 (b) 37
(c) 41 (d) 47

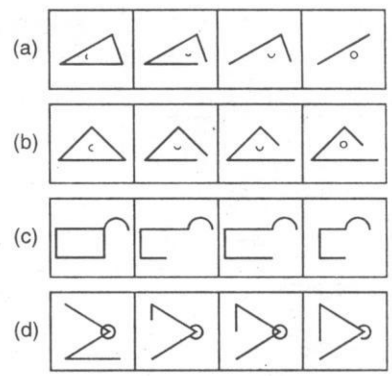
149. What terms will fill the blank spaces?

Z, X, V, T, R, (....), (....)

(a) O, K (b) N, M
(c) K, S (d) P, N

Direction : *In the following question, choose the set of figures which follows the given rule.*

150. Rule : *Closed figures become more and more open and open figures become more and more closed.*



ANSWERS

MATHEMATICS

1.	(c)	2.	(c)	3.	(b)	4.	(d)	5.	(c)	6.	(c)	7.	(d)	8.	(b)
9.	(b)	10.	(d)	11.	(b)	12.	(c)	13.	(c)	14.	(a)	15.	(c)	16.	(a)
17.	(c)	18.	(a)	19.	(d)	20.	(c)	21.	(a)	22.	(d)	23.	(d)	24.	(a)
25.	(b)	26.	(b)	27.	(a)	28.	(a)	29.	(d)	30.	(c)	31.	(a)	32.	(c)
33.	(b)	34.	(b)	35.	(a)	36.	(b)	37.	(d)	38.	(c)	39.	(a)	40.	(a)
41.	(c)	42.	(c)	43.	(d)	44.	(a)	45.	(c)						

PHYSICS

46.	(b)	47.	(d)	48.	(a)	49.	(c)	50.	(a)	51.	(b)	52.	(c)	53.	(d)
54.	(b)	55.	(c)	56.	(c)	57.	(c)	58.	(c)	59.	(b)	60.	(c)	61.	(b)
62.	(c)	63.	(b)	64.	(c)	65.	(b)	66.	(b)	67.	(b)	68.	(c)	69.	(b)
70.	(b)	71.	(c)	72.	(b)	73.	(a)	74.	(b)	75.	(b)	76.	(b)	77.	(c)
78.	(d)	79.	(d)	80.	(d)	81.	(d)	82.	(d)	83.	(d)	84.	(b)	85.	(a)

CHEMISTRY

86.	(b)	87.	(d)	88.	(c)	89.	(b)	90.	(b)	91.	(a)	92.	(c)	93.	(a)
94.	(b)	95.	(a)	96.	(a)	97.	(b)	98.	(b)	99.	(a)	100.	(b)	101.	(b)
102.	(d)	103.	(b)	104.	(c)	105.	(b)	106.	(b)	107.	(c)	108.	(a)	109.	(d)
110.	(d)	111.	(c)	112.	(b)	113.	(b)	114.	(d)	115.	(b)	116.	(c)	117.	(d)
118.	(b)	119.	(a)	120.	(a)	121.	(b)	122.	(c)	123.	(b)	124.	(b)	125.	(b)

ENGLISH

126.	(d)	127.	(c)	128.	(c)	129.	(b)	130.	(b)	131.	(c)	132.	(b)	133.	(d)
134.	(a)	135.	(d)	136.	(a)	137.	(d)	138.	(d)	139.	(a)	140.	(c)		

REASONING

141.	(c)	142.	(b)	143.	(d)	144.	(d)	145.	(d)	146.	(b)	147.	(a)	148.	(c)
149.	(d)	150.	(a)												

HINTS & SOLUTIONS

Mathematics

1. Given equation of line is

$$x + y = 0 \quad \text{...(i)}$$

and equation of circle is

$$x^2 + y^2 + 4y = 0 \quad \text{...(ii)}$$

On solving Eqs. (i) and (ii),

$$x^2 + (-x)^2 + 4(-x) = 0$$

$\Rightarrow \quad 2x^2 - 4x = 0$

$\Rightarrow \quad 2x(x-2) = 0$

$\Rightarrow \quad x = 0, 2 \quad \text{and} \quad y = 0, -2$

Now taking option (c)

i.e., $\quad y^2 = 2x$

at poing $(0, 0) \Rightarrow 0 = 0$

and at point $(2, -2)$

$\Rightarrow \quad (-2)^2 = 2(2) \Rightarrow 4 = 4$

$\therefore$ option (c) is the correct answer.

2. Given equation of ellipse is $4x^2 + 5y^2 = 1$

or $\quad S \equiv 4x^2 + 5y^2 - 1 = 0 \quad \text{...(i)}$

At point $(4, -3)$

$$S \equiv 4(4)^2 + 5(-3)^2 - 1$$
$$\equiv 108 > 0$$

Therefore the given point lies outside the ellipse.

3. Given that

$$\vec{\mathbf{a}} = \hat{\mathbf{i}} + 2\hat{\mathbf{j}} - 3\hat{\mathbf{k}} \quad \text{and} \quad \vec{\mathbf{b}} = 3\hat{\mathbf{i}} - \hat{\mathbf{j}} + 2\hat{\mathbf{k}}$$

Now, $\vec{\mathbf{a}} + \vec{\mathbf{b}} = \hat{\mathbf{i}} + 2\hat{\mathbf{j}} - 3\hat{\mathbf{k}} + 3\hat{\mathbf{i}} - \hat{\mathbf{j}} + 2\hat{\mathbf{k}}$

$= 4\hat{\mathbf{i}} + \hat{\mathbf{j}} - \hat{\mathbf{k}}$

and $\vec{\mathbf{a}} - \vec{\mathbf{b}} = (\hat{\mathbf{i}} + 2\hat{\mathbf{j}} - 3\hat{\mathbf{k}}) - (3\hat{\mathbf{i}} - \hat{\mathbf{j}} + 2\hat{\mathbf{k}})$

$= -2\hat{\mathbf{i}} + 3\hat{\mathbf{j}} - 5\hat{\mathbf{k}}$

Let θ be the angle between $\vec{\mathbf{a}} + \vec{\mathbf{b}}$ and $\vec{\mathbf{a}} - \vec{\mathbf{b}}$

$$\therefore \cos\theta = \frac{(\vec{\mathbf{a}} + \vec{\mathbf{b}}) \cdot (\vec{\mathbf{a}} - \vec{\mathbf{b}})}{|\vec{\mathbf{a}} + \vec{\mathbf{b}}|\ |\vec{\mathbf{a}} - \vec{\mathbf{b}}|}$$

$$= \frac{(4\hat{\mathbf{i}} + \hat{\mathbf{j}} - \hat{\mathbf{k}}) \cdot (-2\hat{\mathbf{i}} + 3\hat{\mathbf{j}} - 5\hat{\mathbf{k}})}{|4\hat{\mathbf{i}} + \hat{\mathbf{j}} - \hat{\mathbf{k}}|\,|-2\hat{\mathbf{i}} + 3\hat{\mathbf{j}} - 5\hat{\mathbf{k}}|}$$

$$= \frac{-8 + 3 + 5}{\sqrt{16 + 1 + 1}\sqrt{4 + 9 + 25}} = 0$$

$\Rightarrow \quad \theta = 90°$

4. Let A and B be two subsets of S. There are following cases to make a subset of S, under the given condition *i.e.* $A \cup B = S$ and $A \cap B = \phi$

Case I : If set A has no element. The number of ways of selection of 0 element from set S is ${}^nC_0$.

Case II : If set A has one element. The number of ways of selection of one element from set S is ${}^nC_1$.

Case III : If set A has two elements. The number of ways of selection of two element from set S is ${}^nC_2$.

....

....

....

....

Case (n) : If set A has n elements. The number of ways of selection of n elements from set S is ${}^nC_n$.

$\therefore$ Total set of $A = {}^nC_0 + {}^nC_1 + {}^nC_2 + \ldots + {}^nC_n$

$$= 2^n$$

Total set of A and $B = 2^n \times 2^n = 2^{2n}$

$\therefore$ Required probability $= \dfrac{2^n}{2^{2n}} = \dfrac{1}{2^n}$

5. Let $A \equiv \begin{vmatrix} 1+\sin^2\theta & \sin^2\theta & \sin^2\theta \\ \cos^2\theta & 1+\cos^2\theta & \cos^2\theta \\ 4\sin 4\theta & 4\sin 4\theta & 1+4\sin 4\theta \end{vmatrix} = 0$

Applying $R_1 \to R_1 + R_2$

$$\Rightarrow \begin{vmatrix} 2 & 2 & 1 \\ \cos^2\theta & 1+\cos^2\theta & \cos^2\theta \\ 4\sin 4\theta & 4\sin 4\theta & 1+4\sin 4\theta \end{vmatrix} = 0$$

Applying $C_1 \to C_1 - 2C_3$, $C_2 \to C_2 - 2C_3$

$$\Rightarrow \begin{vmatrix} 0 & 0 & 1 \\ -\cos^2\theta & 1-\cos^2\theta & \cos^2\theta \\ -2-4\sin 4\theta & -2-4\sin 4\theta & 1+4\sin 4\theta \end{vmatrix} = 0$$

$\Rightarrow$

$[\cos^2\theta(2+4\sin 4\theta) + (1-\cos^2\theta)(2+4\sin 4\theta)] = 0$

$$\Rightarrow [2\cos^2\theta + 4\cos^2\theta\sin 4\theta + 2 + 4\sin 4\theta - 2\cos^2\theta - 4\cos^2\theta\sin 4\theta] = 0$$

$$\Rightarrow \quad 2 + 4\sin 4\theta = 0$$

$$\Rightarrow \quad \sin 4\theta = -\frac{1}{2}$$

6. Given that,

$$\lim_{x\to\infty}\left(\frac{x^2+1}{x+1} - \alpha x - \beta\right) = 0$$

$$\Rightarrow \lim_{x\to\infty}\left(\frac{x^2+1-\alpha(x^2+x)-\beta(x+1)}{x+1}\right) = 0$$

Using L-Hospital's rule, we get

$$\lim_{x\to\infty}\left(\frac{2x-\alpha(2x+1)-\beta(1)}{1}\right) = 0$$

If this limit is zero, then the function

$$2x - \alpha(2x+1) - \beta = 0$$

or $\quad x(2-2\alpha) - (\alpha+\beta) = 0$

Equating the coefficient of x and constant terms, we get

$$2 - 2\alpha = 0 \text{ and } \alpha + \beta = 0$$

$$\Rightarrow \quad \alpha = 1, \ \beta = -1$$

7. Given equations are

$px + y + z = 0$, $x + qy + z = 0$, $x + y + rz = 0$

Since the system have a non-zero solution, then

$$\begin{vmatrix} p & 1 & 1 \\ 1 & q & 1 \\ 1 & 1 & r \end{vmatrix} = 0$$

Applying $C_2 \to C_2 - C_1$

and $\quad C_3 \to C_3 - C_2$

$$\Rightarrow \begin{vmatrix} p & 1-p & 0 \\ 1 & q-1 & 1-q \\ 1 & 0 & r-1 \end{vmatrix} = 0$$

$$\Rightarrow (1-p)(1-q)(1-r)\begin{vmatrix} \frac{p}{1-p} & 1 & 0 \\ \frac{1}{1-q} & -1 & 1 \\ \frac{1}{1-r} & 0 & -1 \end{vmatrix} = 0$$

$$\Rightarrow \quad (1-p)(1-q)(1-r)\left[\frac{p}{1-p}(1) - 1\left(-\frac{1}{1-q} - \frac{1}{1-r}\right)\right] = 0$$

Since, $p, q, r \neq 1$

$$\therefore \quad \frac{p}{1-p} + \frac{1}{1-q} + \frac{1}{1-r} = 0$$

$$\Rightarrow \quad \frac{1}{1-p} - 1 + \frac{1}{1-q} + \frac{1}{1-r} = 0$$

$$\Rightarrow \quad \frac{1}{1-p} + \frac{1}{1-q} + \frac{1}{1-r} = 1$$

8. Given that (α, β) lies on the circle $x^2 + y^2 = 1$.

$$\therefore \quad \alpha^2 + \beta^2 = 1$$

or it can be rewritten as

$$\frac{1}{9}(9\alpha^2 + 4 + 12\alpha) + \beta^2 = 1 + \frac{1}{9}(4 + 12\alpha)$$

$$\Rightarrow \frac{1}{9}(3\alpha^2 + 2)^2 + \beta^2 = 1 + \frac{4}{9}(1 + 3\alpha + 1) - \frac{4}{9}$$

$$\Rightarrow \frac{1}{9}(3\alpha + 2)^2 + \beta^2 = \frac{5}{9} + \frac{4}{9}(3\alpha + 2)$$

The locus of $(3\alpha + 2, \beta)$ is

$$\frac{1}{9}x^2 + y^2 = \frac{5}{9} + \frac{4}{9}x$$

or $\quad x^2 - 4x + 9y^2 - 5 = 0$

On comparing this equation with

$ax^2 + 2hxy + by^2 + 2gx + 2fy + c = 0$

$\Rightarrow \; a = 1, b = 9, h = 0, g = -2, f = 0, c = -5$

Now,

$\Delta = abc + 2fgh - af^2 - bg^2 - ch^2$

$= 1 \times 9 \times (-5) + 2(0) - 1(0)^2 - 9(-2)^2 - 0$

$= -45 - 36 = -81 \neq 0$

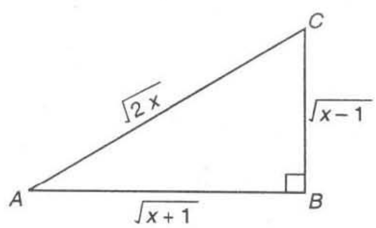
Now, $h^2 - ab = 0 - 9(1) = -9 < 0$

$\therefore \quad \Delta \neq 0$ and $h^2 < ab$,

Hence, it is an ellipse.

9. Given that

$$\sin\frac{\theta}{2} = \sqrt{\frac{x-1}{2x}}$$



In ΔABC

$$\tan\frac{\theta}{2} = \sqrt{\frac{x-1}{x+1}}$$

$$\therefore \quad \tan\theta = \frac{2\tan\frac{\theta}{2}}{1 - \tan^2\frac{\theta}{2}}$$

$$= \frac{2\sqrt{\frac{x-1}{x+1}}}{1 - \frac{x-1}{x+1}} = \frac{2\sqrt{\frac{x-1}{x+1}}}{\frac{2}{x+1}}$$

$$= \sqrt{x^2 - 1}$$

10. Let

$$f(\theta) = \left[\int_0^{\sin^2\theta} \sin^{-1}\sqrt{\phi}\, d\phi + \int_0^{\cos^2\theta} \cos^{-1}\sqrt{\phi}\, d\phi\right]$$

$$f'(\theta) = \frac{d}{d\theta}\sin^2\theta\left[\sin^{-1}\sqrt{\sin^2\theta}\right] + \frac{d}{d\theta}\cos^2\theta\left[\cos^{-1}\sqrt{\cos^2\theta}\right]$$

$= (2\sin\theta\cos\theta)\theta - (2\sin\theta\cos\theta)\theta$

$= 0$

$\therefore \quad f(\theta) = \text{constant} = a$ (say)

$\therefore \quad f\left(\frac{\pi}{4}\right) = a$

$$\Rightarrow \int_0^{1/2} \sin^{-1}\sqrt{\phi}\, d\phi + \int_0^{1/2} \cos^{-1}\sqrt{\phi}\, d\phi = a$$

$$\Rightarrow \int_0^{1/2} (\sin^{-1}\sqrt{\phi} + \cos^{-1}\sqrt{\phi})\, d\phi = a$$

$$\Rightarrow \frac{\pi}{2}[\phi]_0^{1/2} = a$$

$$\Rightarrow \frac{\pi}{4} = a$$

11. Let $I = \int_0^{2n\pi} \left\{|\sin x| - \left|\frac{1}{2}\sin x\right|\right\} dx$

$$= \int_0^{2n\pi} \left\{|\sin x| - \frac{1}{2}|\sin x|\right\} dx$$

$$= \int_0^{2n\pi} \frac{1}{2}|\sin x|\, dx$$

$$= \frac{1}{2}\left[\int_0^{2\pi} |\sin x|\, dx + \int_{2\pi}^{4\pi} |\sin x|\, dx + \ldots\ldots + \int_{2(n-1)\pi}^{2n\pi} |\sin x|\, dx\right]$$

Now, $I_1 = \int_0^{2\pi} |\sin x|\, dx$

$$I_1 = \int_0^{\pi} \sin x\, dx - \int_{\pi}^{2\pi} \sin x\, dx$$

$= [-\cos x]_0^{\pi} + [\cos x]_{\pi}^{2\pi} = -[-1-1] + [+1+1]$

$= 2 + 2$

$= 4$

$\therefore \quad I = \frac{1}{2}[4 + 4 + 4 + \ldots n \text{ times}]$

$= \frac{1}{2}(4n) = 2n$

12. Given that $f(x) = \frac{x^2}{x^2+1}$

Since, it is an even function therefore its values is always greater than equal to 0 and we know

$$x^2 < x^2 + 1 \quad \text{or} \quad \frac{x^2}{x^2+1} < 1$$

$\therefore$ Required range is $[0, 1)$.

13. Given $\sin^{-1}(1-x) + 2\sin^{-1}x = \frac{\pi}{2}$

$\Rightarrow \quad \sin^{-1}(1-x) = \frac{\pi}{2} + 2\sin^{-1}(x)$

$\Rightarrow \quad (1-x) = \sin\left(\frac{\pi}{2} + 2\sin^{-1}x\right)$

$\Rightarrow \quad (1-x) = \cos(2\sin^{-1}x)$

$\Rightarrow \quad (1-x) = \cos[\cos^{-1}(1-2x^2)]$

$\Rightarrow \quad (1-x) = 1-2x^2$

$\Rightarrow \quad 2x^2 - x = 0$

$\Rightarrow \quad x = 0, \frac{1}{2}$

But $x = \frac{1}{2}$ does not satisfy the given equation,

So, $x = \{0\}$ is the answer.

14. Since $\sin A$, $\sin B$ and $\cos A$ are in GP

$\therefore \quad \sin^2 B = \sin A \cos A \quad$ ...(i)

$x^2 + 2x\cot B + 1 = 0 \quad$ (given)

Now, $\quad b^2 - 4ac = 4\cot^2 B - 4$

$$= \frac{4\cos^2 B - 4\sin^2 B}{\sin^2 B} = \frac{4(1-\sin^2 B) - 4\sin^2 B}{\sin^2 B}$$

$$= \frac{4[1-2\sin^2 B]}{\sin^2 B}$$

$$= \frac{4[1-2\sin A\cos A]}{\sin^2 B} \quad \text{[from (i)]}$$

$$= 4\left(\frac{\sin A - \cos A}{\sin B}\right)^2 > 0$$

$\therefore$ Roots are always real.

15. Let $I = \int_{\log 2}^{x} \frac{du}{(e^u - 1)^{1/2}}$

or $I = \int_{\log 2}^{x} \frac{e^u}{e^u(e^u-1)^{1/2}} du$

Let $e^u - 1 = t^2 \Rightarrow e^u\,du = 2t\,dt$

$$= \int_1^{\sqrt{e^x-1}} \frac{2t}{(t^2+1)t} dt = 2\int_1^{\sqrt{e^x-1}} \frac{dt}{(1+t^2)}$$

$$= [\tan^{-1} t]_1^{\sqrt{e^x-1}} = 2\tan^{-1}\sqrt{e^x-1} - \tan^{-1} 1]$$

$\Rightarrow \quad 2\left[\tan^{-1}\sqrt{e^x-1} - \frac{\pi}{4}\right] = \frac{\pi}{6} \quad$ (given)

$\Rightarrow \quad \tan^{-1}\sqrt{e^x-1} = \frac{\pi}{12} + \frac{\pi}{4} = \frac{\pi}{3}$

$\Rightarrow \quad \sqrt{e^x-1} = \tan\left(\frac{\pi}{3}\right)$

$\sqrt{e^x-1} = \sqrt{3}$

$\Rightarrow \quad e^x = 3+1 = 4$

16. Since

$$(1+x)^{2n+1} = C_0 + C_1 x + \ldots + C_n x^n + C_{n+1}x^{n+1} + \ldots + x^{2n+1}$$

$$= 2(C_0 + C_1 + \ldots + C_n x^n)$$

Put $x = 1$

$(1+1)^{2n+1} = 2(C_0 + C_1 + \ldots + C_n)$

$\Rightarrow \quad 2^{2n} = (C_0 + C_1 + \ldots + C_n)$

$\Rightarrow \quad 2^{2n} - 1 = C_1 + C_2 + \ldots + C_n$

$\Rightarrow \quad 2^{2n} - 1 = 63$

$\Rightarrow \quad 2^{2n} = 64 \Rightarrow 2^{2n} = 2^6$

$\Rightarrow \quad 2n = 6 \Rightarrow n = 3$

17. Given that

$x^2 = xy$

Let $\quad x, y \in R$

$xRy = x^2 = xy$

and $\quad yRz = y^2 = yz$

Now, $\quad x^2y^2 = xy^2z$

$\Rightarrow \quad x^2 = xz$

$\Rightarrow \quad xRz$

$\therefore$ It is transitive.

18. Given that $\det(A) = 6 \quad$ ...(i)

Now, $\quad B = 5A^2$

$\Rightarrow \quad \det(B) = \det(5A^2)$

$= 5\det(A^2) = 5\det(A)^2$

$= 5(6)^2 \quad$ (from (i))

$\Rightarrow \quad \det(B) = 180$

19. Given that

$$f(x) = \begin{cases} 1 & \forall \quad x < 0 \\ 1 + \sin x & \forall \quad 0 \le x \le \pi/2 \end{cases}$$

At $\quad x = 0$

$$\text{LHD} = \lim_{h\to 0} \frac{f(0-h) - f(0)}{-h}$$

$$= \lim_{h\to 0} \frac{1-1}{-h} = 0$$

$$\text{RHD} = \lim_{h\to 0} \frac{f(0+h) - f(0)}{h}$$

$$= \lim_{h\to 0} \frac{1+\sin(0+h) - 1}{h}$$

$$= \lim_{h\to 0} \frac{\sin h}{h} = 1$$

$\Rightarrow \quad \text{LHD} \ne \text{RHD}$

$\therefore \quad f'(x)$ does not exist at $x = 0$.

20. Given curve is $\quad y^2 = 4x \quad$ ...(i)

Let the equation of line by $y = mx + c$

Since $\frac{dy}{dx} = m = 1$ and this line is passing through the point (0, 1).

$\therefore \quad 1 = 1(0) + c \Rightarrow c = 1$

$\therefore \quad y = x + 1 \quad$ ...(ii)

Solving Eqs. (i) and (ii), we get

$$(x+1)^2 = 4x$$

$$\Rightarrow \quad (x-1)^2 = 0$$

$$\Rightarrow \quad x = 1 \text{ and } y = 2$$

This shows that line touch the curve at one point. So length of intercept is zero.

21. Given curves are

$$y = x^2 \quad \text{...(i)}$$

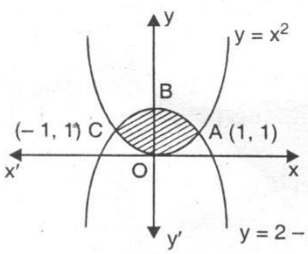
and $\quad y = 2 - x^2$

or $\quad x^2 = -(y-2) \quad \text{...(ii)}$

On solving Eqs. (i) and (ii), we get

$$x = -1, 1$$

and $\quad y = 1, 1$



$\therefore$ Required area = Area of curve $OABCO$

$$= 2 \text{ Area of curve } OABO$$

$$= 2\int_0^1 y\,dx$$

$$= 2\int_0^1 [(2-x^2)-(x^2)]\,dx$$

$$= 2\int_0^1 (2-2x^2)\,dx$$

$$= 4\left[x - \frac{x^3}{3}\right]_0^1$$

$$= 4\left[1 - \frac{1}{3}\right]$$

$$= \frac{8}{3} \text{ sq units.}$$

22. $\lim_{\theta \to 0} \dfrac{4\theta(\tan\theta - 2\theta\tan\theta)}{1-\cos 2\theta}$

$$= \lim_{\theta \to 0} \frac{4(\theta\tan\theta - 2\theta^2\tan\theta)}{1-\cos 2\theta}$$

Using L' Hospital's rule

$$= \lim_{\theta \to 0} \frac{4(\theta\sec^2\theta + \tan\theta - 4\theta\tan\theta - 2\theta^2\sec^2\theta)}{2\sin 2\theta}$$

Again using L' Hospital's rule

$$4(\sec^2\theta + 2\theta\sec^2\theta\tan\theta + \sec^2\theta - 4\tan\theta)$$

$$= \lim_{\theta \to 0} \frac{-4\theta\sec^2\theta - 4\theta\sec^2\theta - 4\theta^2\sec^2\theta\tan\theta}{4\cos 2\theta}$$

$$= \frac{4(1+0+1)}{4} = 2$$

23. Let $f(x) = 2x^3 - 3x^2 - 12x + 5$

$$\therefore \quad f'(x) = 6x^2 - 6x - 12$$

Put $f'(x) = 0$, for maxima or minima.

$$\therefore \quad 6x^2 - 6x - 12 = 0$$

$$\Rightarrow \quad x^2 - x - 2 = 0$$

$$\Rightarrow \quad x^2 - 2x + x - 2 = 0$$

$$\Rightarrow \quad (x-2)(x+1) = 0$$

$$\Rightarrow \quad x = -1, 2$$

Now, $f''(x) = 12x - 6$

$$f''(-1) = -12 - 6 = -18 < 0$$

$\therefore \quad f(x)$ is maximum at $x = -1$.

But $\quad x = 4$

$$f(x) = 37.$$

$\therefore$ The largest value of $f(x)$ is at $x = 4$

24. Let $z = x + iy$

$$\therefore \quad |z-1| = |z-2| = |z-i|$$

$$\Rightarrow \quad |(x-1)+i\,y| = |(x-2)+i\,y|$$

$$= |(x+i(y-1))|$$

$$\Rightarrow x^2 - 2x + 1 + y^2 = x^2 + 4 - 4x + y^2$$

$$= x^2 + y^2 + 1 - 2y$$

Taking Ist and IInd term

$$\Rightarrow \quad -2x + 1 = 4 - 4x$$

$$\Rightarrow \quad 2x = 3 \quad \text{...(i)}$$

Taking IInd and IIIrd term

$$\Rightarrow \quad 4 - 4x = 1 - 2y$$

$$\Rightarrow \quad 4x - 2y = 3 \quad \text{...(ii)}$$

Taking Ist and IIIrd term

$$\Rightarrow \quad -2x + 1 = 1 - 2y$$

$$\Rightarrow \quad 2x - 2y = 0$$

$$\Rightarrow \quad x = y \quad \text{...(iii)}$$

From (i) $x = \dfrac{3}{2}$

On putting value of x in Eq. (iii), we get

$$y = \frac{3}{2}$$

On putting the value of x and y in Eq. (ii), we get $\quad 4\left(\dfrac{3}{2}\right) - 2\left(\dfrac{3}{2}\right) = 3$

$$\Rightarrow \quad 3 = 3$$

$\therefore$ One solution exist.

25. Given that, $P(A') = 0.3, P(B) = 0.4$
and $P(A \cap B') = 0.5$
$P(B') = 1 - P(B) = 1 - 0.4 = 0.6$
$P(A) = 1 - P(A') = 1 - 0.3 = 0.7$
$P(A \cup B') = P(A) + P(B') - P(A \cap B')$
$= 0.7 + 0.6 - 0.5 = 0.8$

26. $(10101101)_2$

$$= 1 \times 2^7 + 0 \times 2^6 + 1 \times 2^5 + 0 \times 2^4 + 1 \times 2^3 + 1 \times 2^2 + 0 \times 2^1 + 1 \times 2^0$$
$$= 128 + 0 + 32 + 0 + 8 + 4 + 0 + 1$$
$$= 173$$

27. Given that $f(x) = \dfrac{e^{2x} - 1}{e^{2x} + 1}$

On differentiating w.r.t. x, we get

$$f'(x) = \frac{2(e^{2x} + 1)(e^{2x}) - 2(e^{2x} - 1)(e^{2x})}{(e^{2x} + 1)^2}$$
$$= \frac{2(e^{2x} + e^{2x})}{(e^{2x} + 1)^2} = \frac{4e^{2x}}{(e^{2x} + 1)^2} > 0$$

$\therefore$ Function is an increasing

28. Given equation is

$$x^2 + y^2 - 2xy\frac{dy}{dx} = 0$$
$$\Rightarrow \quad \frac{dy}{dx} = \frac{x^2 + y^2}{2xy} \quad \text{...(i)}$$

This is a homogeneous equation

$\therefore$ we put $y = vx$ and $\dfrac{dy}{dx} = v + x\dfrac{dv}{dx}$

The Eq. (i) is reduces to

$$v + x\frac{dv}{dx} = \frac{x^2(1 + v^2)}{2x^2 v}$$
$$\Rightarrow \quad x\frac{dv}{dx} = \frac{1 + v^2}{2v} - v = \frac{1 - v^2}{2v}$$
$$\Rightarrow \quad -\frac{2v}{1 - v^2}dv = -\frac{dx}{x}$$

On integrating both sides, we get

$$\log(1 - v^2) = -\log x + \log c$$
$$\Rightarrow \log(x^2 - y^2) - 2\log x = -\log x + \log c$$
$$\Rightarrow \quad \log(x^2 - y^2) = \log xc$$
$$\Rightarrow \quad x^2 - y^2 = xc$$

29. $\because f(x) = ax^2 + bx + c$
and $g(x) = px^2 + qx$
Since, $g(1) = f(1)$

$$\Rightarrow \quad p + q = a + b + c \quad \text{...(i)}$$

and $g(2) - f(2) = 1$

$$\Rightarrow \quad 4p + 2q - 4a - 2b - c = 1 \quad \text{...(ii)}$$

also $g(3) - f(3) = 4$

$$\Rightarrow \quad 9p + 3q - 9a - 3b - c = 4 \quad \text{...(iii)}$$

From Eqs. (i) and (ii)

$$2p = 2a - c + 1$$

Now, $g(4) - f(4)$

$$= 16p + 4q - 16a - 4b - c$$
$$= 12p + 4(p + q) - 16a - 4b - c = 6 - 3c$$

30. Since the given vectors $\alpha\hat{\mathbf{i}} + \hat{\mathbf{j}} + \hat{\mathbf{k}}, \hat{\mathbf{i}} + \beta\hat{\mathbf{j}} + \hat{\mathbf{k}}$ and $\hat{\mathbf{i}} + \hat{\mathbf{j}} + \gamma\hat{\mathbf{k}}$ are coplanar, then

$$\begin{vmatrix} \alpha & 1 & 1 \\ 1 & \beta & 1 \\ 1 & 1 & \gamma \end{vmatrix} = 0$$

Applying $C_2 \to C_2 - C_1, C_3 \to C_3 - C_2$

$$\Rightarrow \begin{vmatrix} \alpha & 1-\alpha & 0 \\ 1 & \beta - 1 & 1 - \beta \\ 1 & 0 & \gamma - 1 \end{vmatrix} = 0$$

$$\Rightarrow (1-\alpha)(1-\beta)(1-\gamma)\begin{vmatrix} \frac{\alpha}{1-\alpha} & 1 & 0 \\ \frac{1}{1-\beta} & -1 & 1 \\ \frac{1}{1-\gamma} & 0 & -1 \end{vmatrix} = 0$$

$$\Rightarrow (1-\alpha)(1-\beta)(1-\gamma)\left[\frac{\alpha}{1-\alpha}(1) - 1\left(-\frac{1}{1-\beta} - \frac{1}{1-\gamma}\right)\right] = 0$$

But $\alpha \neq 1, \beta \neq 1$ and $\gamma \neq 1$

$$\therefore \quad \frac{1}{(1-\alpha)} - 1 + \frac{1}{1-\beta} + \frac{1}{1-\gamma} = 0$$
$$\Rightarrow \quad \frac{1}{1-\alpha} + \frac{1}{1-\beta} + \frac{1}{1-\gamma} = 1$$

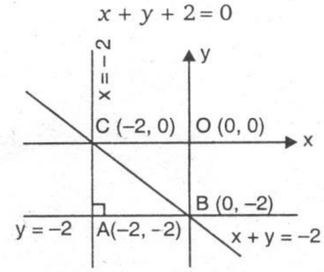
31. Given equation of lines are

$$xy + 2x + 2y + 4 = 0$$

or $(x + 2)(y + 2) = 0$

or $x + 2 = 0, y + 2 = 0$ ...(i)

and $x + y + 2 = 0$ ...(iii)



These three lines makes an right triangle CAB right angled at A.
The circumcentre of a triangle is the mid point of BC i.e. $(-1, -1)$.

32. The centre and radius of the first circle $x^2+y^2+2x+8y-23=0$ are $C_1(-1,-4)$ and $r_1=\sqrt{40}$

Similarly, the centre and radius of second circle $x^2+y^2-4x-10y+9=0$ are $C_2(2,5)$ and $r_2=\sqrt{20}$

Now, $C_1C_2=\sqrt{(2+1)^2+(5+4)^2}$
$$=\sqrt{9+81}=\sqrt{90}$$
and $r_1+r_2=\sqrt{40}+\sqrt{20}$

also $r_1-r_2=\sqrt{40}-\sqrt{20}$

Here, $r_1-r_2<C_1C_2<r_1+r_2$

$\therefore$ Two common tangents can be drawn.

33. Since the line $\frac{x}{\alpha}+\frac{y}{\beta}=1$ touches the circle $x^2+y^2=a^2$.

$\therefore$ The perpendicular distance from centre (0, 0) to the tangent = radius of the circle.

$$\Rightarrow \frac{|-1|}{\sqrt{\frac{1}{\alpha^2}+\frac{1}{\beta^2}}}=a$$
$$\Rightarrow \frac{1}{a^2}=\frac{1}{\alpha^2}+\frac{1}{\beta^2}$$
The locus of $\left(\frac{1}{\alpha},\frac{1}{\beta}\right)$ is
$$\frac{1}{a^2}=\frac{1}{x^2}+\frac{1}{y^2}$$
$\therefore$ It represents a circle.

34. Given equation of line is
$$\frac{x-1}{3}=\frac{y+2}{4}=\frac{z-3}{-2}=k \quad \text{(say)}$$
Any point on the line is
$$(3k+1,4k-2,-2k+3).$$
If the given line intersect the plane $2x-y+3z-1=0$, then any point on the line lies in the plane.

$\therefore 2(3k+1)-(4k-2)+3(-2k+3)-1=0$

$\Rightarrow -4k+12=0 \Rightarrow k=3$

$\therefore$ Point is $(9+1,12-2,-6+3)$

i.e., $(10,10,-3)$.

35. Equation of director circle of given hyperbola $\frac{x^2}{25}-\frac{y^2}{16}=1$ is $x^2+y^2=25-16$
$$\Rightarrow x^2+y^2=9 \quad \text{...(i)}$$
This circle passes through $(2\sqrt{2},1)$ and we know that director circle is the locus of point of intersection of perpendicular tangents drawn to a hyperbola.

Thus the angle between the tangents is $\pi/2$

36. Given that, it is given
$$\alpha\beta\gamma\delta=1 \quad \text{...(i)}$$
As, we know A.M. $\geq$ G.M.
$$\Rightarrow \frac{1+\alpha}{2}\geq\sqrt{\alpha}$$
$$\Rightarrow 1+\alpha\geq 2\sqrt{\alpha} \quad \text{...(ii)}$$
Similarly, $1+\beta\geq 2\sqrt{\beta}$ ...(iii)
$$1+\gamma\geq 2\sqrt{\gamma} \quad \text{...(iv)}$$
and $1+\delta\geq 2\sqrt{\delta}$ ...(v)

Multiplying Eqs. (ii), (iii), (iv) and (v), we get
$$(1+\alpha)(1+\beta)(1+\gamma)(1+\delta)\geq 16\sqrt{\alpha\beta\gamma\delta}$$
$$\Rightarrow (1+\alpha)(1+\beta)(1+\gamma)(1+\delta)=16$$

37. Given that
$$\sum_{k=1}^{6}\left(\sin\left(\frac{2k\pi}{7}\right)-i\cos\left(\frac{2k\pi}{7}\right)\right)$$
$$=-i\sum_{k=1}^{6}\cos\left(\frac{2k\pi}{7}\right)+i\sin\left(\frac{2k\pi}{7}\right)$$
$$=-i\sum_{k=1}^{6}\left(e^{\frac{2\pi i}{7}}\right)^k$$
$$=-i\sum_{k=1}^{6}r^k \quad \left(\text{let } r=e^{\frac{2\pi i}{7}}\right)$$
$$=-i(r^1+r^2+\ldots+r^6)$$
$$=-i\,r\frac{(1-r^6)}{1-r}=\frac{-i(r-r^7)}{1-r}$$
$$=\frac{-i(r-1)}{1-r}=i \quad [\because r^7=e^{2\pi i}=1]$$

38. Given that
$$y(x)=1+\frac{dy}{dx}=\frac{1}{1\cdot 2}\left(\frac{dy}{dx}\right)^2+\frac{1}{1\cdot2\cdot3}\left(\frac{dy}{dx}\right)^3+\ldots$$
or $$y(x)=1+\frac{1}{1!}\left(\frac{dy}{dx}\right)+\frac{1}{2!}\left(\frac{dy}{dx}\right)^2+\frac{1}{3!}\left(\frac{dy}{dx}\right)^3+\ldots$$
$$y(x)=e^{dy/dx}$$
Taking log on both sides, we get
$$\log y(x)=\frac{dy}{dx}$$
$\therefore$ The degree of this equation is 1.

39. Given x_1, x_2 are the roots of the equation
$$x^2+2x-3=0$$
$$\Rightarrow x^2+3x-x-3=0$$
$$\Rightarrow x(x+3)-1(x+3)=0$$
$$\Rightarrow (x-1)(x+3)=0$$
$$\Rightarrow x_1=-3,\ x_2=1$$
and y_1, y_2 are the roots of the equation
$$y^2+4y-12=0$$

$\Rightarrow \quad y^2 + 6y - 2y - 12 = 0$

$\Rightarrow \quad y(y+6) - 2(y+6) = 0$

$\Rightarrow \quad (y-2)(y+6) = 0$

$\Rightarrow \quad y_1 = -6,\ y_2 = 2$

$\therefore$ Points are $P(-3, -6)$ and $Q(1, 2)$.

Since, P and Q are the end points of a diameter.

$\therefore$ Centre = mid point of PQ

$$= \left(\frac{-3+1}{2}, \frac{-6+2}{2}\right)$$

$$= (-1, -2)$$

40. The equation of any plane through $(2, -1, 3)$ is

$a(x-2) + b(y+1) + c(z-3) = 0 \quad \ldots$(i)

where a, b and c are direction ratios, Since Eq. (i) is parallel to $\vec{\mathbf{a}}$ and $\vec{\mathbf{b}}$

$\therefore \quad 3a + 0b - c = 0 \quad \ldots$(ii)

and $\quad -3a + 2b - 2c = 0 \quad \ldots$(iii)

Solving Eqs. (ii) and (iii), we get

$$\frac{a}{2} = -\frac{b}{6-3} = \frac{c}{6} = k \quad \text{(say)}$$

$\Rightarrow \quad a = 2k,\ b = -3k,\ c = 6k$

Putting the values of a, b and c in Eq. (i), we get

$2k(x-2) - 3k(y+1) + 6k(z-3) = 0$

$\Rightarrow \quad 2x - 3y + 6z - 25 = 0$

which is a required equation of a plane.

41. Equation of parabola is

$$y^2 = -4x$$

$\therefore$ focus is $(-1, 0)$.

The equation of line passing through $(-1, 0)$ is

$y - 0 = m(x+1) \quad \ldots$(i)

Since, the line makes an angle $\theta = 120°$

$\therefore \quad m = \tan\theta = \tan 120°$

$\Rightarrow \quad m = -\sqrt{3}$

On putting the value of m in Eq. (i), we get

$$y = -\sqrt{3}(x+1)$$

42. Given that

$x = \alpha = \beta,\ y = \alpha\omega + \beta\omega^2,\ z = \alpha\omega^2 + \beta\omega$

Now, $xyz = (\alpha+\beta)(\alpha\omega + \beta\omega^2)(\alpha\omega^2 + \beta\omega)$

$= (\alpha+\beta)(\alpha^2\omega^3 + \alpha\beta\omega^2 + \alpha\beta\omega^4 + \beta^2\omega^3)$

$= (\alpha+\beta)(\alpha^2 + \alpha\beta(\omega^2+\omega) + \beta^2)$

$$\left[\begin{array}{r}\therefore 1 + \omega + \omega^2 = 0 \\ \text{and } \omega^3 = 1\end{array}\right]$$

$= (\alpha+\beta)(\alpha^2 - \alpha\beta + \beta^2)$

$= \alpha^3 + \beta^3$

43. Given that

$$r = \left[2\phi + \cos^2\left(2\phi + \frac{\pi}{4}\right)\right]^{1/2}$$

On differentiating w.r.t ϕ, we get

$$\frac{dr}{d\phi} = \frac{\left[2 - 2\cos\left(2\phi + \frac{\pi}{4}\right)\sin\left(2\phi + \frac{\pi}{4}\right)\cdot 2\right]}{2\sqrt{2\phi + \cos^2\left(2\phi + \frac{\pi}{4}\right)}}$$

$$= \frac{\left[1 - \sin\left(4\phi + \frac{\pi}{2}\right)\right]}{\sqrt{2\phi + \cos^2\left(2\phi + \frac{\pi}{4}\right)}}$$

$$\Rightarrow \left(\frac{dr}{d\phi}\right)_{\phi = \pi/4} = \frac{\left[1 - \sin\left(\pi + \frac{\pi}{2}\right)\right]}{\sqrt{2\cdot\frac{\pi}{4} + \cos^2\left(\frac{\pi}{2} + \frac{\pi}{4}\right)}}$$

$$= \frac{1+1}{\sqrt{\frac{\pi}{2} + \frac{1}{2}}} = 2\sqrt{\frac{2}{1+\pi}}$$

44. Since, $\vec{\alpha}$ lie in the plane of $\vec{\beta}$ and $\vec{\gamma}$.

It means that all three vectors are coplanar.

$\therefore \quad [\vec{\alpha}\ \vec{\beta}\ \vec{\gamma}] = 0$

45. Given that

$$\vec{\alpha} = 2\hat{\mathbf{i}} + 3\hat{\mathbf{j}} - \hat{\mathbf{k}},\ \vec{\beta} = -\hat{\mathbf{i}} + 2\hat{\mathbf{j}} - 4\hat{\mathbf{k}}$$

and $\quad \vec{\gamma} = \hat{\mathbf{i}} + \hat{\mathbf{j}} + \hat{\mathbf{k}}$

Now,

$$\vec{\alpha} \times \vec{\beta} = \begin{vmatrix} \hat{\mathbf{i}} & \hat{\mathbf{j}} & \hat{\mathbf{k}} \\ 2 & 3 & -1 \\ -1 & 2 & -4 \end{vmatrix}$$

$= \hat{\mathbf{i}}(-12+2) - \hat{\mathbf{j}}(-8-1) + \hat{\mathbf{k}}(4+3)$

$= -10\hat{\mathbf{i}} + 9\hat{\mathbf{j}} + 7\hat{\mathbf{k}}$

and $(\vec{\alpha} \times \vec{\gamma}) = \begin{vmatrix} \hat{\mathbf{i}} & \hat{\mathbf{j}} & \hat{\mathbf{k}} \\ 2 & 3 & -1 \\ 1 & 1 & 1 \end{vmatrix}$

$= \hat{\mathbf{i}}(3+1) - \hat{\mathbf{j}}(2+1) + \hat{\mathbf{k}}(2-3)$

$= -4\hat{\mathbf{i}} - 3\hat{\mathbf{j}} - \hat{\mathbf{k}}$

Now, $(\vec{\alpha} \times \vec{\beta}) \cdot (\vec{\alpha} \times \vec{\gamma})$

$= (-10\hat{\mathbf{i}} + 9\hat{\mathbf{j}} + 7\hat{\mathbf{k}}) \cdot (4\hat{\mathbf{i}} - 3\hat{\mathbf{j}} - \hat{\mathbf{k}})$

$= -40 - 27 - 7$

$= -74$

46. Gravitational acceleration is given by

$$g = \frac{GM}{R^2}$$

where G =gravitational constant

$$\therefore \quad \frac{g}{G} = \frac{M}{R^2}$$

47. In this case the internal force is applied on the system, so he will not succeed. According to Newton's law the state of a body can only be changed if some external force is applied on it.

48. $y = \frac{\text{stress}}{\text{strain}} = \text{N/m}^2$ or pascal (in SI system)

and $y = \frac{\text{dyne}}{\text{cm}^2}$ (in CGS System)

Thus, Nm^{-1} is not the unit of Young's modulus.

49. According to Stefan's law the energy emitted by a body per second is directly proportional to the fourth power of the temperature of the body. Here, the temperature of blue glass is more than that of red glass, so it will look brighter.

50. Chemical energy reduced

$$= VIt$$
$$= 6 \times 5 \times 6 \times 60$$
$$= 10800$$
$$= 1.08 \times 10^4 \text{ V}$$

51. Let the original resistance is $R\,\Omega$.

$$\therefore \quad V = IR$$
$$V = 5 \times R = 5R \quad \text{...(i)}$$

When 2Ω resistance is inserted, then total resistance $= (R + 2)\,\Omega$

$$\therefore \quad V = I'(R + 2) = 4(R + 2) \quad \text{...(ii)}$$

From Eqs. (i) and(II), we get

$$5R = 4(R + 2)$$
$$\therefore \quad R = 8\Omega$$
$$= 100 + \frac{75}{4} = \frac{475}{4}\Omega$$
$$= 118.75\,\Omega$$

52. Let S be the large and R be the smaller resistance.

From formula for metre bridge

$$S = \left(\frac{100 - l}{l}\right)R$$
$$= \frac{100 - 20}{20} R = 4R$$

Again,

$$S = \left(\frac{100 - l}{100}\right)(R + 15)$$
$$= \frac{100 - 40}{40}(R + 15)$$
$$= \frac{3}{2}(R + 15)$$
$$\therefore \quad 4R = \frac{3}{2}(R + 15)$$
$$\frac{8R}{3} - R = 15 \Rightarrow \frac{5R}{3} = 15$$
$$R = 9\Omega$$

53. If we take $R_1 = 4\Omega\ R_2 = 12\Omega$, then in series resistance

$$R = R_1 + R_2$$
$$= 4 + 12$$
$$= 16\Omega$$

In parallel, resistance $R = \frac{4 \times 12}{4 + 12} = 3\Omega$

So, $R_1 = 4\Omega$ and $R = 12\Omega$

54. Let the resistance of voltmeter is $G\,\Omega$.

$\therefore$ Total resistance of the circuit

$$R = \left(\frac{G \times 100}{G + 100} + 50\right)\Omega$$

Total current $i = \frac{V}{R}$

$$= \frac{10}{\left(\frac{G \times 100}{G + 100} + 50\right)}$$

Voltage across $100\,\Omega$ resistance

$$= i\left(\frac{G \times 100}{G + 100}\right) = \frac{10}{\left(\frac{G \times 100}{G + 100} + 50\right)} \times \left(\frac{G \times 100}{G + 100}\right)$$

Reading of voltmeter = 5 V

$\therefore$ Voltage across $100\,\Omega = 5$ V

$$\therefore \quad 5 = \frac{10}{\left(\frac{G \times 100}{G + 100} + 50\right)} \times \left(\frac{G \times 100}{G + 100}\right)$$

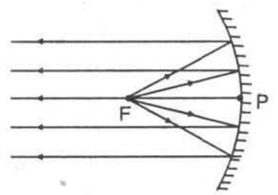
On solving $G = 100\,\Omega$.

55. According to Wien's law

$$\lambda \propto \frac{1}{T}$$

i.e., it depends on the temperature of the surface.

56. It lamp is placed at the focus of concave mirror, then we get parallel beam of light.



58. Here, $E = 1500\text{V/m}$, $B = 0.4\ \text{Wb/m}^2$

Minimum speed of electron along the straight line $v = \frac{E}{B}$

$$= \frac{1500}{0.4}$$
$$= 3750$$
$$= 3.75 \times 10^3\ \text{m/s}$$

59. Shunt resistance

$$S = \frac{I_g G}{I - I_g}$$
$$= \frac{0.1\,G}{1 - 0.1}$$
$$= \frac{G}{9}$$

60. Diamagnetic materials have negative susceptibility. Thus, (c) is wrongly stated.

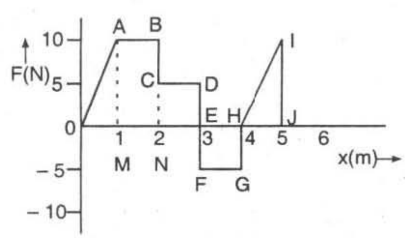
61. The induction coil works on the principle of mutual induction.

62. We know $\quad f = \frac{1}{2\pi\sqrt{LC}}$

or $\quad \sqrt{LC} = \frac{1}{2\pi f} = \text{time}.$

Thus, $\sqrt{LC}$ has the dimension of time.

63. Work done = area enclosed by F-x graph.



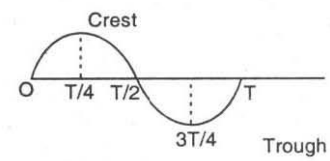
= area of $ABNM$ + area of $CDEN$ – area of $EFGH$ + area of HIJ

$$= 1 \times 10 + 1 \times 5 - 1 \times 5 + \frac{1}{2} \times 1 \times 10$$

$$= 10 + 5 - 5 + 5 = 15\text{J}$$

64. Both the stones will have the same speed when they hit the ground.

66. The time taken by the particle to come to mean position from the trough $= \frac{T}{4}$



67. Speed = 360 rev/min

$$= \frac{360}{60}\ \text{rev/s}$$
$$= 6$$

$\therefore$ Frequency $= 6 \times 60$

$$= 360$$

68. Velocity of sourd $v = \sqrt{\frac{\gamma RT}{M}}$

$$\frac{v_H}{v_O} = \sqrt{\frac{M_O}{M_H}}$$
$$= \sqrt{\frac{16}{1}}$$
$$= 4 : 1$$

69. For sonometer $n \propto \frac{1}{l}$

$$\therefore \quad \frac{n_1}{n_2} = \frac{l_2}{l_1} \Rightarrow \frac{256}{n_2} = \frac{16}{25}$$
$$n_2 = \frac{256 \times 25}{16}$$
$$= 400\ \text{Hz}$$

70. Wave theory of light was first proposed by Christian Huygens.

71. For the liquids, which do not wet the glass, the liquid meniscus is convex upward, so angle of contact is obtuse.

72. Radius of path of electron

$$r = \frac{mv}{Bq}$$

m and q remain unchanged.

So, $\quad \frac{r_1}{r_2} = \frac{v_1}{v_2} \cdot \frac{B_2}{B_1}$

$$= \frac{v}{2v} \cdot \frac{B/2}{B} = \frac{1}{4} \Rightarrow r_2 = 4r$$

73. As $\quad I \propto a^2 \quad$ or $\quad a \propto \sqrt{I}$

$$\therefore \quad \frac{a_1}{a_2} = \sqrt{\frac{I}{4I}}$$

$$\Rightarrow \qquad \frac{a_1}{a_2} = \frac{1}{2}$$

$$\frac{I_{max}}{I_{min}} = \left(\frac{a_1 + a_2}{a_1 - a_2}\right)^2$$

$$= \left(\frac{1+2}{1-2}\right)^2 = \frac{9}{1}$$

$$\therefore \qquad I_{max} = 9I,\ I_{min} = I$$

74. In a hydrogen atom the time period is given by

$$T \propto n^3$$

$$\frac{T_1}{T_2} = \left(\frac{n_1}{n_2}\right)^2 \Rightarrow \frac{8}{1} = \left(\frac{n_1}{n_2}\right)^3$$

$$\therefore \qquad \frac{n_1}{n_2} = \frac{2}{1}$$

Thus, $n_1 = 4$ and $n_1 = 2$

75. On increasing the forward bias voltage, the barrier energy decreases. This results in the flow of majority charge carriers. Hence, width of depletion region decreases.

76. Nuclear forces are charge independent so,

$$F_1 = F_2 = F_3.$$

79. Potential $V = \frac{Q}{C} \Rightarrow V = \frac{Q}{\frac{A\varepsilon_0}{d}}$

Hence, potential depends on the amount of charge, area or geometry and size of the conductor.

78. The potential at each point on the circular path will be equal.

So, work done = $q \times$ potential difference

$$= q \times 0$$

$$= 0$$

79. Capacitance with air

$$C = \frac{A\varepsilon_0}{d}$$

When interspace between the plates is filled with wax, then

$$C' = \frac{KA\varepsilon_0}{2d}$$

or $$C' = \left(\frac{A\varepsilon_0}{d}\right)\frac{K}{2}$$

or $$C' = C\,\frac{K}{2}$$

$$\therefore \qquad 6 = 2 \cdot \frac{K}{2} \Rightarrow K = 6$$

80. de-Broglie wavelength

$$\lambda = \frac{h}{\sqrt{2mE}}$$

$$\therefore \quad \frac{\lambda_1}{\lambda_2} = \sqrt{\frac{E_2}{E_1}} \Rightarrow \frac{1 \times 10^{-9}}{0.5 \times 10^{-9}} = \sqrt{\frac{E_2}{E_1}}$$

$$\Rightarrow \qquad 2 = \sqrt{\frac{E_2}{E_1}} \Rightarrow \frac{E_2}{E_1} = 4$$

$$\therefore \qquad E_2 = 4E_1$$

$\therefore$ Energy to be added $= E_2 - E_1$

$$= 4E_1 - E_1 = 3E_1$$

81. Half-life $T/2 = \frac{T}{1.44} = \frac{100}{1.44}$ s

$$= 69.44 \text{ s}$$

$$= \frac{69.44}{60} \approx 1.155 \text{ min}$$

82. Radioactive decay does not depend upon the time of creation.

84. Coulomb's law is appliable for charged particles, it is not responsible to bind the protons and neutrons in the nucleus of an atom.

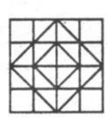
85. If unpolarised light is incident at polarising angle, then reflected light is completely, *i.e*, 100% polarised.

Reasoning

141. (c) Second is the result of the first.

142. (b) In all other groups, the first second and third letters are respectively moved one, five and one step forward to obtain second, third and fourth letters respectively.

143. Clearly, fig. (d) when placed in the blank space of fig (x) will complete the pattern, as shown below.



Hence, the answer is (d).

145. In fig. X, the right half of the rectangular paper sheet is folded over the left half. In fig. Y, two semicircles are punched into the folded paper. When the paper is unfolded, the semicircles in the two halves will join to form circles. Thus, two circles will appear in the unfolded position of fig. Y.

Hence, fig. (d) is the correct answer.

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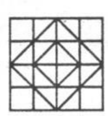

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BITSAT-PILANI

ENGINEERING ENTRANCE

SOLVED PAPER 2006

Mathematics

1. When 2^{301} is divided by 5, the least positive remainder is :

(a) 4 (b) 8
(c) 2 (d) 6

2. If ω is a complex cube root of unity, then

$$\begin{vmatrix} 1 & \omega & \omega^2 \\ \omega & \omega^2 & 1 \\ \omega^2 & 1 & \omega \end{vmatrix}$$ is equal to :

(a) -1 (b) 1
(c) 0 (d) ω

3. The ends of the latus rectum of the conic $x^2 + 10x - 16y + 25 = 0$ are :

(a) $(3, -4), (13, 4)$
(b) $(-3, -4), (13, -4)$
(c) $(3, 4), (-13, 4)$
(d) $(5, -8), (-5, 8)$

4. The equation to the hyperbola having its eccentricity 2 and the distance between its foci is 8, is :

(a) $\frac{x^2}{12} - \frac{y^2}{4} = 1$ (b) $\frac{x^2}{4} - \frac{y^2}{12} = 1$
(c) $\frac{x^2}{8} - \frac{y^2}{2} = 1$ (d) $\frac{x^2}{16} - \frac{y^2}{9} = 1$

5. The solution of $\sin^{-1} x - \sin^{-1} 2x = \pm \frac{\pi}{3}$ is :

(a) $\pm \frac{1}{3}$ (b) $\pm \frac{1}{4}$
(c) $\pm \frac{\sqrt{3}}{2}$ (d) $\pm \frac{1}{2}$

6. In a ΔABC if the sides are $a = 3$, $b = 5$ and $c = 4$, then $\sin \frac{B}{2} + \cos \frac{B}{2}$ is equal to :

(a) $\sqrt{2}$ (b) $\frac{\sqrt{3}+1}{2}$
(c) $\frac{\sqrt{3}-1}{2}$ (d) 1

7. The two circles $x^2 + y^2 - 2x + 22y + 5 = 0$ and $x^2 + y^2 + 14x + 6y + k = 0$ intersect orthogonally provided k is equal to :

(a) 47 (b) -47
(c) 49 (d) -49

8. The radius of the circle $x^2 + y^2 + 4x + 6y + 13 = 0$ is :

(a) $\sqrt{26}$ (b) $\sqrt{13}$
(c) $\sqrt{23}$ (d) 0

9. The centre of the circle $x = 2 + 3\cos\theta$, $y = 3\sin\theta - 1$ is :

(a) $(3, 3)$ (b) $(2, -1)$
(c) $(-2, 1)$ (d) $(-1, 2)$

10. The sum of the focal distances of any point on the conic $\frac{x^2}{25} + \frac{y^2}{16} = 1$ is :

(a) 10 (b) 9
(c) 41 (d) 18

11. The solutions of the equation $\begin{vmatrix} x & 2 & -1 \\ 2 & 5 & x \\ -1 & 2 & x \end{vmatrix} = 0$ are :

(a) $3, -1$ (b) $-3, 1$
(c) $3, 1$ (d) $-3, -1$

12. If $A = \begin{bmatrix} 3 & 5 \\ 2 & 0 \end{bmatrix}$ and $B = \begin{bmatrix} 1 & 17 \\ 0 & -10 \end{bmatrix}$, then $|AB|$ is equal to :

(a) 80 (b) 100
(c) -110 (d) 92

13. The inverse of the matrix $\begin{bmatrix} 5 & -2 \\ 3 & 1 \end{bmatrix}$ is :

(a) $\frac{1}{11}\begin{bmatrix} 1 & 2 \\ -3 & 5 \end{bmatrix}$ (b) $\begin{bmatrix} 1 & 2 \\ -3 & 5 \end{bmatrix}$
(c) $\frac{1}{13}\begin{bmatrix} -2 & 5 \\ 1 & 3 \end{bmatrix}$ (d) $\begin{bmatrix} 1 & 3 \\ -2 & 5 \end{bmatrix}$

14. The projection of the vector $2\hat{\mathbf{i}} + \hat{\mathbf{j}} - 3\hat{\mathbf{k}}$ on the vector $\hat{\mathbf{i}} - 2\hat{\mathbf{j}} + \hat{\mathbf{k}}$ is :

(a) $-\frac{3}{\sqrt{14}}$ (b) $\frac{3}{\sqrt{14}}$

(c) $-\sqrt{\frac{3}{2}}$ (d) $\frac{3}{\sqrt{2}}$

15. If $12\cot^2\theta - 31\operatorname{cosec}\theta + 32 = 0$, then the value of $\sin\theta$ is :

(a) $\frac{3}{5}$ or 1 (b) $\frac{2}{3}$ or $-\frac{2}{3}$

(c) $\frac{4}{5}$ or $\frac{3}{4}$ (d) $\pm\frac{1}{2}$

16. The circumradius of the triangle whose sides are 13, 12 and 5, is :

(a) 15 (b) $\frac{13}{2}$

(c) $\frac{15}{2}$ (d) 6

17. The general solution of $\sin x - \cos x = \sqrt{2}$, for any integer n is :

(a) $n\pi$ (b) $2n\pi + \frac{3\pi}{4}$

(c) $2n\pi$ (d) $(2n+1)\pi$

18. The amplitude of $\frac{1+i\sqrt{3}}{\sqrt{3}+i}$ is :

(a) $\frac{\pi}{3}$ (b) $\frac{\pi}{4}$

(c) $\frac{2\pi}{3}$ (d) $\frac{\pi}{6}$

19. If ${}^nC_{12} = {}^nC_6$, then ${}^nC_2$ is equal to :

(a) 72 (b) 153

(c) 306 (d) 2556

20. The middle term in the expansion of $\left(x - \frac{1}{x}\right)^{18}$ is :

(a) ${}^{18}C_9$ (b) $-{}^{18}C_9$

(c) ${}^{18}C_{10}$ (d) $-{}^{18}C_{10}$

21. If α, β, γ are the roots of the equation $2x^3 - 3x^2 + 6x + 1 = 0$, then $\alpha^2 + \beta^2 + \gamma^2$ is equal to :

(a) $-\frac{15}{4}$ (b) $\frac{15}{4}$

(c) $\frac{9}{4}$ (d) 4

22. If $\vec{\mathbf{a}}$, $\vec{\mathbf{b}}$ and $\vec{\mathbf{c}}$ are mutually perpendicular unit vectors, then $|\vec{\mathbf{a}} + \vec{\mathbf{b}} + \vec{\mathbf{c}}|$ is equal to :

(a) 3 (b) $\sqrt{3}$

(c) $\frac{(\sqrt{a^2+b^2+c^2})}{3}$ (d) 1

23. (0, – 1) and (0, 3) are two opposite vertices of a square. The other two vertices are :

(a) (0, 1), (0, – 3) (b) (3, – 1), (0, 0)

(c) (2, 1), (– 2, 1) (d) (2, 2), (1, 1)

24. The equation to the line bisecting the join of (3, – 4) and (5, 2) and having its intercepts on the x-axis and the y-axis in the ratio 2 : 1 is :

(a) $x + y - 3 = 0$ (b) $2x - y = 9$

(c) $x + 2y = 2$ (d) $2x + y = 7$

25. The distance between the pair of parallel lines $x^2 + 2xy + y^2 - 8ax - 8ay - 9a^2 = 0$ is :

(a) $2\sqrt{5}\,a$ (b) $\sqrt{10}\,a$

(c) $10\,a$ (d) $5\sqrt{2}\,a$

26. The equation to the circle with centre (2, 1) and touching the line $3x + 4y = 5$ is :

(a) $x^2 + y^2 - 4x - 2y + 5 = 0$

(b) $x^2 + y^2 - 4x - 2y - 5 = 0$

(c) $x^2 + y^2 - 4x - 2y + 4 = 0$

(d) $x^2 + y^2 - 4x - 2y - 4 = 0$

27. The condition for a line $y = 2x + c$ to touch the circle $x^2 + y^2 = 16$ is :

(a) $c = 10$ (b) $c^2 = 80$

(c) $c = 12$ (d) $c^2 = 64$

28. $\int \frac{\sin(2x)}{1+\cos^2 x}\,dx$ is equal to :

(a) $-\frac{1}{2}\log(1+\cos^2 x) + c$

(b) $2\log(1+\cos^2 x) + c$

(c) $\frac{1}{2}\log(1+\cos 2x) + c$

(d) $c - \log(1+\cos^2 x)$

29. $\int \frac{e^x(1+\sin x)}{1+\cos x}\,dx$ is equal to :

(a) $e^x \tan\left(\frac{x}{2}\right) + c$

(b) $e^x \tan x + c$

(c) $e^x\left(\frac{1+\sin x}{1-\cos x}\right) + c$

(d) $c - e^x \cot\left(\frac{x}{2}\right)$

30. $\int_{\pi/4}^{\pi/2} \operatorname{cosec}^2 x\,dx$ is equal to :

(a) – 1 (b) 1

(c) 0 (d) $\frac{1}{2}$

31. $\int_0^{\pi/4} \log(1 + \tan x)\, dx$ is equal to :

(a) $\frac{\pi}{8} \log_e 2$ (b) $\frac{\pi}{4} \log_2 e$

(c) $\frac{\pi}{4} \log_e 2$ (d) $\frac{\pi}{8} \log_e \left(\frac{1}{2}\right)$

32. The modulus and amplitude of $\frac{1 + 2i}{1 - (1 - i)^2}$ are :

(a) $\sqrt{2}$ and $\frac{\pi}{6}$ (b) 1 and 0

(c) 1 and $\frac{\pi}{3}$ (d) 1 and $\frac{\pi}{4}$

33. $\lim_{x \to 0} \frac{\tan x - \sin x}{x^3}$ is equal to :

(a) $\frac{1}{2}$ (b) $-\frac{1}{2}$

(c) 0 (d) 1

34. If $f(x) = \begin{cases} \frac{\sin 5x}{x^2 + 2x}, & x \neq 0 \\ k + \frac{1}{2}, & x = 0 \end{cases}$ is continuous at $x = 0$, then the value of k is :

(a) 1 (b) -2

(c) 2 (d) $\frac{1}{2}$

35. The area bounded by the parabola $y^2 = 4ax$ and the line $x = a$ and $x = 4a$ is :

(a) $\frac{35a^2}{3}$ (b) $\frac{4a^2}{3}$

(c) $\frac{7a^2}{3}$ (d) $\frac{56a^2}{3}$

36. A population $p(t)$ of 1000 bacteria introduced into nutrient medium grows according to the relation $p(t) = 1000 + \frac{1000t}{100 + t^2}$. The maximum size of this bacterial population is:

(a) 1100 (b) 1250

(c) 1050 (d) 5250

37. The differential equation representing a family of circles touching the y-axis at the origin is :

(a) $x^2 + y^2 - 2xy \frac{dy}{dx} = 0$

(b) $x^2 + y^2 + 2xy \frac{dy}{dx} = 0$

(c) $x^2 - y^2 - 2xy \frac{dy}{dx} = 0$

(d) $x^2 - y^2 + 2xy \frac{dy}{dx} = 0$

38. The general solution of the differential equation $(2x - y + 1)\, dx + (2y - x + 1)\, dy = 0$ is :

(a) $x^2 + y^2 + xy - x + y = c$

(b) $x^2 + y^2 - xy + x + y = c$

(c) $x^2 - y^2 + 2xy - x + y = c$

(d) $x^2 - y^2 - 2xy + x - y = c$

39. If $y = \tan^{-1} \frac{\sqrt{1 + x^2} - \sqrt{1 - x^2}}{\sqrt{1 + x^2} + \sqrt{1 - x^2}}$, then $\frac{dy}{dx}$ is equal to :

(a) $\frac{x^2}{\sqrt{1 - x^4}}$ (b) $\frac{x^2}{\sqrt{1 + x^4}}$

(c) $\frac{x}{\sqrt{1 + x^4}}$ (d) $\frac{x}{\sqrt{1 - x^4}}$

40. If $x = \sin t$, $y = \cos pt$, then :

(a) $(1 - x^2) y_2 + xy_1 + p^2 y = 0$

(b) $(1 - x^2) y_2 + xy_1 - p^2 y = 0$

(c) $(1 + x^2) y_2 - xy_1 + p^2 y = 0$

(d) $(1 - x^2) y_2 - xy_1 + p^2 y = 0$

41. If ST and SN are the lengths of the subtangent and the subnormal at the point $\theta = \frac{\pi}{2}$ on the curve $x = a(\theta + \sin \theta)$, $y = a(1 - \cos \theta)$, $a \neq 1$, then :

(a) $ST = SN$ (b) $ST = 2SN$

(c) $ST^2 = a\, SN^3$ (d) $ST^3 = a\, SN$

42. If θ is the acute angle of intersection at a real point of intersection of the circle $x^2 + y^2 = 5$ and the parabola $y^2 = 4x$, then $\tan \theta$ is equal to :

(a) 1 (b) $\sqrt{3}$

(c) 3 (d) $\frac{1}{\sqrt{3}}$

43. Universal set,

$U = \{x |\, x^5 - 6x^4 + 11x^3 - 6x^2 = 0\}$

$A = \{x |\, x^2 - 5x + 6 = 0\}$

$B = \{x |\, x^2 - 3x + 2 = 0\}$

what is $(A \cap B)'$ equal to?

(a) $\{1, 3\}$ (b) $\{1, 2, 3\}$

(c) $\{0, 1, 3\}$ (d) $\{0, 1, 2, 3\}$

44. Which of the following statements is not correct for the relation R defined by aRb, if and only, if b lives within on kilometre from a?

(a) R is reflexive

(b) R is symmetric

(c) R is not anti-symmetric

(d) None of the above

45. What is the value of

$$\frac{(1001)_2^{(11)_2}-(101)_2^{(11)_2}}{(1001)_2^{(10)_2}+(1001)_2^{(01)_2}(101)_2^{(01)_2}+(101)_2^{(10)_2}}?$$

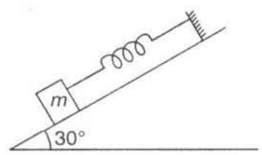
(a) $(1001)_2$ (b) $(101)_2$
(c) $(110)_2$ (d) $(100)_2$

Physics

46. The angle turned by a body undergoing circular motion depends on time as $\theta=\theta_0+\theta_1 t+\theta_2 t^2$. Then the angular acceleration of the body is :
(a) θ_1 (b) θ_2
(c) $2\theta_1$ (d) $2\theta_2$

47. The moment of inertia of a circular disc about an axis passing through the circumference perpendicular to the plane of the disc is :
(a) MR^2 (b) $\frac{3}{2}MR^2$
(c) $\frac{MR^2}{2}$ (d) $\frac{5}{4}MR^2$

48. A body of mass 5 kg is suspended by a spring balance on an inclined plane as shown in figure. The spring balance measure :

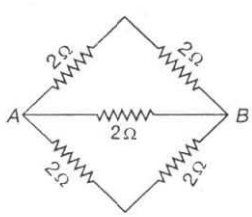


(a) 50 N (b) 25 N
(c) 500 N (d) 10 N

49. Under the action of a force $F=Cx$, the position of a body changes from 0 to x. The work done is :
(a) $\frac{1}{2}Cx^2$ (b) Cx^2
(c) Cx (d) $\frac{1}{2}Cx$

50. If $\vec{\mathbf{A}}\cdot\vec{\mathbf{B}}=\vec{\mathbf{A}}\times\vec{\mathbf{B}}$, then angle between $\vec{\mathbf{A}}$ and $\vec{\mathbf{B}}$ is :
(a) 45° (b) 30°
(c) 60° (d) 90°

51. Each resistance shown in figure is 2Ω. The equivalent resistance between A and B is :



(a) 2Ω (b) 4Ω
(c) 8Ω (d) 1Ω

52. A physical quantity is given by $X=[M^aL^bT^c]$. The percentage error in measurement of M, L and T are α,β and γ respectively. Then, the maximum % error in the quantity X is :
(a) $a\alpha+b\beta+c\gamma$ (b) $a\alpha+b\beta-c\gamma$
(c) $\frac{a}{\alpha}+\frac{b}{\beta}+\frac{c}{\gamma}$ (d) none of these

53. If emf induced in a coil is 2 V by changing the current in it from 8 A to 6 A in 2×10^{-3} s, then the coefficient of self induction is :
(a) 2×10^{-3} H (b) 10^{-3} H
(c) 0.5×10^{-3} H (d) 4×10^{-3} H

54. A hollow metallic sphere of radius R is given a charge Q. Then, the potential at the centre is :
(a) zero (b) $\frac{1}{4\pi\varepsilon_0}\cdot\frac{Q}{R}$
(c) $\frac{1}{4\pi\varepsilon_0}\cdot\frac{2Q}{R}$ (d) $\frac{1}{4\pi\varepsilon_0}\cdot\frac{Q}{2R}$

55. Susceptibility of ferromagnetic substance is :
(a) >1 (b) <1
(c) zero (d) 1

56. What is the refractive index of a prism whose angle $A=60°$ and angle of minimum deviation $d_m=30°$?
(a) $\sqrt{2}$ (b) $\frac{1}{\sqrt{2}}$
(c) 1 (d) $\frac{1}{\sqrt{3}}$

57. A satellite of mass m is placed at a distance r from the centre of earth (mass M). The mechanical energy of the satellite is :
(a) $-\frac{GMm}{r}$ (b) $\frac{GMm}{r}$
(c) $\frac{GMm}{2r}$ (d) $-\frac{GMm}{2r}$

58. A cell of constant emf first connected to a resistance R_1 and then connected to a resistance R_2. If power delivered in both cases

is same then the internal resistance of the cell is :

(a) $\sqrt{R_1 R_2}$ (b) $\sqrt{\frac{R_1}{R_2}}$

(c) $\frac{R_1 - R_2}{2}$ (d) $\frac{R_1 + R_2}{2}$

59. Energy gas between valence band and conduction band of a semiconductor is :

(a) zero (b) infinite

(c) 1 eV (d) 10 eV

60. At what point of a projectile motion, acceleration and velocity are perpendicular to each other ?

(a) At the point of projection

(b) At the point of drop

(c) At the top most point

(d) Anywhere in between the point of projection and top most point

61. An object is placed at a distance 20 cm from the pole of a convex mirror of focal length 20 cm. The image is produced at :

(a) 13.3 cm (b) 20 cm

(c) 25 cm (d) 10 cm

62. Angular momentum is conserved :

(a) always

(b) never

(c) when external force is absent

(d) when external torque is absent

63. The plano-convex lens of focal length 20 cm and 30 cm are placed together to form a double convex lens. The final focal length will be :

(a) 12 cm (b) 60 cm

(c) 20 cm (d) 30 cm

64. Initially two gas samples 1 and 2 are at the same condition. The volume of the two are halved, one isothermally and the other adiabatically. What is the relation between the final pressure P_1 and P_2 ?

(a) $P_1 = P_2$

(b) $P_1 > P_2$

(c) $P_2 > P_1$

(d) Cannot be determined

65. A can is taken out from a refrigerator at 0°C. The atmospheric temperature is 25°C. If t_1 is the time taken to heat from 0°C to 5°C and t_2 is the time taken from 10°C to 15°C, then :

(a) $t_1 > t_2$ (b) $t_1 < t_2$

(c) $t_1 = t_2$ (d) there is no relation

66. A simple pendulum hanging from the ceiling of a stationary lift has time period t_1. When the lift moves downward with constant velocity, the time period is t_2, then :

(a) t_2 is infinity (b) $t_2 > t_1$

(c) $t_2 < t_1$ (d) $t_2 = t_1$

67. Two progressive waves having equation $x_1 = 3 \sin \omega\tau$ and $x_2 = 4 \sin (\omega\tau = 90°)$ are super imposed. The amplitude of the resultant wave is :

(a) 5 unit (b) 1 unit

(c) 3 unit (d) 4 unit

68. In a magnetic field of 0.05 T area of coil changes from 101 cm^2 to 100 cm^2 without changing the resistance which is 2Ω. The amount of charge that flow during this period is :

(a) 2.5×10^{-6} C (b) 2×10^{-6} C

(c) 10^{-6} C (d) 8×10^{-6} C

69. A dielectric is introduced in a charged and isolated parallel plate capacitor, which of the following remains unchanged ?

(a) Energy

(b) Charge

(c) Electric field

(d) Potential difference

70. If in a triode valve amplification factor is 20 and plate resistance is 10 $k\Omega$, then its mutual conductance is :

(a) 2 milli mho

(b) 20 milli mho

(c) (1/2) milli mho

(d) 200 milli mho

71. Which of the following is a fusion reaction?

(a) ${}_1H^2 + {}_1H^2 \rightarrow {}_2He^4$

(b) ${}_1H^2 + {}_1H^2 \rightarrow 2({}_1He^2)$

(c) ${}_1H^1 + {}_1H^1 \rightarrow {}_2He^4$

(d) ${}_1H^1 + {}_1H^2 \rightarrow {}_2He^4 + n$

72. The correct relation between α and β in a transistor is :

(a) $\beta = \frac{\alpha}{1-\alpha}$ (b) $\beta = \frac{\alpha}{1+\alpha}$

(c) $\beta = \frac{1+\alpha}{\alpha}$ (d) $\beta = 1 - \alpha$

73. Which of the following law states that "good absorbers of heat are good emitters"?

(a) Stefan's law (b) Kirchhoff's law

(c) Planck's law (d) Wien's law

74. Doping of intrinsic semiconductor is done :
(a) to neutralize charge carriers
(b) to increase the concentration of majority charge carriers
(c) to make it neutral before disposal
(d) to carry out further purification

75. If λ is the wavelength of hydrogen atom from the transition $n = 3$ to $n = 1$, then what is the wavelength for doubly ionised lithium ion for same transition?
(a) $\frac{\lambda}{3}$ (b) 3λ
(c) $\frac{\lambda}{9}$ (d) 9λ

76. A rocket of mass 1000 kg is exhaust gases at a rate of 4 kg/s with a velocity 3000 m/s. The thrust developed on the rocket is :
(a) 12000 N (b) 120 N
(c) 800 N (d) 200 N

77. Ampere-hour is the unit of :
(a) quantity of charge
(b) potential
(c) energy
(d) current

78. Water falls from a tap, down the streamline :
(a) area decreases
(b) area increases
(c) velocity remains same
(d) area remains same

79. Positively charged particles are projected into a magnetic field. If the direction of the magnetic field is along the direction of motion of the charge particles, the particles get :
(a) accelerated
(b) decelerated
(c) deflected
(d) no changed in velocity

80. In Young's double slit experiment a minima is observed when path difference between the interfering beam is :
(a) λ (b) $1.5\,\lambda$
(c) $2\,\lambda$ (d) $2.25\,\lambda$

81. Calculate the energy released when three α-particles combined to from a ^{12}C nucleus, the mass defect is :
(atomic mass of $_2He^4$ is 4.002603 u)
(a) 0.007809 u (b) 0.002603 u
(c) 4.002603 u (d) 0.5 u

82. In a step-up transformer, if ratio of truns of primary to secondary is 1 : 10 and primary voltage is 230 V. If the load current is 2 A, then the current in primary is :
(a) 20 A (b) 10 A
(c) 2 A (d) 1 A

83. If the equation of transverse wave is $Y = 2\sin(kx - 2t)$, then the maximum particle velocity is :
(a) 4 unit (b) 2 unit
(c) zero (d) 6 unit

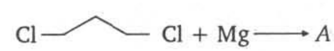
84. Fusion reaction takes place at high temperature because :
(a) KE is high enough to overcome repulsion between nuclei
(b) nuclei are most stable at this temperature
(c) nuclei are unstable at this temeprature
(d) none of the above

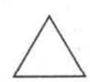
85. An isotope decays to 1/16th of its mass in 1 h. What is the half-life period of the isotope?
(a) 15 min (b) 30 min
(c) 12 min (d) 10 min

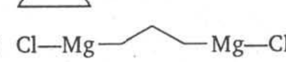
Chemistry

86. The crystal field splitting energy for octahedral (Δ_o) and tetrahedral (Δ_t) complexes is related to :
(a) $\Delta_t = \frac{4}{9}\Delta_o$ (b) $\Delta_t = \frac{1}{2}\Delta_o$
(c) $\Delta_o = 2\Delta_t$ (d) $\Delta_o = \frac{4}{9}\Delta_t$

87. What is the product A in the following ?



(a) 

(b) 

(c) Both (a) and (b)
(d) None of the above

88. Which of the following species has a bond order other than 3 ?
(a) CO (b) CN^-
(c) NO^+ (d) O_2^+

89. The number of waves in an orbit are :
(a) n^2 (b) n
(c) $n-1$ (d) $n-2$

90. When glucose reacts with bromine water the main product is :
(a) gluconic acid (b) glyceraldehyde
(c) sorbitol (d) saccharic acid

91. The ion which exhibits green colour ?
(a) Cu^{2+} (b) Mn^{2+}
(c) Co^{2+} (d) Ni^{2+}

92. The probability of finding the electron in the orbital is :
(a) 100% (b) 90–95%
(c) 70–80% (d) 50–60%

93. Which destroy antigens ?
(a) Insulin (b) Antibodies
(c) Chromoprotein (d) Phosphoprotein

94. In $2HI \rightleftharpoons H_2 + I_2$, the forward reaction is not affected by change in :
(a) catalyst (b) pressure
(c) volume (d) temperature

95. Nylon-66 is an example of :
(a) poly propylene (b) polyester
(c) polyamide (d) polystyrene

96. 1 mole of $N_2O_4(g)$ at 300 K is kept in a closed container under one atmosphere. It is heated to 600 K when 20% by mass of $N_2O_4(g)$ decomposes to $NO_2(g)$. The resultant pressure is :
(a) 1.2 atm (b) 2.4 atm
(c) 2.0 atm (d) 1.0 atm

97. A hypothetical reaction $A \rightarrow 2B$, proceeds through following sequence of steps :
(i) $A \longrightarrow C;\ \Delta H = q$
(ii) $C \longrightarrow D;\ \Delta H = v$
(iii) $\frac{1}{2} D \longrightarrow B;\ \Delta H = x$

Then the heat of reaction is :
(a) $q - v + 2x$ (b) $q + v - 2x$
(c) $q + v + 2x$ (d) $q + 2v - 2x$

98. Following reaction is :

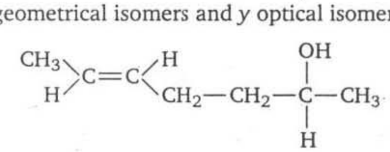
(a) S_N (b) S_E
(c) E1 (d) EI-CB

99. The cathodic reaction of a dry cell is represented by
$$2MnO_2(s) + Zn^{2+} + 2e^- \longrightarrow ZnMn_2O_4(s)$$
If, there are 8 g of MnO_2 in the cathodic compartment then the time for which the dry cell will continue to give a current of 2 milliampere is :
(a) 25.675 day (b) 51.35 day
(c) 12.8 day (d) 6.423 day

100. On heating with oxalic acid at 110°C, glycerine gives :
(a) glyceryl trioxalate
(b) formic acid
(c) glyceryl dioxalate
(d) none of the above

101. Which of the following is not the example of pseudounimolecular reactions ?
(a) $CH_3COOC_2H_5 + H_2O \xrightarrow{H^+} CH_3COOH + C_2H_5OH$
(b) $C_{12}H_{22}O_{11} + H_2O \xrightarrow{H^+} \underset{\text{(Glucose)}}{C_6H_{12}O_6} + \underset{\text{(Fructose)}}{C_6H_{12}O_6}$
(c) $CH_3COCl + H_2O \longrightarrow CH_3COOH + HCl$
(d) $CH_3COOC_2H_5 + H_2O \xrightarrow{OH^-} CH_3COOH + C_2H_5OH$

102. The compound, whose stereo-chemical formula is written below, exhibits x geometrical isomers and y optical isomers.



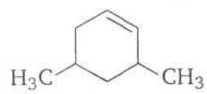
The values of x and y are :
(a) 4 and 4 (b) 2 and 2
(c) 2 and 4 (d) 4 and 2

103. When Na reacts with liquid NH_3 the following substance is formed :

(a) $[Na(NH_3)_x]^-$ (b) $[e(NH_3)_y]^-$

(c) $NaNH_2$ (d) Na_xNH_{3y}

104. IUPAC name of the following compound is :



(a) 3,5-dimethylcyclohexene

(b) 3,5-dimethyl-1-cyclohexene

(c) 1,5-dimethyl-5-cyclohexene

(d) 1,3-dimethyl-5-cyclohexene

105. The purine base present in RNA is :

(a) guanine (b) thymine

(c) cytosine (d) uracil

106. The molar volume of CO_2 is maximum at :

(a) NTP

(b) 0°C and 2.0 atm

(c) 127°C and 1 atm

(d) 273°C and 2 atm

107. SO_2 does not acts as :

(a) bleaching agent (b) oxidising agent

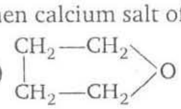
(c) reducing agent (d) dehydrating agent

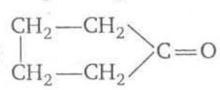
108. The noble gas which is not found in atmosphere :

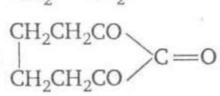
(a) Ne (b) Ar

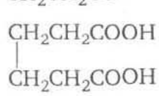
(c) Rn (d) Kr

109. Which one of the following product is formed when calcium salt of adipic acid is heated ?

(a) 

(b) 

(c) 

(d) 

110. Which is not present in chlorophyll ?

(a) Carbon (b) Calcium

(c) Magnesium (d) Hydrogen

111. Glyptal polymer is obtained by the reaction of glycerol with :

(a) malonic acid (b) acetic acid

(c) phthalic acid (d) maleic acid

112. For the following two reactions

(i) $CH_4(g) + 2O_2(g) \longrightarrow CO_2(g) + 2H_2O(g)$; $\Delta H = -890.4$ kJ

(ii) $2HgO(s) \longrightarrow 2Hg(l) + O_2(g) - 181.6$ kJ

Which one of the following statements is correct ?

(a) Both of them are exothermic

(b) Both of them are endothermic

(c) (i) is exothermic and (ii) is endothermic

(d) (i) is endothermic and (ii) is exothermic

113. A compound contains X, Y and Z atoms. The oxidation states of X, Y and Z are +2, +2 and −2 respectively. The possible formula of the compound is :

(a) XYZ_2

(b) $Y_2(XZ_3)_2$

(c) $X_3(Y_4Z)_2$

(d) $X_3(YZ_4)_3$

114. Pinacol is :

(a) 3-methylbutan-2-ol

(b) 2,3-dimethyl-2,3-butanediol

(c) 2,3-dimethyl-2-propanone

(d) none of the above

115. If the H^+ concentration is decreased from 1 M to 10^{-4} M at 25°C for the couple MnO_4^-/Mn^{2+}, then the oxidising power of the MnO_4^-/Mn^{2+} couple decreases by :

(a) −0.18 V (b) 0.18 V

(c) 0.38 V (d) −0.38 V

116. For a first order reaction with rate constant 'k' and initial concentration 'a', the half-life period is given by :

(a) $\frac{\ln 2}{k}$

(b) $\frac{1}{ka}$

(c) $\frac{3}{2ka^2}$

(d) none of the above

117. Aldol condensation will not take place in :

(a) HCHO

(b) CH_3CH_2CHO

(c) CH_3CHO

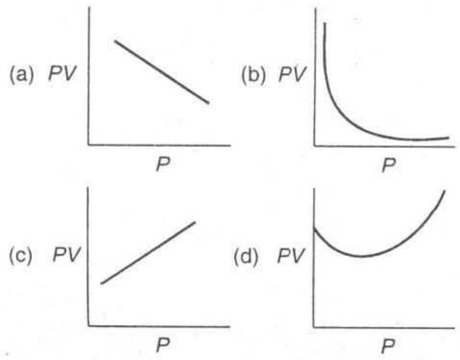
(d) CH_3COCH_3

118. Which of the following is called Berthelot's salt ?

(a) $(NaPO_3)_6$ (b) NaOCl

(c) $KClO_3$ (d) KHF_2

119. Which of the following is a Boyle plot at very low pressure?



120. Calgon used as water softner is :

(a) $Na_2[Na_4(PO_3)_6]$ (b) $Na_4[Na_2(PO_3)_6]$
(c) $Na_2[Na_4(PO_4)_5]$ (d) none of these

121. How many asymmetric carbon atoms are present in :

(i) 1,2-dimethylcyclohexane,
(ii) 3-methylcyclopentene and
(iii) 3-methylcyclohexene ?

(a) two, one, one (b) one, one one
(c) two, none, two (d) two, none, one

122. For which order half-life period is independent of initial concentration ?

(a) Zero (b) First
(c) Second (d) Third

123. In the reaction

$$CH_3CN + 2H \xrightarrow[SnCl_2]{HCl} X \xrightarrow{\text{boiling } H_2O} Y,$$

The term Y is :

(a) acetone (b) ethanamine
(c) acetaldehyde (d) dimethyl amine

124. The speices that undergoes disproportionation in an alkaline medium is :

(a) MnO_4^{2-} (b) ClO_4^-
(c) NO_2 (d) all of these

125. On shaking H_2O_2 with acidified potassium dichromate and ether, ethereal layer becomes :

(a) green (b) red
(c) blue (d) brown

English

Directions : Read the following passage carefully and answer the questions given below it.

PASSAGE

India is a country which has been subjected to foreign invasions since the dawn of Indian history. The fertile plains of India have been attracting avaricious tribals from all over the world. Long back the Aryans from Central Asia invaded India and settled down permanently in this beautiful land where food and fodder were available in plenty. After a chain of invasions from the bordering countries through land routes, the European nations, including the British, finally came to India to exploit her rich resources. The Englishmen came to India as traders but stealthily became her masters. India became the 'brightest Jewel' in the British diadem. They proclaimed to civilise her and started to exploit her. Neither the imperialist might, nor the treachery of some of her sons, nor the treachery of some of her sons, nor the nerve-racking exploitation could curb the indomitable urge for freedom of the people who bid defiance to time. They fought and fought heroically; they never submitted. Their struggle for independence is an inspiring and exhilarating story. It is a story not only of firm determination and will but also of sacrifice and suffering, a story of heroism and courage that happens in all revolutionaries.

126. Why did the Aryans settle permanently in India?

(a) Because here food and fodder were available in plenty
(b) Because they invaded India
(c) Because here food was available in plenty
(d) Because here fodder was available in plenty

127. British came to India:

(a) to exploit her rich resources
(b) to become her master
(c) to civilise her
(d) none of the above

128. The Indians indomitable urge for freedom could be curbed neither :
(a) by the nerve-racking exploitation of the British
(b) by the treachery of some of her sons
(c) by the imperialist might
(d) all of the above

Directions : *In the following questions, out of the four alternatives choose the one which is most opposite in meaning to the word given in capital letters.*

129. INGRATITUDE :
(a) Stimulation (b) Reward
(c) Sympathy (d) Thankfulness

130. GIGANTIC :
(a) Tiny (b) Narrow
(c) Vulgar (d) Attentive

131. COLOURLESS :
(a) Resolute (b) Steadfast
(c) Pleasant (d) Terrible

Directions : *Choose the word which is most nearly the same in meaning to the word given in capital letters.*

132. CONNOISSEUR :
(a) Lover of art (b) Interpreter
(c) Delinquent (d) Ignorant

133. LETHAL :
(a) Unlawful (b) Sluggish
(c) Deadly (d) Smooth

134. PICTURESQUE :
(a) Photogenic
(b) Ugly
(c) Simple
(d) Stimulating

Directions : *The following sentences have been divided into three parts (a), (b), (c). One of the parts may contain an error. Write down the part of the sentence that has an error. If there is No error., mark (d) as your answer.*

135. Whenever is the matter I shall (a) do this work because I have (b) to expose my working capacity at any cost. (c) No error (d)

136. She is so lazy as she cannot (a) do this work properly and (b) cannot cooperate us in your scheme. (c) No error (d)

Directions : *Each of the idioms or phrases is followed by four meanings out of which only one is correct. Pick out the correct meaning.*

137. A hard nut to crack :
(a) Difficult things require extra effort
(b) A difficult problem to solve
(c) A difficult problem solved effortlessly
(d) Costly things need careful handling

138. To beat about the bush :
(a) Not to come to the point
(b) Vigorous search for the culprit
(c) Easily achieved success without much effort
(d) Working hard to achieve the goal

Directions : *Choose the suitable preposition from the given alternatives to fill in the blanks in the following sentences.*

139. So many servants attended ...... him during his illness.
(a) with (b) on
(c) for (d) to

140. At last he yielded ...... the temptation.
(a) on (b) off
(c) for (d) to

Reasoning

141. Kilogram is related to Quintal in the same way as Paisa is related to :
(a) Rupee
(b) Coin
(c) Wealth
(d) Money

142. In the following question four groups of letters are given. Three of them are alike in a certain way while one is different. Select the one which is different.
(a) xXYA (b) ilMP
(c) hHIR (d) DBCE

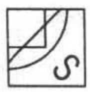
143. Select a figure from the four alternatives, which when placed in the blank space of fig. (x) would complete the pattern.

(x)

(a) 

(b) 

(c) 

(d) 

144. **Statement :** The data given by the U.S. Labour Ministry indicate that till the year 2000, there will be a shortage of 1,00,000 programmers. A spokesman from the industry said, "We should understand this thoroughly America needs Indian programmers. This is not only the question of investment but also of the talent with which the Indian programmers are equipped."

Conclusions :

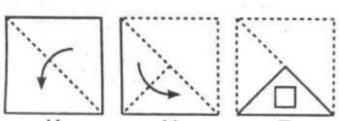
(a) In other sectors also, there will be shortage of the talented labour till the year 2000.

(b) Indian programmers are the most talented in the world.

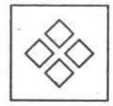
(c) Indian programmers are available on comparatively less salary in comparison to the programmers from other countries.

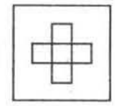
(d) Inspite of entering with huge capital in the Software Training Sector, U.S. could not be able to meet its own needs fully.

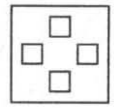
145. Consider the following three figures, marked *X, Y, Z* showing one fold in *X*, another in *Y* and cut in *Z*. From amongst the answer figures *A, B, C* and *D*, select the one, showing the unfolded position of *Z*.

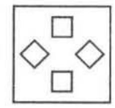


X Y Z

(a) 

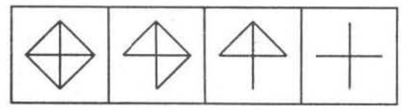
(b) 

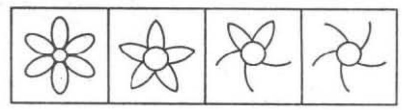
(c) 

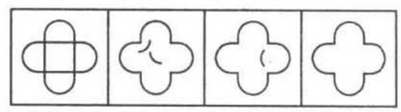
(d) 

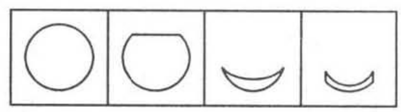
Direction : *In the following question, choose the set of figures which follows the given rule.*

146. Closed figure becomes more and more open.

(a) 

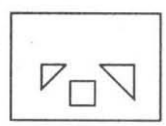
(b) 

(c) 

(d) 

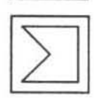
Direction : *In the following question, find out which of the figures (a), (b), (c) and (d) can be formed from the pieces given in (X).*

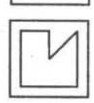
147.

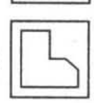


(X)

(a) 

(b) 

(c) 

(d) 

Directions : *Find the missing character from among the given alternatives.*

148.

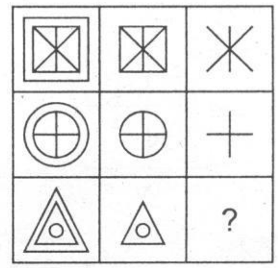
(a) 625 (b) 25
(c) 125 (d) 156

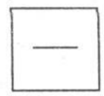
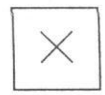
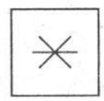
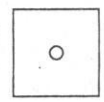
149. Find the wrong term in the letter-number series given below:

G4T, J10R, M20P, P43N, S90L

(a) G4T
(b) J10R
(c) M20P
(d) P43N

150. Select one alternative figure out of (a), (b), (c) and (d), which completes the given matrix.



(a) 
(b) 
(c) 
(d) 

ANSWERS

MATHEMATICS

1.	(c)	2.	(c)	3.	(c)	4.	(b)	5.	(d)	6.	(a)	7.	(a)	8.	(d)
9.	(b)	10.	(a)	11.	(a)	12.	(b)	13.	(a)	14.	(c)	15.	(c)	16.	(b)
17.	(b)	18.	(d)	19.	(b)	20.	(b)	21.	(a)	22.	(b)	23.	(c)	24.	(c)
25.	(d)	26.	(c)	27.	(b)	28.	(d)	29.	(a)	30.	(b)	31.	(a)	32.	(b)
33.	(a)	34.	(c)	35.	(d)	36.	(c)	37.	(d)	38.	(b)	39.	(d)	40.	(d)
41.	(a)	42.	(c)	43.	(c)	44.	(c)	45.	(d)						

PHYSICS

46.	(d)	47.	(b)	48.	(b)	49.	(a)	50.	(a)	51.	(a)	52.	(a)	53.	(a)
54.	(b)	55.	(a)	56.	(a)	57.	(d)	58.	(a)	59.	(c)	60.	(c)	61.	(d)
62.	(d)	63.	(a)	64.	(c)	65.	(b)	66.	(d)	67.	(a)	68.	(a)	69.	(b)
70.	(a)	71.	(a)	72.	(b)	73.	(b)	74.	(b)	75.	(c)	76.	(a)	77.	(a)
78.	(b)	79.	(d)	80.	(b)	81.	(a)	82.	(a)	83.	(a)	84.	(a)	85.	(a)

CHEMISTRY

86.	(a)	87.	(a)	88.	(d)	89.	(b)	90.	(a)	91.	(d)	92.	(b)	93.	(b)
94.	(a)	95.	(c)	96.	(b)	97.	(c)	98.	(a)	99.	(b)	100.	(b)	101.	(d)
102.	(b)	103.	(b)	104.	(a)	105.	(d)	106.	(c)	107.	(d)	108.	(b)	109.	(b)
110.	(b)	111.	(c)	112.	(d)	113.	(a)	114.	(b)	115.	(c)	116.	(a)	117.	(a)
118.	(c)	119.	(d)	120.	(a)	121.	(a)	122.	(b)	123.	(c)	124.	(c)	125.	(c)

ENGLISH

126.	(a)	127.	(a)	128.	(d)	129.	(d)	130.	(a)	131.	(c)	132.	(a)	133.	(c)
134.	(a)	135.	(a)	136.	(a)	137.	(b)	138.	(a)	139.	(d)	140.	(d)		

REASONING

141.	(a)	142.	(d)	143.	(d)	144.	(b)	145.	(c)	146.	(a)	147.	(a)	148.	(a)
149.	(b)	150.	(d)												

HINTS & SOLUTIONS

Mathematics

1. Since, $2^1 = 2, 2^2 = 4, 2^3 = 8, 2^4 = 16, 2^5 = 32$. It is clear that unit place is repeated after every four power.

Then, $2^{301} = (2^4)^{75} \cdot 2$
$= (16)^{75} \cdot 2$

$\therefore$ Digit at unit place in $(16)^{75}$ is 6.

$\therefore$ Digit at units place in 2^{301}
= digit at units place in $(6) \cdot 2$
= 2

Hence, the remainder, when 2^{301} is divided by 5, is 2.

2. Let
$$A = \begin{vmatrix} 1 & \omega & \omega^2 \\ \omega & \omega^2 & 1 \\ \omega^2 & 1 & \omega \end{vmatrix}$$
$$= \begin{vmatrix} 1+\omega+\omega^2 & \omega & \omega^2 \\ 1+\omega+\omega^2 & \omega^2 & 1 \\ 1+\omega+\omega^2 & 1 & \omega \end{vmatrix}$$
$C_1 \to C_1 + C_2 + C_3$
$$= \begin{vmatrix} 0 & \omega & \omega^2 \\ 0 & \omega^2 & 1 \\ 0 & 1 & \omega \end{vmatrix} \quad [\because 1 + \omega + \omega^2 = 0]$$
$= 0$

3. Given that
$$x^2 + 10x - 16y + 25 = 0$$
$\Rightarrow \quad (x+5)^2 = 16y$
$\Rightarrow \quad X^2 = 4AY$

where $X = x + 5, A = 4, Y = y$.

The ends of the latus rectum are
$(2A, A)$ and $(-2A, A)$

$\Rightarrow \quad x + 5 = 2(4)$
$\Rightarrow \quad x = -8 - 5 = 3, y = 4$
and $\quad x + 5 = -2(4)$
$\Rightarrow \quad x = -8 - 5 = -13, y = 4$
$\Rightarrow \quad (3, 4)$ and $(-13, 4)$.

4. Let the equation of hyperbola is
$$\frac{x^2}{a^2} - \frac{y^2}{b^2} = 1$$
Given, $e = 2, 2ae = 8$

$\Rightarrow \quad ae = 4 \Rightarrow a = 2$
Now, $\quad b^2 = a^2(e^2 - 1)$
$\Rightarrow \quad b^2 = 4(4 - 1)$
$\Rightarrow \quad b^2 = 12$

$\therefore$ Equation of hyperbola is
$$\frac{x^2}{4} - \frac{y^2}{12} = 1$$

5. $\sin^{-1} x - \sin^{-1} 2x = \pm \frac{\pi}{3}$

$\Rightarrow \quad \sin^{-1} x - \sin^{-1}\left(\pm \frac{\sqrt{3}}{2}\right) = \sin^{-1} 2x$

$\Rightarrow \sin^{-1}\left[x\sqrt{1 - \frac{3}{4}} - \left(\pm \frac{\sqrt{3}}{2}\sqrt{1 - x^2}\right)\right] = \sin^{-1} 2x$

$\Rightarrow \quad \frac{x}{2} - \left(\pm \frac{\sqrt{3}}{2}\sqrt{1 - x^2}\right) = 2x$

$\Rightarrow \quad -(\pm \sqrt{3}\sqrt{1 - x^2}) = 3x$

On squaring, both sides we get,

$$3(1-x^2)=9x^2$$

$$\Rightarrow \quad 1-x^2=3x^2$$

$$\Rightarrow \quad 4x^2=1$$

$$\Rightarrow \quad x=\pm\frac{1}{2}$$

6. We know,

$$\cos B=\frac{a^2+c^2-b^2}{2ac}$$

$$\therefore \quad \cos B=\frac{3^2+4^2-5^2}{2(3)(4)}=\frac{9+16-25}{2(3)(4)}=0$$

$$\Rightarrow \quad B=90^\circ$$

$$\therefore \quad \sin\frac{B}{2}+\cos\frac{B}{2}=\sin 45^\circ+\cos 45^\circ$$

$$=\frac{1}{\sqrt{2}}+\frac{1}{\sqrt{2}}=\sqrt{2}$$

7. By using the condition that, if two circles are intersect orthogonally, then

$$2(g_1g_2+f_1f_2)=c_1+c_2$$

where $g_1=-1,\ f_1=11,\ c_1=5$

and $g_2=7,\ f_2=3,\ c_2=k$

$$\Rightarrow \quad 2(-1\cdot 7+11\cdot 3)=5+k$$

$$\Rightarrow \quad 2(26)=5+k$$

$$\Rightarrow \quad k=47$$

8. Given equation is

$$x^2+y^2+4x+6y+13=0$$

or $(x^2+4x+4)+(y^2+6y+9)+13=4+9$

or $(x+2)^2\ (y+3)^2=0$

$\therefore$ Radius of circle $=0$.

9. Given parametric equations are

$$x=2+3\cos\theta,\ y=3\sin\theta-1$$

or $\cos\theta=\dfrac{x-2}{3},\ \sin\theta=\dfrac{y+1}{3}$

Since, $\sin^2\theta+\cos^2\theta=1$

$$\Rightarrow \quad \left(\frac{x-2}{3}\right)^2+\left(\frac{y+1}{3}\right)^2=1$$

$$\Rightarrow \quad (x-2)^2+(y+1)^2=3^2$$

$\therefore$ Centre of circle is $(2,-1)$.

10. We know, if P is any point on the curve, then Sum of focal distances = length of major axis

i.e., $SP+S'P=2a$

$=2(5)$ $\quad [\because a^2=5^2]$

$=10$

11. Since,

$$\begin{vmatrix} x & 2 & -1\\ 2 & 5 & x\\ -1 & 2 & x\end{vmatrix}=0$$

$$\Rightarrow \quad \begin{vmatrix} x & 2 & -1\\ 2 & 5 & x\\ -3 & -3 & 0\end{vmatrix}=0 \quad R_3\to R_3-R_2$$

$$\Rightarrow \quad -1(-6+15)-x[-3x+6]=0$$

$$\Rightarrow \quad -9+3x^2-6x=0$$

$$\Rightarrow \quad x^2-2x-3=0$$

$$\Rightarrow \quad (x-3)(x+1)=0$$

$$\Rightarrow \quad x=-1,\ 3$$

12. $A=\begin{bmatrix}3 & 5\\ 2 & 0\end{bmatrix}$ and $B=\begin{bmatrix}1 & 17\\ 0 & -10\end{bmatrix}$

$$\therefore \quad AB=\begin{bmatrix}3 & 5\\ 2 & 0\end{bmatrix}\begin{bmatrix}1 & 17\\ 0 & -10\end{bmatrix}$$

$$=\begin{bmatrix}3+0 & 51-50\\ 2+0 & 34-0\end{bmatrix}=\begin{bmatrix}3 & 1\\ 2 & 34\end{bmatrix}$$

$$\Rightarrow \quad |AB|=\begin{vmatrix}1 & 1\\ 2 & 34\end{vmatrix}$$

$$=102-2$$

$$=100$$

13. Let $A=\begin{bmatrix}5 & -2\\ 3 & 1\end{bmatrix}$

$$|A|=5+6=11$$

and $\quad \text{adj } A=\begin{bmatrix}1 & 2\\ -3 & 5\end{bmatrix}$

$$A^{-1}=\frac{1}{|A|}(\text{adj } A)$$

$$=\frac{1}{11}\begin{bmatrix}1 & 2\\ -3 & 5\end{bmatrix}$$

14. Let $\vec{\mathbf{a}}=2\hat{\mathbf{i}}+\hat{\mathbf{j}}-3\hat{\mathbf{k}}$ and $\vec{\mathbf{b}}=\hat{\mathbf{i}}-2\hat{\mathbf{j}}+\hat{\mathbf{k}}$

Projection of $\vec{\mathbf{a}}$ on $\vec{\mathbf{b}}=\dfrac{\vec{\mathbf{a}}\cdot\vec{\mathbf{b}}}{|\vec{\mathbf{b}}|}$

$$=\frac{(2\hat{\mathbf{i}}+\hat{\mathbf{j}}-3\hat{\mathbf{k}})\cdot(\hat{\mathbf{i}}-2\hat{\mathbf{j}}+\hat{\mathbf{k}})}{\sqrt{1^2+(-2)^2+1^2}}$$

$$=\frac{2-2-3}{\sqrt{6}}=-\frac{3}{\sqrt{6}}$$

$$=-\sqrt{\frac{3}{2}}$$

15.

$$12\cot^2\theta-31\operatorname{cosec}\theta+32=0$$

$$\Rightarrow \quad 12\cos^2\theta-31\sin\theta+32\sin^2\theta=0$$

$$\Rightarrow \quad 12(1-\sin^2\theta)-31\sin\theta+32\sin^2\theta=0$$

$$\Rightarrow \quad 20\sin^2\theta-31\sin\theta+12=0$$

This is a quadratic equation in $\sin\theta$.

$$\therefore \ \sin\theta = \frac{31 \pm \sqrt{31^2 - 4\cdot 20\cdot 12}}{2\cdot 20}$$

$$= \frac{31 \pm \sqrt{961 - 960}}{40} = \frac{31 \pm 1}{40}$$

$$\Rightarrow \quad \sin\theta = \frac{4}{5}, \frac{3}{4}$$

16. Let sides are $a = 13$, $b = 12$, $c = 5$

Now, $\quad a^2 = b^2 + c^2$

$$\Rightarrow \quad (13)^2 = (12)^2 + 5^2$$

$$\Rightarrow \quad 169 = 169$$

$$\Rightarrow \quad \angle A = 90^\circ$$

We know, $R = \dfrac{a}{2 \sin A}$

$$R = \frac{13}{2\cdot \sin 90^\circ} = \frac{13}{2}$$

17. Given that, $\quad \sin x - \cos x = \sqrt{2}$

$$\Rightarrow \quad \frac{1}{\sqrt{2}}\sin x - \frac{1}{\sqrt{2}}\cos x = 1$$

$$\Rightarrow \quad \sin 45^\circ \sin x - \cos 45^\circ \cos x = 1$$

$$\Rightarrow \quad \cos\left(x + \frac{\pi}{4}\right) = -1$$

$$\Rightarrow \quad \cos\left(x + \frac{\pi}{4}\right) = \cos(\pi)$$

$$\Rightarrow \quad x + \frac{\pi}{4} = 2n\pi + \pi$$

$$\Rightarrow \quad x = 2n\pi + \frac{3\pi}{4}$$

18. Let $\quad z = \dfrac{1 + i\sqrt{3}}{\sqrt{3} + i}$

$$= \frac{1 + i\sqrt{3}}{(\sqrt{3} + i)} \times \frac{(\sqrt{3} - i)}{(\sqrt{3} - i)}$$

$$= \frac{\sqrt{3} - i + 3i + \sqrt{3}}{3 + 1} = \frac{\sqrt{3} + i}{2}$$

$$\text{amp}(z) = \tan^{-1}\left(\frac{1}{\sqrt{3}}\right)$$

$$= \frac{\pi}{6}$$

19. Given that $\quad {}^nC_{12} = {}^nC_6$

or $\quad {}^nC_{n-12} = {}^nC_6$

$$\Rightarrow \quad n - 12 = 6$$

$$\Rightarrow \quad n = 18$$

$$\therefore \quad {}^nC_2 = {}^{18}C_2 = \frac{18 \times 17}{2 \times 1}$$

$$= 153$$

20. The general term in the expansion $\left(x - \dfrac{1}{x}\right)^{18}$ is given by

$$T_{r+1} = {}^{18}C_r (x)^{18-r}\left(-\frac{1}{x}\right)^r$$

Here, $\quad n = 18$

$\therefore$ The middle term is T_{9+1}, where $r = 9$

$$\therefore \quad T_{9+1} = {}^{18}C_9 (-1)^9 x^{18-2r}$$

$$= -{}^{18}C_9 x^{18-18} = -{}^{18}C_9$$

21. Since, α, β, γ are the roots of the equation

$$2x^3 - 3x^2 + 6x + 1 = 0,$$

then
$$\alpha + \beta + \gamma = \frac{3}{2} \qquad \dots\text{(i)}$$

$$\alpha\beta + \beta\gamma + \gamma\alpha = 3 \qquad \dots\text{(ii)}$$

$$\alpha\beta\gamma = -\frac{1}{2} \qquad \dots\text{(iii)}$$

On squaring Eq. (i), we get

$$\alpha^2 + \beta^2 + \gamma^2 + 2(\alpha\beta + \beta\gamma + \gamma\alpha) = \frac{9}{4}$$

$$\alpha^2 + \beta^2 + \gamma^2 = \frac{9}{4} - 2(3) \qquad \text{[from (ii)]}$$

$$= \frac{9}{4} - 6 = -\frac{15}{4}$$

22. Since, $\vec{a}$, $\vec{b}$ and $\vec{c}$ are mutually perpendicular to each other, then

$$\vec{a} - \vec{b} = \vec{b}\cdot\vec{c} = \vec{c}\cdot\vec{a} = 0$$

$$|\vec{a} + \vec{b} + \vec{c}|^2 = (\vec{a} + \vec{b} + \vec{c})\cdot(\vec{a} + \vec{b} + \vec{c})$$

$$[\because |\vec{a}|^2 = \vec{a}\cdot\vec{a}]$$

$$= |\vec{a}|^2 + |\vec{b}|^2 + |\vec{c}|^2 + 2(\vec{a}\cdot\vec{b} + \vec{b}\cdot\vec{c} + \vec{c}\cdot\vec{a})$$

$$= 1 + 1 + 1 + 2(0 + 0 + 0)$$

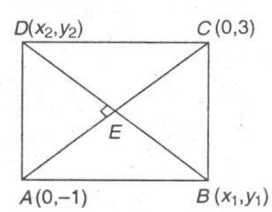
$$[\because \vec{a}\cdot\vec{b} = \vec{b}\cdot\vec{c} = \vec{c}\cdot\vec{a} = 0]$$

$$\Rightarrow \quad |\vec{a} + \vec{b} + \vec{c}|^2 = 3$$

$$\therefore \quad |\vec{a} + \vec{b} + \vec{c}| = \sqrt{3}$$

23. Let the points be $B(x_1, y_1)$ and $D(x_2, y_2)$ mid point of

$$BD = \left(\frac{x_1 + x_2}{2}, \frac{y_1 + y_2}{2}\right)$$



and mid point of $AC = (0, 1)$

We know, mid point of both the diagonal lie on the same point E.

$\Rightarrow \quad \frac{x_1+x_2}{2}=0$ and $\frac{y_1+y_2}{2}=1$

$\Rightarrow \quad x_1+x_2=0 \quad \ldots(i)$

and $\quad y_1+y_2=2 \quad \ldots(ii)$

Slope of BD × slope of $AC = -1$

$$\frac{(y_1-y_2)}{(x_1-x_2)} \times \frac{(3+1)}{(0-0)} = -1$$

$\Rightarrow \quad y_1-y_2=0 \quad \ldots(iii)$

Solving Eqs. (ii) and (iii), we get

$$y_1=1, y_2=1$$

Now, slope of AB × slope of $BC = -1$

$\Rightarrow \quad \frac{(y_1+1)}{(x_1-0)} \times \frac{(y_1-3)}{(x_1-0)} = -1$

$\Rightarrow \quad (y_1+1)(y_1-3) = -x_1^2$

$\Rightarrow \quad 2(-2) = -x_1^2 \quad [\because y_1 = 1]$

$\Rightarrow \quad x_1 = \pm 2$

$\therefore$ The required points are (2, 1) and (– 2, 1).

24. Let the points be A (3, – 4) and B (5, 2) and mid point of AB = (4, – 1).

It is given that the bisecting line intercept the co-ordinate axes in the ratio 2 : 1.

$\therefore$ Point of co-ordinate axes are $(2k, 0)$ and $(0, k)$. The equation of line passing through the above point is

$$y-0=\frac{k-0}{0-2k}(x-2k)$$

or $\quad y=-\frac{1}{2}(x-2k) \quad \ldots(i)$

Since, it is passing through the mid point of AB *i.e.*, (4, – 1)

$\Rightarrow \quad -1=-\frac{1}{2}(4-2k)$

$\Rightarrow \quad 2=4-2k$

$\Rightarrow \quad k=1$

Putting the value of k in Eq. (i), we get

$$y=-\frac{1}{2}(x-2)$$

$\Rightarrow \quad x+2y=2$

25. Given equation is

$$x^2+y^2+2xy-8ax-8ay-9a^2=0$$

or $\quad x^2+y^2+(-4a)^2+2xy-8ax-8ay-25a^2=0$

or $\quad (x+y-4a)^2-(5a)^2=0$

or $\quad (x+y-9a)(x+y+a)=0$

$\Rightarrow \quad x+y-9a=0$

or $\quad x+y+a=0$

These lines are parallel. Now, we find the distance from origin to the line.

Let, $p_1=\frac{0+0-9a}{\sqrt{1^2+1^2}}$, $p_2=\frac{0+0+a}{\sqrt{1^2+1^2}}$

$$p_1=-\frac{9a}{\sqrt{2}}, p_2=\frac{a}{\sqrt{2}}$$

The distance between two lines is

$$|p_2-p_1|=\left|\frac{a}{\sqrt{2}}+\frac{9a}{\sqrt{2}}\right|=\frac{10a}{\sqrt{2}}$$
$$=5\sqrt{2}a$$

26. Distance from centre (2, 1) to the line

$3x+4y-5$ = radius of circle

$\Rightarrow \quad \frac{|3(2)+4(1)-5|}{\sqrt{3^2+4^2}}=r$

$\Rightarrow \quad \frac{5}{5}=r$

$\Rightarrow \quad r=1$

$\therefore$ Equation of circle is

$$(x-2)^2+(y-1)^2=1^2$$

$\Rightarrow \quad x^2+y^2-4x-2y+4+1=1$

$\Rightarrow \quad x^2+y^2-4x-2y+4=0$

27. If $y=mx+c$ touches the circle $x^2+y^2=a^2$, then $c^2=a^2(1+m^2)$

Now, the line $y=2x+c$ touches the circle $x^2+y^2=16$, if

$\therefore \quad c^2=16(1+4)=16\times 5$

or $\quad c^2=80$

28. Let $I=\int \frac{2\sin x\cos x}{1+\cos^2 x}dx$

Put $\quad 1+\cos^2 x=t$

$\Rightarrow \quad -2\cos x\sin x\, dx=dt$

$\therefore \quad I=\int -\frac{dt}{t}=-\log t+c$

$$=-\log(1+\cos^2 x)+c$$

29. Let $I=\int e^x\left(\frac{1+\sin x}{1+\cos x}\right)dx$

$$=\int e^x \frac{\left(1+2\sin\frac{x}{2}\cos\frac{x}{2}\right)}{2\cos^2\frac{x}{2}}dx$$

$$=\int \frac{1}{2}e^x\sec^2\frac{x}{2}dx+\int e^x\tan\frac{x}{2}dx$$

$$=\frac{1}{2}\left[2e^x\tan\frac{x}{2}-\int 2e^x\tan\frac{x}{2}dx+\int e^x\tan\frac{x}{2}dx\right]$$

$$= e^x \tan \frac{x}{2} - \int e^x \tan \frac{x}{2}\, dx + \int e^x \tan \frac{x}{2}\, dx + c$$

$$= e^x \tan \frac{x}{2} + c$$

30. $\int_{\pi/4}^{\pi/2} \operatorname{cosec}^2 x\, dx = [-\cot x]_{\pi/4}^{\pi/2}$

$$= \left(-\cot \frac{\pi}{2} + \cot \frac{\pi}{4}\right)$$

$$= -[0 - (1)] = 1$$

31. Let $I = \int_0^{\pi/4} \log(1 + \tan x)\, dx \quad \ldots(i)$

$$\Rightarrow \quad I = \int_0^{\pi/4} \log\left[1 + \tan\left(\frac{\pi}{4} - x\right)\right] dx$$

$$\left[\because \int_0^a f(x)\, dx = \int_0^a f(a - x)\, dx\right]$$

$$= \int_0^{\pi/4} \log\left[1 + \frac{1 - \tan x}{1 + \tan x}\right] dx$$

$$= \int_0^{\pi/4} \log\left[\frac{2}{1 + \tan x}\right] dx$$

$$= \int_0^{\pi/4} \log 2\, dx - \int_0^{\pi/4} \log(1 + \tan x)\, dx$$

$$\Rightarrow \quad I = \log 2 [x]_0^{\pi/4} - I \quad \text{[from Eq. (i)]}$$

$$\Rightarrow \quad 2I = \frac{\pi}{4} \log_e 2$$

$$\Rightarrow \quad I = \frac{\pi}{8} \log_e 2$$

32. Let $z = \dfrac{1 + 2i}{1 - (1 - i)^2}$

$$= \frac{1 + 2i}{1 - (1^2 + i^2 - 2i)} = \frac{1 + 2i}{1 + 2i}$$

$$= 1$$

$\therefore \quad |z| = 1$ and amp $(z) = \tan^{-1}\left(\dfrac{0}{1}\right) = 0$

33. $\lim_{x \to 0} \dfrac{\tan x - \sin x}{x^3} \left(\dfrac{0}{0} \text{ form}\right)$

(using L'Hospital's rule)

$$= \lim_{x \to 0} \frac{\sec^2 x - \cos x}{3x^2} \quad \left(\frac{0}{0} \text{ form}\right)$$

(using L'Hospital's rule)

$$= \lim_{x \to 0} \frac{2\sec^2 x \tan x + \sin x}{6x} \quad \left(\frac{0}{0} \text{ form}\right)$$

$$= \lim_{x \to 0} \frac{\left[\begin{array}{l} 2(\sec^2 x \sec^2 x + 2\sec x \\ \quad \times \sec x \tan x \tan x) + \cos x \end{array}\right]}{6}$$

(using L'Hospital's rule)

$$= \frac{2[1 \cdot 1 + 2(0)] + 1}{6}$$

$$= \frac{3}{6} = \frac{1}{2}$$

34. $f(x) = \begin{cases} \dfrac{\sin 5x}{x^2 + 2x}, & x \neq 0 \\ k + \dfrac{1}{2}, & x = 0 \end{cases}$

$$\text{LHL } f(0^-) = \lim_{h \to 0} f(0 - h)$$

$$= \lim_{h \to 0} \frac{\sin 5(0 - h)}{(0 - h)^2 + 2(0 - h)}$$

$$= \lim_{h \to 0} \frac{\sin(-5h)}{h^2 - 2h}$$

$$= -\lim_{h \to 0} \frac{\frac{\sin 5h}{5h}}{\frac{1}{5}(h - 2)} = -\frac{1}{\frac{1}{5}(-2)}$$

$$= \frac{5}{2}$$

Since, it is continuous at $x = 0$

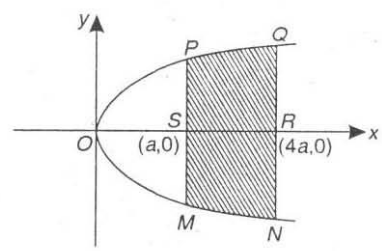
$\therefore \quad$ LHL $= f(0)$

$$\Rightarrow \quad \frac{5}{2} = k + \frac{1}{2}$$

$$\Rightarrow \quad k = 2$$

35. Required area

= area of curve PSMNRQP



= 2 area of curve PSRQP

$$= 2 \int_a^{4a} \sqrt{4ax}\, dx$$

$$= 4\sqrt{a} \left[\frac{x^{3/2}}{3/2}\right]_a^{4a} = \frac{8}{3}\sqrt{a}\,[(4a)^{3/2} - a^{3/2}]$$

$$= \frac{8}{3}\sqrt{a}\,(8a^{3/2} - a^{3/2}) = \frac{56}{3} a^2$$

36. $p(t) = 1000 + \dfrac{1000t}{100 + t^2} \quad \ldots(i)$

On differentiating both side w.r.t. t,

$$p'(t) = 0 + \frac{(100 + t^2)(1000) - 1000t\,(2t)}{(100 + t^2)^2}$$

$$= 1000 \frac{(100 - t^2)}{(100 + t^2)^2} \quad \ldots(ii)$$

Put $p'(t) = 0$ for maxima or minima

$$\Rightarrow \quad 100 - t^2 = 0$$

$$\Rightarrow \quad t = \pm 10$$

Now, again differentiating Eq. (ii), w.r.t. x

$$p''(t) = 1000 \times \left[\frac{(100+t^2)^2(-2t) - (100-t^2)2(100+t^2)2t}{(100+t^2)^4}\right]$$

$$= 1000\,t\,\frac{[(100+t^2)(-2) - (100-t^2)(4)]}{(100+t^2)^3}$$

$$= -1000\,t\,\frac{[600 - 2t^2]}{(100+t^2)^3}$$

At $\quad t = 10$

$$p''(t) < 0$$

$\therefore$ The maximum value is

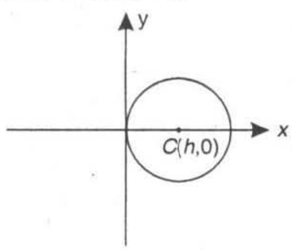
$$p(10) = 1000 + \frac{10000}{100+100}$$

$$= 1000 + \frac{10000}{200} = 1000 + 50$$

$$= 1050$$

37. Since, the circle touches the y-axis, therefore the centre lies on the x-axis. Let the centre be $(h, 0)$.

$\Rightarrow$ Radius of circle $= h$.



$\therefore$ The equation of circle is given by

$$(x-h)^2 + (y-0)^2 = h^2$$

$$\Rightarrow \quad x^2 + y^2 - 2hx = 0 \qquad \ldots\text{(i)}$$

On differentiating both sides w.r.t. x, we get

$$2x + 2y\frac{dy}{dx} - 2h = 0$$

$$\Rightarrow \quad h = x + y\frac{dy}{dx}$$

Putting the value of h in Eq. (i)

$$x^2 + y^2 - 2x\left(x + y\frac{dy}{dx}\right) = 0$$

$$\Rightarrow \quad -x^2 + y^2 - 2xy\frac{dy}{dx} = 0$$

$$\Rightarrow \quad x^2 - y^2 + 2xy\frac{dy}{dx} = 0$$

This is the required differential equation.

38. Given differential equation is

$$(2x - y + 1)\,dx + (2y - x + 1)\,dy = 0$$

$$\Rightarrow \quad 2x\,dx + 2y\,dy - (y\,dx + x\,dy) + dx + dy = 0$$

$$\Rightarrow \quad (2x\,dx + 2y\,dy) - d(xy) + dx + dy = 0$$

On integrating both sides, we get

$$x^2 + y^2 - xy + x + y = c$$

39. $y = \tan^{-1}\dfrac{\sqrt{1+x^2} - \sqrt{1-x^2}}{\sqrt{1+x^2} + \sqrt{1-x^2}}$

Put $x^2 = \cos 2\theta$

$$\therefore \quad y = \tan^{-1}\frac{\sqrt{1+\cos 2\theta} - \sqrt{1-\cos 2\theta}}{\sqrt{1+\cos 2\theta} + \sqrt{1-\cos 2\theta}}$$

$$= \tan^{-1}\frac{\cos\theta - \sin\theta}{\cos\theta + \sin\theta}$$

$$= \tan^{-1}\tan\left(\frac{\pi}{4} - \theta\right)$$

$$\Rightarrow \quad y = \frac{\pi}{4} - \theta = \frac{\pi}{4} - \frac{1}{2}\cos^{-1}x^2$$

On differentiating both sides, we get

$$\frac{dy}{dx} = 0 - \frac{1}{2}\left(-\frac{(2x)}{\sqrt{1-x^4}}\right)$$

$$= \frac{x}{\sqrt{1-x^4}}$$

40. Given that

$$x = \sin t,\ y = \cos pt$$

$$\frac{dx}{dt} = \cot t,\ \frac{dy}{dt} = -p\sin pt$$

$$\frac{dy}{dx} = -\frac{p\sin pt}{\cos t}$$

$$\Rightarrow \quad y_1 = \frac{-p\sqrt{1-y^2}}{\sqrt{1-x^2}}$$

$$\Rightarrow \quad y_1\sqrt{1-x^2} = -p\sqrt{1-y^2}$$

On squaring both sides, we get

$$y_1^2(1-x^2) = p^2(1-y^2)$$

Again differentiating

$$2y_1y_2(1-x^2) - 2xy_1^2 = -2yy_1p^2$$

$$\text{or} \quad (1-x^2)\,y_2 - x\,y_1 + p^2y = 0$$

41. Given that

$$x = a(\theta + \sin\theta) \quad \text{and} \quad y = a(1 - \cos\theta)$$

$$\Rightarrow \frac{dx}{d\theta} = a(1+\cos\theta) \quad \text{and} \quad \frac{dy}{d\theta} = a\sin\theta$$

$$\therefore \quad \frac{dy}{dx} = \frac{a\sin\theta}{a(1+\cos\theta)}$$

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

$$= \tan\frac{\theta}{2}$$

Now, length of subtangent $= \left|\frac{y}{dy/dx}\right|$

$$\therefore \quad ST = \frac{a(1-\cos\theta)}{\tan\frac{\theta}{2}}$$

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

$\Rightarrow$ Length of subtangent at $\theta = \frac{\pi}{2}$,

$$ST = a\sin\frac{\pi}{2} = a$$

And length of subnormal $= \left|y\frac{dy}{dx}\right|$

$$\Rightarrow \quad SN = a(1-\cos\theta)\tan\frac{\theta}{2}$$

$$= a2\sin^2\frac{\theta}{2}\tan\frac{\theta}{2}$$

$\Rightarrow$ Length of subnormal at

$$\theta = \frac{\pi}{2},\ SN = a\cdot 2\cdot\frac{1}{2} = a$$

Hence, $SN = ST$

42. Given equations are

$$x^2 + y^2 = 5 \quad \ldots\text{(i)}$$

and $$y^2 = 4x \quad \ldots\text{(ii)}$$

On solving Eqs. (i) and (ii), we get

$$x = -5, 1$$

at $x = -5$, $y^2 = -20$ (imaginary value)

$\therefore$ at $x = 1$, $y^2 = 4$

$$\Rightarrow \quad y = \pm 2$$

Hence, point of intersection are (1, 2) and (1, − 2).

On differentiating Eq. (i) w.r.t. x, we get

$$2x + 2y\frac{dy}{dx} = 0$$

$$\Rightarrow \quad \frac{dy}{dx} = -\frac{x}{y}$$

$$\therefore \quad m_1 = \left(\frac{dy}{dx}\right)_{(1,\,2)} = -\frac{1}{2}$$

And on differentiating Eq. (ii) w.r.t. x, we get

$$2y\frac{dy}{dx} = 4$$

$$\Rightarrow \quad \frac{dy}{dx} = \frac{2}{y},\ m_2 = \left(\frac{dy}{dx}\right)_{(1,\,2)} = \frac{2}{2} = 1$$

Now, $\tan\theta = \left|\frac{m_1 - m_2}{1 + m_1 m_2}\right|$

$$= \left|\frac{-\frac{1}{2} - 1}{1 - \frac{1}{2}}\right| = \left|\frac{-\frac{3}{2}}{\frac{1}{2}}\right| = 3$$

43. $U = \{x : x^5 - 6x^4 + 11x^3 - 6x^2 = 0\}$

$= \{0, 1, 2, 3\}$

$A = \{x : x^2 - 5x + 6 = 0\}$

$= \{2, 3\}$

and $B = \{x : x^2 - 3x + 2 = 0\}$

$= \{2, 1\}$

$A \cap B = \{2\}$

$\therefore (A \cap B)' = U - (A \cap B)$

$= \{0, 1, 2, 3\} - \{2\} = \{0, 1, 3\}$

44. R is not anti-symmetric.

45. $\because (1001)_2 = 1 \times 2^3 + 2^0 = 8 + 1 = 9$

$(11)_2 = 2^1 + 2^0 = 2 + 1 = 3$

$(101)_2 = 2^2 + 2^0 = 4 + 1 = 5$

$(10)_2 = 2^1 = 2$

and $(01)_2 = 1$

$$\therefore \frac{(1001)_2^{(11)_2} - (101)_2^{(11)_2}}{(1001)_2^{(10)_2} + (1001)_2^{(01)_2}\,(101)_2^{(01)_2} + (101)_2^{(10)}}$$

$$= \frac{9^3 - 5^3}{9^2 + 9 \times 5 + 5^2}$$

$$= \frac{(9-5)(9^2 + 9 \times 5 + 5^2)}{(9^2 + 9 \times 5 + 5^2)}$$

$$= 9 - 5 = 4 = (100)_2$$

Physics

46. Angle turned by the body

$$\theta = \theta_0 + \theta_1 t + \theta_2 t^2$$

Angular velocity

$$\omega = \frac{d\theta}{dt}$$

$$= \frac{d}{dt}(\theta_0 + \theta_1 t + \theta_2 t^2)$$

$$= \theta_1 + 2\theta_2 t$$

Angular acceleration

$$\alpha = \frac{d\omega}{dt} = \frac{d}{dt}(\theta_1 + 2\theta_2 t) = 2\theta_2$$

48. Acceleration of the body down the rough inclined plane = $g \sin\theta$

$\therefore$ Force applied on spring balance

$$= m g \sin\theta = 5 \times 10 \times \sin 30° = 5 \times 10 \times \frac{1}{2} = 25 \text{ N}$$

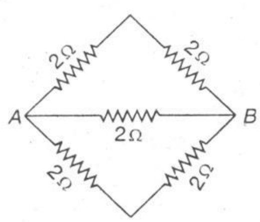
49. Work done $W = \int_0^x F \cdot dx$

$$= \int_0^x Cx\, dx = C\left(\frac{x^2}{2}\right)_0^x = \frac{1}{2}Cx^2$$

50. $\vec{\mathbf{A}} \cdot \vec{\mathbf{B}} = \vec{\mathbf{A}} \times \vec{\mathbf{B}}$

$$AB\cos\theta = A\,B\sin\theta$$
$$\tan\theta = 1$$
$$\tan\theta = \tan 45°$$
$$\theta = 45°$$

51. Given circuit is a balanced Wheatstone bridge. So, diagonal resistance of 2Ω will be ineffective.



Equivalent resistance of upper arms

$$= 2 + 2 = 4\,\Omega$$

Equivalent resistance of lower arms

$$= 2 + 2 = 4\,\Omega$$

$$\therefore \quad R_{AB} = \frac{4 \times 4}{4 + 4} = 2\Omega$$

52. $X = [\mathrm{M}^a \mathrm{L}^b \mathrm{T}^c]$

Maximum % error in X

$$= a\,\alpha + b\,\beta + c\,\gamma$$

53. Induced emf $e = 2$ V

$$i_1 = 8\ A,\ i_2 = 6\ \text{A}$$

$$\Delta t = 2 \times 10^{-3}\ \text{s}$$

Coefficient of self induction

$$L = \frac{e}{\Delta i / \Delta t} = \frac{-2}{(6-8)/2 \times 10^{-3}} = \frac{-2 \times 2 \times 10^{-3}}{-2} = 2 \times 10^{-3}\ \text{H}$$

54. Potential at the centre of a hollow metallic sphere

$$V = \frac{1}{4\pi\varepsilon_0}\frac{Q}{R}$$

56. Refractive index of prism

$$\mu = \frac{\sin\frac{A + \delta_m}{2}}{\sin\frac{A}{2}} = \frac{\sin\frac{60° + 30°}{2}}{\sin\frac{60°}{2}} = \frac{\sin 45°}{\sin 30°} = \frac{1/\sqrt{2}}{1/2} = \frac{1}{\sqrt{2}} \times \frac{2}{1} = \sqrt{2}$$

58. Current given by cell

$$I = \frac{E}{R + r}$$

Power delivered in first case

$$P_1 = I^2 R_1 = \left(\frac{E}{R_1 + r}\right)^2 R_1$$

Power delivered in second case

$$P_2 = I^2 R_2 = \left(\frac{E}{R_2 + r}\right)^2 R_2$$

Power delivered is same in the both the cases.

$$\left(\frac{E}{R_1 + r}\right)^2 R_1 = \left(\frac{E}{R_2 + r}\right)^2 R_2$$

$$\frac{R_1}{(R_1 + r)^2} = \frac{R_2}{(R_2 + r)^2}$$

$$R_1(R_2^2 + r^2 + 2R_2 r) = R_2(R_1^2 + r^2 + 2R_1 r)$$

$$R_1 R_2^2 + R_1 r^2 + 2R_1 R_2 r = R_2 R_1^2 + R_2 r^2 + 2R_1 R_2 r$$

$$R_1 R_2^2 - R_2 R_1^2 = R_2 r^2 - R_1 r^2$$

$$R_1 R_2 (R_2 - R_1) = r^2 (R_2 - R_1)$$

$$r = \sqrt{R_1 R_2}$$

60. At the top most point of the projectile there is only horizontal component of velocity and acceleration due to gravity is vertically downward, so velocity and acceleration are perpendicular to each other.

61. $u = -20$ cm, $f = 20$ cm

From mirror formula,

$$\frac{1}{f} = \frac{1}{v} + \frac{1}{u}$$

$$\frac{1}{20} = \frac{1}{v} + \frac{1}{-20}$$

$$\frac{1}{v} = \frac{1}{20} + \frac{1}{20}$$

$$\frac{1}{v} = \frac{2}{20} \Rightarrow v = 10 \text{ cm}$$

62. According to law of conseration of angular momentum, if there is no torque on the system, then the angular momentum remains constant.

63. Equivalent focal length

$$\frac{1}{F} = \frac{1}{f_1} + \frac{1}{f_2}$$

$$= \frac{1}{20} + \frac{1}{30}$$

$$\therefore \quad F = \frac{20 \times 30}{20 + 30}$$

$$= \frac{600}{50} = 12 \text{ cm}$$

64. For isothermal process

$$PV = K \qquad \text{(constant)}$$

$$P = \frac{K}{V} \qquad \ldots(1)$$

$$= \frac{K}{V/2} = 2K$$

For adiabatic process

$$PV^{\gamma} = K \qquad \text{(constant)}$$

$$\therefore \quad P = \frac{K}{V^{\gamma}} \qquad \ldots(2)$$

$$= \frac{K}{(V/2)^{\gamma}} = K(2^{\gamma})$$

From Eqs. (1) and (2), we have

$$P_2 > P_1$$

65. According to Newton's law of cooling, $t_1 < t_2$.

66. The lift is moving with constant velocity so, there will be no change in the acceleration hence time period will remain same.

67.

$$x_1 = 2 \sin \omega t$$

$$x_2 = 4 \sin (\omega t + 90°)$$

The phase difference between the two waves is 90°.

So, resultant amplitude

$$a = \sqrt{(3)^2 + (4)^2}$$

$$= \sqrt{9 + 16} = \sqrt{25}$$

$$= 5 \text{ unit}$$

68. $B = 0.5$ T

$A_1 = 101 \text{ cm}^2 = 101 \times 10^{-4} \text{ m}^2$

$A_2 = 100 \text{ cm}^2 = 100 \times 10^{-4} \text{ m}^2$

$R = 2\Omega$

Amount of charge

$$q = \frac{B\Delta A}{R}$$

$$= \frac{0.50 \times (101 \times 10^{-4} - 100 \times 10^{-4})}{2}$$

$$= \frac{0.05 \times 1 \times 10^{-4}}{2}$$

$$= 2.5 \times 10^{-6} \text{ C}$$

70. Amplification factor $\mu = 20$

Plate resistance $R_p = 10 \; k\,\Omega$

$= 10 \times 10^3 \; \Omega$

$\therefore$ Mutual conductance

$$g_m = \frac{\mu}{R_p}$$

$$= \frac{20}{10 \times 10^3} = 2 \times 10^{-3} \text{ mho}$$

$$= 2 \text{ milli mho}$$

75. For wavelength

$$\frac{1}{\lambda} = R Z^2 \left(\frac{1}{n_1^2} - \frac{1}{n_2^2}\right)$$

Here, transition is same

So, $$\lambda \propto \frac{1}{Z^2}$$

$$\frac{\lambda_H}{\lambda_{Li}} = \frac{(Z_{Li})^2}{(Z_H)^2} = \frac{(3)^1}{(1)^2} = 9$$

$$\lambda_{Li} = \frac{\lambda_H}{9} = \frac{\lambda}{9}$$

76. $m = 1000$ kg

$$\frac{\Delta m}{\Delta t} = 4 \text{ kg/s}, \; v = 3000 \text{ m/s}$$

Thrust on the rocket

$$F = -v \frac{\Delta m}{\Delta t}$$

$$= -3000 \times 4$$

$$= -12000 \text{ N}$$

(Negative sign indicates that thrust applied in a direction opposite to the direction of escaping gas)

79. The direction of magnetic field is along the direction of motion of the charge particles, so angle will be 0°.

$\therefore$ Force $F = qvB \sin\theta$

$= qvB \sin 0$

$= 0 \qquad (\because \sin 0 = 0)$

So, there will be no change in the velocity.

81. Mass defect

Δm = Total mass of α-particles – mass of ^{12}C nucleus

$= 3 \times 4.002603 - 12$

$= 12.007809 - 12$

$= 0.007809$ unit

82. $\frac{N_p}{N_s} = \frac{1}{10}$

$V_p = 230$ V, $I_s = 2$ A,

$$\frac{I_p}{I_s} = \frac{N_s}{N_p}$$

$$\frac{I_p}{2} = \frac{10}{1}$$

$\Rightarrow \qquad I_p = 20$ A

83. Equation of wave

$$y = 2\sin(kx - 2t)$$

Comparing with standard equation

$$y = A\sin(kx - \omega t)$$

$$A = 2, \omega = 2$$

$\therefore$ Maximum particle velocity

$$v_{max} = A\omega = 2 \times 2$$

$$= 4 \text{ unit}$$

85. $N = N_0 \left(\frac{1}{2}\right)^n$

$$\frac{N_0}{16} = N_0 \left(\frac{1}{2}\right)^2$$

$$\left(\frac{1}{2}\right)^4 = \left(\frac{1}{2}\right)^n$$

$\therefore \qquad n = 4$

$$\frac{T}{T_{1/2}} = 4$$

$\Rightarrow \qquad \frac{1}{T_{1/2}} = 4$

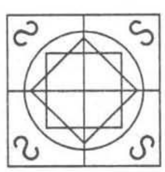
$\Rightarrow \qquad T_{1/2} = \frac{1}{4}\text{ h} = 15 \text{ min}$

Reasoning

141. Second is a bigger unit than the first, though both are used to measure the same quantity.

142. Except (d) all other groups contain only small letter.

143. Clearly. Fig. (d) will complete the pattern when placed in the blank space of fig. (x) as shown below.



In the following question, a statement group of statements is given followed by same conclusion choose the conclusion which logically follows from the given statement.

145. In fig. X, the upper triangular half of the paper has been folded over the lower half.

In fig. Y, the paper is refolded to a quarter triangle.

In fig. Z, a square has been punched in the folded paper.

Clearly, the square will appear in each of the trianglular quarters of the paper.

Thus, when the paper is unfolded, four squares will appear symmetrically over it and it will resemble fig. (C).

148. Clearly, $(3+2)^2 = 25$;

$(15+6)^2 = (21)^2 = 441$;

$(10+7)^2 = (17)^2 = 289$.

So, missing number $= (12+13)^2 = (25)^2 = 625$

149. The first letter of each term is moved three steps forward and the last letter is moved two sleps backward to obtain the corresponding letters of the next term. The numbers follows the sequence. $\times 2 + 1, * 2 + 2, \times 2 + 3, \times 2 + 4$.

So 10 is wrong and must be replaced by $(4 \times 2 + 1)$ *i.e.*, 9.

150. Clearly, in the first and second rows, the second figure is the inner part of the first figure and the third figure is the inner part of the second figure.

Thus, the missing figure should be the inner part of the second figure in third row, *i.e.*, a small circle.

BITSAT ENTRANCE EXAM

SOLVED PAPER 2007

1) The sum of 24 terms of the following series $\overline{2}+\overline{8}+\overline{18}+\overline{32}+\ldots\ldots\ldots\ldots..$ is

(a) 300

(b) 200 $\overline{2}$

(c) 300 $\overline{2}$

(d) 250 $\overline{2}$

2) If sin A + cos B = a and sin B + cos A = b, then sin (A + B) is equal to

(a) $\frac{a^2+b^2}{2}$

(b) $\frac{a^2-b^2+2}{2}$

(c) $\frac{a^2+b^2-2}{2}$

(d) None of these

3) The number of solution of the equation $1+\sin x\, sin^2\,\frac{x}{2}=0,\quad -\pi,\pi$ is -

(a) zero

(b) one

(c) two

(d) three

4) If C = 2 cos θ, then the value of the determinant to

$$\Delta = \begin{vmatrix} C & 1 & 0 \\ 1 & C & 1 \\ 6 & 1 & C \end{vmatrix} \text{ is}$$

(a) $\frac{2\,sin^2\ 2\theta}{\sin\theta}$

(b) $8\ cos^3\ \theta - 4\ \cos\theta + 6$

(c) $\frac{2\sin\ 2\ \theta}{\sin\theta}$

(d) $8\ cos^3\ \theta + 4\ \cos\theta + 6$

5) If A = $\begin{bmatrix} 2 & -1 \\ -1 & 2 \end{bmatrix}$ and I is the unit matrix of order 2, then A^2 equals

(a) 4A - 3I

(b) 3A - 4I

(c) A - I

(d) A + I

6) The horizontal distance between two towers is 60 m and the angle of depression of the top of the first tower as seen from the top of the second is 30°. If the height of the second tower be 150 m, then the height of the first tower is

(a) 90m

(b) $(150 - 60\sqrt{3})$ m

(c) $(150 + 20\sqrt{3})$ m

(d) None of these

7) If a vertex of a triangle is (1, 1) and the mid points of two sides

through the vertex are (-1, 2) and (3, 2), then the centroid of the triangle is

(a) $1, \frac{7}{3}$

(b) $\frac{1}{3}, \frac{7}{3}$

(c) $-\frac{1}{3}, \frac{7}{3}$

(d) $-1, \frac{7}{3}$

8) Let R = {(1, 3), (4, 2), (2, 4), (2, 3), (3, 1)} be a relation on the set A = {1, 2, 3, 4}. The relation R is

(a) A function

(b) Transitive

(c) Not symmetric

(d) Reflexive

9) $(x - 1)(x^2 - 5x + 7) < (x - 1)$, then x belongs to

(a) $(1, 2) \cup (3, \infty)$

(b) $(-\infty, 1) \cup (2, 3)$

(c) $(2, 3)$

(d) none of these

10) Let A be an orthogonal non-singular matrix of order n, then the determinant of matrix 'A $-I_n$' ie, $|A - I_n|$ is equal to

(a) $I_n - A$

(b) $A \quad I_n - A$

(c) A

(d) $-1\ ^{n}\ \mathrm{A}\ \ \mathrm{I_n} - \mathrm{A}$

11) If $\cos\theta + i\sin\theta \quad \cos 2\theta + i\sin 2\theta$ ....

$\cos n\theta \ + \ i\sin n\theta \ = 1$, then the value of θ is

(a) $\frac{2m\pi}{n\ n+1}$

(b) $4m\pi$

(c) $\frac{4m\pi}{n\ \ n+1}$

(d) $\frac{m\pi}{n\ \ n+1}$

12) If one root of the quadratic equation $ax^2 + bx + c = 0$ is equal to nth power of the other root, then the value of $ac^n\ ^{\frac{1}{n+1}} + \ a^n c\ ^{\frac{1}{n+1}}$ is equal to

(a) b

(b) -b

(c) $\frac{1}{b^{n+1}}$

(d) $-b^{n+1}$

13) In how many ways can 5 boys and 5 girls sit in a circle so that no two boys sit together?

(a) 5! × 5!

(b) 4! × 5!

(c) $\frac{5! \times 5!}{2}$

(d) None of these

14) The probability that the same number appear on throwing three dice simultaneously, is

(a) 1/36

(b) 5/36

(c) 1/6

(d) 4/13

15) The length of the common chord of the ellipse

$\frac{(x+1)^2}{9}+\frac{(y-2)^2}{4}=1$ and the circle

$(x-1)^2+(y-2)^2=1$ is

(a) 0

(b) $\sqrt{3}$

(c) 4

(d) 5

16) For hyperbola $\frac{x^2}{cos^2 a}-\frac{y^2}{sin^2 a}=1$ which of the following remains constant with change in 'a.'?

(a) Abscissae of vertices

(b) Abscissae of foci

(c) Eccentricity

(d) Directrix

17) Area of the region satisfying $x \leq 2$, $y \leq |x|$ and $x \geq O$ is

(a) 4 sq unit

(b) 1 sq unit

(c) 2 sq unit

(d) None of these

18) The solution of the differential equation $\frac{dy}{dx} + \frac{2yx}{1+x^2} = \frac{1}{(1+x^2)^2}$ is

(a) $y(1 + x^2) = c + \tan^{-1} x$

(b) $\frac{y}{1+x^2} = c + tan^{-1}x$

(c) $y \log(1 + x^2) = c + \tan^{-1} x$

(d) $y(1 + x^2) = c + \sin^{-1} x$

19) Number of solutions of $y = e^x$ and $y = \sin x$ is

(a) 0

(b) 1

(c) 2

(d) infinite

20) If f $f(x) = \begin{cases} \frac{1-\cos x}{x} & , x \neq 0 \\ x & , x = 0 \end{cases}$ is continuous at x = 0, then the value of k is

(a) 0

(b) $\frac{1}{2}$

(c) $\frac{1}{4}$

(d) $-\frac{1}{2}$

21) In Δ ABC, $(a-b)^2 \cos^2 \frac{C}{2} + (a+b)^2 \sin^2 \frac{C}{2}$ *is equal to*

(a) a^2

(b) b^2

(c) c^2

(d) None of these

22) $\int \frac{1+tan^2 x}{1-tan^2 x}\ dx$ *is equal to*

(a) log $\frac{1-\tan x}{1+\tan x}$ + c

(b) $\log \frac{1+\tan x}{1-\tan x} + c$

(c) $\frac{1}{2} \log \frac{1-\tan x}{1+\tan x} + c$

(d) $\frac{1}{2}\log \frac{1+\tan x}{1-\tan x} + c$

23) $\int_0^8 \ x - 5 \ dx$ is equal to

(a) 17

(b) 9

(c) 12

(d) 18

24) If $I_1 = \int_0^1 2^{x^2} dx,\ I_2 = \int_0^1 2^{x^3}\ dx,\ I_3 = \int_1^2 2^{x^2}\ dx\ \ and\ I_4 = \int_1^2 2^{x^3}$dx, then

(a) $I_3 > I_4$

(b) $I_3 = I_4$

(c) $I_1 > I_2$

(d) $I_2 > I_1$

25) Distance between the pair of lines represented by the equation

$x^2 - 6xy + 9y^2 + 3x - 9y - 4 = 0$ is

(a) $\frac{15}{\overline{10}}$

(b) $\frac{1}{2}$

(c) $\frac{\overline{5}}{2}$

(d) $\frac{1}{\overline{10}}$

26) Centre of circle whose normals are

$x^2 - 2xy - 3x + 6y = 0$, is

(a) $3, \frac{3}{2}$

(b) $3, -\frac{3}{2}$

(c) $\frac{3}{2}, 3$

(d) None of these

27) A coin is tossed n times. The probability of getting head at least once is greater than 0.8, then the least value of n is

(a) 2

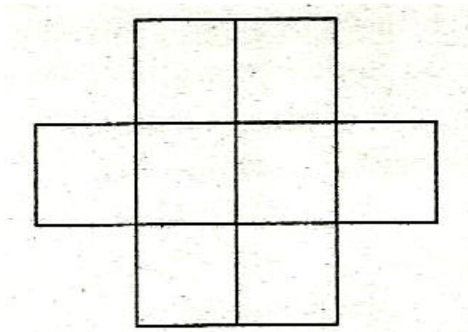
(b) 3

(c) 5

(d) 4

28) Six Xs have to be placed in the square of the figure such that

each row contains at least one 'X'. In how many different ways can this be done?



(a) 27

(b) 28

(c) 26

(d) 35

29) For all complex numbers z_1, z_2 satisfying $|z_1| = 12$ and $| z_2 - 3 - 4|1 = 5$, the minimum value of $| z_1 - z_2|$ is

(a) 4

(b) 3

(c) 1

(d) 2

30) If $a = \log_2 3$, $b = \log_2 5$, $C = \log_7 2$, then $\log_{140} 63$ in terms of a, b, c is

(a) $\frac{2ac+1}{2c+abc+1}$

(b) $\frac{2ac+1}{2a+c+a}$

(c) $\frac{2ac+1}{2c+ab+a}$

(d) None of these

31) $49^n + 16n - 1$ is divisible by

(a) 3

(b) 29

(c) 19

(d) 64

32) The solution set of the equation $\sin^{-1} x = 2 \tan^{-1} x$ is

(a) {1, 2}

(b) {-1, 2}

(c) {-1, 1, 0}

(d) $1, \frac{1}{2}, 0$

33) The sum to n terms of the infinite series $1 \cdot 3^2 + 2 \cdot 5^2 + 3 \cdot 7^2 + \ldots \infty$ is

(a) $\frac{n}{6}(n + 1)(6n^2 + 14n + 7)$

(b) $\frac{n}{6}(n + 1)(2n + 1)(3n + 1)$

(c) $4n^3 + 4n^2 + n$

(d) None of the above

34) The minimum value of $2x + 3y$, when $xy = 6$, is

(a) 9

(b) 12

(c) 8

(d) 6

35) The derivative of $\sin^{-1}\frac{2x}{1+x^2}$ with respect to $cos^{-1}\frac{1-x^2}{1+x^2}$ is

(a) -1

(b) 1

(c) 2

(d) 4

36) The equation of the sides of a triangle are x – 3y = 0, 4x + 3y = 5 and 3x + y = 0. The line 3x - 4y = 0 passes through

(a) the incentre

(b) the centroid

(c) the orthocentre

(d) the circumcentre

37) The centres of a set of circles, each of radius 3, lie on the circle $x^2 + y^2 = 25$. The locus of any point in the set is

(a) $4 \leq x^2 + y^2 \leq 64$

(b) $x^2 + y^2 \leq 25$

(c) $x^2 + y^2 \geq 25$

(d) $3 \leq x^2 + y^2 \leq 9$

38) If $\sin^{-1} x + \sin^{-1} y = \frac{\pi}{2}$, then $\frac{dy}{dx}$ is equal to

(a) $\frac{x}{y}$

(b) $-\frac{x}{y}$

(c) $\frac{y}{x}$

(d) $-\frac{y}{x}$

39) If $\lim_{x\to\infty} \frac{x^3+1}{x^2+1} - \quad ax+b \quad = 2, then$

(a) a = 1 and b = 1

(b) a = 1 and b = -1

(c) a = 1 and b = -2

(d) a = 1 and b = 2

40) The unit vector which is orthogonal to the vector

$3\imath$ + $2\jmath$ + 6 k and is coplanar with the vectors $2\imath$ + $\jmath$ + k and $\imath$ - $\jmath$ + k is

(a) $\frac{2\,\imath+6\jmath+k}{\overline{41}}$

(b) $\frac{2\imath-3\jmath}{\overline{13}}$

(c) $\frac{3\jmath-k}{\overline{10}}$

(d) $\frac{4\,\imath+3\,\jmath-3k}{\overline{34}}$

41) Let a, b and c be three non-coplanar vectors and let p, q and r be vectors defined by the relations

$p = \frac{b\times C}{abc},\ q = \frac{c\times a}{ab\ c}\ and\ r = \frac{a\times b}{abc}$

Then the value of the expression

$(a + b).\ p + (b + c).\ q + (c + a).\ r$ is equal to

(a) 0

(b) 1

(c) 2

(d) 3

42) The points (5, - 4, 2), (4, - 3, 1), (7 - 6, 4) and (8, - 7, 5) are the vertices of

(a) a rectangle

(b) a square

(c) a parallelogram

(d) None of these

43) Let A = [-1, 1] and f: A $\rightarrow$ A be defined as f (x) = x | x | for all x $\in$ A, then f(x) is

(a) many-one into function

(b) one-one into function

(c) many-one onto function

(d) one-one onto function

44) The radius of a cylinder is increasing at the rate of 3 m/s and its altitude is decreasing at the rate of 4 m/s. The rate of change of volume when radius is 4 m/s. The rate of change of volume when radius is 4m and altitude is 6m, is

(a) 80 π cu m/s

(b) 144 π cu m/s

(c) 80 cu m/s

(d) 64 cu m/s

45) Equation of the parabola with its vertex at (1, 1) and focus (3, 1) is

(a) $(x - 1)^2 = 8(y - 1)$

(b) $(y - 1)^2 = 8(x - 3)$

(c) $(y - 1)^2 = 8(x - 1)$

(d) $(x - 3)^2 = 8(y - 1)$

Physics

46) In the relation $P = \frac{\alpha}{\beta} e^{-\frac{\alpha z}{k\theta}}$, p is the pressure, z the distance, k is Boltzmann constant and θ is the temperature, the dimensional formula of β will be –

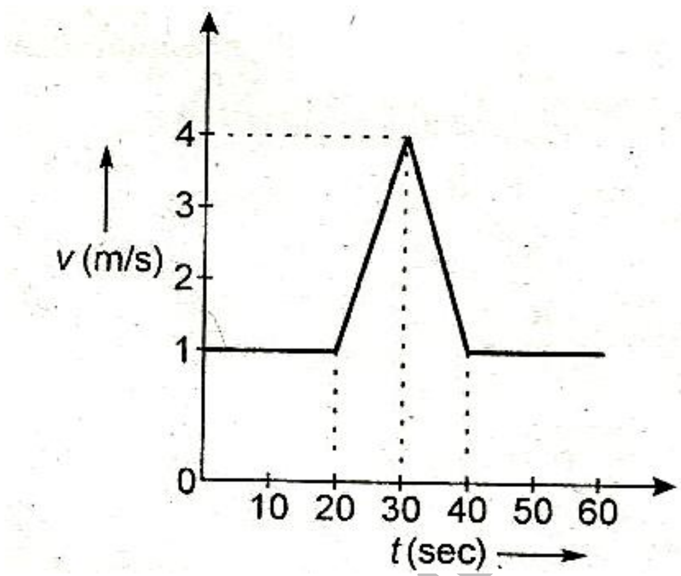
(a) $M^0L^2T^0$

(b) $ML^2\ T$

(c) ML^0T^{-1}

(d) $ML^2 T^{-1}$

47) Velocity time (v - t) graph r a moving object is shown in the figure. Total displacement of the object during the time interval when there is non-zero acceleration and retardation is –



(a) 60 m

(b) 50 m

(c) 30 m

(d) 40 m

48) Three weights w, 2w and 3w are connected to identical spring suspended from a rigid horizontal rod. The assembly of the rod and the weights fall freely. The positions of the weight from the rod are such that

(a) 3w will be farthest

(b) w will be farthest

(c) All will be at the same distance

(d) 2w will be farthest

49) At the top of the trajectory of a projectile, the direction of its velocity and acceleration are

(a) Perpendicular to each other

(b) Parallel to each other

(c) Inclined to each other at an angle of 45°

(d) Antiparallel to each other

50) Consider the following statement. When jumping from some height, you should bend your knees as you come to rest instead of keeping your legs stiff. Which of the following relations can be useful in explaining the statement?

(a) $\Delta p_1 = -\Delta p_2$

(b) $\Delta E = -\Delta\ PE + KE\ = 0$

(c) $F\ \Delta t = m\ \Delta F$

(d) $\Delta\ x \propto \Delta F$

where symbols have their usual meaning.

51) A ball is released from the top of a tower. The ratio of work done by force of gravity in first, second and third second of the motion of the ball is

(a) 1: 2: 3

(b) 1: 4: 9

(c) 1: 3: 5

(d) 1: 5: 3

52) 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 is 1: 8. The value of n is

(a) 2

(b) $2\ \overline{2}$

(c) 4

(d) $\frac{1}{2}$

53) There are two planets. The ratio of radius of the two planets is K but ratio of acceleration due to gravity of both planets is g. What will be the ratio of their escape velocity?

(a) $(Kg)^{1/2}$

(b) $(Kg)^{-1/2}$

(c) $(Kg)^{2}$

(d) $(Kg)^{-2}$

54) The extension in a string obeying Hooke's law v is x. The speed of sound in the stretched string is v. If the extension in the string is increased to 1.5 x, the speed of sound will be

(a) 1.22 v

(b) 0.61 v

(c) 1.50 v

(d) 0.75 v

55) A ball whose density is 0.4×10^3 kg/m^3 falls into water from a height of 9 cm. To what depth does the ball sink?

(a) 9 cm

(b) 6 cm

(c) 4.5 cm

(d) 2.25 cm

56) A thermodynamical system is changed from state (P_1, V_1) to (P_2, V_2) by two different processes, the quantity which will remain same will be

(a) ΔQ

(b) ΔW

(c) $\Delta Q + \Delta W$

(d) $\Delta Q - \Delta W$

57) The relative humidity on a day when partial pressure of water vapour is 0.012×10^5 Pa at 12°C is (Take vapour pressure of water at this temperature as 0.016×10^5 Pa)

(a) 70%

(b) 40%

(c) 75%

(d) 25%

58) In the absence of intermolecular forces of attraction, the observed pressure P will be

(a) P

(b) < P

(c) > P

(d) Zero

59) Ina second pendulum, mass of bob is 30 g. If it is replaced by 90 g mass, then its time period will be

(a) 1 s

(b) 2 s

(c) 4s

(d) 3s

60) A wave has velocity v in medium P and velocity 2v in medium Q. If the wave is incident in medium P at an angle of 30°, then the angle of refraction will be

(a) 30°

(b) 45°

(c) 60°

(d) 90°

61) The equation of progressive wave is $y = 0.2 \sin 2\pi \ \frac{t}{0.01} - \frac{x}{0.3}$, where x and y are in metre and t is in second. The velocity of propagation of the wave is

(a) 30 m/s

(b) 40 m/s

(c) 300 m/s

(d) 400 m/s

62) The displacement of a charge Q in the electric field

$E = e_1 \imath + e_2 \jmath + e_3 k$ is $r = a\imath + b\jmath$. The work done is

(a) $Q(ae_1 + be_2)$

(b) $Q\sqrt{ae_1{}^2 + be_2{}^2}$

(c) $Q(e_1 + e_2)\sqrt{a^2 + b^2}$

(d) $Q\sqrt{e_1^2 + e_2^2}\ \ a + b$

63) An electric line of force in the xy plane is given by equation $x^2 + y^2 = 1$. A particle with unit positive charge, initially at rest at the point $x = 1$, $y = 0$ in the xy plane

(a) not move at all

(b) will move along straight line

(c) will move along the circular line of force

(d) information is insufficient to draw any conclusion

64) If a rod has resistance 40 and if rod is turned as half circle, then the resistance along diameter is

(a) 1.56 Ω

(b) 2.44 Ω

(c) 4 Ω

(d) 2 Ω

65) The relation between voltage sensitivity (σ_V) and current sensitivity (σ_1) of a moving coil galvanometer is (resistance of galvanometer is G).

(a) $\frac{a_i}{G} = \sigma_v$

(b) $\frac{\sigma_v}{G} = \sigma_i$

(c) $\frac{G}{\sigma_v} = \sigma_i$

(d) $\frac{G}{\sigma_i} = \sigma_v$

66) A current carrying small loop behaves like a small magnet. If A be its area and M its magnetic moment, the current in the loop will be

(a) W/A

(b) A/M

(c) MA

(d) AM^2

67) A magnet of magnetic moment 20 CGS units is freely suspended in a uniform magnetic field of intensity 0.3 CGS units. The amount of work done in deflecting it by an angle of 30° in CGS units is

(a) 6

(b) 3 $\overline{3}$

(c) 3(2 - $\overline{3}$)

(d) 3

68) An inductor of 2 H and a resistance of 100 are connected in series with a battery of 5 V. The initial rate of change of current is

(a) 0.5 A/s

(b) 2.0 A/s

(c) 2.5 A/s

(d) 0.25 A/s

69) When radiation is incident on a photoelectron emitter, the stopping potential is found to be 9V. If elm for the electron is 1.8×10^{11} C kg^{-1}, the maximum velocity of the ejected electron is

(a) 6×10^{5} ms^{-1}

(b) 8×10^{5} ms^{-1}

(c) 1.8×10^{6} ms^{-1}

(d) 1.8×10^{5} ms^{-1}

70) A and B are two radioactive substances whose half-lives are 1 and 2 years respectively. Initially 10 g of A and, 1 g of B is taken. The time (approximate) after which they will have same quantity remaining is

(a) 6.62 year

(b) 5 year

(c) 3.2 year

(d) 7 year

71) The optical path of a monochromatic light is same if it goes through 4.0 cm of glass of 4.5 cm of water. If the refractive index of glass is 1.53, the refractive index of the water is

(a) 1.30

(b) 1.36

(c) 1.42

(d) 1.46

72) The length, breadth and thickness of a block are given by l = 12 cm, b = 6 cm, and t = 2.45 cm. The volume of the block according to the idea of significant figure should be

(a) 1×10^2 cm^3

(b) 2×10^2 cm^3

(c) 1.763×10^2 cm^3

(d) None of these

73) 10000 small balls, each weighing 1g strike one square centimetre of area per second with a velocity 100 m/s in a normal direction and rebound with the same velocity. The value of pressure on the surface will be

(a) 2×10^3 N/m^2

(b) 2×10^5 N/m^2

(c) 10^7 N/m^2

(d) 2×10^7 N/m^2

74) Two springs have their force constant as k_1 and k_2 ($k_1 > k_2$). when they are stretched by the same force

(a) no work is done in case of both the springs

(b) equal work is done in case of both the springs

(c) more work is done in case of second spring

(d) more work is done in case of first spring

75) A mass m is moving with a constant velocity along a line parallel to x-axis. Its angular momentum with respect to origin on z-axis is

(a) Zero

(b) Remains constant

(c) Goes on increasing

(d) Goes on decreasing

76) At a given place where acceleration due to gravity is 'g' m/s^2, a sphere of lead of density 'd' kg/m^3 is gently released in a column of liquid of density 'ρ' kg/m^3. If $d > \rho$, the sphere will

(a) fall vertically with an acceleration 'g' m/s^2

(b) fall vertically with no acceleration

(c) fall vertically with an acceleration g $\frac{d-p}{d}$

(d) fall vertically with an acceleration g $\frac{\rho}{d}$

77) Amplitude of a wave is represented by

$A = \frac{c}{a+b-c}$

Then resonance will occur when

(a) b = -c/2

(b) b = 0 and a = c

(c) b = - a/2

(d) None of these

78) Capacitance of a capacitor made by a thin metal foil is 2μF. If the foil is folded with paper of thickness 0.15 mm, dielectric constant of paper is 2.5 and width of paper is 400 mm, the length of foil will be

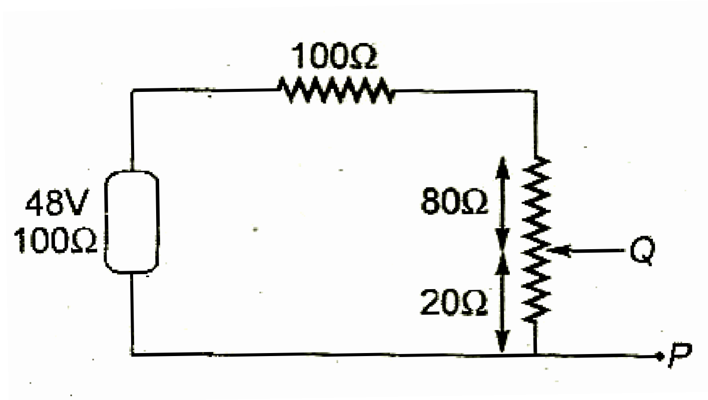
(a) 0.34 m

(b) 1.33 m

(c) 13.4 m

(d) 33.9 m

79) In the circuit, the potential difference across PQ will be nearest to



(a) 9.6 V

(b) 6.6.V

(c) 4.8 V

(d) 3.2 V

80) A rod of a certain metal is 1.0 m long and 0.6 cm in diameter. Its resistance is 3.0×10^{-3} ohm.

Another disc made of the same metal is 2.0 cm in diameter and 1.0 mm thick. What is the resistance between the round faces of the disc?

(a) $1.35 \times 10^{-8}\ \Omega$

(b) $2.70 \times 10^{-7}\ \Omega$

(c) $4.05 \times 10^{-6}\ \Omega$

(d) $8.10 \times 10^{-5}\ \Omega$

81) The cyclotron frequency of an electron grating in a magnetic field

of 1 T is approximately

(a) 28 MHZ

(b) 280 MHZ

(c) 2.8 GHZ

(d) 28 GHZ

82) The transformation ratio in the step-up transformer is

(a) 1

(b) Greater than one

(c) less than one

(d) the ratio greater or less than one depends on the other factors

83) Radiations of intensity 0.5 W/m^2 are striking a metal plate. The pressure on the plate is

(a) 0.166×10^{-8} N/m^2

(b) 0.332×10^{-8} N/m^2

(c) 0.111×10^{-8} N/m^2

(d) 0.083×10^{-8} N/m^2

84) If n represents the order of a half period zone the area of this zone is approximately proportional to n" where m is equal to

(a) zero

(b) half

(c) one

(d) two

85) Monochromatic light of wavelength 3000 Å is incident on a surface area 4 cm 2. If intensity of light is 150 mW/m^2, then rate at which photons strike the target is

(a) 3×10^{10} /sec

(b) 9×10^{13} / sec

(c) 7×10^{15} /sec

(d) 6×10^{19}/sec

Chemistry

86) The ratio of Fe_2O_3 and Al, in thermite is

(a) 1 : 3

(b) 1: 2

(c) 3: 1

(d) None of these

87) A solid has a structural in which 'W' atom are located at the corners of a cubic lattice 'O' atom at the centre of edge and Na atoms at the centre of cube. The formula for the compound is

(a) $Na_2 WO_3$

(b) Na_2WO_2

(c) $NaWO_2$

(d) $Na WO_3$

88) Which one of the following substances is used in the laboratory for a fast drying of neutral gases?

(a) Phosphorous pentoxide

(b) Active charcol

(c) Anhydrous calcium chloride

(d) Na_3PO_4

89) H_2O_2 used in rocket has the concentration

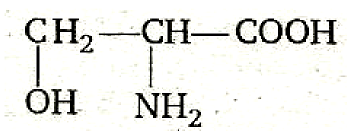
(a) 50%

(b) 70%

(c) 30%

(d) 90%

90) The IUPAC name of the compound,



(a) 2-Amino-3-hydroxy propanoic acid

(b) 1-Hydroxy-2-amino propan-3-oic acid

(c) 1-Amino-2-hydroxypropanoic acid

(d) 3-Hydroxy-2-amino propanoic acid

91) The compound which gives the most stable carbonium ion on dehydration is

(a) $CH_3CH(CH_3)CH_2OH$

(b) $(CH_3)_3$ COH

(c) $CH_2 = CHCH_2CH_2OH$

(d) $CH_3CHOHCH_2\text{-}CH_3$

92) The ionic conductance is least for

(a) Cs^+

(b) Rb^+

(c) K^+

(d) Na^+

93) Setting of plaster of Peris involves

(a) Oxidation with atmospheric oxygen

(b) Combination with atmospheric CO_2

(c) Dehydration

(d) hydration to yield another hydrate

94) A solution of sucrose (Molar mass = 342g/mol) is prepared by dissolving 68.4 g of it per litre of solution, what is its osmotic pressure (R = 0.082 L atom K^{-1} mol^{-1}) at 273 K?

(a) 3.92 atm

(b) 4.48 atm

(c) 5.92 atm

(d) 29.4 atm

95) A 27°C one mole of an ideal gas is compressed isothermally and reversible from a pressure of 2 atm to 10 atm. The value of till and q are (R = 2 cal)

(a) 0, - 965.84 cal

(b) - 965.84 cal, - 865.58 cal

(c) + 865.58 cal, - 865.58 cal

(d) + 965.84 cal, + 865.58 cal

96) For a reaction equilibrium, $N_2O_4(g) \rightleftharpoons 2NO_2\ (g)$, the concentrations of N_2O_4 and NO_2 at equilibrium are 4.8×10^{-2} and 1.2×10^{-2} mol/L respectively. The value of k, for the reaction is:

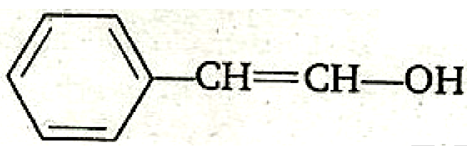
(a) 3×10^{-3} mol/L

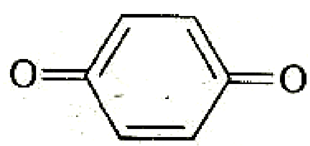
(b) 3.3×10^{-3} mol/L

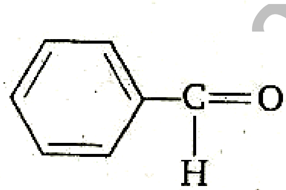
(c) 3×10^{-1} mol/L

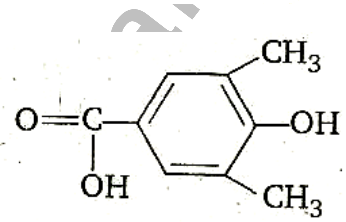
(d) 3.3×10^{-1} mol/L

97) Tautomerism is exhibited by

(a) 

(b) 

(c) 

(d) 

98)

$$CH_3-C\equiv C-CH_3 \xrightarrow[\text{(ii) } Zn/H_2O]{\text{(i) } x} CH_3-\underset{\substack{\| \\ O}}{C}-\underset{\substack{\| \\ O}}{C}-CH_3$$ In the above reaction x is.

(a) HNO_3

(b) O_2

(c) O_3

(d) $KMnO_4$

99)

$$C_7H_8 \xrightarrow{3Cl_2,\ \text{Heat}} A \xrightarrow{Fe\ /\ Br_2} B \xrightarrow{Zn/HCl} C$$

Here, the compound C is

(a) 3-Bromo 2, 4, = 6-trichlorotoluene

(b) O- bromo toluene

(c) P - bromo toluene

(d) m - bromo toluene

100) Alizarin belongs to the class of

(a) Vat dyes

(b) Mordant dyes

(c) Basic dyes

(d) Reactive dyes

101) 2,4-Dichlorophenoxyacetic add is used as

(a) Fungicide

(b) Insecticide

(c) Herbicide

(d) Moth repellant

102) Which glass has the highest percentage of lead?

(a) Soda glass

(b) Flint glass

(c) Jena glass

(d) Pyrex glass

103) Which one of the following pentafluoride cannot be formed?

(a) PF_5

(b) AsF_5

(c) SbF_5

(d) BiF_5

104) Which out of the following compounds is called photogropher's fixer?

(a) Na_2SO_3

(b) $Na_2S_2O_3 \cdot 5H_2O$

(c) Na_2SO_4

(d) Na_2S

105) The isoelectronic pair is

(a) Cl_2O, ICl^-_2

(b) Cl_2, ClO_2

(c) IF^+_2, I_3^-

(d) ClO_2, ClF_2^+

106) When radioactive minerals like clevelte, monazite and pitchblende are heated to 1273 K in vacuo the noble gas obtained is

(a) Rn

(b) Kr

(c) He

(d) Ne

107) Conjugate base of H_2PO_4 is

(a) H_3PO_4

(b) P_2O_5

(c) PO_4^{3-}

(d) HPO_4^{2-}

108) Given standard electrode potentials

$Fe^{2}: + 2e^- \rightarrow Fe \quad E° = -0.440\ V$

$Fe^{3+} + 3e^- \rightarrow Fe \quad E° = -0.036\ V$

The standard electrode potential (E°) for

$Fe^{3+} + e^- \rightarrow Fe^{2+}$ is:

(a) + 0.772 V

(b) - 0.772 V

(c) + 0.417 V

(d) - 0.414 V

109) For the reaction

$$N_2 + 3H_2 \rightleftharpoons 2NH_3$$

The rate of change of concentration for hydrogen is

$0.3 \times 10^{-4}\ Ms^{-1}$

The rate of change of concentration of ammonia is:

(a) -0.2×10^{-4}

(b) 0.2×10^{-4}

(c) 0.1×10^{-4}

(d) 0.3×10^{-4}

110) The root mean square velocity of a gas is double when temperature is

(a) increased four times

(b) increased two times

(c) reduced to half

(d) reduced to one-fourth

111) The specific conductivity of 0.1 N KCI solution is 0.0129 ohm^{-1} cm^{-1}. The resistance of the solution in the cell is 100 n. The cell constant of the cell will be

(a) 1.10

(b) 1.29

(c) 0.56

(d) 2.80

112) Which of the most volatile compounds?

(a) HI

(b) HCl

(c) HBr

(d) HF

113) Which of the following transition metal ions will have definite value of magnetic moment?

(a) Sc^{3+}

(b) Ti^{3+}

(c) Cu^{+}

(d) Zn^{2+}

114) Cr has electronic configuration as

(a) $3s^2\ 3p^6\ 3d^4\ 4s^1$

(b) $3s^2\ 3p^6\ 3d^5\ 4s^1$

(c) $3s^2\ 3p^6\ 3d^6$

(d) None of these

115) Which of the following compound is expected to be coloured?

(a) Ag_2SO_4

(b) CuF_2

(c) MgF_2

(d) CuCl

116) The effective atomic number of Cr (at no = 24) in $[Cr(NH_3)_6]Cl_3$ is

(a) 35

(b) 27

(c) 33

(d) 36

117) In Nessler's reagent for the detection of ammonia the active species is

(a) Hg_2Cl_2

(b) Mg^{2+}

(c) Hg_2I_2

(d) HgI_4^{2-}

118) Which of the following ketones will not respond to iodoform test?

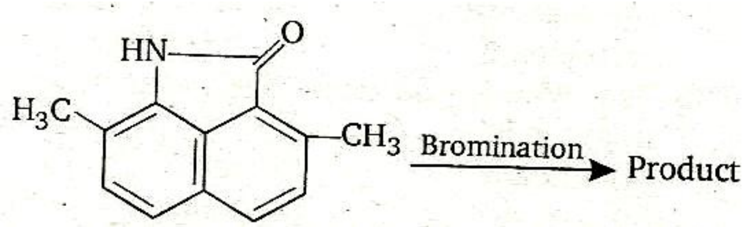
(a) Methyl isopropyl ketone

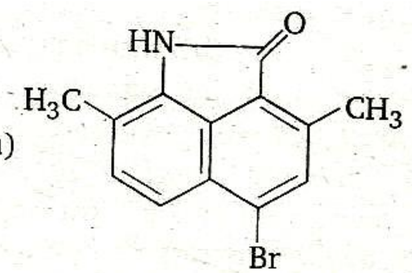
(b) Ethyl isopropyl ketone

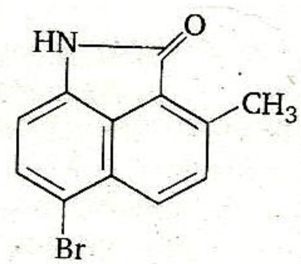
(c) Dimethyl ketone

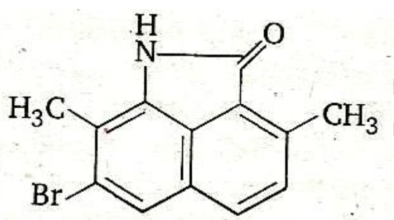
(d) 2-hexanone

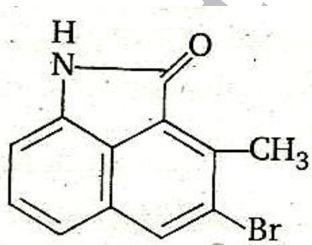
119)



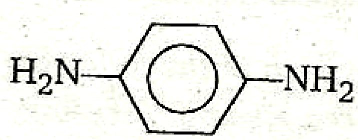
(a) 

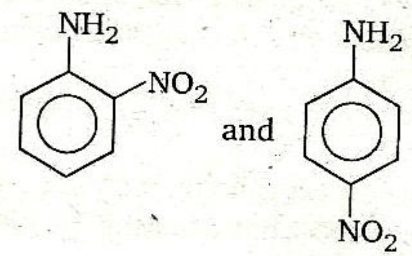
(b) 

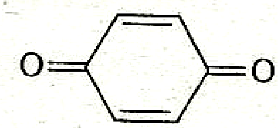
(c) 

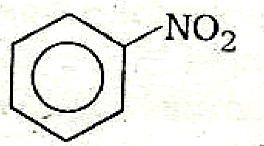
(d) 

120) Aniline reacts with cone HNO_3 to give

(a) 

(b) 

(c) 

(d) 

121) Bakelite is a product of the reaction between

(a) formaldehyde and NaOH

(b) aniline and Urea

(c) phenol and Methanal

(d) phenol and Chloroform

122) Cellulose is a polymer of

(a) glucose

(b) fructose

(c) ribose

(d) sucrose

123) Iodine value related to

(a) fats and oils

(b) alcohols

(c) Esters

(d) hydrocarbon

124) In aqueous solution, amino acids mostly exit as

(a) NH_2 – CHR - COOH

(b) NH_2 – CHR - COO^-

(c) NH_3 – CHR - COOH

(d) H_3N^-CHR - COO

125) Gibb's free energy G, enthalpy H and entropy S are interrelated as in

(a) G = H + TS

(b) G = H - TS

(c) G – TS = H

(d) G = S = H

English

Directions: In each of the following questions, a sentence has been given in Active/Passive voice. Out of the four alternatives, select the one which best expresses the same sentence in Passive/Active voice.

126) People claim to have seen the suspect in several cities

(a) The suspect is being seen in several cities

(b) The suspect has been the people in several cities

(c) The suspect is claimed to have been seen in several cities

(d) The suspect was seen by people in several cities

127) The teacher punished the boys who had not done their homework.

(a) The boys who had not done their homework had been punished by their teacher

(b) The boys were punished by their teacher who had not done their homework

(c) The boys who had not done their homework were punished by the teacher

(d) The boys who had not done their homework were being punished by the teacher

Directions: In each of the following questions, choose the alternative which best expresses the meaning of the idiom/phrase given in italics in the sentence.

128) The prices are going up by leaps and bounds.

(a) systematically

(b) irregularly

(c) gradually

(d) rapidly

129) He bids fair to be an excellent cricketer.

(a) seems likely

(b) is ambitious

(c) is confident

(d) is unlikely

130) To find real happiness in the world is a wild goose chase –

(a) ideal seeking

(b) hunting

(c) futile search

(d) real aim

Directions: In each of the following questions, choose the alternative which can best improve the given sentence by substituting the italicised portion. If the sentence is correct as it is, your answer is (d).

131) The monograph which was published 3 years ago, would suggest that by 2001 there will be 73 million TV sets in India.

(a) has been suggesting

(b) had suggested

(c) would have suggested

(d) no improvement

132) Vishal, who studies medicine at present, hopes to go abroad after graduation.

(a) has been studying

(b) is studying

(c) will study

(d) no improvement

133) The greatest thing in style is to have a use of metaphor.

(a) command

(b) knowledge

(c) need

(d) no improvement

Directions: In each of the following questions, choose the best alternative to fill in the blank.

134) Mr. Shyam Lal. has gone to his native village with the ..... of starting an adult school.

(a) suggestion

(b) presumption

(c) opinion

(d) intention

135) The twins are so alike that I cannot.. .... one from the other.

(a) discern

(b) tell

(c) say

(d) notice

136) We must ……………… to authority.

(a) bend

(b) surrender

(c) subdue

(d) submit

Directions: In each of the following questions, choose the alternative 'which is closest to the opposite in meaning of the italicised word.

137) The doctor advised us to give him wholesome nutrition.

(a) sickly

(b) stupendous

(c) depressing

(d) fragmentary

138) He is good fellow; but what I dislike is his reckless handling of things.

(a) intelligent

(b) cautious

(c) soft

(d) brilliant

Directions: In each of the following questions, choose the alternative which best expresses the meaning of the italiciSed word.

139) The one who is rich possesses many superfluous things.

(a) needless

(b) superior

(c) essential

(d) expensive

140) Many of his acquaintances avoid him because he is so garrulous.

(a) proud

(b) unreasonable

(c) talkative

(d) quarrelsome

141) 'Cell' is related to 'Tissue' in the same way as Tissue' is related to :

(a) object

(b) organ

(c) limb

(d) None of these

142) In the following question, which pair of numbers is different from the other three.

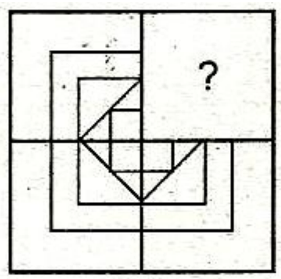
(a) 488

(b) 929

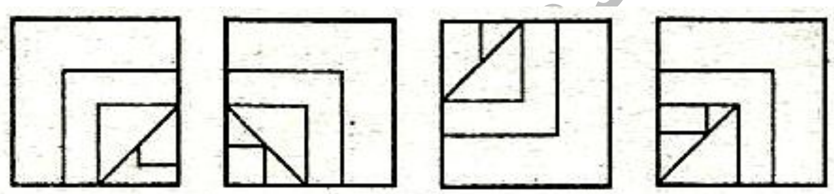
(c) 776

(d) 667

143) Identify the missing part of the figure and select it from the given alternatives.



(x)



Direction: In the following question, a statement is given followed by some conclusions. Choose the conclusion which logically follows from the given statement.

144) **Statement:** Soldiers serve their country.

Conclusions:

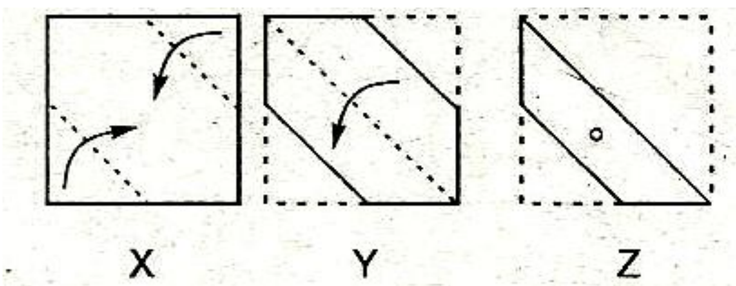
(a) men generally serve their country

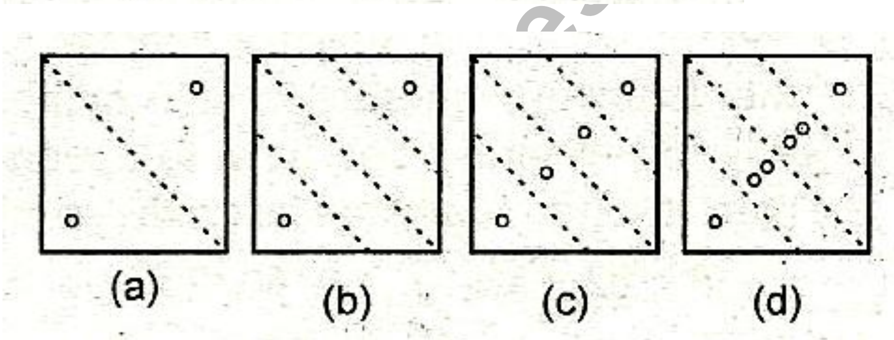
(b) These who serve their country are soldiers

(c) Some men who are soldiers serve their country

(d) Women do not serve their country because they are not soldiers.

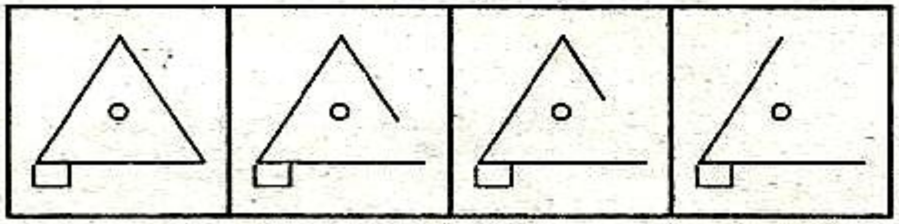
145) In the following question, a set of three figures X, Y and Z showing a sequence in which a paper is folded and finally cut from a particular section. Below these figures a set of answer figures marked (a, b, c and d) showing the design which the paper actually acquires when it is unfolded. You have to select the answer figure which most closely resembles the unfolded piece of paper.

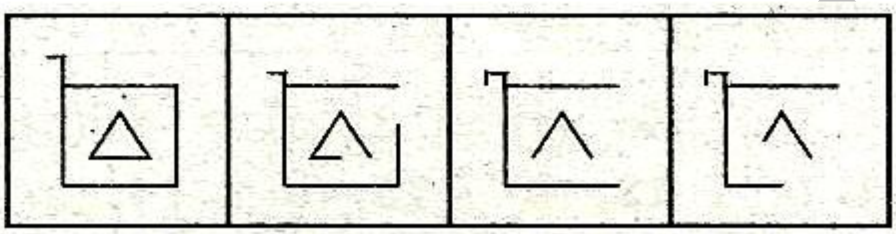


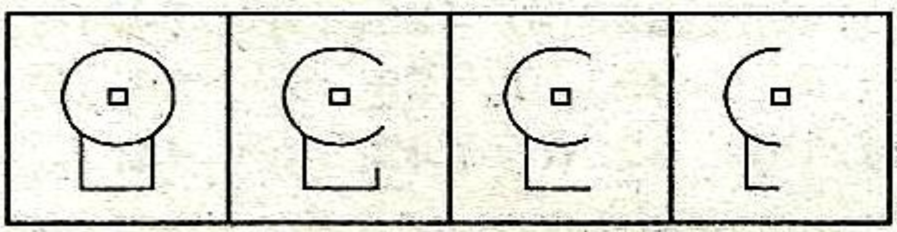


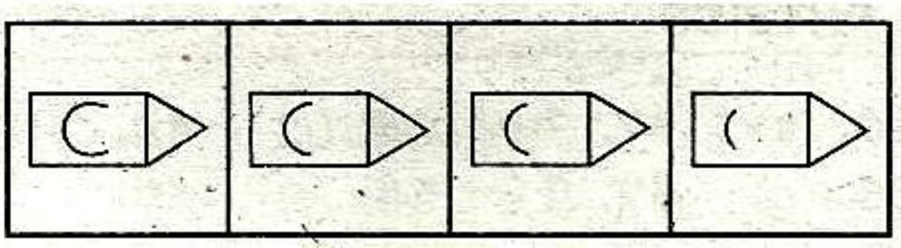
Direction: In the following question, choose the set of figures which follows the given rule.

146) **Rule:** Closed figures become more and more open and open figures become more and more closed.

(a) 

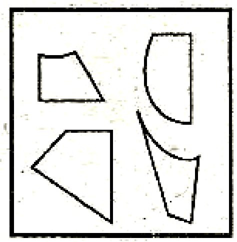
(b) 

(c) 

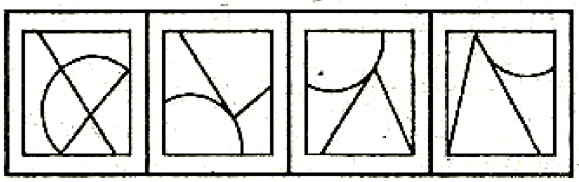
(d) 

Direction: In the following question, find out which of the figures (a), (b), (c) and (d) can be formed from the pieces given in (x).

147) In (X)

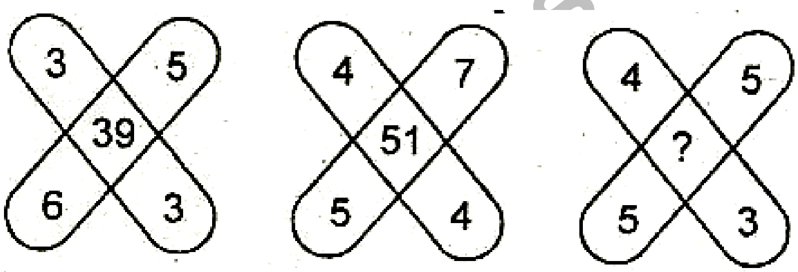


(X)



(a) (b) (c) (d)

148) Which number will come in place of '2'?



(a) 35

(b) 37

(c) 45

(d) 47

149) In the following questions, one number is missing in the series. You have to understand the pattern of the series and insert the number.

83, 82, 81, ……………. 69, 60, 33

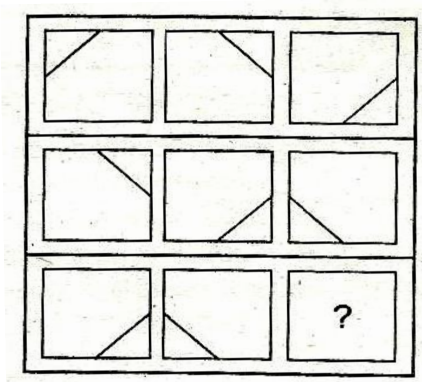
(a) 73

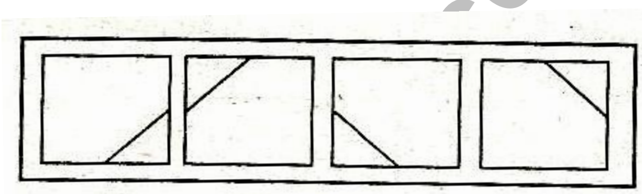
(b) 80

(c) 77

(d) None of these

150) Select one alternative figure out of (a), (b), (c) and (d) which completes the given matrix.





(a) (b) (c) (d)

ANSWERS

MATHEMATICS

1. (c)	2. (c)	3. (a)	4. (b)	5. (a)	6. (c)
7. (a)	8. (c)	9. (b)	10. (b)	11. (c)	12. (b)
13. (b)	14. (a)	15. (a)	16. (b)	17. (c)	18. (a)

19. (d)	20. (a)	21. (c)	22. (d)	23. (a)	24. (c)
25. (c)	26. (a)	27. (b)	28. (c)	29. (d)	30. (d)
31. (d)	32. (c)	33. (a)	34. (b)	35. (b)	36. (c)
37. (a)	38. (b)	39. (c)	40. (c)	41. (d)	42. (c)
43. (d)	44. (a)	45. (c)			

PHYSICS

46. (a)	47. (b)	48. (c)	49. (a)	50. (c)	51. (c)
52. (a)	53. (a)	54. (a)	55. (b)	56. (d)	57. (c)
58. (c)	59. (b)	60. (d)	61. (a)	62. (a)	63. (c)
64. (c)	65. (a)	66. (a)	67. (c)	68. (c)	69. (c)
70. (a)	71. (b)	72. (b)	73. (d)	74. (c)	75. (b)
76. (c)	77. (b)	78. (d)	79. (d)	80. (b)	81. (d)
82. (b)	83. (a)	84. (a)	85. (b)		

CHEMISTRY

86. (c)	87. (d)	88. (c)	89. (d)	90. (a)	91. (b)
92. (d)	93. (d)	94. (b)	95. (a)	96. (a)	97. (a)
98. (c)	99. (d)	100. (b)	101. (c)	102. (b)	103. (d)
104. (b)	105. (d)	106. (c)	107. (d)	108. (a)	109. (b)
110. (a)	111. (b)	112. (b)	113. (b)	114. (b)	115. (b)
116. (c)	117. (d)	118. (b)	119. (b)	120. (c)	121. (c)

122. (a)	123. (a)	124. (d)	125. (b)		

ENGLISH

126. (c)	127. (c)	128. (d)	129. (a)	130. (c)	131. (b)
132. (b)	133. (b)	134. (d)	135. (b)	136. (d)	137. (a)
138. (b)	139. (a)	140. (c)			

REASONING

141 (b)	142. (d)	143. (b)	144. (c)	145. (c)
146. (b)	147. (b)	148. (b)	149. (c)	150. (b)

HINTS & SOLUTIONS

1) Now, $\sqrt{2}+\sqrt{8}+\sqrt{18}+\sqrt{32}+\ldots\ldots\ldots.$

$= \quad 1\times\sqrt{2}+2\sqrt{2}+3\sqrt{2}+4\sqrt{2}+\cdots\ldots\ldots$

$= \quad \sqrt{2}\,(1+2+3+4+ \ldots\ldots$ upto 24 terms$)$

$= \quad \sqrt{2}\times\frac{24\times25}{2}=300\sqrt{2} \quad \because \Sigma n=\frac{n\ n+1}{2}$

2) Given that,

sin A + cos B = a ………. (i)

and sin B + cos A = b ………. (ii)

On squaring and adding Eqs. (i) and (ii), we get

$\sin^2 A+\cos^2 B + 2\sin A\cos B+\sin^2 B$

$+\cos^2 A+2\sin B\cos A=a^2+b^2$

$\Rightarrow \quad 2\sin(A+B)+2=a^2+b^2$

$\Rightarrow \quad \sin A+B = \frac{a^2+b^2-2}{2}$

3) Given that, $1+\sin x\sin^2\frac{x}{2}=0$

$\therefore \quad 1+\sin x\ \frac{1-\cos x}{2}=0$

$\Rightarrow \quad 2+\sin x-\sin x\cos x=0$

$\Rightarrow \quad \sin 2x-2\sin x=4$

Since, the maximum values of sin x and sin 2x are 1, which is not possible for any x in $[-\pi,\pi]$.

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4) Given that,

$$\Delta = \begin{vmatrix} C & 1 & 0 \\ 1 & C & 1 \\ 6 & 1 & C \end{vmatrix} = C\,(C^2 - 1) - 1\,(C - 6)$$

$$\Rightarrow \quad \Delta\, 2\cos\theta\ \ (4\cos^2\theta - 1) - (2\cos\theta - 6)$$

$$\because C = 2\cos\theta \text{ given}$$

$$= 8\cos^3\theta - 4\cos\theta + 6$$

5) Now, $\circ\, A^2 = \begin{bmatrix} 2 & -1 \\ -1 & 2 \end{bmatrix}\begin{bmatrix} 2 & -1 \\ -1 & 2 \end{bmatrix}$

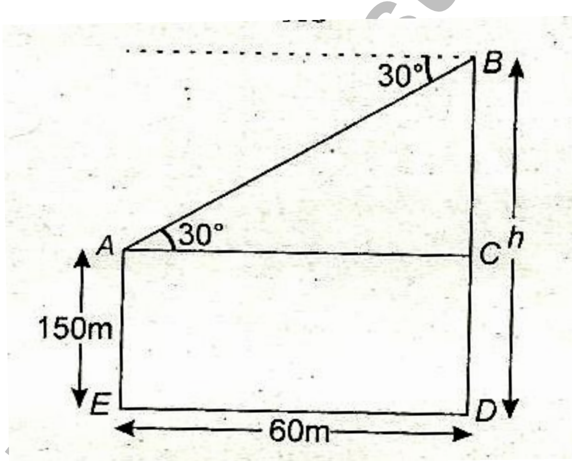
$$= \begin{bmatrix} 4+1 & -2-2 \\ -2-2 & 1+4 \end{bmatrix} = \begin{bmatrix} 5 & -4 \\ -4 & 5 \end{bmatrix}$$

Again now, $4A - 3I = 4\begin{bmatrix} 2 & -1 \\ -1 & 2 \end{bmatrix} - \begin{bmatrix} 3 & 0 \\ 0 & 3 \end{bmatrix}$

$$= \begin{bmatrix} 5 & -4 \\ -4 & 5 \end{bmatrix}$$

$$\therefore \quad A^2 = 4A - 3I$$

6) In Δ ABC, tan 30° $= \frac{BC}{AC}$



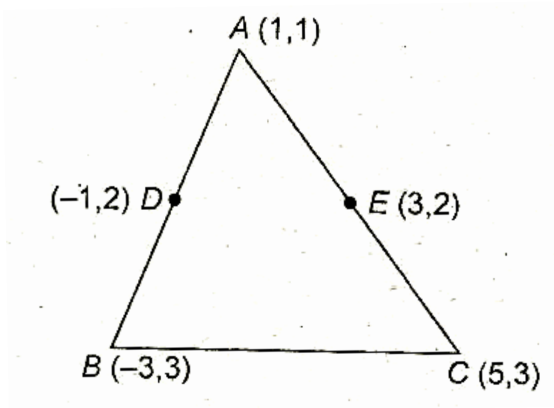
$$\Rightarrow \quad \frac{1}{\sqrt{3}} = \frac{h - 150}{60}$$

$$\Rightarrow \quad h - 150 = \frac{60}{\sqrt{3}}$$

$\Rightarrow \quad h = \quad 150 + 20\ \overline{3}\ \ m$

7) Let D and E are the mid points of AB and AC.

So, coordinates of B and C are (-3, 3) and (5, 3) respectively.



Centroid of triangle

$= \frac{x_1 + x_2 + x_3}{3}, \frac{y_1 + y_2 + y_3}{3}$

$= \frac{1-3+5}{3}, \frac{1+3+3}{3} \quad = \quad 1, \frac{7}{3}$

8) Let R = {(1, 3), (4, 2), (2, 4), (2, 3), (3, 1)} be a relation on the set A = {1, 2, 3, 4}, then

(a) Since, (2, 4) $\in$ R and (2, 3) $\in$ R, so R is not a function.

(b) Since (1, 3) $\in$ R and (3, 1) $\notin$ R but (1, 1) $\notin$ R, so R is not transitive:

(c) Since (2, 3) $\in$ R but (3, 2) $\notin$ 'R, so R is not symmetric.

(d) Since (1, 1) $\notin$ R, so R is not relexive.

Hence, option (c) is correct.

9) Given that, $(x - 1)(x^2 - 5x + 7) < (x - 1)$

$\therefore$ $(x - 1)(x^2 - 5x + 6) < 0$

$\Rightarrow$ $(x - 1)(x - 2)(x - 3) < 0$

$\Rightarrow$ $x \in (-\infty, 1) \cup (2, 3)$

10) We know, $A A^T = I_n$

$\therefore$ $A - I_n = A - A A^T = A(I_n - A^T)$

$\Rightarrow$ $|A - I_n| = |A(I_n - A^T)|$

$=$ $|A|\,|I_n - A^T|$

$=$ $|A|\,|I_n - A|$

11) We have, $(\cos\theta + i\sin\theta)(\cos 2\theta + i\sin 2\theta)$ ………

$(\cos n\theta + i\sin n\theta) = 1$

$\therefore$ $\cos(\theta + 2\theta + 3\theta + \ldots\ldots\ldots + n\theta)$

$+ i\sin(\theta + 2\theta + 3\theta + \ldots\ldots\ldots + n\theta) = 1$

$\Rightarrow$ $\cos \frac{n\ n+1}{2}\theta + i\sin\frac{n\ n+1}{2}\theta = 1$

On comparing the coefficients of real and imaginary parts on both sides; we get

$\cos\frac{n\ n+1}{2}\theta = 1$

And $\sin\frac{n\ n+1}{2}\theta = 0$

$\therefore$ $\frac{n\ n+1}{2} \therefore = 2m\pi$

$\Rightarrow$ $\theta = \frac{4m\pi}{n\ n+1}$

12) Let a and a^n be the roots of the equation, then

$a + a^n = -\frac{b}{a}$ and $a.a^n = \frac{c}{a}$

$\Rightarrow \quad a^{n+1} = \frac{c}{a}$

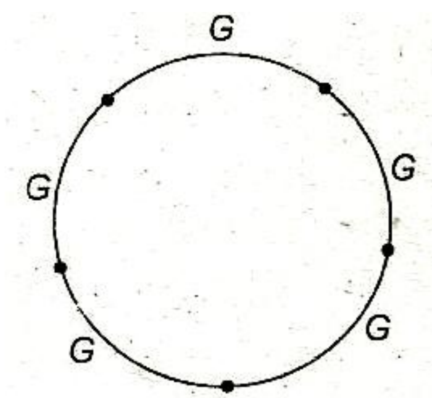
On eliminating a, we get

$$\frac{c}{a}^{\frac{1}{n+1}} + \frac{c}{a}^{\frac{n}{n+1}} = -\frac{b}{a}$$

$\Rightarrow \quad a.a^{\frac{1}{n+1}} c^{\frac{1}{n+1}} + a.a^{\frac{n}{n+1}} c^{\frac{n}{n+1}} = -b$

$\Rightarrow \quad a^n c^{\frac{1}{n+1}} + ac^n{}^{\frac{1}{n+1}} = -b$

13) First we fix the alternate position of the girls. Five girls can be seated around the circle in (5-1)! =4! , 5 boys can be seated in five -vacant place by 5!.



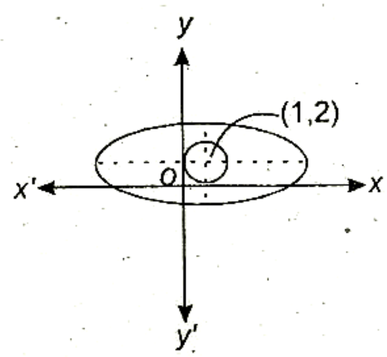
$\therefore$ Required number of ways = 4! × 5!

14) Total number of favourable cases = 6

Total number of cases = 216

Require probability = $\frac{6}{216} = \frac{1}{36}$

15) It is clear from the figure that the two curves do not intersect each other.



16) Given equation is comparing on

$\frac{x^2}{a^2} - \frac{y^2}{b^2} = 1.$

We get

$a^2 = \cos^2 a$ and $b^2 = \sin^2 a$

$\therefore \quad \sin^2 a + \cos^2 a = a^2 + b^2$

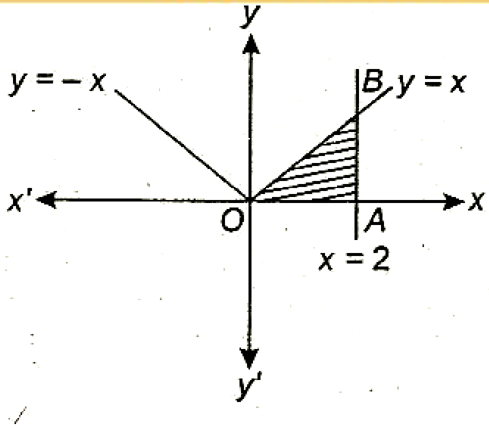
$\Rightarrow \quad e = \sqrt{\frac{a^2 + b^2}{a^2}}$

Now,

$= \sqrt{\frac{1}{cos^2 a}} = \frac{1}{\cos a}$

$Now,\ foci\ ae = \cos a\,.\frac{1}{\cos\ a} = 1$

17) Required area = Area of shaded region OAB



$= \int_0^2 y\,dx = \int_0^2 x\,dx = \left[\frac{x^2}{2}\right]_0^2$

$=$ 2sq unit

Alternate Solution

Required area = Area of Δ OAB

$= \frac{1}{2} \times 2 \times 2$

$=$ 2 sq unit

18) Given Equation is $\frac{dy}{dx} + \frac{2yx}{1+x^2} = \frac{1}{(1+x^2)^2}$

It is comparing with linear differential equation

$\frac{dy}{dx} + Py = Q, we\ get$

$P = \frac{2x}{1+x^2}$ $and\ Q = \frac{1}{(1+x^2)^2}$

Now, IF $= e^{\int P\,dx} = e^{\int \frac{2x}{1+x^2}\,dx}$

$e^{\log(1+x^2)} = 1 + x^2$

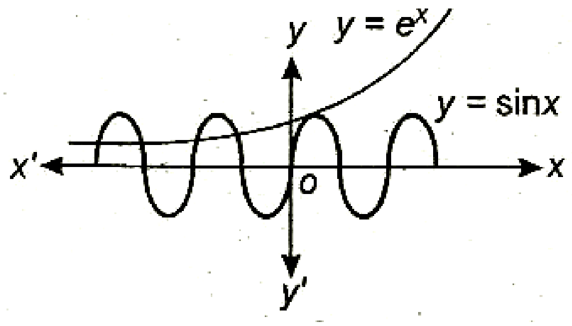
Solution of differential equation is

y (1 + x^2) $= \int \frac{1}{(1+x^2)^2}(1+x^2)\,dx + c$

$\Rightarrow \quad y(1+x^2) = \int \frac{1}{1+x^2}\,dx + c$

$\Rightarrow \quad y\ 1+x^2\ = tan^{-1}x + c$

19) Given equation of curves are y = e^x and y = sin x.



It is clear from the figure that two curves intersect at infinite number of points,

20) Given that, f(x) = $\begin{matrix} \frac{1-\cos x}{x} & , & x \neq 0 \\ k & , & x = 0 \end{matrix}$

Now, $\lim_{x\to 0} f\ x\ = \lim_{x\to 0} \frac{1-\cos x}{x}$

$= \lim_{x\to 0} \frac{2\ sin^2 x/2}{4\ \frac{x}{2}^2}\ x = 0$

And $\quad$ f(0) = k

Since, function is continuous at x = 0,

$\therefore \quad \lim_{x\to 0} f\ x\ = f\ 0$

$\Rightarrow \quad k = 0$

21) (a- b)^2 cos^2 $\frac{C}{2}$ + (a + b)^2 sin^2 - $\frac{C}{2}$

= $\quad$ (a^2 + b^2 - 2ab) cos^2 $\frac{C}{2}$ + (a^2 + b^2 + 2ab) sin^2 $\frac{C}{2}$

$= \quad (a^2 + b^2) + 2ab(\sin^2 \frac{C}{2} - \cos^2 \frac{C}{2})$

$= \quad a^2 + b^2 - 2ab \cos C = a^2 + b^2 - (a^2 + b^2 - c^2)$

$= \quad c^2$

22) $Let\ I \;=\; \frac{1+\ tan^2 x}{1-\ tan^2 x}\ dx \;=\; \frac{sec^2\ x}{1-tan^2 x}\ dx$

Put tan x = t

$\Rightarrow \quad sec^2\ \ x\, dx \;=\; dt$

$\therefore \quad I = \; \frac{dt}{1-t^2} = \frac{1}{2\times 1}\ \log \quad \frac{1+t}{1-t} \;+\; c$

$= \frac{1}{2}\ \log \;\ \frac{1+\tan x}{1-\tan x} \;\; + c$

23) Let $I = \ {}_0^8\ x - 5\ \ dx$

$= \ {}_0^5 - \ \ x - 5\ \ \ dx + \ \ {}_5^8\ \ x - 5\ \ \ dx$

$= \ -\frac{x^2}{2} + 5x\ {}_0^5 \ + \ \ \frac{x^2}{2} - 5x\ {}_5^8$

$= \ -\frac{25}{2} + \ 25 + 0 \ + \ \frac{64}{2} - 40 - \ \ \frac{25}{2} - \ 25$

$= \ \frac{25}{2} \ + \ \ -\frac{16}{2} + \frac{25}{2} \ = 25 - 8 \ = 17$

24) Given that,

$I_1 \ = \ {}_0^1\, 2^{x^2}\ \ dx,\ I_2 \ = \ {}_0^1\, 2^{x^3}\ dx,\ I_3 \ = \ {}_1^2\ 2^{x^2}\ dx$

And $I_4 = \ {}_1^2\, 2^{x^3}\ dx$

$\because \quad 2^{x^3} < \ 2^{x^2}, 0 \ < \ \ x < 1\ \ and\ 2^{x^3} \ > \ 2^{x^2},\ \ x > 1$

$\therefore \quad I_4 < I_3\ \ and\ I_2 < I_1$

25) Given equation is

$X^2 - 6xy + 9y^2 + 3x - 9y - 4 = 0$

Here a = 1 b = 9 c = - 4 h = - 3, g = $\frac{3}{2}$

Now, $h^2 = ab \Rightarrow 9 = 9$

Since, the lines are parallel

$\therefore$ The distance between two parallel lines

26) Given equation can be rewritten as

$x(x - 2y) - 3(x - 2y) = 0$

or $(x - 3)(x - 2y) = 0$

or $x = 3,$ …………… (i)

$x = 2y$ ………….. (ii)

Since, we know the normals always passing through the centre. Therefore the point of intersection of two normals are the coordinates of the centre.

$\therefore$ On solving Eqs. (i) and (ii), we get the required coordinates of centre are (3, $\frac{3}{2}$).

27) Let X be the number of heads getting in n tossed. Therefore X follows binomial distribution with parameters

$n,\ p = \frac{1}{2},\ q = \frac{1}{2}.$

Given that $P(X \geq 1) \geq 0.8$

$\therefore$ $1 - P(X = 0) \geq 0.8$

$\Rightarrow$ $P(X = 0) \leq 0.2$

$\Rightarrow \quad {}^nC_0 \left(\frac{1}{2}\right)^n \left(\frac{1}{2}\right)^0 \le 0.2$

$\Rightarrow \quad \frac{1}{2^n} \le \frac{1}{5}$

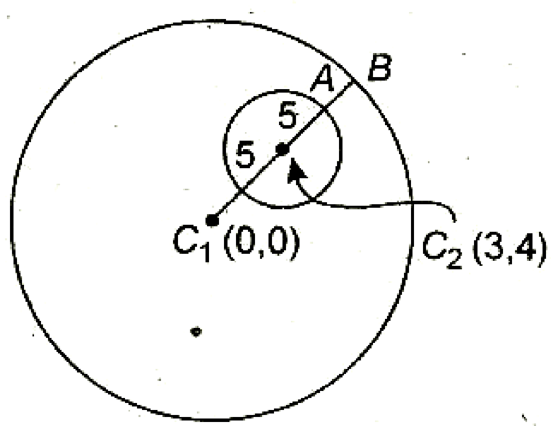
$\Rightarrow \quad 2^n \ge 5$

$\therefore$ The least value of n is 3.

28) In all, we have 8 squares in which six 'X' have to be placed and it can be done in ${}^8C_6 = 28$ ways.

But 'this includes the possibility that either the top or horizontal row does not have any 'X. Since, we want each row must have at least one 'X, these two possibilites are to be excluded. Hence, required number of ways = 28 - 2 = 26.

29) The two circles whose centre and radius are C_1 (0, 0), $r_1 = 12$, $C_2(3, 4)$, $r_2 = 5$ and it passes through origin ie, the centre of C_1.



Now, $C_1C_2 = \sqrt{3^2 + 4^2} = 5$

and $r_1 - r_2 = 12 - 5 = 7$

$\therefore \quad C_1C_2 < r_1 - r_2$

Hence, circle C_2 lies inside the circle C_1.

From figure the 'minimum distance between, them is

AB $= C_1B - C_1A = r_1 - 2r_2$

$= 12 - 10 \quad = 2$

30) Now, $\log_{140} 63 = \log_{2^2\times5\times7}\ 3\times3\times7$

$= \frac{\log_2\ 3\times3\times7}{\log_2\ 2^2\times5\times7} = \frac{\log_2 3+\log_2 3+\log_2 7}{2\log_2 2+\log_2 5+\log_2 7}$

$= \frac{2a+\frac{1}{c}}{2+b+\frac{1}{c}} = \frac{2ac+1}{2c+bc+1}$

31) Now, $49^n + 16n-1 = (1 + 48)^n + 16n-1$

$= \quad 1 + {}^nC_1(48) + {}^nC_2\,(48)^2 + \ldots\ldots + {}^nC_n\,(48)^n + 16n-1$

$= \quad (48n + 16n) + {}^nC_2(48)^2 + {}^nC_3\,(48)^3 + \ldots\ldots + {}^nC_n\,(48)^n$

$= \quad 64n + 8^2({}^nC_2\,6^2 + {}^nC_3\,.\,6^3\,.\,8 + {}^nC_4\,.\,6^4.\,8^2$

$+\ldots\ldots + {}^nC_n\,.6^n\,8^{n-2})$

Hence, $49^n + 16n - 1$ is divisible by 64.

32) We have,

$\sin^{-1} x = 2\tan^{-1}$

$\therefore \quad \sin^{-1} x = \sin^{-1}\ \frac{2x}{1+x^2}$

$\Rightarrow \quad x = \frac{2x}{1+x^2}$

$\Rightarrow \quad x^3 - x = 0$

$\Rightarrow \quad x\ \ x+1\quad x-1\ \ = 0$

$\Rightarrow \quad x \in\ -1, 1\,, 0$

33) Given series is

$1 \cdot 3^2 + 2.\ 5^2 + 3 \cdot 7^2 + \ldots\ldots\ldots\ \infty.$

This is an arithmetic-geometric series whose nth term is equal to

$$T_n = n(2n + 1)^2 = 4n^3 + 4n^2 + n$$

$\therefore \quad S_n = \sum_1^n T_n = \sum_1^n (4n^3 + 4n^2 + n)$

$$= 4\sum_1^n n^3 + 4\sum_1^n n^2 + \sum_1^n n$$

$$= 4\left[\frac{n}{2}(n+1)\right]^2 + \frac{4}{6}n(n+1)(2n+1) + \frac{n}{2}(n+1)$$

$$= n(n+1)\left[n^2 + n + \frac{4}{6}(2n+1) + \frac{1}{2}\right]$$

$$= \frac{n}{6}(n+1)(6n^2 + 14n + 7)$$

34) Let $f(x) = 2x + 3y$

$\therefore \quad f(x) = 2x + \frac{18}{x} \qquad (\because xy = 6 \text{ given})$

On differentiating, we get

$$f'(x) = 2 - \frac{18}{x^2}$$

Put $f'(x) = 0$ for maximum or minima.

$\Rightarrow \quad 0 = 2 - \frac{18}{x^2}$

$\Rightarrow \quad x = \pm 3$

And $\quad f''(x) = \frac{36}{x^3}$

$\Rightarrow \quad f''(3) = \frac{36}{3^3} > 0$

$\therefore \quad At\ x = 3,\ f(x)\ \ is\ minimum.$

The minimum value is

$f(3) = 2(3) + 3(2) = 12$

35) Let $p = sin^{-1}\frac{2x}{1+x^2} = 2\,tan^{-1}x$

And $q = cos^{-1}\frac{1-x^2}{1+x^2} = 2\,tan^{-1}x$

$\therefore \quad \frac{dp}{dx} = \frac{2}{1+x^2} = and\ \frac{dq}{dx} = \frac{2}{1+x^2}$

$\Rightarrow \quad \frac{dp}{dq} = \frac{\frac{dp}{dx}}{\frac{dq}{dx}} = \frac{\frac{2}{1+x^2}}{\frac{2}{1+x^2}} = 1$

36) Two sides x - 3y = 0 and 3x + y = 0 are perpendicular to each other. Therefore, its orthocentre is the point of intersection of x - 3y = 0 and 3x + y = 0 ie, (0, 0).

So, the line. 3x - 4y = 0 passes through the orthocentre of triangle.

37) Let (h, k) be the-centre of a circle, then equation of circle is

$(x - h)^2 + (y - k)^2 = 9$

This centre lies on $x^2 + y^2 = 25$

$\Rightarrow \quad h^2 + k^2 = 25$

$\therefore \quad 2 \le$ distance between the centres of the two circles ≤ 8

$\Rightarrow \quad 2 \le \sqrt{(h-0)^2 + (k-0)^2} \le 8$

$\Rightarrow \quad 2 \le \sqrt{h^2 + k^2} \le 8$

$\Rightarrow \quad 4 \le h^2 + k^2 \le 64$

$\therefore \quad$ Locus of (h, k) is $4 \le x^2 + y^2 \le 64$.

38) Given that,

$sin^{-1}\ x + sin^{-1}\ y = \frac{\pi}{2}$

$\therefore \quad sin^{-1}\ x = cos^{-1}\ y$

$\Rightarrow \quad y = \sqrt{1 - x^2}$

On differentiating with respect to x, we get

$$\frac{dy}{dx} = \frac{1}{2\sqrt{1- x^2}} \quad -2x \quad = -\frac{x}{y}$$

39) Given that,

$$\mathrm{Lim}_{x \to \infty} \frac{x^3+1}{x^2+1} - \quad ax + b \quad = 2$$

$$\Rightarrow \quad \lim_{x \to \infty} \frac{x^3 \ \ 1-a \ - bx^2 - ax + \ 1-b}{x^2+1} = 2$$

$$\Rightarrow \quad \lim_{x \to \infty} \frac{x \ \ 1-a \ \ -b - \frac{a}{x} + \frac{1-b}{x^2}}{1 + \frac{1}{x^2}} = 2$$

This limit will exist, if

1 - a = 0 and b = - 2

$\Rightarrow$ a = 1 and b = - 2

40) As we know, a vector caplanar to a, b and orthogonalto c is λ $\{(a \times b) \times c\}$.

$\therefore$ A vector coplanar to (2$\imath$ + $\jmath$ + k), ($\imath$ - $\jmath$ + k) and orthogonal to (3$\imath$ + 2$\jmath$ + 6k).

= λ [{2$\imath$ + $\jmath$ + k) × ($\imath$ - $\jmath$ + k)} × (3$\imath$ + 2$\jmath$ + 6k)]

= $\lambda \ \ -21\jmath + 7\mathrm{k}$

$\therefore$ A unit vector is $\pm \frac{a \times b \ \times c}{a \times b \ \times c}$

$= \pm \frac{-21 \ \jmath + 7k}{\overline{-21 \ ^2 + \ 7 \ ^2}} = \frac{\pm \ 3 \jmath - k}{\overline{10}}$

41) Given that,

$p = \frac{b \times c}{a \ b \ c}, q = \frac{c \times a}{a \ b \ c} \ and \ r \ = \frac{a \times b}{a \ b \ c}$

$\therefore \quad a.p \ = \frac{b \times c}{a \ b \ c} = \frac{a. \ b \times c}{a \ b \ c} = 1$

And $\quad a. \ q = a.\frac{c \times a}{a \ b \ c} = \frac{a. \ b \times c}{a \ b \ c} = 0$

Similarly, $\quad b.q \ = \ c \ .r \ = 1$

And $\quad a. \ r \ = \ b \ p \ = c \ q \ = c. \ p = b \ r \ = 0$

$\therefore \quad a \ + b \ .p + \ b + \ c \ .q + \ c + a \ .r$

$= a.p \ + b.p + \ bq + \ c.q + \ c.r + \ a.r$

$= \ 1 + 1 + 1 = \ 3$

42) Let A = (5, - 4,2), B = (4, - 3, 1), C = (7, - 6, 4)

and D =(8, -7,5).

Now, AB = $\overline{\ 4 - 5 \ ^2 + \ -3 + 4 \ ^2 \ + \ 1 - 2 \ ^2}$

$= \overline{1 + 1 + 1} = \ \overline{3}$

BC = $\overline{\ 7 - 4 \ ^2 + \ -6 + 3 \ ^2 + + \ 4 - 1 \ ^2}$

$= \overline{9 + 9 + 9 +} = 3 \ \overline{3}$

CD = $\overline{\ 8 - 7 \ ^2 + + \ -7 + 6 \ ^2 + + \ 5 - 4 \ ^2}$

$= \overline{1 + 1 + 1} = \ \overline{3}$

And $AD = \sqrt{(8-5)^2 + (-7+4)^2 + (5-2)^2}$

$= \sqrt{9+9+9} = 3\sqrt{3}$

Again Now, position vectors of

AB = (4 - 5)$\hat{i}$ + (- 3 + 4)$\hat{j}$ + (1 - 2)$\hat{k}$

$= -\hat{i} + \hat{j} - \hat{k}$

BC = (7 - 4)$\hat{i}$ + (- 6 + 3)$\hat{j}$ + (4 -1)$\hat{k}$

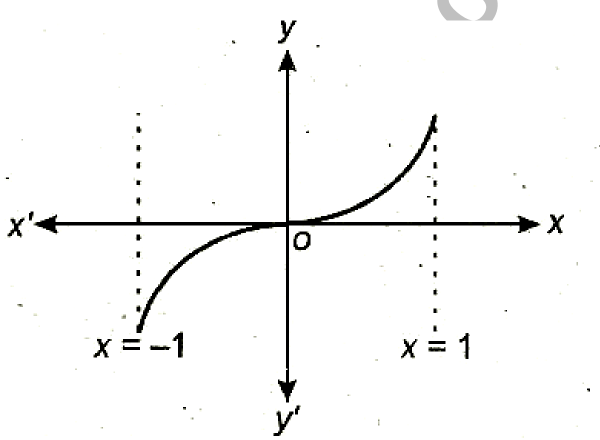
= 3$\hat{i}$ - 3$\hat{j}$ + 3$\hat{k}$

$\therefore$ $AB \cdot BC$ = (- $\hat{i}$ + $\hat{j}$ - $\hat{k}$). (3$\hat{i}$ - 3$\hat{j}$ + 3$\hat{k}$)

= -3 – 3 – 3 $\neq$ 0

$\therefore$ ABCD is a parallelogram.

43) $f(x) = x|x| = \begin{cases} x^2 & x \geq 0 \\ -x^2, & x < 0 \end{cases}$



Since – 1 $\leq$ x $\leq$ 1, therefore -1 $\leq$ f(x) $\leq$ 1

$\therefore$ Function is one-one onto.

44) Let hand r be the height and radius of cylinder.

Given that $\frac{dr}{dt} = 3\, m/s$, $\frac{dh}{dt}$ = - 4 m/s

Also, V = $\pi r^2 h$

On differentiating with respect to t, we get

$$\frac{dV}{dt} = \pi \quad r^2 \frac{dh}{dt} + h.2r \ \frac{dr}{dt}$$

At r = 4 m and h = 6 m

$$\therefore \quad \frac{DV}{dt} = \pi \ -64 + 144 \quad = 80\,\pi \ \text{cu m/s}$$

45) Given vertex of parabola (h, k) ≡ (1, 1) and its focus (a + h, k) ≡ (3, 1) or a +, h = 3

$\Rightarrow$ a = 2

Since, y-coordinate of vertex and focus are same, therefore axis of parabola is parallel to x-axis. Thus equation of parabola is

$(y - k)^2 = 4a(x - h)$

$\Rightarrow$ $(y - 1)^2 = 8(x - 1)$

46) In given equation, $\frac{az}{k\theta}$ should be dimensionless.

$$\therefore \quad a = \frac{k\theta}{z}$$

$$\Rightarrow \quad a = \frac{ML^2T^{-2}\,K^{-1} \times K}{L} = MLT^{-2}$$

And $p = \frac{a}{\beta}$

$$\Rightarrow \quad \beta = \frac{a}{\rho} = \frac{MLT^{-2}}{ML^{-1}T^{-2}} = M^0 L^2\, T^0$$

47) Between time interval 20 s te 40 s, there is non-zero acceleration and retardation. Hence, distance travelled during

this interval

= Area between time interval 20 s to 40 s

= $\frac{1}{2} \times 20 \times 3 + 20 \times 1 = 30 + 20 = 50$m

48) For w, 2 w, 3 W apparent weight will be zero because the system is falling freely. So, the distances of the weights from the rod will be same.

49) Direction of velocity is always tangent to the path, so at the top of trajectory it is in horizontal direction and acceleration due to gravity is always in vertically downward direction.

Hence, v and g are perpendicular to each other.

50) $F \ \Delta t = \ m\Delta v$

$\Rightarrow \quad F = \frac{m \, \Delta v}{t}$

By doing so time of change in momentum increases and impulsive force on knees decreases.

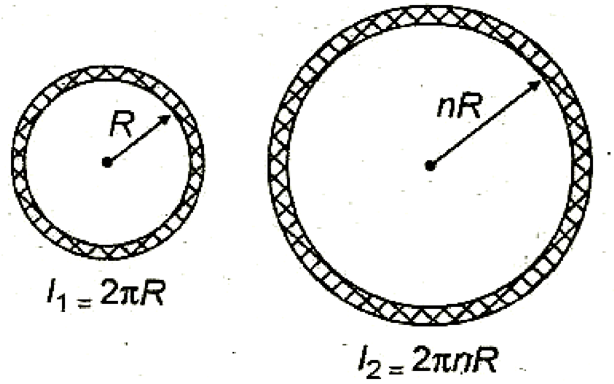
51) When the ball is released from the top of tower then ratio of distances covered by the ball in first, second and third second is

$h_{I} : h_{II} : h_{III} = 1 : 3 : 5$ [because $h_n \propto (2n - 1)$]

$\therefore$ Ratio of work done

$mgh_{I} : mgh_{II} : mgh_{III} = 1 : 3 : 5$

52)



Ratio of moment of inertia of the rings

$$\frac{I_1}{I_2} = \frac{M_1}{M_2}\left(\frac{R_1}{R_2}\right)^2 = \frac{\lambda l_3}{\lambda l_2}\left(\frac{R_1}{R_2}\right)^2 = \frac{2\pi R}{2\pi nR}\left(\frac{R}{nR}\right)^2$$

λ = linear density of wire = constant

$$\Rightarrow \quad \frac{L_1}{L_2} = \frac{1}{n^3} = \frac{1}{8} \quad given$$

$$\therefore \quad n^3 = 8 \Rightarrow n = 2$$

53) $v = \sqrt{2gR}$

$$\therefore \quad \frac{v_1}{v_2} = \sqrt{\frac{g_1}{g_2} \times \frac{R_1}{R_2}} = \sqrt{g \times K} = Kg^{1/2}$$

54) Speed of sound in a starched string

$$v = \sqrt{\frac{T}{\mu}}$$

where T is the tension in the string and μ is mass per unit length.

According to Hooke's law, F $\propto$ x

$\therefore$ T $\propto$ x ……………. (ii)

From Eqs. (i) and (ii)

$V \propto \sqrt{x}$

$\therefore \quad v' = \sqrt{1.5}\, v = 1.22v$

55) The velocity of ball before entering the water surface

$V = \sqrt{2gh} = \sqrt{2\, g \times 9}$

When ball enters into water, due to up thrust of water the velocity of ball decreases (or retarded)

The retardation,

$$a = \frac{apparent\ wegiht}{mass\ of\ ball}$$

$$= \frac{V(\rho - \sigma)g}{V\rho} = \frac{\rho - \sigma}{\rho}$$

$$= \frac{0.4 - 1}{0.4}\, g = -\frac{3}{2} g$$

It h be the depth upto which ball sin x, then

$$0 - v^2 = 2 \times \left(\frac{-3}{2} g\right) \times h$$

$\Rightarrow \quad 2g \times 9 = 3gh$

$\therefore \quad h = 6cm.$

56) For all processes, change in internal energy ΔU ($-\Delta Q$ $-\Delta W$) does not change. It depends only on initial and final states.

57) Relative humidity at a given temperature (R)

$$= \frac{\text{Partial pressure of water vapour}}{\text{Vapour pressure of water}}$$

$$= \frac{0.012 \times 10^5}{0.016 \times 10^5} = 0.75 = 75\%$$

58) In the absence of intermolecular forces, there will be no stickiness of molecules. Hence, pressure will increase.

59) Time period is independent of mass of bob of pendulum.

60) $v = \frac{\sin i}{\sin r} = \frac{v_1}{v_2}$

$\Rightarrow \quad \sin r = \sin 30° \times \frac{2v}{v} \Rightarrow \sin r = \frac{1}{2} \times 2 \times 1$

$\Rightarrow \quad r = 90°$

61) $v = \frac{coefficient\ of\ t}{coefficient\ of\ x} = \frac{2\pi/0.01}{2\pi/0.3} = 30\ m/s$

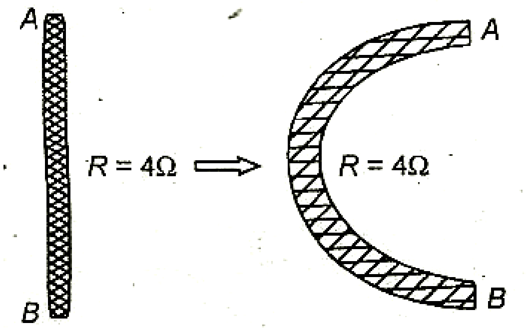
62) By using W = Q $(E\ \Delta r)$

$\Rightarrow \quad W = Q[(e_1\hat{\imath} + e_2\hat{\jmath} + e_3\hat{k}) . (a\hat{\imath} + b\hat{\jmath})]$

$= Q(e_1a + e_2b)$

63) Charge will move along the circular line of force because $x^2 + y^2 = 1$ is the equation of circle in xy-plane.

64)



65) $\sigma_i = \frac{\theta}{i} = \frac{\theta}{iG}.\ G = \sigma_v G \Rightarrow \frac{\sigma_i}{G} = \sigma_v$

66) M = Ia $\Rightarrow$ $i = \frac{m}{A}$

67) Work done, W =-MB$_{\mu}$ (1 - cos θ)

= 20 × 0.3(1 - cos 30^0)

$= 6\left(1 - \frac{\sqrt{3}}{2}\right) = 3\left(2 - \sqrt{3}\right)$

68) $i = i_0\left(1 - e^{-\frac{Rt}{L}}\right)$

$\Rightarrow \quad \frac{di}{dt} = \frac{d}{dt}\left(i_0 - \frac{d}{dt}\left(i_0\, e^{-\frac{Rt}{L}}\right)\right) = 0 + \frac{i_0 R}{L} e^{-\frac{Rt}{L}}$

Initially, t = 0

$\Rightarrow \quad \frac{di}{dt} = \frac{i_0 \times R}{L} = \frac{E}{L} = \frac{5}{2} = 2.5\ A/s$

69) $\frac{1}{2}\ mv_{max}^2 = eV_0$

$\Rightarrow \quad v_{max} = \sqrt{2\left(\frac{e}{m}\right)V_o} = \sqrt{2 \times 1.8 \times 10^{11} \times 9}$

$$= 18 \times 10^5 \ \ m/s$$

$$= 1.8 \times 10^6 \ \ m/s$$

70) $N = N_0 \ \ \frac{1}{2}^{t/T_{1/2}}$

$\Rightarrow \quad N_A = 10 \ \ \frac{1}{2}^{t/2} \ \ and \ N_B \ = \ 1 \ \ \frac{1}{2}^{t/2}$

Given

$\Rightarrow \quad 10 \ \ \frac{1}{2}^{t} \ = \ \frac{1}{2}^{t/2} \ \Rightarrow 10 = \ \frac{1}{2}^{-t/2}$

$\Rightarrow \quad 10 = 2^{t/2}$

Taking log on both the sides

$\log_{10} = \frac{t}{2} \log_{10} 2 \ \ \Rightarrow \ 1 = \frac{t}{2} \times 0.3010$

$\Rightarrow \quad t = 6.62 \ \ years$

71) Optical path, μx = constant

$ie, \quad \mu_1 \, x_1 \ = \ \mu_2 \, x_2 \ \Rightarrow \ 1.53 \times 4 = \ \mu_2 \times 4.5$

$\Rightarrow \quad \mu_2 \ = \frac{1.53 \times 4}{4.5} = 1.36$

72) Volume, V = l × b × t = 12 × 6 × 2.45

= 176.4 cm^3

Or V = 1.764 × 10^2 cm^3

Since, the minimum number of significant figure is one in breadth, hence volume will also contain only one significant figure. Hence,

V = 2x 102cm^3. •

73) $P = \frac{F}{A} = \frac{n\ mv- \ -mv}{A} = \frac{2\ mnv}{A}$

$= \frac{2\times10^{-3}\times10^{4}\times10^{2}}{10^{-4}} = 2\times10^{7}\ N/m^{2}$

74) $W = \frac{F^2}{2k}$

If both springs are stretched by same force then

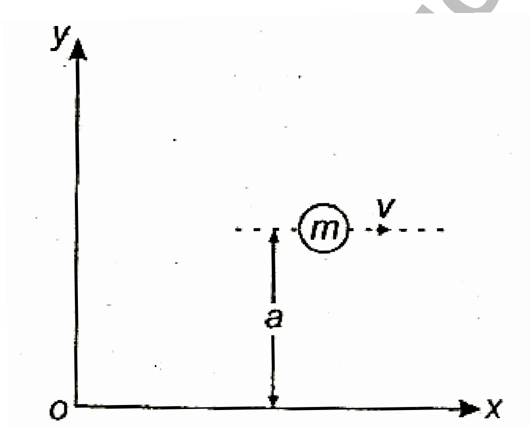
$W \propto \frac{1}{k}$.

As $k_1 > k_2$ therefore, $W_1 < W_2$

ie; more work is done in case of second spring.

75) Angular moment of particle w.r.t., origin

= linear momentum x perpendicular distance of line of action of linear momentum from origin



$= mv \times a = mva =$ constant

76) Apparent weight = actual weight – upthrust

$$Vdg' = Vdg - V\rho g$$

$$\Rightarrow \quad g' = \frac{d-\rho}{d} \quad g$$

77) A= $\frac{c}{a+b-c}$: when b = 0, a = c

Amplitude A $\rightarrow \infty$. This corresponds to resonance,

78) If length of the foil is l then

$$C = \frac{K\varepsilon_0 \quad l\times b}{d}$$

$$\Rightarrow \quad 2 \times 10^{-6} = \frac{2.5\times8.85\times10^{-12} \quad l\times400\times10^{-3}}{0.15\times10^{-3}}$$

$\Rightarrow$ l = 33.9m

79) Potential difference across PQ i.e., potential difference across the resistance of 20 Ω, which is V = i × 20

And $i = \frac{48}{100+100+80+20} = 0.16\,A$

$\therefore \quad V = 0.16 \times 20 = 3.2\,V$

80) Resistivity of the material of the rod

$$\rho = \frac{RA}{\tau} = \frac{3\times10^{-3}\times\pi \quad 0.3\times10^{-2} \quad ^2}{1}$$

$= 27 \times 10^{-9}\,\pi\,\Omega$m

Resistance of disc,

$$R = \frac{\text{Resistivity of rod x Thickness}}{\text{Area of corss– section}}$$

$$= 27 \times 10^{-9}\,\pi \times \frac{10^{-3}}{\pi\times \quad 1\times10^{-2} \quad ^2}$$

$= 2.7 \times 10^{-7}\ \Omega$

81) Cyclotron frequency, v = $\frac{Bq}{2\pi m}$

$\Rightarrow \quad v = \frac{1\times1.6\times10^{-19}}{2\times3.14\times9.1\times10^{-31}}$

$= 2.79 \times 10^{10}\ Hz\ = 28\ GHz$

82) Transformation ratio,

$k = \frac{N_s}{N_p},\ = \frac{V_s}{V_p}$

For step-up transformer,

$N_s > N_p$, i.e., $V_s > V_p$, hence, k > 1.

83) Intensity or power per unit area of the radiations,

P = pv

$\Rightarrow \quad p = \frac{p}{v}\ = \frac{0.5}{3\times10^8}\ = 0.166 \times 10^{-8}\ N/m^2$

84) Area of half period zone is independent of order of zone. Therefore, m is equal to zero in n^m.

85) $\frac{n}{t} = \frac{IA\lambda}{hc}\ = \frac{150\times10^{-3}\times4\times10^{-4}\times3\times10^{-7}}{6.6\times10^{-34}\times3\times10^{8}}$

$= 9 \times 10^{13}$ s

Chemistry

86) Thermite is the mixture of Fe_2O_3 and Al. Due to great affinity of aluminium toward oxygen, it readily combines' with oxygen. Hence, Goldsmith used Al to reduce metal oxides in extraction. In thermite the ratio of Fe_2O_3 and

Al is taken 3: 1 by weight.

$$Fe_2O_3 \quad + \quad 2Al \quad \rightarrow \quad 2Fe + Al_2O_3$$

$(2 \times 56 + 3 \times 16 = 160)$ $(2 \times 27 = 54)$

87) In a unit cell, W atoms at the corner $= \frac{1}{8} \times 8 = 1$

O-atoms at the centre of edge $= \frac{1}{4} \times 12 = 3$

Na atoms at the centre of the cube = 1

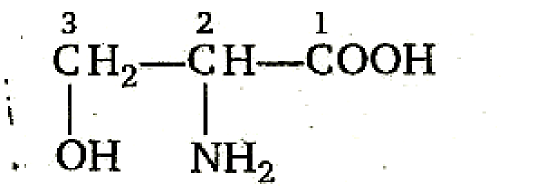
W : O : Na = 1 : 3: 1

Hence, formula = $NaWO_3$

88) Anhydrous $CaCl_2$ is used for fast drying of neutral gases.

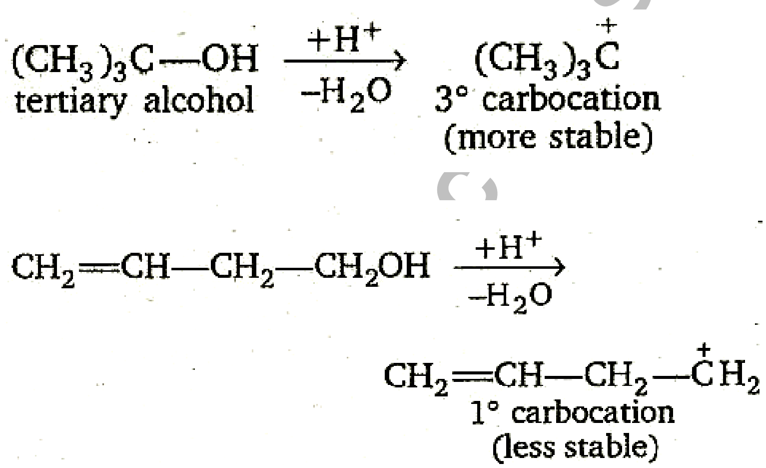
89) H_2O_2 is used as an oxidant for rocket fuel and has 90% concentration to be used in rockets.

90)



2-amino-3-hydroxy-propanoic acid

91)



Increasing order of stability of carbocation.

1° carbocation.< 2° carbocation < 3° carbocation

92) Due to small size of Na^+, it is heavily hydrated and become large molecule.

Ionic conductance increase down the group in alkali metals.

Order of ionic conductance

$Na^+ < K^+ < Rb^+ < Cs^+$

93) On hydration of Plaster of Paris, converts into Gypsum.

$$\underset{\text{Plaster of Paris}}{CaSO_4 \cdot \frac{1}{2} H_2O} + \frac{3}{2} H_2O \longrightarrow \underset{\text{Gypsum}}{CaSO_4 \cdot 2H_2O}$$

94) Osmatic pressure (π) = CRT

Here, C = concentration of solution

$C = \frac{n}{V}$

$\therefore \quad n = \frac{w}{m} = \frac{weight\ in\ gram\ of\ substance}{Mol.weight\ of\ substance}$

$V = 1\ litre$

$C = \frac{68.4}{342}$

$\pi = \frac{68.4}{342} \times 0.082 \times 273$

$= 4.48\ atm$

95) Isothermally (at constant temperature) and reversible work.

$w = 2.303\ nRT \log \frac{P_2}{P_1}$

$= 2.303 \times 1 \times 2 \times 300 \log \frac{10}{2}$

$= 2.303 \times 600 \times \log 5$

$= 965.84$

at constant temperature, $\Delta E = 0$

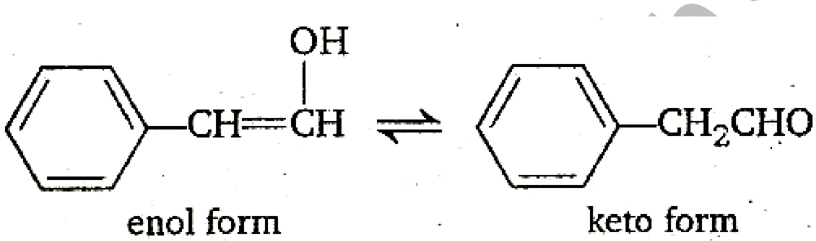
$\Delta E = q + w, q = -w = - 965.84$ cal

96) According law of active mass

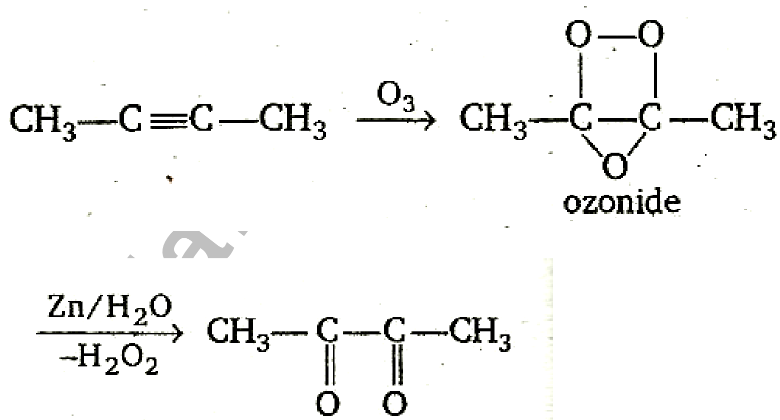
$$K_c = \frac{NO_2{}^2}{N_2O_4} = \frac{1.2\times10^{-2}{}^{2}}{4.8\times10^{-2}}$$

$$= 0.3 \times 10^{-2} = 3 \times 10^{-3}$$

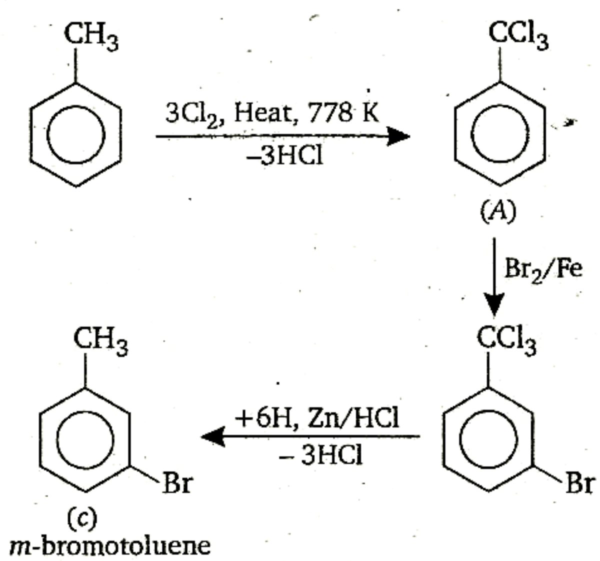
97) **Tautomerism** It is functional isomerism in -which the isomers are readily interchangeable and maintain a dynamic equilibrium with each other.



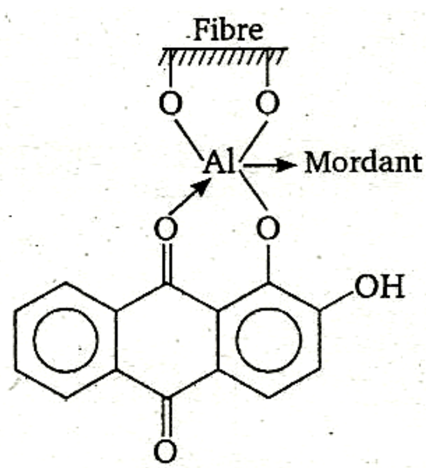
98)



99)



100) Alizarin is Mordant dye. Alizarin gives a bright red colour with aluminium and a blue colour with barium.



101) 2,4-6 or 2,4-dichlorophenoxyacetic acid is used as a herbicides.

102) Flint glass or lead glass has composition of $K_2O \cdot PbO \cdot 6SiO_2$.

It is used in making electric bulb and optical instruments.

103) The +5 oxidation state of Bi is unstable due to inert pair effect. Thus, BiFs can not be formed.

104) $Na_2S_2O_3 . 5H_2O$ (Hypo).

It is called photographer's fixer because it removes the excess AgBr in the form of soluble silver complex.

105) Cl_2O = 42 electrons

ICI_2 = 87 electrons

CI_2^- = 35 electrons

IF^+_2 = 70 electrons

I^-_3 = 160 electrons

CIO_2 = 33 electrons

CIO^-_2 = 34 electrons

CIF^+_2 = 34 electrons

CIO_2^- and CIF^+_2 contain 34 electrons each hence they are isoelectronic.

106) These radioactive minerals have entrapped He atoms, produced from a-particle, which they give on heating in Vacuo.

107)

$$\underset{\text{acid}}{H_2PO_4^-} + H_2O \longrightarrow H_3O^+ + \underset{\text{Conjugated base}}{HPO_4^{2-}}$$

$H_2PO^-_4$ gives HPO^{2-}_4 (conjugated base) in aqueous solution. It acts as proton donor.

108) $\Delta G° = - nFE°$

$Fe^{2+} + 2e^{-} \rightarrow Fe$

$\Delta G° = - 2 \times F \times (- 0.440V) = 0.880\ F$ ………….. (1)

$Fe^{3+} + 3e^{-} \rightarrow Fe$

$\Delta G° = -3 \times F \times (- 0.036)$

$= 0.108\ F$ ………….. (2)

On subtracting Eqs. (1) and (2)

$Fe^{3+} + e^{-} \rightarrow Fe^{2+}$

$\Delta G° = 0.108F - 0.880F = -0.772F$

$$E° = -\frac{\Delta G°}{nF} = \frac{-0.772F}{1 \times F} = +0.772\ v$$

109) $N_2 + 3H_2 \rightleftharpoons 2NH_3$

$$\frac{d\ H_2}{dt} = -0.3 \times 10^{-4}\ Ms^{-1}$$

$$Rate = -\frac{1}{3}\frac{d\ H_2}{dt} = +\frac{1}{2}\frac{d\ NH_3}{dt}$$

$$= \frac{d\ NH_3}{dt} = -\frac{2}{3}\frac{d\ H_2}{dt}$$

$$= -\frac{2}{3} \times -0.3 \times 10^{-4}$$

$$= 0.2 \times 10^{-4}$$

110) $V_{rms} = \sqrt{\frac{3RT}{M}}$

$V_{rms} \propto \sqrt{T}$

$\frac{V_{rms}}{V_{rms}} = \sqrt{\frac{T}{T'}}$

$\frac{1}{2} = \sqrt{\frac{T}{T'}}$

$T' = 4T$

111) Specific conductivity (K) = $\frac{1}{R}$ × cell constant

Cell constant = K × R

= 0.0129 × 100 = 1.29

112) Boiling point of HF is highest due to H-bonding.

For other halogen acids b.p. increase in the order

HCI < HBr < HI.

Therefore, most volatile (with Lower b.pt.) is HCI

113) Value of magnetic moment depends upon number of unpaired electrons.

All except Ti^{3} + $|3d^{1}|$ have either fully filled d-subshell (i.e., Zn^{2+}, Cu^{+}) or empty d-subshell (i.e., Sc^{3+}).

As such only Ti^{3+} has a net value of magnetic, moment.

Magnetic moment of Ti^{3+} $= \sqrt{n(n+2)}$ BM

$= \sqrt{1(1+2)}$ BM

$= \sqrt{3} = 1.73$ BM

114) Cr(24) = $1s^2, 2s^2, 2p^6, 3s^2, 3p^6, 3d^5, 4s^1$

115) Ag_2SO_4 contain Ag+ ($4d^{10}$) and is colourless.

CuF_2 contains Cu^{2+} ($3d^9$) and is coloured due to the presence of one unpaired electron is d-orbital of Cu^{2+}.

MgF_2 contains Mg^{2+} and is colourless n/2 CuCI contains Cu + ($3d^{10}$) and is colourless.

116) Effective atomic number = Electrons in Cr^{3+} + electrons from $6NH_3$ ligands.

$$= \quad 21 + 6 \times 2 = 33$$

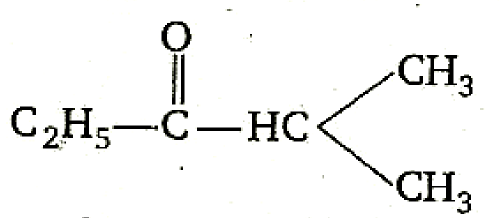
117) Nessler's reagent gives brown ppt, of iodide of million base with ammonium salt.

$[HgI_4]^{2-} + NH_4Cl + 4OH^- \rightarrow$ $NH_2HgOHgI$

Iodide of million base (Brown ppt.)

$+ I^- + Cl^- + 3H_2O$

118) All the ketones except ethyl isopropyl ketone gives iodoform test in this question.

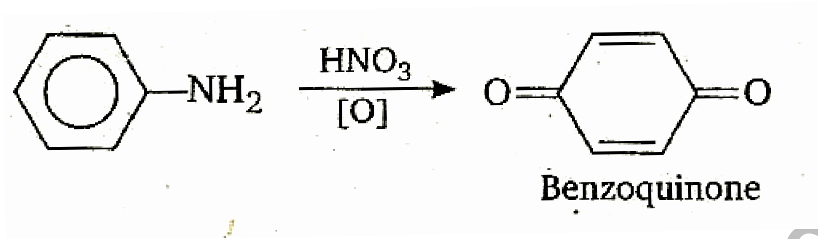


Ethyl isopropyl ketone

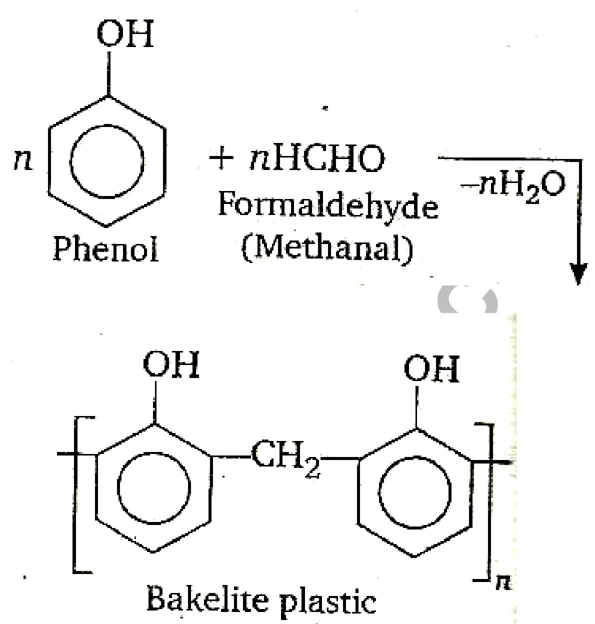
119) – NH – is stronger electron releasing group than CH_3 group, therefore bromination will take place at p-position with respect

to –NH group.

120)



121)

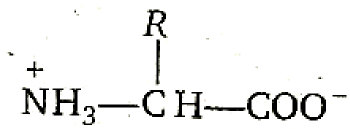


122) Cellulose is a polymer of glucose-β-D(+) glucose units are attached to each other by C_1 to C_4 bonds through β-glycosidic linkage in structure of cellulose.

123) Iodine value is related to oils and fats. Iodine value measures the drying quality of an oil. More the unsaturation better is the drying quality of an oil. When on oil is treated with I_2. It adds to

double bond. Iodine value is defined as the number of centigrams of I_2 that can be taken by 1g of the oil.

124) In aqueous solutions, amino acids mostly exist as zwitter ions.



(Zwitter ion)

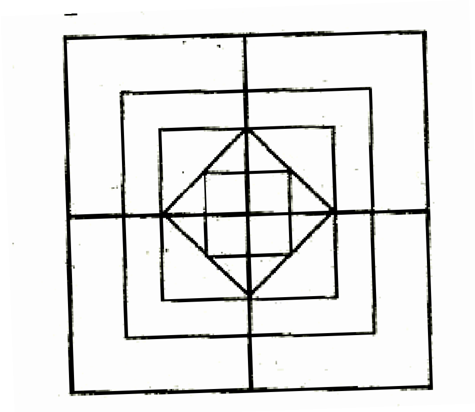
125) Gibb's free energy G_1, enthalpy H and entropy S are interrelated as

$$G = H - TS$$

Reasoning

141) 'Tissue' is made up of 'cell' and 'organ' is made up of 'tissue'.

142) Sum of digits is 20.



143) It is clear that answer figure (b) complete the original figure. Which look like as shown in the adjacent figure. Hence, alternative (b) is the correct answer.

148) Here, $3 \times 3 + 6 \times 5 = 39$

$4 \times 4 + 5 \times 7 = 51$

and $4 \times 3 + 5 \times 5 = 37$

149) Series is written in reverse order with a difference of 1^2, 1^3, 2^2, 2^2, 2^3, 3^2, 3^3, i.e., 1, 4, 8, 9, 27.

150) The line inside the square moves from one corner to another clockwise, as we moves from left to right in a row.

BITSAT

Engineering Entrance Exam

Mathematics

1) If f: R → R and g : R → R are defined by f(x) = |x| and g(x) = [x - 3] for x∈ R, then

$g\ f\ x\ \ : -\frac{8}{5} < x < \frac{8}{5}$ is equal to

(a) {0, 1}

(b) {1, 2}

(c) {-3, -2}

(d) {2, 3}

2) For any integer n ≥ 1, the sum $_{k=1}^{n}\ k\ \ k+2$ is equal to

(a) $\frac{n(n+1)\ (n+2)}{6}$

(b) $\frac{n(n+1)(2n+1)}{6}$

(c) $\frac{n(n+1)(2n+7)}{6}$

(d) $\frac{n(n+1)(2n+9)}{6}$

3) 9 balls are to be placed in 9 boxes and 5 of the balls cannot fit into 3 small boxes. The number of ways of arranging one ball in each of the boxes is

(a) 18720

(b) 18270

(c) 17280

(d) 12780

4) If ${}^{n}p_{r}$ = 30240 and ${}^{n}C_{r}$ = 252, then the ordered pair (n, r) is equal to

(a) (12, 6)

(b) (10, 5)

(c) (9, 4)

(d) (16, 7)

5) If $(1 + x + x^2 + x^3)^5 = \sum_{k=0}^{15} a_k x^k$ then $\sum_{k=0}^{7} a_{2k}$ is equal to

(a) 128

(b) 256

(c) 512

(d) 1024

6) If a + P = - 2 and $a^3 + \beta^3 = -56$, then the quadratic equation whose roots are a and β is

(a) $x^2 + 2x - 16 = 0$

(b) $x^2 + 2x + 15 = 0$

(c) $x^2 + 2x - 12 = 0$

(d) $x^2 + 2x - 8 = 0$

7) The cubic equation whose roots are thrice to each of the roots of $x^3 + 2x^2 - 4x + 1 = 0$ is

(a) $x^3 - 6x^2 + 36x + 27 = 0$

(b) $x^3 + 6x^2 + 36x + 27 = 0$

(c) $x^3 - 6x^2 - 36x + 27 = 0$

(d) $x^3 + 6x^2 - 36x + 27 = 0$

8) If $A = \begin{matrix} 1 & -2 \\ 4 & 5 \end{matrix}$ and $f(t) = t^2 - 3t + 7$, then

$f\ A + \begin{matrix} 3 & 6 \\ -12 & -9 \end{matrix}$ is equal to

(a) $\begin{matrix} 1 & 0 \\ 0 & 1 \end{matrix}$

(b) $\begin{matrix} 0 & 0 \\ 0 & 0 \end{matrix}$

(c) $\begin{matrix} 0 & 1 \\ 1 & 0 \end{matrix}$

(d) $\begin{matrix} 1 & 1 \\ 0 & 0 \end{matrix}$

9) $\begin{matrix} a-b-c & 2a & 2a \\ 2b & b-c-a & 2b \\ 2c & 2c & c-a-b \end{matrix}$ is equal to

(a) 0

(b) $a + b + c$

(c) $(a + b + c)^2$

(d) $(a + b + c)^3$

10) If co is a complex cube root of unity, then sin

$\omega^{10} + + \omega^{23}\ \pi - \frac{\pi}{4}$ is equal to

(a) $\frac{1}{2}$

(b) $\frac{1}{2}$

(c) 1

(d) $\frac{\overline{3}}{2}$

11) $\overline{3}$ cosec 20° - sec 20° is equal to

(a) 2

(b) 2 sin 20° - cosec 40°

(c) 4

(d) 4 sin 20°, cosec 40°

12) If tan θ + tan $(\theta + \frac{\pi}{3})$ + tan $(\theta + \frac{2\pi}{3})$ = 3, then which of the following is equal to 1 ?

(a) tan 2θ

(b) tan 3θ

(c) $\tan^2 \theta$

(d) $\tan^3 \theta$

13) $\{x \in R: \cos 2x + 2\cos^2 x = 2\}$ is equal to

(a) $2n\pi + \frac{\pi}{3} : n \in Z$

(b) $n\pi \pm \frac{\pi}{6} : n \in Z$

(c) $n\pi + \frac{\pi}{3} : n \in Z$

(d) $2n\pi - \frac{\pi}{3} : n \in Z$

14) If $\sin^{-1}\frac{3}{x} + \sin^{-1}\frac{4}{x} = \frac{\pi}{2}$, then x is equal to

(a) 3

(b) 5

(c) 7

(d) 11

15) In ΔABC, $if\ \frac{1}{b+c} + \frac{1}{c+a} = \frac{3}{a+b+c}$, then C is equal to

(a) 90°

(b) 60°

(c) 45°

(d) 30°

16) In a triangle, if $r_1 = 2r_2 = 3r_3$, then $\frac{a}{b} + \frac{b}{c} + \frac{c}{a}$ is equal to

(a) $\frac{75}{60}$

(b) $\frac{155}{60}$

(c) $\frac{176}{60}$

(d) $\frac{191}{60}$

17) From the top of a hill h metres high the angles of depressions of the top and the bottom of a pillar are a and β respectively. The height (in metres) of the pillar is

(a) $\frac{h\ \tan\beta - \tan a}{\tan\beta}$

(b) $\frac{h \tan\beta - \tan\alpha}{\tan\alpha}$

(c) $\frac{h \tan\beta + \tan\alpha}{\tan\beta}$

(d) $\frac{h \tan\beta + \tan\alpha}{\tan\alpha}$

18) The position vectors of P and Q are respectively a and b, If R is a point on PQ PQ such that PR = 5 PQ, then the position vector of R is

(a) 5 b – 4 a

(b) 5 b + 4 a

(c) 4 b - 5a

(d) 4 b + 5a

19) If the position vectors of A, B and C are respectively 2$\imath$ - $\jmath$ + k, $\imath$ – 3$\jmath$ - 5k and 3$\imath$ – 4$\jmath$ - 4k, then $\cos^2$ A is equal to

(a) 0

(b) $\frac{6}{41}$

(c) $\frac{35}{41}$

(d) 1

20) Let a be a unit vector, b = 2$\imath$ + $\jmath$ - k and c = $\imath$ + 3k. Then, maximum value of [a b c] is

(a) -1

(b) $\overline{10} + \overline{6}$

(c) $\overline{10} - \overline{6}$

(d) $\overline{59}$

21) If A and B are independent events of a random experiment such that $P(A \cap B) = \frac{1}{6}$ and $P(A \cap B) = \frac{1}{3}$, then P(A) is equal to (Here, E is the complement of the event E)

(a) $\frac{1}{4}$

(b) $\frac{1}{3}$

(c) $\frac{5}{7}$

(d) $\frac{2}{3}$

22) For k = 1, 2, 3 the box B_k contains k red balls and (k + 1) white balls, Let $P(B_1) = \frac{1}{2}$, $P(B_2) = 1$ and $P(B_3) = \frac{1}{6}$. A box is selected at random and a ball is drawn from it. If a red ball is drawn, then the probability that it has come from box B_2, is

(a) $\frac{35}{78}$

(b) $\frac{14}{39}$

(c) $\frac{10}{13}$

(d) $\frac{12}{13}$

23) If the sum of the distances of a point P from two perpendicular lines in a plane is 1, then the locus of P is a

(a) rhombus

(b) circle

(c) straight line

(d) pair of straight lines-

24) The transformed equation of $3x^2 + 3y^2 + 2xy = 2$. when the coordinate axes are rotated through an angle of 45°, is

(a) $x^2 + 2y^2 = 1$

(b) $2x^2 + y^2 = 1$

(c) $x^2 + y^2 = 1$

(d) $x^2 + 3y^2 = 1$

25) If l, m, n are in arithmetic progression, then the straight line $lx + my + n = 0$ will pass through the point

(a) (-1, 2)

(b) (1, -2)

(c) (1, 2)

(d) (2, 1)

26) A pair of perpendicular straight lines passes through the origin and also through the point of intersection of the curve $x^2 + y^2 = 4$ with $x + y = a$. The set containing the value of 'a' is

(a) {-2, 2}

(b) {-3, 3}

(c) {-4, 4}

(d) {-5, 5}

27) In Δ ABC the mid points of the sides AB, BC and CA are respectively (l, 0, 0), (0, m, 0) and (0, 0, n). Then,

$\frac{AB^2 + BC^2 + CA^2}{l^2 + m^2 + n^2}$ is equal to

(a) 2

(b) 4

(c) 8

(d) 16

28) If the lines 2x - 3y = 5 and 3x - 4y = 7 are two diameters of a circle of radius 7, then the equation of the circle is

(a) $x^2 + y^2 + 2x - 4y - 47 = 0$

(b) $x^2 + y^2 = 49$

(c) $x^2 + y^2 - 2x + 2y - 47 = 0$

(d) $x^2 + y^2 = 17$

29) The inverse of the point (1, 2) with respect to the circle $x^2 + y^2 - 4x - 6y + 9 = 0$, is

(a) $1, \frac{1}{2}$

(b) (2, 1)

(c) (0, 1)

(d) (1, 0)

30) If 2x + 3y + 12 = 0 and x - y + 4λ = 0 are conjugate with respect to the parabola y 2 = 8x, then λ is equal to

(a) 2

(b) - 2

(c) 3

(d) -3

31) The distance between the foci of the hyperbola $x^2 - 3y^2 - 4x - 6y - 11 = 0$ is

(a) 4

(b) 6

(c) 8

(d) 10

32) The radius of the circle with the polar equation $r^2 - 8r(\sqrt{3}\cos\theta + \sin\theta) + 15 = 0$ is

(a) 8

(b) 7

(c) 6

(d) 5

33) If $f : R \to R$ is defined by $f(x) = [x - 3] + |x - 4|$ for $x \in R$, then $\lim_{x \to 3} f(x)$ is equal to

(a) -2

(b) -1

(c) 0

(d) 1

34) If $f : R \to R$ is defined by

$f(x) = \begin{cases} \dfrac{\cos 3x - \cos x}{x^2}, & for\ x \neq 0 \\ \lambda, & for\ x = 0 \end{cases}$ and if f is continuous at x = 0, then λ is equal to

(a) -2

(b) -4

(c) -6

(d) -8

35) If f(2) = 4 and f'(2) = 1, then

$\lim_{x \to 2} \frac{x f(2) - 2f(x)}{x-2}$ is equal to

(a) -2

(b) 1

(c) 2

(d) 3

36) If $x = a\left(\cos\theta + \log\tan\frac{\theta}{2}\right)$ and y = a sin θ, then $\frac{dy}{dx}$ is equal to

(a) cot θ

(b) tan θ

(c) sin θ

(d) cos θ

37) The equation of the normal to the curve $y^4 = ax^3$ at (a, a) is

(a) x + 2y = 3a

(b) 3x - 4y + a = 0

(c) 4x + 3y = 7a

(d) 4x - 3y = 0

38) The length of the sub tangent at (2, 2) to the curve $x^5 = 2y^4$ is

(a) $\frac{5}{2}$

(b) $\frac{8}{5}$

(c) $\frac{2}{5}$

(d) $\frac{5}{8}$

39) If $e^x \left(\frac{1-\sin x}{1-\cos x}\right) dx = f(x) +$ constant, then f(x) is equal to

(a) $e^x \cot \frac{x}{2} + c$

(b) $e^{-x} \cot \frac{x}{2} + c$

(c) $-e^x \cot \frac{x}{2} + c$

(d) $-e^{-x} \cot \frac{x}{2} + c$

40) If $e^x (1 + x) . \sec^2 (xe^x) dx$

= f(x) + constant, then f(x) is equal to

(a) cos (xe^x)

(b) sin (xe^x)

(c) 2 $\tan^{-1}$ (x)

(d) tan (x e^x)

41) $\int_{-\pi/2}^{\pi/2} \sin x$ dx is equal to

(a) 0

(b) 1

(c) 2

(d) π

42) The area (in sq unit) of the region bounded by the curves 2x = y^2 - 1 and x = 0 is

(a) $\frac{1}{3}$

(b) $\frac{2}{3}$

(c) 1

(d) 2

43) The solution of the differential equation

$\frac{dy}{dx} = \frac{xy+y}{xy+x}$ is

(a) $x + y - \log \frac{cy}{x}$

(b) x + y = log (cxy)

(c) x - y - log $\frac{cx}{y}$

(d) y - x = log $\frac{cx}{y}$

44) The solution of the differential equation

$\frac{dy}{dx} - y \tan x = e^x \sec x$ *is*

(a) y = e^x cos x + c

(b) $y \cos x = e^x + c$

(c) $y = e^x \sin x + c$

(d) $y \sin x = e^x + c$

45) The solution of the differential equation

$xy^2\, dy - (x^3 + y^3)\, dx = 0$ is

(a) $y^3 = 3x^3 + c$

(b) $y^3 = 3x^3 \log (cx)$

(c) $y^3 = 3x^3 + \log (cx)$

(d) $y^3 + 3x^3 = \log (cx)$

Physics

46) The energy (E), angular momentum (L) and universal gravitational constant (G) are chosen as fundamental quantities. The dimensions of universal gravitational constant in the dimensional formula of Planck's constant (h) is

(a) Zero

(b) -1

(c) $\frac{5}{3}$

(d) 1

47) The component of vector A = a_x $\imath$ + a_y $\jmath$ + a_z k along the direction of $\imath - \jmath$ is

(a) a_x - a_y + a_z

(b) a_x - a_y

(c) (a_x - a_y)/ $\overline{2}$

(d) (a_x + a_y + a_z)

48) A body thrown vertically up to reach its maximum height in t second. The total time from the time of projection to reach a point at half of its maximum height while returning (in second) is

(a) $\overline{2}\,t$

(b) $1 + \frac{1}{\overline{2}}\ t$

(c) $\frac{3t}{2}$

(d) $\frac{t}{\overline{2}}$

49) If a body is projected with an angle e to the horizontal, then

(a) its velocity is always perpendicular to its acceleration

(b) its velocity becomes zero at its maximum height

(c) its velocity makes zero angle with the horizontal at its maximum height

(d) the body just before hitting the ground, the direction of velocity coincides with the acceleration

50) A river of salty water is flowing with a velocity 2 m/s, If the density of the water is 1.2 g/cc, then the kinetic energy of each cubic metre of water is

(a) 2.4 J

(b) 24 J

(c) 2.4 kJ

(d) 4.8 kJ

51) A ball is dropped from a height h on a floor of coefficient of restitution e. The total distance covered by the ball just before second hit is

(a) $h(1 - 2e^2)$

(b) $h(1 + 2e^2)$

(c) $h(1 + e^2)$

(d) he^2

52) Two particles A and B initially at rest, move towards each other, under mutual force of attraction. At an instance when the speed of A is v and speed of B is 2v, the speed of centre of mass (CM) is

(a) Zero

(b) v

(c) 2.5v

(d) 4v

53) Starting from rest, the time taken by a body sliding down on a rough inclined plane at 45° with the horizontal is, twice the time taken to travel on a smooth plane of same inclination and same distance. Then the coefficient of kinetic friction is

(a) 0.25

(b) 0.33

(c) 0.50

(d) 0.75

54) A steel wire can withstand a load up to 2940 N. A load of 150 kg is suspended from a rigid support. The maximum angle through which the wire can be displaced from the mean position, so that the wire does not break when the load passes through the position of equilibrium, is

(a) 30°

(b) 60°

(c) 80°

(d) 85°

55) The moment of inertia of a thin circular disc about an axis passing through its centre and perpendicular to its plane is 1. Then, the moment of inertia of the disc about an axis parallel to its diameter and touching the edge of the rim is

(a) I

(b) 2 I

(c) $\frac{3}{2}$ I

(d) $\frac{5}{2}$ I

56) The orbit of geo-stationary satellite is circular, the time period of satellite depends on –

(i) mass of the satellite

(ii) mass of the earth

(iii) radius of the orbit

(iv) height of the satellite from the surface of earth

Which of the following is correct?

(a) (i) only

(b) (i) and (ii)

(c) (i), (ii) and (iii)

(d) (ii), (iii) and (iv)

57) A particle is executing simple harmonic motion with an amplitude A and time period T. The displacement of the particles after 2 T period from its initial position is

(a) A

(b) 4 A

(c) 8 A

(d) Zero

58) A load of 1 kg weight is a attached to one end of a steel wire of area of cross-section 3 mm^2 and Young's modulus 10^{11} N/m^2. The other end is suspended vertically from a hook on a wall, then the load is pulled horizontally and released. When the load passes through its lowest position the fractional change in length is ($g = 10\ m/s^2$)

(a) 0.3×10^{-4}

(b) 0.3×10^{-3}

(c) 0.3×10^{3}

(d) 0.3×10^{4}

59) The surface tension of soap solution is 0.03 N/m. The work done in blowing to form a soap bubble of surface area 40 cm^2, (in J), is

(a) 1.2×10^{-4}

(b) 2.4×10^{-4}

(c) 12×10^{-4}

(d) 24×10^{-4}

60) Two rain drops reach the earth with different terminal velocities having ratio 9: 4. Then the ratio of their volumes is

(a) 3 : 2

(b) 4 : 9

(c) 9 : 4

(d) 27 : 8

61) One litre of oxygen at a pressure of 1 atm and two litres of

nitrogen at a pressure of 0.5 atm, are introduced into a vessel of volume 1 L. If there is no change in temperature, the final pressure of the mixture of gas (in atm) is

(a) 1.5

(b) 2.5

(c) 2

(d) 4

62) There is some change W length when a 33000 N tensile force is applied on a steel rod of area of cross-section 10^{-3} m^2. The change of temperature required to produce the same elongation, if the steel rod is heated, is (The modulus of elasticity is $3 \times 10^{11} N/m^2$ and the coefficient of linear expansion of steel is $1.1 \times 10^{-5}/^oC$).

(a) 20°C

(b) 15°C

(c) 10°C

(d) 0°C

63) In the adiabatic compression, the decrease in volume is associated with

(a) increase in temperature and decrease in pressure

(b) decrease in temperature and increase in pressure

(c) decrease in temperature and decrease in pressure

(d) increase in temperature and increase in pressure

64) Which of the following is true in the case of an adiabatic process,

where $\gamma = C_p / C_v$?

(a) $p^{1-\gamma} T^{1-\gamma}$ = constant

(b) $p^{\gamma} T^{1-\gamma}$ = constant

(c) pT^{γ} = constant

(d) $p^{\gamma} T$ = constant

65) Two slabs A and B of equal surface area are placed one over the other such that their surfaces are completely in contact. The thickness of slab A is twice that of B. The coefficient of thermal conductivity or slab A is twice that of B. The first surface of slab A is maintained at 100°C, while the second surface of slab B is maintained at 25°C. The temperature at the contact of their surfaces is

(a) 62.5°C

(b) 45°C

(c) 55°C

(d) 85°C

66) When a sound wave or wavelength A. is propagating in a medium, the 'maximum velocity of the particle is equal to the wave velocity. The amplitude of wave is

(a) λ

(b) $\frac{\lambda}{2}$

(c) $\frac{\lambda}{2\pi}$

(d) $\frac{\lambda}{4\pi}$

67) A car is moving with a speed of 72 km/h towards a hill. Car blows horn at a distance of 1800 m from the hill. If echo is heard after 10 s, the speed of sound (in m/s) is

(a) 300

(b) 320

(c) 340

(d) 360

68) The refractive index of a material of a planoconcave lens is 5/3, the radius of curvature is 0.3 m. The focal length of the lens in air is

(a) - 0.45 m

(b) - 0.6 m

(c) - 0.75 m

(d) -1.0 m

69) **Statement (S):** Using Huygen's eye-piece measurements can be taken but are not correct.

Reason (R): The cross wires, scale .and final image are not magnified proportionately because the image of the object is magnified by two lenses, whereas the cross wire scale is magnified by one lens only.

Identify the correct one of the following

(a) Both (S) and (R) are true, (R) explains (S).

(b) Both (S) and (R) are true, but (R) canner explain (S).

(c) Only (S) is correct, but (R) is wrong.

(d) Both-(S) and (R) are wrong.

70) An achromatic combination of lenses produces –

(a) images in black and white

(b) coloured images ,

(c) images unaffected by variation of refractive index with wavelength

(d) highly enlarged images are formed

71) In Fraunhofer diffraction experiment, L is the distance between screen and the obstacle, b is the size of obstacle and A. is wavelength of incident light. The general condition for the applicability of Fraunhofer diffraction is

(a) $\frac{b^2}{L\lambda} \gg 1$

(b) $\frac{b^2}{L\lambda} = 1$

(c) $\frac{b^2}{L\lambda} \ll 1$

(d) $\frac{b^2}{L\lambda} \neq 1$

72) With a standard rectangular bar magnet 'the time period of a vibration magnetometer is 4 s. The bar magnet is cut parallel to its length into four equal pieces. The time period of vibration magnetometer when one piece is used (in second) (bar magnet breadth is, small) is

(a) 16

(b) 8

(c) 4

(d) 2

73) The magnetised wire of moment M and length l is bent in the form of semicircle of radius r. Then its magnetic moment is

(a) $\frac{2M}{\pi}$

(b) 2M

(c) $\frac{M}{\pi}$

(d) zero

74) A charge of 1 π C is divided into two parts such that their charges are in the ratio of 2: 3. These two charges are kept at a distance 1 m apart in vacuum. Then, the electric force between them (in N) is

(a) 0.216

(b) 0.00216

(c) 0.0216

(d) 2.16

75) Two charges +q and -q are kept apart. Then at any point on the right bisector of line joining the two charges

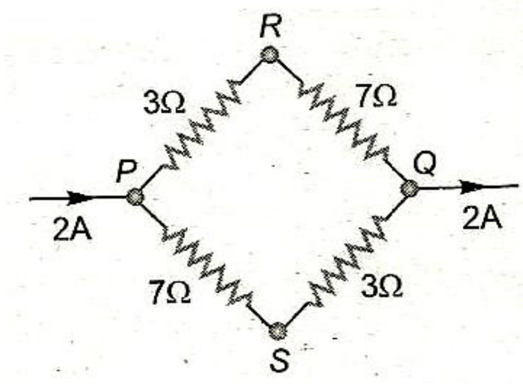
(a) The electric field strength is zero

(b) The electric potential is zero

(c) Both electric potential and electric field strength are zero

(d) Both electric potential and electric field strength are non-zero

76) A current of 2 A flows in an electric circuit as shown in figure. The potential difference (V_R - V_S), in volts (V_R and V_S are potentials at R and S respectively) is



(a) -4

(b) +2

(c) +4

(d) -2

77) When a battery connected across a resistor of 16Ω, the voltage across the resistor is 12 V. When the same battery is connected across a resistor of 10 Ω, voltage across it is 11 V. The internal resistance of the battery (in ohm) is

(a) $\frac{10}{7}$

(b) $\frac{20}{7}$

(c) $\frac{25}{7}$

(d) $\frac{30}{7}$

78) One junction of a certain thermoelectric couple is at a fixed temperature T, and the other junction is at temperature T. The thermo-electromotive force for this is expressed by

$E = k\ T - T_r \quad T_0 - \frac{1}{2}\ T + T_2$. At temperature T = $\frac{1}{2}$ T_0, the thermoelectric power is

(a) 19 G

(b) $\frac{G}{19}$

(c) 20 G

(d) $\frac{G}{20}$

79) In a galvanometer 5% of the total current in the circuit passes through it. If the resistance of the galvanometer is G, the shunt resistance 5 connected to the galvanometer is

(a) 19 G

(b) $\frac{G}{19}$

(c) 20 G

(d) $\frac{G}{20}$

80) Two concentric coils of 10 turns each are placed in the same plane. Their radii are 20 cm and 40 cm and carry 0.2 A and 0.3 A. current respectively in opposite directions. The magnetic induction (in tesla) at the centre is

(a) $\frac{3}{4}\mu_0$

(b) $\frac{5}{4}\mu_0$

(c) $\frac{7}{4}\mu_0$

(d) $\frac{9}{4}\mu_0$

81) The number of turns in primary- and secondary coils of a transformer is 50 and 200 respectively. If the current in the primary coil is 4 A, then the current in the secondary coil is

(a) 1 A

(b) 2 A

(c) 4 A

(d) 5 A

82) X-rays of wavelength 0.140 nm are scattered' from a block of carbon. What will be the wave lengths of X-rays scattered at 90° ?

(a) 0.140 nm

(b) 0.142 nm

(c) 0.144 nm

(d) 0.146 nm

83) An X-ray tube produces a continuous spectrum of radiation with its shortest wavelength of 45×10^{-2} Å. The maximum energy of a photon in the radiation in eV is ($h = 6.62 \times 10^{-34}$ J-s, $c = 3 \times 10^{8}$ m/s)

(a) 27,500

(b) 22,500

(c) 17,500

(d) 12,500

84) F_{pp}, F_{nn} and F_{np} are the nuclear forces between proton-proton, neutron-neutron and neutron-proton respectively. Then relation between them is

(a) $F_{pp} = F_{nn} \neq P_{np}$

(b) $F_{pp} \neq F_{nn} = F_{np}$

(c) $F_{pp} = F_{nn} = F_{np}$

(d) $F_{pp} \neq F_{nn} \neq F_{np}$

85) Which of the following statements is not correct when a junction diode is in forward bias?

(a) The width of depletion region decreases.

(b) Free electrons on n-side will move towards' the junction.

(c) Holes on p-side move towards the junction.

(d) Electron on n-side and holes on p-side will move away from junction.

86) An electronic transition in hydrogen atom results - in the formation of H_a line of hydrogen in Lyman series, the energies associated with the electron in each of the orbits involved in the transition (in kcal mol^{-1}) are

(a) -313.6, - 34.84

(b) -313.6, -78.4

(c) -78.4, - 34.84

(d) -78.4, -19.6

87) The velocities of two particles A and B are 0.05 and 0.02 ms^{-1} respectively. The mass of B is five times the mass of A. The ratio of their de- Broglie's wavelength is

(a) 2 : 1

(b) -1: 4

(c) 1 : 1

(d) 4 : 1

88) If the mass defect of $_5B^{11}$ is 0.081 u, its average binding energy (in MeV) is

(a) 8.60

(b) 6.85

(c) 5.60

(d) 5.86

89) The atomic numbers of elements A, B, C and D are Z - 1, Z, Z + 1 and Z + 2, respectively. If 'B' is a noble gas, choose the correct answers from the following statements

(1) 'A' has higher electron affinity

(2) 'C" exists in +2 oxidation state

(3) 'D' is an alkaline earth metal

(a) (1) and (2)

(b) (2) and (3)

(c) (1) and (3)

(d) (1), (2) and (3)

90) The bond length of HCI molecule is 1.275 Å and its dipole moment is 1.03 D. The ionic character of the molecule (in percent) (charge of the electron = 4.8×10^{-10} esu) is

(a) 100

(b) 67.3

(c) 33.66

(d) 16.83

91) Which one of the following is a correct set?

(a) H_2O, Sp^3, angular

(b) BCl_3, Sp^3, angular

(c) NH^+_4, dsp^2, square planar

(d) CH_4, dsp^2, tetrahedral

92) Match the following:

	List-I		List-II (At STP)
(A)	10 g $CaCO_3 \xrightarrow[\text{decomposition}]{\Delta}$	(i)	0.224 L CO_2
(B)	1.06 g $Na_2CO_3 \xrightarrow{\text{Excess HCl}}$	(ii)	4.48 L CO_2
(C)	2.4 g C $\xrightarrow[\text{combustion}]{\text{Excess } O_2}$	(iii)	0.448 L CO_2
(D)	0.56 g CO $\xrightarrow[\text{combustion}]{\text{Excess } O_2}$	(iv)	2.24 L CO_2
		(v)	22.4 L CO_2

The correct match is

	A	B	C	D
(a)	iv	i	ii	iii
(b)	v	i	ii	iii

(c) iv i iii ii

(d) i iv ii iii

93) What is the temperature at which the kinetic energy of 0.3 moles of helium is equal to the kinetic energy of 0.4 moles of argon -at 400 K?

(a) 400 K

(b) 873 K

(c) 533 K

(d) 300 K

94) When 25 g of a non-volatile solute is dissolved in 100.g of water, the vapour pressure is lowered by 2.25×10^{-1} mm. If the vapour pressure of water at 20°C is 17.5 mm, what is the molecular weight of the solute?

(a) 206

(b) 302

(c) 350

(d) 276

95) 50 mL of H_2O is added to 50 mL of 1×10^{-3} M barium hydroxide solution. What is the pH of the resulting solution?

(a) 3.0

(b) 3.3

(c) 11.0

(d) 11.7

96) **Assertion (A):** The aqueous solution of CH_3COONa is alkaline in nature.

Reason (R): Acetate ion undergoes anionic hydrolysis

The correct answer is

(a) both (A) and (R) are true and (R) is the correct explanation of (A).

(b) both (A) and (R) are true but (R) is not the correct explanation of (A).

(c) (A) is true but (R) is not true.

(d) (A) is not true but (R) is true.

97) When same quantity of electricity is passed through aqueous $AgNO_3$ and H_2SO_4 solutions connected in series, 5.04×10^{-2} g of H_2 is liberated. What is the mass of silver (in grams) deposited? (Eq. wts. of hydrogen = 1. 008, silver = 108)

(a) 54

(b) 0.54

(c) 5.4

(d) 10.8

98) When electric current is passed through acidified water for 1930 s, 1120 mL of H_2 gas is collected (at STP) at the cathode. What is the current passed in amperes?

(a) 0.05

(b) 0.50

(c) 5.0

(d) 50

99) For a crystal, the angle of diffraction (2θ) is 90° and the second order line has a d value of 2.28 Å. The wavelength (in Å) of X-rays used for Bragg's diffraction is

(a) 1.612

(b) 2.00

(c) 2.28

(d) 4.00

100) In a 500 mL flask, the degree of dissociation of PCl_5 at equilibrium is 40% and the initial amount is 5 moles. The value of equilibrium constant in mol L^{-1} for the decomposition of PCl_5 is

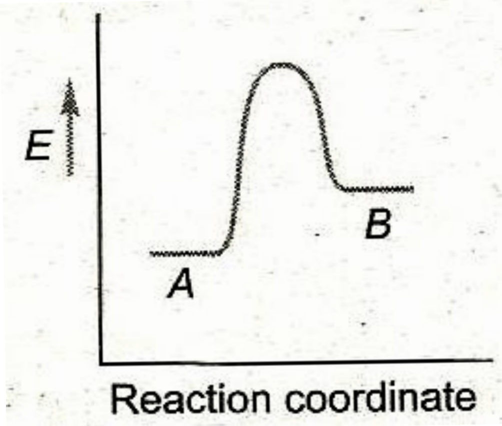
(a) 2.33

(b) 2.66

(c) 5.32

(d) 4.66

101) For a reversible reaction $A \rightleftharpoons B$, which one of the following statements is wrong from the given energy profile diagram?



(a) Activation energy of forward reaction is greater than backward reaction

(b) The forward reaction is endothermic

(c) The threshold energy is less than that of activation energy

(d) The energy of activation of forward reaction is equal to the sum of heat of reaction and the energy of activation of backward reaction

102) Calculate ΔH in kJ for the following reaction

$C(g) + O_2(g) \rightarrow CO_2(g)$

Given that,

$H_2O(g) + C(g) \rightarrow CO(g) + H_2(g)$;

$\Delta H = + 131$ kJ

$CO\ g + \frac{1}{2} O_2\ g \rightarrow CO_2\ g$;

$\Delta H = - 282$ kj

$H_2\ g + \frac{1}{2} O_2\ g \rightarrow H_2\ O\ g$;

$\Delta H = - 242$ kj

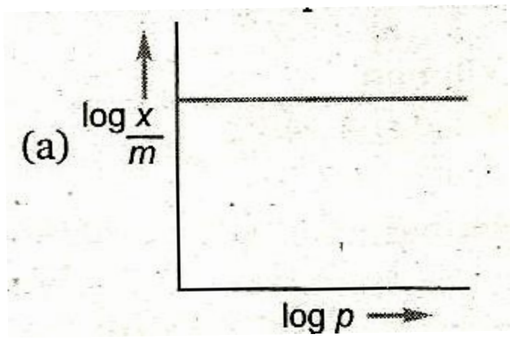
(a) -393

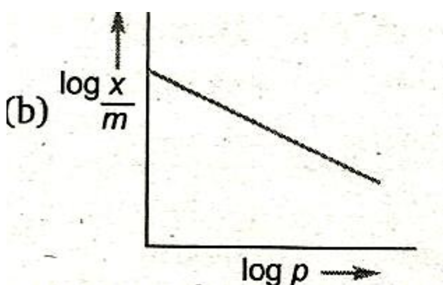
(b) +393

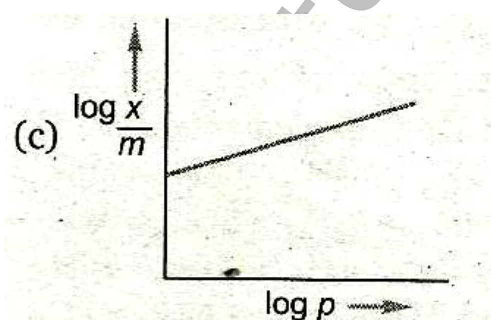
(c) +655

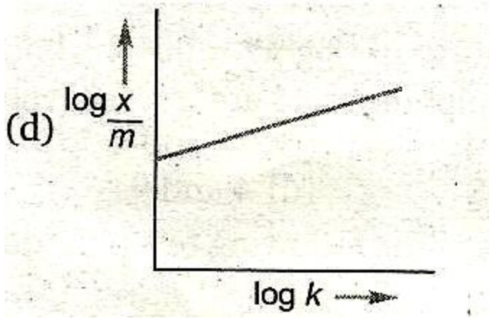
(d) -655

103) Which one of the following graphs represents "Freundlich adsorption isotherm?







(d) 

104) Which one of the following reactions represents the oxidising property of H_2O_2?

(a) $2KMnO_4 + 3H_2O_4 + 5H_2O_2 \rightarrow$

$K_2SO_4 + 2MnSO_4 + 8H_2O + 5O_2$

(b) $2K_3[Fe(CN)_6] + 2KOH + H_2O_2 \rightarrow$

$2K_4[Fe(CN)_6] + 2H_2O + O_2$

(c) $PbO_2 + H_2O_2 \rightarrow PbO + H_2O + O_2$

(d) $2KI + H_2SO_4 + H_2O_2 \rightarrow K_2SO_4 + 12 + 2H_2O$

105) Which of-the following statements are correct for alkali metal compounds?

(i) Superoxides are paramagnetic in nature.

(ii) The basic strengths of hydroxides increases down the group.

(iii) The conductivity of chlorides in their aqueous solutions decreases down the group.

(iv) The basic nature of carbonates in aqueous solutions is due to cationic hydrolysis.

(a) (i), (ii) and (iii) only

(b) (i) and (ii) only

(c) (ii), (iii) and (iv) only

(d) (iii) and (iv) only

106) Boron halides behave as Lewis acids because of their nature.

(a) proton donor

(b) covalent

(c) electron deficient

(d) ionising

107) Identify B in the following reaction

$$H_4SiO_4 \xrightarrow[-H_2O]{1000\ °C} A \xrightarrow[\Delta]{\text{Carbon}} B + CO$$

(a) corundum

(b) quartz

(c) silica

(d) carborundum

108) The correct order of reducing abilities of hydrides of V group elements is

(a) $NH_3 < PH_3 < AsH_3 < SbH_3 < BiH_3$

(b) $NH_3 > PH_3 > AsH_3 > SbH_3 > BiH_3$

(c) $NH_3 < PH_3 > AsH_3 > SbH_3 > BiH_3$

(d) $SbH_3 > BiH_3 > AsH_3 > NH_3 > PH_3$

109) The number of sigma and pi bonds in peroxodisulphuric acid are, respectively

(a) 9 and 4

(b) 11 and 4

(c) 4 and 8

(d) 4 and 9

110) Which one of the following reactions does not occur?

(a) $F_2 + 2CI^- \rightarrow 2F^- + Cl_2$

(b) $Cl_2 + 2F^- \rightarrow 2CI^- + F_2$

(c) $Br_2 + 2I^- \rightarrow 2Br^- + I_2$

(d) $Cl_2 + 2Br^- \rightarrow 2Cr + Br_2$

111) The compound in which the number of dπ- pπ bonds are equal to those present in CIO^-_4

(a) XeF_4

(b) XeO_3

(c) XeO_4

(d) XeF_6

112) $[Co(NH_3)_5$ SO4] Br and $[Co(NH_3)_5$ Br) SO_4 are a pair of isomers.

(a) ionisation

(b) ligand

(c) coordination

(d) hydrate

113) Among the following compounds, which one is not responsible for depletion of ozone layer?

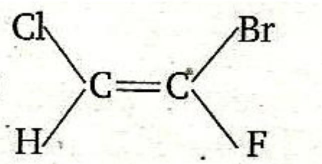
(a) CH_4

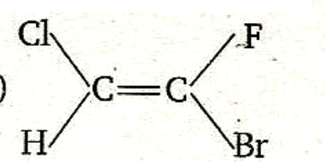
(b) $CFCl_3$

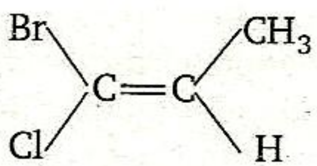
(c) NO

(d) Cl_2

114) Which of the following correspond (s) has 'Z' configuration?

(i) 

(ii) 

(iii) 

(a) (i) only

(b) (ii) only

(c) (iii) only

(d) (i) and (iii)

115) According to Cahn-Ingold-Prelog sequence rules, the correct order of priority for the given groups is

(a) – COOH > – CH_2OH > – OH > – CHO

(b) – COOH > – CHO > -CH_2 OH > – OH

(c) -OH> – CH_2OH > – CHO > –COOH

(d) -OH > – COOH > – CHO > – CH_2OH

116) What are X and Y respectively in the following reaction?

Z - product ^{Y} butyne ^{X} product

(a) Na/NH_3(liq.) and $Pd/BaSO_4 + H_2$

(b) Ni/140°C and $Pd/BaSO_4 + H_2$

(c) Ni/140°C and Na/NH_3(liq.)

(d) Pd/ $BaSO_4 + H_2$ and Na/NH_3(liq.)

117) In which of the following reactions, chlorine acts as an oxidising agent?

(i) $CH_3CH_2OH + Cl_2 \rightarrow CH_3CHO + HCI$

(ii) $CH_3CHO + Cl_2 \rightarrow CCl_3 . CHO + HCI$

(iii) $CH_4 + Cl_2 \rightarrow CH_3CI + HCl$

The correct answer is

(a) (i) only

(b) (ii) only

(c) (i) and (iii)

(d) (i), (ii) and (iii)

118) The correct order of reactivity of hydrogen halides with ethyl alcohol is

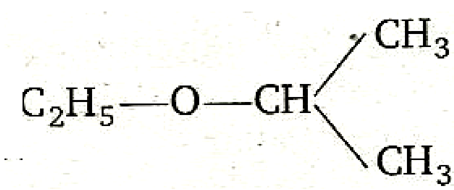
(a) HF > HCI > HBr > HI

(b) HCl > HBr > HF > HI

(c) HBr > HCl > HI > HF

(d) HI > HBr > HCl > HF

119) The IUPAC name of



is

(a) ethoxy propane'

(b) 1, 1-dimethyl ether

(c) 2-ethoxy isopropane

(d) 2-ethoxy propane

120) Acetone on addition to methyl magnesium bromide forms a complex, which on decomposition with acid gives X and Mg(OH)Br. Which one of the following is X?

(a) CH_3OH

(b) $(CH_3)_3COH$

(c) $(CH_3)_2$ CHOH

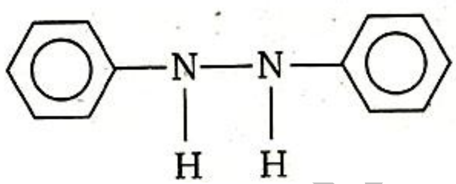
(d) CH_3CH_2OH

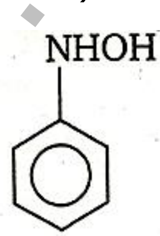
121) Identify A and B in the following reaction

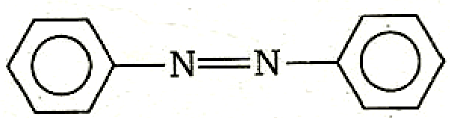
$$CH_3—CH_3 \xleftarrow{B} CH_3COOH \xrightarrow{A} CH_3CH_2OH$$

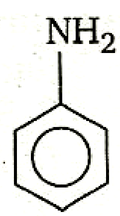
	A	B
(a)	HI + red P	$LiAlH_4$
(b)	NV /Δ	$LiAlH_4$
(c)	$LiAIH_4$	HI + red P
(d)	$Pd\text{-}BaSO_4$	Zn+ HCl

122) The structure of the compound formed, when nitrobenzene is reduced by lithium aluminum hydride ($LiAlH_4$) is

(a) 

(b) 

(c) 

(d) 

123) Match the following:

	List-I		List-II
(A)	Oxyhemoglobin	(i)	Analgesic
(B)	Aspirin	(ii)	Oxygen carrier
(C)	Hemoglobin	(iii)	Photosynthesis

(D)	Chlorophyll	(iv)	Oil of winter green
		(v)	Fe^{2+} paramagnetic

The correct match is

	A	B	C	D
(a)	(v)	(i)	(ii)	(iii)
(b)	(iv)	(ii)	(i)	(iii)
(c)	(iii)	(i)	(ii)	(iv)
(d)	(v)	(ii)	(iii)	(i)

124) If $\overline{M}_W$ is the weight average molecular weight and $\overline{M}_n$ is the number average molecular weight of a polymer, the poly dispersity index (PDI) of the polymer is given by

(a) $\frac{\overline{M}_n-}{M_w}$

(b) $\frac{\overline{M}_W}{M_n}$

(c) $\overline{M}_w \times \overline{M}_n$

(d) $\frac{1}{\overline{M}_w \times \overline{M}_n}$

125) Hydrolysis of sucrose with dilute aqueous sulphuric acid yields

(a) 1: 1 D - (+)- glucose; D-(-)-fructose

(b) 1: 2 D - (+)-glucose; D-(-)-fructose

(c) 1: 1 D-H-glucose; p- (+) -fructose

(d) 1: 2 D-(-)-glucose; D- (+) -fructose

English & Reasoning

Directions: In each of the following questions, choose the most appropriate alternative to fill in the blank.

126) The teacher ordered Kamal to leave the room …………… him to return.

(a) stopped

(b) refused

(c) forbade

(d) callenged

127) I hope you must have ……….. by now that failures are the stepping stones to success

(a) know

(b) felt

(c) decided

(d) realised

128) In a little published deal, Pepsi Cola has the entire soft drink market in Afghanistan.

(a) conquered

(b) swallowed

(c) captured

(d) occupied

Directions: In each of the following questions, put the parts P, Q, R and S in their proper order to produce the correct sentence.

129) The Bible,

(P) has in many respects

(Q) the sacred book of all Christians

(R) among all the books of the world

(S) a unique character and position

(a) QPSR

(b) QRPS

(c) RPQS

(d) RQPS

130) The ultimate hope

(P) will force the nations

(Q) that the destructive nature of weapons

(R) to give up war

(S) has not been fulfilled

(a) PQRS

(b) PRQS

(c) QPRS

(d) RSQP

131) It was

(P) in keeping with my mood

(Q) a soft summer evening,

(R) as I walked sedately

(S) in the direction of the new house

(a) QPRS

(b) QRPS

(c) SQPR

(d) SRPQ

Directions: In each of the following questions, choose the alternative which is most nearly the some in meaning to the "word given in capitol letters.

132) EPHEMERAL

(a) Uneral

(b) Mythical

(c) Short-living

(d) Artificial

133) STUBBORN

(a) Easy

(b) Obstinate

(c) Willing

(d) Pliable

134) PROGNOSIS

(a) Indentification

(b) Preface

(c) Forecast

(d) Scheme

Directions: In each of the following questions, choose the alternative which is opposite in meaning to the word given in capitol letters.

135) INFALLIBLE

(a) Erring

(b) Untrustworthy

(c) Dubious

(d) Unreliable

136) GATHER

(a) Separate

(b) Suspend

(c) Scatter

(d) Spend

137) EXALT

(a) Depreciate

(b) Ennoble

(c) Glorify

(d) Simplify

Directions: In each of the following questions, choose the alternative which can be substituted for the' given words/sentence.

138) Elderly woman in charge of a girl on social occasions

(a) Spinster

(b) Matron

(c) Chaperon

(d) Chandler

139) Land so surrounded by water as to be almost an island

(a) Archipelago

(b) Isthmus

(c) Peninusula

(d) Lagoon

140) A Place adjoining kitchen, for washing dishes etc.

(a) Cellar

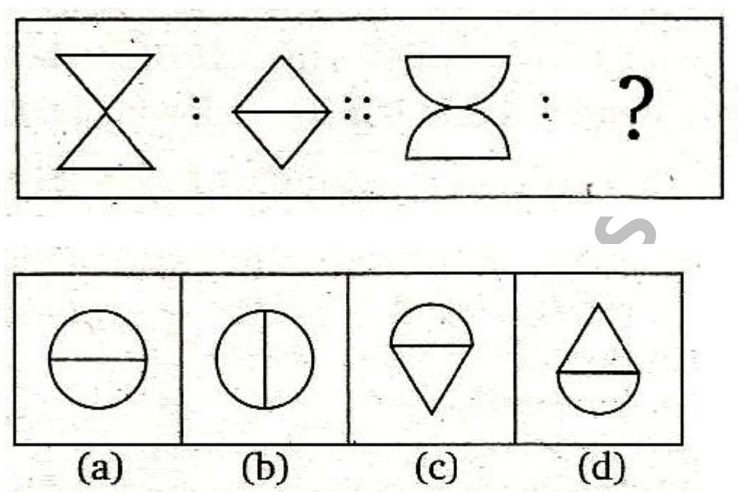
(b) Wardrobe

(c) Scullery

(d) Pantry

Direction: In each of these questions, two figure/words are given to the left of the sign:: and one figures word to the right of the sign:: with four alternatives under it out of which one of the alternatives has the same relationship with the figures/words to the right of the sign:: as between the two figures/words to the left of the sign (::). Find the correct alternative.

141)



142) **Direction:** In the question, three words are given. They are followed by four words one of which stands for the class to which these three words belong. Identify that word.

Newspaper, Hoarding. Television

(a) Press

(b) Media

(c) Broadcast

(d) Rumour

143) **Direction:** Find out the number which will come next in the series.

2, 5, 14, 122, 365

(a) 1029

(b) 1094

(c) 1059

(d) 1000

144) **Direction:** In the given question, some statements are followed by one or more inferences. The inference or inferences may be wrongly or correctly drawn. Select one of the alternatives which contains the correctly drawn inference or inferences.

Which of the conclusions drawn from the given statements are correct?

Given statements

Foreigners in Jordon without a valid work permit will be deported. A few Indian emplyees in the building industry in jordon do not possess valid work permits.

Inferences

(1) All Indians engaged in building industry in Jordon will be deported to India.

(2) A few Indians in building industry in Jordon will be deported.

(3) A bulk of Indians in Jordon will be deported to India.

(4) Indian employees in building industry without work permit will be deported from Jordon.

The inferences correctly drawn are

(a) 1 and 3

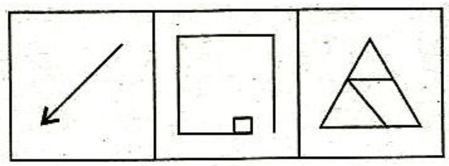
(b) -3 and 4

(c) -2 and 4

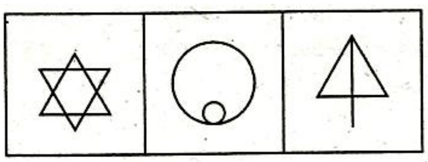
(d) 1 and 2

145) Select the series which obeys the given rule:

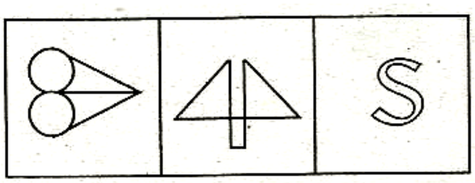
Any figure can be traced by a single unbroken line without retracing



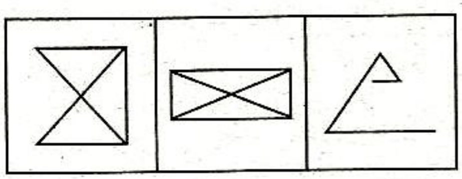
(a)



(b)

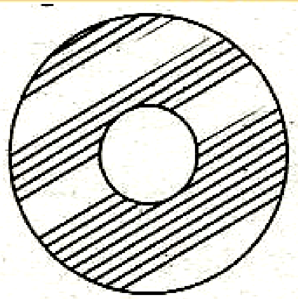


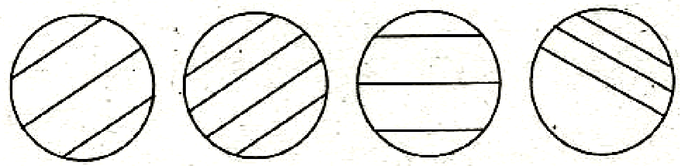
(c)



(d)

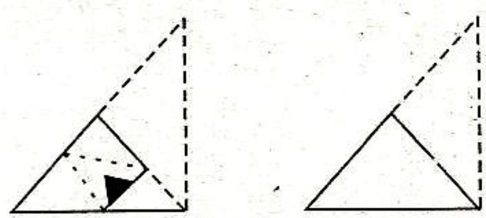
146) Select from amongst the four alternative figures, the one which complete the pattern in the problem figure.

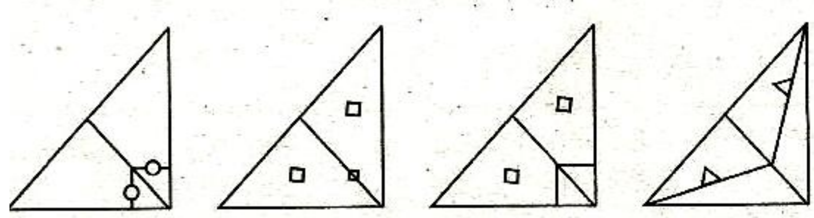




(a) (b) (c) (d)

147) **Direction:** In the following question a piece of paper is folded, cut and unfolded. One of the four figures given below is exactly like this unfolded paper. Find this out.

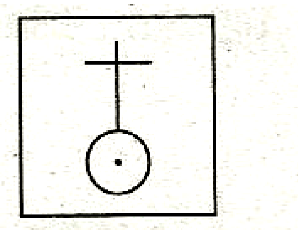


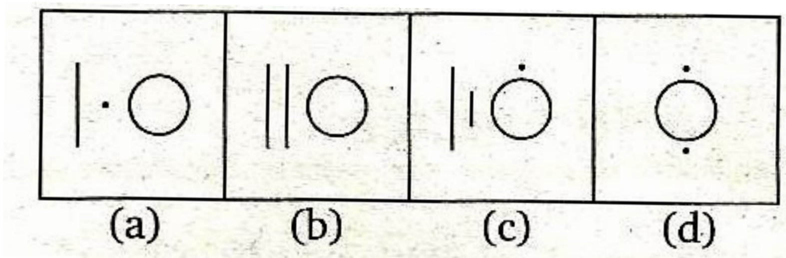


(a) (b) (c) (d)

148) **Direction:** In the question a figure is given, its components are

given in one of the four alternative figures. Find this one





149) **Direction:** In the given question, Jour numbers/number-pairs are given. Select the one which is different from the other three.

(a) 1234

(b) 2345

(c) 4567

(d) 7896

Direction: Find the group of letters from the four alternative which is obtained by applying the same rule to this given word to the right of the sign ::

150) FILM: ADGH:: MILK: ?

(a) ADGF

(b) HDGE

(c) HDGF

(d) HEGF

ANSWERS

MATHEMATICS

1. (c)	2. (c)	3. (c)	4. (b)	5. (c).	6. (d)
7. (d)	8. (b)	9. (d)	10. (a)	11. (c)	12. (b)
13. (b)	14. (b)	15. (b)	16. (d)	17. (a)	18. (a)
19. (c)	20. (d)	21. (b).	22. (b)	23. (a)	24. (b)

25. (b)	26. (a)	27. (c)	28. (c)	29. (c)	30. (d)
31. (c)	32. (b)	33. (c)	34. (b)	35. (c)	36. (b)
37. (c)	38. (b)	39. (c)	40. (d)	41. (c)	42. (b)
43. (d)	44. (b)	45. (b)			

PHYSICS

46. (a)	47. (c)	48. (b)	49. (c)	50. (c)	51. (b)
52. (a)	53. (d)	54. (b)	55. (d)	56. (d)	57. (d)
58. (a)	59. (b)	60. (d)	61. (c)	62. (c)	63. (d)
64. (a)	65. (a)	66. (c)	67. (c)	68. (a)	69. (a)
70. (c)	71. (c)	72. (c)	73. (a)	74. (b)	75. (b)
76. (c)	77. (b)	78. (a)	79. (b)	80. (b)	81. (a)
82. (b)	83. (a)	84. (c)	85. (d)		

CHEMISTRY

86. (b)	87. (a)	88. (b)	89. (c)	90. (d)	91. (a)
92. (a)	93. (c)	94. (c)	95. (c)	96. (a)	97. (c)
98. (c)	99. (a)	100. (b)	101. (c)	102. (a)	103. (c)
104. (d)	105. (b)	106. (c)	107. (d)	108. (a)	109. (b)
110. (b)	111. (b)	112. (a)	113. (a)	114. (d)	115. (d)
116. (a)	117. (d)	118. (d)	119. (d)	120. (b)	121. (c)
122. (c)	123. (a)	124. (b)	125. (a)		

ENGLISH & REASONING

126. (c)	127. (d)	128. (c)	129. (a)	130. (c)	131. (a)
132. (c)	133. (b)	134. (c)	135. (a)	136. (c)	137. (a)
138. (c)	139. (c)	140. (c)	141. (a)	142. (b)	143. (b)
144. (c)	145. (b)	146. (b)	147. (a)	148. (c)	149. (d)
150. (c)					

Hints and Solutions

Mathematics

1) Given that, f (x) = |x| and g(x) = [x – 3]

For $-\frac{8}{5} < x < \frac{8}{5}, 0 \le f(x) < \frac{8}{5}$

Now, for 0 < f(x) < 1,

g(f(x)) = [f(x) – 3]

= –3 $\because -3 \le f(x) - 3 < -2$

Again, for 1 < f(x) < 1.6

g(f(x)) = –2

$\because -2 \le f(x) - 3 < -1.4$

hence, required set is {–3, –2}.

2) Now, $\sum_{k=1}^{n} k(k+2)$

= $\sum_{k=1}^{n} (k^2 + 2k) = \sum_{k=1}^{n} k^2 + 2\sum_{k=1}^{n} k$

= $\frac{n(n+1)(2n+1)}{6} + \frac{2.n(n+1)}{2}$

= n(n + 1) $\left(\frac{2n+1}{6} + 1\right)$

= $\frac{n(n+1)(2n+7)}{6}$

3) Required number of arrangements

= $^6P_5 \times 4!$

= 720 × 24

= 17280

4) Given that, ${}^nP_r = 30240$ and ${}^nC_r = 252$

$\Rightarrow \frac{n!}{n-r\ !} = 30240$ and $\frac{n!}{n-r\ !r!} = 252$

$\Rightarrow r! = \frac{30240}{252} = 120$

$\Rightarrow r = 5$

$\therefore \frac{n!}{n-5\ !} = 30240$

$\Rightarrow n(n - 1)(n - 2)\ (n - 3)(n - 4) = 30240$

$\Rightarrow n(n - 1)(n - 2)(n - 3)(n - 4)$

$= 10\ (10 - 1)(10 - 2)(10 - 3)(10 - 4)$

$\Rightarrow n = 10$

Hence, required ordered pair is (10, 5).

5) Given, $(1 + x + x^2 + x^3)^5 = {}^{15}_{k=0}\, a_k x^k$

$\Rightarrow [(1 + x) + x\ (1 + x)]^5 = {}^{15}_{k=0}\, a_k x^k$

$\Rightarrow (1 + x)^{10} = a_0x^0 + a_1x + a_2x^2 + \ldots + a_{15}x^{15}$

$\Rightarrow {}^{10}C_0 + {}^{10}C_1x + {}^{10}C_2x^2 + \ldots + {}^{10}C_{10}x^{10}$

$= a_0 + a_1x + a_2x^2 + a_3x^3 + \ldots + a_{15}x^{15}$

On equating the coefficient of constant and even powers of x, we get

$a_0 = {}^{10}C_0,\ a_2 = {}^{10}C_2,$

$a_4 = {}^{10}C_4, \ldots, a_{10} = {}^{10}C_{10},$

$a_{12} = a_{14} = 0$

$\therefore \quad \sum_{k=0}^{7} a_2k = {}^{10}C_0 + {}^{10}C_2 + {}^{10}C_4 + {}^{10}C_6 + {}^{10}C_8 + {}^{10}C_{10} + 0 + 0$

$= 2^{10-1} = 29$

$= 512$

6) Given that, $\alpha + \beta = -2$ and $\alpha^3 + \beta^3 = -56$

$\Rightarrow \quad (\alpha + \beta)(\alpha^2 + \beta^2 - \alpha\beta) = -56$

$\Rightarrow \quad \alpha^2 + \beta^2 - \alpha\beta = 28$

Now, $\quad (\alpha + \beta)^2 = (-2)^2$

$\Rightarrow \quad \alpha^2 + \beta^2 + 2\alpha\beta = 4$

$\Rightarrow \quad 28 + 3\alpha\beta = 4$

$\Rightarrow \quad \alpha\beta = -8$

$\therefore$ Required equation is

$x^2 - (-2)x + (-8) = 0$

$\Rightarrow \quad x^2 + - 2x - 8 = 0$

7) Given equation is

$x^3 + 2x^2 - 4x + 1 = 0$

Let α, β and γ be the roots of the given equation

$\therefore \quad \alpha + \beta + \gamma = -2, \alpha\beta + \beta\gamma + \gamma\alpha = -4$

and $\quad \alpha\beta\gamma = -1$

Let the required cubic equation has the roots 3α, 3β and 3γ.

$\Rightarrow \quad 3\alpha + 3\beta + 3\gamma = -6,$

$3\alpha \cdot 3\beta + 3\beta + 3\gamma + 3\gamma \cdot 3\alpha = 36$

and $\quad 3\alpha \cdot 3\beta \cdot 3\gamma = -27$

$\therefore$ Required equation is

$$x^3 - (-6)x^2 + (-36)x - (-27) = 0$$

$$\Rightarrow \quad x^3 + 6x^2 - 36x + 27 = 0$$

8) Given that,

$A = \begin{bmatrix} 1 & -2 \\ 4 & 5 \end{bmatrix}$ and $f(t) = t^2 - 3t + 7$

Now, $A^2 = \begin{bmatrix} 1 & -2 \\ 4 & 5 \end{bmatrix}\begin{bmatrix} 1 & -2 \\ 4 & 5 \end{bmatrix}$

$= \begin{bmatrix} -7 & -12 \\ 24 & 17 \end{bmatrix}$

Now, $f(A) = A^2 - 3A + 7$

$= \begin{bmatrix} -7 & -12 \\ 24 & 17 \end{bmatrix} - 3\begin{bmatrix} 1 & -2 \\ 4 & 5 \end{bmatrix} + 7\begin{bmatrix} 1 & 0 \\ 0 & 1 \end{bmatrix}$

$= \begin{bmatrix} -3 & -6 \\ 12 & 9 \end{bmatrix}$

$\therefore f(A) + \begin{bmatrix} 3 & 6 \\ -12 & -9 \end{bmatrix} = \begin{bmatrix} -3 & -6 \\ 12 & 9 \end{bmatrix} + \begin{bmatrix} 3 & 6 \\ -12 & -9 \end{bmatrix}$

$= \begin{bmatrix} 0 & 0 \\ 0 & 0 \end{bmatrix}$

9) Let $\Delta = \begin{vmatrix} a-b-c & 2a & 2a \\ 2b & b-c-a & 2b \\ 2c & 2c & c-a-b \end{vmatrix}$

Applying $R_1 \to R_1 + R_2 + R_3$ and taking common (a + b + c) from R_1

$= (a + b + c)\begin{vmatrix} 1 & 1 & 1 \\ 2b & b-c-a & 2b \\ 2c & 2c & c-a-b \end{vmatrix}$

Applying $C_2 \to C_2 \to C_1$ and $C_3 \to C_3 \to C_1$,

$$= (a + b + c)\begin{vmatrix} 1 & 0 & 0 \\ 2b & -b-c-a & 0 \\ 2c & 0 & -a-b-c \end{vmatrix}$$

= (a + b + c)[(− b − c − a)(− a − b − c)]

= (a + b + c)

10) Since, ω is a cube root of unity,

$\therefore$ sin $\left(\omega^{10} + \omega^{23}\right)\pi - \frac{\pi}{4}$

= sin $\left(\omega + \omega^{2}\right)\pi - \frac{\pi}{4}$

= sin $\left(-\pi - \frac{\pi}{4}\right)$ $(\because 1 + \omega + \omega^2 = 0)$

= sin $\left(-\pi - \frac{\pi}{4}\right) = \sin\frac{\pi}{4}$

$= \frac{1}{\sqrt{2}}$

11) $\sqrt{3}$ cosec 20° – sec 20°

$= \frac{\tan 60^o}{\sin 20^o} - \frac{1}{\cos 20^o}$

$= \frac{\sin 60^o \cos 20^o - \sin 20^o \cos 60^o}{\cos 60^o \sin 20^o \cos 20^o}$

$= \frac{\sin 40^o}{\cos 60^o \sin 20^o \cos 20^o}$

$= \frac{2 \sin 20^o \cos 20^o}{\frac{1}{2} \sin 20^o \cos 20^o} = 4$

12) Given,

tan θ + tan $\left(\theta + \frac{\pi}{3}\right) + \tan\left(\theta + \frac{2\pi}{3}\right) = 3$

$\Rightarrow \quad \tan\theta + \frac{\tan\theta + \sqrt{3}}{1 - \sqrt{3}\tan\theta} + \frac{\tan\theta - \sqrt{3}}{1 + \sqrt{3}\tan\theta} = 3$

$\Rightarrow \quad \tan\theta + \frac{8\tan\theta}{1 - 3\tan^2\theta} = 3$

$\Rightarrow \quad \frac{9\tan\theta - 3\tan^2\theta}{1 - 3\tan^2\theta} = 3$

$\Rightarrow \quad 3\tan 3\theta = 3 \qquad \Rightarrow \quad \tan 3\theta = 1$

Hence, option (b) is correct.

13) Given equation is

$\cos 2x + 2\cos^2 x = 2$

$\Rightarrow \quad 2\cos^2 x - 1 + 2\cos^2 x = 2$

$\Rightarrow \quad 4\cos^2 x = 3$

$\Rightarrow \quad \cos^2 x = \frac{3}{4}$

$\Rightarrow \quad \cos x = \pm \frac{\sqrt{3}}{2}$

$\therefore \quad x = n\pi \pm \frac{\pi}{6} : n \in Z$

14) Given that,

$\sin^{-1} \frac{3}{x} \; \sin^{-1} \frac{4}{x} = \frac{\pi}{2}$

$\therefore \quad \sin^{-1} \frac{3}{x} = \frac{\pi}{2} - \sin^{-1} \frac{4}{x}$

$\Rightarrow \quad \sin^{-1} \frac{3}{x} = \cos^{-1} \frac{4}{x}$

$\Rightarrow \quad \sin^{-1} \frac{3}{x} = \sin^{-1} \frac{\sqrt{x^2 - 16}}{x}$

$\Rightarrow \quad \frac{3}{x} = \frac{\sqrt{x^2 - 16}}{x}$

$\Rightarrow \quad 9 = x^2 - 16 \quad \Rightarrow \quad x^2 = 25$

$\Rightarrow \quad x = \underline{+}\, 5$

$\Rightarrow \quad x = 5$

($\because$ −5 is not satisfied the given equation)

15) Given that,

$$\frac{1}{b+c} + \frac{1}{c+a} = \frac{3}{a+b+c}$$

$\Rightarrow \quad 1 + \frac{b}{a+c} + 1 + \frac{a}{b+c} = 3$

$\Rightarrow \quad b(b + c) + a(a + c) = (a + c)(b + c)$

$\Rightarrow \quad b^2 + bc + a^2 + ac = ab + ac + bc + c^2$

$\Rightarrow \quad a^2 + b^2 - c^2 = ab$

We know that, $\cos C = \frac{a^2+b^2-c^2}{2ab} = \frac{ab}{2ab} = \frac{1}{2}$

$\Rightarrow \quad C = 60^o$

16) Given that, $r_1 = 2r_2 = 3r_3$

$\therefore \quad \frac{\Delta}{s-a} = \frac{2\Delta}{s-b} = \frac{3\Delta}{s-c} = \frac{\Delta}{k} \quad$ (say)

Then, $s - a = k$, $s - b = 2k$, $s - c = 3k$

$\Rightarrow \quad 3x - (a + b + c) = 6k \quad \Rightarrow \quad s = 6k$

$\therefore \quad \frac{a}{5} = \frac{b}{4} = \frac{c}{3} = k$

Now, $\frac{a}{b} + \frac{b}{c} + \frac{c}{a} = \frac{5}{4} + \frac{4}{3} + \frac{3}{5}$

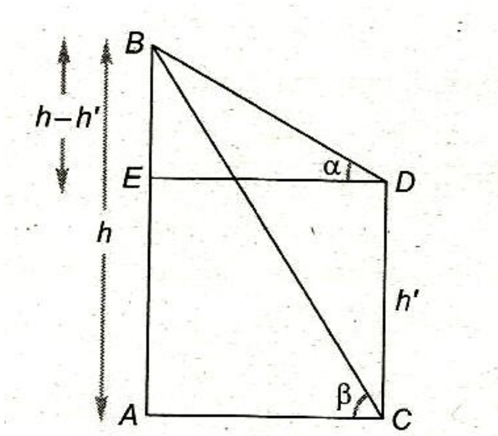
$= \frac{75+80+36}{60} = \frac{191}{60}$

17) Let AB be a hill whose height is h metres and CD be a pillar of height h′ metres.

In ΔEDB,

$$\tan\alpha = \frac{h-h'}{ED} \qquad \text{...... (i)}$$

and in ΔACB,



$$\tan\beta = \frac{h}{AC} = \frac{h}{ED} \qquad \text{...... (ii)}$$

Eliminate ED from Eqs. (i) and (ii), we get

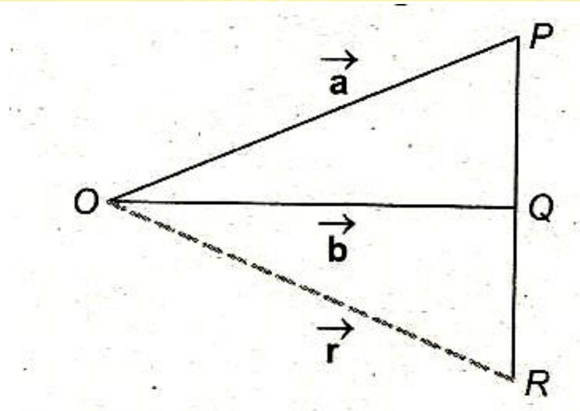
$$\tan\alpha = \frac{h-h'}{\frac{h}{\tan\beta}}$$

$$\Rightarrow \quad h\,\frac{\tan\alpha}{\tan\beta} = h - h'$$

$$\Rightarrow \quad h' = \frac{h\ \tan\beta - \tan\alpha}{\tan\beta}$$

18) Given that,

$$PR = 5PQ$$



It mean R divides PQ externally in the ratio 5 : 4.

$\therefore$ Position vector of R = $\frac{5b-4a}{5-4}$

$$= 5b - 4a$$

19) Let $OA = 2\imath - \jmath + k$, $OB = \imath - 3\jmath - 5k$ and $OC = 3\imath - 4\jmath - 4k$

$\therefore$ a = $|OA| = \sqrt{6}, b = |OB| = \sqrt{35}$

and c = $|OC| = \sqrt{41}$

$\therefore$ cos A = $\frac{b^2+c^2-a^2}{2bc}$

$$= \frac{(\sqrt{35})^2 + (\sqrt{41})^2 - (\sqrt{6})^2}{2\sqrt{35}\sqrt{41}}$$

$\Rightarrow$ cos A = $\frac{70}{2\sqrt{35}\sqrt{41}} = \sqrt{\frac{35}{41}}$

$\Rightarrow$ $\cos^2 A = \frac{35}{41}$

20) Given that,

$b = 2\imath + \jmath - k$ and $c = \imath + 3k$

Now, $b \times c = \begin{vmatrix} \hat{\imath} & \hat{\jmath} & \hat{k} \\ 2 & 1 & -1 \\ 1 & 0 & 3 \end{vmatrix}$

$= \hat{\imath}(3 - 0) - \hat{\jmath}(6 + 1) + \hat{k}(0 - 1)$

$= 3\hat{\imath} - 7\hat{\jmath} - \hat{k}$

Now, $[a\ b\ c] = a.\ (b \times c)$

$= |a|\ |b \times c| \cos\theta$

$= 1\ \sqrt{3^2 + 7^2 + 1^2}\ \cos\theta$

$= \sqrt{59} \cos\theta$

$\Rightarrow [a\ b\ c]_{max} = \sqrt{59}\ .\ 1$

($\because$ maximum value of $\cos\theta$ is 1)

Hence, maximum value is $\sqrt{59}$.

21) Given that, $P(A \cap B) = \frac{1}{6}$ and $P(\overline{A} \cap \overline{B}) = \frac{1}{3}$

Since, A and B are independent.

$\therefore$ $P(A)P(B) = \frac{1}{6}$ and $P(\overline{A})P(\overline{B}) = \frac{1}{3}$

$\Rightarrow \quad [1 - P(A)][1 - P(B)] = \frac{1}{3}$

$\Rightarrow \quad 1 - [P(A) + P(B)] + P(A)P(B) = \frac{1}{3}$

$\Rightarrow \quad 1 + \frac{1}{6} - \frac{1}{3} = P(A) + P(B)$

$\Rightarrow \quad P(A) + P(B) = \frac{5}{6}$

$\Rightarrow \quad P(A) = \frac{1}{2}, P(B) = \frac{1}{3}$

and $\quad P(A) = \frac{1}{3}, P(B) = \frac{1}{2}$

Hence, options (b) and (c) are correct.

22) In a box,

$B_1 = 1R, 2W$

$B_2 = 2R, 3W$

and $B_3 = 3R, 4W$

Also, given that,

$P(B_1) = \frac{1}{2}$, $P(B_2) = \frac{1}{3}$ and $P(B_3) = \frac{1}{6}$

$\therefore$ P $\frac{B_2}{R}$

$$= \frac{P\ B_2\ P\ \frac{R}{B_2}}{P\ B_1\ P\ \frac{R}{B_1}\ +P\ B_2\ P\ \frac{R}{B_2}\ +P\ B_3\ P\ \frac{R}{B_3}}$$

$$= \frac{\frac{1}{3}\times\frac{2}{5}}{\frac{1}{2}\times\frac{1}{3}\times\frac{1}{3}\times\frac{2}{5}+\frac{1}{6}\times\frac{3}{7}} = \frac{\frac{2}{15}}{\frac{1}{6}+\frac{2}{15}+\frac{1}{14}}$$

$$= \frac{\frac{2}{15}}{\frac{35+28+15}{210}} = \frac{2}{15}\times\frac{210}{78} = \frac{14}{39}$$

23) The sum of the distance of a point P from two perpendicular lines in a plane is 1, then the locus of P is a rhombus.

24) Since, the axes are rotated through an angle 45^o, then we replace (x, y) by

$(x \cos 45^o - y \sin 45^o, x \sin 45^o + y \cos 45^o)$

in the given equation $3x^2 + 3y^2 + 2xy = 2$

$$\therefore \quad 3\ \frac{x}{\sqrt{2}} - \frac{y}{\sqrt{2}}\ ^2 + 3\ \frac{x+y}{\sqrt{2}}\ + 2\ \frac{x-y}{\sqrt{2}}\ \ \frac{x+y}{\sqrt{2}}\ = 2$$

$\Rightarrow \quad \frac{3}{2}(x^2 + y^2 + 2xy) + \frac{3}{2}(x^2 + y^2 - 2xy) + \frac{2}{2}(x^2 - y^2) = 2$

$\Rightarrow \quad 4x^2 = 2y^2 = 2$

$\Rightarrow \quad 2x^2 + y^2 = 1$

25) Since, l, m, n are in AP.

$\therefore \quad 2m = l + n$

Given equation of line is

$lx + my + n = 0$

Now, assume that the point (1, −2) satisfy the given equation.

$\therefore \quad l - 2m + n = 0$

$\Rightarrow \quad 2m = l + n$

$\Rightarrow$ l, m, n are in AP.

Hence, option (b) is correct.

26) To make the given curves $x^2 + y^2 = 4$ and $x + y = a$ homogenous.

$\therefore \quad x^2 + y^2 - 4\left(\frac{x+y}{a}\right)^2 = 0$

$\Rightarrow \quad a^2(x^2 + y^2) - 4(x^2 + y^2 + 2xy) = 0$

$\Rightarrow \quad x^2(a^2 - 4) + y^2(a^2 - 4) - 8xy = 0$

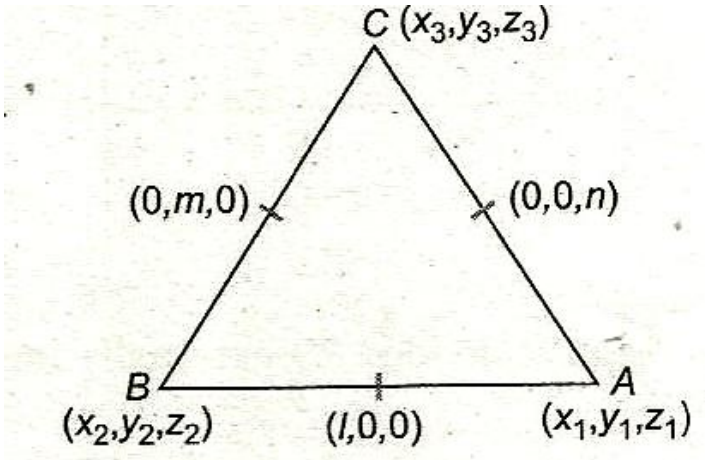
Since, this is a perpendicular pair of straight lines.

$\therefore \quad a^2 - 4 + a^2 - 4 = 0$

$\Rightarrow \quad a^2 = 4 \Rightarrow a = \pm 2.$

Hence, required set of a is {−2, 2}.

27) From the figure,



$x_1 + x_2 = 2l$, $y_1 + y_2 = 0$, $z_1 + z_2 = 0$,

$x_2 + x_3 = 0$, $y_2 + y_3 = 2m$, $z_2 + z_3 = 0$

and $x_1 + x_3 = 0$, $y_1 + y3 = 0$, $z_1 + z_3 = 2n$

On solving, we get

$x_1 = l$, $x_2 = l$, $x_3 = -l$,

$y_1 = -m$, $y_2 = m$, $y_3 = m$

and $z_1 = n$, $z_2 = -n$, $z_3 = n$

$\therefore$ Coordinates are A(l, −m, n), B(l, m, −n) and C(−l, m, n)

$$\therefore \quad \frac{AB^2+BC^2+CA^2}{l^2+m^2+n^2}$$

$$= \frac{4m^2+4n^2 \; + \; 4l^2+4n^2 \; +(4l^2+4m^2)}{l^2+m^2+n^2}$$

$= 8$

28) Since, the lines 2x − 3y = 5 and 3x − 4y = 7 are the diameters of a circle. Therefore, the point of intersection is the centre of

the circle. On solving the given equations, we get $x = 1$ and $y = -1$ i.e., the centre of the circle.

Required equation of circle is

$$(x - 1)^2 + (y + 1)^2 = 72$$

$\Rightarrow \quad x^2 + y^2 - 2x + 2y + 2 = 49$

$\Rightarrow \quad x^2 + y^2 - 2x + 2y - 47 = 0$

29) The equation of pole w.r.t. the point (1, 2) to the circle $x^2 + y^2 - 4x - 6y + 9 = 0$ is

$$x + 2y - 2(x + 1) - 3(y + 2) + 9 = 0$$

$\Rightarrow \quad x + y - 1 = 0$

Since, the inverse of the point (1, 2) is the foot (α, β) of the perpendicular from the point (1, 2) to the line $x + y - 1$.

$\therefore \quad \frac{\alpha-1}{1} = \frac{\beta-2}{1} = -\frac{1.1+1.2-1}{1^2+1^2}$

$\Rightarrow \quad \alpha - 1 = \beta - 2 = -1$

$\Rightarrow \quad \alpha = 0, \beta = 1$

Hence, required point is (0, 1).

30) Using the condition that if two lines $l_1x + m_1y + n_1 = 0$ and $l_2x + m_2y + n_2 = 0$ are conjugate w.r.t. parabola $y^2 = 4ax$, then

$$l_1n_2 + l_2n_1 = 2am_1m_2 \qquad \text{...... (i)}$$

Given conjugate lines are $2x + 3y + 12 = 0$ and $x - y + 4\lambda = 0$ and equation of parabola is $y^2 = 8x$.

Here, $l_1 = 2$, $m_1 = 3$, $n_1 = 12$; $l_2 = 1$, $m_2 = -1$,

$n_2 = 4\lambda$ and $a = 2$

$\therefore$ From Eq. (i),

$$2 \times 4\lambda + 1 \times 12 = 2 \times 2 \times 3 \times (-1)$$

$$8\lambda = -12 - 12 \quad \Rightarrow \quad \lambda = -3$$

31) Given, equation of hyperbola is

$$x^2 - 3y^2 - 4x - 6y - 11 = 0$$

$$\Rightarrow \quad (x^2 - 4x + 4) - 3(y^2 + 2y + 1) - 11$$

$$= 4 - 3$$

$$\Rightarrow \quad (x - 2)^2 - 3(y + 1)^2 = 12$$

$$\Rightarrow \quad \frac{(x-2)^2}{12} - \frac{(y+1)^2}{4} = 1$$

Now, $\quad e = \sqrt{1 + \frac{4}{12}} = \frac{2}{\sqrt{3}}$

$\therefore$ Distance between foci

$$= 2ae = 2 \times \sqrt{12} \times \frac{2}{\sqrt{3}} = 8$$

32) Given polar equation of circle is

$$r^2 - 8(\sqrt{3}\cos\theta + \sin\theta) + 15 = 0$$

or $\quad r^2 - 8(\sqrt{3}\, r\cos\theta + r\sin\theta) + 15 = 0$

where $r\cos\theta = x$ and $y = r\sin\theta$.

It can be rewritten in cartesian form

$$x^2 + y^2 - 8(\sqrt{3}x + y) + 15 = 0$$

$$\Rightarrow \quad x^2 + y^2 - 8\sqrt{3}x - 8y + 15 = 0$$

Now, radius = $\sqrt{(4\sqrt{3})^2 + (4)^2 - 15}$

$= \sqrt{48 + 16 - 15} = 7$

33) Given that,

f(x) = [x – 3] + |x – 4|

$\therefore \lim_{x\to 3^-} f(x) = \lim_{x\to 3^-} [x-3] + |x-4|$

$= \lim_{h\to 0} [3-h-3] + |3-h-4|$

$= \lim_{h\to 0} [-h] + 1 + h$

= – 1 + 1 + 0 = 0

34) Given that,

$$f(x) = \begin{cases} \frac{\cos 3x - \cos x}{x^2} & for\ x \neq 0 \\ \lambda & for\ x = 0 \end{cases}$$

Now, LHL = $\lim_{x\to 0^-} f(x)$

$= \lim_{x\to 0^-} \frac{\cos 3x - \cos x}{x^2}$

$= \lim_{h\to 0} \frac{\cos 3(0-h) - \cos(0-h)}{(0-h)^2}$

$= \lim_{h\to 0} \frac{\cos 3h - \cos h}{h^2}$

$= \lim_{h\to 0} \frac{-3\sin 3h + \sin h}{2h}$

(using L’ Hospitals’ rule)

$= \frac{-9+1}{2} = -4$

Since, f(x) is continuous at x = 0

$\therefore \quad \lim_{x\to 0^-} f(x) = f(0)$

$\Rightarrow \quad -4 = \lambda \quad \Rightarrow \quad \lambda = -4$

35. Given that, f(2) = 4 and f′(2) = 1

$\therefore \quad \lim_{x\to 2} \frac{xf(2) - 2f(x)}{x-2}$

$= \lim_{x\to 2} \frac{xf(2) - 2f(2) + 2f(2) - 2f(x)}{x-2}$

$= \lim_{x\to 2} f(2) - 2\lim_{x\to 2} \frac{f(x) - f(2)}{x-2}$

= f(2) – 2f′(2)

= 4 – 2(1)

= 2

36) Given that,

x = a $\left(\cos\theta + \log\tan\frac{\theta}{2}\right)$ and y = a sin θ

On differentiating w.r.t. θ respectively, we get

$\frac{dx}{d\theta} = a\left(-\sin\theta + \frac{1}{\tan\frac{\theta}{2}}.\sec^2\frac{\theta}{2}.\frac{1}{2}\right)$

$= a\left(-\sin\theta + \frac{1}{\sin\theta}\right) = \frac{a\cos^2\theta}{\sin\theta}$

and $\frac{dy}{d\theta}$ = a cos θ

$\therefore \quad \frac{dy}{dx} = \frac{dy/d\theta}{dx/d\theta} = \frac{a\cos\theta}{a\cos^2\theta/\sin\theta}$

= tan θ

37. Given curve is $y^4 = ax^3$

On differentiating w.r.t. x, we get

$$4y^3 \frac{dy}{dx} = 3ax^2$$

$$\Rightarrow \quad \frac{dy}{dx}_{a,a} = \frac{3a^3}{4a^3} = \frac{3}{4}$$

$\therefore$ Equation of normal at point (a, a) is

$$y - a = -\frac{4}{3}(x - a)$$

$$\Rightarrow \quad 4x + 3y = 7a$$

38. Given that,

$$2y^4 = x^5$$

On differentiating w.r.t. x, we get

$$8y^3 \frac{dy}{dx} = 5x^4$$

$$\Rightarrow \quad \frac{dy}{dx}_{2,2} = \frac{5\ 2^{4}}{8\ 2^{3}} = \frac{5}{4}$$

$\therefore$ Length of subtangent $= \frac{y}{dy/dx}$

$$= \frac{2}{5/4} = \frac{8}{5}$$

39. $e^x \ \frac{1-\sin x}{1-\cos x} \ dx$

$$= e^x \ \frac{1-2\sin\frac{x}{2}\cos\frac{x}{2}}{2\sin^2\frac{x}{2}} \ dx$$

$$= \frac{1}{2} \ e^x \ cosec^2\frac{x}{2} \ dx - \ e^x \cot\frac{x}{2} \ dx$$

$$= \frac{1}{2} \ -e^x\cot\frac{x}{2}.2 + \ e^x \ \cot\frac{x}{2} \ 2dx$$

$$- \quad e^x \; cot\frac{x}{2} dx + c$$

$$= -e^x cot\frac{x}{2} + c$$

40. Given that,

$$e^x \;\; 1 + x \; .sec^2 \;\; xe^x \;\; dx = f \;\; x$$ + constant

Put $\quad xe^x$ = t in LHS

$\Rightarrow \quad (e^x + xe^x)\ dx = dt$

$\therefore \quad$ LHS = $\;\; sec^2 t \, dt$

= tan t + constant

$\Rightarrow \quad$ tan (xe^x) + constant = f(x) + constant

$\Rightarrow \quad$ f(x) = tan (xe^x)

41. Let $\quad I = \;_{-\pi/2}^{\pi/2} sin \;\; x \;\; dx$

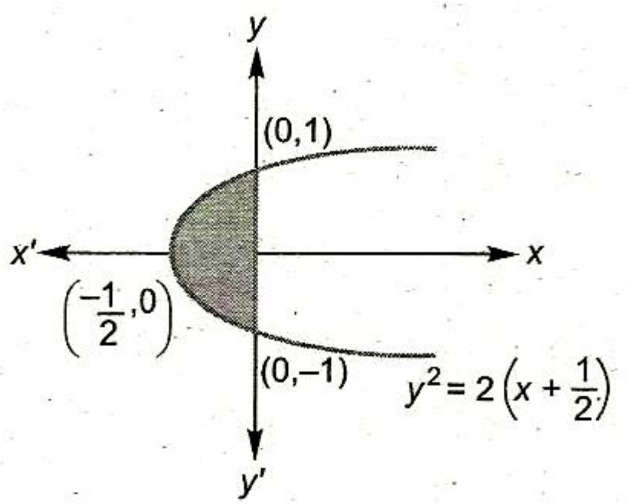
$$= 2 \;\; _{-\pi/2}^{\pi/2} sin \, x \, dx$$

$$= 2 \;\; -cos \, x \;\; _0^{\pi/2}$$

$$= 2$$

42. Given curve can be rewritten as

$$y^2 = 2 \;\; x + \frac{1}{2}$$



$\therefore$ Required area = $\,{}^{1}_{-1}\, x\,dy$

$= 2\,{}^{1}_{0}\,\frac{y^2-1}{2}\,dy$

$= \frac{y^3}{3} - y\,{}^{1}_{0}$

$= \frac{1}{3} - 1 \quad = \frac{2}{3}$ sq unit

43. Given differential equation is

$$\frac{dy}{dx} = \frac{xy+y}{xy+x}$$

$\Rightarrow \quad \frac{dy}{dx} = \frac{y\;1+x}{x\;1+y}$

$\Rightarrow \quad \frac{1+y}{y}\,dy = \frac{1+x}{x}\,dx$

$\Rightarrow \quad \frac{1}{y} + 1\;\; dy = \;\; \frac{1}{x} + 1\;\; dx$

$\Rightarrow$ log ydy dx+ y = log x + x + log c

$\Rightarrow$ y – x = log $\frac{cx}{y}$

44. Given linear differential equation is

$$\frac{dy}{dx} - y \tan x = e^x \sec x$$

$\therefore$ IF $= e^{\ -\tan x\, dx} = e^{-\log \sec x}$

$$= \frac{1}{\sec x}$$

$\therefore$ Complete solution is

$$y \cdot \frac{1}{\sec x} = \quad e^x \sec x . \frac{1}{\sec x} dx$$

$\Rightarrow$ $\frac{y}{\sec x} = e^x + c$

$\Rightarrow$ $y \cos x = e^x + c$

45. Given differential equation can be rewritten as

$$\frac{dy}{dx} = \frac{x^3+y^3}{xy^2}$$

It is a homogeneous differential equation.

Put $y = vx \Rightarrow \frac{dy}{dx} = v + x\frac{dv}{dx}$

$\therefore$ $x\frac{dv}{dx} + v = \frac{x^3+v^3x^3}{x^3v^2}$

$\Rightarrow$ $x\frac{dv}{dx} + v = \frac{1+v^3}{v^2}$

$\Rightarrow$ $x\frac{dv}{dx} = \frac{1}{v^2} \Rightarrow v^2 dv = \frac{dx}{x}$

On integrating both sides, we get

$\frac{v^3}{3} = \log x + \log c$

$\Rightarrow$ $\frac{1}{3}\ \frac{y}{x}\ ^3 = \log x + \log c$

$\Rightarrow$ $y^3 = 3x^3 \log cx$

Physics

46. h $G^xL^yE^z$

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

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

Comparing the power, we get

$1 = -x + y + z$ … (i)

$2 = 3x + 2y + 2z$ … (ii)

$-1 = -2x - y - 2z$ … (iii)

On solving Eq. (i), (ii) and (iii), we get

$x = 0$

47. Let $B = \imath - \jmath$

$= \frac{A.B}{B}$

$= \frac{a_x\imath + a_y\jmath + a_z k\ .\ \imath - \jmath}{\imath - \jmath}$

$= \frac{a_x - a_y}{2}$

48. The ball is thrown vertically upwards then according to equation of motion

$(0)^2 - u^2 = -2gh$ … (i)

and $0 = u - gt$ ... (ii)

From Eqs. (i) and (ii),

$$h = \frac{gt^2}{2}$$

When the ball is falling downwards after reaching the maximum height

$$s = ut' + \frac{1}{2} g(t')^2$$

$$\frac{h}{2} = (0)t' + \frac{1}{2} g(t')^2$$

$$\Rightarrow \quad t' = \sqrt{\frac{h}{g}}$$

$$t' = \frac{t}{\sqrt{2}}$$

Hence, the total time from the time of projection to reach a point at half of its maximum height while returning = t + t'

$$= t + \frac{t}{\sqrt{2}}$$

49. Direction of velocity is always tangent to the path so at the top of trajectory, it is in horizontal direction.

50. Given, velocity of river, (v) = 2 m/s

Density of water $\rho = 1.2$ g/cc

Mass of each cubic metre

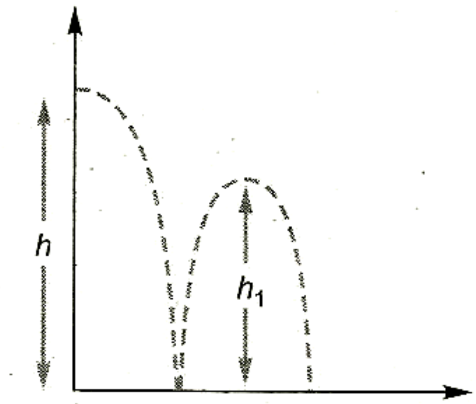
$$m = \frac{1.2 \times 10^{-3}}{(10^{-2})^{3'}} = 1.2 \times 10^3 \text{ kg}$$

$\therefore$ Kinetic energy $= \frac{1}{2} mv^2$

$$= \frac{1}{2} \times 1.2 \times 10^3 \times (2)^2$$

$= 2.4 \times 10^3$ J = 2.4 kJ

51.



Total distance travelled by the ball before its second hit is

$H = h + 2h_1$

$= h[1 + 2e^2]$ $\quad [\because h_1 = he^2]$

52. As initially both the particles were at rest therefore velocity of centre of mass was zero and there is no external force on the system so speed of centre of mass remains constant i.e., it should be equal to zero.

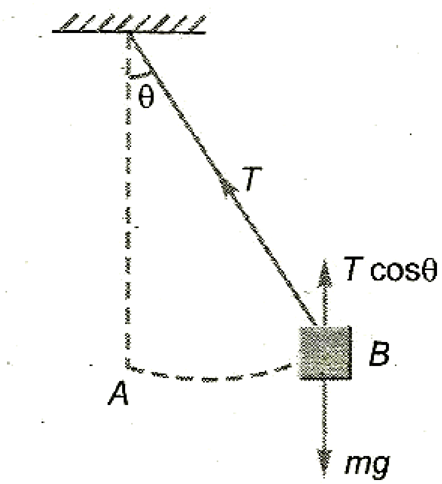
53. $\mu = \tan\theta \left(1 - \frac{1}{n^2}\right)$

Here, $\theta = 45^\circ$ and $n = 2$

$\therefore \quad \mu = \tan 45^\circ \left(1 - \frac{1}{2^2}\right)$

$= 1 - \frac{1}{4} = \frac{3}{4} = 0.75$

54. Now, at B



In equilibrium,

$$T \cos \theta = mg$$

$$\Rightarrow \quad \cos \theta = \frac{150 \times 9.8}{2940}$$

$$\Rightarrow \quad \cos \theta = 0.5$$

$$\Rightarrow \quad \theta = 60^o$$

55. Moment of inertia of a circular disc about an axis passing through centre of gravity and perpendicular to its plane

$$I = \frac{1}{2} MR^2 \qquad \text{....... (i)}$$

From Eq. (i) $MR^2 = 2\,I$

Then, moment of inertia of disc about tangent in a plane

$$= \frac{5}{4} MR^2$$

$$= \frac{5}{4} (2I)$$

$$= \frac{5}{2} I$$

56. Time period of satellite

T $\frac{1}{M^{1/2}}$, where M is mass of earth.

$\propto$ (R + h)$^{3/2}$ where R is radius of the orbit, h is the height of satellite from the earth's surface.

57. It is the least interval of time after which the periodic motion of a body repeats itself. Therefore, displacement will be zero.

58. Y = $\frac{mgl}{A\,\Delta l}$

$\Rightarrow \quad \frac{\Delta l}{l} = \frac{mg}{AY}$

$\therefore \quad \frac{\Delta l}{l} = \frac{1 \times 10}{3 \times 10^{-6} \times 10^{11}}$

$= 0.3 \times 10^{-4}$

59. In case of soap bubble

W = T × 2 × ΔA

= 0.03 × 2 × 40 × 10^{-4}

= 2.4 × 10^{-4} J

60. Terminal velocity, $v_T \propto r^2$

Or $\quad \frac{v_{T_1}}{v_{T_2}} = \frac{r_1^2}{r_2^2}$

$\therefore \quad \bar{\frac{9}{4}} = \frac{r_1}{r_2}$

Or $\frac{r_1}{r_2} = \frac{3}{2}$

∴ $v = \frac{4}{3}\pi r^3$

Or $\frac{v_1}{v_2} = \frac{r_1^3}{r_2^3} = \frac{27}{8}$

61. Ideal gas equation is given by

$pV = nRT$ ... (i)

For oxygen, $p = 1$ atm, $V = 1$ L, $n = n_O$

Therefore Eq. (i) becomes

∴ $1 \times 1 = n_{O_2}RT$

⇒ $n_{O_2} = \frac{1}{RT}$

For nitrogen $p = 0.5$ atm, $V = 2$ L, $n = nN$

∴ $0.5 \times 2 = n_{N_2}RT$

⇒ $n_{N_2} = \frac{1}{RT}$

For mixture of gas

$p_{mix}V_{mix} = n_{mix}RT$

Here, $n_{mix} = nO + n_{N_2}$

∴ $\frac{p_{mix}V_{mix}}{RT} = \frac{1}{RT} + \frac{1}{RT}$

⇒ $p_{mix}V_{mix} = 2$

62. Modulus of elasticity $= \frac{Force}{Area} \times \frac{l}{\Delta l}$

$3 \times 10^{11} = \frac{33000}{10^{-3}} \times \frac{l}{\Delta l}$

$$\frac{\Delta l}{l} = \frac{33000}{10^{-3}} \times \frac{1}{3\times10^{11}}$$

$$= 11 \times 10^{-5}$$

Change in length, $\frac{\Delta l}{l} = \alpha\ \Delta T$

$$11 \times 10^{-5} = 1.1 \times 10^{-5} \times \Delta T$$

$\Rightarrow \quad \Delta T = 10$ K or 10^{o}C

63. In adiabatic compression temperature and hence internal energy of the gas increases. In compression pressure will increase.

64. For adiabatic change equation of state is

$$pV^{\gamma} = \text{constant}$$

It can also be re-written as

$$TV^{\gamma-1} = \text{constant} \quad as\ p = \frac{nRT}{V}$$

and $\quad p^{1-\gamma}T^{\gamma} = \text{constant} \quad as\ V = \frac{nRT}{p}$

65. The temperature at the contact of the surface

$$= \frac{K_1 d_2 \theta_1 + K_2 d_1 \theta_2}{K_1 d_2 + K_2 d_1}$$

$$= \frac{2K_2 d_2 \times 100 + 2d_2 \times K_2 \times 25}{2K_2 d_2 + K_2 2d_2}$$

$$= \frac{200+50}{4} = 62.5^{o}C$$

66. $\quad v_{max} = v$

$\Rightarrow \quad A\omega = v$

$\Rightarrow \quad A \times 2\pi v = v\lambda$

Or $\quad A = \frac{\lambda}{2\pi}$

67. The speed of the car is 72 km/h

$= 72 \times \frac{5}{18} = 20$ m/s

The distance travelled by car in 10 s

$= 10 \times 20 = 200$ m

Hence, the distance travelled by sound in reaching the hill and coming back to the moving driver

$= 1800 + (1800 - 200)$

$= 3400$ m

So, the speed of sound $= \frac{3400}{10} = 340$ m/s

68. Lens maker's formula

$= \frac{1}{f} = \ \mu - 1 \quad \frac{1}{R_1} - \frac{1}{R_2}$

where, $R_2 = \infty$, $R_1 = 0.3$ m

$\therefore \quad \frac{1}{f} = \ \frac{5}{3} - 1 \quad \frac{1}{0.3} - \frac{1}{\infty}$

$\Rightarrow \quad \frac{1}{f} = \frac{2}{3} \times \frac{1}{0.3}$

Or $\quad f = 0.45$ m

69. Using Huygen's eye-piece, measurements can be taken but not accurately due to the reason given.

70. The image of an object in white light formed by a lens is usually coloured and blurred. This defect of image is called chromatic aberration and arises due to the fact that focal length of a lens is different for different colours. In case of two thin lenses in contact, the combination will be free from chromatic aberration. The lens combination which satisfies this condition are called achromatic lenses.

71. The general condition for Froun hofer diffraction is $\frac{b^2}{L\lambda} << 1$.

72. Time period of magnet, T = $2\pi \sqrt{\frac{I}{MB}}$

When magnet is cut parallel to its length into four equal pieces. Then new

magnetic moment, M′ = $\frac{M}{4}$

New moment of inertia, I′ = $\frac{I}{4}$

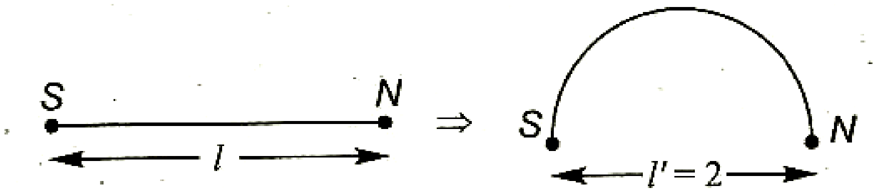
$\therefore$ New time period, T′ = $2\pi \sqrt{\frac{I'}{M'B'}}$

$\Rightarrow$ T = T′ = 4s

73. On bending a wire its pole strength remains unchanged whereas its magnetic moment changes.

New magnetic moment,

M′ = m(2r) = m $\frac{2l}{\pi}$ = $\frac{3M}{\pi}$



74. Ratio of charges = 2:3

$\therefore$ $q_1 = \frac{2}{5} \times 1\ \mu C$ and $q_2 = \frac{3}{5} \times 1\ \mu C$

Electrostatic force between the two charges

$$F = \frac{1}{4\pi\varepsilon_0}\frac{q_1 q_2}{r^2}$$

$$= \frac{9\times10^9\times2\times10^{-6}\times3\times10^{-6}}{5\times5\times\ 1\ ^2}$$

$$= 2.16 \times 10^{-3}\ N$$

75. At equatorial point

$$E_e = \frac{1}{4\pi\varepsilon_0}\frac{p}{r^3}$$

(directed from +q to –q) and $V_e = 0$,

76. Current through each arm

PRQ and PSQ = 1 A

$V_P - V_R = 3V$ ... (i)

$V_P - V_S = 7\ V$ ... (ii)

From Eqs. (i) and (ii), we get

$V_R - V_S = +\ 4\ V$

77. Here, $V < E$

$\therefore$ $E = V + Ir$

For first case

$$E = 12 + \frac{12}{16} r \quad \text{... (i)}$$

For second case

$$E = 11 + \frac{11}{10} r \quad \text{... (ii)}$$

From Eqs. (i) and (ii),

$$12 + \frac{12}{16} r = 11 + \frac{11}{10} r$$

$\Rightarrow$ $r = \frac{20}{7}\ \Omega$

78. We know that thermoelectric power

$$S = \frac{dE}{dT}$$

Given, $E = K(T - T_r)\ T_0 - \frac{1}{2}\ T + T_r$

By differentiating the above equation w.r.t. T and putting $T = \frac{1}{2} T_0$, we get $S = \frac{1}{2} kT_0$

79. Shunt of an ammeter,

$$S = \frac{I_g \times G}{I - I_g}$$

$$= \frac{5 \times G}{100 - 5}$$

$$= \frac{G}{19}$$

80. Two coils carry currents in opposite directions, hence net magnetic field at centre will be difference of the two fields.

ie, $B_{net} = \frac{\mu_0}{4\pi} \cdot 2\pi N \; \frac{i_1}{r_1} - \frac{i_2}{r_2}$

$= \frac{10\mu_0}{2} \; \frac{0.2}{0.2} - \frac{0.3}{0.4}$

$= \frac{5}{4}\mu_0$

81. In a transformer

$\frac{N_P}{N_S} = \frac{I_S}{I_P}$

$\frac{50}{200} = \frac{I_S}{4}$

$\Rightarrow \quad I_S = 1$ A

82. For $\phi = 90^o$, $\cos\phi = 0$

So, $\lambda' = \lambda + \frac{h}{m_e c}$

$= 0.140 \times 10^{-9} + \frac{6.63\times10^{-34}}{9.1\times10^{-31} \quad 3\times10^{8}}$

$= (0.140 \times 10^{-9} + 2.4 \times 10^{-12})$m

$= 0.142$ nm

83. $E = \frac{hc}{\lambda}$

$= \frac{6.62\times10^{-34}\times3\times10^{8}}{45\times10^{-12}}$

$= \frac{0.44\times10^{-14}}{1.6\times10^{-19}}$

$= 0.275 \times 10^5$ eV

$= 0.275 \times 10^5$ eV

84. Nuclear force between two particles is independent of charges of particles.

$\Rightarrow \quad F_{pp} = F_{nn} = F_{np}$

85. In forward biasing both electrons and protons move towards the junction and hence the width of depletion region decreases.

Chemistry

86. Energy of an electron in n^{th} orbit,

$$E_n = -\frac{2\pi^2 k^2 m Z^2 e^4}{n^2 h^2}$$

On substituting the values of k, m, e and h, we get

$$E_n = -\frac{2.172\times10^{-18} Z^2}{m^2} \text{ J atom}^{-1}$$

or $\quad = -\frac{1311.8 Z^2}{n^2} \text{ kJ mol}^{-1}$

or $\quad = -\frac{313.52 Z^2}{n^2} \text{ kcal mol}^{-1}$

[$\because$ 1 kcal = 4.184 kJ]

For H-atom, $\quad Z = 1$

For Lyman series, $n_1 = 1$, $n_2 = 2$

Energy of electron in n_1 orbit

$= -\frac{313.52 \times 1^2}{1^2}$ kcal mol^{-1}

$= -313.52$ kcal mol^{-1}

$= -313.6$ kcal mol^{-1}

Energy of electron in n_2 orbit

$= -\frac{313.52 \times 1^2}{2^2}$ kcal mol^{-1}

$= -\frac{313.52}{4}$ kcal mol^{-1}

$= -78.38$ kcal mol^{-1}

87. Given, velocity of particle A = 0.05 ms^{-1}

Velocity of particle B = 0.02 ms^{-1}

Let the mass of particle A = x

∴ The mass of particle B = 5x

de-Broglie's equation is

$\lambda = \frac{h}{mv}$

For particle A

$\lambda_A = \frac{h}{x \times 0.05}$ ... (i)

For particle B

$\lambda = \frac{h}{5x \times 0.02}$ ... (ii)

Eq (i)/(ii)

$\frac{\lambda_A}{\lambda_B} = \frac{5x \times 0.02}{x \times 0.05}$

$\frac{\lambda_A}{\lambda_B} = \frac{2}{1}$

Or 2:1

88. Given, Δm for ${}_5B^{11}$ = 0.0821 u

Number of nucleons = 11

Binding energy = $931 \times \Delta m$ MeV

$= 931 \times 0.081$

$= 75.411$ MeV

Average binding energy

$$= \frac{binding\ energy}{number\ of\ nucleons}$$

$$= \frac{75.411}{11}$$

= 6.85 MeV

89. Given,

Atomic number of element B = Z

($\because$ noble gas $\therefore$ belong to zero group)

Atomic number of element A = Z – 1

(ie, halogens)

Atomic number of element C = Z + 1

(ie, group IA)

Atomic number of element D = Z + 2

(ie, group IIA)

$\because$ Element B is a noble gas

$\therefore$ Element A must be a halogen ie, have highest electron affinity.

and element C must be an alkali metal and exist in +1 oxidation state.

and element D must be an alkaline earth metal with +2 oxidation state.

90. Given,

observed dipole moment = 1.03 D

Bodn length of HCl molecule, d = 1.275 Å

$= 1.275 \times 10^{-8}$ cm

Charge of electrons, $e^{-} = 4.8 \times 10^{-10}$ esu

Percentage ionic character = ?

Theoretical value of dipole moment = e × d

$= 4.8 \times 10^{-10} \times 1.275 \times 10^{-8}$ esu – cm

$= 6.12 \times 10^{-18}$ esu – cm

= 6.12 D

Percentage ionic character

$= \frac{observed\ dipole\ moment}{theoretical\ value\ of\ dipole\ moment} \times 100$

$= \frac{1.03}{6.12} \times 100$

= 16.83 %

91.

Molecule	bp + lp	Hybridisation	Shape
H_2O	2+2	sp^3	angular
BCl_3	3+0	sp^2	trigonal planar
NH_4^+	4+0	sp^3	tetrahedral
CH_4	4+0	sp^3	tetrahedral

92. $A \underset{100g}{CaCO_3} \xrightarrow[decomposition]{\Delta} CaCO + \underset{22.4L}{CO_2}$

$\because$ 100 g $CaCO_3$ on decomposition gives = 22.4 L CO_2

$\therefore$ 10 g $CaCO_3$ on decomposition will give

$= \frac{22.4 \times 10}{100}$ L CO_2

= 2.24 L CO_2

$B \underset{106g}{Na_2CO_3} \xrightarrow{Excess\ HCl} 2NaCl + H_2O + \underset{22.4L}{CO_2}$

106 g Na_2CO_3 gives = 22.4 L CO_2

1.06 g Na_2CO_3 will give

$= \frac{22.4 \times 1.06}{106}$ L CO_2

= 0.224 L CO_2

$C \quad \underset{12\ g}{C} \xrightarrow[combustion]{Excess\ O_2} \underset{22.4L}{CO_2}$

12 g carbon on combustion gives = 22.4 L CO_2

2.4 g carbon on combustion will give

$= \frac{22.4 \times 2.4}{12}$ L CO_2

$= 2 \times 2.24$ L CO_2

$= 4.48$ L CO_2

$D \quad \underset{\underset{56\,g}{2\,[12+16]}}{2CO} \xrightarrow[combustion]{Excess\ O_2} \underset{2\times22.4L}{CO_2}$

56 g carbon monoxide on combustion gives $= 2 \times 22.4$ L CO_2

0.56 g carbon monoxide on combustion will give

$= \frac{2\times22.4\times0.56}{56}$ L CO_2

$= 0.448$ L CO_2

Hence, A—(iv), B—(i), C—(ii), D—(iii)

93. Number of moles of helium = 0.3

Number of moles of argon = 0.4

We know that KE = nRT

KE of helium $= 0.3 \times R \times T$ … (i)

KE of argon $= 0.4 \times R \times 400$ … (ii)

According to question

KE of helium = KE of argon

$0.3 \times R \times T = 0.4 \times R \times 400$

$T = 533$ K

94. Given,

Weight of non-volatile solute,

w = 25 g

Weight of solvent, W = 100 g

Lowering of vapour pressure,

$p^o - p_s = 0.225$ mm

Vapour pressure of pure solvent,

$p^o = 17.5$ mm

Molecular weight of solvent (H_2O), M = 18 g

Molecular weight of solute, m = ?

According to Raoult's law

$$\frac{p^o - p_s}{p^o} = \frac{w \times M}{m \times W}$$

$$\frac{0.225}{17.5} = \frac{25 \times 18}{m \times 100}$$

$$m = \frac{25 \times 18 \times 17.5}{22.5}$$

$$= 350 \text{ g}$$

95. In water, barium hydroxide is hydrolysed as follows,

$$Ba(OH)_2 \rightleftharpoons Ba^{2+} + 2OH^-$$

conc. of $Ba^{2+} = 1 \times 10^{-3}$ M

conc. Of $[OH^-] = 2 \times 1 \times 10^{-3}$ M

$= 2 \times 10^{-3}$ M

pOH = $-\log [OH^-]$

$= -\log (2 \times 10^{-3})$

$= 2.69$

pH + pOH = 14

pH = 14 – pOH

$= 14 - 2.69$

$= 11.3$

≈ 11.0

96. $CH_3COONa + H_2O \rightarrow CH_3COOH + NaOH$

The above process takes place in following steps

$$\underset{}{CH_3COONa} \xrightarrow[\text{in aqueous solution}]{\text{Ionisation}} \underset{\text{strong base}}{CH_3COO^-} + Na^+$$

$CH_3COO^- + H_2O \rightarrow CH_3COOH + OH^-$

Acetate ion undergoes hydrolysis and the resulting solution is slightly basic due to excess of OH^- ions. Hence, both (A) and (R) are true and (R) is the correct explanation of (A).

97. Given, weight of hydrogen liberated

$= 5.04 \times 10^{-2}$ g

Eq. wt. of hydrogen = 1.008

Eq. wt. of silver = 108

Weight of silver deposited, w =?

According to Faraday's second law of electrolysis

$$\frac{weight\ of\ silver\ deposited}{weight\ of\ hydrogen\ liberated}$$

$$= \frac{eq.\ wt.\ of\ silver}{eq.\ wt.\ of\ hydrogern}$$

$$\frac{w}{5.04 \times 10^{-2}} = \frac{108}{1.008}$$

$$w = \frac{108 \times 5.04 \times 10^{-2}}{1.008} = 5.4 \text{ g}$$

98) Electrolysis of water takes place as follows.

$$H_2O \rightleftharpoons \underset{\text{cathode}}{H^+} + \underset{\text{anode}}{OH^-}$$

At anode

$$OH^- \xrightarrow{\text{Oxidation}} OH + e^-$$

$$4OH \longrightarrow 2H_2O + O_2$$

At cathode

$$2H^+ + 2e^- \xrightarrow{\text{Reduction}} H_2$$

Given, time, t = 1930 s

Number of moles of hydrogen collected

$= \frac{1120\times10^{-3}}{22.4}\ moles$

= 0.05 moles

∵ 1 mole of hydrogen is deposited by = 2 moles of electrons

∴ 0.05 moles of hydrogen will be deposited by = 2 × 0.05

= 0.10 mole of electrons

Charge, Q = nF

= 0.1 × 96500

Charge, Q = it

0.1 × 96500 = i × 1930

$i = \frac{0.1\times96500}{1930}$

= 5.0A

99) Given, angle of diffraction (2 θ) = 90° θ

= 45°

Distance-between two planes, d = 2.28 Å

$n = 2$ [$\because$ second order diffraction]

Bragg's equation is

$n\lambda = 2d \sin \theta$

$2 \times \lambda = 2 \times 2.28 \times \sin 45°$

$\lambda = 1.612$

100)

PCl_5	$\rightleftharpoons PCl_3$	$+ Cl_2$	
5	0	0	initial moles
$5(1-\alpha)$	5α	5α	moles at equilibrium
$\frac{5(1-\alpha)}{0.5}$	$\frac{5\alpha}{0.5}$	$\frac{5\alpha}{0.5}$	conc at equilibrium

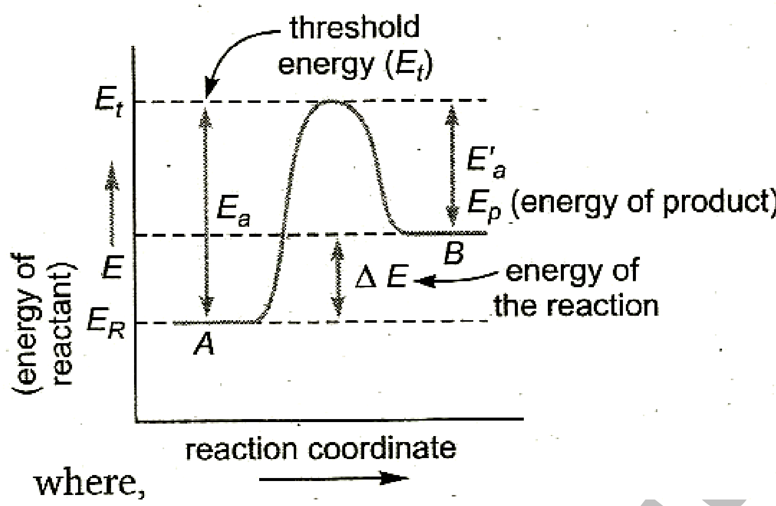
$\alpha = 40\%$
$= 0.4$

$$K_c = \frac{PCl_3 \quad Cl_2}{PCl_5}$$

$$= \frac{\frac{5\times0.4}{0.5} \quad \frac{5\times 0.4}{0.5}}{\frac{5\times0.6}{0.5}} = \frac{16}{6}$$

$$= 2.66\, mol/L$$

101)



where,

E_a = activation energy of forward reaction

E_a = activation energy of backward reaction

The above energy profile diagram shows that

$$E_a > E'_a$$

The potential energy of the product is greater than that of the reactant, so the reaction is endothermic.

$$E_a = E_a' + \Delta E$$

$$E_t = E_a \text{ or } E_t > E_a'$$

102) Given,

$H_2O\ (g) + C(g) \quad \rightarrow \quad CO(g) + H_2(g);$

$\Delta H = 131$ kJ .... (i)

$CO(g) + \frac{1}{2} O_2(g) \quad \rightarrow \quad CO_2(g);$

$\Delta H =$ - 2S2 kJ .... (ii)

$H_2(g) + \frac{1}{2}O_2(g) \rightarrow H_2O(g);$

$\Delta H = -242$ kJ .... (iii)

$C(g) + O_2(g) \rightarrow CO_2(g); \quad \Delta H = ?$ .... (iv)

On adding Eqs (i), (ii) and (iii), we get Eq (iv)

$H_2O(g) + C(g) \rightarrow CO(g) + H_2(g);$

$\Delta H = +131$ kJ

$CO(g) + \frac{1}{2}O_2(g) \rightarrow CO_2(g);$

$\Delta H = -282$ kJ

$H_2(g) + \frac{1}{2}O_2(g) \rightarrow H_2O(g);$

$C\ g\ +\ O_2\ g \rightarrow CO_2\ g$

$\Delta H = (131 - 282 - 242)$ kj

$= -393$ kj

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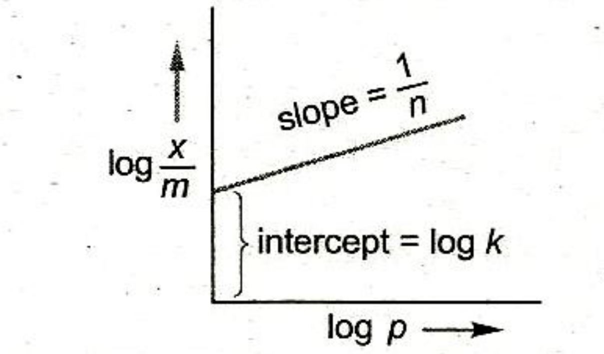
103) When we plot a graph between log (x/m) and log p, a straight line with positive slope will be obtained. This graph represents the Freundlich adsorption isotherm.



Graph of Freundlich adsorption isotherm.

104) The reaction in which H_2O_2 is reduced while the other reactant is oxidised, represents the oxidising property of H_2O_2.

reduction

$$2\,K\overset{-1}{I} + H_2SO_4 + H_2\overset{-1}{O_2} \longrightarrow K_2SO_4 + \overset{0}{I_2} + 2H_2\overset{-2}{O}$$

(oxidising agent)

oxidation

105) (i) The alkali metal superoxides contain O_2^- ion, which has an unpaired electron, hence they are paramagnetic in nature.

(ii) The basic character of alkali metal hydroxides increases on moving down the group.

(iii) The conductivity of alkali metal chlorides in their aqueous solution increases on moving down the group because in aqueous solution alkali metal chlorides ionise to give alkali metal ions. On moving down the group the size of alkali metal ion increases, thus degree of hydration decreases, due to this reason their conductivity in aqueous solution increases on moving down the group.

$$\text{(iv) } M_2CO_3 \underset{\text{aq solution}}{\overset{\text{Ionisation in}}{\rightleftharpoons}} 2M^+ + CO_3^{2-}$$

$$CO_3^{2-} + 2H_2O \longrightarrow H_2CO_3 + 2OH^-$$

Thus, basic nature of carbonates in aqueous solution is due to anionic hydrolysis.

106) According to Lewis, the compound which can accept a lone pair of electron, are called acids.

Boron halides, being electron deficient compounds, can accept a lone pair of electrons, so termed as Lewis acid.

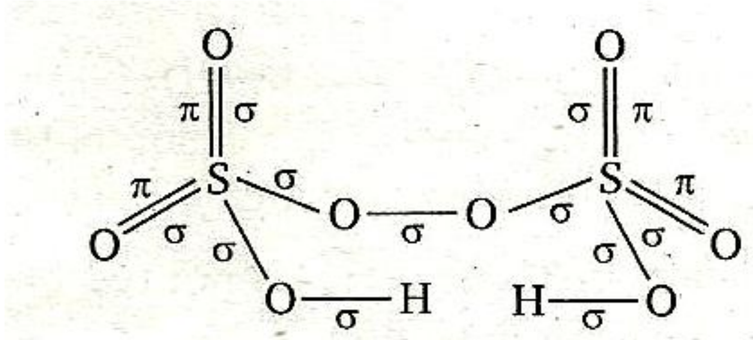
107) Orthosilicic acid (H_4SiO_4), on heating at high temperature, loses two water molecules and gives silica (SiO_2) which on reduction with carbon gives carborundum (SiC) and CO.

$$H_4SiO_4 \xrightarrow[-2H_2O]{1000°C} SiO_2 \xrightarrow[\Delta]{C} \underset{\text{carborundum}}{SiC} + CO$$

108) The reducing character of the hydrides of group V elements depends upon the stability of hydrides. With progressive decrease in stability, the reducing character of hydrides increases as we move down the group. Thus, ammonia, being stable, has least reducing ability. The order of reducing abilities of V group hydrides is

$NH_3 < PH_3 < AsH_3 < SbH_3 < BiH_3$

109) The structure of peroxodisulphuric acid ($H_2S_2O_8R$) is



Hence, it contains 11σ and 4π bonds.

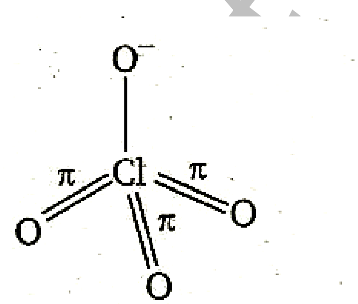
110) With progressive increase in atomic number, the reduction potential of halogens decreases, thus oxidising power also decreases, Hence, a halogen with lower atomic number will oxidise the halide ion of higher atomic number and therefore, will liberate them from their salt solution.

Hence, the reaction

$$Cl_2 + 2F^- \rightarrow 2Cl^- + F_2$$

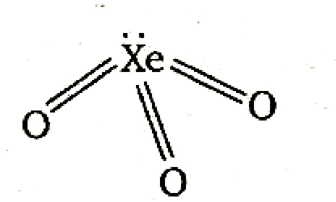
is not possible.

111) The structure of ClO_4^- is



Thus, it contains 3 dπ - pπ bonds,

XeO_3 also contains 3 dπ- pπ bonds as



112) $[Co(NH_3)_5\ SO_4]Br \rightleftharpoons [Co(NH_3)_5\ SO_4]^+ + Br^-$

$[Co(NH_3)_5\ Br]SO_4 \rightleftharpoons [CO(NH_3)_5\ Br]^{2+} + SO^{2-}_4$ the molecular formula of both of the above compounds is same but on ionisation they give different ions in solution, so they are called ionisation isomers.

113) In stratosphere the following reactions takes place which are responsible for depletion of ozone layer.

$NO + O_3 \rightarrow NO_2 + O_2$

$CF_2Cl_2 \xrightarrow{hv} C^{\bullet}\ F_2CI + C^{\bullet}I$

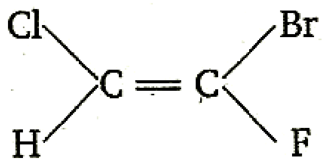
$CFCl_3 \xrightarrow{hv} C^{\bullet}FCl_2 + C^{\bullet}l$

$C^{\bullet}l + O_3 \rightarrow ClO^{\bullet} + O_2$

$Cl^{\bullet}O + O \rightarrow C^{\bullet}l + O_2$

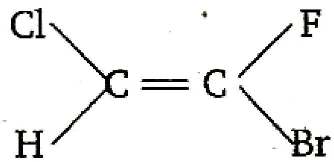
Hence, methane (CH_4) is not responsible for ozone layer depletion.

114) When the groups with higher priority (ie, with high atomic number) are present on same side of double bond, then the configuration is Z but when present on opposite side of double bond, the configuration is E.

(i) 

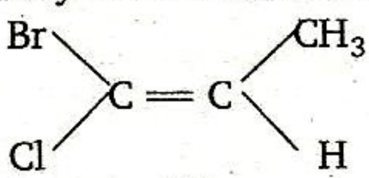
(Z)

(Priority : Cl > H and Br > F)

(ii) 

(E)

(Priority : Cl > H and Br > F)

(iii) 

(Z)

(Priority: Br > CI and CH_3 > H)

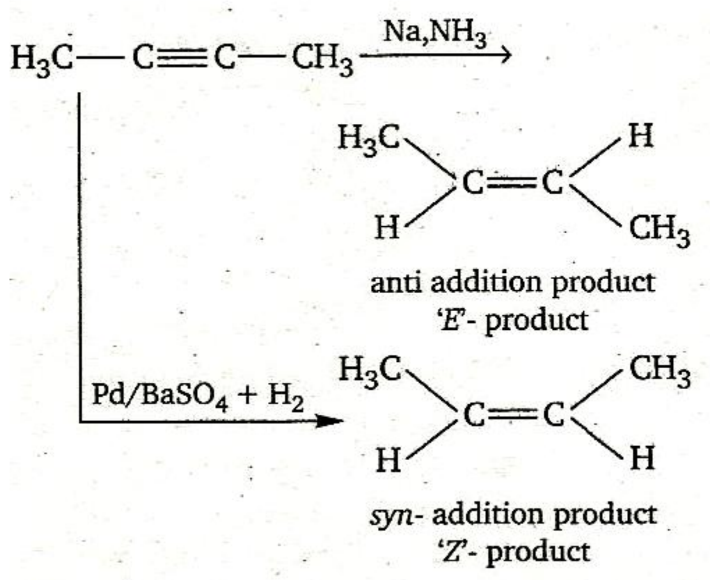
Hence, compound (i) and (iii) have (Z) configuration.

115) According to Cahn-Ingold-Prelog sequence rules, the priority of groups is decided by the atomic number of their atoms. When the atom -(which is directly attached to the asymmetric carbon atom) of a group has higher atomic number, then the group gets higher priority. Groups with atoms of comparable atomic number having double or triple bond, have high priority than those have single bond

Hence, the order of priority of groups is

— OH> — COOH > — CHO > — CH_2OH

116)



Hence, reagent X and Yare respectively

Na, NH_3 and Pd/$BaSO_4$ + H_2.

117) In a reaction, the reagent, which is reduced or remove hydrogen from the other reactant

(reagent), is termed as oxidising agent.

reduction

$$\text{(i)}\quad CH_3CH_2OH + \overset{0}{Cl_2} \longrightarrow CH_3CHO + H\overset{-1}{Cl}$$

oxidising agent

removal of hydrogen
ie, oxidation

reduction

$$\text{(ii)}\quad CH_3CHO + \overset{0}{Cl_2} \longrightarrow CCl_3{\cdot}CHO + H\overset{-1}{Cl}$$

oxidising agent

oxidation (removal of H)

reduction

$$\text{(iii)}\quad CH_4 + \overset{0}{Cl_2} \xrightarrow{h\nu} CH_3Cl + H\overset{-1}{Cl}$$

oxidising agent

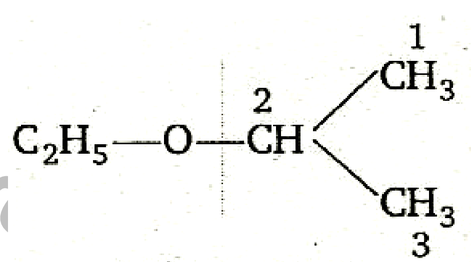
oxidation

Hence, in all of the above reactions, chlorine acts as an oxidising agent.

118) Among hydrogen halides, as the size of halide ion increases, its reactivity towards ethyl alcohol also increases. Thus, the order of reactivity of hydrogen halides is

HI> HBr > HCl> HF

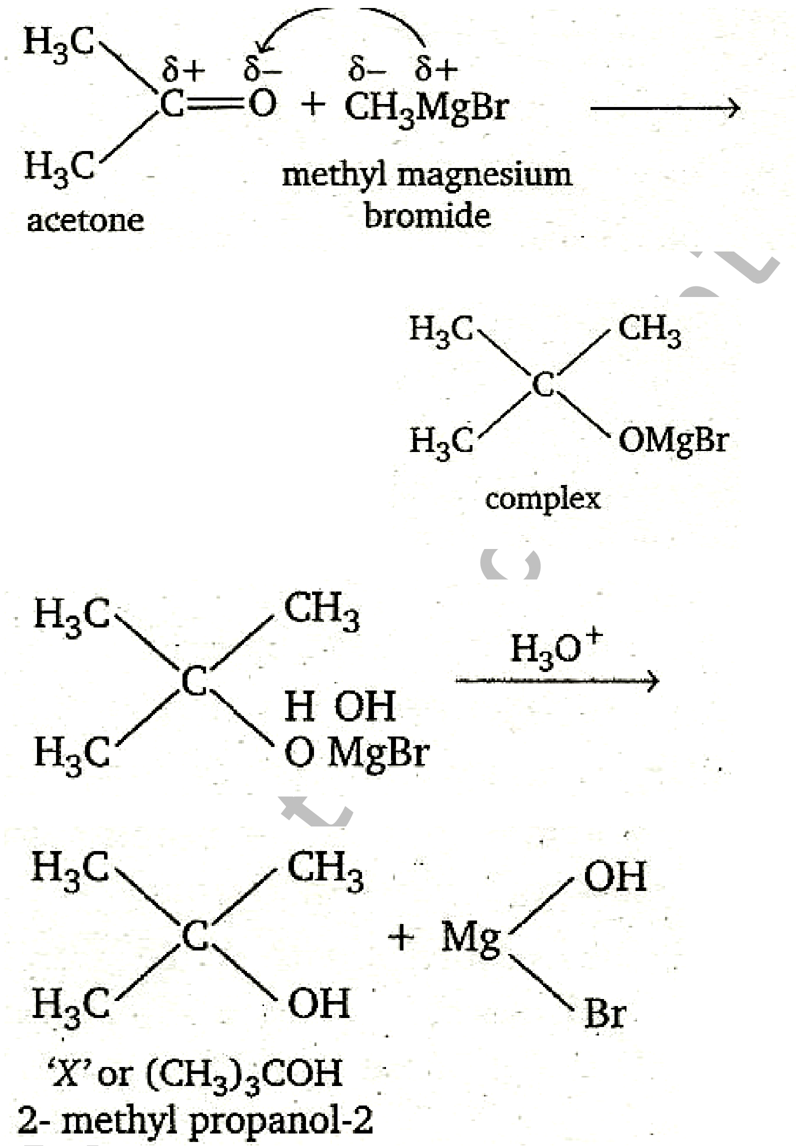
119)



2-ethoxy propane

The above compound is an ether and its name is written as alkoxy alkane. Oxy is attached with the lower group. Hence, the IUPAC name of above compound is 2-ethoxy propane.

120)



121) Acetic acid on reduction with lithium aluminiumhydride ($LiAlH_4$) gives ethyl alcohol while on reduction with HI and red P gives

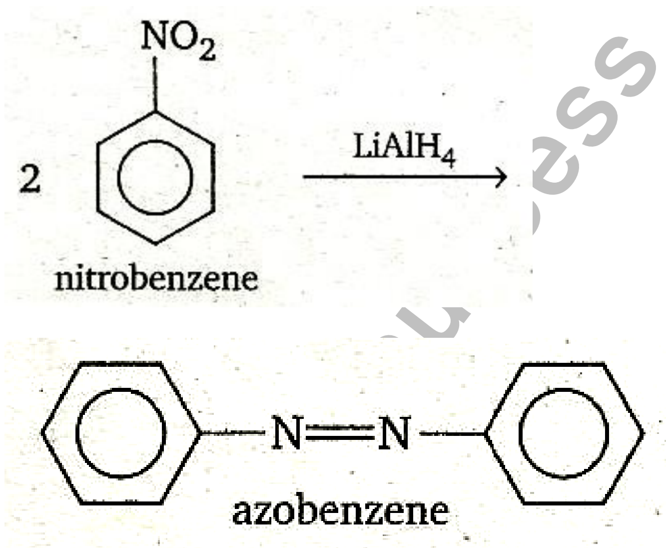
ethane.

$$CH_3COOH \xrightarrow{LiAlH_4} \underset{\text{ethyl alcohol}}{CH_3CH_2OH}$$

$$CH_3COOH \xrightarrow{\text{Red P + HI}} \underset{\text{ethane}}{CH_3-CH_3}$$

Hence, reagent A and B are respectively $LiAlH_4$ and Hi/red P.

122) Nitrobenzene on reduction with lithium aluminium hydride ($LiAlH_4$) gives azobenzene.



123) Aspirin is used as analgesics as well as antipyretics, ie, it serve a dual purpose.

Chlorophyll is used in photosynthesis. Oxyhaemoglobin contains Fe^{2+} ion, so it is paramagnetic and haemoglobin works as oxygen carrier.

Hence, A-(v), B-(i), C-(ii), D-(iii).

124) The ratio of weight average molecular weight and the number average molecular weight is called poly dispersity index (PDI).

$$\mathrm{PDI} = \frac{\overline{M}_w}{M_n}$$

where,

$\overline{M}_w$ = weight average molecular weight

$\overline{M}_n$ = number average molecular weight

PDI is unity for natural monodispersed polymer but for synthetic polymers it is always greater than unity.

125) On hydrolysis with dilute aqueous sulphuric acid, sucrose gives a equimolar mixture of D-(+) glucose and D-(-)-fructose.

$$\underset{\text{sucrose}}{C_{12}H_{22}O_{11}} + H_2O \xrightarrow{H_2SO_4}$$

$$\underset{\substack{\text{D-(+) glucose} \\ 1}}{C_6H_{12}O_6} \; \underset{:}{+} \; \underset{\substack{\text{D-(–) fructose} \\ 1}}{C_6H_{12}O_6}$$

Sucrose is dextrorotatory but after hydrolysis gives dextrorotatory glucose and laevorotatory fructose, laevorotatory fructose is more, so the mixture is laevorotatory.

BITSAT

Engineering Entrance Exam Solved Paper 2009

MATHEMATICS

1. $x \in R : \frac{2x-1}{x^3+4x^2+3x} \in R$ Equals

(a) R - {0}

(b) R - {0, 1, 3}

(c) R - {0, -1, - 3}

(d) R − $0, -1, -3, +\frac{1}{2}$

2. The number of subsets of {1, 2, 3, ……. , 9} containing at least one odd number is –

(a) 324

(b) 396

(c) 496

(d) 512

3. The coefficient of x^{24} in the expansion of $(1 + x^2)^{12}(1 + x^{12})(1 + x^{24})$ is

(a) ${}^{12}C_6$

(b) ${}^{12}C_6 + 2$

(c) ${}^{12}C_6 + 4$

(d) ${}^{12}C_6 + 6$

4. For | x | < 1, the constant term in the expansion of $\frac{1}{x-1\;^{2}\;x-2}\ is$

(a) 2

(b) 1

(c) 0

(d) $-\frac{1}{2}$

5. The roots of

(x - a) (x - a-1) + (x - a -1) (x - a - 2) + (x - a) (x - a - 2) = 0, a $\in$ R are always

(a) Equal

(b) Imaginary

(c) real and distinct

(d) rational and equal

6. Let f(x) = x^2 + ax + b, where a, b $\in$ R. If f(x) = 0 has all its roots imaginary, then the roots of f(x) + f' (x) + f" (x) = 0 are

(a) Real and distinct

(b) Imaginary

(c) Equal

(d) Rational and equal

7. If one of the roots of $\begin{matrix} 3 & 5 & x \\ 7 & x & 7 \\ x & 5 & 3 \end{matrix} = 0 \text{ is } -10, \text{then}$ the other roots are

(a) 3, 7

(b) 4, 7

(c) 3, 9

(d) 3, 4

8. If x, y, z are all positive and are the pth, qth and rth terms of a geometric progression respectively, then the value of the determinant

$$\begin{matrix} \log x & p & 1 \\ \log y & q & 1 \\ \log z & r & 1 \end{matrix} \text{ equals}$$

(a) log xyz

(b) (p -1) (q - 1)(r -1)

(c) pqr

(d) 0

9. If $\begin{matrix} 1 & -1 & x \\ 1 & x & 1 \\ x & -1 & 1 \end{matrix}$ has no inverse, then" the real value of x is

(a) 2

(b) 3

(c) 0

(d) 1

10. The locus of z satisfying the inequality $\frac{z+2i}{2z+i} < 1, where\ z = x + iy, is$

(a) $x^2 + y^2 < 1$

(b) $x^2 - y^2 < 1$

(c) $x^2 + y^2 > 1$

(d) $2x^2 + 3y^2 < 1$

11. The period of $\sin^4 x + \cos^4 x$ is

(a) $\frac{\pi^4}{2}$

(b) $\frac{\pi^2}{2}$

(c) $\frac{\pi}{4}$

(d) $\frac{\pi}{2}$

12. $\frac{\cos x}{\cos\ x-2y} = \lambda \Rightarrow \tan\ x-y\ \ \tan y$ is equal to

(a) $\frac{1+\lambda}{1-\lambda}$

(b) $\frac{1+\lambda}{1+\lambda}$

(c) $\frac{\lambda}{1+\lambda}$

(d) $\frac{\lambda}{1-\lambda}$

13. cos A cos 2A cos 4A ... cos 2^{n-1} A equals

(a) $\frac{\sin 2^n A}{2^n \sin A}$

(b) $\frac{2^n \sin 2^n A}{\sin A}$

(c) $\frac{2^n \sin A}{\sin 2^n A}$

(d) $\frac{\sin A}{2^n \sin 2^n A}$

14. If 3 cos x ≠ -2 sin x, then the general solution of $\sin^2 x - \cos 2x = 2 - \sin 2x$ is

(a) $n\pi + (-1)^n \frac{\pi}{2},\ n \in Z$

(b) $\frac{n\pi}{2},\ n \in Z$

(c) $(4n \pm 1)\frac{\pi}{2},\ n \in Z$

(d) $(2n - 1)\pi, n \in Z$

15. In a Δ ABC

$\frac{(a+b+c)(b+c-a)(c+a-b)(a+b-c)}{4b^2c^2}$ equals

(a) $\cos^2 A$

(b) $\cos^2 B$

(c) $\sin^2 A$

(d) $\sin^2 B$

16. P is a point on the segment joining the feet of two vertical poles of heights a and b. The angles of elevation of the tops of the poles from P are 45° each. Then, the square of the distance between the tops of the poles is

(a) $\frac{a^2 + b^2}{2}$

(b) $a^2 + b^2$

(c) $2(a^2 + b^2)$

(d) $4(a^2 + b^2)$

17. In a quadrilateral ABCD, the point P divides DC in the ratio 1:2 and Q is the mid point of AG. If AB + 2AD + BC - 2**DC** = k **PQ**, then k is equal to

(a) - 6

(b) - 4

(c) 6

(d) 4

18. If m_1, m_2, m_3 and m_4 are respectively the magnitudes of the vectors

$a_1 = 2\imath - \jmath + k$, $a_2 = 3\imath - 4\jmath - 4k$,

$a_3 = \imath + \jmath - k$ and $a_4 = -\imath + 3\jmath + k$,

then the correct order of m_1, m_2, m_3 and m_4 is

(a) $m_3 < m_1 < m_4 < m_2$

(b) $m_3 < m_1 < m_2 < m_4$

(c) $m_3 < m_4 < m_1 < m_2$

(d) $m_3 < m_4 < m_2 < m_1$

19. The volume of the tetrahedron having the edges $\imath + 2\jmath - k$, $\imath + \jmath + k$, $\imath - \jmath + \lambda k$ as coterminous, is $\frac{2}{3}$ cubic unit. Then λ equals

(a) 1

(b) 2

(c) 3

(d) 4

20. If A and B are events of a random experiment such that P(A∪B) = $\frac{4}{5}$, P($A \cup \overline{B}$) = $\frac{7}{10}$ and P(B) = $\frac{2}{5}$, then P(A) equals

(a) $\frac{9}{10}$

(b) $\frac{8}{10}$

(c) $\frac{7}{10}$

(d) $\frac{3}{5}$

21. If X is a binomial variate with the range {a, 1, 2, 3, 4, 5, 6} and P(X = 2) = 4P (X = 4), then the parameter p of X is

(a) $\frac{1}{3}$

(b) $\frac{1}{2}$

(c) $\frac{2}{3}$

(d) $\frac{3}{4}$

22. The area (in square unit) of the circle which touches the lines 4x + 3y = 15 and 4x + 3y = 5 is

(a) 4 π

(b) 3 π

(c) 2 π

(d) π

23. The point on the line 3x + 4y = 5 which is equidistant from (1,

2) and (3, 4) is

(a) (7, - 4)

(b) (15, -10)

(c) (1/7, 8/7)

(d) (0, 5/4)

24. The equation of the straight line perpendicular to the straight line 3x, + 2y = 0 and passing through. the point of intersection of the lines x + 3y - 1 = 0 and x - 2y + 4 = 0 is

(a) $2x - 3y + 1 = 0$

(b) $2x - 3y + 3 = 0$

(c) $2x - 3y + 5 = 0$

(d) $2x - 3y + 7 = 0$

25. The value of A with. | λ | < 16 such that $2x^2 - 10xy + 12y^2 + 5x + \lambda y - 3 = 0$ represents a pair of straight lines, is

(a) -10

(b) -9

(c) 10

(d) 9

26. The area (in square unit) of the triangle formed by x + y + 1 = 0 and the pair of straight lines $x^2 - 3xy + 2y^2 = 0$ is

(a) 7/12

(b) 5/12

(c) 1/12

(d) 1/6

27. The pairs of straight lines $x^2 - 3xy + 2y^2 = 0$ and $x^2 - 3xy + 2y^2 + x - 2 = 0$ form a

(a) Square but not rhombus

(b) Rhombus

(c) Parallelogram

(d) Rectangle but not a square

28. The equations of the circle which pass through the origin and makes intercepts of lengths 4 and 8 on the x and y-axes respectively are

(a) $x^2 + y^2 \pm 4x \pm 8y = 0$

(b) $x^2 + y^2 \pm 2x \pm 4y = 0$

(c) $x^2 + y^2 \pm 8x \pm 16y = 0$

(d) $x^2 + y^2 \pm x \pm y = 0$

29. The locus of centre of a circle which passes through the origin and cuts off a length of 4 unit from the line x = 3 is

(a) $y^2 + 6x = 0$

(b) $y^2 + 6x = 13$

(c) $y^2 + 6x = 10$

(d) $x^2 + 6y = 13$

30. The point (3, - 4) lies on both the circles $x^2 + y^2 - 2x + 8y + 13 = 0$ and $x^2 + y^2 - 4x + 6y + 11 = 0$ Then, the angle between the circles is -

(a) 60°

(b) $\tan^{-1} \frac{1}{2}$

(c) $\tan^{-1} \frac{3}{5}$

(d) 135°

31. The equation of the circle which passes through the origin and cuts orthogonally each of the circles $x^2 + y^2 - 6x + 8 = 0$

and $x^2 + y^2 - 2x - 2y = T$ is

(a) $3x^2 + 3y^2 - 8x - 13y = 0$

(b) $3x^2 + 3y^2 - 8x + 29y = 0$

(c) $3x^2 + 3y^2 + 8x + 29y = 0$

(d) $3x^2 + 3y^2 - 8x - 29y = 0$

32. The number of normals drawn to the parabola $y^2 = 4x$ from the point (1, 0) is

(a) 0

(b) 1

(c) 2

(d) 3

33. If the circle $x^2 + y^2 = a^2$ intersects the hyperbola $xy = c^2$ in four points (x_i, y_i), fori = 1, 2, 3 and 4, then $y_1 + y_2 + y_3 + y_4$ equals

(a) 0

(b) c

(c) a

(d) c^4

34. The mid point of the chord $4x - 3y = 5$ of the hyperbola $2x^2 - 3y^2 - 12$ is

(a) $0, -\frac{5}{3}$

(b) $2, 1$

(c) $\frac{5}{4}, 0$

(d) $\frac{11}{4}, 2$

35. If a line in the space makes angle a, p and y with the coordinate axes, then

$\cos 2a + \cos 2\beta + \cos 2y + \sin^2 a + \sin^2 \beta + \sin^2 y$ equals

(a) -1

(b) 0

(c) 1

(d) 2

36. The image of the point (3, 2, 1) in the plane 2x-y+3z = 7 is

(a) (1, 2, 3)

(b) (2, 3, 1)

(c) (3, 2, 1)

(d) (2, 1, 3)

37. $\lim_{x\to\infty} \left(\frac{x+5}{x+2}\right)^{x+3}$ *equals*

(a) e

(b) e^2

(c) e^3

(d) e^5

38. If f: R → R is defined by

$f(x) = \begin{cases} \frac{2\sin x - \sin 2x}{2x\cos x}, & \text{if } x \neq 0 \\ a, & \text{if } x = 0 \end{cases}$, then the value of a so that f is continuous at 0 is

(a) 2

(b) 1

(c) -1

(d) 0

39. $x = \frac{1-\sqrt{y}}{1+\sqrt{y}} \Rightarrow \frac{dy}{dx}$ is equal to

(a) $\frac{4}{(x+1)^2}$

(b) $\frac{4(x-1)}{(1+x)^3}$

(c) $\frac{x-1}{(1+x)^3}$

(d) $\frac{4}{(x+1)^3}$

40. $\frac{d}{dx}\left[a\tan^{-1} x + b\log\left(\frac{x-1}{x+1}\right)\right] = \frac{1}{x^4-1} \Rightarrow$ a - 2b is equal to

(a) 1

(b) -1

(c) 0

(d) 2

41. $y = e^{a \sin^{-1} x} \Rightarrow (1 - x^2)\, y_{n+2} - (2n + 1)\, xy_{n+1}$ is equal to

(a) $-(n^2 + a^2)y_n$

(b) $(n^2 - a^2)y_n$

(c) $(n^2 + a^2)\, y_n$

(d) $-(n^2 - a^2)\, y_n$

42. The function $f(x) = x^3 + ax^2 + bx + c$, $a^2 \leq 3b$ has

(a) one maximum value

(b) one minimum value

(c) no extreme value

(d) one maximum and one minimum value

43. $\frac{2-\sin 2x}{1-\cos 2x}\, e^x$ dx is equal to

(a) $-e^x \cot x + c$

(b) $e^x \cot x + c$

(c) $2e^x \cot x + c$

(d) $-2e^x \cot x + c$

44. ${}_0^{\pi} \frac{1}{1+\sin x}$ dx is equal to

(a) 1

(b) 2

(c) -1

(d) -2

45. The solution of the differential equation $\frac{dy}{dx} = \sin x + y \tan x + y - 1 \ is$

(a) cosec (x + y) + tan(x + y) = x + c

(b) x + cosec (x + y) = c

(c) x + tan (x + y) = c

(d) x + sec (x + y) = c

Physics

46. When a wave traverses a medium the displacement of a particle located at x at a time is given by y = a sin (bt - cx), where a, band are constants of the wave, which of the following is a quantity with dimensions?

(a) $\frac{y}{a}$

(b) bt

(c) cx

(d) $\frac{b}{c}$

47. A body is projected vertically upwards at time t = 0 and it is seen at a height H at time t_1 and t_2 second during its flight. The maximum height attained is (g is acceleration due to gravity)

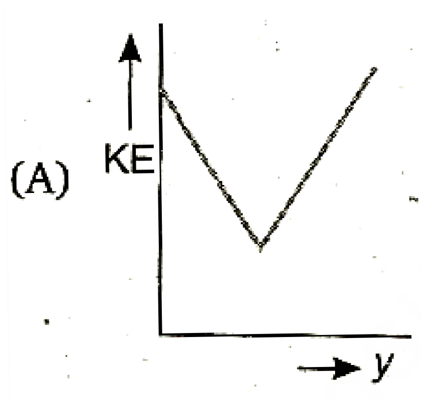
(a) $\frac{g\ t_2-t_1\ ^2}{8}$

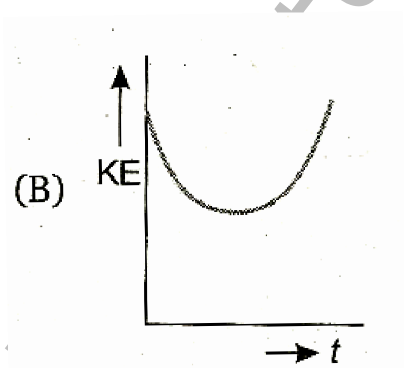
(b) $\frac{g\ t_1+t_2\ ^2}{4}$

(c) $\frac{g\ t_1+t_2\ ^2}{8}$

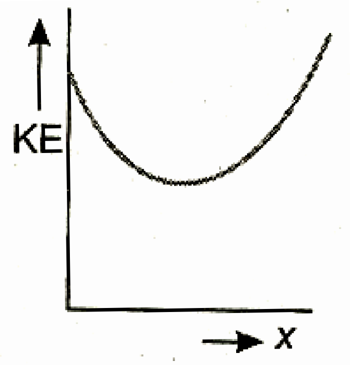
(d) $\frac{g\ t_2-t_1\ ^2}{4}$

48. A particle is projected up from a point at an angle θ with the horizontal direction. At any time t, if P is the linear momentum, y is the vertical displacement, x is horizontal displacement, the graph among the following which does not represent the variation of kinetic energy KE of the particle is

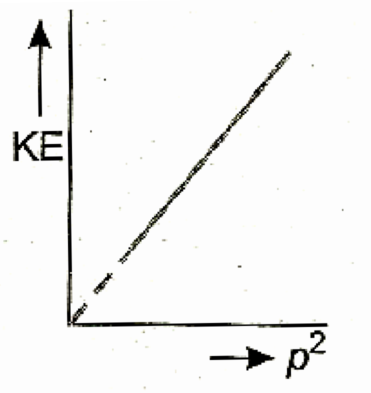




(C)



(D)



(a) graph (A)

(b) graph (B)

(c) graph (C)

(d) graph (D)

49. A motor of power Po is used to deliver water at a certain rate through a given horizontal pipe. To increase the rate of flow of water through the same pipe n times, the power of the motor is increased to P_1. The ratio of P_1 to P_0 is

(a) n: 1

(b) n^2: 1

(c) n^3: 1

(d) $n^4 : 1$

50. A body of mass 5 kg makes an elastic collision with another body at rest and continues to move in the original direction after collision with a velocity equal to 1/10th of its original velocity. Then the mass of the second body is

(a) 4.09 kg

(b) 0.5 kg

(c) 5 kg

(d) 5.09 kg

51. A particle of mass 4 m explodes into three pieces, of masses m, m and 2 m. The equal masses move along X-axis and Y-axis with velocities 4 ms^{-1} and 6 ms^{-1} respectively. The magnitude of the velocity of the heavier mass is

(a) $\sqrt{17}\, ms^{-1}$

(b) $2\sqrt{13}\, ms^{-1}$

(c) $\sqrt{13}\, ms^{-1}$

(d) $\frac{\sqrt{13}}{2}\, ms^{-1}$

52. body is projected vertically upwards from the surface of the earth with a velocity equal to half the escape velocity. If R is the radius of the earth, maximum height attained by the body from the surface of the earth is

(a) R/6

(b) R/3

(c) 2R/3

(d) R

53. The displacement of a particle executing SHM is given by

$$y = 5\sin\left(4t + \frac{\pi}{3}\right).$$

If T is the time period and the mass of the particle is 2 g, the kinetic energy of the particle when $t = \frac{T}{4}$ is given by

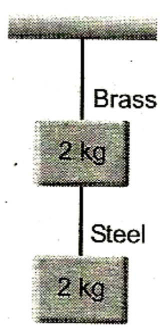
(a) 0.4 J

(b) 0.5 J

(c) 3 J

(d) 0.3 J

54. If the ratio of lengths, radii and Young's modulus of steel and brass wires shown in the figure are a, band c respectively, the ratio between' the increase in lengths of brass and steel wires would be



(a) $\frac{b^2 a}{2c}$

(b) $\frac{bc}{2a^2}$

(c) $\frac{ba^2}{2c}$

(d) $\frac{a}{24\pi Tr^2}$

55. A soap bubble of radius r is blown up to form a bubble of radius 2 r under isothermal conditions. If T is the surface tension of soap solution, the energy spent in the blowing

(a) $3 \pi Tr^2$

(b) $6 \pi Tr^2$

(c) $12 \pi Tr^2$

(d) $24 \pi Tr^2$

56. Eight spherical rain drops of the same mass and radius are falling down with a terminal speed of 6 cm s^{-1}. If they coalesce to form one big drop, what will be the terminal speed of bigger drop? (Neglect the buoyancy of the air)

(a) 1.5 cm-s^{-1}

(b) 6 cm –s^{-1}

(c) 24 cm-s^{-1}

(d) 32 cm-s^{-1}

57. A clock pendulum made of invar has a period of 0.5 s, at 20°C. If the clock is used in a climate where the temperature averages to 30°C, how much time does the clock lose in each oscillation?

(For invar, a = 9×10^{-7} /°C, g = constant)

(a) 2.25×10^{-6} s

(b) 2.5×10^{-7} s

(c) 5×10^{-7} s

(d) 1.125×10^{-6} s

58. A piece of metal weighs 45 g in air and 25 g in a liquid of density 1.5×10^3 kg-m^{-3} kept at 30°C.

When the temperature of the liquid is raised to 40°C, the metal piece weighs 27 g. The density of liquid at 40°C is 1.25×10^3 kg-m^{-3}. The coefficient of linear expansion of metal is

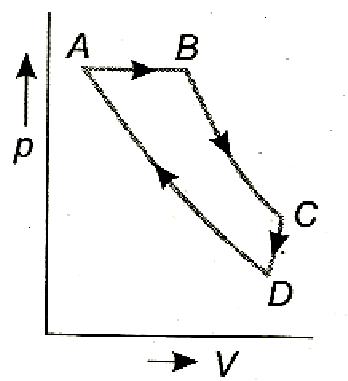
(a) 1.3×10^{-3}/°C

(b) 5.2×10^{-3}/°C

(c) 2.6×10^{-3}/°C

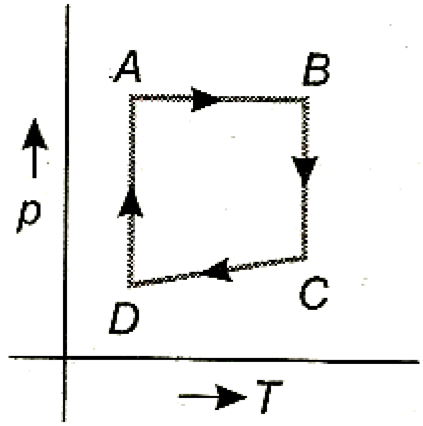
(d) 0.26×10^{-3}/°C

59. An ideal gas is subjected to a cyclic process ABCD as depicted in the p- V diagram given below:

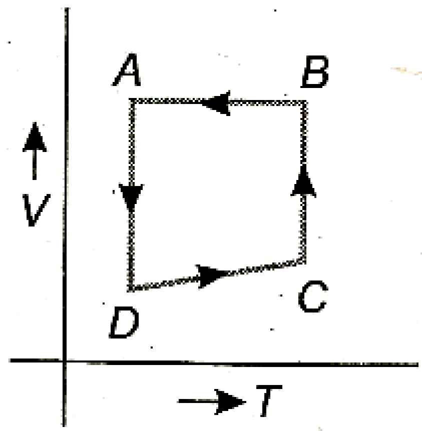


Which of the following curves represents the equivalent cyclic process?

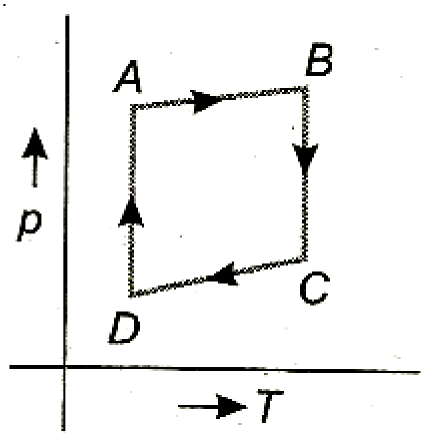
(a)

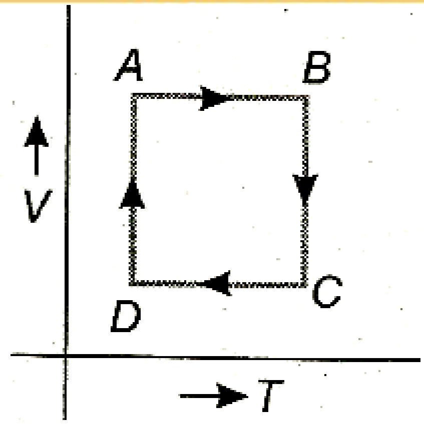


(b)



(c)



(d) 

60. An ideal gas is subjected to cyclic process involving four thermodynamic states, the amounts of heat (Q) and work (W) involved in each of these states are

Q_1 = 6000 J,

Q_2 = - 5500 J;

Q_3 = - 3000 J;

Q_4 = 3500 J

W_1 = 2500 J;

W_2 = -1000 J;

W_3 = -1200 J;

W_4 = x J.

The ratio of the net work done by the gas to the total heat absorbed by the gas is η. The values of x and η respectively are

(a) 500; 7.5%

(b) 700; 10.5%

(c) 1000; 21%

(d) 1500; 15%

61. Two cylinders A and B fitted with pistons contain equal number of moles of an ideal mono atomic gas at 400 K. The piston of A is free to move while that of B is held fixed. Same amount of heat energy is given to the gas in each cylinder. If the rise in temperature of the gas in A is 42 K, the rise in temperature of the gas in B is

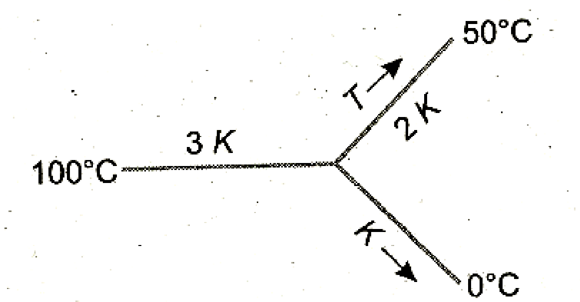
(a) 21 K

(b) 35 K

(c) 42 K

(d) 70 K

62. Three rods of same dimensional have thermal conductivity 3 K, 2 K and K. They are arranged as shown in the figure below



Then, the temperature of the junction in steady state is

(a) $\frac{200}{3}$°C

(b) $\frac{100}{3}$°C

(c) 75°C

(d) $\frac{50}{3}$°C

63. Two sources A and B are sending notes of frequency 680 Hz. A listener moves from A and B with-a constant velocity u. If the speed of sound in air is 340 ms^{-1}, what must be the value of u so that he hears 10 beats per second?

(a) 2.0 ms^{-1}

(b) 2.5 ms^{-1}

(c) 3.0 ms^{-1}

(d) 3.5 ms^{-1}

64. Two identical piano wires have a fundamental frequency of 600 cycle per second when kept under the same tension. What fractional increase in the tension of one wires will lead to the occurrence of 6 beats per second when both wires vibrate simultaneously?

(a) 0.01

(b) 0.02

(c) 0.03

(d) 0.04

65. In the Young's double slit experiment, the intensities at two points P_1 and P_2 on the screen are respectively I_1 and I_2, If P_1 is located at the centre of a bright fringe and P_2 is located at a distance equal to a quarter of fringe width from

P_1, then $\frac{I_1}{I_2}$ is

(a) 2

(b) $\frac{1}{2}$

(c) 4

(d) 16

66. In Young's double slit experiment, the 10th maximum of wavelength λ_1 is at a distance of λ_1 from the central maximum. When the wavelength of the source is changed to λ_2, 5th maximum is at a distance of y_2 from its central maximum. The ratio $\frac{y_1}{y_2}$ is

(a) $\frac{2\lambda_1}{\lambda_2}$

(b) $\frac{2\lambda_2}{\lambda_1}$

(c) $\frac{\lambda_1}{2\lambda_2}$

(d) $\frac{\lambda_2}{2\lambda_1}$

67. Four light sources produce the following four waves:

(i) $y_1 = a' \sin(\omega t + \phi_1)$

(ii) $y_2 = a' \sin 2\omega t$

(iii) $y_3 = a' \sin(\omega t + \phi_2)$

(iv) $y_4 = a' \sin(3\omega t + \phi)$

Super Position of which two waves give rise to interference?

(a) (i) and (ii)

(b) (ii) and (iii)

(c) (i) and (iii)

(d) (iii) and (iv)

68. The two lenses of an achromatic doublet should have

(a) Equal powers

(b) Equal dispersive powers

(c) Equal ratio of their power and dispersive power

(d) Sum of the product of their powers and dispersive power equal to zero

69. Two bar magnets A and B are placed one over the other and are allowed to Vibrate in a vibration magnetometer. They make 20 oscillations per minute when the similar poles of A and B are on the same side, while they make 15 oscillations per minute when their opposite poles lie on the same side. If M_A and M_B are the magnetic' moments of A and B and if $M_A > M_B$, the ratio of M_A and M_B is

(a) 4: 3

(b) 25:7

(c) 7: 5

(d) 25: 16

70. A bar magnet is 10 cm long is kept with its north (N)-pole pointing north. A neutral point is formed at a distance of 15 cm from each pole:

Given the horizontal component of earth's field is 0.4 Gauss, the pole strength of the magnet is

(a) 9 A-m

(b) 6.75 A-m

(c) 27 A-m

(d) 1.35 A-m

71. An infinitely long thin straight wire has uniform linear charge density of $\frac{1}{3}\ cm^{-1}$ cm^{-1}. Then, the magnitude of the electric intensity at a point 18 cm away is

(given $\varepsilon_0 = 8.8 \times 10^{-12}$ C^2Nm^{-2})

(a) 0.33×10^{11} NC^{1}

(b) 3×10^{11} NC^{-1}

(c) 0.66×10^{11} NC^{1}

(d) 1.32×10^{11} NC^{1}

72. Two point charges -q and + q are located at point's (0, 0, - a) and, (0, 0, a) respectively. The electric potential at a point (0, 9, z), where z > a is

(a) $\frac{qa}{4\pi\,\varepsilon_0 z^2}$

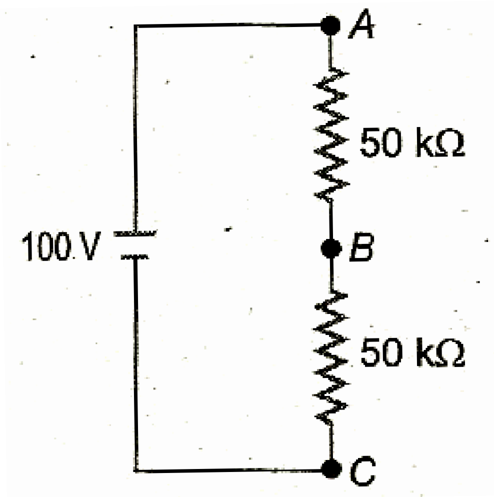
(b) $\frac{q}{4\,\pi\,\varepsilon_0 a}$

(c) $\frac{2qa}{4\pi\varepsilon_0\ z^2 - a^2}$

(d) $\frac{2qa}{4\pi\varepsilon_0\ z^2 + a^2}$

73. In the adjacent shown circuit, a voltmeter of internal resistance R, when connected across B an C reads $\frac{100}{3}$ V.

Neglecting the internal resistance of the battery, the value of R is



(a) 100 kΩ

(b) 75 kΩ

(c) 50 kΩ

(d) 25 kΩ

74. A cell in secondary circuit gives null deflection for 2.5 m length of potentiometer having 10 m length of wire. If the length of the potentiometer wire is increased by 1 m without changing the cell in the primary, the position of the null point now is -

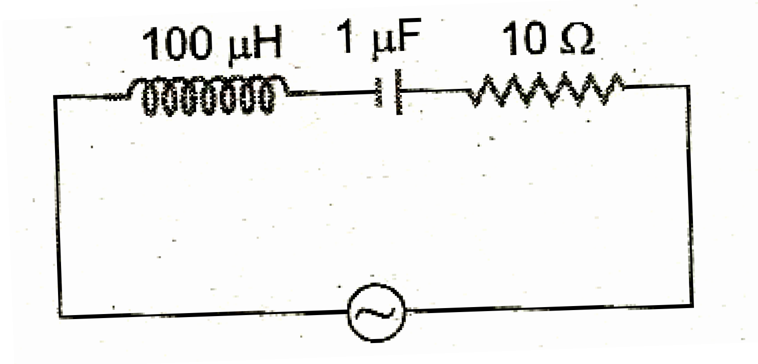
(a) 3.5 m

(b) 3 m

(c) 2.75 m

(d) 2.0 m

75. The following series L-C-R circuit, when driven by an emf source of angular frequency 70 kilo-radians per second, the circuit effectively behaves like



(a) Purely resistive circuit

(b) Series R-L circuit

(c) Series R-C circuit

(d) Series L-C circuit with R = 0

76. A wire of length l is bent into a circular loop of radius R and carries a current l. The magnetic field at the centre of the loop is B. The same wire is now bent into a double loop of equal radii. If both loops carry the same current l and it is in the same direction, the magnetic field at the centre of the double loop will be –

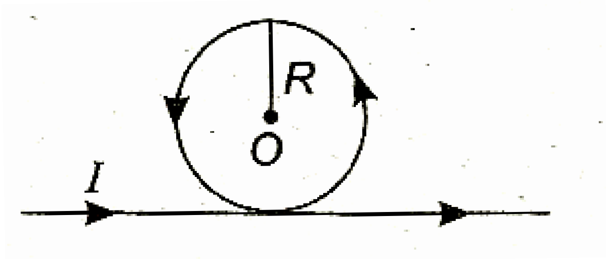
(a) Zero

(b) 2 B

(c) 4 B

(d) 8 B

77. An infinitely long straight conductor is bent into the shape as shown below. It carries a current of I ampere and the radius of the circular loop is R metre. Then, the magnitude of magnetic induction at the centre of the circular loop is –



(a) $\frac{\mu_0 I}{2\pi R}$

(b) $\frac{\mu_0 nI}{2R}$

(c) $\frac{\mu_0 I}{2\pi R}\ \pi + 1$

(d) $\frac{\mu_0 I}{2\ \pi R}\ \pi - 1$

76. The work function of a certain metal is 3.31×10^{-19} J. Then, the maximum kinetic energy of photoelectrons emitted by incident radiation of wavelength 5000 A is

(Given, $h = 6.62 \times 10^{-34}$ J-s,

$c = 3 \times 10^{8}$ ms^{-1}. $e = 1.6 \times 10^{-19}$ C)

(a) 248 eV

(b) 0.41 eV

(c) 2.07 eV

(d) 0.82 eV

79. A photon of energy E ejects; a photoelectron from a metal surface whose work function is W_0. If this electron enters into a uniform magnetic field of induction B in a direction perpendicular to the field and describes a circular path of radius r, then the radius r is given by, (in the usual notation)

(a) $\frac{\sqrt{2m\ E-W_0}}{eB}$

(b) $\overline{2m\ E - W_0\ eB}$

(c) $\frac{\overline{2e\ E - W_0}}{mB}$

(d) $\frac{\overline{2m\ E - W_0}}{eB}$

80. Two radioactive materials X_1 and X_2 have decay constants 10λ and A respectively. If initially they have the same number of nuclei, then the ratio of the number of nuclei of X_1 to that of X_2 will be 1/ e after a time

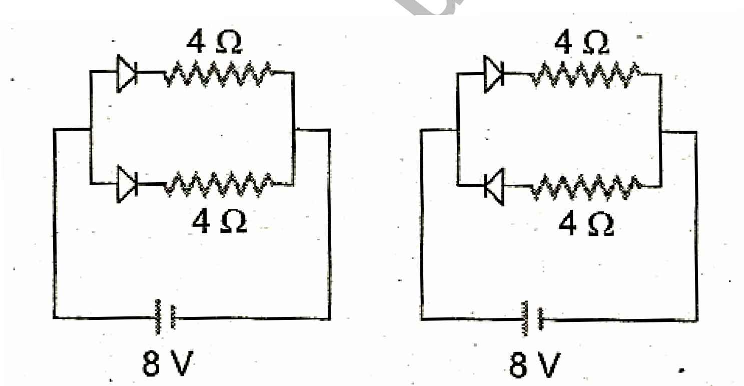
(a) $(1/10\lambda)$

(b) $1/(11\lambda)$

(c) $11/(10\lambda)$

(d) $1/(9\lambda)$

81. Currents flowing in each of the following circuits A and B respectively are



(Circuit A) (Circuit B)

(a) 1 A, 2 A

(b) 2 A, 1 A

(c) 4 A, 2 A

(d) 2 A, 4 A

82. A bullet of mass 0.02 kg travelling horizontally with velocity 250 ms^{-1} strikes a block of wood of mass 0.23 kg which rests on a rough horizontal surface. After the impact, the block and bullet move together arid come to rest after travelling a distance of 40 m. The coefficient of sliding friction of the rough surface is (g = 9.8 ms^{-2})

(a) 0.75

(b) 0.61

(c) 0.51

(d) 0.30

83. Two persons A and B are located in X - Y plane at the points (0, 0) and (0, 10) respectively. (The distances are measured in MKS unit). At a time t = 0, they start moving simultaneously with velocities $v_A = 2j\, ms^{-1}$ and $v_B = 2\,\imath\, ms^{-1}$ respectively. The time after which A arid B are at their closest distance is

(a) 2.5 s

(b) 4 s

(c) 1 s

(d) $\frac{10}{2} s$

84. A rod of length l is held vertically stationary with its lower end located at a point P, on the horizontal plane. When the rod is released to topple about P, the velocity of the upper end of the rod with which it hits the ground is

(a) $\overline{\frac{g}{l}}$

(b) $\sqrt{3gl}$

(c) $3\sqrt{\frac{g}{l}}$;

(d) $\sqrt{\frac{3g}{l}}$

85. A wheel of radius 0.4 m can rotate freely about its axis as shown in the figure. A string is wrapped over its rim and a mass of 4 kg is hung. An angular acceleration of 8 rad-s^{-2} is produced in it due to the torque. Then, moment of inertia of the wheel is (g = 10 ms^{-2})

(a) 2 kg-m^2

(b) 1 kg-m^2

(c) -4 kg-m^2

(d) 8 kg-m^2

CHEMISTRY

86. Given that $\Delta H_f(H)$ = 218 kJ/mol, express the H-H bond energy in kcal/mol.

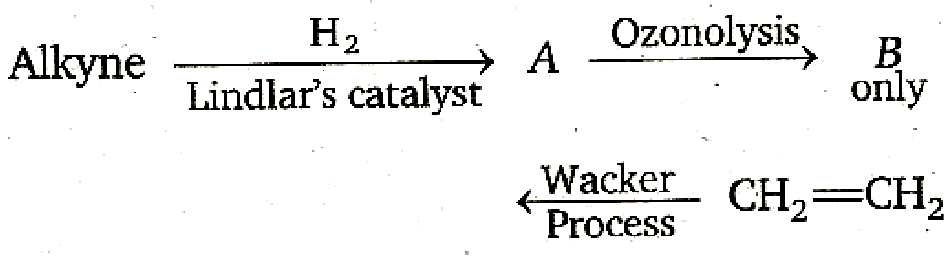
(a) 52.15

(b) 911

(c) 104

(d) 52153

87. Identify the alkyne in the following sequence of reactions,



(a) $H_3C - C \equiv C - CH_3$

(b) $H_3C - CH_2 - C \equiv CH$

(c) $H_2C = CH - C \equiv CH$

(d) $HC = C - CH_2 - C \equiv CH$

88. Fluorine reacts with dilute NaOH and forms a gaseous product A. The bond angle in the molecule of A is

(a) 104°40'

(b) 103°

(c) 107°

(d) 109°28'

89. One mole of alkene X on ozonolysis gave one mole of acetaldehyde and one mole of acetone. The IUPAC name of X is

(a) 2-methyl-2-butene

(b) 2-methyl-1-butene

(c) 2-butene

(d) 1-butene

90. The number of $p\pi$-$d\pi$ 'pi' bonds present in XeO_3 and XeO_4 molecules, respectively are

(a) 3, 4

(b) 4, 2

(c) 2, 3

(d) 3, 2

91. The wavelengths of electron waves in two orbits is 3: 5. The ratio of kinetic energy of electrons will be

(a) 25: 9

(b) 5: 3

(c) 9: 25

(d) 3: 5

92. Which one of the following sets correctly represents the increase in the paramagnetic property of the ions?

(a) $Cu^{2+} > V^{2+} > Cr^{2+} > Mn^{2+}$

(b) $Cu^{2+} < Cr^{2+} < V^{2+} < Mn^{2+}$

(c) $Cu^{2+} < V^{2+} < Cr^{2+} < Mn^{2+}$

(d) $V^{2+} < Cu^{2+} < Cr^{2+} < Mn^{2+}$

93. Electrons with a kinetic energy of 6.023×10^{4} J/mol are evolved from the surface of a metal, when it is exposed to radiation of wavelength of 600 nm. The minimum amount of energy required to remove an electron from the metal atom is

(a) $2.3125 \times 10^{4}19$ J

(b) 3×10^{-19} J

(c) 6.02×10^{-19} J

(d) 6.62×10^{-34} J

94. The chemical entities present in thermosphere of the atmosphere are

(a) $O^{+}2$, O^{+}, NO^{+}

(b) O_3

(c) N_2, O_2, CO_2, H_2O

(d) O_3, $O^{+}{}_2$, O_2

95. The type of bonds present in sulphuric anhydride are -

(a) 3σ and three $p\pi$ - $d\pi$

(b) 3σ one $p\pi$- $p\pi$ and two $p\pi$-$d\pi$

(c) 2σ and three $p\pi$- $d\pi$

(d) 2σ and two $p\pi$- $d\pi$

96. In Gattermann reaction, a diazonium group is replaced by $\underline{X}$ using $\underline{Y}$ $\underline{X}$ and $\underline{Y}$ are –

	$\underline{X}$	$\underline{Y}$
(a)	$Cl^{\ominus}$	Cu/HCI
(b)	$CI^{\oplus}$	$CuCl_2$/HCI
(c)	$Cl^{\oplus}$	$CuCl_2$/HCI
(d)	Cl_2	Cu_2O/HCI

97. Which pair of oxyacids of phosphorus contains 'P-H' bonds?

(a) H_3PO_4, H_3PO_3

(b) H_3PO_3, $H_4P_2O_7$

(c) H_3PO_3, H_3PO_2

(d) H_3PO_2, HPO_3

98. Dipole moment of HCl = 1.03 D, HI = 0.38 D. Bond length of HCI = 1.3 Å and HI = 1.6 Å. The ratio of fraction of electric charge ,δ, existing on each atom in HCl and HI is

(a) 12: 1

(b) 2.7: 1

(c) 3.3: 1

(d) 1: 3.3

99. $SiCl_4$ on hydrolysis forms 'X' and HCl. Compound 'X' loses water at 1000°C and gives 'Y'. Compounds 'X' and 'Y' respectively are

(a) H_2SiCl_6, SiO_2

(b) H_4SiO_4, Si

(c) SiO_2, Si

(d) H_4SiO_4, SiO_2

100. 1.5 g of $CdCl_2$ was found to contain 0.9 g of Cd. Calculate the atomic weight of Cd.

(a) 118

(b) 112

(c) 106.5

(d) 53.25

101. Aluminium reacts with NaOH and forms compound 'X'. If the coordination number of aluminium in 'X' is 6, the correct formula of X is

(a) $[Al(H_2O)_4(OH)_2]^+$

(b) $[Al(H_2O_3)(OH)_3]$

(c) $[Al(H_2O)_2(OH)_4]^-$

(d) $[Al(H_2O)_6](OH)_3$

102. The average kinetic energy of one molecule of an ideal gas at 27°C and 1 atm pressure is

(a) 900 cal K^{-1} mol^{-1}

(b) 6.21×10^{-21} JK^{-1} $molecule^{-1}$

(c) 336.7 JK^{-1} $molecule^{-1}$

(d) 3741.3 JK^{-1} mol^{-1}

103. **Assertion (A)** K, Rb and Cs form superoxides. Reason (R) The stability of the superoxides increases from 'K' to 'Cs' due to decrease in lattice energy.

The correct answer is

(a) Both (A) and (R) are true and (R) is the correct explanation of (A)

(b) Both (A) and (R) are true but (R) is not the correct explanation of (A)

(c) (A) is true but (R) is not true

(d) (A) is not true but (R) is true

104. How many 'mL' of perhydrol is required to produce sufficient oxygen which can be used to completely convert 2L of SO_2 gas

to SO_3 gas?

(a) 10 mL

(b) 5 mL

(c) 20 mL

(d) 30 mL

105. pH of a buffer solution decreases by 0.02 units when 0.12 g of acetic acid is added to 250 mL of a buffer solution of acetic acid and potassium acetate at 27°C. The buffer capacity of the solution is

(a) 0.1

(b) 10

(c) 1

(d) 0.4

106. Match the following.

	List I		List II
(A)	Flespar	(I)	$[Ag_3SbS_3]$
(B)	Asbestos	(II)	$Al_2O_3 \cdot H_2O$
(C)	Pyrargyrite	(III)	$MgSO_4 \cdot H_2O$
(D)	Diaspore	(IV)	$KAlSi_3O_8$
		(V)	$CaMg_3(SiO_3)_4$

The correct answer is

	(A)	(B)	(C)	(D)
(a)	IV	V	II	I
(b)	IV	V	I	II
(c)	IV	I	III	II
(d)	II	V	IV	I

107. Which one of the following order is correct for the first ionisation energies of the elements?

(a) B < Be< N < O

(b) Be < B < N < O

(c) B < Be < O < N

(d) B < O < Be < N

108. What are $\underline{K}$ and $\underline{Y}$ in the following reaction sequence?

$C_2H_5OH \xrightarrow{Cl_2} \underline{X} \xrightarrow{Cl_2} \underline{Y}$

(a) C_2H_5Cl, CH_3CHO

(b) CH_3CHO, CH_3CO_2H

(c) CH_3CHO, CCl_3CHO

(d) C_2H_5Cl, CCl_3CHO

109. What are $\underline{A}$ $\underline{B}$ $\underline{C}$ in the following reactions?

(I) $(CH_3CO_2)_2\,Ca \xrightarrow{\Delta} \underline{A}$

(II) $CH_3CO_2H \xrightarrow[\text{Red P}]{\text{HI}} \underline{B}$

(III) $2CH_3\,CO_2 \xrightarrow{P_4O_{10}} \underline{C}$

	A	B	C
(a)	C_2H_6	CH_3COCH_3	$(CH_3CO)_2O$
(b)	$(CH_3CO)_2O$	C_2H_6	CH_3COCH_3
(c)	CH_3COCH_3	C_2H_6	$(CH_3CO)_2O$
(d)	CH_3COCH_3	$(CH_3CO)_2O$	C_2H_6

110. One per cent composition of an organic compound A is, carbon: 85.71% and hydrogen 14.29%. Its vapour density is 14. Consider the following reaction sequence

$\underline{A} \xrightarrow{Cl_2/H_2O} \underline{B} \xrightarrow[\text{ii } H_3O^+]{\text{i } KCN/ETOH}$

Identify $\underline{C}$

(a) $CH_3 - CH - CO_2\,H$
$\qquad\qquad |$
$\qquad\qquad OH$

(b) $HO - CH_2 - CH_2 - CO_2H$

(c) $HO - CH_2 - CO_2\,H$

(d) $CH_3 - CH_2 - CO_2\,H$

111. How many tripeptides can be prepared by linking the amino acids glycine, alanine and phenyl alanine?

(a) One

(b) Three

(c) Six

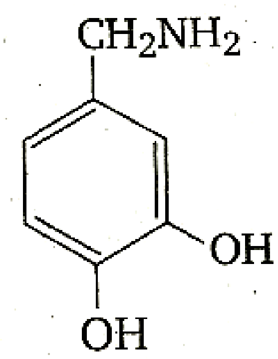
(d) Twelve

112. A codon has a sequence of A, and specifies a particular B that is 'to be incorporated into a C. What are A, B, C?

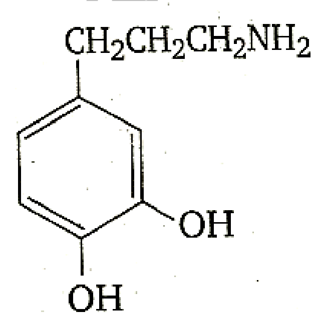
	A	B	C
(a)	3 bases	amino acid	carbohydrate
(b)	3 acids	carbohydrate	protein
(c)	3 bases	protein	amino acid
(d)	3 bases	amino acid	protein

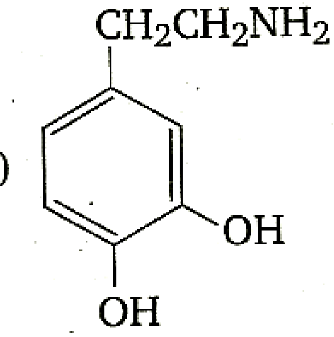
113. Parkinson's disease is linked to abnormalities in the levels of dopamine in the body. The structure of donamine is –

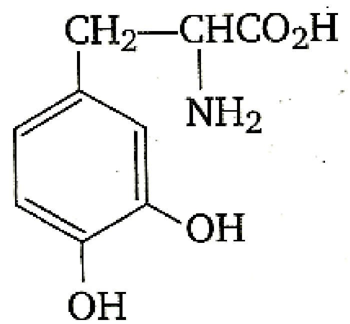
(a)



(b)



(c)


(d)


114. During the depression in freezing point experiment, an equilibrium is established between the molecules of -

(a) Liquid solvent and solid solvent

(b) Liquid solute and solid solvent

(c) Liquid solute and solid solute

(d) Liquid solvent and solid solute

115. Consider the following reaction,

$C_2H_5Cl + AgCN \xrightarrow{EtOH/H_2O} \underline{X}$ (major)

Which one of the following statements is true for $\underline{X}$?

(I) It gives propionic acid on hydrolysis

(II) It has an ester functional group

(III) It has a nitrogen linked to ethyl carbon

(IV) It has a cyanide group

(a) IV

(b) III

(c) II

(d) I

116. For the following cell reaction,

Ag | Ag^+ | AgCl | $Cl^{\ominus}$ | Cl_2, Pt

$\Delta G_f°/(AgCl) = -109$ kJ/mol

$\Delta G°_f/(Cl^{\ominus}) = -129$ kJ/mol

$\Delta G°_f/(Ag^+) = 78$ kJ/mol

E° of the cell is

(a) - 0.60 V

(b) 0.60 V

(c) 6.0 V

(d) None of these

117. The synthesis of crotonaldehyde from acetaldehyde is an example of ……….. reaction

(a) nucleophilic addition

(b) elimination

(c) electrophilic addition

(d) nucleophilic addition-elimination

118. At 25°C, the molar conductances at infinite dilution for the strong electrolytes NaOH, NaCl and $BaCl_2$ are 248×10^{-4}, 126×10^{-4} and 280×10^{-4} $Sm^2\ mol^{-1}$ respectively, $\lambda_m°$ $Ba(OH)_2$ in $Sm^2\ mol^{-1}$ is –

(a) 52.4×10^{-4}

(b) 524×10^{-4}

(c) 402×10^{-4}

(d) 262×10^{-4}

119. The cubic unit cell of a metal (molar mass = 63.55 g mol^{-1}) has an edge length of 362 pm.

Its density is 8.92g cm^{-3} the type of unit cell is

(a) Primitive

(b) Face centred

(c) Body centred

(d) End centred

120. The equilibrium constant for the given reaction is 100.

$$N_2(g) + 2O_2(g) \rightleftharpoons 2NO_2(g)$$

What is the equilibrium constant for the reaction given below?

$NO_2(g) \rightleftharpoons \frac{1}{2} N_2(g) + O_2(g)$

(a) 10

(b) 1

(c) 0.1

(d) 0.01

121. For a first order reaction at 27°C, the ratio of time required for 75% completion to 25% completion of reaction is –

(a) 3.0

(b) 2.303

(c) 4.8

(d) 0.477

122. The concentration of an organic compound in chloroform is 6.15 g per 100 mL of solution. A portion of this solution in a 5 cm polarimeter' rube causes an observed rotation of -1.2°. What is the specific rotation of the compound?

(a) + 12°

(b) -3.9°

(c) -39°

(d) +61.5°

123. 20 mL of 0.1 M acetic acid is mixed with 50 mL of potassium acetate. K_a of acetic acid = 1.8×10^{-5} at 27°C. Calculate concentration of potassium acetate if pH of the mixture is 4.8.

(a) 0.1 M

(b) 0.04 M

(c) 0.4 M

(d) 0.02 M

124. Calculate $\Delta H°$ for the reaction,

$Na_2(s) + SO_3(g) \rightarrow Na_2SO_4(g)$ given the following:

(A) $Na(s) + H_2O(l) \rightarrow NaOH(s) + \frac{1}{2} H_2(g)$

$\Delta H° = -146\ kJ$

(B) $Na_2SO_4(S) + H_2O(l) \rightarrow 2NaOH(s) + SO_3(g)$

$\Delta H° = +418\ kJ$

(C) $2Na_2O(s) + 2H_2(g) \rightarrow 4Na(s) + 2H_2O(l)$

$\Delta H° = +259\ kJ$

(a) + 823 kJ

(b) -581 kJ

(c) -435 kJ

(d) +531 kJ

125. Which one of the following is most effective in causing the coagulation of an As_2S_3 sol?

(a) KCl

(b) $AlCl_3$

(c) $MgSO_4$

(d) $K_3Fe(CN)_6$

REASONING

Directions (Q. 126-128): In each of the following questions, choose the most appropriate alternative to fill in the blank.

126. It is difficult to believe what he tells us because his account of any event is always full of .... of all sorts.

(a) Discrepancies

(b) Differences

(c) Discretions

(d) Distinctions

127. The bank clerk tried to .... money from his friend's account.

(a) Empower

(b) Embellish

(c) Embroil

(d) Embezzle

128. Eight scientists have .... the national awards for outstanding contribution and dedication to the profession-

(a) Bestowed

(b) Picked

(c) Bagged

(d) Conferred

Directions (Q. 129-131): In the following questions, some parts have been jumbled up. You are required to rearrange these parts, which are labelled P, Q, R and S, to produce the correct sentence.

129. Freedom, is the restricted kind in the sense/(P), the rich and

poor woman/(Q), that a wide gulf separates/ (R), which a modern woman enjoys(S)

(a) P S R Q

(b) S R Q P

(c) R Q P S

(d) S P R Q

130. In life, some rules are/(P), as in business/(Q), they seem almost instinctive/(R), learnt so early that/(S)

(a) R S P Q

(b) Q P S R

(c) R P S Q

(d) Q S P R

131. Kapil, left in an aeroplane/(P), after reading a sailing magazine/(Q), had decided/(R), to build his own boat nine years earlier/(S)

(a) P R Q S

(b) R S Q P

(c) R Q P S

(d) P S R Q

Directions (Q. 132-134): In each of the following questions is choose the alternative which is most nearly the same in meaning to the word given in capital letters.

132. DENOUEMENT

(a) Outcome

(b) Eschew

(c) Action

(d) Character

133. GAUCHE

(a) Vain

(b) Rich

(c) Polished

(d) Tactless

134. ACCOLADE

(a) Honour

(b) Appreciation

(c) Greeting

(d) Gift

Directions (Q. 135-137): In each of the following questions, choose the alternative which is opposite in meaning to the word given in capital letters.

135. REPRIMAND

(a) Reward

(b) Appreciate

(c) Encourage

(d) Praise

136. IMPERTINENT

(a) Polite

(b) Indifferent

(c) Unpleasant

(d) Stubborn

137. EQUIVOCAL

(a) Mistaken

(b) Quaint

(c) Clear

(d) Universal

Directions (Q. 138-140): In each of the following questions, choose the alternative which can be substituted for the given words/sentence.

138. Design made by putting together coloured pieces of glass or stones –

(a) Oleograph

(b) Mosaic

(c) Tracery

(d) Relief

139. The doctrine that human soul passes from one body to another at the time of death

(a) Metamorphosis

(b) Transition

(c) Transmigration

(d) Extrapolation

140. A style in which a writer makes a display of his knowledge

(a) Pedantic

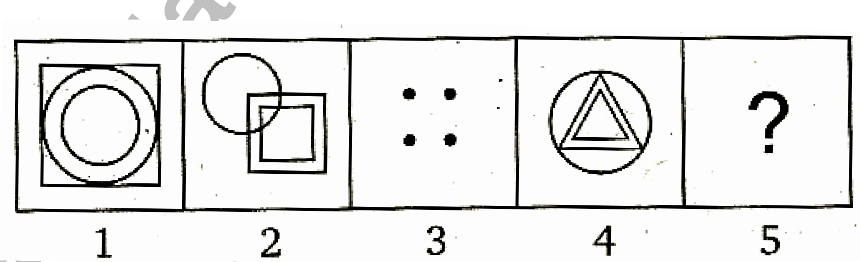
(b) Ornate

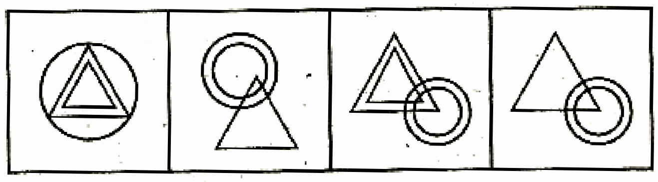
(c) Verbose

(d) Pompous

Directions (Q. 141): In each of these questions, two figure/words are given to the left of the sign :: and one figures word to the right of the sign:: with four alternatives under it out. of which one of the alternatives has the same relationship with the figures/words to the right of the sign:: as between the two figures/words to the left of the sign (::). Find the correct alternative.

141.





Directions (Q. 142): In the following question, choose the missing word or sign (?) on the basis of the relationship between the words given on the left/right hand side of the signs.

142. Doctor: Nurse:: ? : Follower

(a) Worker

(b) Employer

(c) Union

(d) Leader

143. One of the, numbers does not fit into the series.

Find the wrong number

1788, 892, 444, 220, 112, 52, 24

(a) 52

(b) 112

(c) 220

(d) 444

Directions (Q. 144): In the question below is given a statement followed by three assumptions numbered I, II and III. An assumption is something supposed or taken for granted. You have to consider the statement and the following assumptions and decide which of the assumption(s) is/are implicit in the statement.

144. **Statement:** Large number of people affected by the flood in the area gathered at the relief camp for food, water and shelter organized by the state government

Assumptions:

I. The relief camp has enough supplies to provide food and water to the affected people in the area.

II. All those whose houses are submerged can be accommodated in the temporary shelters.

III. Many more affected people are yet to reach the relief camp.

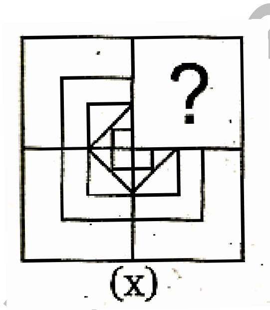
(a) Only I is implicit

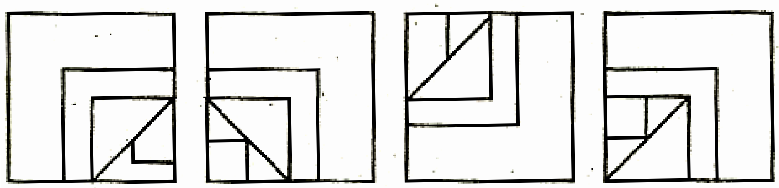
(b) Only I and II are implicit

(c) Only II is implicit

(d) Only II and III are implicit

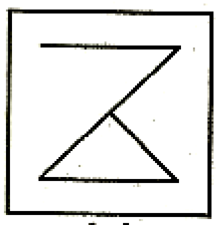
145. Identify the missing part of the figure and select it from the given alternatives.



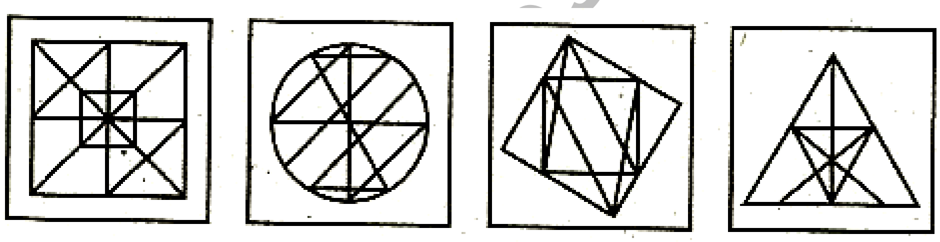


(a) (b) (c) (d)

146. Figure (x) is embedded in anyone of the four alternative figures. Choose the alternative which contains figure (x).

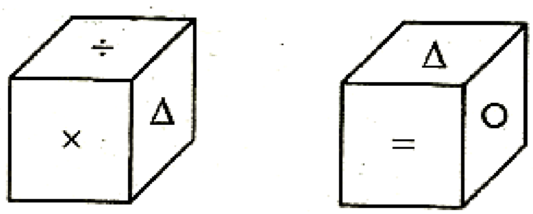


(x)



(a) (b) (c) (d)

147. Which symbol will appear on the opposite surface to the symbol x?



(i) (ii)

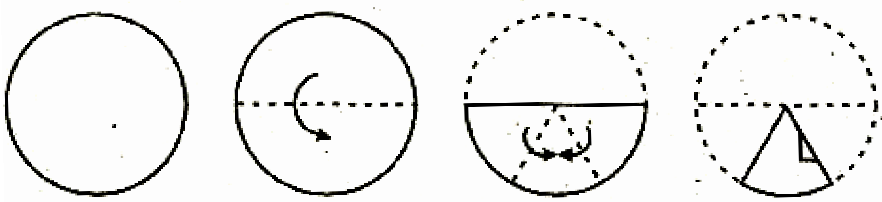
(a) '÷'

(b) '×'

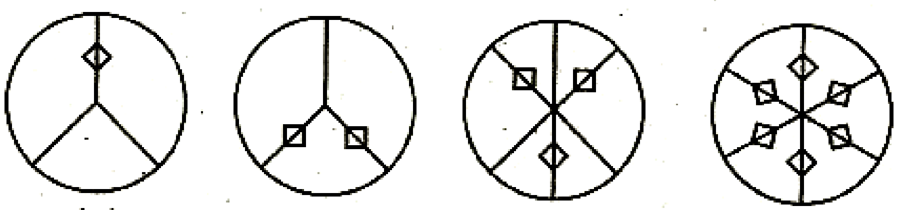
(c) '+'

(d) '–'

148. The three figures marked X, Y, Z show the manner in which a paper is folded step by step and then cut. From the answer figures (a), (b), (c), (d), select the one, showing the unfolded position of the Paper after the cut.



P X Y Z



(a) (b) (c) (d)

149. SERVANT: QGPXYPR :: KING?

(a) MKPI

(b) IKLI

(c) IGLE

(d) IGPI

149. If P denotes '÷'

Q denotes, '×'

R denotes '+'

S denotes '–',

Then what is the value of 18 Q 12 P 4 R 5 S 6 =?

(a) 64

(b) 81

(c) 53

(d) 24

Answers

MATHEMATICS

1. (c)	**2.** (c)
3. (b)	**4.** (d)
5. (c)	**6.** (b)
7. (a)	**8.** (d)
9. (d)	**10.** (c)
11. (d)	**12.** (b)
13. (a)	**14.** (c)
15. (c)	**16.** (c)
17. (a)	**18.** (a)
19. (a)	**20.** (c)
21. (a)	**22.** (d)
23. (b)	**24.** (d)
25. (b)	**26.** (c)
27. (c)	**28.** (a)
29. (b)	**30.** (d)
31. (b)	**32.** (b)
33. (a)	**34.** (b)
35. (c)	**36.** (c)
37. (c)	**38.** (d)
39. (b)	**40.** (b)
41. (c)	**42. (c)**
43. (a)	**44. (b)**

45. (b)	

PHYSICS

46. (d)	**47.** (c)
48. (a)	**49.** (a)
50. (a)	**51.** (c)
52. (b)	**53.** (d)
54. (d)	**55.** (d)
56. (c)	**57.** (a)
58. (c)	**59.** (a)
60. (b)	**61.** (c)
62. (a)	**63.** (b)
64. (b)	**65.** (d)
66. (a)	**67.** (c)
68. (d)	**69.** (b)
70. (d)	**71.** (a)
72. (c)	**73.** (c)
74. (c)	**75.** (c)
76. (c)	**77.** (c)
78. (b)	**79.** (d)
80. (d)	**81.** (c)
82. (c)	**83.** (a)
84. (b)	**85.** (a)

CHEMISTRY

86. (c)	**87.** (a)
88. (b)	**89.** (a)
90. (a)	**91.** (a)
92. (c)	**93.** (a)
94. (a)	**95.** (b)
96. (a)	**97.** (c)
98. (c)	**99.** (d)
100. (c)	**101.** (c)
102. (b)	**103.** (c)
104. (a)	**105.** (d)
106. (b)	**107.** (c)
108. (c)	**109.** (c)
110. (b)	**111.** (c)
112. (d)	**113.** (c)
114. (a)	**115.** (b)
116. (a)	**117.** (d)
118. (b)	**119.** (b)
120. (c)	**121.** (c)
122. (c)	**123.** (b)

124. (b)	**125.** (b)

REASONING

126. (a)	**127.** (d)
128. (c)	**129.** (d)
130. (b)	**131.** (b)
132. (a)	**133.** (d)
134. (b)	**135.** (b)
136. (a)	**137.** (c)
138. (b)	**139.** (c)
140. (a)	**141.** (d)
142. (d)	**143.** (b)
144. (b)	**145.** (b)
146. (b)	**147.** (d)
148. (b)	**149.** (a)
150. (c)	

Solutions

MATHEMATICS

1. Let A = $x \in R: \frac{2x-1}{x^3 + 4x^2 + 3x}$

Now, $x^3 + 4x^2 + 3x = x(x^2 + 4x + 3)$

$= x(x + 3)(x + 1)$

$A = R - \{0, -1, -3\}$

2. The total number of subsets of given set is $2^9 = 512$

Even numbers are {2, 4, 6, 8}.

Case I When selecting only one even number.

$= {}^4C_1 = 4$

Case II When selecting only two even numbers

$= {}^4C_2 = 6$

Case III When selecting only' three even numbers.

$= {}^4C_3 = 4$

Case IV When selecting only four even numbers = ${}^4C_4 = 1$

$\therefore$ Required number of ways

$= 512-(4 + 6 + 4 + 1) - 1$

$= 496$

[Here, we subtract 1 for due to the null set]

3. Now, $(1 + x^2)^{12}(1 + x^{12} + x^{24} + x^{36})$

$= [1 + {}^{12}C_1(x^2) + {}^{12}C_2 (x^2)^3 + {}^{12}C_3(x^2)^3$

$+ {}^{12}C_4(x^2)^4 + {}^{12}(x^2)_5 + {}^{12}C_6 (x^2)^6$

$+ \ldots\ldots + {}^{12}C_{12}(x^2)^{12}] \times (1 + x^{12} + x^{24} + x^{36})$

Coefficient of $x^{24} = {}^{12}C_6 + {}^{12}C_{12} + 1$

$= {}^{12}C_6 + 2$

4. $\frac{1}{(x-1)^2(x-2)} = \frac{1}{-2(1-x)^2\left(1-\frac{x}{2}\right)}$

$= -\frac{1}{2}(1-x)^{-2}\left(1-\frac{x}{2}\right)^{-1}$

$= -\frac{1}{2}(1+2x+\ldots..)\left(1+\frac{x}{2}+\ldots\ldots\right)$

$\therefore$ Coefficient of constant term is $-\frac{1}{2}$.

5. Given,

$(x - a)(x - a - 1) + (x - a - 1)(x - a - 2) + (x - a)(x - a - 2) = 0$

Let $x - a = t$, then

$t(t-1) + (t-1)(t-2) + t(t-2) = 0$

$\Rightarrow t^2 - t + t^2 - 3t + 2 + t^2 - 2t = 0$

$\Rightarrow 3t^2 - 6t + 2 = 0$

$\Rightarrow t = \frac{6 \pm \sqrt{36-24}}{2\cdot 3} = \frac{6 \pm 2\sqrt{3}}{2\cdot 3}$

$\Rightarrow x - a = \frac{3 \pm \sqrt{3}}{3}$

$\Rightarrow x = a + \frac{3 \pm \sqrt{3}}{3}$

Hence, x is real and distinct.

6. Given, $f(x) = x^2 + ax + b$ has imaginary roots.

$\therefore$ Discriminant, $D < 0 \Rightarrow a^2 - 4b < 0$

Now, $f'(x) = 2x + a$

$f'(x) = 2$

Also, $f(x) + f'(x) + f''(x) = 0$ ………. (i)

$\Rightarrow x^2 + ax + b + 2x + a + 2 = 0$

$\Rightarrow x^2 + (a + 2)x + b + a + 2 = 0$

$$\therefore \quad x = \frac{-(a+2) \pm \sqrt{(a+2)^2 - 4(a+b+2)}}{2}$$

$$= \frac{-(a+2) \pm \sqrt{a^2-4b-4}}{2}$$

Since, $a^2 - 4b < 0$

$a^2 - 4b - 4 < 0$

Hence, Eq. (i) has imaginary roots.

7. Given, $\begin{vmatrix} 3 & 5 & x \\ 7 & x & 7 \\ x & 5 & 3 \end{vmatrix} = 0$

$\Rightarrow 3(3x - 35) - 5(21 - 7x) + x(35 - x^2) = 0$

$\Rightarrow 9x - 105 - 105 + 35x + 35x - x^3 = 0$

$\Rightarrow x^3 - 79x + 210 = 0$

$\Rightarrow (x + 10)(x - 3)(x - 7) = 0$

$\Rightarrow x = -10, 3, 7$

8. Let a and R be the first term and common ratio of a GP.

$\therefore T_p = aR^{P-1} = x$

$T_q = aR^{q-1} = y$

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And $T_r = aR^{r-1} = z$

$\Rightarrow$ log x = log a + (p - 1) log R

log y = log a + (q - 1) log R

and log z = log a + (r -1) log R

$$\therefore \begin{vmatrix} \log x & x & 1 \\ \log y & y & 1 \\ \log z & z & 1 \end{vmatrix} = \begin{vmatrix} \log a + (p-1)\log R & p & 1 \\ \log a + (q-1)\log R & q & 1 \\ \log a + (r-1)\log R & r & 1 \end{vmatrix}$$

$$= \begin{vmatrix} \log a & p & 1 \\ \log a & q & 1 \\ \log a & r & 1 \end{vmatrix} + \begin{vmatrix} (p-1)\log R & p & 1 \\ (q-1)\log R & q & 1 \\ (r-1)\log R & r & 1 \end{vmatrix}$$

$$= \log a \begin{vmatrix} 1 & p & 1 \\ 1 & q & 1 \\ 1 & r & 1 \end{vmatrix} + \log R \begin{vmatrix} p-1 & p-1 & 1 \\ q-1 & q-1 & 1 \\ r-1 & r-1 & 1 \end{vmatrix}$$

$C_2 \to C_2 - C_3$

= 0 + 0 = 0 ($\because$ two columns are identical)

9. If matrix has no inverse it means the value of determinant should be zero.

$$\therefore \begin{vmatrix} 1 & -1 & x \\ 1 & x & 1 \\ x & -1 & 1 \end{vmatrix} = 0$$

If we put x = 1, then column Ist and IIIrd are identical.

Hence, option (d) is correct.

10. Let z = x + iy

Given, $\frac{z+2i}{2z+i} < 1$

$\Rightarrow \quad \frac{\sqrt{x^{2}+\ y+2^{\ 2}}}{\sqrt{2x^{\ 2}+\ 2y+1^{\ 2}}} < 1$

$\Rightarrow \quad x^2 + y^2 + 4 + 4y < 4x^2 + 4y^2 + 1 + 4y$

$\Rightarrow \quad 3x^2 + 3y^2 > 3$

$\Rightarrow \quad x^2 + y^2 > 1$

11. Let $f(x) = \sin^4 x + \cos^4 x$

$= \quad (\sin^2 x + \cos^2 x)^2 - 2 \sin^2 x \cos^2 x$

$= \quad 1 - \frac{1}{4}.2\ \ \sin\ 2x\ ^{2}$

$= \quad 1 - \frac{1}{4}\ \ 1 - \cos 4x$

$= \frac{3}{4} + \frac{\cos 4x}{4}$

$\therefore \quad$ Period of $f(x) = \frac{2\pi}{4} = \frac{\pi}{2}$

12. Now, $\tan (x - y) \tan y$

$= \frac{\sin\ x-y\ \ \sin\ y}{\cos\ x-y\ \ \cos y} \times \frac{2}{2}$

$= \frac{\cos\ x-2y\ \ -\cos\ x}{\cos\ x-2y\ \ +\cos\ x}$

$= \frac{1-\frac{\cos x}{\cos\ x-2y}}{1+\frac{\cos\ x}{\cos\ x-2y}}$

$= \frac{1-\lambda}{1+\lambda}\ \ Given, \lambda = \frac{\cos x}{\cos\ x-2y}$

13. It is a standard result.

cos A cos 2A cos 2^2 A ..... cos 2^{n-1} A

$= \frac{\sin 2^n A}{2^n \sin A}$

14. $\sin^2 x - \cos 2x = 2 - \sin 2x$

$\Rightarrow \quad 1 - \cos^2 x - (2\cos^2 x - 1) = 2 - 2 \sin x \cos x$

$\Rightarrow \quad -3\cos^2 x + 2 \sin x \cos x = 0$

$\Rightarrow \quad \cos x (2 \sin x - 3 \cos x) = 0$

$\Rightarrow \quad \cos x = 0, \quad (\because 2 \sin x - 3 \cos x \neq 0)$

$\Rightarrow \quad x = 2n\pi \pm \frac{\pi}{2}$

$\Rightarrow \quad x = (4n \pm 1)\frac{\pi}{2}$

15. We know that, 2s = a + b + c

$\therefore \quad \frac{a+b+c \quad b+c-a \quad c+a-b \quad a+b-c}{4b^2c^2}$

$= \quad \frac{2s \; 2s-2a \quad 2s-2b \quad 2s-2c}{4b^2c^2}$

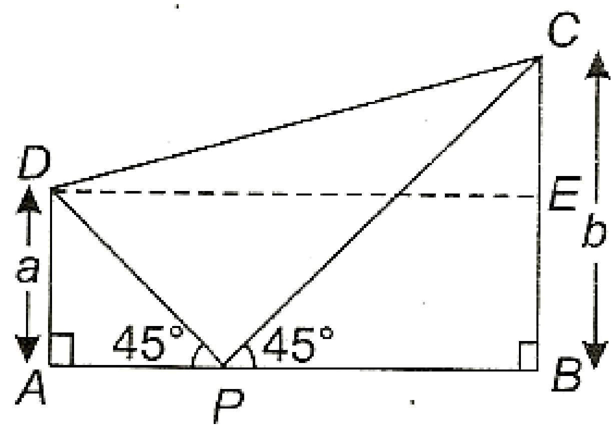
$= \quad 4\frac{s \; s-a}{bc} \times \frac{s-b \quad s-c}{bc}$

$= \quad 4\cos^2 \frac{A}{2} \times \sin^2 \frac{A}{2}$

$= \quad \sin^2 A$

16. In Δ APD

$\tan 45° = \frac{a}{AP} \Rightarrow AP = a$



And in $\triangle BPC$, $\tan 45° = \frac{b}{PB} \Rightarrow PB = b$

$\therefore \quad DE = a + b$ and $CE = b - a$

In Δ DEC, $\quad DC^2 = DE^2 + EC^2$

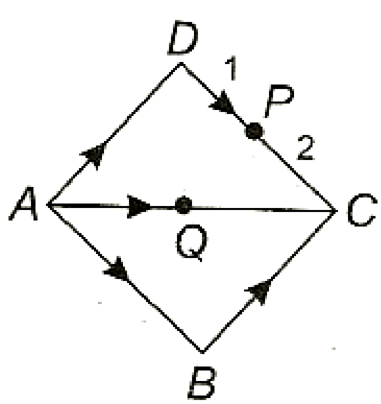
$$= (a + b)^2 + (b - a)^2$$

$$= 2(a^2 + b^2)$$

17. Now, $\vec{AB} + 2\vec{AD} + \vec{BC} - 2\vec{DC}$

$= \quad \vec{AC} + 2\vec{AD} - 2\vec{DC}$

$= \quad \vec{AC} + 2\,(\vec{AC} + \vec{CD}) - 2\,\vec{DC}$



= $3AC$ - $4DC$

= $3(2QC)$ - $4\left(\frac{3}{2}PC\right)$

= $6\,\boldsymbol{QC}$ - $6\,\boldsymbol{PC} = 6(QC + CP)$

= $k\,\boldsymbol{PQ} = 6\,\boldsymbol{QP}$ = - $6PQ$ (given)

$\Rightarrow$ k = -6

18. Given, $m_1 = |a_1| = \sqrt{2^2 + (-1)^2 + (1)^2} = \sqrt{6}$

$m_2 = |a_2| = \sqrt{3^2 + (-4)^2 + (-4)^2} = \sqrt{6}$

$m_3 = |a_3| = \sqrt{1^2 + 1^2 + (-1)^2} = \sqrt{3}$

and $m_4 = |a_4| = \sqrt{(-1)^2 + (3)^2 + (1)^2} = \sqrt{11}$

$\therefore$ $m_3 < m_1 < m_4 < m_2$

19. Let $a = \hat{\imath} + 2\hat{\jmath} - k$, $b = \hat{\imath} + \hat{\jmath} + k$

and $c = \hat{\imath} - \hat{\jmath} + \lambda k$

Since, volume of tetrahedron = $\frac{1}{6}[abc]$

$$\Rightarrow \frac{2}{3} = \frac{1}{6}\begin{vmatrix} 1 & 2 & -1 \\ 1 & 1 & 1 \\ 1 & -1 & \lambda \end{vmatrix}$$

$\Rightarrow$ $4 = -\lambda + 5$

$\Rightarrow$ $\lambda = 1$

20. Given, $P(\bar{A} \cup \bar{B}) = P(\overline{A \cap B}) = \frac{7}{10}$

Since, $P(A \cap B) + P(\overline{A \cap B}) = \frac{1}{3}$

$\Rightarrow \quad P\ A \cap B\ = 1 - \frac{7}{10} = \frac{3}{10}$

Also, P(A ∪ B) = P(A) + P(B) - P(A ∩ B)

$\Rightarrow \quad \frac{4}{5} = P\ A\ + \frac{2}{5} - \frac{3}{10}$

$\Rightarrow \quad P\ A\ = \frac{4}{5} - \frac{2}{5} + \frac{3}{10}$

$= \frac{2}{5} + \frac{3}{10} = \frac{7}{10}$

21. Here, n = 6

According to the question

$^6C_2\, p^2q^4 = 4 \cdot {}^6C_4 p^4q^2$

$\Rightarrow \quad q^2 = 4p^2$

$\Rightarrow \quad (1- p)^2 = 4p^2$

$\Rightarrow \quad 3p^2 + 2p - 1 = 0$

$\Rightarrow \quad (p + 1)(3p -1) = 0$

$\Rightarrow \quad p = \frac{1}{3}$

($\because$ p cannot be negative)

22. Since, given lines are parallel.

$\therefore \quad d = \frac{15-5}{\sqrt{4^2+3^2}} = \frac{10}{5}$

$\Rightarrow \quad$ d = 2 = diameter of the circle

$\therefore \quad$ Radius of circle = 1

$\therefore \quad$ Area of circle = $\pi r^2 = \pi$ sq unit

23. Let point (x_1, y_1) be on the line 3x + 4y = 5.

$3x_1 + 4y_1 = 5$ .... (i)

Also, $(x_1 - 1)^2 + (y_1 - 2)^2 = (x_1 - 3)^2 + (y_1 - 4)^2$

$\Rightarrow \quad x_1 + y^2{}_1 - 2x_1 - 4y_1 + 5$

$= x^2{}_1 + y^2{}_1 - 6x_1 - 8y_1 + 25$ .... (ii)

$\Rightarrow \quad 4x_1 + 4y_1 = 20$ .... (iii)

On solving Eqs. (i) and (ii), we get, $x_1 = 15$, $y_1 = -10$

24. The point of intersection of lines

$x + 3y - 1 = 0$ and $X - 2y + 4 = 0$ is (-2, 1).

Let equation of line perpendicular to the given line is

$2x - 3y + \lambda = 0$.

Since, it passes through (-2, 1).

$\therefore \quad 2(-2) - 3(1) + \lambda = 0$

$\Rightarrow \quad \lambda = 7$

$\therefore$ Required line is $2x - 3y + 7 = 0$

25. Given equation is

$2x^2 - 10xy + 12y^2 + 5x + \lambda y - 3 = 0$

Here, $a = 2$, $h = -5$, $b = 12$, $g = \frac{5}{2}$, $f = \frac{\lambda}{2}$, $c = -3$

For pair of lines $\begin{vmatrix} a & h & g \\ h & b & f \\ g & f & c \end{vmatrix} = 0$

$$\Rightarrow \begin{vmatrix} 2 & -5 & 5/2 \\ -5 & 12 & \lambda/2 \\ 5/3 & \lambda/2 & -3 \end{vmatrix} = 0$$

$\Rightarrow \quad 2\ \ -36-\frac{\lambda^2}{4}\ \ +5\ \ 15-\frac{5\lambda}{4}$

$+\frac{5}{2}\ \ \frac{-5\lambda}{2}-\ 30\ \ =0$

$\Rightarrow \quad -72-\frac{\lambda^2}{2}+\ 75-\frac{25\lambda}{4}-\frac{25\lambda}{4}-\ 75=0$

$\Rightarrow \quad \lambda^2+\ 25\lambda\ +144=0$

$\Rightarrow \quad \lambda+9\ \ \lambda\ +16\ \ =0$

$\Rightarrow \quad \lambda\ =\ -9 \qquad\qquad \because\ \ \lambda\ <16$

26. Given, $x^2 - 2xy - xy + 2y^2 = 0$

$\Rightarrow$ (x - 2y) (x - y) = 0

$\Rightarrow$ x = 2y, x = y .... (i)

Also, x + y + 1 = 0 .... (ii)

On solving Eqs. (i) and (ii), we get

$A\ \ -\frac{2}{3},-\frac{1}{3}\ \ B\ \ -\frac{1}{2},-\frac{1}{2}\ \ ,\ C\ \ 0,0$

$\therefore \quad \text{Area of } \Delta ABC = \frac{1}{2}\ \begin{matrix} -\frac{2}{3} & -\frac{1}{3} & 1 \\ -\frac{1}{2} & -\frac{1}{2} & 1 \\ 0 & 0 & 1 \end{matrix}$

$=\frac{1}{2}\ \ \frac{1}{3}-\frac{1}{6}\ \ =\frac{1}{2}\ \frac{1}{6}\ \ =\ \frac{1}{12}$

27. Given pair of lines are $x^2 - 3xy + 2y^2 = 0$

and $x^2 - 3xy + 2y^2 + x - 2 = 0$

$\therefore$ (x - 2y) (x - y) = 0

And (x - 2y + 2) (x - y -1) = 0

$\Rightarrow$ x - 2y = 0, x - y = 0 and x - 2y + 2 = 0,

$x - y - 1 = 0$

Since, the lines $x - 2y = 0$, $x - 2y + 2 = 0$ and $x - y = 0$, $x - y - 1 = 0$ are parallel.

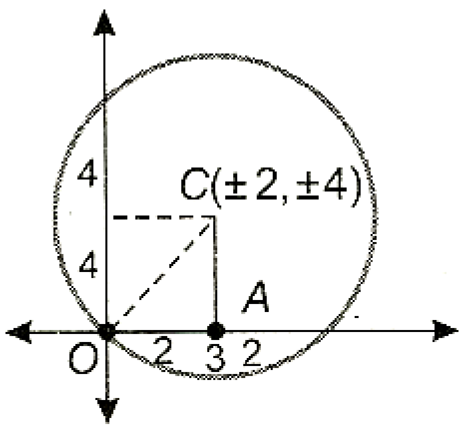
Also, angle between $x - 2y = 0$ and $x - y = 0$ is not 90°.

$\therefore$ It is a parallelogram.

28. In Δ OAC,

$OC^2 = 2^2 + 4^2 = 20$

$\therefore$ Required equation of circle is



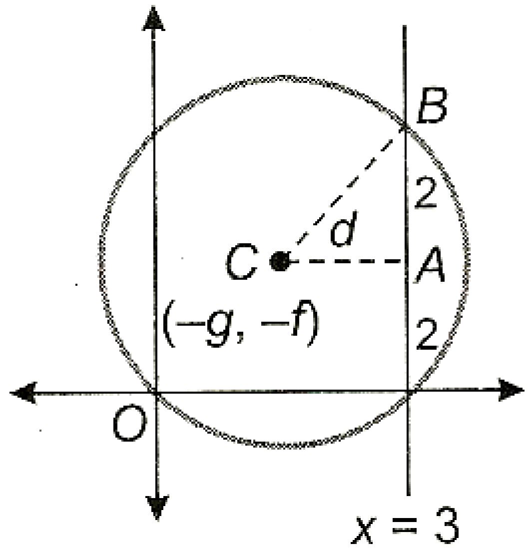
$(x \pm 2)^2 + (y \pm 4)^2 = 20$

$\Rightarrow$ $x^2 + y^2 \pm 4x \pm 8y = 0$

29. Let centre of circle be C(-g, - f), then equation of circle passing through origin be

$x^2 + y^2 + 2, gx + 2fy = 0$

$\therefore$ Distance, $d = |- g - 3| = g + 3$



In Δ ABC, $(BC) = AC^2 + BA^2$

$\Rightarrow \quad g^2 + f^2 = (g + 3)^2 + 2^2$

$\Rightarrow \quad g^2 + f^2 = g^2 + 6g + 9 + 4$

$\Rightarrow \quad f^2 = 6g + 13$

Hence, required locus is $y^2 + 6x = 13$

30. Given circles are $x^2 + y^2 - 2x + 8y + 13 = 0$ and $x^2 + y^2 - 4x + 6y + 11 = 0$.

Here, $C_1 = (1, -4)$, $C_2 = (2, -3)$,

$\Rightarrow \quad r_1 = \sqrt{1 + 16 - 13} = 2$

and $\quad r_2 = \sqrt{4 + 9 - 11} = \sqrt{2}$

Now, $d = C_1C_2 = \sqrt{(2-1)^2 + (-3+4)^2} = \sqrt{2}$

$\therefore \quad \cos\theta = \frac{d^2 - r_1^2 - r_2^2}{2r_1r_2} = \frac{2-4-2}{2\times 2\times \sqrt{2}} = -\frac{1}{\sqrt{2}}$

$\Rightarrow \quad \theta = 135°$

31. Let the required equation of circle be $x^2 + y^2 + 2gx + 2fy = 0$.

Since, the above circle cuts the given circles orthogonally.

$\therefore$ $2(-3g) + 2f(0) = 8 \Rightarrow 2g = -\frac{8}{3}$

And $-2g - 2f = -7$

$\Rightarrow$ $2f = +7 + \frac{8}{3} = \frac{29}{3}$

$\therefore$ Required equation of circle is

$x^2 + y^2 - \frac{8}{3}x + \frac{29}{3}y = 0$

Or $3x^2 + 3y^2 - 8x + 29y = 0$

33. Given,

$x^2y^2 = c^4$

$\Rightarrow$ $y^2(a^2 - y^2) = c^4$

$\Rightarrow$ $y^4 - a^2y^2 + c^4 = 0$

Let $y_1 + y_2 + y_3$ and y_4 are the roots.

$\therefore$ $y_1 + y_2 + y_3 + y_4 = 0$

34. Given, $4x - 3y = 5$ and $2x^2 - 3y^2 = 12$

$\therefore$ $2\left(\frac{5+3y}{4}\right)^2 - 3y^2 = 12$

$\Rightarrow$ $\frac{25+9y^2+30y}{8} - 3y^2 = 12$

$\Rightarrow$ $15y^2 - 30y + 71 = 0$

$\Rightarrow$ $y = \frac{30 \pm \sqrt{900-4260}}{30}$

$$= 1 \pm \frac{\sqrt{-3360}}{30}$$

Also, $2x^2 - 3\left(\frac{4x-5}{3}\right)^2 = 12$

$\Rightarrow \quad 10x^2 - 40x + 61 = 0$

$\Rightarrow \quad x = \frac{40 \pm \sqrt{1600 - 4 \times 10 \times 61}}{2 \times 10}$

$$= \frac{40 \pm \sqrt{-840}}{20}$$

$$= 2 \pm \frac{\sqrt{-840}}{20}$$

$\therefore$ Point are $A\left(2 + \frac{\sqrt{-840}}{20}, 1 + \frac{\sqrt{-3360}}{30}\right)$ *and*

B $\left(2 - \frac{\sqrt{-840}}{20}, 1 - \frac{\sqrt{-3360}}{30}\right)$.

$\therefore$ Mid point of AB is (2, 1).

35. cos 2a + cos 2β + cos 2y + sin^2 a + sin^2 β + sin^2 y

= (cos^2 a - sin^2 a) + (cos^2 β - sin^{2}β)

+ (cos^2 y - sin^2 y) + sin^2 a + sin^2 β + sin^2 y

= cos^2 a + cos^2 β + cos^2 y = 1

36. We know that image (x, y, z) of a point (x_1, y_1, z_1) in a plane ax + by + cz + d = 0 is

$$\frac{x - x_1}{a} = \frac{y - y_1}{b} = \frac{z - z_1}{c}$$

$$= \frac{-2(ax_1 + by_1 + cz_1 + d)}{a^2 + b^2 + c^2}$$

Here, point is (3, 2, 1) and plane is 2x - y + 3z = 7.

$\therefore \quad \frac{x-3}{2} = \frac{y-2}{-1} = \frac{z-1}{3}$

$$= \frac{-2\ 2\ 3\ -\ 2\ +3\ 1\ -7}{2^2+1^2+3^2}$$

$$\Rightarrow \quad \frac{x-3}{2} = \frac{y-2}{-1} = \frac{z-1}{3} = -2\ \ 0$$

$$\Rightarrow \quad x = 3, y = 2, z = 1$$

37. $\lim_{x\to\infty} \frac{x+5}{x+2}^{\ x+3} = \lim_{x\to\infty}\ 1 + \frac{3}{x+2}^{\ x+3}$

$$= \lim_{x\to\infty}\ \ 1 + \frac{3}{x+2}^{\ \frac{x+2}{3}\ \frac{3\ x+3}{x+2}}$$

$$= e^{\lim_{x\to\infty} 3\ \frac{1+\frac{3}{x}}{1+\frac{2}{x}}} = e^3$$

38. Given, f(x) = $\begin{cases} \frac{2\sin x - \sin 2x}{2x\cos x}, & \text{if } x \neq 0 \\ a, & \text{if } x = 0 \end{cases}$

Now, $\lim_{x\to 0} f\ x\ = \lim_{x\to 0} \frac{2\sin x - \sin 2x}{2x\cos x}\ \ \frac{0}{0}\ form$

$$= \lim_{x\to 0} \frac{2\cos x - 2\cos 2x}{2\ \ \cos x - x\sin x}$$

$$= \lim_{x\to 0} \frac{2-2}{2\ \ 1-0} = 0$$

Since, f(x) is continuous at x = 0

$$\therefore \quad f\ 0\ = \lim_{x\to 0} f\ x$$

$$\Rightarrow \quad a = 0$$

39. Given, $\frac{x}{1} = \frac{1-\ \sqrt{y}}{1+\ \sqrt{y}}$

Applying componendo and dividendo, we get

$$\frac{1+x}{1-x} = \frac{1+\ \sqrt{y}\ +\ 1-\ \sqrt{y}}{1+\ \sqrt{y}\ -\ 1-\ \sqrt{y}}$$

$\Rightarrow \quad \frac{1+x}{1-x} = \frac{2}{2\sqrt{y}}$

$\Rightarrow \quad y = \left(\frac{1-x}{1+x}\right)^2$

On differentiating w.r.t. x, we get

$\frac{dy}{dx} = \frac{-2(1+x)^2(1-x) - (1-x)^2.2(1+x)}{(1+x)^4}$

$= \frac{(1-x)(1+x)(-2-2x-2+2x)}{(1+x)^2}$

$= \frac{4(x-1)}{(x-1)^3}$

40. Given, $\frac{d}{dx}\left(a\,tan^{-1}(x) + b\log\left(\frac{x+1}{x+1}\right)\right) = \frac{1}{x^4-1}$

On integrating both sides, we get

$a\,tan^{-1}(x) + b\log\left(\frac{x-1}{x+1}\right)$

$= \frac{1}{2}\int\left(\frac{1}{x^2-1} - \frac{1}{x^2+1}\right)dx$

$\Rightarrow \quad a\,tan^{-1}x + b\,\log\left(\frac{x-1}{x+1}\right)$

$= \frac{1}{4}\log\left(\frac{x-1}{x+1}\right) - \frac{1}{2}tan^{-1}(x)$

$\Rightarrow \quad a = -\frac{1}{2},\ b = \frac{1}{4}$

$\therefore \quad a - 2b = -\frac{1}{2} - 2\left(\frac{1}{4}\right) = -1$

41. Given, $Y = e^{a\,sin^{-1}(x)}$

On differentiating w.r.t. x, we get

$y_1 = e^{a\,sin^{-1}x}\ a.\frac{1}{\sqrt{1-x^2}}$

$\Rightarrow \quad y_1\sqrt{1-x^2} = ay$

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$\Rightarrow \quad 1 - x^2 \;\; y_1^2 = a^2 y^2$

Again, differentiating w.r.t. x, we get

$$(1 - x^2)2y_1y_2 - 2xy_1^2 = a^2\, 2yy_1$$

$\Rightarrow \quad (1 - x^2)y_2 - xy_1 - a^2y = 0$

Using Leibnitz's rule,

$(1 - x^2)y_{n+2} + {}^nC_1y_{n+1}(-2x) + {}^nC_2\, y_n(-2)$

$\qquad -xy_{n+1} - {}^nC_1yn - a^2yn = 0$

$\Rightarrow \quad (1 - x^2)y_{n+2} + xy_{n+1}(-2n - 1)$

$\qquad + y_n[-n(n - 1) - n - a^2] = 0$

$\Rightarrow \quad (1 - x^2)y_{n+2} - (2n + 1)xy_{n+1} = (n^2 + a^2)y_n$

42. Given, $f(x) = x^3 + ax^2 + bx + c$, $a^2 \le 3b$.

On differentiating w.r.t. x, we get

$$f'(x) = 3x^2 + 2ax + b$$

Put $\quad f'(x) = 0$

$\Rightarrow \quad 3x^2 + 2ax + b = 0$

$\Rightarrow \quad x = \frac{-2a \pm \sqrt{4a^2 - 12b}}{2 \times 3} = \frac{-2a \pm 2\sqrt{a^2 - 3b}}{3}$

Since, $a^2 = 3b$,

$\therefore \quad$ x has an imaginary value.

Hence; no extreme value of x exist.

43. Let $I = \quad \frac{2 - \sin 2x}{1 - \cos 2x} \;\; e^x \; dx$

$= \quad \frac{2 - 2\sin x \cos x}{2\sin^2 x} \;\; e^x \; dx$

$= \int cosec^2 x\, e^x\, dx - \int \cot x\, e^x\, dx$

$= -\cot x\, e^x - \int -\cot x\, e^x\, dx$

$- \int \cot x\, e^x\, dx + c$

$= -\cot x\, e^x + c$

44. $Let\ I = \int_0^{\pi} \frac{1}{1+\sin x}\, dx = \int_0^{\pi} \frac{1}{1+\frac{2\tan\frac{x}{2}}{1+tan^2\frac{x}{2}}}\, dx$

$= \int_0^{\pi} \frac{sec^2\frac{x}{2}}{\left(1+\tan\frac{x}{2}\right)^2}\, dx$

Put $\tan\frac{x}{2} = t \Rightarrow \frac{1}{2}\sec^2\frac{x}{2}\, dx = dt$

$\therefore \quad I = \int_0^{\infty} \frac{2\, dt}{(1+t)^2} = \left[-\frac{2}{1+t}\right]_0^{\infty} = 2$

45. Given, $\frac{dy}{dx} = \sin(x+y)\tan(x+y) - 1$

Put $x+y = z \Rightarrow 1 + \frac{dy}{dx} = \frac{dz}{dx}$

$\therefore \quad \frac{dz}{dx} - 1 = \sin z \tan z - 1$

$\Rightarrow \quad \int \frac{\cos z}{sin^2 z}\, dz = \int dx$

Put $\sin z = t \Rightarrow \cos z\, dz = dt$

$\therefore \quad \int \frac{1}{t^2}\, dt = x - c \Rightarrow -\frac{1}{t} = x - c$

$\Rightarrow \quad -cosec\ z = x - c$

$\Rightarrow \quad x + cosec(x+y) = c$

46. Given, y = a sin (bt - cx)

Comparing the given equation with general wave equation

$y = a \sin\left(\frac{2\pi t}{T} - \frac{2\pi x}{\lambda}\right)$

we get $b = \frac{2\pi}{T},\ c = \frac{2\pi}{\lambda}$

(a) Dimensions of $\frac{y}{a} = \frac{metre}{metre} = \frac{L}{L}$

(b) Dimensions of $bt = \frac{2\pi}{T}.t = \frac{T}{T}$

(c) Dimensions of $cx = \frac{2\pi}{\lambda}.\ x = \frac{L}{L}$

(d) Dimensions of $\frac{b}{c} = \frac{2\pi}{T} / \frac{2\pi}{\lambda} = \lambda/T = LT^{-1}$

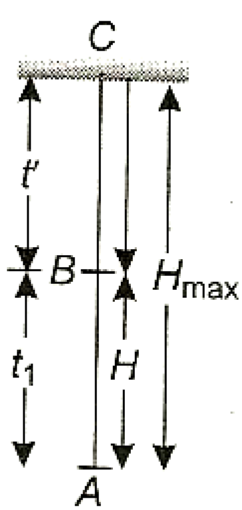
Thus, option (d) has dimensions.

47. Let time taken by the body to fall from point C to B is t′.

Then $t_1 + 2t' = t_2$

$t' = \frac{t_2 - t_1}{2}$ .... (i)

Total time taken to reach point C



$T = t_1 + t'$

$= t_1 + \frac{t_2 - t_1}{2}$

$= \frac{2t_1 + t_2 - t_1}{2}$

$= \frac{t_1 + t_2}{2}$

Maximum height attained

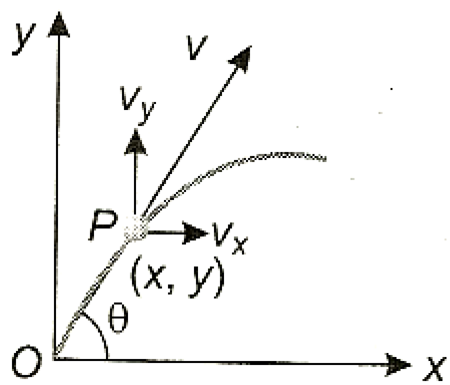
$H_{max} = \frac{1}{2} g T^2$

$= \frac{1}{2} g \left(\frac{t_1 + t_2}{2}\right)^2$

$= \frac{1}{2} g . \frac{(t_2 + t_2)^2}{4}$

$\Rightarrow \quad H_{max} = \frac{1}{8} g . (t_1 + t_2)^2 m$

48. Momentum, p = m. v



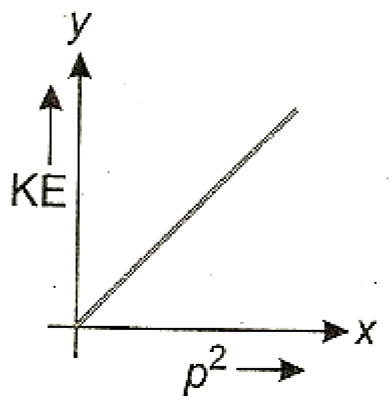
$\Rightarrow \quad v = \frac{p}{m}$

Kinetic energy, $KE = \frac{1}{2} mv^2$

$= \frac{1}{2} m \frac{p^2}{m^2} = \frac{1}{2n} p^2$

$\Rightarrow \quad KE \propto p^2 \quad \because \frac{1}{2m} = \text{constant}$

Hence, the graph between KE and p^2 will be linear as shown below



Now, Kinetic energy KE = $\frac{1}{2}mv^2$

The velocity component at point P,

v_y = (u sin a - gt)

and $v_x = u\cos\theta$

Resultant velocity at point P,

$$v = v_y\hat{j} + v_x\hat{i}$$

$$= (u\sin\theta - gt)\hat{j} + (u\cos\theta)\hat{i}$$

$$v = \sqrt{(u\cos\theta)^2 + (u\sin\theta - gt)^2}$$

$$= \sqrt{u^2\cos^2\theta + u^2\sin^2\theta + g^2t^2 - 2ugt\sin\theta}$$

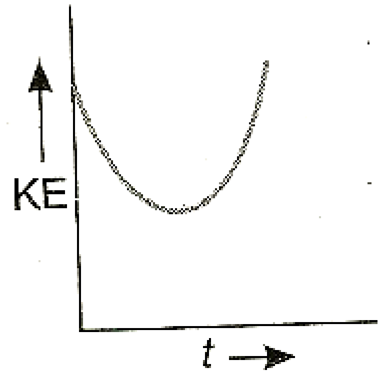
$$\therefore \quad = \sqrt{u^2(\cos^2\theta + \sin^2\theta) + g^2t^2 - 2ugt\sin\theta}$$

$$KE = \frac{1}{2}m(u^2 + g^2t^2 - 2ugt\sin\theta)$$

$\Rightarrow$ KE $\propto t^2$

Hence, graph will be parabolic with intercept on y-axis.

Hence, the graph between KE and t



Now, in case of height

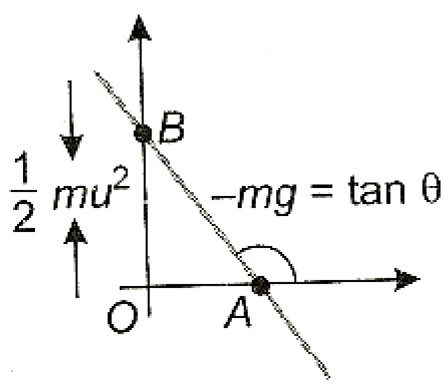
$$KE = -\frac{1}{2}m(v^2)$$

and $\quad v^2 = (u^2 - 2gy)$

$\therefore \quad KE = \frac{1}{2}\ m(u^2 - 2gy)$

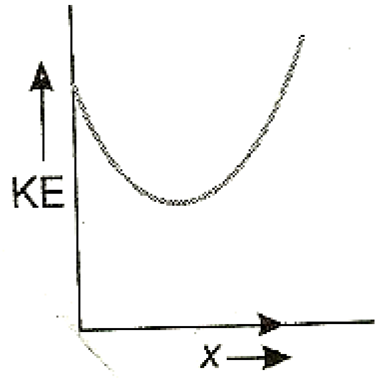
$$KE = -\ mgy + \frac{1}{2}mu^2$$

Intercept on y-axis = $\frac{1}{2}\ mu^2$



Now, $KE = \frac{1}{2}\ mv^2$

$$KE = \frac{1}{2}\ m\ \frac{x}{t}^{\ 2}$$



KE ∝ x^2. Thus graph between KE and x will be parabolic.

49. Power of motor initially = P_0

Let, rate of flow of motor = (x)

Since, power, $P_0 = \frac{\text{work}}{\text{time}} = \frac{\text{mgy}}{\text{t}}$

$$= mg \quad \frac{y}{t} \, ,$$

$$= \frac{y}{t} = x = rate\ of\ flow\ of\ water$$

$$= mgx \qquad \ldots\ldots\ldots\ldots\ldots \text{(i)}$$

If rate of flow of water is increased by n times, ie, (nx).

Increased power $P_1 = \frac{mgy'}{t}$

$$= mg \quad \frac{y'}{t}$$

$$= mgn.x \qquad \ldots\ldots\ldots\ldots \text{(ii)}$$

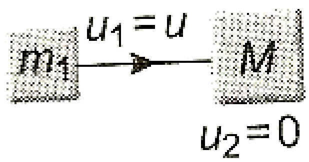
$$= nmgx$$

The ratio of power

$$\frac{P_1}{P_0} = \frac{nmgx}{mgx}$$

$$\frac{p_1}{P_0} = \frac{n}{1} \Rightarrow P_1 : P_0 = n : 1$$

50. Mass of the first body m_1 = 5 kg, for elastic collision e = 1.



Suppose initially body m_1 moves with velocity v after collision velocity becomes $\frac{u}{10}$.

Let after collision velocity of M block becomes (v_2).

By conservation of momentum

$$m_1u_1 + m_2u_2 = m_1v_1 + m_2v_2$$

or $\quad 5u + M \times 0 = 5 \times \frac{u}{10} + Mv_2$

or $\quad 5u = \frac{u}{2} + Mv_2$ .... (i)

Since, $v_1 - v_2 = -e(u_1 - u_2)$

$$\frac{u}{10} - v_2 = -u$$

Or $\quad \frac{u}{10} + u = v_2$

$$\frac{11u}{10} = v_2$$

Substituting value of v_2 in Eq. (i) from Eq. (ii). we get

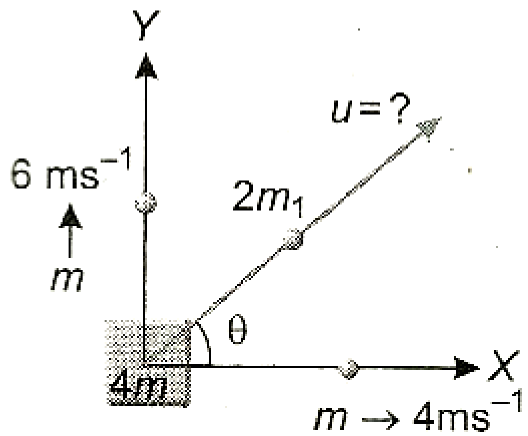
$$5u = \frac{u}{2} + M \frac{11u}{10}$$

Or $\quad 5 - \frac{1}{2} = M \frac{11}{10}$

Or $\quad M = \frac{9 \times 10}{2 \times 11}$

Or $\quad M = \frac{45}{11} = 4.09\ kg$

51.



Let third mass particle (2 m) moves making angle 8 with X-axis.

The horizontal component of velocity of 2 m mass particle = u cos θ and vertical component = u sin θ

From conservation of linear momentum in X-direction

$m_1u_1 + m_2u_2 = m_1v_1 + m_2v_2$

or $0 = m \times 4 + 2m\,(u \cos\theta)$

or $-4 = 2u \cos\theta$

or $-2 = u \cos\theta$ .... (i)

Again, applying law of conservation of linear momentum in y-direction.

$0 = m \times 6 + 2m(u \sin\theta)$

$\Rightarrow$ $-\frac{6}{2} = u \sin\theta$

or $-3 = u \sin\theta$ .... (ii)

Squaring Eqs. (i) and (ii) and adding, we get

$(4) + (9) = u^2 \cos^2\theta + u^2 \sin^2\theta$

$= u^2 (\cos^2\theta + \sin^2\theta)$

or $\quad 13 = u^2$

or $\quad u = \sqrt{13}\ ms^{-1}$

52. Maximum height attained by a projectile

$$h = \frac{v^2R}{2gR - v^2} \qquad \text{............... (i)}$$

Velocity of body = half the escape velocity

$$v = \frac{v_e}{2}$$

Or $\quad v = \frac{\sqrt{2gR}}{2} \Rightarrow v^2 = \frac{2gR}{4}$

Or $\quad v^2 = \frac{gR}{2}$

Now, putting value of v^2 in Eq. (i), we get

$$h = \frac{\frac{gR}{2}.R}{2gR - \frac{gR}{2}}$$

$$= \frac{gR^2/R}{3gR/2}$$

Or $\quad h = \frac{R}{3}$

53. The displacement of particle, executing SHM is

$$y = 5\sin\left(4t + \frac{\pi}{3}\right) \qquad \text{............. (i)}$$

Velocity of particle

$$\frac{dy}{dt} = \frac{5d}{dt}\sin\left(4t + \frac{\pi}{3}\right)$$

$$= 5\cos\left(4t + \frac{\pi}{3}\right)$$

$$= 20\cos\left(4t + \frac{\pi}{3}\right)$$

Velocity at t = $\frac{T}{4}$

$$\left(\frac{dy}{dt}\right)_{t=\frac{T}{4}} = 20\cos\left(4\times\frac{T}{4}+\frac{\pi}{3}\right)$$

Or $\quad u = 20\cos\left(T+\frac{\pi}{3}\right)$ .... (ii)

Now, putting value of T in Eq. (ii), we get

$$u = 20\cos\left(\frac{\pi}{2}+\frac{\pi}{3}\right)$$

$$= -20\sin\frac{\pi}{3}$$

$$= -20\times\frac{\sqrt{3}}{2}$$

$$= -10\times\sqrt{3}$$

The kinetic energy of particle,

$$KE = \frac{1}{2}mu^2$$

$\because \quad m = 2g = 2\times10^{-3}$ kg

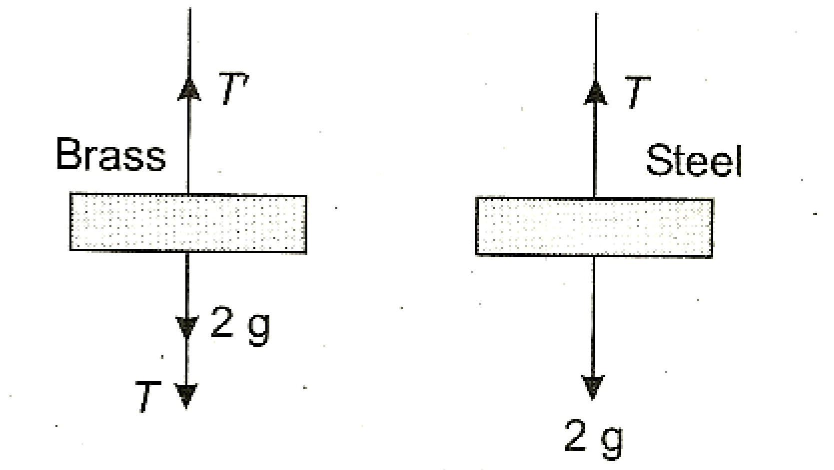
$$= \frac{1}{2}\times2\times10^{-3}\times\left(-10\sqrt{3}\right)^2$$

$$= 10^{-3}\times100\times3$$

$$= 3\times10^{-1}$$

KE $= 0.3$ J

54. Free body diagram of the two blocks are



Given, $\frac{l_1}{l_2} = a,\ \frac{r_1}{r_2} = b,\ \frac{Y_1}{Y_2}$

Let Young's modulus of steel is Y_1 and of brass is Y_2.

$\therefore \quad Y_1 = \frac{F_1 .\ l_1}{A_1\ .\Delta l_1}$ .... (i)

And $\quad Y_2 = \frac{F_2 . l_2}{A_2\ \Delta l_2}$ .... (ii)

Diving Eq. (i) by Eq. (ii), we get

$$\frac{Y_1}{Y_2} = \frac{\frac{F_1 l_1}{A_1 l_1}}{\frac{F_2 . l_2}{A_2 . \Delta l_2}}$$

Or $\quad \frac{Y_1}{Y_2} = \frac{F_1 . A_2 . l_1 . \Delta l_2}{F_2 . A_1 . l_2\ . \Delta l_1}$ .... (iii)

Force on steel wire from free body diagram

T = F_1 = (2g) newton

Force on brass wire from free body diagram

F_2 = T' = T + 2g = (4g) newton

Now, putting the value of F_1, F_2, in Eq. (iii), we get

$$\frac{Y_1}{Y_2} = \frac{2g}{4g} . \frac{\pi r_2^2}{\pi r_1^2} . \frac{l_2}{l_2} . \frac{\Delta l_2}{\Delta l_1}$$

Or $c = \frac{1}{2} \; \frac{1}{b^2} \; .a \; \frac{\Delta l_2}{\Delta l_1}$

Or $\frac{\Delta l_1}{\Delta l_2} = \; \frac{a}{2b^2 \, c}$

55. Initially area of soap bubble $A_1 = 4\pi r^2$

Under isothermal condition radius becomes 2 r,

Then, area $A_2 = 4n(2r)^2$

$= 4n. \, 4r^2$

$= 16\pi \, r^2$

Increase in surface area

$\Delta A = 2(A_2 - A_1)$

$= 2(16\pi r^2 - 4 \, \pi r^2)$

$= 24\pi r^2$

Energy spent

$W = T \times \Delta A$

$= T. \, 24\pi \, r^2$

or $W = 24\pi \, Tr^2$ J

56. Let now radius of big drop is R.

Then $\frac{4}{3} \pi R^3 = \frac{4}{3} \times \pi r^3 .8$

R = 2r

where r is radius of small drops. Now, terminal velocity of drop in liquid.

$$v_e = \frac{2}{9} \times \frac{r^2}{\eta} \; \rho - \sigma \; g$$

where η is coefficient of viscosity and ρ is density of drop σ is density of liquid.

Terminal speed drop is 6 cm s^{-1}

$\therefore \quad 6 = \frac{2}{9} \times \frac{r^2}{\eta} \; \rho - \sigma \;\; g$ ………… (i)

Let terminal velocity becomes v' after coalesce, then

$v' = \frac{2}{9} \; \frac{R^2}{\eta} \; \rho - \sigma \; g$ …………… (ii)

Dividing Eq. (i) by Eq. (ii), we get

$$\frac{6}{v'} = \frac{\frac{2}{9}\frac{r^2}{\eta} \;\; \rho - \sigma \; g}{\frac{2}{9}\frac{R^2}{\eta} \;\; \rho - \sigma \; g}$$

Or $\quad \frac{6}{v'} = \frac{r^2}{2r^{\;2}}$

Or $\quad v' = 24 \;\; cm\, s^{-1}$

57. Time period of oscillation,

$$T = 2\pi \; \overline{\frac{1}{g}}$$

$\Rightarrow \quad \frac{dT}{T} = \frac{1}{2} \frac{dl}{l}$

As, $\quad \frac{dl}{l} = \; adt$

$\Rightarrow \quad \frac{dT}{T} = \frac{1}{2} \, adt$

$= \frac{1}{2} \times 9 \times 10^{-7} \; \times \;\; 30 - 20$

$= 4.5 \times 10^{-6}$

$\therefore$ Loss in time = $4.5 \times 10^{-6} \times 0.5$

$= 2.25 \times 10^{-6} \; s$

58. The volume of the metal at 30°C is

$$V_{30} = \frac{\text{loss of weight}}{\text{specific gravity} \times g}$$

$$= \frac{45-25\ g}{1.5 \times g} = 13.33\ cm^3$$

Similarly, volume of metal at 40°C is

$$V_{40} = \frac{40-27\ g}{1.25 \times g}$$

$$= 14.40\ cm^3$$

Now, $V_{40} = V_{30}\ 1 + \gamma\ t_2 - t_1$

Or $\gamma = \frac{V_{40} - V_{30}}{V_{30}\ t_2 - t_1}$

$$= \frac{14.40 - 13.33}{13.33\ 40 - 30}$$

$$= 8.03 \times 10^{-3} / °C$$

∴ Coefficient of linear expansion of the metal is

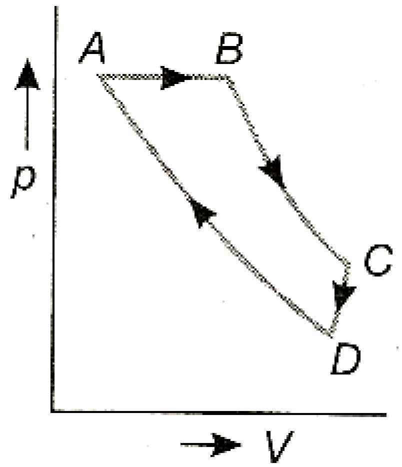
$$a = \frac{\gamma}{3} = \frac{8.03 \times 10^{-3}}{3}$$

$$\approx 2.6 \times 10^{-3} / °C$$

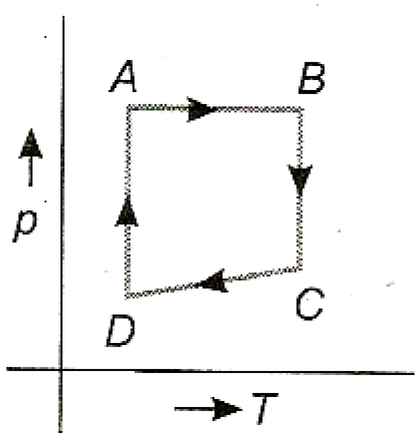
59. A → B → C → D → A is clockwise process.

During A → B, pressure is constant and B → C, process follows p $\propto \frac{1}{V}$, it means T is constant.

During process C → D, both p and V changes and process D → A follows p $\propto \frac{1}{V}$ which means T is constant:



Hence, from above data it is dear that equivalent cyclic process is



60. From first law of thermodynamics

$Q = \Delta U + W$

or $\Delta U = Q - W$

$\therefore$ $\Delta U_1 = Q_1 - W_1 = 6000 - 2500 = 3500$ J

$\Delta U_2 = Q_1 - W_2 = -5500 + 1000 = -4500$ J

$\Delta U_3 = Q_3 - W_3 = -3000 + 1200 = -1800$ J

$\Delta U_4 = Q_4 - W_4 = 3500 - x = 0$

For cyclic process $\Delta U = 0$

$\therefore$ $3500 - 4500 - 1800 + 3500 - x = 0$

or $x = 700$ J

Efficiency, $\eta = \frac{output}{input} \times 100$

$$= \frac{W_1 + W_2 + W_3 + W_4}{Q_1 + Q_4} \times 100$$

$$= \frac{2500 - 1000 - 1200 + 700}{6000 + 3500} \times 100$$

$$= \frac{1000}{9500} \times 100$$

$\eta = 10.5\%$

61. From first law of thermodynamics

$Q = \Delta U + W$

For cylinder A pressure remains constant

$\therefore$ Work done by a system

$$W = \frac{\mu R}{\gamma - 1}\ T_1 - T_2$$

For monatomic gases

$\mu = 1$

$\gamma = \frac{5}{3}$

$\therefore$ $W = \frac{1 \times R}{5}\ \ 442 - 400\ = \frac{3}{2} R \times 42$

or $W = 63R$

But $\Delta U = 0$, for cylinder A

$Q = 0 + 63R$

$Q = 63R$

For cylinder B volume is constant,

$\therefore \quad W = 0$

and $\quad Q = \mu C_v \Delta T$

For mono atomic gas

$$C_V = \frac{3}{2}R$$

$$Q = 1 \times \frac{3}{2} R\Delta T$$

As heat given to both cylinder is same

$\therefore \quad 63R = \frac{3}{2} R \Delta T$

$\Delta T = 42K$

62. According to the figure

$H = H_1 + H_2$

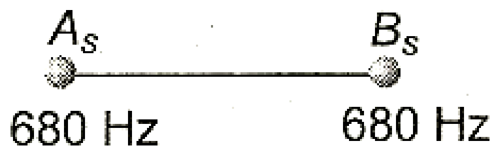
$$\Rightarrow \quad \frac{3KA\ \ 100-T}{l} = \frac{2KA\ \ T-50}{l} + \frac{KA\ \ T-0}{l}$$

$300 - 3T = 2T - 100 + T$

$\Rightarrow \quad 6T = 400$

Or $\quad T = \frac{200}{3}\,°C$

63. Listener go from A $\rightarrow$ B with velocity (u) let the apparent frequency of sound from source A by listener



$$n' = n \ \frac{v - v_0}{v + v_s}$$

or $\quad n' = 680 \ \frac{340 - u}{340 + 0}$

The apparent frequency of sound from source B by listener

$$n'' = \ n \ \frac{v + v_0}{v - v_s} \ = 680 \ \frac{340 + u}{340 - 0}$$

But listener hear 10 beats per second.

Or $\quad 680 \ \frac{340 + u}{340} \ - \ 680 \ \frac{340 - u}{340} \ = 10$

Or $\quad 2 \ 340 + u - 340 + u \ = 10$

$$u = 2.5 \, m \, s^{-1}$$

64. Beats per second when both the wires vibrate simultaneously.

$$n_1 \pm n_2 = 6$$

or $\quad \frac{1}{2l} \sqrt{\frac{T}{m}} \pm \frac{1}{2l} \sqrt{\frac{T'}{m}} = 6$

or $\quad \frac{1}{2l} \sqrt{\frac{T'}{m}} - \frac{1}{2l} \sqrt{\frac{T}{m}} = 6$

or $\quad \frac{1}{2l} \sqrt{\frac{T'}{m}} - \ 600 = 6$

$\frac{1}{2l} \sqrt{\frac{T'}{m}} = 606 \qquad$ .... (i)

Given that fundamental frequency

$$\frac{1}{2l}\sqrt{\frac{T}{m}} = 600 \qquad \text{............. (ii)}$$

Dividing Eq.(i) by Eq. (ii), we get

$$\frac{\frac{1}{2l}\sqrt{\frac{T'}{m}}}{\frac{1}{2l}\sqrt{\frac{T}{m}}} = \frac{606}{600}$$

Or $\sqrt{\frac{T'}{T}} = 1.01$

Or $\frac{T'}{T} = 1.02\ \%$

Or $T' = T\ 1.02$

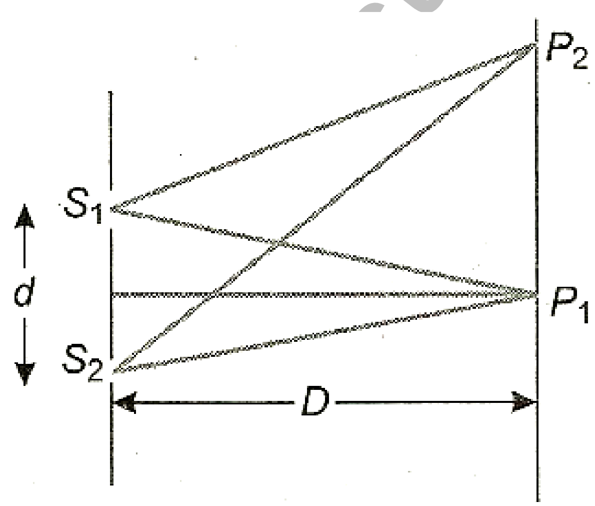
Increase in tension

$$\Delta T' = T \times 1.02 - T$$

$$= 0.02T$$

Hence, $\Delta T' = 0.02$

65.



Fringe width $\beta = \frac{\lambda D}{d}$

Let the amplitude of that place where constructive inference takes place is a.

The position of fringe at p_2 is

$$x = \frac{n\lambda D}{d}$$

Given, $\beta' = \frac{\beta}{4}$

$\therefore \quad \frac{\lambda D}{4d} = \frac{n\lambda D}{d}$

or $\quad n = \frac{1}{4}$

$\therefore \quad \frac{I_1}{I_2} = \frac{a^2}{\left(\frac{a}{4}\right)^2}$

Or $\quad I_1 : I_2 = 16 : 1$

66. Position fringe from central maxima

$$y_1 = \frac{n\lambda_1 D}{d}$$

Given, n = 10

$\therefore \quad y_1 = \frac{10\lambda_1 D}{d}$ .... (i)

For second source

$y_2 = \frac{5\lambda_2 D}{d}$ .... (ii)

$\therefore \quad \frac{y_1}{y_2} = \frac{\frac{10\lambda_1 D}{d}}{\frac{5\lambda_2 D}{d}}$

$\Rightarrow \frac{y_1}{y_2} = \frac{2\lambda_1}{\lambda_2}$

67. Interference phenomenon takes place between two waves which

have equal frequency and propagate in same direction.

Hence, $y_1 = a \sin(\omega t + \phi)_1$

$y_3 = a' \sin(\omega t + \phi_2)$

will give rise to interference as the two waves have same frequency ω.

68. The two lenses of an achromatic doublet should have, sum of the product of their powers and dispersive power equal to zero.

69. Ratio of magnetic moments of two magnets of equal size when in sum and difference position is

$$\frac{M_A}{M_B} = \frac{T_d^2 + T_s^2}{T_d^2 - T_s^2} = \frac{v_s^2 + v_d^2}{v_s^2 - v_d^2}$$

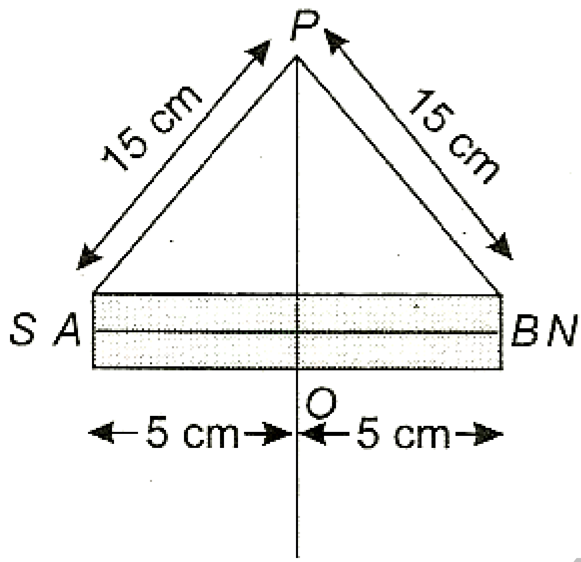
$$= \frac{\frac{1}{20}^2 + \frac{1}{15}^2}{\frac{1}{15}^2 - \frac{1}{20}^2}$$

$$= \frac{400 + 225}{400 - 225}$$

$$\Rightarrow \quad M_A : M_B = 25 : 7$$

70. Length of magnet = 10 cm = 10×10^{-2} m,

$r = 15 \times 10^{-2}$ m



$OP = \sqrt{225 - 25} = \sqrt{200}$ cm

Since, at the neutral point, magnetic field due to the magnet is equal to B_H

$$B_H = \frac{\mu_0}{4\pi} \cdot \frac{M}{(OP^2 + AO^2)^{3/2}}$$

$$0.4 \times 10^{-4} = 10^{-7} \times \frac{M}{(200\times10^{-4} + 25\times10^{-4})^{3/2}}$$

$$\frac{0.4\times10^{-4}}{10^{-7}} \times (225 \times 10^{-4})^{3/2} = M$$

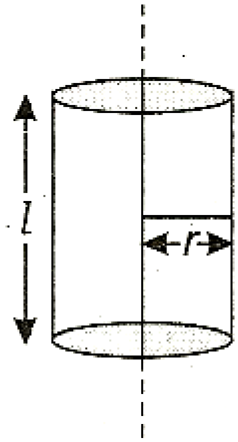
$$0.4 \times 10^{3} \times 10^{-6} (225)^{3/2} = M$$

$$M = 1.35\ A - m$$

71. Charge density of long wire

$$\lambda = \frac{1}{3}\ C - m$$

And $r = 18 \times 10^{-2}\ m$



From Gauss theorem

$$\mathrm{E.dS} = \frac{q}{\varepsilon_0}$$

$$E \quad dS = \frac{q}{\varepsilon_0}$$

or $\quad E \times 2\pi rl = \frac{q}{\varepsilon_0}$

or $\quad E = \frac{q}{2\pi\varepsilon_0 rl} = \frac{q/l}{2\pi\varepsilon_0 r}$

$$= \frac{\lambda \times 2}{2\pi\varepsilon_0 r \times 2} = \frac{\lambda \times 2}{4\,\pi\varepsilon_0 r}$$

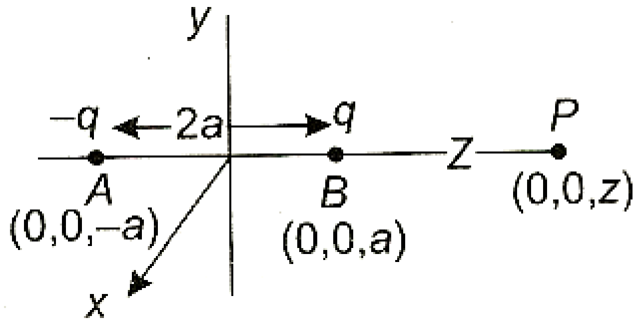
$$= 9 \times 10^9 \times \frac{1}{3} \times 2 \times \frac{1}{18 \times 10^{-2}}$$

$$= \frac{1}{3} \times 10^{11} = 0.33 \times 10^{11}$$

$$= 0.33 \times 10^{11} \; NC^{-1}$$

72. Potential at P due to (+q) charge

$$V_1 = \frac{1}{4\pi\varepsilon_0} \cdot \frac{q}{z-a}$$



Potential at P due to (-q) charge

$$V_2 = \frac{1}{4\pi\,\varepsilon_0} \cdot \frac{-q}{z+a}$$

Total potential at P due to (AB) electric dipole

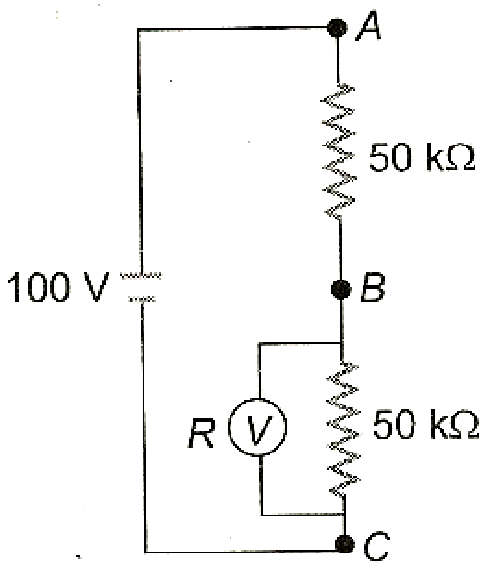
$$V = V_1 + V_2$$

$$= \frac{1}{4\pi\,\varepsilon_0} \cdot \frac{q}{z-a} - \frac{1}{4\pi\,\varepsilon_0} \frac{q}{z-a}$$

$$= \frac{q}{4\pi\,\varepsilon_0} \frac{z-a-z+a}{z-a \quad z+a}$$

$$\Rightarrow \qquad V = \frac{2qa}{4\,\pi\varepsilon_0 \;\; z^2-a^2}$$

73.



Internal resistance of voltmeter is R.

Therefore effective resistance across B and C, R' is given by

$$\frac{1}{R'} = \frac{1}{R} + \frac{1}{50} = \frac{50 + R}{50\,R}$$

Or $\quad R' = \frac{50\,R}{50+R}$

According to Ohm's law

$$V' = IR'$$

or $\quad \frac{100}{3} = I \,.\, \frac{50\,R}{50+R}$

or $\quad \frac{100}{3} \; \frac{50+R}{50\,R} = I$

Now, total resistance of circuit

$$R'' = 50 + \frac{50\,R}{50+R}$$

Or $\quad R'' = \frac{2500+100\,R}{50\,+R}$

Now, V'' = IR''

$\Rightarrow \quad 100 = \frac{100}{3} \; \frac{50+R}{50R} \; \frac{2500+100R}{50+R}$

or $150R = 2500 + 100R$

or $50R = 2500$

or $R = 50\ k\Omega$

74. Resistance of potentiometer wire

$$R = \rho \times \frac{1}{A}$$

Or $R' = \frac{2.5\rho}{A\times 10}$

Potential $V'\ I \times R'$

$$= I \ \frac{2.5\ \rho}{A\times 10}$$

Now, again the length of potentiometer wire is increased by 1 m, then resistance of null position wire.

$$R'' = \frac{\rho\times l}{11\times A}$$

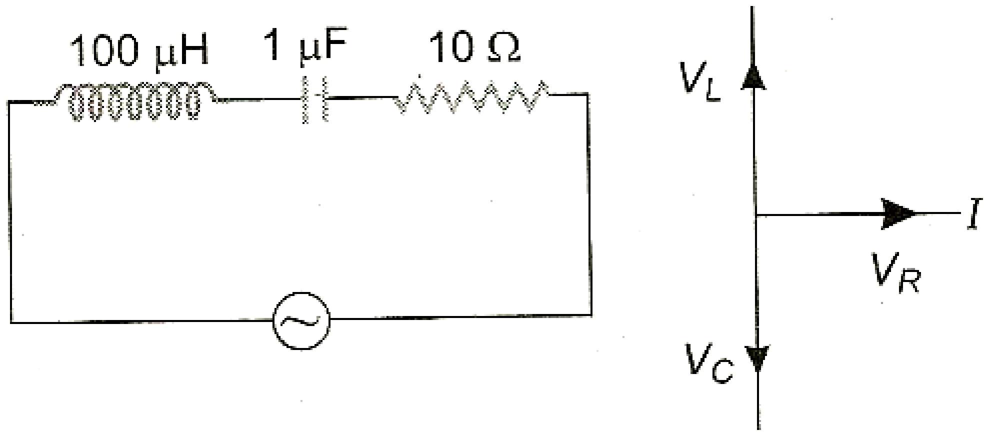
$V'' = IR''$

And $V = V'$

$$\frac{I\times 2.5\ \rho}{A\times 10} = \frac{\rho\times l}{11\times A} \times I$$

Or $\frac{2.5\times 11}{10} = l = 2.75\ m$

75.



Impedance, $Z = \sqrt{(X_L \sim X_c)^2 + R^2}$

Or $Z = \sqrt{\left(\omega L \sim \frac{1}{\omega C}\right)^2 + R^2}$

Inductive reactance

$X_L = \omega L = 70 \times 10^3 \times 100 \times 10^{-6} = 7\Omega$

Capacitance reactance

$X_C = \frac{1}{\omega C} = \frac{1}{70 \times 10^3 \times 1 \times 10^{-6}}$

$= \frac{1}{7 \times 10^{-2}} = \frac{10^2}{7} = \frac{100}{7}$

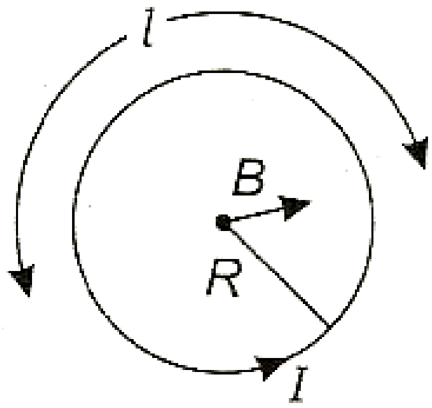
As $X_C > X_L$

Hence, circuit behave like as R - C circuit.

76. Magnetic field at the centre of the loop

$B = \frac{\mu_0}{4\pi} \cdot \frac{I \cdot 2\pi R}{R^2}$ .... (i)

For the wire which is looped double let radius becomes r



Then, $\frac{1}{2} = 2\pi r$

or $\frac{l}{4\pi} = r$

$\therefore$ $B' = \frac{\mu_0}{4\,\pi} . \frac{I.2\pi r \times 2}{r^2}$

Or $B' = \frac{\mu_0}{4\,\pi} . \frac{I.\frac{l}{2}.2}{\frac{l}{4\pi}^{2}}$

Or $B' = \frac{\mu_0}{4\pi} . \frac{Il \times 16\,\pi^2}{l^2}$ .... (ii)

Now, $B = \frac{\mu_0}{4\pi} . \frac{I\,.\,l}{\frac{l}{2\pi}^{2}} \quad R = \frac{l}{2\pi}$ .... (iii)

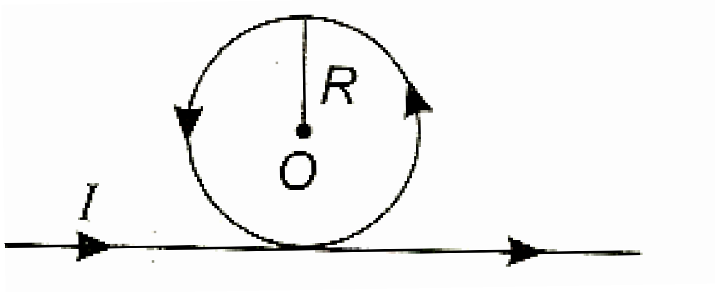
Dividing Eq (ii) by Eq. (iii) we get

$$\frac{B\prime}{B} = \frac{\frac{\mu_0}{4\pi} . \frac{I\,l.16\pi^2}{l^2}}{\frac{\mu_0}{4\pi} . \frac{Il.4\pi^2}{l^2}}$$

Or $\frac{B'}{B} = 4$

Or $B' = 4B$

77.



Magnetic field due to long wire at O point

$$B_1 = \frac{\mu_0}{2\pi} \frac{I}{R} \quad upward\ direciton$$

Magnetic field due to loop at O point

$$B_2 = \frac{\mu_0}{4\pi} \cdot \frac{I.2\pi R}{R^2}$$

$$B_2 = \frac{\mu_0}{2} \cdot \frac{I}{R} \quad in\ upward\ \ direction$$

Hence, resultant magnetic field at centre O

$$B = B_1 + B_2$$

$$B = \frac{\mu_0 I}{2\pi.R} \quad \pi + 1 \quad T$$

78. Work function $W_0 = 3.31 \times 10^{-19}$ J

Wavelength of incident radiation

$$\lambda = 5000 \times 10^{-10} \text{ m}$$

$$E = W_0 + KE$$

(According to Einstein equation)

$$\frac{hc}{\lambda} = 3.31 \times 10^{-19} + KE$$

$$KE = - 3.31 \times 10^{-19} + \frac{6.62 \times 10^{-34} \times 3 \times 10^{8}}{5000 \times 10^{-10}}$$

$$= - 3.31 \times 10^{-19} + \frac{6.62 \times 3}{5} \times 10^{-19}$$

$$= (-3.31 \times 1.324 \times 3) \times 10^{-19}$$

$= (3.972 - 3.31) \times 10^{-19} = 0.662 \times 10^{-19}$ J

$\Rightarrow \quad E = \frac{0.662 \times 10^{-19}}{1.6 \times 10^{-19}} = 0.41 \; eV$

79. From Einstein's equation

$$E = W_0 + \frac{1}{2} \; mv^2$$

$$\sqrt{\frac{2 \; E - W_0}{m}} = v$$

or A charged particle placed in uniform magnetic field experience a force

$$F = \frac{mv^2}{r}$$

or $\quad evB = \frac{mv^2}{r}$

or $\quad r = \frac{mv}{eB}$

or $\quad r = \frac{m \sqrt{\frac{2 \; E - W_0}{m}}}{eB}$

$\Rightarrow \quad r = \frac{\sqrt{2m \; E - W_0}}{eB}$

80. $N_1 = N0e^{-10\lambda t}$

and $\quad N_2 = N_0e^{-\lambda t}$

$\Rightarrow \quad \frac{N_1}{N_2} = \frac{1}{e} = e^{-1} = e^{\;-10\lambda + \lambda \; t}$

$= e^{-9\lambda t}$

$\Rightarrow \quad t = \frac{1}{9\lambda}$

81. In circuit A, both (p-n) junction diode act as forward biasing.

Hence, current flows in circuit A.

Total resistance R is given by

$$\frac{1}{R} = \frac{1}{4} + \frac{1}{4}$$

Or $\quad \frac{1}{R} = \frac{2}{4}$

Or $\quad R = 2\Omega$

According to Ohm's law

$$V = I_A R$$

or $\quad 8 = I_A \times 2$

or $\quad I_A = 4A$

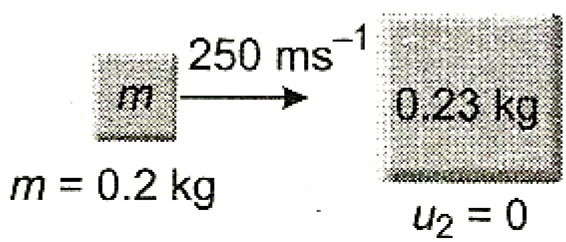
In circuit B, lower p-n-junction diode is reverse biased. Hence, no current will flow but upper diode is forward biased so current, can flow through it

$$V = I_B R$$

or $\quad 8 = I_B \times 4$

or $\quad I_B = 2\ A$

82. After impact the bullet and block move together and come's to rest after covering a distance of 40 m.



By conservation of momentum,

$$m_1u_1 + m_2u_2 = m_1v_1 + m_2v_2$$

or $\quad 0.02 \times 250 + 0.23 \times 0 = 0.02\ v + 0.23\ v$

$5 + 0 = v\ (0.25)$

$\frac{500}{25} v = 20\ ms^{-1}$

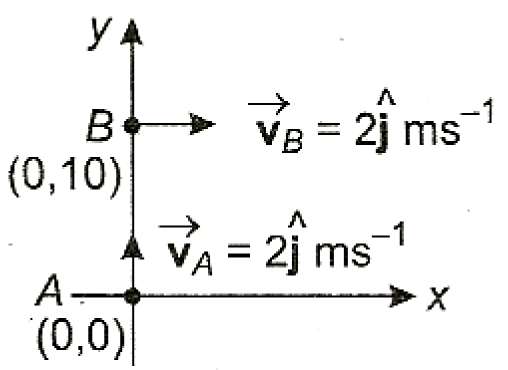
Now, by conservation of energy

$\frac{1}{2} Mv^2 = \mu R.d$

or $\quad \frac{1}{2} \times 0.25 \times 400 = \mu \times 0.25 \times 9.8 \times 40$

$\Rightarrow \quad \mu = \frac{200}{9.8 \times 40} = 0.51$

83. Let after the time (t) the position of A is $(0, v_A\ t)$ and position of B = $(v_B t, 10)$. Distance between them



$y = \sqrt{(0 - v_B t)^2 + (v_A t - 10)^2}$

or $\quad y^2 = (2t)^2 + (2t - 10)^2$

or $\quad y^2 = 1 = 4t^2 + 4t^2 + 100 - 40t$

$\Rightarrow \quad l = 8t^2 + 100 - 40\ t$

Now, $\frac{dl}{dt} (16t - 40) = 0$

$t = \frac{40}{16} = 2.5s$

As $\frac{d^2l}{dt^2}$ = -16 = (-ve)

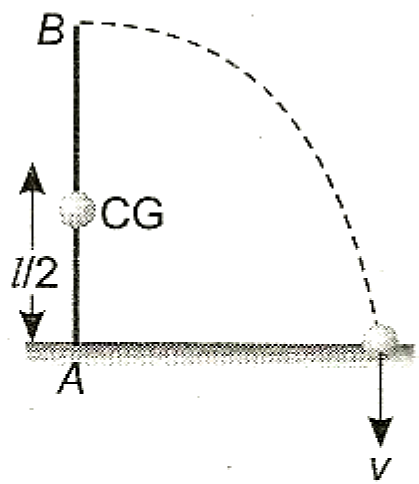
Hence, l will be minimum.

84. In this process potential energy of the metre stick will be converted into rotational kinetic energy.

PE of metre stick = $\frac{mgl}{2}$

Because its centre of gravity lies at the middle of the rod.

Rotational kinetic energy E = $\frac{1}{2}\ I\omega^2$



I = moment of inertia of metre stick about point $A = \frac{3l^2}{3}$.

By the law of conservation of energy

$$mg\ \frac{l}{2} = \frac{1}{2}\ I\omega^2 = \frac{1}{2}\frac{ml^2}{3}\ \frac{v_B}{l}^{\ 2}$$

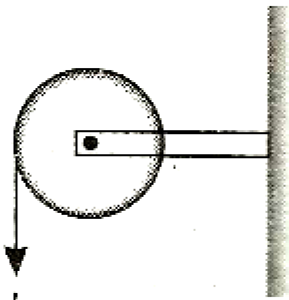
By solving, we get $v_B = \sqrt{3gl}$

85. Given, r = 0.4 m,

a = 8 rad s^{-1},

$m = 4$ kg, $1 = ?$

Torque, $\tau = Ia$



$mgr + I.\ a$

or $4 \times 10 \times 0.4 = I \times 8$

$\Rightarrow$ $I = \frac{16}{8} = 2\text{kg-m}^2$

or $I = 2\text{kg - m}^2$

CHEMISTRY

86. Given: ΔH_f (H) = 218 kJ/mol

ie; $\frac{1}{2} H_2 \rightarrow H$; $\Delta H = 218$ kJ/mol

or $H_2 \rightarrow 2H$; $\Delta H = 436$ kJ/mol

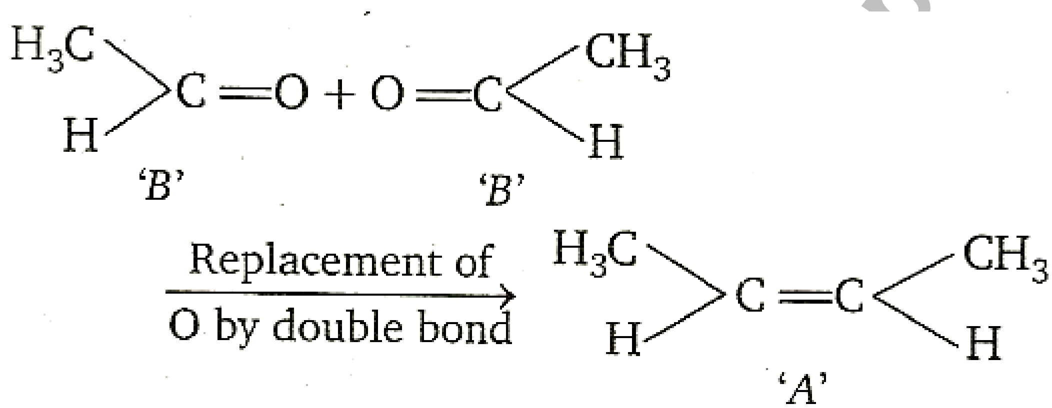
$= \frac{436}{4.18} = 104.3$ kcal/mol

Thus, 104.3 kcal/mol energy is absorbed for breaking one mole of H-H. bonds. Hence, H-H bond energy is 104.3 kcal/mol.

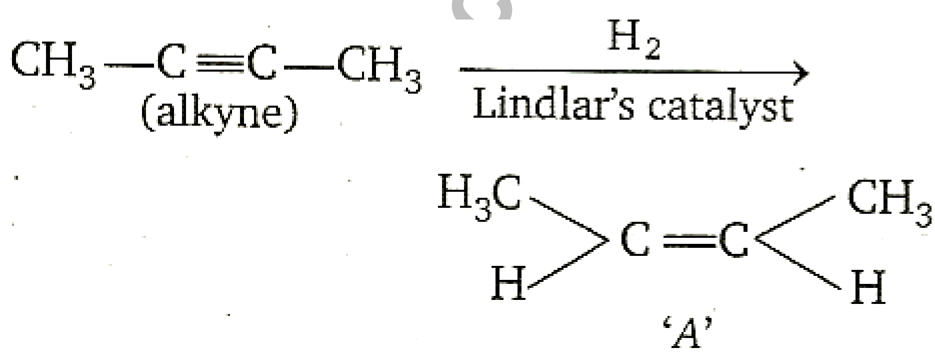
87. In Wacker process, alkene is oxidised into aldehyde.

$$CH_2 = CH_2 + \frac{1}{2} \xrightarrow[H_2O]{PdCl_2\ CuCl} \underset{B}{CH_3CHO}$$

Since on ozonolysis, only alkenes produce aldehydes, 'A' must be an alkene. To decide the structure of alkene that undergoes ozonolysis, bring the products together in such a way that 0 atoms are face to face and, replace O by double (=) bond. Thus,

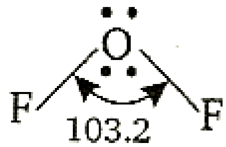


Therefore, alkyne must be



88. $2F_2 + \underset{dilute}{2NaOH} \rightarrow 2NaF + \underset{A}{OF_2} \uparrow + H_2O$

The structure of 'A' (OF_2) is as



σ bonds made by O = 2

Lone pairs of electrons on O = 2

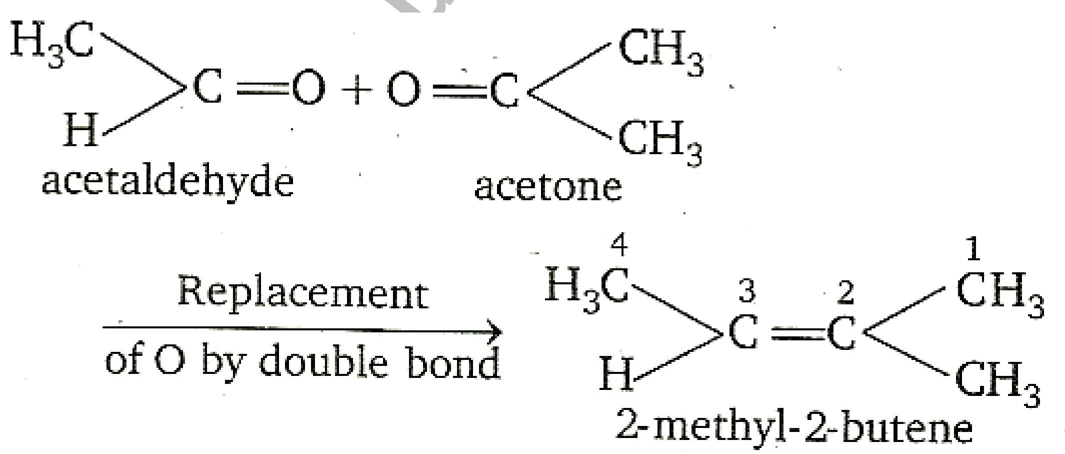
∴ No. of orbitals used by O for hybridisation

= 2 + 2 = 4

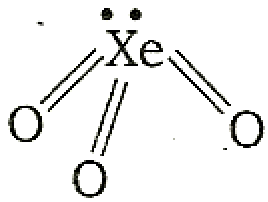
∴ Hybridisation of O in OF_2 = sp^3

Due to repulsion between" two lone pairs of electrons, its shape gets distorted. Therefore, the bond angle in the molecule is 103°.

89. To decide the structure of alkene that undergoes " ozonolysis, bring the products together in such a way that O atoms are face to face, and replace 0 by double (=) bond. Thus,

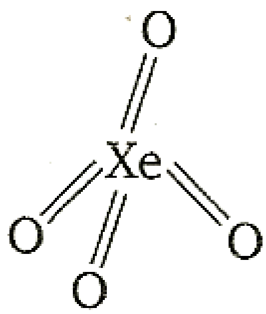


90. **Structure of XeO_3**



$\Rightarrow$ 3pμ - dπ pi bonds.

Structure of XeO_4



$\Rightarrow$ 4 pπ - dπ bonds.

91. From de-Broglie's equation

$$\lambda = \frac{h}{mv}$$

$$\Rightarrow \quad \lambda^2 = \frac{h^2}{m^2\,v^2}$$

$$\Rightarrow \quad mv^2 = \frac{h^2}{m\lambda^2}$$

$$\because \quad KE\ K = \frac{1}{2}\ mv^2$$

$$\therefore \quad KE\ K = \frac{1}{2}\,\frac{h^2}{m\lambda^2}$$

$$\Rightarrow \frac{K_1}{K_2} = \left(\frac{\lambda_2}{\lambda_1}\right)^2 = \left(\frac{5}{3}\right)^2$$

$$\therefore \quad K_1 : K_2 = 25 : 9$$

92. Paramagnetic property depends upon the number of unpaired electrons. Higher the number of unpaired electrons, higher the paramagnetic property will be.

Cu^{2+} = [Ar] $3d^9$, no. of unpaired electrons = 1

v^{2+} = [Ar] $3d^3$, no. of unpaired electrons = 3

Cr^{2+} = [Ar] $3d^4$, no. of unpaired electrons = 4

Mn^{2+} = [Ar] $3d^5$, no. of unpaired electrons = 5

Hence, correct order is -

$Cu^{2+} < V^{2+} < Cr^{2+} < Mn^{2+}$

93. 1 mol = 6.023×10^{23} atoms

KE of 1 mol = 6.023×10^4 J

or KE of 6.023×10^{23} atoms

$= 6.023 \times 10^4$ J

$\therefore \quad KE\ \ of\ 1\ atom = \frac{6.023 \times 10^4}{6.023 \times 10^{23}}$

$= 1.0 \times 10^{-19}\, J$

$h\nu_{energy} = \frac{hc}{\lambda} = \frac{6.626 \times 10^{-34} \times 3 \times 10^8}{600 \times 10^{-9}}$

$= 3.313 \times 10^{-19}\, J$

Minimum amount of energy required to remove an electron from the metal ion (ie, Threshold energy)

= hv - KE

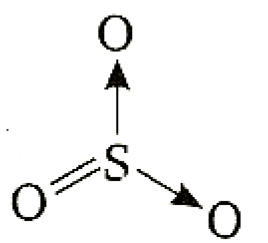
$= 3.313 \times 10^{-19} - 1.0 \times 10^{-19}$

$= 2.313 \times 10^{-19}$ J

94. The thermosphere is the fourth layer of the earth's atmosphere

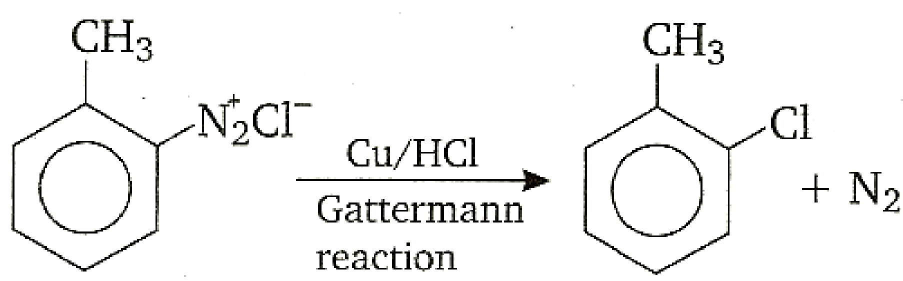
and is located above the mesosphere. The air is thin in the thermosphere. The earth's thermosphere also includes the region of the atmosphere, called the ionosphere. The ionosphere is the region of the atmosphere that is filled with charged particles such as O^+, NO^+. The high temperature in the thermosphere can cause molecules to ionize.

95. Sulphuric anhydride is SO_3 and its structure is as follows:

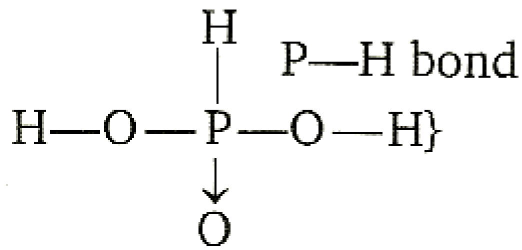


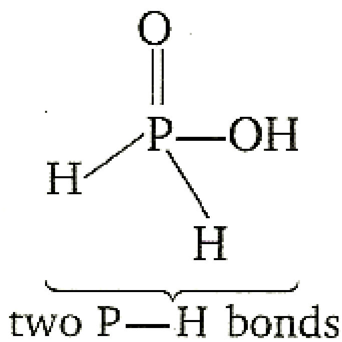
$\Rightarrow$ 3σ, 1 $p\pi$, 2 $p\pi$- $d\pi$ bonds are present.

96.



97.

$H_3PO_3 \Rightarrow$ 

$H_3PO_2 \Rightarrow$ 

98. From the definition of dipole moment,

$\mu = 8 \times d$

where, δ = magnitude of electric charge

d = distance between particles (here bond length)

$\therefore \quad \delta = \frac{\mu}{d}$

or, $\frac{\delta_{HCl}}{\delta_{HI}} = \frac{\mu_{HCl}}{d_{HCl}} \times \frac{d_{HI}}{\mu_{HI}}$

$= \frac{1.03 \times 1.6}{1.3 \times 0.38} = 3.3 : 1$

99. $SiCl_4 + 4H_2O \rightarrow H_4SiO_4 + 4HCl$

$H_4SiO_4 \xrightarrow[1000°c]{\Delta} SiO_2 + 2H_2O$

100. % of Cd in $CdCl_2 = \frac{0.9}{1.5} \times 100$

$= 60\%$

Therefore, % of Cl_2 in $CdCl_2$ = 100 - 60 = 40%

$\because$ 40% part (Cl_2) has atomic weight

= 2 × 35.5 = 71.0

$\therefore$ 60% part (Cd) has atomic weight

$= \frac{71.0 \times 60}{40}$

= 106.5

101. $2Al + 2NaOH + 2H_2O \rightarrow 2NaAlO_2 + 3H_2$

sodium meta aluminate

Sodiummetaaluminate, thus formed, is soluble in water and changes into the complex $[Al(H_2O)_2(OH)_4]^-$, in which coordination number of Al is 6.

102. Average kinetic energy per molecule

$= \frac{3}{2}\ kT$

Or $= \frac{3}{2}\frac{R}{N_0}\ T$

$= \frac{3}{2} \times \frac{8.314}{6.023 \times 10^{23}} \times 300$

$= 6.21 \times 10^{-21}\ JK^{-1}\ molecule^{-1}$

103. Superoxides are the species having an O – O bond and O in ana oxidation state of $-\frac{1}{2}$ (Superoxide ion is O^-_2). Usually these are formed by active metals such as KO_2, RbO_2 and CsO_2. For the salts of larger anions (like O^-_2), lattice energy increases in a

group. Since, lattice energy is the driving force for the formation of an ionic compound and its stability, the stability of the superoxides from 'K' to 'Cs' also increases.

104. Perhydrol means 30% solution of H_2O_2.

H_2O_2 decomposes as

$$2H_2O_2 \rightarrow 2H_2O + O_2$$

Volume strength of 30% H_2O_2 solution is 100 chat means 1 mL of this solution on decomposition gives 100 mL oxygen.

SO_2	+	$\frac{1}{2}$ 2	$\rightarrow$	SO_3
$1L$		$\frac{1}{2}L$		$1L$
$2L$		$1L$		$2L$

Since, 100 mL of oxygen is obtained by

=1 mL of H_2O_2

$\therefore$ 1000 mL of oxygen will be obtained by

$= \frac{1}{100} \times 1000$ mL of H_2O_2

= 10 mL of H_2O_2

105. Buffer capacity, $\beta = \frac{dC_{HA}}{d_{pH}}$,

where, dC_{HA} = no. of moles of acid added per litre

d_{PH} = change in pH.

$$dC_{HA} = \frac{moles\ of\ acetic\ acid}{volume}$$

$$= \frac{0.12/60}{250/1000} = \frac{1}{125}$$

$$\therefore \quad \beta = \frac{1/125}{0.02} = \frac{1}{2.5} = 0.4$$

106. (A) Felspar (orthoclase) ($KAlSi_3O_8$)

It is used in the manufacture of porcelain.

(B) Asbestos $\{CaMg_3(SiO_3)_4\}$

It is used for fireproof sheets, cloths etc.

(C) Pyrargyrite (Ruby silver) (Ag_3SbS_3)

It is an ore of silver.

(D) Diaspore ($Al_2O_3 . H_2O$)

It is an ore of aluminium.

107. First ionisation energy increases in. a period. Thus, the first IE of the elements of the second period should be as follows

Be < B < N < O

But in practice, the elements do not follow the above order. The first IE of these elements is

B < Be < O < N

The lower IE of B than that of Be is because in B ($1s^2$, $2s^2$ $2p^1$), electron is to be removed from 2p which is easy while in Be ($1s^2$, $2s^2$), electron is to be removed from 25 which is difficult. The low IE of O than that of N is because of the half-filled 2 p orbitals in N ($1s^2$, $2s^2$ $2p^3$).

108. $CH_3\,CH_2\,OH + Cl_2 \xrightarrow{-2HCl} \underset{X}{CH_3\,CHO}$

Acetaldehyde $\xrightarrow[-3HCl]{3Cl_2} \underset{\substack{Y \\ chloral}}{CCl_3\,CHO}$

109.

I. $$\begin{matrix} CH_3COO \\ CH_3COO \end{matrix} \Big> Ca \xrightarrow[-CaCO_3]{\Delta} CH_3COCH_3$$

II. $$CH_3COOH \longrightarrow 6HI \xrightarrow{\text{Red P}} CH_3CH_3 + 3I_2 + 2H_2O$$

III. $$\begin{matrix} CH_3CO|OH \\ CH_3COO|H \end{matrix} \xrightarrow{\Delta, P_4O_{10}} \begin{matrix} CH_3CO \\ CH_3CO \end{matrix} \Big> O + H_2O$$

110. $C = 85.71\% \quad = \frac{85.71}{12} = 7.14; \qquad \frac{7.14}{7.14} = 1$

$H = 14.29\% \quad = \frac{14.29}{1} \quad = 14.29; \quad \frac{14.29}{7.14} = 2$

$\therefore$ Empirical formula = CH_2

And, empirical formula weight = 12 + 2 =14

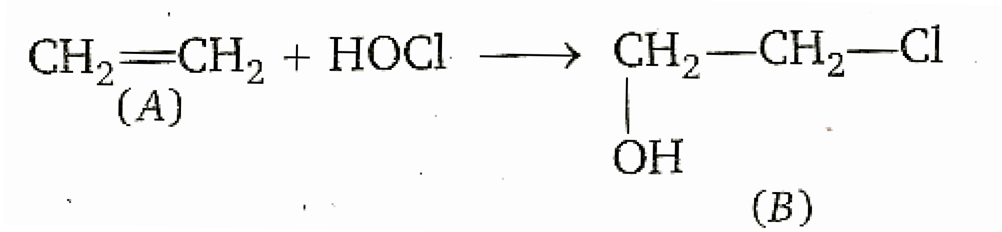
Again, molecular formula weight

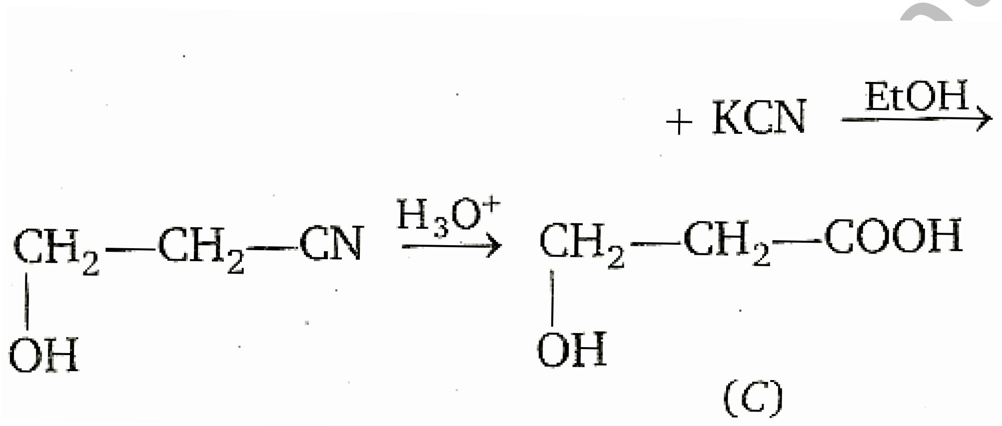
$= 2 \times vapour\ density$

$= 2 \times 14 = 28$

$\therefore$ n $= \frac{28}{14} = 2$

$\therefore$ Molecular formula = $CH_2\ {}_2 = C_2H_4$





111. Tripeptides are amino acids polymers in which three individual amino acid units, called residues, are linked together by amide bonds.

In these, an amine group "from one residue forms an amide bond with the carboxyl group of a second residue, the amino group of the second forms an amide bond with the carboxyl group of the third.

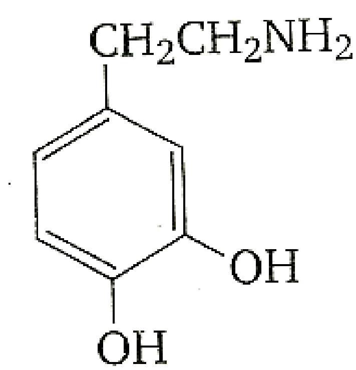
Therefore, glycine (NH_2-CH_2 - COOH), alanine ($CH_3-\underset{\displaystyle NH_2}{\underset{|}{CH}}-COOH$) and phenyl alanine

$C_6H_5-CH_2-\underset{\displaystyle NH_2}{\underset{|}{CH}}COOH$ can be linked in six

different ways.

112. A codon is a specific sequence of three adjacent bases on a strand of DNA or RNA that provides genetic code information for a particular amino acid.

113. Dopamine is produced in several areas of the brain. If the amount of dopamine increases in the brain, the patient may be affected with Parkinson's disease. The IUPAC name of dopamine is 2-(3, 4-dihydroxyphenyl) ethylamine and its structure is as follows:



114. Freezing point of a substance is the temperature at which the solid and the liquid forms" of the substance are in equilibrium."

If a non-volatile solute is added to the solvent, there is decrease in vapour pressure of the solution and thus the freezing point of the solution is less than that of pure solvent. It is called depression in freezing point.

115.

$$C_2H_5\text{—}Cl + AgCN \xrightarrow[H_2O]{EtOH/} C_2H_5\text{—}NC + AgCl$$

$$\Downarrow$$

N-linked to ethyl carbon

116. For the given cell,

Ag|Ag$^+$| AgCl| $Cl^{\ominus}$| Cl_2, Pt

The cell reactions are as follows

At anode:

$$Ag \rightarrow Ag^+ + e^-$$

At cathode:

$$AgCl + e^- \rightarrow Ag(s) + Cl^-$$

Net cell reaction:

$$AgCl \rightarrow Ag^+ + Cl^-$$

$$\therefore \quad \Delta G^\circ_{reaction} = \Sigma\Delta G^\circ_P - \Sigma\Delta G^\circ_R$$

$$= 78 - 129 - -109$$

$$= +58 \text{ kJ / mol}$$

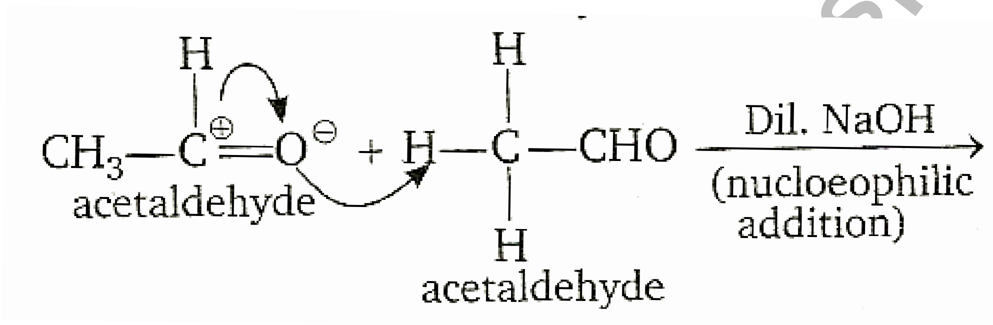
$$\Delta G^\circ = -nFE^\circ$$

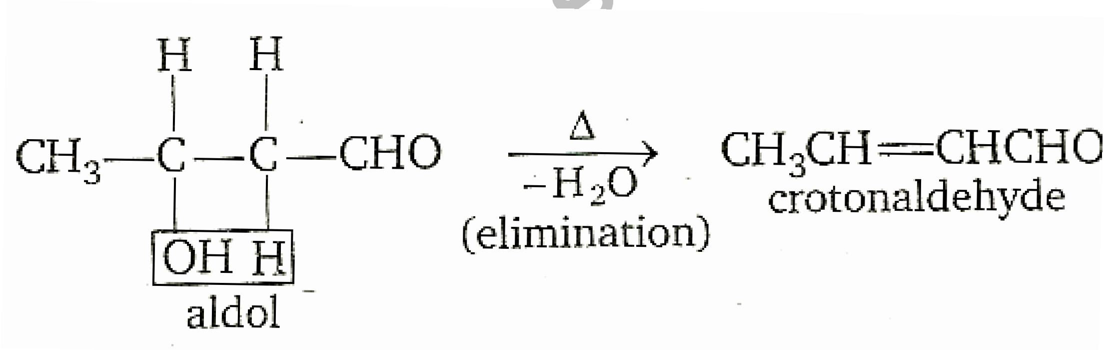
58 × 103 J = -1 × 96500 × $E°_{cell}$

$$E°_{cell} = \frac{-58\times1000}{96500}$$

$$= -0.6V$$

117. Crotonaldehyde is produced by the aldol condensation of acetaldehyde-





118. $BaCl_2 + 2NaOH \rightarrow Ba(OH)_2 + 2NaCl$

$\lambda°_{m\,Ba\,(OH)_2} = \lambda°_{m\,BaCl_2} + 2\lambda^{\infty}_{m\;NaCl}$

$= 280 \times 10^{-4} + 2 \times 248 \times 10^{-4}$

$- 2 \times 126 \times 10^{-4}$

$= (280 + 496 - 252) \times 10^{-4}$

$= 524 \times 10^{-4}$ $Sm^2\ mol^{-1}$

119. Density, d= $\frac{MZ}{N_0\, a^3}$

where, Z = number of atoms in unit cell

$\therefore \qquad Z = \frac{dN_0\ a^3}{M}$

$= \frac{8.92 \times 6.023 \times 10^{23} \times\ \ 362 \times 10^{-10}\ \ ^3}{63.55}$

= 4.0

Thus, metal has face centred unit cell.

120. $N_2 + 2O_2 \rightleftharpoons 2\, NO_2$

$K_1 = \frac{NO_2\ ^2}{N_2\ \ O_2\ ^2}$

or $\quad 100 = \frac{NO_2\ ^2}{N_2\ \ O_2\ ^2}$ .... (i)

Again, $NO_2 \ \rightleftharpoons \frac{1}{2} N_2 + O_2$

$K_2 = \frac{N_2\ ^{1/2}\ O_2}{NO_2}$

or $\quad K_2^2 = \frac{N_2\ \ O_2\ ^2}{NO_2\ ^2}$ .... (ii)

eqs. (i) × (ii), we get

$100 \times K_2^2 = 1$

or $\quad K_2^2 = \frac{1}{100}\ or\ K_2 = \frac{1}{10} = 0.1$

121. For a first order reaction,

$t = \frac{2.303}{\lambda} \log_{10} \frac{a}{a-x}$

Let initial amount of reactant is 100.

$$\frac{t_1}{t_2} = \frac{\log\frac{100}{100-75}}{\log\frac{100}{100-25}}$$

$\because$ λ remains constant

$$= \frac{\log\frac{100}{25}}{\log\frac{100}{75}} = \frac{\log 4}{\log 4/3}$$

$$= \frac{\log 4}{\log 4 - \log 3}$$

$$= \frac{2\times0.3010}{2\times0.3010-0.4771}$$

122. $a = \frac{a_{\ observed}}{l\times C} = \frac{-1.2}{5\times\frac{6.15}{1000}} = -39°$

123. Let me concentration or potassium acetate is x.

From Henderson's equation,

$$pH = pK_a + \log\frac{salt}{acid}$$

$$4.8 = -\log\ 1.8\times10^{-5} + \log\frac{x\times50}{20\times0.1\ M}$$

$$4.8 = 4.74 + \log 25\,x$$

or $\log\ 25x = 0.06$

$25x = 1.148$

$\therefore$ x = 0.045 M

124. By $'2A + \frac{C}{2} - B'$, we get

$$Na_2O + SO_3 \rightarrow Na_2SO_4;$$

$$\Delta H = -2\times146 + \frac{259}{2} - 418$$

or ΔH = - 580.5 ≈ 581 kJ

125. As_2S_3 is a negative sol. It is obvious that cations are effective in coagulating negative sols. According to Hardy Schulze rule, greater the valency of the coagulating ion, greater is its coagulating power. Thus, out of the given, $AlCl_3$ (Al^{3+}) is most effective for causing coagulation of As_2S_3 sol.

REASONING

141. From problem figure (1) to (2), double figure is converted into single figure and vice-versa. Also, figures change place in a set order. Hence, answer figure (d) will replace the sign?

142. 'Nurse' receives instructions from 'Doctor' and 'Follower' receives instructions from 'Leader'.

143. $24 \times 2 + 4 = 52$,

$52 \times 2 + 4 = 108$,

$108 \times 2 + 4 = 220$,

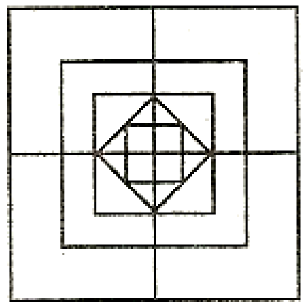
$220 \times 2 + 4 = 444$,

and so on. Hence, number 112 is wrong and should be replaced by 108.

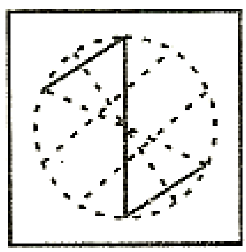
144. Only I and III are implicit because in the relief camp the facilities of food, water and shelter are available.

145. It is clear that answer figure (b) completes the original figure, which looks like as shown in the adjacent figure. Hence,

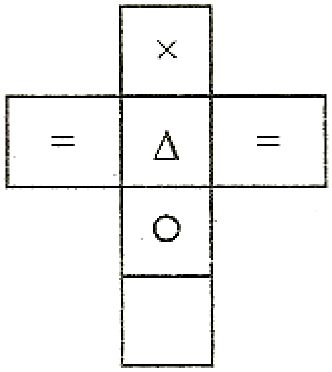
alternative (b) is the correct answer.



146. Clearly figure (x) is embedded in alternative figure (b). The portion which figure (x) occupies in the alternative figure has been shown in the adjacent figure. Hence, the correct answer figure is - (b),



147. Symbol appearing on the faces of dice can be shown as given in the figure. We see from the figure that symbol o will appear on the opposite face symbol x.



148. Figure X is the first step in which a circular piece of paper is folded from upper to the lower half along the diameter. In figure Y both the extreme ends of the figure X have been folded to form a triangle and then as given in figure Z, a cut has been marked from the right side. It is clear that this cut will result into two marks, one in the lower half and one in the upper half of the paper, when it will be unfolded. Answer figure (b) represents the correct design of the unfolded paper and hence, is the correct answer.

150. Converting alphabets into mathematical symbols as- given above, we get

$18 \times 1274 + 5 - 6$

$= 18 \times \frac{12}{4} + 5 - 6$

$= 18 \times 3 + 5 - 6$

$= 54 + 5 - 6$

$= 59 - 6 = 53$

Hence, option (c) is the correct answer.

BITSAT

Solved Paper 2011

Instructions

1. There are 150 questions in all. The number of questions in each part is as follows

Subjects	No. of Questions
Part I (Physics)	1–40
Part II (Chemistry)	41–80
Part III	
(a) English Proficiency	81–95
(b) Logical Reasoning	96–105
Part IV (Mathematics)	106-150

2. All questions are multiple choice questions with four options, only one being correct.
3. Each correct answer fetches 3 marks while incorrect answer fetches –1 mark.

Part I

Physics

1. Suppose the gravitational force varies inversely as the nth power of distance. Then the time period of a planet in circular orbit of radius R around the sun will be proportional to

(a) $R^{(n+1)/2}$ (b) $R^{(n-1)/2}$
(c) R^n (d) $R^{(n-2)/2}$

2. Two wires are made of the same material and have the same volume. However wire 1 has cross-sectional area A and wire 2 has cross-sectional area $3A$. If length of wire 1 increased by Δx on applying force F, how much force is needed to stretch wire 2 by the same amount?

(a) $4F$ (b) $6F$
(c) $9F$ (d) F

3. The satellite of mass m revolving in a circular orbit of radius r around the earth has kinetic energy E. Then its angular momentum will be

(a) $\sqrt{\frac{E}{mr^2}}$ (b) $\frac{E}{2mr^2}$
(c) $\sqrt{2Emr^2}$ (d) $\sqrt{2Emr}$

4. A galvanometer of resistance 100Ω gives full scale deflection with 0.01 A current. How much resistance should be connected in parallel to convert it into an ammeter of range 10 A?

(a) $0.100\,\Omega$ (b) $1.00\,\Omega$
(c) $10.00\,\Omega$ (d) $100.00\,\Omega$

5. A car is moving on a circular road of diameter 50 m with a speed of 5 m/s. It is suddenly accelerated at a rate of 1 m/s^2. If the mass of the car is 500 kg, then the net force acting on the car is

(a) 5 N (b) 1000 N
(c) $500\sqrt{2}$ N (d) $\frac{500}{\sqrt{2}}$ N

6. 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

(a) $< 124\,kV$

(b) $> 124\,kV$

(c) between 60 kV and 70 kV

(d) $= 100\,kV$

7. Natural length of a spring is 60 cm and its spring constant is 4000 N/m. A mass of 20 kg is hung from it. The extension produced in the spring is (Take $g = 9.8\,m/s^2$)

(a) 4.9 cm (b) 0.49 cm

(c) 9.4 cm (d) 0.94 cm

8. A point source of light is placed 4 m below the surface of water of refractive index $\frac{5}{3}$. The minimum diameter of a disc, which should be placed over the source, on the surface of water to cut-off all right coming out of water is

(a) infinite (b) 6 m

(c) 4 m (d) 3 m

9. What is the maximum acceleration of the particle doing the SHM?

$y = 2\sin\left[\frac{\pi t}{2} + \phi\right]$, where 2 is in cm

(a) $\frac{\pi}{2}\,cm/s^2$ (b) $\frac{\pi^2}{2}\,cm/s^2$

(a) 10 days (b) 20 days

(c) 40 days (d) None of these

13. The velocity of efflux of a liquid through an orific in the bottom of the tank does not depend upon

(a) size of orific

(b) height of liquid

(c) acceleration due to gravity

(d) density of liquid

14. A neutron with velocity v strikes a stationary deuterium atom, its KE changes by a factor of

(a) $\frac{15}{16}$ (b) $\frac{1}{2}$

(c) $\frac{2}{1}$ (d) None of these

15. The Poisson's ratio of a material is 0.5. If a force is applied to a wire of this material, there is a decrease in the cross-sectional area by 4%. The percentage increase in the length is

(a) 1% (b) 2%

(c) 2.5% (d) 4%

16. Lenz's law of electromagnetic induction corresponds to the

(a) law of conservation of charge

(b) law of conservation of energy

(c) law of conservation of momentum

(d) law of conservation of angular

19. The force constant of a spring gun is 50 N/m. If a ball of 20 g be shoot by the gun so, that its spring is compressed by 10 cm, the velocity of the ball is

(a) 5 m/s (b) 15 m/s
(c) 25 m/s (d) 20 m/s

20. 1 g of water (volume 1 cm^3) becomes 1671 cm^3 of steam when boiled at a pressure of 1 atm. The latent heat of vapourisation is 540 cal/g, then the external work done is
($1 \text{ atm} = 1.013 \times 10^5 \text{ N/m}^2$)

(a) 499.7 J (b) 40.3 J
(c) 169.2 J (d) 128.57 J

21. A cube has a side of length 1.2×10^{-2}m. Calculate its volume.

(a) $1.7 \times 10^{-6} \text{m}^3$ (b) $1.73 \times 10^{-6} \text{m}^3$
(c) $1.70 \times 10^{-6} \text{m}^3$ (d) $1.732 \times 10^{-6} \text{m}^3$

22. A ball is dropped from height h and another from $2h$. The ratio of time taken by the two balls to reach the ground is

(a) $1 : \sqrt{2}$ (b) $\sqrt{2} : 1$
(c) $2 : 1$ (d) $1 : 2$

23. The linear momentum p of a body moving in one dimension varies with time t according to the equation $p = a + bt^2$, where a and b are positive constant. The net force acting on the body is

(a) a constant
(b) proportional to t^2
(c) inversely proportional to t
(d) proportional to t

24. Which of the following is not an example of perfectly inelastic collision?

(a) A bullet fired into a block, if bullet gets embedded into block
(b) Capture of an electron by an atom
(c) A man jumping onto a moving boat
(d) A ball bearing striking another ball bearing

25. If a new planet is discovered rotating around sun with the orbital radius double that of the earth, then what will be its time period? (in earth's days)

(a) 1032 (b) 1023
(c) 1024 (d) 1043

26. If density of earth increases 4 times and its radius becomes half of what it is, our weight will

(a) be 4 times its present value
(b) be doubled
(c) remain same
(d) be halved

27. The magnitude of electric field intensity E, such that an electron placed in it would experience an electrical force equal to its weight, is given by

(a) mge (b) $\frac{mg}{e}$
(c) $\frac{e}{mg}$ (d) $\frac{e^2}{m^2} g$

28. The work done in placing a charge of 8×10^{-18} C on a capacitor of capacity 100 μF is

(a) 32×10^{-32} J (b) 16×10^{-32} J
(c) 3.1×10^{-26} J (d) 4×10^{-10} J

29. A steady current flow in a metallic conductor of non-uniform cross-section. The quantity/quantities remaining constant along the whole length of the conductor is/are

(a) current, electric field and drift speed
(b) drift speed only
(c) current and drift speed
(d) current only

30. A galvanometer of 50 Ω resistance has 25 divisions. A current of 4×10^{-4} A gives a deflection of one division. To convert this galvanometer into a voltmeter having a range of 25 V, it should be connected with a resistance of

(a) 2500 Ω as a shunt
(b) 2950 Ω as in shunt
(c) 2550 Ω in series
(d) 2450 Ω in series

31. The cyclotron frequency of an electron gyrating in a magnetic field of 1 T is approximately

(a) 28 MHz
(b) 280 MHz
(c) 2.8 GHz
(d) 28 GHz

32. If $\mathbf{M}$ is magnetic moment and $\mathbf{B}$ is the magnetic field, then the torque is given by
(a) $\mathbf{M} \cdot \mathbf{B}$
(b) $\frac{|\mathbf{M}|}{|\mathbf{B}|}$
(c) $\mathbf{M} \times \mathbf{B}$
(d) $|\mathbf{M}||\mathbf{B}|$

33. A coil of inductance L is carrying a steady current I what is the nature of its stored energy?
(a) Magnetic
(b) Electrical
(c) Both magnetic and electrical
(d) Heat

34. Energy conversion in a photoelectric cell takes place from
(a) chemical to electrical
(b) magnetic to electrical
(c) optical to electrical
(d) mechanical to electrical

35. If the ionisation potential of helium atom is 24.6 V, the energy required to ionise it will be
(a) 24.6 eV
(b) 24.6 V
(c) 13.6 V
(d) 13.6 V

36. Fast neutrons can easily be solved down by
(a) the use of lead shielding
(b) passing them through water
(c) elastic collision with heavy nuclei
(d) applying a strong electric field

37. A film projector magnifies a 100 cm^2 film strip on a screen. If the linear magnification is 4, the area of the magnified film on the screen is
(a) 1600 cm^2
(b) 400 cm^2
(c) 800 cm^2
(d) 6400 cm^2

38. If v_m is the speed of sound in moist air and v_d is the speed of sound in dry air under identical conditions of pressure and temperature, then
(a) $v_m > v_d$
(b) $v_m < v_d$
(c) $v_m = v_d$
(d) $v_m \cdot v_d = 1$

39. A hot and a cold body are kept in vacuum separated from each other. Which of the following cause decrease in temperature of the hot body?
(a) Radiation
(b) Convection
(c) Conduction
(d) Temperature remains unchanged

40. An ideal refrigerator has a freezer at a temperature of −13°C. The coefficient of performance of the engine is 5. The temperature of the air (to which heat is rejected) will be
(a) 325°C
(b) 325 K
(c) 39°C
(d) 320°C

Part II

Chemistry

41. The mutual heat of neutralisation of 40 g NaOH and 60 g CH_3COOH will be
(a) 57.1 kJ
(b) less than 57.1 kJ
(c) more than 57.1 kJ
(d) 13.7 kJ

42. Which has the smallest size?
(a) Al^{3+}
(b) Mg^{2+}
(c) P^{5+}
(d) Na^{+}

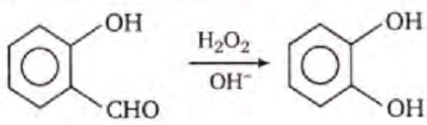
43. The treatment of benzene with *iso*-butene in the presence of sulphuric acid gives
(a) *iso*-butylbenzene
(b) *tert*-butylbenzene
(c) *n*-butylbenzene
(d) no reaction

44. Toluene on reaction with N-bromo-succinimide gives
(a) *p*-bromomethylbenzene
(b) *o*-bromomethylbenzene
(c) phenyl bromomethane
(d) *m*-bromomethylbenzene

45. Pinacolone is
(a) 2, 3-dimethyl-2, 3-butanediol
(b) 3, 3-dimethyl-2-butanone
(c) 1-phenyl-2-propanone
(d) 1, 1-diphenyl-1, 2-ethandiol

46. A synthetic rubber which is resistant to the action of oils, gasoline and other solvents is
(a) buna-S
(b) polyisoprene
(c) neoprene
(d) polystyrene

47. Ozone depletion over Antarctica is due to the
(a) formation of chlorine nitrate ($ClONO_2$)
(b) formation of HCl
(c) formation of HOCl and Cl_2 which are converted back into reactive Cl atoms
(d) None of the above

48. 

This reaction is called
(a) Reimer-Tiemann reaction
(b) Liebermann's nitroso reaction
(c) Dakin reaction
(d) Leader-Manase reaction

49. Which anion is the weakest base?
(a) $C_2H_5O^-$ (b) NO_3^-
(c) F^- (d) CH_3COO^-

50. K_b for water is 0.52 K/m. Then 0.1 m solution of NaCl will boil approximately at
(a) 100.52°C (b) 100.052°C
(c) 101.04°C (d) 100.104°C

51. One mole of P_2O_5 undergoes hydrolysis as

$$P_2O_5 + H_2O \longrightarrow H_3PO_4$$

The normality of the phosphoric acid formed is (The volume of solution is 1 L.)
(a) 2 (b) 12
(c) 24 (d) 4

52. 1 L of a gas is at a pressure of 10^{-6} mm of Hg at 25°C. How many molecules are present in the vessel?
(a) 3.2×10^6 (b) 3.2×10^{13}
(c) 3.2×10^{10} (d) 3×10^4

53. Which of the following has the largest de-Broglie wavelength, given that all have equal velocity?
(a) CO_2 molecule (b) NH_3 molecule
(c) Electron (d) Proton

54. 1 g of U–235 is converted into UF_6. The radioactivity of UF_6 thus obtained is
(a) zero
(b) less than that of 1 g of U–235
(c) more than that of 1 g of U–235
(d) same as that of 1 g of U–235

55. In which of the following molecules S atom does not assume sp^3 hybridisation?
(a) SO_4^{2-} (b) SF_4
(c) SF_2 (d) S_8

56. For the reaction,

$$N_2(g) + 3H_2(g) \rightleftharpoons 2NH_3(g)$$

the units of K are
(a) $L\ mol^{-1}$ (b) $L^2\ mol^{-2}$
(c) $mol\ L^{-1}$ (d) No units

57. A sulphuric acid solution has pH = 3. Its normality is
(a) 1/1000 (b) 1/200
(c) 1/2000 (d) 1/100

58. The oxidation number of N and Cl in $NOClO_4$ respectively are
(a) + 2 and + 7 (b) + 3 and + 7
(c) – 3 and + 5 (d) + 2 and – 7

59. Pyrolusite is a/an
(a) oxide ore (b) sulphide ore
(c) carbide ore (d) Not an ore

60. When potassium ferrocyanide crystals are heated with conc. H_2SO_4, the gas evolved is
(a) SO_2 (b) NH_3
(c) CO_2 (d) CO

61. The product/s of the reaction,

$$Na_2CO_3 + CO_2 + H_2O \longrightarrow \text{ is/are}$$

(a) $2NaOH + CO_2$ (b) $Na_2CO_3 + H_2CO_3$
(c) $2NaHCO_3$ (d) None of these

62. Which among the following is likely to show geometrical isomerism?
(a) $CH_3CH{=}NOH$
(b) $CH_3CH{=}CH_2$
(c) $CH_2{=}CH{-}CH{=}CCl_2$
(d) $CH_3C(Cl){=}C(CH_3)_2$

63. A fuel has the same knocking property as a mixture of 70% *iso*-octane (2, 2, 4-trimethylpentane) and 30% *n*-heptane by volume. The octane number of the fuel is
(a) 100 (b) 70
(c) 50 (d) 40

64. Sodium carbonate reacts with SO_2 in aqueous medium to give
(a) $NaHSO_3$ (b) $Na_2S_2O_3$
(c) $NaHSO_4$ (d) Na_2SO_4

65. For a given reaction $t_{1/2} = 1/ka$. The order of this reaction is
(a) 0 (b) 1
(c) 2 (d) 3

66. Which of the following compounds will react with two moles of CH_3MgBr?
(a) C_2H_5COOH (b) CH_3COOH
(c) $CH_3C \equiv CCH_3$ (d) $HC \equiv C—CH_2OH$

67. The number of polypeptide chains present in a molecule of haemoglobin is
(a) four (b) one
(c) two (d) three

68. *The pentose sugar in DNA and RNA has the*
(a) open chain structure
(b) pyranose structure
(c) furanose structure
(d) All of the above

69. Which of the following is an artificial edible colour?
(a) Saffron (b) Carotene
(c) Tetrazine (d) Melamine

70. The number of unpaired electrons in nickel carbonyl is
(a) zero (b) one
(c) four (d) five

71. The time taken for 90% of a first order reaction to complete is approximately
(a) 1.1 times that of half-life
(b) 2.2 times that of half-life
(c) 3.3 times that of half-life
(d) 4.4 times that of half-life

72. The pH of a 0.01 M HCN solution for which pK_a is 4 is
(a) 0.47 (b) 1.2
(c) 3.0 (d) 4.0

73. Which of the following does not contain any coordinate bond?
(a) H_3O^+ (b) BF_4^-
(c) HF_2^- (d) NH_4^+

74. If E is the energy of the combining atomic orbitals, E_1 and E_2 are the energies of the bonding and anti-bonding molecular orbitals formed, then
(a) $E - E_1 > E_2 - E$
(b) $E - E_1 < E_2 - E$
(c) $E - E_1 = E_2 - E$
(d) Any one of the above is possible

75. The equilibrium constant (K) for the reaction
$Cu(s) + 2Ag^+(aq) \rightarrow Cu^{2+}(aq) + 2Ag(s)$
will be [Given, $E^\circ_{cell} = 0.46$ V]
(a) K_c = Antilog 15.6 (b) K_c = Antilog 2.5
(c) K_c = Antilog 1.5 (d) K_c = Antilog 12.2

76. E° for Fe/Fe^{2+} is +0.44 V and E° for Cu/Cu^{2+} is – 0.32 V. Then, in the cell
(a) Cu oxidises Fe^{2+} ion
(b) Cu^{2+} oxidises iron
(c) Cu reduces Fe^{2+} ion
(d) Cu^{2+} ion reduces Fe

77. Which of the following carbon atoms is most electronegative?
$$\overset{\text{III}}{CH_3}—\overset{\text{II}}{CH_2}—\overset{\text{I}}{C}\equiv CH$$
(a) I
(b) II
(c) III
(d) All are equally electronegative

78. The reaction/method that does not give an alkane is
(a) catalytic hydrogenation of alkenes
(b) hydrolysis of alkylmagnesium bromide
(c) Kolbe's electrolytic method
(d) dehydrohalogenation of an alkyl halide

79. Which of the following will yield a mixture of 2-chlorobutene and 3-chlorobutene on treatment with HCl?
(a) $CH_2{=}C{=}CH—CH_3$
(b) $H_2C{=}\underset{\substack{|\\ CH_3}}{C}—CH{=}CH_2$
(c) $CH_2{=}CH—CH{=}CH_2$
(d) $HC{\equiv}C—CH{=}CH_2$

80. The well known urinary antiseptic urotropine is formed when formaldehyde reacts with
(a) NH_2OH (b) NH_3
(c) $NH_2 \cdot NH_2$ (d) $C_6H_5NH \cdot NH_2$

96. Which one number is wrong in the given series?

5, 10, 17, 24, 37

(a) 10 (b) 17
(c) 24 (d) 37

97. Find the next two letters in the given series.

E F H K O ?

(a) T, Z (b) Z, T
(c) S, Z (d) T, Y

98. If MONKEY is coded as NNOJFX, what will be the code for TARGET?

(a) ZUSFFS (b) SFFSZU
(c) UZSFSF (d) UZSFFS

99. Among six friends L, M, N, P, Q and S, each having a different height, N is shorter than Q and P but taller than M. S is shorter than only L. Which of the following represents the tallest among six friends?

(a) P
(b) Q
(c) L
(d) Cannot be determined

100. Manick is fourteenth from the right end in a row of 40 boys. What is his position from the left end?

(a) 24^{th} (b) 25^{th}
(c) 26^{th} (d) 27^{th}

101. The missing number in the given figure is

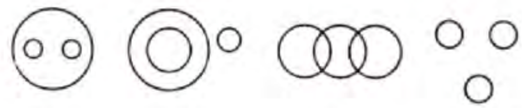
(a) 13 (b) 15
(c) 17 (d) 19

102. Select the combination of numbers so that the letters arranged will form a meaningful word.

H N R C A B
1 2 3 4 5 6

(a) 2, 5, 3, 4, 1, 6 (b) 3, 5, 6, 4, 1, 2
(c) 4, 1, 5, 6, 2, 3 (d) 6, 3, 5, 2, 4, 1

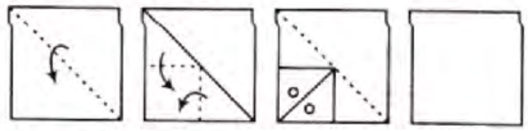
103. Which of the given Venn diagrams out of (a), (b), (c) or (d) correctly represents the relationship among the following classes?
Rose, Flower, Lotus



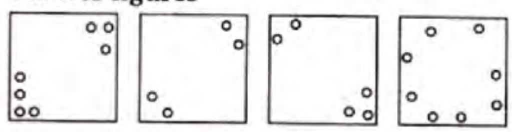
(a) (b) (c) (d)

104. A piece of paper is folded and a cut is made as shown below. From the given responses indicate how it will appear when opened?

Question figures



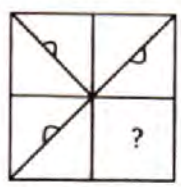
Answer figures



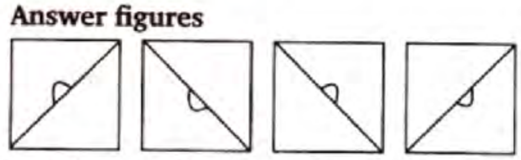
(a) (b) (c) (d)

105. Which answer figure will complete the question figure?

Question figure



Answer figures



(a) (b) (c) (d)

Part IV

Mathematics

106. The equation of the normal to the circle $x^2 + y^2 = a^2$ at point (x', y') will be

(a) $x'y - xy' = 0$ (b) $xx' - yy' = 0$
(c) $x'y + xy' = 0$ (d) $xx' + yy' = 0$

107. Equation of the bisector of the acute angle between lines $3x + 4y + 5 = 0$ and $12x - 5y - 7 = 0$ is

(a) $21x + 77y + 100 = 0$
(b) $99x - 27y + 30 = 0$
(c) $99x + 27y + 30 = 0$
(d) $21x - 77y - 100 = 0$

108. If $z = \cos\theta + i\sin\theta$, then the value of $z^n + \dfrac{1}{z^n}$ will be

(a) $\sin 2n\theta$ (b) $2\sin n\theta$
(c) $2\cos n\theta$ (d) $\cos 2n\theta$

109. If α and β are the roots of the equation $x^2 - 2x + 4 = 0$, then the value of $\alpha^n + \beta^n$ will be

(a) $i2^{n+1}\sin(n\pi/3)$ (b) $2^{n+1}\cos(n\pi/3)$
(c) $i2^{n-1}\sin(n\pi/3)$ (d) $2^{n-1}\cos(n\pi/3)$

110. If $A = \begin{bmatrix} 3 & 1 \\ -1 & 2 \end{bmatrix}$ and $I = \begin{bmatrix} 1 & 0 \\ 0 & 1 \end{bmatrix}$, then the correct statement is

(a) $A^2 + 5A - 7I = O$
(b) $-A^2 + 5A + 7I = O$
(c) $A^2 - 5A + 7I = O$
(d) $A^2 + 5A + 7I = O$

111. The value of the determinant $\begin{vmatrix} a-b-c & 2a & 2a \\ 2b & b-c-a & 2b \\ 2c & 2c & c-a-b \end{vmatrix}$ will be

(a) $(a-b-c)(a^2+b^2+c^2)$
(b) $(a+b+c)^3$
(c) $(a+b+c)(ab+bc+ca)$
(d) None of the above

112. If $(1+x)^n = C_0 + C_1x + C_2x^2 + \ldots + C_nx^n$, then $C_0 - C_1 + C_2 - C_3 + \ldots + (-1)^n \cdot C_n$ is equal to

(a) 3^n (b) 2^n
(c) 1 (d) 0

113. If AM and HM between two numbers are 27 and 12 respectively, then their GM is

(a) 9 (b) 18
(c) 24 (d) 36

114. For any two events A and B, if $P(A \cup B) = 5/6$, $P(A \cap B) = 1/3$, $P(B) = 1/2$, then $P(A)$ is

(a) 1/2 (b) 2/3
(c) 1/3 (d) None of these

115. A bag contains 3 white and 5 black balls. One ball is drawn at random. Then, the probability that it is white, is

(a) $\dfrac{1}{8}$ (b) $\dfrac{3}{8}$
(c) $\dfrac{5}{8}$ (d) $\dfrac{3}{5}$

116. $\mathbf{a} \cdot (\mathbf{b} \times \mathbf{c}) = 0$, then the correct statement is

(a) out of **a**, **b**, **c** any two vectors are parallel
(b) **a**, **b**, **c** are coplanar
(c) any two are equal **a**, **b**, **c**
(d) at least one above statement is correct

117. If $2\mathbf{i} + \mathbf{j} - \mathbf{k}$ and $\mathbf{i} - 4\mathbf{j} + \lambda\mathbf{k}$ are perpendicular to each other, then λ is equal to

(a) -3 (b) -2
(c) -1 (d) 0

118. If $\dfrac{d}{dx}(\phi(x)) = f(x)$, then $\int_1^2 f(x)\,dx$ is equal to

(a) $f(1) - f(2)$ (b) $\phi(1) - \phi(2)$
(c) $f(2) - f(1)$ (d) $\phi(2) - \phi(1)$

119. $\int_0^2 |1 - x|\,dx$ is equal to

(a) 0 (b) 1
(c) $\dfrac{3}{2}$ (d) $\dfrac{1}{2}$

120. $\displaystyle\int \frac{\sin 2x}{\sin^4 x + \cos^4 x}\,dx$ is equal to

(a) $2\tan^{-1}(\tan^2 x) + C$
(b) $\tan^{-1}(x\tan^2 x) + C$
(c) $\tan^{-1}(\tan^2 x) + C$
(d) None of the above

121. The function $\sin x + \cos x$ is maximum when x is equal to

(a) $\frac{\pi}{6}$ (b) $\frac{\pi}{4}$

(c) $\frac{\pi}{3}$ (d) $\frac{\pi}{2}$

122. $\frac{d}{dx}(x^x)$ is equal to

(a) $x^x \log(e/x)$ (b) $x^x \log ex$

(c) $\log ex$ (d) $x^x \log x$

123. $\lim_{x \to 0} \frac{\sin x}{x}$ is equal to

(a) 2 (b) −1

(c) 1 (d) 0

124. The set $A = \{x : x \in R, x^2 = 16 \text{ and } 2x = 6\}$ equals

(a) ϕ (b) $\{14, 3, 4\}$

(c) $\{3\}$ (d) $\{4\}$

125. In how many ways can 5 prizes be distributed among four students when every student can take one or more prizes?

(a) 1024 (b) 625

(c) 120 (d) 600

126. The value of $(\sqrt{5}+1)^5 - (\sqrt{5}-1)^5$ is

(a) 252 (b) 352

(c) 452 (d) 552

127. The value of

$7\log\left(\frac{16}{15}\right) + 5\log\left(\frac{25}{24}\right) + 3\log\left(\frac{81}{80}\right)$ is equal to

(a) log 2 (b) 3

(c) 5 (d) 7

128. The value of $\frac{2}{1!} + \frac{2+4}{2!} + \frac{2+4+6}{3!} + \ldots \infty$ is

(a) e (b) $2e$

(c) $3e$ (d) None of these

129. The sum of the series $\log_4 2 - \log_8 2 + \log_{16} 2 - \ldots$ is

(a) e^2 (b) $\log_e 2$

(c) $\log_e 3 - 2$ (d) $1 - \log_e 2$

130. If the domain of the function $f(x) = x^2 - 6x + 7$ is $(-\infty, \infty)$, then the range of function is

(a) $(-\infty, \infty)$ (b) $[-2, \infty)$

(c) $(-2, 3)$ (d) $(-\infty, -2)$

131. $\lim_{x \to 0} \frac{\cos(\sin x) - 1}{x^2}$ is equal to

(a) 1 (b) −1

(c) $\frac{1}{2}$ (d) $-\frac{1}{2}$

132. In order that the function $f(x) = (x+1)^{1/x}$ is continuous at $x = 0$, $f(0)$ must be defined as

(a) $f(0) = 0$ (b) $f(0) = e$

(c) $f(0) = \frac{1}{e}$ (d) $f(0) = 1$

133. The function $f(x) = |x|$ at $x = 0$ is

(a) continuous but non-differentiable

(b) discontinuous and differentiable

(c) discontinuous and non-differentiable

(d) continuous and differentiable

134. The point (0, 5) is closer to the curve $x^2 = 2y$ at

(a) $(2\sqrt{2}, 0)$ (b) (0, 0)

(c) (2, 2) (d) None of these

135. The function $f(x) = x^{1/x}$ is

(a) increasing in $(1, \infty)$

(b) decreasing in $(1, \infty)$

(c) increasing in $(1, e)$, decreasing in (e, ∞)

(d) decreasing in $(1, e)$, increasing in (e, ∞)

136. The area bounded by the x-axis and the curve $y = \sin x$ and $x = 0$, $x = \pi$ is

(a) 1 sq unit (b) 2 sq units

(c) 0 (d) 4 sq units

137. The order and degree of the differential equation $\sqrt{\frac{dy}{dx}} - 4\frac{dy}{dx} - 7x = 0$ are

(a) 1 and $\frac{1}{2}$ (b) 2 and 1

(c) 1 and 1 (d) 1 and 2

138. The line $x + y = 4$ divides the line joining the points (−1, 1) and (5, 7) in the ratio

(a) 2 : 1 (b) 1 : 2

(c) 1 : 2 externally (d) None of these

139. The angle between the pair of lines given by equation $x^2 + 2xy - y^2 = 0$, is

(a) $\frac{\pi}{3}$ (b) $\frac{\pi}{6}$

(c) $\frac{\pi}{2}$ (d) 0

140. The length of tangent from point (5, 1) to the circle $x^2 + y^2 + 6x - 4y - 3 = 0$ is

(a) 81 (b) 29
(c) 7 (d) 21

141. The length of the latusrectum of the parabola $169\{(x-1)^2 + (y-3)^2\} = (5x - 12y + 17)^2$ is

(a) $\frac{14}{13}$ (b) $\frac{12}{13}$
(c) $\frac{28}{13}$ (d) None of these

142. The angle of intersection between the curves $x^2 = 8y$ and $y^2 = 8x$ at (0, 0) is

(a) $\frac{\pi}{4}$ (b) $\frac{\pi}{3}$
(c) $\frac{\pi}{6}$ (d) $\frac{\pi}{2}$

143. If the centre, one of the foci and semi-major axis of an ellipse be (0, 0), (0, 3) and 5, then its equation is

(a) $\frac{x^2}{16} + \frac{y^2}{25} = 1$ (b) $\frac{x^2}{25} + \frac{y^2}{16} = 1$
(c) $\frac{x^2}{9} + \frac{y^2}{25} = 1$ (d) None of these

144. The radius of the director circle of the hyperbola $\frac{x^2}{a^2} - \frac{y^2}{b^2} = 1$ is

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

145. If projection of any line on coordinate axes 3, 4 and 5, then its length is

(a) 12 (b) 50
(c) $5\sqrt{2}$ (d) $3\sqrt{2}$

146. If $\tan\theta = \frac{1}{2}$ and $\tan\phi = \frac{1}{3}$, then the value of $\theta + \phi$ is

(a) $\frac{\pi}{6}$ (b) π
(c) 0 (d) $\frac{\pi}{4}$

147. If $\sin\theta = \frac{1}{2}$, $\tan\theta = \frac{1}{\sqrt{3}}$, $\forall\, n \in I$, then most general values of θ is

(a) $2n\pi + \frac{\pi}{6}, \forall\, n \in I$ (b) $2n\pi + \frac{\pi}{4}, \forall\, n \in I$
(c) $2n\pi + \frac{\pi}{3}, \forall\, n \in I$ (d) $2n\pi + \frac{\pi}{3}, \forall\, n \in I$

148. The principal value of $\sin^{-1}\left(-\frac{\sqrt{3}}{2}\right)$ is

(a) $-\frac{2\pi}{3}$ (b) $-\frac{\pi}{3}$
(c) $\frac{4\pi}{3}$ (d) $\frac{5\pi}{3}$

149. A ladder rests against a wall so that its top touches the roof of the house. If the ladder makes an angle of 60° with the horizontal and height of the house be $6\sqrt{3}$ m, then the length of the ladder is

(a) $12\sqrt{3}$ m (b) 12 m
(c) $\frac{12}{\sqrt{3}}$ m (d) None of these

150. If angles A, B and C are in AP, then $\frac{a+c}{b}$ is equal to

(a) $2\sin\left(\frac{A-C}{2}\right)$ (b) $2\cos\left(\frac{A-C}{2}\right)$
(c) $\cos\left(\frac{A-C}{2}\right)$ (d) $\sin\left(\frac{A-C}{2}\right)$

Answers

Physics

1. (a)	**2.** (c)	**3.** (c)	**4.** (a)	**5.** (c)	**6.** (a)	**7.** (a)	**8.** (b)	**9.** (b)	**10.** (d)
11. (a)	**12.** (a)	**13.** (a)	**14.** (d)	**15.** (d)	**16.** (b)	**17.** (a)	**18.** (c)	**19.** (a)	**20.** (c)
21. (a)	**22.** (a)	**23.** (d)	**24.** (d)	**25.** (a)	**26.** (b)	**27.** (b)	**28.** (a)	**29.** (d)	**30.** (d)
31. (d)	**32.** (c)	**33.** (a)	**34.** (c)	**35.** (a)	**36.** (b)	**37.** (a)	**38.** (a)	**39.** (a)	**40.** (c)

Chemistry

41. (b)	**42.** (c)	**43.** (b)	**44.** (c)	**45.** (b)	**46.** (c)	**47.** (c)	**48.** (c)	**49.** (b)	**50.** (d)
51. (b)	**52.** (b)	**53.** (c)	**54.** (d)	**55.** (b)	**56.** (b)	**57.** (a)	**58.** (b)	**59.** (a)	**60.** (d)
61. (c)	**62.** (a)	**63.** (b)	**64.** (a)	**65.** (c)	**66.** (d)	**67.** (a)	**68.** (c)	**69.** (c)	**70.** (a)
71. (c)	**72.** (c)	**73.** (c)	**74.** (b)	**75.** (a)	**76.** (b)	**77.** (a)	**78.** (d)	**79.** (a)	**80.** (b)

(a) English Proficiency

81. (b)	**82.** (d)	**83.** (a)	**84.** (d)	**85.** (d)	**86.** (a)	**87.** (b)	**88.** (c)	**89.** (c)	**90.** (b)
91. (c)	**92.** (b)	**93.** (b)	**94.** (c)	**95.** (c)					

(b) Logical Reasoning

96. (c)	**97.** (a)	**98.** (d)	**99.** (c)	**100.** (d)	**101.** (b)	**102.** (d)	**103.** (a)	**104.** (d)	**105.** (b)

Mathematics

106. (a)	**107.** (c)	**108.** (c)	**109.** (b)	**110.** (c)	**111.** (b)	**112.** (d)	**113.** (b)	**114.** (b)	**115.** (b)
116. (b)	**117.** (b)	**118.** (d)	**119.** (b)	**120.** (d)	**121.** (b)	**122.** (b)	**123.** (c)	**124.** (a)	**125.** (a)
126. (b)	**127.** (a)	**128.** (c)	**129.** (d)	**130.** (b)	**131.** (d)	**132.** (b)	**133.** (a)	**134.** (d)	**135.** (c)
136. (b)	**137.** (d)	**138.** (c)	**139.** (c)	**140.** (c)	**141.** (c)	**142.** (d)	**143.** (a)	**144.** (c)	**145.** (c)
146. (d)	**147.** (a)	**148.** (b)	**149.** (b)	**150.** (b)					

Hints & Solutions

Physics

1. The necessary centripetal force required for a planet to move round the sun

= gravitational force exerted on it

$$\frac{mv^2}{R} = \frac{GM_e m}{R^n}$$

or $$v = \left(\frac{GM}{R^{n-1}}\right)^{1/2}$$

as $$T = \frac{2\pi R}{v} = 2\pi R \times \left(\frac{R^{n-1}}{GM}\right)^{1/2}$$

$$T = 2\pi\left[\frac{R^{\frac{(n+1)}{2}}}{(GM_e)^{1/2}}\right]$$

$\therefore$ $$T \propto R^{(n+1)/2}$$

2. $$Y = \frac{FL}{A\Delta L}$$

or $$F = \frac{YA\Delta L}{L} = \frac{YA^2\Delta L}{AL}$$

$$= \frac{YA^2\Delta L}{V} = \frac{YA^2\Delta x}{V}$$

where $AL = V =$ Volume of wire, Young modulus in the same as both the wires are made of same material. It is given that both the wire have same volume and same extension in length

$\therefore$ $$\frac{F'}{F} = \frac{A'^2}{A^2} = \frac{(3A)^2}{A^2} = 9$$

$$F' = 9F$$

3. KE of a satellite

$$E = \frac{1}{2}mv^2$$

or $$mv = \sqrt{2Em}$$

Angular momentum

$$L = mvr = (\sqrt{2Em}) \times r$$

$$= \sqrt{2mEr^2}$$

4. Shunt is given by

$$S = \frac{I_g \times R_g}{I - I_g} = \frac{0.01 \times 100}{10 - 0.01}$$

$$= \frac{0.01 \times 100}{9.99} = 0.100\,\Omega$$

5. Given, $r = 25$ m, $v = 5$ m/s, $m = 500$ kg

$$a_t = 1\text{ m/s}^2,\ a_r = \frac{v^2}{r} = \frac{5 \times 5}{25} = 1\text{ m/s}^2$$

$$a_{net} = \sqrt{a_t^2 + a_r^2} = \sqrt{1^2 + 1^2} = \sqrt{2}\text{ m/s}^2$$

$$F = ma_{net} = 500\sqrt{2}\text{ N}$$

6. From conservation of energy the electron kinetic energy equals the maximum photon energy (we neglect the work function ϕ because it is normally so small compared to eV_0)

$$eV_0 = h\nu_{max}$$

$$eV_0 = \frac{hc}{\lambda_{min}}$$

$$V_0 = \frac{hc}{e\lambda_{min}}$$

$$V_0 = \frac{12400 \times 10^{-10}}{10^{-11}}$$

$$= 124\text{ kV}$$

Hence, accelerating voltage for electrons is X-ray machine should be less than 124 kV.

7. Given $l = 60$ cm $= 60 \times 10^{-2}$ m

$$m = 20\text{ kg},\quad k = 400\text{ N/m}$$

The weight hung from the spring

$$= mg = 20 \times 9.8 = 196\text{ N}$$

Suppose x is the extension produced in spring

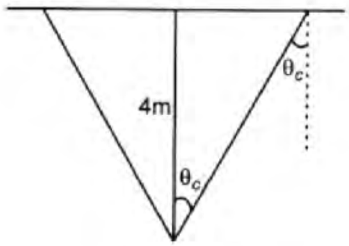
Now, force applied by the spring

= downward force on the spring

$$\therefore\quad kx = mg \Rightarrow x = \frac{mg}{k}$$

$$x = \frac{20 \times 9.8}{4000} = 0.049\text{ m} = 4.9\text{ cm}$$

8. $\sin\theta_c = \frac{1}{\mu} = \frac{3}{5}$



$$\frac{r}{4} = \tan\theta_c = \frac{3}{4}$$

Radius, r = radius = 3 m

Diameter, d = 6 m

9. $y = 2\sin\left(\frac{\pi t}{2} + \phi\right)$

Comparing the equation with the standard equation

$$y = A\sin(\omega t + \phi)$$

So $\quad A = 2$ cm, $\omega = \frac{\pi}{2}$

Acceleration of particle is

$$a = \omega^2 x \qquad \text{(numerically)}$$

at $x = +A$, $a = a_{max}$

$$\therefore \quad a_{max} = \omega^2 A$$

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

$$= 2 \times \frac{\pi^2}{4}$$

$$= \frac{\pi^2}{2} \text{ cm/s}^2$$

10. Apparent frequency heard will be

$$n' = n\left(\frac{v}{v - v_s}\right)$$

v = velocity of sound

v_s = velocity of source of sound

n = frequency

= 3 kHz

$$\therefore \quad n' = 3 \times \frac{v}{v - 0.5v}$$

$$= 3 \times \frac{v}{0.5v}$$

$$= 6 \text{ kHz}$$

11. Bernoulli's theorem is applicable only for tube flow of non-uniform cross-section.

12. From the formula

$$N = N_0\left(\frac{1}{2}\right)^n$$

$$\frac{N}{16} = N_0\left(\frac{1}{2}\right)^n$$

N_0 = original number of atom

$$\left(\frac{1}{2}\right)^4 = \left(\frac{1}{2}\right)^n$$

$\Rightarrow \quad n = 4$

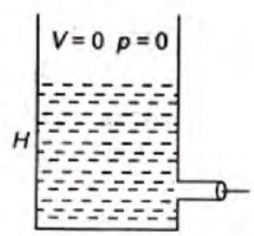
4 half lives

$$\therefore \quad 4T_{1/2} = 40$$

$$T_{1/2} = \frac{40}{4} = 10 \text{ days}$$

13. v = velocity of efflux through an orifice

$$= \sqrt{2g\,H}$$

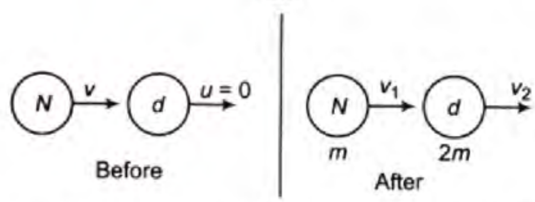


It is independent of the size of orifice.

14. Neutron velocity = v, mass = m

Deuteron contains 1 neutron and 1 proton

$= 2m$



In elastic collision, both momentum and KE are conserved

$$p_i = p_f$$

$$mv = m_1v_2 + m_2v_2$$

$$mv = mv_1 + 2mv_2$$

By kinetic energy

$$\frac{1}{2}mv^2 = \frac{1}{2}mv_1^2 + \frac{1}{2}(2m)v_2^2$$

By solving

$$v_1 = \frac{m_1 - m_2}{m_1 + m_2}v + \frac{2m_2}{(m_1 + m_2)}v$$

$$v_1 = \frac{m_1 - 2m}{3m}$$

$$v_1 = -\frac{v}{3}$$

$$K_i = \frac{1}{2}mv^2$$

$$K_f = \frac{1}{2}mv_1^2$$

$$\frac{K_i - K_f}{K_i} = 1 - \frac{v_1^2}{v^2}$$

$$= 1 - \frac{1}{9}$$

$$= \frac{8}{9} \text{ fractional change in KE}$$

15. Poisson's ratio = 0.5

Since, density is constant therefore change in volume is zero, we have

$$V = A \times l = \text{constant}$$

$$\log V = \log A + \log l$$

or

$$\frac{dA}{A} + \frac{dl}{l} = 0$$

$$\frac{dl}{l} = -\frac{dA}{A}$$

$\therefore$ Percentage increase in length = 4%

16. Lenz's law of electromagnetic induction compounds to the law of conservation of energy.

17. Rotational kinetic energy $= \frac{1}{2}I\omega^2$

According to question

$$\frac{1}{2}I\omega^2 = 1500$$

$$\frac{1}{2}I(\alpha t)^2 = 1500$$

$$(1.2) \times (25)^2 \times t^2 = 3000$$

$$1.2 \times 625 \times t^2 = 3000$$

$$t^2 = \frac{3000}{1.2 \times 625} = 4$$

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

18. For a solenoid

$$B = \mu_0 ni$$

$$\because \quad n = \frac{N}{2\pi r}$$

$$\therefore \quad B = \frac{\mu_0 NI}{2\pi r}$$

Flux linked with the solenoid

$$\phi = NBA$$

$$\phi = \frac{\mu_0 N^2 IA}{2\pi r}$$

$$= \frac{4\pi \times 10^{-7} \times (1200)^2 \times 12 \times 10^{-4}}{2\pi \times 15 \times 10^{-2}}$$

$$L = 2.3 \times 10^{-3}\ \text{H}$$

$$= 2.3\ \text{mH}$$

19.

$$\frac{1}{2}mv^2 = \frac{1}{2}kx^2$$

$$v = \sqrt{\frac{R}{m}}x$$

$$= \sqrt{\frac{50}{20 \times 10^{-3}}}(10 \times 10^{-2})$$

$$= 50 \times 10^{-1}$$

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

20. Work done, $W = p\Delta V$

$$= 1.013 \times 10^5 \times (1671 - 1) \times 10^{-6}$$

$$= 1.013 \times 10^5 \times 1670 \times 10^{-6}$$

$$= 169.2\ \text{J}$$

21. Volume, $V = l^3 = (1.2 \times 10^{-2}\text{m})^3$

$$= 1.728 \times 10^{-6}\text{m}^3$$

Since length (l) has two significant figure, the volume (V) will also have two significant figure.

Therefore, the correct answer is

$$V = 1.7 \times 10^{-6}\text{m}^3$$

22. $t = \sqrt{\frac{2h}{g}}$ and $t' = \sqrt{\frac{2(2h)}{g}}$

$$\therefore \quad \frac{t}{t'} = \frac{1}{\sqrt{2}}$$

23. Given, $P = a + bt^2$

$$\frac{dP}{dt} = 2bt$$

$$\because \quad F = \frac{dP}{dt}$$

$$\therefore \quad F = 2bt$$

or $\quad F \propto t$

24. A ball bearing striking another ball bearing is not an example of perfectly inelastic collision.

25. By Kepler's third law, $T^2 \propto R^3$

$$\therefore \left(\frac{T_2}{365 \text{ days}}\right)^2 = \left(\frac{2r}{r}\right)^3$$

$$T_2 = 365 \times 2\sqrt{2} = 1032 \text{ days}$$

26. Weight, $w = mg = m\frac{4}{3}\pi GR\rho$

$$\therefore \quad \frac{w'}{w} = \frac{R'\rho'}{R\rho} = \left(\frac{1}{2}\right) \times 4 = 2$$

$$w' = 2w$$

27. Force on electron

$$|F| = qE = eE = mg$$

$$E = \frac{mg}{e}$$

28. Work done, $W = \frac{q^2}{2C}$

$$= \frac{(8 \times 10^{-18})^2}{2 \times 100 \times 10^{-6}}$$

$$= 32 \times 10^{-32} \text{ J}$$

29. In a metallic conductor of non-uniform cross section, only the current remains constant along the entire length of the conductor.

30. Here, $I_g = 25 \times 4 \times 10^{-4} \text{A} = 10^{-2}$ A

To convert the galvanometer into a voltmeter we must join a series resistance of

$$R = \frac{V}{I_g} - G$$

$$= \frac{25}{10^{-2}} - 50 = 2500 - 50$$

$$= 2450\,\Omega$$

31. Cyclotron of frequency, $\nu = \frac{Bq}{2\pi m}$

$$= \frac{1 \times 1.6 \times 10^{-19}}{2\pi \times 9.1 \times 10^{-31}}$$

$$= 2.8 \times 10^{10} \text{ Hz}$$

$$= 28 \text{ GHz}$$

32. Torque, $\tau = \mathbf{M} \times \mathbf{B}$

33. Energy is stored in an inductor in the form of magnetic potential energy.

34. In a photoelectric cell, optical energy is being transformed into electrical energy because light photons are being absorbed and photoelectric current is being produced.

35. Ionisation energy $E = eV$

$$= 1.6 \times 10^{-19} \times 24.6 \text{ J}$$

$$= 24.6 \text{ eV}$$

36. Fast neutrons can easily be slowed down by passing them through water. Slowing down process is due to collision between neutron and hydrogen nucleus present in water.

37. As linear magnification $m = 4$,

hence, a real magnification $m_a = m^2$

$$= (4)^2 = 16$$

$\therefore$ Surface area of film image on the screen

$$= 16 \times 100 = 1600 \text{ cm}^2$$

38. Under identical pressure and temperature condition, speed of sound in moist air is more than that in dry air, *i.e.*, $v_m > v_d$

39. Heat flow through vacuum is possible in radiation mode due to which temperature of hot body falls.

40. Given, $T_2 = -13°\text{C} = 260$ K and $\beta = 5$

$$\beta = \frac{T_2}{T_1 - T_2}$$

$$5 = \frac{260}{T_1 - 260}$$

$$T_1 = 312 \text{ K}$$

or $\quad T_1 = 312 \text{ K} = 39°\text{C}$

Chemistry

41. $40\text{g NaOH} = \frac{40}{40} = 1\text{ mol NaOH}$

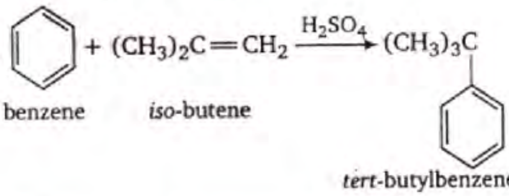
$60\text{g } CH_3COOH = \frac{60}{60} = 1\text{ mol } CH_3COOH$

Since acetic acid is a weak acid, some of the heat is utilised to ionise it. So, enthalpy of neutralisation of 1 mol of NaOH by 1 mol CH_3COOH is less than 57.1 kJ.

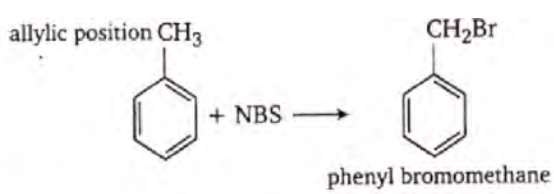
Enthalpy of neutralisation of a strong acid by a strong base is always 57.1 kJ.

42. Ionic size varies inversely with nuclear charge. Higher the nuclear charge, smaller the radii. Thus, P^{5+} because of the high nuclear charge, has the smallest size.

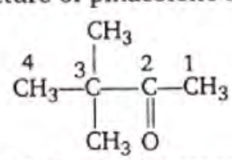
43.



44. NBS (N-bromosuccinimide) causes bromination at allylic position.

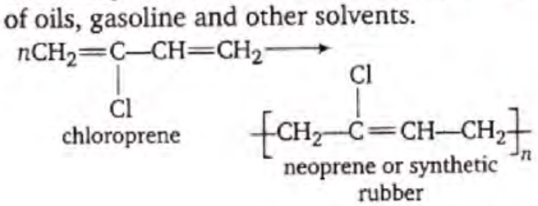


45. The structure of pinacolone is



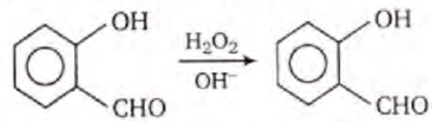
3,3-dimethyl-2-butanone

46. Neoprene is synthetic rubber. It is a polymer of chloroprene and is resistant to the action of oils, gasoline and other solvents.



47. HOCl and Cl_2 are formed over Antarctica. These are converted back into reactive Cl atoms which start the chain reaction with O_3 causing its depletion.

48. The reduction of —CHO group to —OH by H_2O_2/OH^- is called Dakin reaction.



Thus, the above reaction is Dakin reaction.

49. Conjugated base of a stronger acid is weak. The corresponding acids of the given conjugated bases are as (in order of acidity)

$$C_2H_5OH < CH_3COOH < HF < HNO_3$$

$\therefore$ The order of basicity is

$$C_2H_5O^- > CH_3COO^- > F^- > NO_3^-$$

Thus, NO_3^- is the weakest base among the given.

50. $\Delta T_b = ik_b \cdot m = 2 \times 0.52 \times 0.1 = 0.104°C$

$$T_b = 100 + 0.104°C = 100.104°C$$

51. $\underset{1\text{ mol}}{P_2O_5} + 6H_2O \longrightarrow \underset{4\text{ mol}}{4H_3PO_4}$

$\therefore$ 1 L solution contains 4 mol H_3PO_4.

$\therefore$ Molarity of $H_3PO_4 = 4$ M

Normality = Molarity × Basicity

$= 4 \times 3\text{ N} = 12\text{ N}$

52. $$\frac{p_1V_1}{T_1} = \frac{p_2V_2}{T_2}$$

$$\Rightarrow \frac{10^{-6} \times 1000}{298} = \frac{760 \times V_2}{273}$$

$$V_2 = 1.2 \times 10^{-6}\text{cc (at STP)}$$

$$\text{No. of molecules} = \frac{6.02 \times 10^{23}}{22400} \times 1.2 \times 10^{-6}$$
$$= 3.2 \times 10^{13}$$

53. $\lambda = h/mv$

For same velocity $\lambda \propto 1/m$

Electron has the least mass, so its wavelength is maximum.

54. Radioactivity does not depend upon the state of combination so it remains unaffected.

55. In $SO_4^{2-} \Rightarrow bp = 4; lp = 0 \therefore$ hybridisation sp^3

In $SF_4 \Rightarrow bp = 4; lp = 1 \therefore$ hybridisation sp^3d

In $SF_2 \Rightarrow bp = 2; lp = 2 \therefore$ hybridisation sp^3

In $S_8 \Rightarrow bp = 2; lp = 2 \therefore$ hybridisation sp^3

Thus, only SF_4 does not have sp^3 hybridisation.

56. $N_2(g) + 3H_2(g) \rightleftharpoons 2NH_3(g)$

$$K = \frac{[NH_3]^2}{[N_2][H_2]^3} = \frac{\left[\frac{mol}{L}\right]^2}{\left[\frac{mol}{L}\right]\left[\frac{mol}{L}\right]^3}$$

$$= \left[\frac{mol}{L}\right]^{-2} = L^2 mol^{-2}$$

57. pH = 3

$$[H^+] = 1 \times 10^{-3} \text{ mol/L}$$

$$H_2SO_4 \longrightarrow 2H^+ + SO_4^{2-}$$

$$[H_2SO_4] = \frac{1 \times 10^{-3}}{2} = \frac{1}{2000} \text{ M}$$

$$N = 2\text{ M} \qquad (\text{for } H_2SO_4)$$

$$\text{Normality} = \frac{2}{2000} = \frac{1}{1000} \text{ N}$$

58. $NOClO_4$ is actually $NO^+ClO_4^-$.

Let the oxidation state of N in NO^+ is x.

NO^+ $\quad x + (-2) = +1$

$\quad x = +1 + 2 = +3$

Let the oxidation state of Cl in ClO_4^- is y.

ClO_4^- $\quad y + (-2) \times 4 = -1$

$\quad y - 8 = -1 ; y = +7$

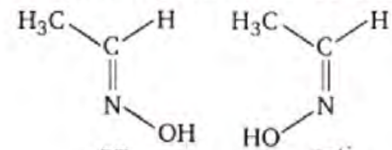
59. Pyrolusite is MnO_2. Thus, it is an oxide ore.

60. $K_4[Fe(CN)_6] + 6H_2SO_4 + 6H_2O \longrightarrow 2K_2SO_4 + FeSO_4 + 3(NH_4)_2SO_4 + 6CO$

61. When sodium carbonate is treated with CO_2 and H_2O, it gets converted into sodium bicarbonate.

$$Na_2CO_3 + CO_2 + H_2O \longrightarrow \underset{\text{sodium bicarbonate or sodium hydrogen carbonate}}{2NaHCO_3}$$

62. Among the given only $CH_3CH{=}NOH$ (oxime) satisfy the conditions essential for exhibiting geometrical isomerism. So, it will exhibit *syn-anti* geometrical isomerism.



syn $\qquad$ *anti*

63. Octane number is defined as the percentage of *iso*-octane (by volume) in a mixture of *iso*-octane and *n*-heptane which has the same anti-knocking properties as the fuel under consideration.

Thus, the octane number of the given fuel is 70 as it contains 70% *iso*-octane.

64. When SO_2 is passed in the sodium carbonate solution, CO_2 gas is evolved and sodium carbonate is converted into $NaHSO_3$ (sodium bisulphite).

$$Na_2CO_3 + 2SO_2 + H_2O \rightarrow 2NaHSO_3 + CO_2$$

65. $t_{1/2} \propto \dfrac{1}{(a)^{n-1}}$

Given, $\quad t_{1/2} \propto \dfrac{1}{a}$

On comparing, $\quad a^{n-1} = a^1$

$\quad n - 1 = 1$

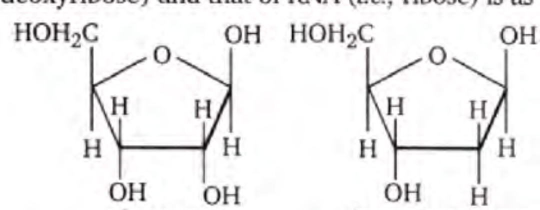
$\quad n = 1 + 1 = 2$

66. In $HC{\equiv}C{-}CH_2OH$ two active hydrogen atoms are present, hence it will react with two moles of CH_3MgBr (Grignard reagent).

$$HC{\equiv}C{-}CH_2OH + 2CH_3MgBr \longrightarrow 2CH_4 + BrMgC{\equiv}CCH_2OMgBr$$

67. Haemoglobin molecule contains four polypeptide chains.

68. The structure of sugar of DNA (*i.e.*, deoxyribose) and that of RNA (*i.e.*, ribose) is as



ribose sugar $\qquad$ deoxyribose sugar

Thus, it is clear that these have furanose structure.

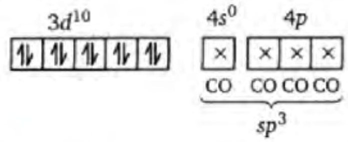
69. Tetrazine is an artificial edible colour.

70. In nickel carbonyl, $Ni(CO)_4$, Ni is present as Ni.

$Ni = [Ar]\ 3d^8 4s^2$

CO being strong field ligand, shifts electrons from $4s$ to $3d$ orbital.

$Ni(CO)_4$ = [Ar]



Therefore, number of unpaired electrons in nickel carbonyl is 0.

71. For a first order reaction,

$$k = \frac{2.303}{t} \log \frac{a}{a-x}$$

$$t = \frac{2.303 \times t_{1/2}}{0.693} \log \frac{100}{(100-90)}$$

$$\left[\because k = \frac{t_{1/2}}{0.693}\right]$$

$$= \frac{2.303 \times t_{1/2}}{0.693} \log 10$$

$$= 3.3\, t_{1/2}$$

= 3.3 times that of half-life

72. Given, $pK_a = 4$

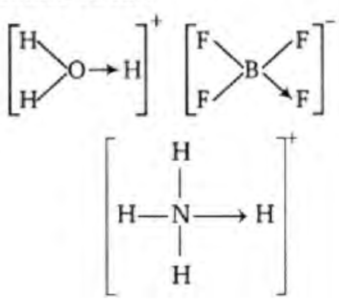
$$\therefore \quad K_a = 1 \times 10^{-4}$$

$$[H^+] = \sqrt{K_a \cdot C} = \sqrt{1 \times 10^{-4} \times 0.01}$$

$$= \sqrt{10^{-6}} = 10^{-3} M$$

$$pH = -\log[H^+] = -\log 10^{-3} = 3$$

73. Among the given, only HF_2^- has H-bonding $[F—H..F]^-$. Rest all the molecules have coordinate bonds.



74. Anti-bonding molecular orbital is raised more in energy than the energy by which bonding molecular orbital is lowered.

75.

$$E° = \frac{0.059}{n} \log K_c$$

$$0.46 = \frac{0.059}{2} \log K_c$$

$$\log K_c = \frac{0.46 \times 2}{0.059} = 15.6$$

$$K_c = \text{antilog } 15.6$$

76.

Reduction

$$Fe + Cu^{2+} \longrightarrow Fe^{2+} + Cu$$

Oxidation

$$E^\circ_{cell} = E^\circ_{Fe/Fe^{2+}} + E^\circ_{Cu^{2+}/Cu} = 0.44 + 0.32$$

$$= 0.76 \text{ V}$$

77. $\overset{\text{III}}{\underset{sp^3}{CH_3}}—\overset{\text{II}}{\underset{sp^3}{CH_2}}—\underset{sp}{C}\equiv\overset{\text{I}}{\underset{sp}{CH}}$

Electronegativity $\propto$ s-character.

In sp hybrid orbitals, s character = 50%

and in sp^3 hybrid orbitals, s character = 33.3%

Thus, I is the most electronegative.

78. Dehydrohalogenation of alkyl halide gives alkenes but not alkane.

$$R—CH_2—CH_2X \xrightarrow[-HX]{\text{Alco. KOH}} RCH{=}CH_2$$

79. $CH_2{=}C{=}CH—CH_3 + H^+ \longrightarrow$

$$[CH_2{=}\overset{+}{C}—CH_2CH_3 + CH_2{=}CH—\overset{+}{C}HCH_3]$$

$$\xrightarrow{Cl^-} \underset{\text{2-chlorobutene}}{CH_2{=}C(Cl)CH_2CH_3} + \underset{\text{3-chlorobutene}}{CH_2{=}CH—CH(Cl)CH_3}$$

80. When formaldehyde reacts with ammonia, a well known urinary antiseptic urotropine (also called hexamethylene tetramine) is obtained.

$$6HCHO + 4NH_3 \rightarrow (CH_2)_6N_4 + 4H_2O$$

structure of urotropine

(b) Logical Reasoning

96. The pattern of the series is

$$\begin{array}{ccccc} & & & \boxed{26} & \\ 5 & 10 & 17 & 24 & 37 \\ \uparrow & \uparrow & \uparrow & \uparrow & \uparrow \\ 2^2+1 & 3^2+1 & 4^2+1 & 5^2+1 & 6^2+1 \end{array}$$

Hence, 24 is the wrong number.

97. The pattern of the series is

$$E \xrightarrow{+1} F \xrightarrow{+2} H \xrightarrow{+3} K \xrightarrow{+4} O \xrightarrow{+5} T \xrightarrow{+6} Z$$

98. As,

$$\begin{array}{lll} M \xrightarrow{+1} N & \quad \text{Similarly,} & T \xrightarrow{+1} U \\ O \xrightarrow{-1} N & & A \xrightarrow{-1} Z \\ N \xrightarrow{+1} O & & R \xrightarrow{+1} S \\ K \xrightarrow{-1} J & & G \xrightarrow{-1} F \\ E \xrightarrow{+1} F & & E \xrightarrow{+1} F \\ Y \xrightarrow{-1} X & & T \xrightarrow{-1} S \end{array}$$

99. $L > S > (P, Q) > N > M$

Hence, L is the tallest among six friends.

100. Number of boys towards the left of Manick

$$= (40 - 14) = 26$$

So, Manick is 27th from the left end.

101. The sum of the two numbers in the upper part is seven times the number in the lower part.

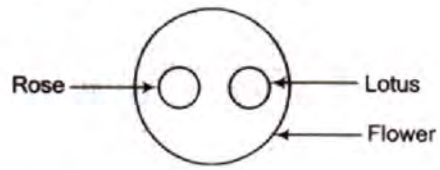
$$(25 + 17) \div 7 = 6$$
$$(38 + 18) \div 7 = 8$$

So, missing term $= (89 + 16) \div 7$

$$= 105 \div 7$$
$$= 15$$

102. Clearly, the given letters, when arranged in the order of '6, 3, 5, 2, 4, 1' form the word 'BRANCH'.

103. Rose and Lotus are different type of flowers. Hence, the diagram will be



104. Answer figure (d) will appear when a piece of paper is folded and cut.

105. Answer figure (b) will complete the question figure.

Mathematics

106. Given, $x^2 + y^2 = a^2$

On differentiating w.r.t. x, we get

$$2x + 2y\frac{dy}{dx} = 0$$

$$\Rightarrow \quad \frac{dy}{dx} = -\frac{x}{y}$$

$$\Rightarrow \quad \left(\frac{dy}{dx}\right)_{(x', y')} = -\frac{x'}{y'}$$

$\therefore$ Equation of normal is

$$y - y' = \frac{y'}{x'}(x - x')$$

$$\Rightarrow \quad x'y - y'x' = xy' - y'x'$$

$$\Rightarrow \quad x'y - xy' = 0$$

107. Given equations are

$$3x + 4y + 5 = 0$$

and $\quad 12x - 5y - 7 = 0$

$$\therefore \quad a_1a_2 + b_1b_2 = 3 \times 12 + 4 \times (-5)$$
$$= 16 > 0$$

$\therefore$ For acute angle bisector

$$\frac{a_1x + b_1y + c_1}{\sqrt{a_1^2 + b_1^2}} = -\frac{(a_2x + b_2y + c_2)}{\sqrt{a_2^2 + b_2^2}}$$

$$\therefore \quad \frac{3x + 4y + 5}{\sqrt{9 + 16}} = -\frac{(12x - 5y - 7)}{\sqrt{12^2 + (-5)^2}}$$

$$\Rightarrow \quad \frac{3x + 4y + 5}{5} = -\frac{(12x - 5y - 7)}{13}$$

$$\Rightarrow 39x + 52y + 65 = -60x + 25y + 35$$

$$\Rightarrow \quad 99x + 27y + 30 = 0$$

108. Given, $z = \cos\theta + i\sin\theta$

$$\therefore z^n + \frac{1}{z^n} = (\cos\theta + i\sin\theta)^n + (\cos\theta + i\sin\theta)^{-n}$$

$$= \cos n\theta + i\sin n\theta + \cos n\theta - i\sin n\theta$$

$$= 2\cos n\theta$$

109. Since, α and β are the roots of $x^2 - 2x + 4 = 0$

$$\therefore \quad \alpha + \beta = 2 \text{ and } \alpha\beta = 4$$

Now, $$(\alpha - \beta) = \sqrt{(\alpha+\beta)^2 - 4\alpha\beta} = \sqrt{4 - 16} = 2\sqrt{3}\,i$$

On solving, we get

$$2\alpha = 2 + 2\sqrt{3}\,i$$

$$\Rightarrow \quad \alpha = 2\left(\frac{1}{2} + \frac{\sqrt{3}}{2}i\right) = 2\left(\cos\frac{\pi}{3} + i\sin\frac{\pi}{3}\right)$$

and $$\beta = \frac{2 - 2\sqrt{3}\,i}{2} = 2\left(\cos\frac{\pi}{3} - i\sin\frac{\pi}{3}\right)$$

$$\therefore \quad \alpha^n + \beta^n = \left[2\left(\cos\frac{\pi}{3} + i\sin\frac{\pi}{3}\right)\right]^n + \left[2\left(\cos\frac{\pi}{3} - i\sin\frac{\pi}{3}\right)\right]^n$$

$$= 2^n\left[2\cos\frac{n\pi}{3}\right] = 2^{n+1}\cos\frac{n\pi}{3}$$

110. Now, $$A^2 = \begin{bmatrix} 3 & 1 \\ -1 & 2 \end{bmatrix}\begin{bmatrix} 3 & 1 \\ -1 & 2 \end{bmatrix} = \begin{bmatrix} 8 & 5 \\ -5 & 3 \end{bmatrix}$$

$$\therefore A^2 - 5A + 7I = \begin{bmatrix} 8 & 5 \\ -5 & 3 \end{bmatrix} - \begin{bmatrix} 15 & 5 \\ -5 & 10 \end{bmatrix} + \begin{bmatrix} 7 & 0 \\ 0 & 7 \end{bmatrix} = \begin{bmatrix} 0 & 0 \\ 0 & 0 \end{bmatrix}$$

Hence, option (c) is the correct answer.

111. Applying $R_1 \to R_1 + R_2 + R_3$ and taking common from R_1, we get

$$\Delta = (a+b+c)\begin{vmatrix} 1 & 1 & 1 \\ 2b & b-c-a & 2b \\ 2c & 2c & c-a-b \end{vmatrix}$$

Applying $C_2 \to C_2 - C_1$ and $C_3 \to C_3 - C_1$

$$\Delta = (a+b+c)\begin{vmatrix} 1 & 0 & 0 \\ 2b & -(a+b+c) & 0 \\ 2c & 0 & -(a+ \end{vmatrix}$$

$$= (a+b+c)^3$$

112. Given,

$$(1+x)^n = C_0 + C_1x + C_2x^2 + \ldots + C_nx^n$$

Put $x = -1$, we get

$$C_0 - C_1 + C_2 - \ldots + (-1)^n \cdot C_n = 0$$

113. Let a and b be two numbers, then

$$\text{AM} = \frac{a+b}{2}$$

$$\Rightarrow \quad 27 = \frac{a+b}{2}$$

$$\Rightarrow \quad a + b = 54$$

and $$\text{HM} = \frac{2ab}{a+b}$$

$$\Rightarrow \quad 12 = \frac{2ab}{54}$$

$$\Rightarrow \quad ab = 324$$

$$\therefore \quad \text{GM} = \sqrt{ab} = \sqrt{324} = 18$$

114. Given, $P(A \cup B) = \frac{5}{6}$, $P(A \cap B) = \frac{1}{3}$, $P(B) = \frac{1}{2}$,

$$\because \quad P(A \cup B) = P(A) + P(B) - P(A \cap B)$$

$$\therefore \quad P(A) = \frac{5}{6} - \frac{1}{2} + \frac{1}{3} = \frac{5 - 3 + 2}{6} = \frac{4}{6} = \frac{2}{3}$$

115. $\therefore$ Required probability $= \frac{{}^3C_1}{{}^8C_1} = \frac{3}{8}$

116. Since, scalar triple product is zero, then **a**, **b** and **c** are coplanar.

117. Since, given vectors are perpendicular.

$$\therefore (2\mathbf{i} + \mathbf{j} - \mathbf{k}) \cdot (\mathbf{i} - 4\mathbf{j} + \lambda\mathbf{k}) = 0$$

$$\Rightarrow \quad 2-4-\lambda=0$$
$$\Rightarrow \quad \lambda=-2$$

118. $\int_1^2 f(x)dx=\int_1^2 \frac{d}{dx}(\phi(x))dx$

$$=[\phi(x)]_1^2=\phi(2)-\phi(1)$$

119. $\int_0^2 |1-x|\,dx=\int_0^1 (1-x)\,dx+\int_1^2 (x-1)\,dx$

$$=\left[x-\frac{x^2}{2}\right]_0^1+\left[\frac{x^2}{2}-x\right]_1^2$$
$$=1-\frac{1}{2}+\left[2-2-\left(\frac{1}{2}-1\right)\right]$$
$$=\frac{1}{2}+\frac{1}{2}=1$$

120. Let $I=\int \frac{\sin 2x}{\sin^4 x+\cos^4 x}dx$

$$=\int \frac{\sin 2x}{(\sin^2 x+\cos^2 x)^2-2\sin^2 x\cos^2 x}dx$$
$$=\int \frac{\sin 2x}{1-\frac{1}{2}(\sin 2x)^2}dx$$
$$=\int \frac{\sin 2x}{1-\frac{1}{2}(1-\cos^2 2x)}dx$$
$$=\int \frac{\sin 2x}{\frac{1}{2}(1+\cos^2 2x)}dx$$

Put $\cos 2x=t \Rightarrow -2\sin 2x\,dx=dt$

$$\therefore \quad I=-\int \frac{dt}{1+t^2}=-\tan^{-1}t+C$$
$$=-\tan^{-1}(\cos 2x)+C$$

121. Let $y=\sin x+\cos x$

$$=\sqrt{2}\left(\sin\left(\frac{\pi}{4}+x\right)\right)$$

Here, y will be maximum when

$$x=\frac{\pi}{4}$$

122. Let $y=x^x$

$$\Rightarrow \quad \log y=x\log x$$

On differentiating w.r.t. x, we get

$$\frac{1}{y}\frac{dy}{dx}=\frac{x}{x}+\log x$$
$$\Rightarrow \quad \frac{dy}{dx}=y(1+\log x)$$
$$\Rightarrow \quad =x^x(\log e+\log x)$$
$$=x^x(\log ex)$$

123. $\lim_{x\to 0}\frac{\sin x}{x}=\lim_{x\to 0}\frac{\cos x}{1}$

$$=\cos 0=1$$

124. Since, $x^2=16 \Rightarrow x=\pm 4$

and $\quad 2x=6 \Rightarrow x=3$

Hence, no value of x is satisfied.

$$\therefore \quad A=\phi$$

125. Required number of ways

$$=4^5=2^{10}=1024$$

126. Since, $(\sqrt{5}+1)^5-(\sqrt{5}-1)^5$

$$=2\{{}^5C_1(\sqrt{5})^4+{}^5C_3(\sqrt{5})^2+{}^5C_5\cdot 1\}$$
$$=2\{5\times 25+50+1\}$$
$$=2(176)=352$$

127. $\therefore 7\log\left(\frac{16}{15}\right)+5\log\left(\frac{25}{24}\right)+3\log\left(\frac{81}{80}\right)$

$$=\log\left[\left(\frac{16}{15}\right)^7\cdot\left(\frac{25}{24}\right)^5\cdot\left(\frac{81}{80}\right)^3\right]$$
$$=\log 2$$

128. Here, $T_n=\frac{n(n+1)}{n!}=\frac{n-1+2}{(n-1)!}$

$$=\frac{1}{(n-2)!}+\frac{2}{(n-1)!}$$
$$\therefore \quad S=\sum_{n=1}^{\infty}T_n=\sum_{n=1}^{\infty}\frac{1}{(n-2)!}+2\sum_{n=1}^{\infty}\frac{1}{(n-1)!}$$
$$=e+2e=3e$$

129. $\log_4 2-\log_8 2+\log_{16} 2-\ldots$

$$=\left(\frac{1}{2}-\frac{1}{3}+\frac{1}{4}-\ldots\right)-1+1$$
$$=-\left(1-\frac{1}{2}+\frac{1}{3}-\frac{1}{4}+\ldots\right)+1$$
$$=1-\log(1+1)=1-\log_e 2$$

130. Now, $x^2 - 6x + 7 = (x-3)^2 - 2$

It is obvious that minimum value is -2 and maximum value is ∞.

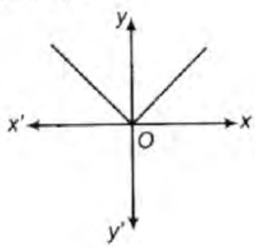
131. $\lim\limits_{x \to 0} \dfrac{\cos(\sin x) - 1}{x^2} = \lim\limits_{x \to 0} \dfrac{-2\sin^2\left(\dfrac{\sin x}{2}\right)}{x^2}$

$$= -2 \lim_{x \to 0} \frac{\sin^2\left(\dfrac{\sin x}{2}\right) \cdot \left(\dfrac{\sin x}{2}\right)^2}{\left(\dfrac{\sin x}{2}\right)^2 \times x^2}$$

$$= -2(1)^2 \frac{1}{4} = -\frac{1}{2}$$

132. $\lim\limits_{x \to 0} f(x) = f(0) = \lim\limits_{x \to 0} (1+x)^{1/x} = e$

133. Given, $f(x) = |x|$



It is clear from the graph, $f(x)$ is continuous but non-differentiable at $x = 0$.

134. Let any point on the curve be (h, k).

Then, $h^2 = 2k$

$\therefore$ Distance $D = \sqrt{h^2 + (k-5)^2}$

$\Rightarrow \quad D = \sqrt{2k + (k-5)^2}$

$\Rightarrow \dfrac{dD}{dk} = \dfrac{1}{2\sqrt{2k + (k-5)^2}} \times \{2 + 2(k-5)\} = 0$ (say)

$\therefore \quad k = 4$

Then, point will be $(\pm 2\sqrt{2}, 4)$.

135. Let $y = x^{\frac{1}{x}} \Rightarrow \log y = \dfrac{1}{x} \log x$

$\Rightarrow \quad \dfrac{1}{y}\dfrac{dy}{dx} = \dfrac{1}{x^2} - \dfrac{\log_e x}{x^2}$

$\Rightarrow \quad \dfrac{dy}{dx} = x^{1/x}\left(\dfrac{1 - \log_e x}{x^2}\right)$

For $\quad 1 < x < \infty, x^{1/x} > 0$

and $\quad \dfrac{1 - \log_e x}{x^2} > 0$ in $(1, e)$

and $\quad \dfrac{1 - \log_e x}{x^2} < 0$ in (e, ∞)

Hence, $f(x)$ is increasing in $(1, e)$ and decreasing in (e, ∞).

136. $\therefore$ Required area $= \int_0^\pi \sin x \, dx$

$$= [-\cos x]_0^\pi$$
$$= [+1 + 1]$$
$$= 2 \text{ sq units}$$

137. Given, $\sqrt{\dfrac{dy}{dx}} - 4\dfrac{dy}{dx} - 7x = 0$

On squaring, we get

$$\frac{dy}{dx} = 16\left(\frac{dy}{dx}\right)^2 + 49x^2 + 56x\frac{dy}{dx}$$

Here, order is 1 and degree is 2.

138. $\therefore$ Required ratio $= -\dfrac{(-1+1-4)}{(5+7-4)} = \dfrac{1}{2}$

139. Here, $a + b = 1 - 1 = 0$

Hence, pair of lines are perpendicular.

140. Length of tangent $= \sqrt{S_1}$

$$= \sqrt{5^2 + 1^2 + 30 - 4 - 3}$$
$$= \sqrt{49} = 7$$

141. Given equation can be rewritten as

$$(x-1)^2 + (y-3)^2 = \left(\frac{5x - 12y + 17}{13}\right)^2$$

$\Rightarrow \quad SP = PM$

Here, focus is $(1, 3)$, directrix

$$5x - 12y + 17 = 0$$

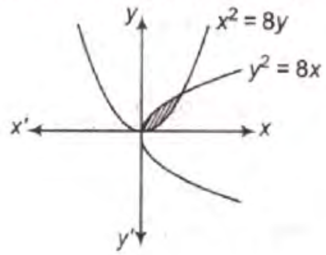
$\therefore$ The distance of the focus from the directrix

$$= \left|\frac{5 - 36 + 17}{\sqrt{25 + 144}}\right|$$

$$= \frac{14}{13} = 2a$$

$\therefore$ Latusrectum $= 2 \times \dfrac{14}{13} = \dfrac{28}{13}$

142. It is clear that angle between the curves



= angle between the x-axis and y-axis is $\frac{\pi}{2}$.

143. Given centre (0, 0), focus (0, 3), $b = 5$

$\Rightarrow be = 3 \Rightarrow e = \frac{3}{5}$

$$\therefore \quad a = b\sqrt{1-e^2} = 5\sqrt{1-\frac{9}{25}} = 4$$

Hence, required equation is

$$\frac{x^2}{16} + \frac{y^2}{25} = 1$$

144. The equation of director circle to the hyperbola is $x^2 + y^2 = a^2 - b^2$

$$\therefore \quad \text{Radius} = \sqrt{a^2 - b^2}$$

145. Let d be the length of line, then projection on x-axis $= dl = 3$, projection of y-axis $= dm = 4$ and projection on z-axis $= dn = 5$

Now, $\quad d^2(l^2 + m^2 + n^2) = 50$

$\Rightarrow \quad d^2 = 50 \Rightarrow d = 5\sqrt{2}$

146. $\therefore \tan(\theta + \phi) = \dfrac{\tan\theta + \tan\phi}{1 - \tan\theta \cdot \tan\phi}$

$$= \left(\frac{1}{2} + \frac{1}{3}\right) \Big/ \left(1 - \frac{1}{2} \cdot \frac{1}{3}\right) = 1$$

$\Rightarrow \quad \theta + \phi = \frac{\pi}{4}$

147. $\because \sin\theta = \frac{1}{2} = \sin\frac{\pi}{6}$

$\Rightarrow \quad \theta = \frac{\pi}{6}, \pi - \frac{\pi}{6}$

and $\quad \tan\theta = \frac{1}{\sqrt{3}} = \tan\left(\frac{\pi}{6}\right)$

$\Rightarrow \quad \theta = \frac{\pi}{6}, \pi + \frac{\pi}{6}$

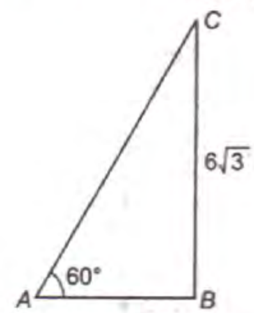
$\therefore$ Common value of θ is $\frac{\pi}{6}$.

$\therefore$ General value of θ is

$$2n\pi + \frac{\pi}{6}, \forall n \in I$$

148. $\therefore \sin^{-1}\left(-\frac{\sqrt{3}}{2}\right) = \sin^{-1}\left(\sin\left(-\frac{\pi}{3}\right)\right) = -\frac{\pi}{3}$

149. $\therefore$ Length of ladder, $AC = \dfrac{6\sqrt{3}}{\sin 60^\circ} = 12$ m



150. Since. $A + B + C = \pi$

But $\quad 2B = A + C$

$\therefore \quad 3B = \pi \Rightarrow B = \pi/3$

$$\frac{a+c}{b} = \frac{\sin A + \sin C}{\sin B}$$

$$= \frac{2\sin\left(\frac{A+C}{2}\right)\cos\left(\frac{(A-C)}{2}\right)}{\sin\frac{\pi}{3}}$$

$$= \frac{2\sin\frac{\pi}{3}\cos\left(\frac{A-C}{2}\right)}{\sin\frac{\pi}{3}}$$

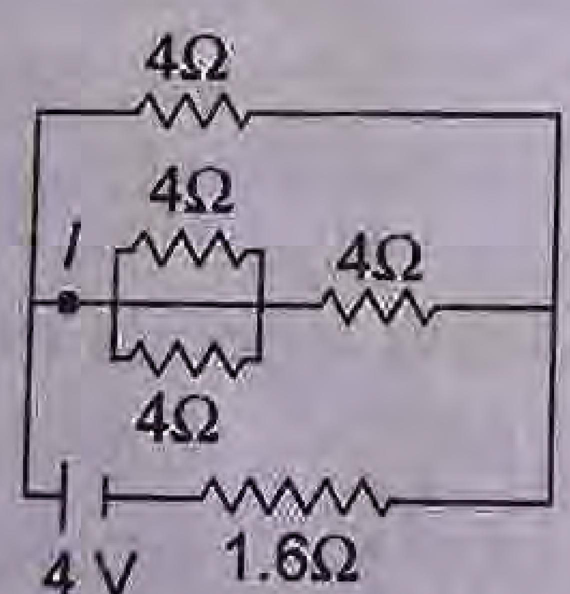
$$= 2\cos\left(\frac{A-C}{2}\right)$$

Part I

Physics

1. A straight wire of mass 200 g and length 1.5 m carries a current of 2 A. It is suspended in mid-air by a uniform horizontal magnetic field B. The magnitude of B (in tesla) is (assume $g = 9.8\ ms^{-2}$)
   (a) 2 (b) 1.5
   (c) 0.55 (d) 0.65

2. In the circuit shown the value of I in ampere is



   (a) 1 (b) 0.60 (c) 0.4 (d) 1.5

3. When light of wavelength 300 nm falls on a photoelectric emitter, photoelectrons are liberated. For another emitter, light of wavelength 600 nm is sufficient for liberating photoelectrons. The ratio of the work function of the two emitters is
   (a) 1 : 2 (b) 2 : 1
   (c) 4 : 1 (d) 1 : 4

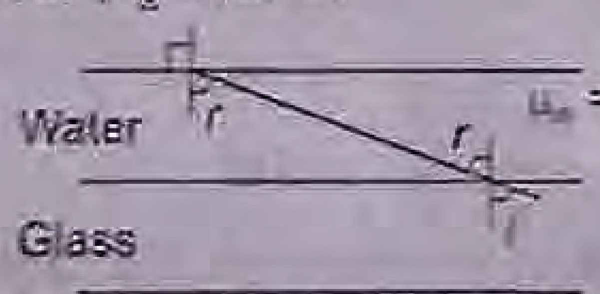
4. A monatomic gas is suddenly compressed to (1/8)th of its initial volume adiabatically. The ratio of its final pressure to the initial pressure is (Given, the ratio of the specific heats of the given gas to be 5/3)
   (a) 32 (b) 40/3
   (c) 24/5 (d) 8

5. The intensity of the magnetic induction field at the centre of a single turn circular coil of radius 5 cm carrying current of 0.9 A is
(a) $36\pi \times 10^{-7}$ T (b) $9\pi \times 10^{-7}$ T
(c) $36\pi \times 10^{-6}$ T (d) $9\pi \times 10^{-6}$ T

6. A capacitor of capacity 0.1 μF connected in series to a resistor of 10 MΩ is charged to a certain potential and then made to discharge through resistor. The time in which the potential will take to fall to half its original value is
(Given, $\log_{10} 2 = 0.3010$)
(a) 2 s (b) 0.693 s
(c) 0.5 s (d) 1.0 s

7. If the force is given by $F = at + bt^2$ with t as time. The dimensions of a and b are
(a) $[MLT^{-4}]$, $[MLT^{-2}]$
(b) $[MLT^{-3}]$, $[MLT^{-4}]$
(c) $[ML^2T^{-3}]$, $[ML^2T^{-2}]$
(d) $[ML^2T^{-3}]$, $[ML^3T^{-4}]$

8. A ray of light is incident on the interface between water and glass at an angle i and refracted parallel to the water surface, then value of μ_g will be



(a) $(4/3)\sin i$ (b) $\frac{1}{\sin i}$
(c) $\frac{4}{3}$ (d) 1

9. A body is moved in straight line by constant power of machine. What will be the relation between the travelling distance and time?
(a) $s^2 \propto t^3$ (b) $s^2 \propto t^3$
(c) $s^3 \propto t^2$ (d) $s \propto t^3$

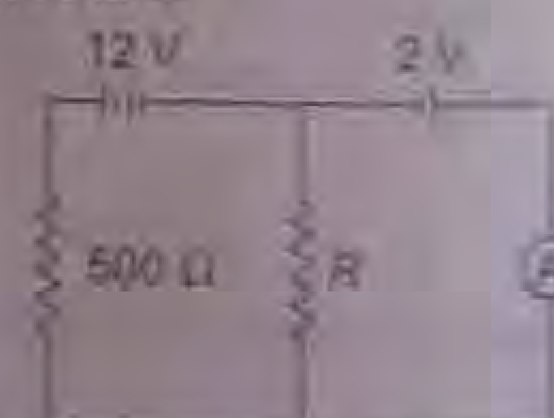
10. Magnetic moment of bar magnet is M. The work done to turn the magnet by 90° of magnet in direction of magnetic field B will be
(a) Zero (b) $\frac{1}{2}MB$
(c) $2MB$ (d) MB

11. Voltage V and current i in AC circuit are given by
$V = 50 \sin (50t)$ volt
$i = 50 \sin \left(50t + \frac{\pi}{3}\right)$ mA
The power dissipated in circuit is
(a) 5.0 W (b) 2.5 W
(c) 1.25 W (d) zero

12. A simple wave motion represents by $y = 5 (\sin 4\pi t + \sqrt{3} \cos 4\pi t)$. Its amplitude is
(a) 5 (b) $5\sqrt{3}$
(c) $10\sqrt{3}$ (d) 10

13. A large open tank has two holes in the wall. One is a square hole of side L at a depth y from the top and the other is a circular hole of radius R at a depth $4y$ from the top. When the tank is completely filled with water, the quantities or water flowing out per second from the two holes are the same. Then, the value of R is
(a) $\frac{L}{\sqrt{2\pi}}$ (b) $2\pi L$
(c) $L\sqrt{\frac{2}{\pi}}$ (d) $\frac{L}{2\pi}$

14. In the circuit shown below, the ammeter reading is zero. Then, the value of the resistance R is



(a) 50 Ω (b) 100 Ω
(c) 200 Ω (d) 400 Ω

15. The dimensional formula for inductance is
(a) $[ML^2T^{-2}A^{-2}]$ (b) $[ML^2TA^{-2}]$
(c) $[ML^2T^{-1}A^{-2}]$ (d) $[ML^2T^{-2}A^{-1}]$

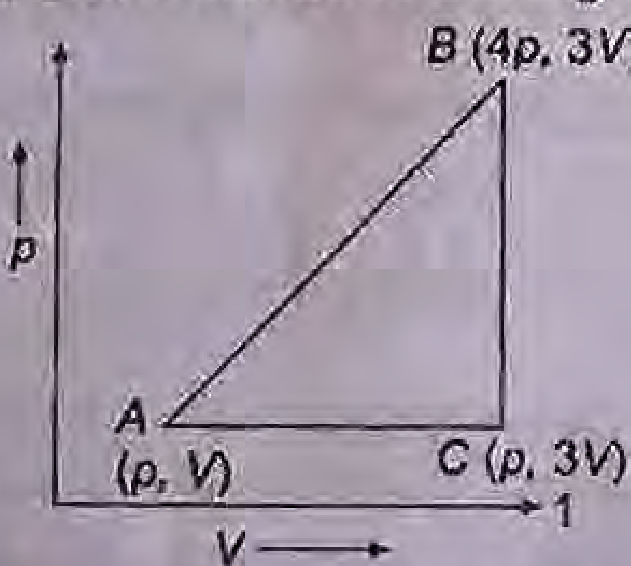
16. The maximum current that can be measured by a galvanometer of resistance 40 Ω is 10 mA. It is converted into a voltmeter that can read upto 50 V. The resistance to be connected in series with the galvanometer (in ohms) is

(a) 2010 (b) 4050
(c) 5040 (d) 4960

17. For a given velocity, a projectile has the same range R for two angles of projection if t_1 and t_2 are the time of flight in the two cases, then

(a) $t_1 t_2 \propto R$ (b) $t_1 t_2 \propto R^2$
(c) $t_1 t_2 \propto \frac{1}{R^2}$ (d) $t_1 t_2 \propto \frac{1}{R}$

18. A sample of ideal monoatomic gas is taken round the cycle *ABCA* as shown in the figure. The work done during the cycle is



(a) $3\,pV$ (b) zero
(c) $9\,pV$ (d) $6\,pV$

19. A sound source is moving towards stationary listener with $\frac{1}{10}$th of the speed of sound. The ratio of apparent to real frequency is

(a) $\left(\frac{9}{10}\right)^2$ (b) $\frac{10}{9}$ (c) $\frac{11}{10}$ (d) $\left(\frac{11}{10}\right)^2$

20. A satellite is in a circular orbit round the earth at an altitude R above the earth's surface, where R is the radius of the earth. If g is the acceleration due to gravity on the surface of the earth, the speed of the satellite is

(a) $\sqrt{2Rg}$ (b) $\sqrt{Rg}$
(c) $\sqrt{\frac{Rg}{2}}$ (d) $\frac{\sqrt{Rg}}{4}$

21. A 10 kg stone is suspended with a rope of breaking strength 30 kg-wt. The minimum time in which the stone can be raised through a height 10 m starting from rest is (Taking $g = 10\ \text{Nkg}^{-1}$)

(a) 0.5 s (b) 1.0 s
(c) $\sqrt{\frac{2}{3}}$ s (d) 2.0 s

22. How much work must be done by a force on 50 kg body in order to accelerate it from rest to 20 m/s in 10 s?

(a) 10^3 J (b) 10^4 J
(c) 2×10^3 J (d) 4×10^4 J

23. A and B are two metals with threshold frequencies 1.8×10^{14} Hz and 2.2×10^{14} Hz. Two identical photons of energy 0.825 eV each are incident on them. Then photoelectrons are emitted by (Taking $h = 6.6 \times 10^{-34}$ J-s)

(a) B alone
(b) A alone
(c) Neither A nor B
(d) Both A and B

24. The square of resultant of two equal forces is three times their product. Angle between the forces is

(a) π (b) $\frac{\pi}{2}$ (c) $\frac{\pi}{4}$ (d) $\frac{\pi}{3}$

25. An object placed on a ground is in stable equilibrium. If the objects is given a slight push, then initially the position of centre of gravity

(a) moves nearer to ground
(b) rises higher above the ground
(c) remains as such
(d) may remain at same level

26. The maximum height attained by a projectile when thrown at an angle θ with the horizontal is found to be half the horizontal range. Then, θ is equal to

(a) $\tan^{-1}(2)$ (b) $\frac{\pi}{6}$
(c) $\frac{\pi}{4}$ (d) $\tan^{-1}\left(\frac{1}{2}\right)$

27. A shell of mass 20 kg at rest explodes into two fragments whose masses are in the ratio 2 : 3. The smaller fragment moves with a velocity of 6 ms^{-1}. The kinetic energy of the larger fragment is
(a) 96 J
(b) 216 J
(c) 144 J
(d) 360 J

28. If the displacement of simple pendulum at any time is 0.02 m and acceleration is 2 m/s^2, then in this time angular velocity will be
(a) 100 rad/s
(b) 10 rad/s
(c) 1 rad/s
(d) 0.1 rad/s

29. Which is constant, the earth revolving around the sun?
(a) Angular momentum
(b) Linear momentum
(c) Rotational kinetic energy
(d) Kinetic energy

30. In non-elastic collision,
(a) momentum is conserved
(b) energy is conserved
(c) momentum and energy are conserved
(d) momentum and energy are non-conserved

31. A mica slit of thickness t and refractive index μ is introduced in the ray from the first source S_1. By how much distance of fringes pattern will be displaced?
(a) $\frac{d}{D}(\mu - 1)t$
(b) $\frac{D}{d}(\mu - 1)t$
(c) $\frac{d}{(\mu - 1)D}$
(d) $\frac{D}{d}(\mu - 1)$

32. The refractive index of water is 4/3 and that of glass is 5/3. What will be the critical angle for the ray of light entering water from the glass?
(a) $\sin^{-1}\left(\frac{4}{5}\right)$
(b) $\sin^{-1}\left(\frac{5}{4}\right)$
(c) $\sin^{-1}\left(\frac{1}{2}\right)$
(d) $\sin^{-1}\left(\frac{2}{1}\right)$

33. The produced rays in sonography are
(a) microwaves
(b) infrared waves
(c) sound waves
(d) ultra sound

34. The ratio of secondary of primary winding of a step up transformer is 4 : 1. If a current of 4 A is applied to the primary, the induced current in secondary will be
(a) 8 A
(b) 2 A
(c) 1 A
(d) 0.5 A

35. The minimum force required to move a body up an inclined plane is three times the minimum force required to prevent it from sliding down the plane. If the coefficient of friction between the body and the inclined plane is $\frac{1}{2\sqrt{3}}$, the angle of the inclined plane is
(a) 60°
(b) 45°
(c) 30°
(d) 15°

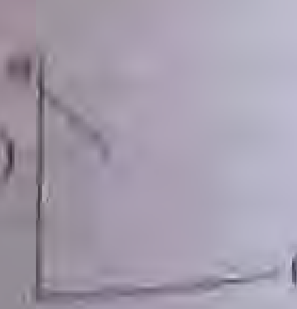
36. If k_s and k_p respectively are effective spring constant in series and parallel combination of springs as shown in figure, find $\frac{k_s}{k_p}$

(a) $\frac{9}{2}$
(b) $\frac{3}{7}$
(c) $\frac{2}{9}$
(d) $\frac{7}{3}$

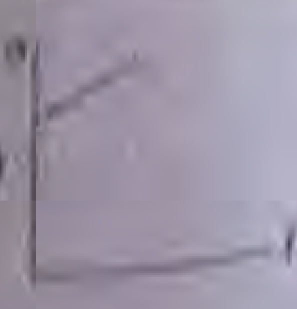
37. The power dissipated across resistance R which is connected across a battery of potential V is P. If resistance is doubled then the power becomes
(a) 1/2
(b) 2
(c) 1/4
(d) 2

38. A body moves with uniform acceleration then which of the following graph is correct?

(a)


(b)


(c)


(d)


39. The rate at which a black body emits radiation at a temperature T is proportional to

(a) $\frac{1}{T}$ (b) T
(c) T^3 (d) T^4

40. Two equal charges q are kept fixed at a and $+a$ along the x-axis. A particle of mass m and charge $\frac{q}{2}$ is brought to the origin and given a small displacement along the x-axis, then

(a) the particle executes oscilatory motion
(b) the particle remains stationary
(c) the particle executes, SHM along x-axis
(d) the particle executes SHM along y-axis

Chemistry

41. The ionic conductance of Ba^{2+} and Cl^- are respectively 127 and $76\ \Omega^{-1}\ cm^2$ at infinite dilution. The equivalent conductance (in $\Omega^{-1}\ cm^2$) of $BaCl_2$ at infinite dilution will be

(a) 330 (b) 203
(c) 139.5 (d) 51

42. If the elevation in boiling point of a solution of 10 g of solute (mol. wt. = 100) in 100 g of water is ΔT_b, the ebullioscopic constant of water is

(a) $\frac{\Delta T_b}{10}$ (b) ΔT_b
(c) $10 \Delta T_b$ (d) $100\ \Delta T_b$

43. Given that;

$H_2O(l) \longrightarrow H^+(aq) + OH^-(aq)$; $\Delta H = 57.32\ kJ$

$H_2(g) + \frac{1}{2}O_2(g) \longrightarrow H_2O(l)$; $\Delta H = -286.02\ kJ$

Then calculate the enthalpy of formation of OH^- at 25°C.

(a) -228.8 kJ (b) -343.52 kJ
(c) $+228.8$ kJ (d) $+343.52$ kJ

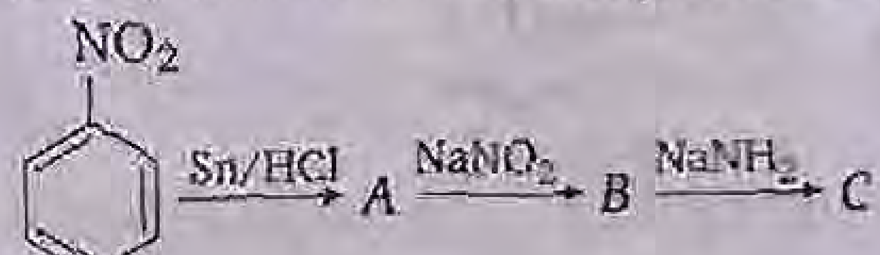
44. Calculate the amount of heat evolved when 500 cm^3 of 0.1 M HCl is mixed with 200 cm^3 of 0.2 M NaOH.

(a) 57.3 kJ (b) 2.865 kJ
(c) 2.292 kJ (d) 0.573 kJ

45. Which of the following will be the most effective in the coagulation of $Fe(OH)_3$ sol?

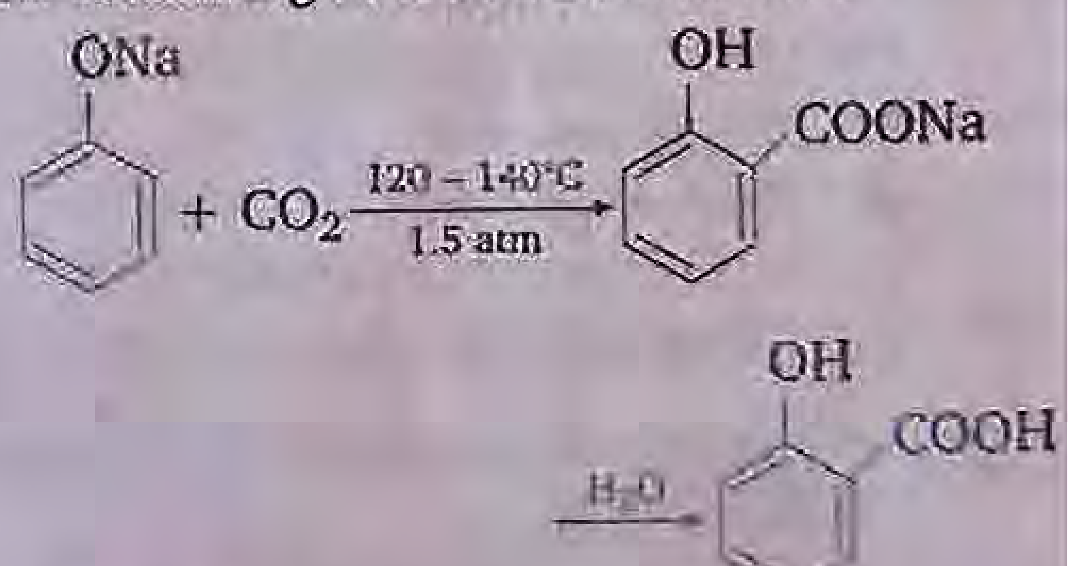
(a) $Mg_3(PO_4)_2$ (b) $BaCl_2$
(c) NaCl (d) KCN

46. Identify 'C' in the following reaction;



(a) benzamide (b) benzoic acid
(c) chlorobenzene (d) aniline

47. The following reaction is known as



(a) Friedel-Craft reaction
(b) Kolbe reaction
(c) Reimer-Tiemann reaction
(d) Wittig reaction

48. Which of the following is isoelectronic of carbon?

(a) Na^+ (b) Al^{3+} (c) O^{2-} (d) N^+

49. In which of the following species only one type of hybridisation is present?

(a) $CH_3—CH_2—CH=CH_2$
(b) $CH_3—CH=CH—CH_3$
(c) $CH_2=CH—CH=CH_2$
(d) $CH_3—CH=CH—CH_3$

50. $2MnO_4^- + 5H_2O_2 + 6H^+ \longrightarrow$

$2Z + 5O_2 + 8H_2O$

Identify Z in the above reaction
(a) Mn^{2+} (b) Mn^{4+}
(c) Mn (d) MnO_2

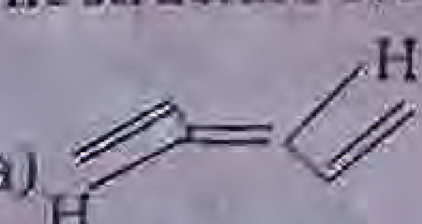
51. In the titration of NaOH and HCl, which of the following indicator will be used?
(a) Methyl orange
(b) Methyl red
(c) Both (a) and (b)
(d) None of (a) and (b)

52. Which of the following is correct IUPAC name for $K_2[Cr(CN)_2O_2(O)_2NH_3]$?
(a) Potassium amminecyanoperoxodioxochromatic (IV)
(b) Potassium amminecyanoperoxodioxochromium (V)
(c) Potassium amminecyanoperoxodioxochromium (VI)
(d) Potassium amminedicyanodioxoper-oxochromate (VI)

53. Which of the following is process used for the preperation of acetone?
(a) Waber process
(b) Wacker process
(c) Wolf-Kishner reduction
(d) Gattermann-Koch synthesis

54. Lindane can be obtained by the reaction of benzene with
(a) CH_3Cl/anhydrous $AlCl_3$
(b) C_2H_5I/anhydrous $AlCl_3$
(c) CH_3COCl/anhydrous $AlCl_3$
(d) Cl_2 in sunlight

55. The structure of *cis-bis* (propenyl) ethene is

(a)  (b) 

(c)  (d) 

56. 5 moles of $Ba(OH)_2$ are treated with excess of CO_2. How much $BaCO_3$ will be formed?
(a) 39.4 g (b) 197 g
(c) 591 g (d) 985 g

57. A diatomic molecule has a dipole moment of 1.2 D. If its bond distance is 1.0 Å, what fraction of an electronic charge, e exists on each atom?
(a) 25% of e (b) 50% of e
(c) 60% of e (d) 75% of e

58. A gas is heated through 1°C in a closed vessel and so the pressure increases by 0.4%. The initial temperature of the gas was
(a) − 23°C (b) + 23°C
(c) 250°C (d) 523°C

59. For $2NOBr(g) \rightleftharpoons 2NO(g) + Br_2(g)$ at equilibrium, $p_{Br_2} = \frac{p}{q}$ and p is the total pressure, the ratio $\frac{K_p}{p}$ will be
(a) $\frac{1}{3}$ (b) $\frac{1}{9}$ (c) $\frac{1}{27}$ (d) $\frac{1}{81}$

60. The decomposition temperature is maximum for
(a) $MgCO_3$ (b) $CaCO_3$
(c) $BaCO_3$ (d) $SrCO_3$

61. When some amount of zinc is treated separately with excess of sulphuric acid and excess of sodium hydroxide solution the ratio of volumes of hydrogen evolved is
(a) 1 : 1 (b) 1 : 2 (c) 2 : 1 (d) 2 : 3

62. A compound (*A*) when treated with PCl_5 and then ammonia gave (*B*). (*B*) when treated with bromine and caustic potash produced (*C*). (*C*) on treatment with $NaNO_2$ and HCl at 0°C and then boiling produce *ortho*-cresol. Compound (*A*) is
(a) *o*-chlorotoluene
(b) *o*- toluic acid
(c) *m*-toluic acid
(d) *o*-bromotoluene

63. Alizarin is an example of
(a) triaryl dye
(b) azo dye
(c) vat dye
(d) anthraquinone dye

64. What will be the main product when acetylene reacts with hypochlorous acid?
(a) Trichloro acetaldehyde
(b) Acetaldehyc
(c) Dichloro acetaldehyde
(d) Chloro acetaldehyde

65. Barium titanate has the periovskite structure, *i.e.*, a cubic lattice with Ba^{2+} ions at the corners of the unit cell, oxide ions at the face centres and titanium ions at the body centre. The molecular formula of barium titanate is
(a) $BaTiO_3$ (b) $BaTiO_4$
(c) $BaTiO_2$ (d) BaTiO

66. Which of the following hormone, is responsible for the growth of animals?
(a) Auxin (b) Insulin
(c) Adrenaline (d) Somatotropin

67. Which of the following have the largest ionic size?
(a) F^- (b) O^{2-} (c) Na^+ (d) Mg^{2+}

68. If the radius of H is 0.53 Å then what will be the radius of $_3Li^{2+}$?
(a) 0.17 Å (b) 0.36 Å
(c) 0.53 Å (d) 0.59 Å

69. Which of the following will have highest value of pK_a?
(a) FCH_2CH_2COOH
(b) $CH_3CH(F)COOH$
(c) $CH_3CH(Br)COOH$
(d) CH_3CH_2COOH

70. Gas (A) + NaOH $\longrightarrow B \xrightarrow{\Delta} C \xrightarrow{H^+} D$
C and D decolourises acidified $KMnO_4$. Identify C and D.
(a) Na_2CO_3, NaOH
(b) $(COOH)_2$, $(COONa)_2$
(c) $(COONa)_2$, $(COOH)_2$
(d) None of the above

71. The polymer polyurethanes are formed by treating di-isocyanate with
(a) butadiene (b) isoprene
(c) glycol (d) acrylonitrile

72. What will be the volume of O_2 at NTP liberated by 5 A current flowing for 193 s through acidulated water?
(a) 56 mL (b) 112 mL
(c) 158 mL (d) 965 mL

73. CO_2 goes to air, causes green house effect and gets dissolved in water. What will be the effect on soil fertility and pH of the water?
(a) Increase (b) Decrease
(c) Remain same (d) None of these

74. $2N_2O_5 \rightleftharpoons 4NO_2 + O_2$
If rate and rate constant for above reaction are 2.40×10^{-5} mol L^{-1} s^{-1} and 3×10^{-5} s^{-1} respectively, then calculate the concentration of N_2O_5.
(a) 1.4 (b) 1.2 (c) 0.04 (d) 0.8

75. The molecule BF_3 and NF_3 both are covalent compounds, but BF_3 is non-polar and NF_3 is polar. The reason is that
(a) boron is a metal and nitrogen is a gas in uncombined state.
(b) BF_3 bonds have no dipole moment whereas NF_3 bond have dipole moment.
(c) atomic size of boron is smaller than that of nitrogen.
(d) BF_3 is symmetrical molecule whereas NF_3 is unsymmetrical.

76. 1.2% NaCl solution is isotonic with 7.2% glucose solution. What will be the van't Hoff factor, i?
(a) 0.5 (b) 1
(c) 2 (d) 6

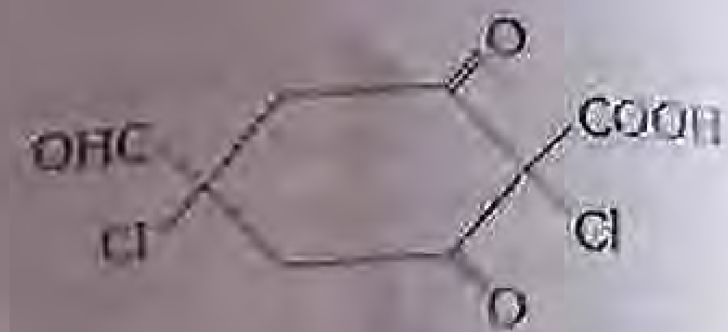
77. Green vitriol is
(a) ferrous sulphate
(b) tin oxide
(c) zinc oxide
(d) ferrous carbonate

78. 2-bromopentane with alcoholic KOH yields a mixture of three alkenes. Which of the following alkene is predominant?
(a) 1-pentene

(b) *Cis*-2-pentene
(c) *Trans*-2-pentene
(d) *Cis*-1-pentene

79. In which of the following compounds, the bond length between hybridised carbon atom and other carbon atom is minimum ?
(a) Butane
(b) Propyne
(c) Propene
(d) Butene

80. Which of the following is IUPAC name of compound?



(a) 1, 4-dichloro-2, 6-dioxo-4-ca
1-oic acid
(b) 2,4-dioxo-1, 4-dichlorohexane-1-
carboxylic acid
(c) 1,4-dichloro-2, 4, 6-dioxocycl
-1- carboxylic acid
(d) 1, 4-dichloro-4-formyl-2, 6-
cyclohexane -1-carboxylic acid

English Proficiency

Directions (Q.Nos. 81 to 83) *Out of the four alternatives, choose the one which expresses the right meaning of the given word.*

81. Dubious
(a) Doubtful (b) Disputable
(c) Duplicate (d) Dangerous

82. Flabbergasted
(a) Scared
(b) Embarrassed
(c) Dumbfounded
(d) Humiliated

83. Eternal
(a) Innumerable
(b) Unmeasurable
(c) Prolonged
(d) Perpetual

Directions (Q.Nos. 84 to 86) *Choose the word opposite in meaning to the given word.*

84. Despair
(a) Belief (b) Trust
(c) Hope (d) Faith

85. In toto
(a) Bluntly (b) Partially
(c) Entirely (d) Strongly

86. Protean
(a) Amateur (b) Catholic
(c) Unchanging (d) Rapid

Directions (Q.Nos. 87 to 89) *A part of the sentence is underlined. Below are given alternatives to the underlined part at a, b and c which may improve the sentence. Choose the correct alternative. In case no improvement is needed, your answer is 'd'.*

87. He declined all the allegations against him.
(a) spurned (b) refused
(c) refuted (d) No improvement

88. It is time we leave.
(a) left (b) have to leave
(c) would leave (d) No improvement

89. We spent an hour discussing about his character.
(a) on his character
(b) of his character
(c) his character
(d) No improvement

Directions (Q.Nos. 90 to 92) *Sentences are given with blanks to be filled in with an appropriate and suitable word. Four alternatives are suggested for each question. Choose the correct alternative out of the four.*

90. Are your really desirous ...... visiting Japan?
(a) of (b) in
(c) to (d) about

91. When Indians from the South move North, they find certain aspects of life quite ...... from their own.
(a) strange (b) separate
(c) different (d) divergent

92. The sky is overcast, we .... the storm will soon burst.
(a) expect (b) hope
(c) trust (d) suspect

Directions (Q. Nos. 93 to 95) *The first and the last parts of the sentence are numbered 1 to 6. The rest of the sentence is spelt into four parts and named P, Q, R and S. These four parts are not given in their proper order. Read the parts and find out which of the four combinations is correct. Then find the correct answer.*

93. 1. Early to bed, early to rise, makes a man healthy, wealthy and wise.
P. But for the morning tea, I had to wait for someone to get up before me.
Q. This saying inspired me to rise early.
R. That day I was the first to get up.
S. One day I got up early in the morning.
6. Then I realised that it was a waste of time to get up early and wait for the morning tea.
(a) QSRP (b) QPRS
(c) PQRS (d) SPQR

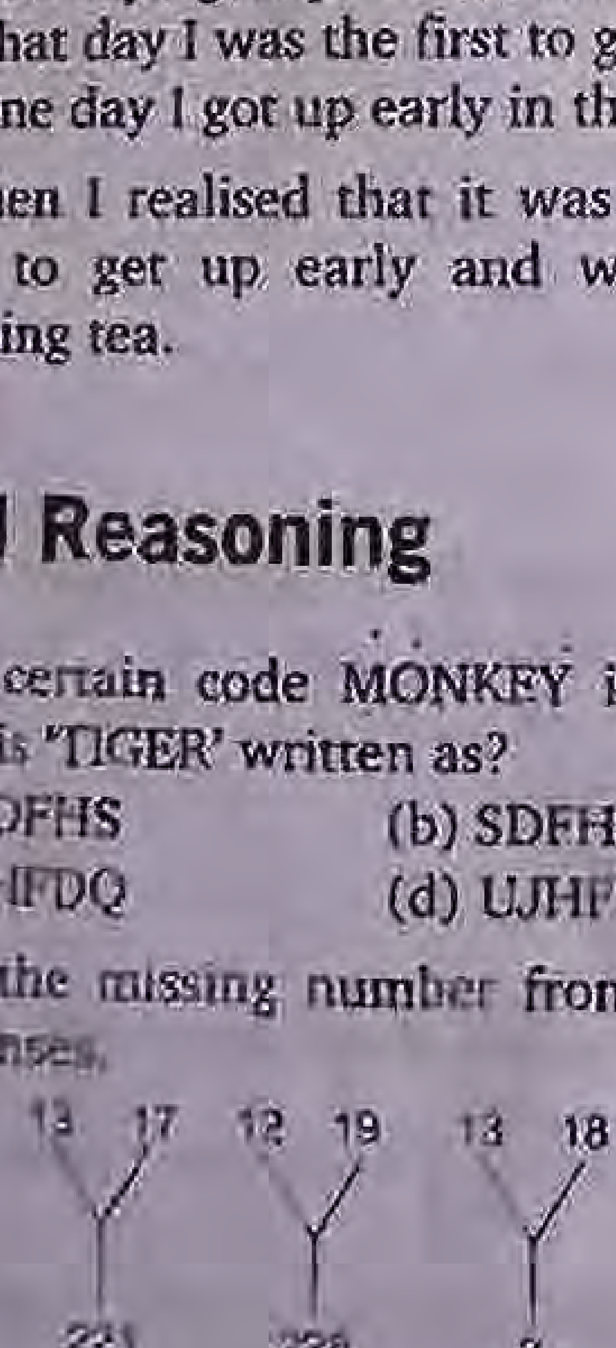
94. 1. A wood-cutter was cutting a tree on a river bank.
P. He knelt down and prayed.
Q. His axe slipped and fell into the water.
R. God Mercury appeared before him and asked about the matter.
S. He could not get it back as the river was very deep.
6. He dived into the water and came up with an axe of good.
(a) RPQS (b) RPSQ
(c) QSRP (d) QSPR

95. 1. A dog stole a piece of meat from a butcher's shop.
P. He barked in anger.
Q. He ran to the jungle with the piece of meat.
R. He saw his reflection.
S. He crossed a river on the way.
6. He lost his piece of meat.
(a) QPSR
(b) QSRP
(c) QPRS
(d) SRPQ

Logical Reasoning

96. In a certain code MONKEY is XDJMNL. How is 'TIGER' written as?
(a) QDFHS (b) SDFHS
(c) SHFDQ (d) UJHFS

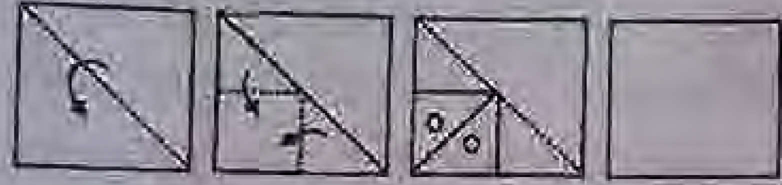
97. Find the missing number from the given responses.



(a) 31 (b) 229
(c) 234 (d) 312

98. If the day before yesterday was Thursday, when will Sunday be?
(a) tomorrow
(b) day after tomorrow
(c) today
(d) two days after today

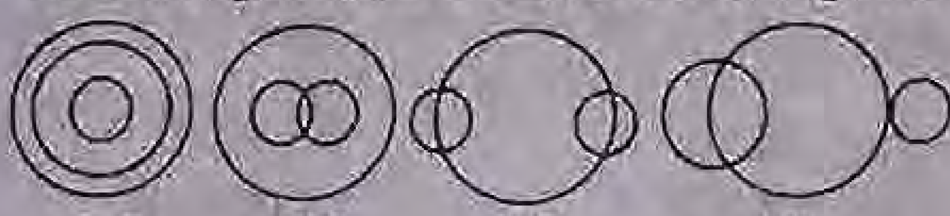
99. In a row of children Ravi is fourth from right and Shyam is second from left. When they interchange positions Ravi is ninth from right. What will be Shyam position from left?
(a) Fifth (b) Sixth
(c) Seventh (d) Eighth



Answer Figures

(a) (b) (c) (d)

101. Which represents carrot, food, vegetable?



(a) (b) (c) (d)

102. "All the members of the Tennis club are members of the badminton club too". No woman plays badminton?

(a) Some women play Tennis

(b) No member of the Tennis club plays badminton

(c) Some women are members of the Tennis club

(d) No woman is a member of Tennis club

103. Which number is wrong in the given series?

1, 9, 25, 50, 81

(a) 1 (b) 25 (c) 50 (d) 81

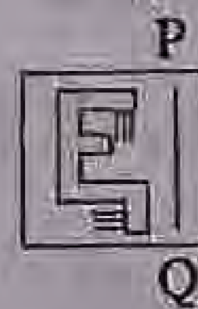
104. In the following question and Δ stands for any of the Mathematical signs at different places, which are given as choices under each question. Select the choice with the correct sequence of signs which when substituted makes the question as correct equation?

$$24 \Delta 4 \Delta 5 \Delta 4$$

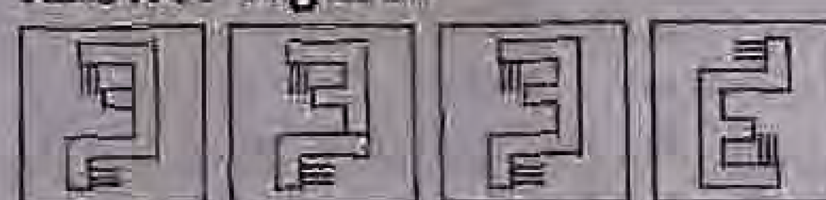
(a) $\times + =$ (b) $= \times +$

(c) $+ \times =$ (d) $= + \times$

105. Which answer figure is the exact mirror image of the given figure when the mirror is held from the right at PQ ?



Answer Figures



(a) (b) (c) (d)

Mathematics

106. The equation of the base BC of an equilateral ΔABC is $x + y = 2$ and A is $(2, -1)$. The length of the side of the triangle is

(a) $\sqrt{2}$ (b) $\left(\frac{3}{2}\right)^{1/2}$

(c) $\left(\frac{1}{2}\right)^{1/2}$ (d) $\left(\frac{2}{3}\right)^{1/2}$

107. The equation of the circle circumscribing the triangle formed by the lines $x + y = 6$, $2x + y = 4$ and $x + 2y = 5$ is

(a) $x^2 + y^2 + 17x + 19y - 50 = 0$

(b) $x^2 + y^2 - 17x - 19y - 50 = 0$

(c) $x^2 + y^2 + 17x - 19y - 50 = 0$

(d) $x^2 + y^2 - 17x - 19y + 50 = 0$

108. The length of the tangent from (5, 1) to the circle $x^2 + y^2 + 6x - 4y - 3 = 0$ is

(a) 7

(b) 49

(c) 63

(d) 21

109. If the length of the major axis of the ellipse $\left(\frac{x^2}{a^2}\right) + \left(\frac{y^2}{b^2}\right) = 1$ is three times the length of minor axis, its eccentricity is

(a) $\frac{1}{3}$ (b) $\frac{1}{\sqrt{3}}$

(c) $\sqrt{\frac{2}{3}}$ (d) $\frac{2\sqrt{2}}{3}$

110. S and T are the foci of the ellipse $\left(\frac{x^2}{a^2}\right)+\left(\frac{y^2}{b^2}\right)=1$ and B is an end of the minor axis. If STB is an equilateral triangle, then eccentricity of the ellipse is

(a) $\frac{1}{4}$ (b) $\frac{1}{3}$ (c) $\frac{1}{2}$ (d) $\sqrt{\frac{3}{2}}$

111. The difference of the focal distance of any point on the hyperbola is equal to its

(a) latusrectum
(b) eccentricity
(c) length of the transverse axis
(d) half the length of the transverse axis

112. If $A+B+C=180°$, then

$\frac{\cot A+\cot B+\cot C}{\cot A\cot B\cot C}$ is equal to

(a) 1 (b) $\cot A\cos B\cot C$
(c) -1 (d) 0

113. The angles of a triangle are in AP and the least angle is 30°. The greatest angle in radians is

(a) $\frac{7\pi}{12}$ (b) $\frac{2\pi}{3}$ (c) $\frac{5\pi}{6}$ (d) $\frac{\pi}{2}$

114. If $\tan 20°=p$, then $\frac{\tan 160°-\tan 110°}{1+\tan 160°\tan 110°}$ is equal to

(a) $\left(\frac{1-p^2}{2p}\right)$ (b) $\left(\frac{2p}{1+p^2}\right)$
(c) $\left(\frac{1+p}{2p}\right)$ (d) $\left(\frac{1-p}{2p}\right)$

115. If $4\sin^{-1}x+\cos^{-1}x=\pi$, then x is equal to

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

116. In a ΔABC, $a=2$, $b=3$ and $\sin A=\frac{2}{3}$. Then, $\cos C$ is equal to

(a) $\frac{1}{2}$ (b) $\frac{2}{3}$
(c) $\frac{2}{\sqrt{13}}$ (d) $\frac{1}{\sqrt{13}}$

117. The vector equation

$$\mathbf{r}=\mathbf{i}-2\mathbf{j}-\mathbf{k}+t(6\mathbf{j}-\mathbf{k})$$

represents a straight line passing through the points

(a) $(0,6,-1)$ and $(1,-2,-1)$
(b) $(0,6,-1)$ and $(-1,-4,-2)$
(c) $(1,-2,-1)$ and $(1,4,-2)$
(d) $(1,-2,-1)$ and $(0,-6,1)$

118. The work done by the force $4\mathbf{i}-3\mathbf{j}+2\mathbf{k}$ in moving a particle along a straight line from the point $(3,2,-1)$ to $(2,-1,4)$ is

(a) 0 units (b) 4 units
(c) 15 units (d) 19 units

119. $\lim_{x\to 0}\left(\frac{(2+x)\sin(2+x)-2\sin 2}{x}\right)$ is equal to

(a) $\sin 2$ (b) $\cos 2$
(c) 1 (d) $2\cos 2+\sin 2$

120. If $f(x)=\frac{3x+\tan^2 x}{x}$ is continuous at $x=0$, then $f(0)$ is equal to

(a) 3 (b) 2 (c) 4 (d) 0

121. If x is measured in degree, then $\frac{d}{dx}(\cos x)$ is equal to

(a) $-\sin x$ (b) $-\frac{180}{\pi}\sin x$
(c) $-\frac{\pi}{180}\sin x$ (d) $\sin x$

122. $\left(\frac{d}{dx}\right)[\log(\sec x-\tan x)]$ is equal to

(a) $-\sec x$ (b) $\sec x+\tan x$
(c) $\sec x$ (d) $\sec x-\tan x$

123. If $x=\cos^3\theta$ and $y=\sin^3\theta$, then $1+\left(\frac{dy}{dx}\right)^2$ is equal to

(a) $\tan^2\theta$ (b) $\cot^2\theta$
(c) $\sec^2\theta$ (d) $\mathrm{cosec}^2\theta$

124. If $x=at^2$, $y=2at$, then $\frac{d^2y}{dx^2}$ is equal to

(a) $-\frac{1}{t^2}$ (b) $-\frac{1}{2at^3}$ (c) $\frac{1}{t^3}$ (d) $-\frac{a}{2t^3}$

125. If the rate of change in the circumference of a circle of 0.3 cm/s, then the rate of change in the area of the circle when the radius is 5 cm, is
(a) 1.5 sq cm/s
(b) 0.5 sq cm/s
(c) 5 sq cm/s
(d) 3 sq cm/s

126. If $y = x^3 - ax^2 + 48x + 7$ is an increasing function for all real values of x, then a lies in
(a) $(-14, 14)$ (b) $(-12, 12)$
(c) $(-16, 16)$ (d) $(-21, 21)$

127. Rolle's theorem is not applicable for the function $f(x) = |x|$ in the interval $[-1, 1]$ because
(a) $f'(1)$ does not exist
(b) $f'(-1)$ does not exist
(c) $f(x)$ is discontinuous at $x = 0$
(d) $f'(0)$ does not exist

128. $\int \frac{2dx}{(e^x + e^{-x})^2}$ is equal to
(a) $-\frac{e^{-x}}{(e^x + e^{-x})} + C$ (b) $-\frac{1}{(e^x + e^{-x})} + C$
(c) $\frac{1}{(e^x + 1)^2} + C$ (d) $\frac{1}{(e^x - e^{-x})^2} + C$

129. $\int_0^{\pi/2} \frac{\sin^n \theta}{\sin^n \theta + \cos^n \theta} d\theta$ is equal to
(a) 1 (b) 0
(c) $\frac{\pi}{2}$ (d) $\frac{\pi}{4}$

130. $\int_0^{\pi} \cos^{101} x\, dx$ is equal to
(a) $\frac{\pi}{4}$ (b) $\frac{1}{102}$
(c) $\left(\frac{\pi}{3}\right)^{101}$ (d) 0

131. $\lim_{n \to \infty} \left[\frac{1}{n+1} + \frac{1}{n+2} + \dots + \frac{1}{6n}\right]$
(a) $\log 2$ (b) $\log(1 + \sqrt{5})$
(c) $\log 6$ (d) 0

132. By eliminating the arbitrary constant A and B from $y = Ax^2 + Bx$, we get the differential equation
(a) $\frac{d^3y}{dx^3} = 0$
(b) $x^2 \frac{d^2y}{dx^2} - 2x\frac{dy}{dx} + 2y = 0$
(c) $\frac{d^2y}{dx^2} = 0$
(d) $x^2 \frac{d^2y}{dx^2} + y = 0$

133. If $f(x) = \frac{\log(1 + ax) - \log(1 - bx)}{x}$ for $x \neq 0$ and $f(0) = k$ and $f(x)$ is continuous at $x = 0$, then k is equal to
(a) $a + b$ (b) $a - b$
(c) a (d) b

134. If $4 - 5i$ is a root of the quadratic equation $x^2 + ax + b = 0$, then (a, b) is equal to
(a) $(8, 41)$ (b) $(-8, 41)$
(c) $(41, 8)$ (d) $(-41, 8)$

135. If α and β are the roots of the quadratic equation $4x^2 + 3x + 7 = 0$, then the value of $\frac{1}{\alpha} + \frac{1}{\beta}$ is
(a) $-\frac{3}{4}$ (b) $-\frac{3}{7}$
(c) $\frac{3}{7}$ (d) $\frac{4}{7}$

136. If α, β are the roots of $ax^2 + bx + c = 0$ and $\alpha + k, \beta + k$ are the roots of $px^2 + qx + r = 0$, then $\frac{b^2 - 4ac}{q^2 - 4pr}$ is equal to
(a) $\frac{a}{p}$ (b) 1 (c) $\left(\frac{a}{p}\right)^2$ (d) 0

137. Area of the triangle in the argand diagram formed by the complex numbers z, iz, $z + iz$, where $z = x + iy$ is
(a) $|z|$ (b) $|z|^2$
(c) $2|z|^2$ (d) $\frac{1}{2}|z|^2$

138. The sum of n terms of the series $\frac{1}{2}+\frac{3}{4}+\frac{7}{8}+\frac{15}{16}+\dots$ is

(a) $n-1+2^{-n}$ (b) 1
(c) $n-1$ (d) $1+2^{-n}$

139. $0.2+0.22+0.222+\dots$ to n terms is equal to

(a) $\left(\frac{2}{9}\right)-\left(\frac{2}{81}\right)(1-10^{-n})$

(b) $n-\left(\frac{1}{9}\right)(1-10^{-n})$

(c) $\left(\frac{2}{9}\right)\left[n-\left(\frac{1}{9}\right)(1-10^{-n})\right]$

(d) $\left(\frac{2}{9}\right)$

140. The number of ways in which a team of 11 players can be selected from 22 players including 2 of them and excluding 4 of them is

(a) ${}^{16}C_{11}$ (b) ${}^{16}C_5$
(c) ${}^{16}C_9$ (d) ${}^{20}C_8$

141. The number of ways four boys can be seated around a round table in four chairs of different colours is

(a) 24 (b) 12
(c) 23 (d) 64

142. If the coefficient of second, third and fourth terms in the expansion of $(1+x)^n$ are in AP, then n is equal to

(a) 7 (b) 4 (c) 5 (d) 6

143. If

$$\Delta=\begin{vmatrix}1 & a & a^2\\ 1 & b & b^2\\ 1 & c & c^2\end{vmatrix}=k(a-b)(b-c)(c-a),$$

then k is equal to

(a) -2 (b) 1
(c) 2 (d) abc

144. $\begin{vmatrix}a+b & a & b\\ a & a+c & c\\ b & c & b+c\end{vmatrix}$ is equal to

(a) $4abc$ (b) abc
(c) $a^2b^2c^2$ (d) $4a^2bc$

145. If $\Delta_1=\begin{vmatrix}x & a & b\\ b & x & a\\ a & b & x\end{vmatrix}$ and $\Delta_2=\begin{vmatrix}x & b\\ a & x\end{vmatrix}$ are the given determinants, then

(a) $\Delta_1=3(\Delta_2)^2$

(b) $\left(\frac{d}{dx}\right)(\Delta_1)=3\Delta_2$

(c) $\left(\frac{d}{dx}\right)(\Delta_1)=3(\Delta_2)^2$

(d) $\Delta_1=3(\Delta_2)^{3/2}$

146. The system

$x+4y-2z=3,\ 3x+y+5z=7$
and $2x+3y+z=5$ has

(a) infinite number of solutions
(b) unique solution
(c) trivial solution
(d) no solution

147. If the three points $(k, 2k)$, $(2k, 3k)$, $(3, 1)$ are collinear, then k is equal to

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

148. The foot of the perpendicular from the point $(3, 4)$ on the line $3x-4y+5=0$ is

(a) $\left(\frac{81}{25}, \frac{92}{25}\right)$ (b) $\left(\frac{92}{25}, \frac{81}{25}\right)$
(c) $\left(\frac{46}{26}, \frac{54}{24}\right)$ (d) $\left(-\frac{81}{25}, -\frac{92}{25}\right)$

149. A kite is flying at an inclination of $60°$ with the horizontal. If the length of the thread is 120 m, then the height of the kite is

(a) $60\sqrt{3}$ m (b) 60 m
(c) $\frac{60}{\sqrt{3}}$ m (d) 120 m

150. If the focus of parabola is at $(0, -3)$ and its directrix is $y=3$, then its equation is

(a) $x^2=-12y$ (b) $x^2=12y$
(c) $y^2=-12y$ (d) $y^2=12x$

Answers

Physics

1. (d)	**2.** (c)	**3.** (a)	**4.** (a)	**5.** (a)	**6.** (b)	**7.** (b)
8. (b)	**9.** (a)	**10.** (d)	**11.** (c)	**12.** (d)	**13.** (a)	**14.** (b)
15. (a)	**16**. (d)	**17.** (a)	**18.** (a)	**19.** (b)	**20.** (c)	**21.** (b)
22. (b)	**23**. (b)	**24.** (d)	**25.** (b)	**26.** (a)	**27.** (a)	**28.** (b)
29. (a)	**30**. (d)	**31.** (b)	**32.** (a)	**33.** (d)	**34.** (c)	**35.** (c)
36. (c)	**37.** (c)	**38.** (c)	**39.** (d)	**40.** (c)		

Chemistry

41. (c)	**42.** (b)	**43.** (a)	**44.** (c)	**45.** (a)	**46.** (d)	**47.** (b)
48. (d)	**49.** (c)	**50.** (a)	**51.** (c)	**52.** (d)	**53.** (b)	**54.** (d)
55. (b)	**56.** (d)	**57.** (a)	**58.** (a)	**59.** (d)	**60.** (d)	**61.** (a)
62. (b)	**63.** (d)	**64.** (c)	**65.** (a)	**66.** (d)	**67.** (b)	**68.** (a)
69. (d)	**70.** (c)	**71.** (c)	**72.** (a)	**73.** (b)	**74.** (d)	**75.** (d)
76. (c)	**77.** (a)	**78.** (c)	**79.** (b)	**80.** (d)		

Logical Reasoning & English Proficiency

81. (a)	**82.** (c)	**83.** (d)	**84.** (c)	**85.** (b)	**86.** (c)	**87.** (d)
88. (a)	**89.** (c)	**90.** (a)	**91.** (c)	**92.** (d)	**93.** (a)	**94.** (d)
95. (b)	**96.** (c)	**97.** (c)	**98.** (a)	**99.** (c)	**100.** (d)	**101.** (a)
102. (d)	**103.** (c)	**104.** (b)	**105.** (c)			

Mathematics

106. (d)	**107.** (d)	**108.** (a)	**109.** (d)	**110.** (c)	**111.** (c)	**112.** (a)
113. (d)	**114.** (a)	**115.** (a)	**116.** (b)	**117.** (c)	**118.** (c)	**119.** (d)
120. (a)	**121.** (c)	**122.** (a)	**123.** (c)	**124.** (b)	**125.** (a)	**126.** (b)
127. (a)	**128.** (a)	**129.** (d)	**130.** (d)	**131.** (c)	**132.** (b)	**133.** (a)
134. (b)	**135.** (b)	**136.** (c)	**137.** (d)	**138.** (a)	**139.** (c)	**140.** (c)
141. (a)	**142.** (a)	**143.** (b)	**144.** (a)	**145.** (b)	**146.** (d)	**147.** (a)
148. (a)	**149.** (a)	**150.** (a)				

SOLVED PAPER 2013

(Memory Based)

MATHEMATICS

1. If α, β are the roots of $ax^2 + bx + c = 0$, then $-\frac{1}{\alpha}, -\frac{1}{\beta}$ are the roots of
   (a) $ax^2 - bx + c = 0$
   (b) $cx^2 - bx + a = 0$
   (c) $cx^2 + bx + a = 0$
   (d) $ax^2 - bx - c = 0$
2. The number of real roots of the equation $(x-1)^2 + (x-2)^2 + (x-3)^2 = 0$ is
   (a) 1 (b) 2
   (c) 3 (d) None of these
3. If S is the set containing values of x satisfying $[x]^2 - 5[x] + 6 \le 0$, where [x] denotes GIF, then S contains
   (a) $(2, 4)$ (b) $(2, 4]$
   (c) $[2, 3]$ (d) $[2, 4)$
4. Seven people are seated in a circle. How many relative arrangements are possible?
   (a) 7! (b) 6!
   (c) ${}^7P_6$ (d) ${}^7C_6$
5. In how many ways can 4 people be seated on a square table, one on each side?
   (a) 4! (b) 3!
   (c) 1 (d) None of these
6. Four different items have to be placed in three different boxes. In how many ways can it be done such that any box can have any number of items?
   (a) 3^4 (b) 4^3
   (c) ${}^4P_3$ (d) ${}^4C_3$
7. What is the probability that, if a number is randomly chosen from any 31 consecutive natural numbers, it is divisible by 5?
   (a) $\frac{6}{31}$ (b) $\frac{7}{31}$
   (c) $\frac{6}{31}$ or $\frac{7}{31}$ (d) None of these
8. The mean of a binomial distribution is 5, then its variance has to be
   (a) > 5 (b) = 5
   (c) < 5 (d) = 25
9. If a is the single A.M. between two numbers a and b and S is the sum of n A.M.'s between them, then $\frac{S}{A}$ depends upon
   (a) n, a, b (b) n, a
   (c) n, b (d) n
10. $2^{\frac{1}{4}} 4^{\frac{1}{8}} 8^{\frac{1}{16}} 16^{\frac{1}{32}} \ldots$ upto ∞ equal to
   (a) 1 (b) 2
   (c) $\frac{3}{2}$ (d) $\frac{5}{2}$
11. The odds in favour of India winning any cricket match is 2 : 3. What is the probability that if India plays 5 matches, it wins exactly 3 of them?
   (a) ${}^5C_3\left(\frac{2}{5}\right)^2\left(\frac{3}{5}\right)^3$ (b) ${}^5C_3\left(\frac{2}{3}\right)^2\left(\frac{1}{3}\right)^3$
   (c) ${}^5C_3\left(\frac{2}{5}\right)^3\left(\frac{3}{5}\right)^2$ (d) ${}^5C_3\left(\frac{2}{3}\right)^2\left(\frac{1}{3}\right)^2$
12. For an A.P., $S_{2n} = 3S_n$. The value of $\frac{S_{3n}}{S_n}$ is equal to
   (a) 4 (b) 6
   (c) 8 (d) 10
13. $1 + \sin x + \sin^2 x + \sin^3 x + \ldots = 4 + 2\sqrt{3}$, $0 < x < \pi$, $x \ne \frac{\pi}{2}$ then x =
   (a) $\frac{\pi}{6}, \frac{\pi}{3}$
   (b) $\frac{\pi}{6}, \frac{5\pi}{6}$
   (c) $\frac{\pi}{3}, \frac{2\pi}{3}$
   (d) $\frac{\pi}{3}, \frac{5\pi}{6}$

14. $\sum_{n=0}^{\infty} \frac{(\log_e x)^{2n}}{n!} =$

(a) x^2 (b) x

(c) $\log_e(1+x)$ (d) $\log_e x^2$

15. The ends of a line segment are P(1, 3) and Q(1, 1). R is a point on the line segment PQ such that PR : QR = 1 : λ. If R is an interior point of the parabola $y^2 = 4x$, then

(a) $\lambda \in (0, 1)$ (b) $\lambda \in \left(-\frac{3}{5}, 1\right)$

(c) $\lambda \in \left(-\frac{1}{2}, -\frac{3}{5}\right)$ (d) None of these

16. Set of values for which $\frac{\tan 3x - \tan 2x}{1 + \tan 3x \tan 2x} = 1$ is true is

(a) ϕ (b) $n\pi + \frac{\pi}{4},\ n \in Z$

(c) $\left(\frac{\pi}{4}\right)$ (d) $2n\pi + \frac{\pi}{4},\ n \in Z$

17. The distance between the lines 3x + 4y = 9 and 6x + 8y + 15 = 0 is

(a) $\frac{3}{10}$ (b) $\frac{33}{10}$

(c) $\frac{33}{5}$ (d) None of these

18. Let A = (3, –4), B(1, 2) and P = (2k – 1, 2k + 1) is a variable point such that PA + PB is the minimum. Then k is

(a) $\frac{7}{9}$ (b) 0

(c) $\frac{7}{8}$ (d) None of these

19. The length of the y-intercept made by the circle $x^2 + y^2 - 4x - 6y - 5 = 0$ is

(a) 6 (b) $\sqrt{14}$

(c) $2\sqrt{14}$ (d) 3

20. If x + y = k is normal to $y^2 = 12x$, then k =

(a) 3

(b) 6

(c) 9

(d) None of these

21. The number of values of c such that the straight line y = 4x + c touches the curve $\frac{x^2}{4} + y^2 = 1$ is

(a) 0 (b) 1

(c) 2 (d) infinite

22. $\left|\frac{\sqrt{3}+i}{(1+i)(1+\sqrt{3}i)}\right| =$

(a) 1 (b) $\sqrt{2}$

(c) $\frac{1}{2}$ (d) $\frac{1}{\sqrt{2}}$

23. Locus of the point z satisfying Re $\left(\frac{1}{z}\right) = k$, k is a non-zero real number, is

(a) a straight line (b) a circle

(c) an ellipse (d) a hyperbola

24. The points of z satisfying arg $\left(\frac{z-1}{z+1}\right) = \frac{\pi}{4}$ lies on

(a) an arc of a circle (b) a parabola

(c) an ellipse (d) a straight line

25. The coefficients of the (3r)th term and the (r + 2)th term in the expansion $(1 + x)^{2n}$ are equal, then

(a) n = 2r (b) n = 3r

(c) n = 2r + 1 (d) None of these

26. $S = 1 + \frac{3}{1!} + \frac{5}{2!} + \frac{7}{3!} + \ldots \infty$

(a) 2e (b) e

(c) e – 1 (d) 3e

27. If a = 13, b = 12, c = 5 in ΔABC, then $\sin\frac{A}{2} =$

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

(c) $\sqrt{\frac{32}{35}}$ (d) $\frac{1}{\sqrt{2}}$

28. $2\tan^{-1}\left(\frac{3}{4}\right) =$

(a) $\sin^{-1}\frac{24}{25}$ (b) $\sin^{-1}\frac{12}{13}$

(c) $\cos^{-1}\left(\frac{24}{25}\right)$ (d) $\cos^{-1}\left(\frac{12}{13}\right)$

29. Two pairs of straight lines have the equations $y^2 + xy - 12x^2 = 0$ and $ax^2 + 2hxy + by^2 = 0$. One line will be common among them if

(a) $a = -3(2h + 3b)$
(b) $a = 8(h - 2b)$
(c) $a = 2(b + h)$
(d) Both (a) and (b)

30. If a circle passes through the point (3, 4) and cuts $x^2 + y^2 = 9$ orthogonally, then the locus of its centre is $3x + 4y = \lambda$. Then λ =

(a) 11 (b) 13
(c) 17 (d) 23

31. For what value of x, the matrix A is singular

$$A = \begin{bmatrix} 3-x & 2 & 2 \\ 2 & 4-x & 1 \\ -2 & -4 & -1-x \end{bmatrix}$$

(a) x = 0, 2 (b) x = 1, 2
(c) x = 2, 3 (d) x = 0, 3

32. If 7 and 2 are two roots of the following equation

$$\begin{vmatrix} x & 3 & 7 \\ 2 & x & 2 \\ 7 & 6 & x \end{vmatrix} = 0,$$ then its third root will be

(a) –9 (b) 14
(c) $\frac{1}{2}$ (d) None of these

33. Period of $f(x) = \sin^4 x + \cos^4 x$

(a) π (b) $\frac{\pi}{2}$
(c) 2π (d) None of these

34. The range of $\log_e (\sin x)$

(a) $(-\infty, \infty)$ (b) $(-\infty, 1)$
(c) $(-\infty, 0]$ (d) $(-\infty, 0)$

35. $\lim\limits_{x \to 0} \frac{1-\cos(1-\cos x)}{x^4}$ is equal to

(a) $\frac{1}{8}$ (b) $-\frac{1}{8}$
(c) $\frac{2}{3}$ (d) $\frac{3}{2}$

36. Let $y = \log \sin(x^2)$, $0 < x \le \frac{\pi}{2}$. The value of $\frac{dy}{dx}$ at $x = \frac{\sqrt{\pi}}{2}$ is

(a) 0 (b) 1
(c) $\frac{\pi}{4}$ (d) $\sqrt{\pi}$

37. For the curve $x = t^2 - 1$, $y = t^2 - t$ tangent is parallel to x–axis where

(a) t = 0 (b) $t = \frac{1}{\sqrt{3}}$
(c) $t = \frac{1}{2}$ (d) $t = -\frac{1}{\sqrt{3}}$

38. $f(x) = x^3 - 6x^2 + 12x - 16$ is strictly decreasing for

(a) $x \in R$ (b) $x \in R - \{1\}$
(c) $x \in R^+$ (d) $x \in \phi$

39. The value of b for which the function $f(x) = \sin x - bx + c$ is a strictly decreasing function $\forall x \in R$ is

(a) $b \in (-1, 1)$
(b) $b \in (-\infty, 1)$
(c) $b \in (1, \infty)$
(d) $b \in [1, \infty)$

40. Maximum value of the expression $2\sin x + 4\cos x + 3$ is

(a) $2\sqrt{5} + 3$
(b) $2\sqrt{5} - 3$
(c) $\sqrt{5} + 3$
(d) None of these

41. If $\sin\theta = 3\sin(\theta + 2\alpha)$, then the value of $\tan(\theta + \alpha) + 2\tan\alpha$ is

(a) 3 (b) 2
(c) 1 (d) 0

42. $A = \begin{bmatrix} 1 & 2 \\ 3 & 4 \end{bmatrix}, B = \begin{bmatrix} 2 & 1 \\ 3 & 4 \end{bmatrix}$ then $\left|(B^T A^T)^{-1}\right|$ is equal to

(a) 10 (b) $\frac{1}{10}$
(c) 1 (d) –1

43. If $\sqrt{1+x^2}+\sqrt{1+y^2}=a$ then find $\frac{dy}{dx}=$

(a) $\sqrt{\frac{1-y^2}{1-x^2}}$ (b) $-\frac{x}{y}\sqrt{\frac{1+y^2}{1+x^2}}$

(c) $\sqrt{\frac{x^2-1}{y^2-1}}$ (d) None of these

44. Length of the subtangent to the curve $y=e^{x/a}$ is

(a) $e^{x/a}$ (b) a

(c) $\frac{2}{a}$ (d) None of these

$f(x)=x^3-3x-2$ in $[-2, 3]$ is

(a) $\sqrt{\frac{7}{3}}$

(b) $\sqrt{\frac{3}{7}}$

(c) $\frac{\sqrt{7}}{3}$

(d) $\frac{\sqrt{3}}{7}$

PHYSICS

46. A gold coin has a charge of $+10^{-4}$ C. The number of electrons removed from it is

(a) 10^6

(b) 625×10^{10}

(c) 1.6×10^{-25}

(d) 1.6×10^{-13}

47. A small sphere of mass m and electric charge q_1 is suspended by a light thread. A second sphere carrying a charge q_2 is placed directly below the first sphere at a distance 'd' away. Then

(a) tension in thread may reduce to zero if the spheres are positively charged

(b) tension in thread may reduce to zero if the spheres are oppositely charged

(c) tension in thread can never be zero

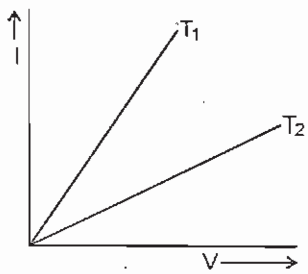
(d) tension in thread is independent of the nature of the charges

48. A pitch ball covered with a tin foil having a mass m kg hangs by a fine silk thread of length ℓ metres in an electric field E. When the ball is given an electric charge of q coulomb, it stands out d metre apart from the vertical line. The magnitude of an electric field will be

(a) $\frac{mgd}{\sqrt{\ell^2-d^2}}$ (b) $\frac{mgd}{q\ell}$

(c) $\frac{mg\ell}{q\sqrt{\ell^2-d^2}}$ (d) $\frac{mg\ell}{q\left(\sqrt{\ell^2-d^2}\right)}$

49. The current I and voltage V graphs for a given metallic wire of two different temperatures T_1 and T_2 are shown in the following figure. It is concluded that



(a) $T_1 > T_2$ (b) $T_1 < T_2$

(c) $T_1 = T_2$ (d) $T_1 = 2T_2$

50. The resistance of a 20 cm long wire is 5 Ω. The wire is stretched to form a uniform wire of 40 cm length. The resistance now will be

(a) 5 Ω (b) 10 Ω

(c) 20 Ω (d) 200 Ω

51. If a copper wire is stretched to make its radius decrease by 0.1%, then the percentage increase in its resistance is approximately

(a) 0.1% (b) 0.2%

(c) 0.4% (d) 0.8%

52. When a charged particle is acted on only by a magnetic force, its

(a) potential energy changes

(b) its kinetic energy changes

(c) total energy changes

(d) energy does not change

53. A positively charged particle projected towards east is deflected towards north by a magnetic field. The field may be

(a) towards west (b) towards south

(c) upwards (d) downward

54. The permanent magnetic moment of the atoms of a material is not zero. The material

(a) must be paramagnetic

(b) must be diamagnetic

(c) must be ferromagnetic

(d) may be paramagnetic

55. A paramagnetic material is kept in a magnetic field. The field is increased till the magnetization becomes constant. If the temperature is now decreased, the magnetization

(a) will decrease

(b) will increase

(c) remain constant

(d) may increase or decrease

56. A metallic wire bent in form of a semi-circle of radius 0.1 m is moved in a direction parallel to its plane, but perpendicular to a magnetic field B = 20m T with a velocity of 10 m/sec. What is the induced e.m.f. in wire?

(a) 4×10^{-3} Volts (b) 4×10^{-2} Volts

(c) 4×10^{-1} Volts (d) None of these

57. A glass rod of length ℓ moves with a velocity v in a uniform magnetic field B, what will be the emf induced in the rod

(a) Zero (b) 0.01 volts

(c) 0.1 volts (d) None of these

58. A $10\,\mu F$ capacitor is connected across a 200 V 50 Hz A.C. supply. the peak current through the circuit is

(a) 0.6 A (b) $0.6\sqrt{2}$ A

(c) $\left(0.6\sqrt{2}\right)$ A (d) $0.6\frac{\pi}{2}$ A

59. An alternating voltage $E = 200\sqrt{2}$ sin (100t) is connected to a 1 μF capacitor through an A.C. ammeter. The reading of the ammeter shall be

(a) 10 mA (b) 20 mA

(c) 40 mA (d) 80 mA

60. The first diffraction minima due to a single slit diffraction is at $\theta = 30°$ for a light of wavelength 5000 Å. The width of the slit is

(a) 5×10^{-5} cm (b) 10×10^{-5} cm

(c) 2.5×10^{-5} cm (d) 1.25×10^{-5} cm

61. A beam of light of wavelength 600 nm from a distant source falls on a single slit 1.00 mm wide and the resulting diffraction pattern is observed on a screen 2 M away. The distance between the first dark fringe on either side of the central maxima is

(a) 1.2 cm (b) 1.2 mm

(c) 2.4 cm (d) 4.8 mm

62. A concave mirror of focal length F produces a real image n times the size of the object. The distance of the object from the mirror is

(a) (n – 1)F (b) (n + 1)F

(c) $\frac{n+1}{n}F$ (d) $\frac{n-1}{n}F$

63. An object is placed at a distance of 2f from a concave mirror. Light reflected from the mirror falls on a plane mirror. The distance of the plane mirror from the concave mirror equals f. The distance of the final image from the concave mirror (due to reflection at both concave and plane mirror) is

(a) f (b) $\frac{f}{2}$

(c) 2f (d) zero

64. A body starts from rest and moves with a uniform acceleration. The ratio of the distance covered in the *n*th sec to the distance covered in *n* sec is

(a) $\frac{2}{n}-\frac{1}{n^2}$ (b) $\frac{1}{n^2}-\frac{1}{n}$

(c) $\frac{2}{n^2}-\frac{1}{n}$ (d) $\frac{1}{n}-\frac{1}{n^2}$

65. The range of a projectile when launched at angle θ is same as when launched at angle 2θ. What is the value of θ?

(a) 15° (b) 30°

(c) 45° (d) 60°

66. A balloon is descending at a constant acceleration α. The mass of the baloon is M. When a mass m is released from the balloon, it starts rising with the same acceleration α. Assuming that the volume does not change when the mass is released, what is the value of m ?

(a) $\frac{\alpha}{\alpha+g}M$ (b) $\frac{2\alpha}{\alpha+g}M$

(c) $\frac{\alpha+g}{\alpha}M$ (d) $\frac{\alpha+g}{2\alpha}M$

67. A heavy block of mass M is slowly placed on a conveyer belt moving with a speed v. The coefficient of friction between the block and the belt is μ. Through what distance will the block slide on the belt ?

(a) $\frac{v}{\mu g}$ (b) $\frac{v^2}{\mu g}$

(c) $\frac{v}{2\mu g}$ (d) $\frac{v^2}{2\mu g}$

68. Under the action of a force, a 2 kg body moves such that its position x as a function of time is given by $x=\frac{t^3}{3}$ where x is in metre and t in second. The work done by the force in the first 2 s is

(a) 1,600 J (b) 160 J

(c) 16 J (d) 1.6 J

69. Three particles of mass M each are placed at corners of an equibterol triangle of side 'd' If the sides are increased to '2d' then

(a) The P.E. $=\frac{-3GM^2}{2d}$

(b) Work done $=\frac{3GM^2}{2d}$

(c) Work done $=\frac{GM^2}{2d}$

(d) P. E. $=\frac{-3GM}{2d}$

70. The de Broglie wavelength of a neutron when its kinetic energy is K, is λ. What will be its wavelength when its kinetic energy is 4k?

(a) $\frac{\lambda}{4}$ (b) $\frac{\lambda}{2}$

(c) 2λ (d) 4λ

71. According to Bohr's theory, the radius of the n^{th} orbit of an atom of atomic number Z is proportional to

(a) $\frac{n^2}{z^2}$ (b) $\frac{n^2}{z}$

(c) $\frac{n}{z}$ (d) n^2z^2

72. When $^{235}_{92}U$ undergoes fission , 0.1 % of its original mass is changed into energy. How much energy is released if 1 kg of $^{235}_{92}U$ undergoes fission ?

(a) 9×10^{10} J (b) 9×10^{11} J

(c) 9×10^{12} J (d) 9×10^{13} J

73. The alternating current gain of a junction transistor in common base arrangement is 0.98. What is the change in the base current corresponding to a change of 5 mA in the emitter current and a change of 4.9 mA in the collector current?

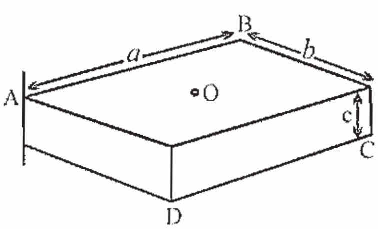
(a) 0.1 mA

(b) 0.2 mA

(c) 0.3 mA

(d) 0.4 mA

74. Fig. shows a uniform solid block of mass M and edge lengths a, b and c. Its M.I about an axis through one edge and perpendicular (as shown) to the large face of the block is



(a) $\frac{M}{3}(a^2+b^2)$

(b) $\frac{M}{4}(a^2+b^2)$

(c) $\frac{7M}{12}(a^2+b^2)$

(d) $\frac{M}{12}(a^2+b^2)$

75. A thick walled hollow sphere has outer radius R. It rolls down an inclined plane without slipping and its speed at the bottom is υ. If the inclined plane is frictionless and the sphere slides down without rolling, its speed at the bottom will be $5\upsilon/4$. What is the radius of gyration of the sphere?

(a) $\frac{R}{\sqrt{2}}$ (b) $\frac{R}{2}$

(c) $\frac{3R}{4}$ (d) $\frac{\sqrt{3}R}{4}$

76. How much force is required to produce an increase of 0.2% in the length of a brass wire of diameter 0.6 mm? (Young's modulus for brass $= 0.9 \times 10^{11} N/m^2$)

(a) nearly 17 N
(b) nearly 34 N
(c) nearly 51 N
(d) nearly 68 N

77. A liquid drops at temperature T, isolated from its surroundings, breaks into a number of droplets. The temperature of the droplets will be

(a) equal to T
(b) greater than T
(c) less than T
(d) either (a), (b), or (c) depending on the surface tension of the liquid

78. In SHM the net force towards mean position is related to its displacement (x) from mean position by the relation

(a) $F \propto x$ (b) $F \propto \frac{1}{x}$

(c) $F \propto x^2$ (d) $F \propto \frac{1}{x^2}$

79. The acceleration (a) of SHM at mean position is

(a) zero (b) $\propto x$
(c) $\propto x^2$ (d) None of these

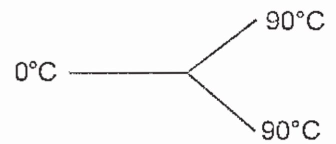
80. When the temperature of air rises by 3 K from 300 K, what is the percentage rise in the velocity of sound?

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

81. A tuning fork vibrating with a sonometer having 20 cm wire produces 5 beats per second. The beat frequency does not change, if the length of the wire is changed to 21 cm. The frequency of tuning fork is

(a) 200 Hz
(b) 210 Hz
(c) 205 Hz
(d) 215 Hz

82. Three rods made of the same material and having the same cross-section have been joined as shown in the fig. Each rod is of the same length. The left and right ends are kept at 0°C and 90°C respectively. The temperature of the junction of the three rods will be



(a) 45°C (b) 60°C
(c) 30°C (d) 20°C

83. If γ be the ratio of specific heats of a perfect gas, the number of degrees of freedom of a molecule of the gas is:

(a) $\frac{25}{2}(\gamma - 1)$ (b) $\frac{3\gamma - 1}{2\gamma - 1}$

(c) $\frac{2}{\gamma - 1}$ (d) $\frac{9}{2}(\gamma - 1)$

84. An ideal gas heat engine operates in Carnot cycle between 227°C and 127°C. It absorbs 6×10^4 cal of heat at higher temperature. Amount of heat converted to work is:

(a) 2.4×10^4 cal
(b) 6×10^4 cal
(c) 1.2×10^4 cal
(d) 4.8×10^4 cal

85. In a room where the temperature is 30°C, a body cools from 61°C to 59°C in 4 min. The time (in min) taken by the body to cool from 51°C to 49°C will be

(a) 4 (b) 6
(c) 5 (d) 8

86. The energy of first excited state of Li^{2+} will be

(a) 13.6 eV (b) 27.2 eV
(c) 30.6 eV (d) 40.8 eV

87. Which of the following phenomena will occur when two atoms of the elements having same spin of electron approach for bonding?

(a) Orbital overlap will not occur
(b) Bonding will not occur
(c) Both (a) and (b) are correct
(d) None of these is correct

88. The number of octahedral sites per sphere in fcc structure are

(a) 8 (b) 4
(c) 2 (d) 1

89. Due to Frenkel defect, the density of ionic solids

(a) decreases
(b) increases
(c) does not change
(d) change depends on crystal structure

90. For the given electrolyte A_xB_y, the degree of dissociation 'α' can be given as

(a) $\alpha = \frac{i-1}{x+y-1}$
(b) $i = (1-\alpha) + x\alpha + y\alpha$
(c) $\alpha = \frac{1-i}{1-x-y}$
(d) All of these

91. The efficiency of a heat engine is maximum when

(a) temperature of sink > temperature of source
(b) temperature of source > temperature of sink
(c) the difference between temperature of source and sink is very high
(d) None of these

92. If three faradays of electricity is passed through the solution of $AgNO_3$, $CuSO_4$ and $AuCl_3$, the molar ratio of the cations deposited at the cathodes will be

(a) 1 : 1 : 1 (b) 1 : 2 : 3
(c) 3 : 2 : 1 (d) 6 : 3 : 2

93. A gas 'X' at 1 atm is bubbled through a solution containing a mixture of 1 M Y^- and 1 M Z^- at 25° C. If the standard reduction potential of Z > Y > X, then

(a) Y will oxidize X and not Z
(b) Y will oxidize Z and not X
(c) Y will oxidize both X and Z
(d) Y will reduce both X and Z

94. The rate constant of a chemical reaction can be increased by

(a) decreasing the temperature
(b) increasing the temperature
(c) increasing concentration of reactants
(d) decreasing concentration of reactants

95. Consider the two equations at a particular temperature

$$2N_2O_5 \rightarrow 4NO_2 + O_2$$

$$N_2O_5 \rightarrow 2NO_2 + \frac{1}{2}O_2$$

If E_1 and E_2 represents the activation energy for the first and second reaction respectively then

(a) $E_1 > E_2$ (b) $E_1 < E_2$
(c) $E_1 = 2E_2$ (d) $E_1 = E_2$

96. Which one of the following is an example of a hydrophilic colloidal sol?

(a) sulphur
(b) As_2S_3
(c) gold sol
(d) starch

97. In P_4O_{10} the number of oxygen atoms attached to each phosphorus atom is

(a) 2 (b) 3
(c) 4 (d) 5

98. Which of the following compound acts both as an oxidising as well as reducing agent?
(*a*) SO_2 (*b*) MnO_2
(*c*) Al_2O_3 (*d*) CrO_3

99. Green vitriol is
(*a*) $CuSO_4$ (*b*) $CuSO_4.7H_2O$
(*c*) $CuSO_4.5H_2O$ (*d*) $FeSO_4.7H_2O$

100. Only lanthanide which is radioactive is
(*a*) Sn (*b*) Yb
(*c*) Pm (*d*) Eu

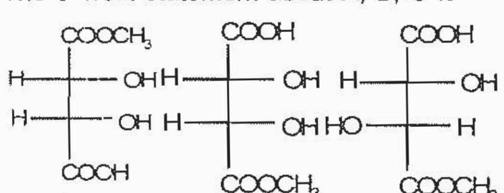
101. When $^{27}_{13}Al$ is bombarded with α particles, a radioactive isotope of phosphorus $^{30}_{15}P$ with the emission of .... is formed
(*a*) neutrons (*b*) protons
(*c*) positrons (*d*) electrons

102. A freshly prepared radioactive source of half life period 2 hours, emits radiations of intensity which is 64 times the permissible safe level. The minimum time after which it would be possible to work with this source is
(*a*) 6 hours (*b*) 12 hours
(*c*) 24 hours (*d*) 48 hours

103. Which of the following has the highest paramagnetism?
(*a*) $[Cr(H_2O)_6]^{3+}$ (*b*) $[Fe(H_2O)_6]^{2+}$
(*c*) $[Cu(H_2O)_6]^{2+}$ (*d*) $[Zn(H_2O)_6]^{2+}$

104. Which of the following will form an octahedral complex?
(*a*) d^4 (low spin) (*b*) d^8 (high spin)
(*c*) d^6 (low spin) (*d*) all of these

105. The correct statement about A, B, C is

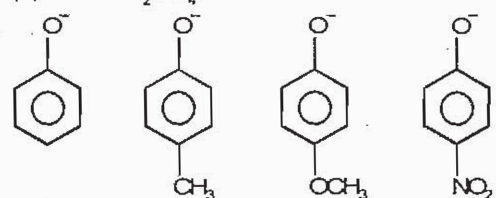


(A) (B) (C)

(*a*) A and B are identical
(*b*) A and B are diastereomers
(*c*) A and C are enantiomers
(*d*) A and B are enantiomers

106. Phenol and benzoic acid can be distinguished by
(*a*) aqueous $NaHCO_3$
(*b*) aqueous $NaNO_3$
(*c*) aqueous NaOH
(*d*) conc. H_2SO_4

107.



I II III IV

(*a*) I > II > III > IV
(*b*) IV > I > II > III
(*c*) I > II > IV > III
(*d*) II > III > IV > I

108. When acetaldehyde is heated with Fehling's solution, it gives a precipitate of
(*a*) Cu
(*b*) CuO
(*c*) $Cu + Cu_2O + CuO$
(*d*) Cu_2O

109. The principal organic product formed in the reaction
$CH_2 = CH(CH_2)_8COOH + HBr \xrightarrow{\text{Peroxide}}$
is
(*a*) $CH_3CH(Br)(CH_2)_8COOH$
(*b*) $CH_2 = CH(CH_2)_8COBr$
(*c*) $CH_2Br(CH_2)_9COOH$
(*d*) $CH_2 = CH(CH_2)_7CHBrCOOH$

110. Secondary nitroalkanes on treatment with nitrous acid form
(*a*) nitrolic acids (*b*) carboxylic acids
(*c*) pseudonitroles (*d*) ketones

111. In HS^-, I^-, $R-NH_2$, NH_3, the order of proton accepting tendency will be
(*a*) $I^- > NH_3 > R-NH_2 > HS^-$
(*b*) $NH_3 > R-NH_2 > HS^- > I^-$
(*c*) $R-NH_2 > NH_3 > HS^- > I^-$
(*d*) $HS^- > R-NH_2 > NH_3 > I^-$

(a) sulphur reacts to form new compound
(b) sulphur cross links are introduced
(c) sulphur forms a very thin protective layer over rubber
(d) All the statements are correct

113. Which of the following does not represent a disaccharide?
(a) Maltose (b) Sucrose
(c) Lactose (d) Dextrose

114. Which one of the following vitamins contains a metal atom?
(a) Riboflavin (b) Vitamin B_{12}
(c) Vitamin A (d) Vitamin B_6

115. Veronal, a barbiturate drug is used as
(a) antihistamine (b) sedative
(c) antiseptic (d) anti-malarial

116. Gay Lussac's law of gaseous volume is derived from
(a) law of definite proportions
(b) law of multiple proportions
(c) law of reciprocal proportions
(d) experimental observation

117. One litre flask contains air, water vapour and small amount of liquid water at a pressure of 200 mm Hg. If this is connected to another one litre evacuated flask, what will be the final pressure of the gas mixture at equilibrium. Assume the temperature to be 50° C.
(Aqueous tension at 50° C = 93 mm Hg)
(a) 120.56 mm
(b) 230 mm
(c) 146.5 mm
(d) 109.4 mm

118. The correct order of decreasing ionic radius among the following anions would be
(a) Se^{2-}, I^-, Br^-, F^-, O^{2-}
(b) F^-, Br^-, O^{2-}, Se^{2-}, I^-
(c) I^-, Se^{2-}, Br^-, O^{2-}, F^-
(d) F^-, O^{2-}, Br^-, Se^{2-}, I^-

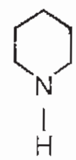
119. $I_2 + I^- \rightleftharpoons I_3^-$
This reaction is set up in aqueous medium. We start with 1 mole of I_2 and 0.5 mole of I^- in 1 L flask. After equilibrium, the excess of $AgNO_3$ gave 0.25 mole of yellow ppt. Then the equilibrium constant is
(a) 1.33 (b) 2.66
(c) 2.00 (d) 3.00

120. At 90° C, pure water has $[H^+] = 10^{-6}$ M. The value of K_w at 90° C is
(a) 10^{-6} (b) 10^{-8}
(c) 10^{-12} (d) 10^{-14}

121. Nitrogen dioxide cannot be obtained by heating
(a) $Pb(NO_3)_2$ (b) $Cu(NO_3)_2$
(c) $AgNO_3$ (d) KNO_3

122. Which of the following is heterocyclic aromatic species?
(a) 

(b) 
(c) 

(d) 

123. Which of the following halides undergoes nucleophilic substitution most readily?
(a) $p - H_3CC_6H_4Cl$
(b) $o - MeOC_6H_4Cl$
(c) $p - ClC_6H_4Cl$
(d) $C_6H_5CH(Cl)CH_3$

124. Dumas' method involves the determination of nitrogen content in the organic compound in the form of
(a) NH_3 (b) N_2
(c) NaCN (d) $(NH_4)_2SO_4$

125. Group V cations are precipitated in form of carbonates by $(NH_4)_2CO_3$. Why can we not use Na_2CO_3 in stead of $(NH_4)_2CO_3$?
(a) Because Na_2CO_3 will precipitate $MgCO_3$
(b) Because Na_2CO_3 is insoluble in water
(c) Because it is an ionic compound
(d) None of these

LOGICAL REASONING

126. In a certain code language MADRAS is coded as 'ARSARS', then how will 'MUMBAI' be coded in that language?

(a) U B M U B M

(b) U B I U B I

(c) M U M M U M

(d) M B A M B A

127. Find the last number of the following number series

10, 8, 16, 13, 39, 35, ?

(a) 75

(b) 100

(c) 130

(d) 140

128. If '×' means subtract, '÷' means multiply, '+' means divide and '–' means add, then which of the following would result in a value of 10.

(a) 15 + 12 × 3 ÷ 2 – 3

(b) 15 × 12 ÷ 3 + 2 – 3

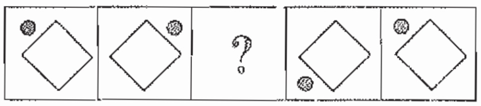
(c) 15 + 12 × 3 – 2 ÷ 3

(d) 15 × 12 + 3 ÷ 2 – 3

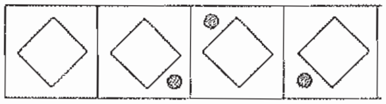
Directions (Q. 129 – 130): *In these questions, there are two sets of figures. The Problem Figures and the Answer Figures. The four Problem Figures make a series. That means they change from left to right in a specific order. The question is, if the figures continue to change in the same order, what should be the third figure, so that the series is completed?*

Study the following problem based on series.

Problem Figures



Answer Figures

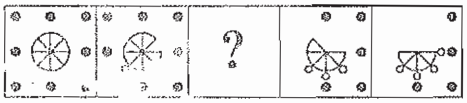


(a) (b) (c) (d)

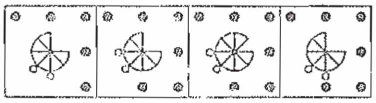
Study the position of the dot in all the Problem Figures. Note that it keeps moving around the square in the clockwise direction. Where would it be in the third position? If you observe in the second figure, the dot is at the upper right corner and in the fourth figure the dot is at the bottom left corner. Hence, in the third figure, it should be at the bottom right corner. Therefore, the answer is b.

Now, solve the following questions.

129. Problem Figures



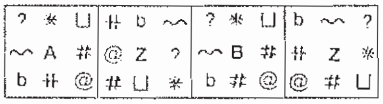
Answer Figures



(a) (b) (c) (d)

130. Problem Figures

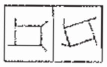
Answer Figures



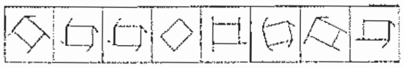
(a) (b) (c) (d)

Directions (Q. 131 – 132): *In each of the following problems a related pair of figures is followed by five numbered pairs of figures. Select the pair that has a similar relationship to that of original pair. The best answer is to be selected from the given choices.*

131.



I II



I (a) II I (b) II I (c) II I (d) II

132.

A	B	C	D	E	@
H	@	D	G	A	F
G	F	E	C	B	H

I II

(a)

8	9	10	13	12	@
15	@	11	14	8	9
14	13	12	15	11	10

(b)

*	↑	=	×	−	@
S	@	×	÷	*	+
÷	−	+	=	↑	S

(c)

P	Q	R	S	U	*
W	*	S	V	P	Q
V	U	T	R	T	W

(d)

1	2	3	4	5	@
8	@	4	7	1	6
7	6	5	3	2	8

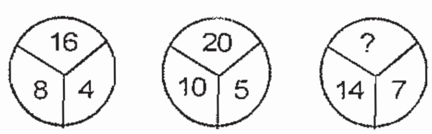
133. In a family of 6 members A, B, C, D, E and F. There are three males and three females. There are two fathers. C is aunt of F who is the grandson of A. D is the daughter in law of E who is mother of C. What is the relation between D and F?

(*a*) Father-son
(*b*) Sister-brother
(*c*) Sibling
(*d*) Mother-son

134. Five persons Anurag, Anuj, Ajay, Atul and Anand live in a five storey building at different floors. Anurag lives above Ajay but below Anand. Atul lives above Ajay but below Anurag. Anuj lives below Anand but above Atul. In which floor does Anuj live?

(*a*) 2nd (*b*) 3rd
(*c*) 4th (*d*) Either (*b*) or (*c*)

135. What is the missing number?



(*a*) 22 (*b*) 24
(*c*) 28 (*d*) 27

136. Insert the missing number.

23	22	24	21	?
46	47	45	48	?

(*a*) $\frac{24}{45}$ (*b*) $\frac{23}{46}$

(*c*) $\frac{25}{44}$ (*d*) $\frac{25}{48}$

137. There are fifty birds on a tree. A hunter shot at them with a rifle and three birds fell dead. How many birds were left on the tree?

(*a*) 47
(*b*) 45
(*c*) 46
(*d*) None

138. Ram is older than Shyam and Raju. Raju is older than Kumar. Sachin is younger than Shyam but older than Kumar. Sachin is younger than Raju. Ram is younger than Saurav. Who is the oldest man?

(a) Ram (*b*) Shyam
(*c*) Raju (*d*) Saurav

139. Sheetal beats Hema at Tennis but losses to Monica. Sonali usually wins against Hema, sometimes against Sheetal, but never against Monica. Who is the weakest player?

(*a*) Sheetal
(*b*) Hema
(*c*) Sonali
(*d*) Monica

Directions for question 140: *Read the information and answer the questions given below:*

'A + B' means 'A is the daughter of B',
'A × B' means 'A is the son of B', and
'A – B' means 'A is the wife of B'

140. If T – S × B – M, which of the following is not true?

(*a*) B is mother of S.
(*b*) M is the husband of B.
(*c*) T is the daughter of M.
(*d*) T is the daughter-in-law of B.

ENGLISH

Directions (Q. 141 – 144): *The passage given below is followed by a set of questions. Choose the best answer for each question.*

PASSAGE – I

Given overwhelming evidence for the primacy of sociocultural factors in determining both drinking patterns and their consequences, it is clear that ethnographic research findings on the social and cultural roles of alcohol may have important implications for policy-makers - particularly in areas such as Europe where economic and political 'convergence' could have significant impact on drinking-cultures and their associated lifestyles.

In this context, it is essential for those concerned with policy and legislation on alcohol to have a clear understanding of the sociocultural functions and meanings of drinking. This passage outlines the principal conclusions that can be drawn from the available cross-cultural material regarding the symbolic uses of alcoholic beverages, the social functions of drinking-places and the roles of alcohol in transitional and celebratory rituals.

From the ethnographic material available, it is clear that in all cultures where more than one type of alcoholic beverage is available, drinks are classified in terms of their social meaning, and the classification of drinks is used to define the social world. Few, if any, alcoholic beverages are 'socially neutral': every drink is loaded with symbolic meaning, every drink conveys a message. Alcohol is a symbolic vehicle for identifying, describing, constructing and manipulating cultural systems, values, interpersonal relationships, behavioural norms and expectations. Choice of beverage is rarely a matter of personal taste.

At the simplest level, drinks are used to define the nature of the occasion. In many Western cultures, for example, champagne is synonymous with celebration, such that if champagne is ordered or served at an otherwise 'ordinary' occasion, someone will invariably ask "What are we celebrating?"

In the Weiner Becken in Austria, sekt is drunk on formal occasions, while schnapps is reserved for more intimate, convivial gatherings - the type of drink served defines both the nature of the event and the social relationship among the drinkers. The choice of drink also dictates behaviour, to the extent that the appearance of a bottle of schnapps can prompt a switch from the 'polite' form of address, sie, to the highly intimate du.

141. According to the author,

(*a*) Drinks are classified in order to define the economic scenario of the country.

(*b*) Drinks are classified in order to depict the real-life political situation of the world.

(*c*) Drinks are classified in order to define the social world.

(*d*) Drinks are classified on the basis of public demand.

142. All of the following are true in terms of the passage except:

(*a*) Champagne is similar to celebration in Western countries.

(*b*) Drink determines the behaviour of the person.

(*c*) Every drink carries a symbolic meaning with it.

(*d*) All alcoholic drinks are "socially neutral".

143. The author states the different functions of drinking in order to:

(*a*) describe that drinking is socially positive.

(*b*) the names of different drinks and the occasions when they are consumed.

(*c*) bring about the hidden aspects of the Western culture.

(*d*) emphasize that alcohol is a symbolic representation of determining cultural values, relationships and behavioural patterns.

144. Which of the following words is closest in meaning to the word "convivial" used in the fifth paragraph of the passage?

(*a*) Genial (*b*) Intimidate

(*c*) Harassing (*d*) Rude

Directions (Q. 145 – 146): *Each question below consists of a word, followed by four words. Choose the word that is most nearly the same in meaning to the word given in the question.*

145. Incongruous
(*a*) regular (*b*) fighting
(*c*) discordant (*d*) mandatory

146. Felicity
(*a*) jubilation (*b*) encouragement
(*c*) appropriate (*d*) pleasant

Direction for question 147: *Choose the active form of the sentence given below:*

147. Akki was made to join the art academy because of his father's interest.
(*a*) Akki was forced to join the art academy because of his father's interest.
(*b*) Akki took the decision of joining the art academy because of his father's interest.
(*c*) Akki's father is responsible for his joining of the art academy.
(*d*) Akki joined the art academy because of his father's interest.

Directions (Q. 148 – 149): *Fill in the blanks with the suitable collective nouns from the options given below the sentences:*

148. They were delighted to see a ______ of fish near the bank of the river.
(*a*) platoon (*b*) shoal
(*c*) tidings (*d*) meeting

149. Children were excited to see a ___ of candies.
(*a*) mint (*b*) plague
(*c*) wisp (*d*) prattle

150. Further complicating the situation in the US is the fact that whatever decision is made can be overruled by the family.
(*a*) that whatever decision is made can be overruled by the family
(*b*) whatever decision is made can be overruled by the family
(*c*) that what decision is made can be overruled by the family
(*d*) that whatever decision is made can be ruled by the family

ANSWERS

MATHEMATICS

1. (*b*)	2. (*d*)	3. (*c*)	4. (*b*)	5. (*b*)	6. (*d*)	7. (*c*)	8. (*c*)	9. (*d*)	10. (*b*)
11. (*c*)	12. (*b*)	13. (*c*)	14. (*a*)	15. (*b*)	16. (*a*)	17. (*b*)	18. (*c*)	19. (*c*)	20. (*c*)
21. (*c*)	22. (*d*)	23. (*b*)	24. (*a*)	25. (*a*)	26. (*d*)	27. (*d*)	28. (*a*)	29. (*d*)	30. (*c*)
31. (*d*)	32. (*b*)	33. (*b*)	34. (*c*)	35. (*a*)	36. (*d*)	37. (*c*)	38. (*d*)	39. (*c*)	40. (*a*)
41. (*d*)	42. (*b*)	43. (*b*)	44. (*b*)	45. (*a*)					

PHYSICS

46. (*b*)	47. (*a*)	48. (*a*)	49. (*a*)	50. (*c*)	51. (*a*)	52. (*c*)	53. (*c*)	54. (*c*)	55. (*a*)
56. (*b*)	57. (*d*)	58. (*d*)	59. (*b*)	60. (*b*)	61. (*d*)	62. (*c*)	63. (*d*)	64. (*a*)	65. (*b*)
66. (*b*)	67. (*d*)	68. (*c*)	69. (*b*)	70. (*b*)	71. (*b*)	72. (*d*)	73. (*a*)	74. (*a*)	75. (*b*)
76. (*c*)	77. (*c*)	78. (*a*)	79. (*a*, *b*)	80. (*a*)	81. (*c*)	82. (*b*)	83. (*c*)	84. (*c*)	85. (*b*)

CHEMISTRY

86. (*c*)	87. (*c*)	88. (*d*)	89. (*c*)	90. (*c*)	91. (*c*)	92. (*d*)	93. (*a*)	94. (*b*)	95. (*d*)
96. (*a*)	97. (*c*)	98. (*a*)	99. (*d*)	100. (*c*)	101. (*a*)	102. (*b*)	103. (*b*)	104. (*c*)	105. (*d*)
106. (*a*)	107. (*d*)	108. (*d*)	109. (*c*)	110. (*c*)	111. (*c*)	112. (*b*)	113. (*d*)	114. (*b*)	115. (*b*)
116. (*d*)	117. (*c*)	118. (*c*)	119. (*a*)	120. (*c*)	121. (*d*)	122. (*c*)	123. (*d*)	124. (*b*)	125. (*a*)

LOGICAL REASONING

126. (*b*)	127. (*d*)	128. (*d*)	129. (*d*)	130. (*d*)	131. (*b*)	132. (*d*)	133. (*d*)	134. (*d*)	135. (*c*)
136. (*c*)	137. (*d*)	138. (*d*)	139. (*b*)	140. (*c*)					

ENGLISH

141. (*c*)	142. (*d*)	143. (*d*)	144. (*a*)	145. (*c*)	146. (*a*)	147. (*d*)	148. (*b*)	149. (*a*)	150. (*c*)

ANSWERS

MATHEMATICS

1. (b)	2. (d)	3. (c)	4. (b)	5. (b)	6. (d)	7. (c)	8. (c)	9. (d)	10. (b)
11. (c)	12. (b)	13. (c)	14. (a)	15. (b)	16. (a)	17. (b)	18. (c)	19. (c)	20. (c)
21. (c)	22. (d)	23. (b)	24. (a)	25. (a)	26. (d)	27. (d)	28. (a)	29. (d)	30. (c)
31. (d)	32. (b)	33. (b)	34. (c)	35. (a)	36. (d)	37. (c)	38. (d)	39. (c)	40. (a)
41. (d)	42. (b)	43. (b)	44. (b)	45. (a)					

PHYSICS

46. (b)	47. (a)	48. (a)	49. (a)	50. (c)	51. (a)	52. (c)	53. (c)	54. (c)	55. (a)
56. (b)	57. (d)	58. (d)	59. (b)	60. (b)	61. (d)	62. (c)	63. (d)	64. (a)	65. (b)
66. (b)	67. (d)	68. (c)	69. (b)	70. (b)	71. (b)	72. (d)	73. (a)	74. (a)	75. (b)
76. (c)	77. (c)	78. (a)	79. (a, b)	80. (a)	81. (c)	82. (b)	83. (c)	84. (c)	85. (b)

CHEMISTRY

86. (c)	87. (c)	88. (d)	89. (c)	90. (c)	91. (c)	92. (d)	93. (a)	94. (b)	95. (d)
96. (a)	97. (c)	98. (a)	99. (d)	100. (c)	101. (a)	102. (b)	103. (b)	104. (c)	105. (d)
106. (a)	107. (d)	108. (d)	109. (c)	110. (c)	111. (c)	112. (b)	113. (d)	114. (b)	115. (b)
116. (d)	117. (c)	118. (c)	119. (a)	120. (c)	121. (d)	122. (c)	123. (d)	124. (b)	125. (a)

LOGICAL REASONING

126. (b)	127. (d)	128. (d)	129. (d)	130. (d)	131. (b)	132. (d)	133. (d)	134. (d)	135. (c)
136. (c)	137. (d)	138. (d)	139. (b)	140. (c)					

ENGLISH

141. (c)	142. (d)	143. (d)	144. (a)	145. (c)	146. (a)	147. (d)	148. (b)	149. (a)	150. (c)