disha
Nurturing Ambitions

JEE MAIN

MOCK TEST - 01

Student Name : ____________________ **MM : 360**

Time : 3 Hours **Date : ....**

SYLLABUS

PHYSICS : COMPLETE SYLLABUS

CHEMISTRY : COMPLETE SYLLABUS

MATHEMATICS : COMPLETE SYLLABUS

INSTRUCTIONS

1. Immediately fill in the particulars on this page of the Test Booklet with Blue/Black Ball Point Pen. Use of pencil is strictly prohibited.

2. The Answer Sheet is kept inside this Test Booklet. When you are directed to open the Test Booklet, take out the Answer Sheet and fill in the particulars carefully.

3. The test is of 3 hours duration.

4. The Test Booklet consists of 90 questions. The maximum marks are 360.

5. There are three parts in the question paper.

Subject	No. of Questions	Mark per Question	Negative Marking	Total Marks
Physics	30	4	–1	120
Chemistry	30	4	–1	120
Maths	30	4	–1	120
Total	**90**			**360**

6. Each question consists of four marks.

¼ (one fourth) mark will be deducted for indicating incorrect response of each question. No deduction from the total score will be made if no response is indicated for an item in the answer sheet.

7. Use Blue/Black Ball Point Pen only for writing particulars/marking responses on Side-1 and Side-2 of the Answer Sheet. Use of pencil is strictly prohibited.

8. No candidate is allowed to carry any textual material, printed or written, bits of papers, pager, mobile phone, any electronic device, etc. except the Admit Card inside the examination hall/room.

9. Rough work is to be done on the space provided for this purpose in the Test Booklet only.

10. On completion of the test, the candidate must hand over the Answer Sheet to the Invigilator on duty in the Room/Hall. However, the candidates are allowed to take away this Test Booklet with them.

11. Do not fold or make any stray marks on the Answer Sheet.

SPACE FOR ROUGH WORK

PART A – PHYSICS

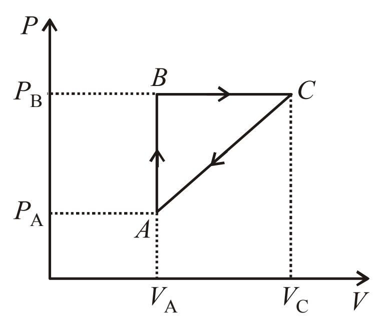
DIRECTIONS : There are 30 multiple choice questions numbered 1 to 30. Each question has 4 choices (a), (b), (c) and (d), out of which ONLY ONE is correct.

1. A small mass slides down a fixed inclined plane of inclination θ with the horizontal. The coefficient of friction is $\mu = \mu_0 x$ where x is the distance through which the mass slides down and μ_0 is a constant. Then the speed is maximum after the mass covers a distance of

(a) $\frac{\cos\theta}{\mu_0}$ (b) $\frac{\sin\theta}{\mu_0}$

(c) $\frac{\tan\theta}{\mu_0}$ (d) $\frac{2\tan\theta}{\mu_0}$

2. A thermodynamical process is shown in the figure with $P_A = 3 \times P_{atm}$, $V_A = 2 \times 10^{-4}\,m^3$, $P_B = 8 \times P_{atm}$, $V_C = 5 \times 10^{-4}\,m^3$, in the process AB and BC, 600 J and 200 J heat are added to the system, respectively. Find the change in internal energy of the system in the process *CA*. ($1\,P_{atm} = 10^5\,N/m^2$)



(a) 560 J (b) – 560 J

(c) – 40 J (d) + 40 J

3. Dimensionally wavelength is equivalent to

(a) $\frac{E\sqrt{LC}}{B}$ (b) $\frac{E}{B\sqrt{LC}}$

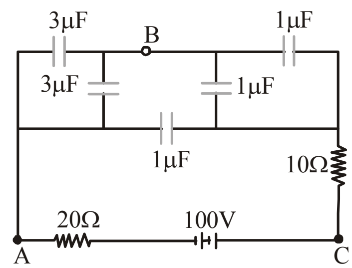
(c) $\frac{B\sqrt{LC}}{E}$ (d) $\frac{B}{E\sqrt{LC}}$

4. Two polaroids are placed in the path of unpolarized beam of intensity I_0 such that no light is emitted from the second polaroid. If a third polarioid whose polarization axis makes an angle θ with the polarization axis of first polaroids, is placed between these polaroids then the intensity of light emerging from the last polaroid will be

(a) $\left(\frac{I_0}{8}\right)\sin^2 2\theta$ (b) $\left(\frac{I_0}{4}\right)\sin^2 2\theta$

(c) $\left(\frac{I_0}{2}\right)\cos^4\theta$ (d) $I_0\cos^4\theta$

5. In the figure below, what is the potential difference between the point A and B and between B and C respectively in steady state



(a) $V_{AB} = V_{BC} = 100\,V$

(b) $V_{AB} = 75, V_{BC} = 25\,V$

(c) $V_{AB} = 25V, V_{BC} = 75V$

(d) $V_{AB} = V_{BC} = 50V$

6. A ball is thrown upward with initial velocity $v_0 = 15.0$ m/s at an angle of 30° with the horizontal. The thrower stands near the top of a long hill which slopes downward at an angle of 20°. When does the ball strike the slope ?

(a) 2.49s (b) 1.13s

(c) 2.12s (d) 5.12s

7. An electromagnetic wave in vacuum has the electric and magnetic field $\vec{E}$ and $\vec{B}$, which are always perpendicular to each other. The direction of polarization is given by $\vec{X}$ and that of wave propagation by $\vec{k}$. Then

(a) $\vec{X} \parallel \vec{B}$ and $\vec{k} \parallel \vec{B} \times \vec{E}$

(b) $\vec{X} \parallel \vec{E}$ and $\vec{k} \parallel \vec{E} \times \vec{B}$

(c) $\vec{X} \parallel \vec{B}$ and $\vec{k} \parallel \vec{E} \times \vec{B}$

(d) $\vec{X} \parallel \vec{E}$ and $\vec{k} \parallel \vec{B} \times \vec{E}$

8. For a completely inelastic two-body collision, the total kinetic energy retained by the objects is the same as

(a) the total kinetic energy before the collision

(b) the difference in the kinetic energies of the objects before the collision

(c) $\frac{1}{2}Mv_{com}^2$, where M is the total mass and v_{com} is the velocity of the center of mass

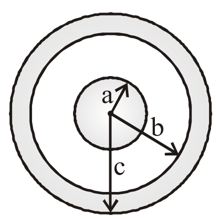
(d) the kinetic energy of the less massive body before the collision

9. An example of a perfect diamagnet is a superconductor. This implies that when a superconductor is put in a magnetic field of intensity B, the magnetic field B_s inside the superconductor will be such that:

(a) $B_s = -B$ (b) $B_s = 0$

(c) $B_s = B$ (d) $B_s < B$ but $Bs \neq 0$

10. A solid conducting sphere of radius a has a net positive charge 2Q. A conducting spherical shell of inner radius b and outer radius c is concentric with the solid sphere and has a net charge – Q. The surface charge density on the inner and outer surfaces of the spherical shell will be



(a) $-\frac{2Q}{4\pi b^2}, \frac{Q}{4\pi c^2}$

(b) $-\frac{Q}{4\pi b^2}, \frac{Q}{4\pi c^2}$

(c) $0, \frac{Q}{4\pi c^2}$

(d) None of these

11. A particle of mass 1 kg is placed in a potential field. Its potential energy is given by $U = 10x^2 + 5$. The frequency of oscillations of the particle is given by

(a) $\left(\sqrt{10}\right)$ (b) $\left(\sqrt{5}\right)$

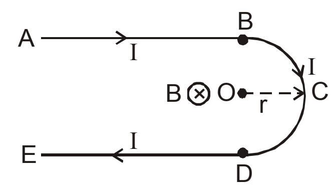
(c) $\left(\sqrt{\frac{10}{\pi}}\right)$ (d) $\left(\frac{\sqrt{5}}{\pi}\right)$

12. A spherical uniform planet is rotating about its axis. The velocity of a point on its equator is v. Due to the rotation of planet about its axis the acceleration due to gravity g at equator is 1/2 of g at poles. The escape velocity of a particle on the pole of planet in terms of v is

(a) $v_e = 2v$ (b) $v_e = v$

(c) $v_e = v/2$ (d) $v_e = \sqrt{3}v$

13. A long wire is bent into shape ABCDE as shown in fig., with BCD being a semicircle with centre O and radius r metre. A current of I amp. flows through it in the direction $A \to B \to C \to D \to E$. Then the magnetic induction at the point O of the figure in vacuum is



(a) $\mu_0\left[\frac{I}{2\pi r} + \frac{I}{4r}\right]$

(b) $\mu_0\left[\frac{I}{2\pi r} - \frac{I}{4r}\right]$

(c) $\mu_0 I / 4r$

(d) $\mu_0 I / \pi r$

14. The radius of curvature of a thin plano-convex lens is 10 cm (of curved surface) and the refractive index is 1.5. If the plane surface is silvered, then it behaves like a concave mirror of focal length

(a) 10 cm (b) 15 cm

(c) 20 cm (d) 5 cm

15. A particle starts sliding down a frictionless inclined plane. If S_n is the distance travelled by it from time $t = n - 1$ sec to $t = n$ sec, the ratio S_n/S_{n+1} is

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

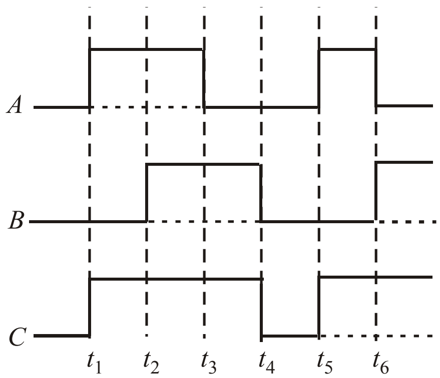
(c) $\frac{2n}{2n+1}$ (d) $\frac{2n+1}{2n-1}$

16. At very high temperatures vibrational degrees also becomes active. At such temperatures an ideal diatomic gas has a molar specific heat at constant pressure, C_p is

(a) 3R/2 (b) 5R/2

(c) 6R/2 (d) 9R/2

17. The figure shows a logic circuit with two inputs *A* and *B* and the output *C*. The voltage wave forms across *A*, *B* and *C* are as given. The logic gate circuit is :



(a) OR gate (b) NOR gate
(c) AND gate (d) NAND gate

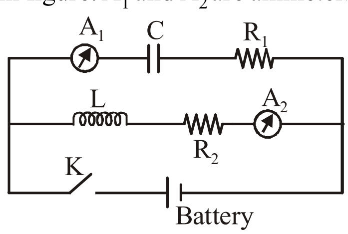
18. The frequency deviation in a FM transmission is 18.75 KHz. If it broadcasts in 88-108 MHz band, then the percent modulation is
(a) 10% (b) 25%
(c) 50% (d) 75%

19. The decay constants of a radioactive substance for α and β emission are λ_α and λ_β respectively. If the substance emits α and β simultaneously, then the average half life of the material will be

(a) $\dfrac{2T_\alpha T_\beta}{T_\alpha + T_\beta}$ (b) $T_\alpha + T_\beta$

(c) $\dfrac{T_\alpha T_\beta}{T_\alpha + T_\beta}$ (d) $\dfrac{1}{2}\left(T_\alpha + T_\beta\right)$

20. In a circuit inductance L and capacitance C are connected as shown in figure. A_1 and A_2 are ammeters.

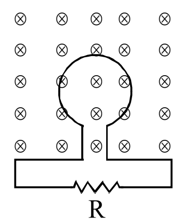


When key K is pressed to complete the circuit, then just after closing key (K), the readings of A_1 and A_2 will be
(a) zero in both A_1 and A_2
(b) maximum in both A_1 and A_2
(c) zero in A_1 and maximum in A_2
(d) maximum in A_1 and zero in A_2

21. Excitation energy of a hydrogen like ion in its excitation state is 40.8 eV. Energy needed to remove the electron from the ion in ground state is
(a) 54.4 eV (b) 13.6 eV (c) 40.8 eV (d) 27.2 eV

22. A rubber cord catapult has cross-sectional area 25 mm^2 and initial length of rubber cord is 10 cm. It is stretched to 5 cm and then released to project a missile of mass 5 gm. Taking $Y_{rubber} = 5 \times 10^8$ N/m^2. Velocity of projected missile is
(a) 20 ms^{-1} (b) 100 ms^{-1}
(c) 250 ms^{-1} (d) 200 ms^{-1}

23. In the figure the flux through the loop perpendicular to the plane of the coil and directed into the paper is varying according to the relation $\phi = 6t^2 + 7t + 1$ where ϕ is in milliweber and t is in second. The magnitude of the emf induced in the loop at t = 2 s and the direction of induce current through R are

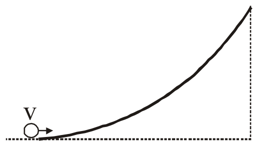


(a) 39 mV; right to left (b) 39 mV; left to right
(c) 31 mV; right to left (d) 31 mV; left to right

24. A body initially at 80°C cools to 64°C in 5 minutes and to 52°C in 10 minutes. The temperature of the body after 15 minutes will be :
(a) 42.7°C (b) 35°C (c) 47°C (d) 40°C

25. A proton has kinetic energy *E* = 100 keV which is equal to that of a photon. The wavelength of photon is λ_2 and that of proton is λ_1. The ration of λ_2/λ_1 is proportional to
(a) E^2 (b) $E^{1/2}$
(c) E^{-1} (d) $E^{-1/2}$

26. A small object of uniform density rolls up a curved surface with an initial velocity v. It reaches up to a maximum height of $\frac{3v^2}{4g}$ with respect to the initial position. The object is

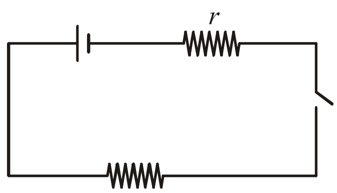


(a) Ring
(b) Solid sphere
(c) Hollow sphere
(d) Disc

27. A tiny spherical oil drop carrying a net charge q is balanced in still air will a vertical uniform electric field of strength $\frac{81\pi}{7} \times 10^5\ Vm^{-1}$. When the field is switched off, the drop is observed to fall with terminal velocity $2 \times 10^{-3}\ ms^{-1}$.(Given : $g = 9.8\ ms^{-2}$, viscosity of the air $= 1.8 \times 10^{-5}\ Nsm^{-2}$ and the density of oil $= 900\ kgm^{-3}$) the magnitude of q is

(a) 1.6×10^{-19} C
(b) 3.2×10^{-19} C
(c) 4.8×10^{-19} C
(d) 8.0×10^{-19} C

28. The current in the circuit shown is constant when the switch is closed. The energy dissipated in the internal resistance *r* of the battery is 15J when a charge of 40C passes through it. For the same amount of charge, 45J of energy is transferred in the resistor *R*. Which of the following gives the emf of the battery ?



(a) $\frac{15}{40}$V
(b) $\frac{30}{40}$V
(c) $\frac{45}{40}$V
(d) $\frac{60}{40}$V

29. A body of mass M is kept on a rough horizontal surface (friction coefficient μ). A person is trying to pull the body by applying a horizontal force but the body is not moving. The force by the surface on the body is F, then

(a) $F = Mg$
(b) $F = \mu Mg$
(c) $Mg \le F \le Mg\sqrt{1+\mu^2}$
(d) $Mg \ge F \ge Mg\sqrt{1+\mu^2}$

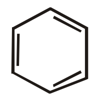
30. 25 tunning forks are arranged in series in order of decreasing frequency. Any two successive forks produce 3 beats/sec. If the frequency of the first tuning fork is the octave of the last fork, then the frequency of the 21st fork is

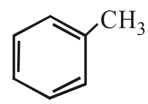
(a) 72 Hz
(b) 288 Hz
(c) 84 Hz
(d) 87 Hz

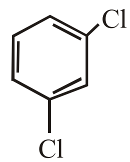
PART B – CHEMISTRY

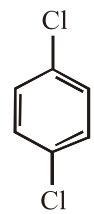
DIRECTIONS : There are 30 multiple choice questions numbered 31 to 60. Each question has 4 choices (a), (b), (c) and (d), out of which ONLY ONE is correct.

31. Arrange the following compounds in the increasing order of their densities.

(i) 

(ii) 

(iii) 

(iv) 

(a) (i) < (ii) < (iii) < (iv)
(b) (i) < (iii) < (iv) < (ii)
(c) (iv) < (iii) < (ii) < (i)
(d) (ii) < (iv) < (iii) < (i)

32. The degree of dissociation of 1.0 M weak acid, HA, is 0.5%. If 2 ml of 1.0 M HA solution is diluted to 32 ml, the degree of dissociation of the acid and H_3O^+ ion concentration in the resulting solution will be respectively:

(a) 0.02 and 3.125×10^{-4}
(b) 0.02 and 1.25×10^{-3}
(c) 1.25×10^{-3} and 0.02
(d) 0.02 and 8.0×10^{-12}

33. For real gases, the relation between P, V and T is given by van der Waal's equation $\left(P + \frac{an^2}{V^2}\right)(V - nb) = nRT$. For the gases CH_4, CO_2, O_2 and H_2 which gas will have

(i) highest value of a
(ii) lowest value of *b*?

(a) (i) CO_2, (ii) H_2
(b) (i) CH_4, (ii) CO_2
(c) (i) H_2, (ii) CO_2
(d) (i) O_2, (ii) H_2

SPACE FOR ROUGH WORK

34. A fire of lithium, sodium and potassium can be extinguished by
(a) H_2O (b) Nitrogen
(c) CO_2 (d) Asbestose blanket

35. An '*fcc*' in a unit cell of aluminium contains the equivalent of how many atoms ?
(a) 1 (b) 2 (c) 3 (d) 4

36. Moissan boron is
(a) amorphous boron of ultra purity
(b) crystalline boron of ultra purity
(c) amorphous boron of low purity
(d) crystalline boron of low purity

37. Which reaction characteristic(s) is/are changed by the addition of a catalyst to a reaction at constant temperature ?
(i) Activation energy
(ii) Equilibrium constant
(iii) Reaction enthalpy
(a) (i) only (b) (iii) only
(c) (i) and (ii) only (d) All of these

38. Which one of the following is the lightest?
(a) 0.2 mole of hydrogen gas
(b) 6.023×10^{22} molecules of nitrogen
(c) 0.1 g of silver
(d) 0.1 mole of oxygen gas

39. A metal M reacts with N_2 to give a compound 'A' (M_3N). 'A' on heating at high temperature gives back 'M' and 'A' on reacting with H_2O gives a gas 'B'. 'B' turns $CuSO_4$ solution blue on passing through it. M and B can be :
(a) Al and NH_3 (b) Li and NH_3
(c) Na and NH_3 (d) Mg and NH_3

40. There is no S–S bond in :
(a) $S_2O_4^{2-}$ (b) $S_2O_5^{2-}$
(c) $S_2O_3^{2-}$ (d) $S_2O_7^{2-}$

41. When ethanal reacts with CH_3MgBr and C_2H_5OH/dry HCl, the product formed are :
(a) ethyl alcohol and 2-propanol
(b) ethane and hemi acetal
(c) 2-propanol and acetal
(d) propane and methyl acetate

42. If the solutions of NaCl and $NaNO_3$ are mixed in one beaker and the temperature adjusted to 383° K, the contents of the beaker will most likely:
(a) freeze
(b) boil
(c) exhibit precipitation of $NaNO_3$
(d) exhibit a marked color change

43. Which one of the alkali metals, forms only, the normal oxide, M_2O on heating in air ?
(a) Rb (b) K (c) Li (d) Na

44. Given the molecular formula of the hexa-coordinated complexes (i) $CoCl_3.6NH_3$, (ii) $CoCl_3.5NH_3$, (iii) $CoCl_3.4NH_3$ If the number of co-ordinated NH_3 molecules in (i), (ii) and (iii) respectively are 6, 5, 4, the primary valencies in (i), (ii) and (iii) are :
(a) 6, 5, 4 (b) 3, 2, 1 (c) 0, 1, 2 (d) 3, 3, 3

45. The repeating unit present in Nylon 6 is
(a) $—[NH(CH_2)_6NHCO(CH_2)_4CO]—$
(b) $—[CO(CH_2)_5NH]—$
(c) $—[CO\,(CH_2)_6NH]—$
(d) $—[CO\,(CH_2)_4NH]—$

46. The helical structure of proteins is stabilized by
(a) H-bonding (b) van der Waal's forces
(c) ionic bond (d) peptide bond

47. With a change in hybridization of the carbon bearing the charge, the stability of a carbanion decreases in the order :
(a) $sp < sp^2 < sp^3$ (b) $sp < sp^3 < sp^2$
(c) $sp^3 < sp^2 < sp$ (d) $sp^2 < sp < sp^3$

48. What is the molarity of H_2SO_4 solution if 25ml is exactly neutralized with 32.63 ml of 0.164 M, NaOH ?
(a) 0.107 M (b) 0.126 M
(c) 0.214 M (d) –0.428 M

49. Which of the following has zero dipole moment?
(a) ClF (b) PCl_3 (c) SiF_4 (d) $CFCl_3$

50. Which of the following compounds are not arranged in order of decreasing reactivity towards electrophilic substitution?
(a) Methoxybenzene > Toluene > Bromobenzene
(b) Phenol > N-Propylbenzene > Benzoic acid
(c) Chlorotoluene > Para-Nitrotoluene > 2-Chloro-4-nitrotoluene
(d) Benzoic acid > Phenol > N-Propylbenzene

SPACE FOR ROUGH WORK

51. The temperature of an ideal gas is reduced from 927°C to 27°C. the r.m.s. velocity of the molecules becomes.
(a) double the inital value
(b) half of the initial value
(c) four times the initial value
(d) ten times the initial value

52. Which is not true for beryllium ?
(a) Beryllium is amphoteric
(b) It forms unusual carbide, Be_2C
(c) $Be(OH)_2$ is basic
(d) Beryllium halides are electron deficient

53. Which of the following pairs show reverse properties on moving along a period from left to right and from up to down in a group :
(a) Nuclear charge and electron affinity
(b) Ionization energy and electron affinity
(c) Atomic radius and electron affinity
(d) None of the above

54. According to the first law of thermodynamics which of the following quantities represents change in a state function ?
(a) q_{rev} (b) $q_{rev} - W_{rev}$
(c) q_{rev}/W_{rev} (d) $q_{rev} + W_{rev}$

55. The relative abundance of two isotopes of atomic weight 85 and 87 is 75% and 25% respectively. The average atomic weight of element is
(a) 75.5 (b) 85.5
(c) 40.0 (d) 86.0

56. The strongest base in aqueous solution among the following amines is
(a) N, N-diethylethanamine
(b) N-ethylethanamine
(c) N-methylmethanamine
(d) ethanamine

57. Which of the following compounds is **not** expected to show Lassaigne's test for nitrogen ?
(a) Propanenitrile
(b) Hydroxylamine hydrochloride
(c) Nitromethane
(d) Ethanamine

58. A white sodium salt dissolves readily in water to give a solution which is neutral to litmus. When silver nitrate solution is added to the solution, a white precipitate is obtained which does not dissolve in dil. HNO_3. The anion could be
(a) CO_3^{2-} (b) Cl^- (c) SO_4^{2-} (d) S^{2-}

59. If 0.5 mol of $BaCl_2$ is mixed with 0.2 mole of Na_3PO_4, find the maximum amount of $Ba_3(PO_4)_2$ that can be formed.
(a) 1 mole (b) 0.5 mole
(c) 0.1 mole (d) 0.01 mole

60. Which one of the following statement is *not true*?
(a) In vulcanization the formation of sulphur bridges between different chains make rubber harder and stronger.
(b) Natural rubber has the *trans* -configuration at every double bond.
(c) Buna-S is a copolymer of butadiene and styrene.
(d) Natural rubber is a 1, 4 - polymer of isoprene.

PART C – MATHEMATICS

DIRECTIONS : There are 30 multiple choice questions numbered 61 to 90. Each question has 4 choices (a), (b), (c) and (d), out of which ONLY ONE is correct.

61. The function $f(x) = \log\left(\frac{1+x}{1-x}\right)$ satisfies the equation
(a) $f(x+2)-2f(x+1)+f(x)=0$
(b) $f(x+1)+f(x)=f(x(x+1))$
(c) $f(x_1)\cdot f(x_2)=f(x_1+x_2)$
(d) $f(x_1)+f(x_2)= f\left(\frac{x_1+x_2}{1+x_1x_2}\right)$

62. If $3f(x)-f\left(\frac{1}{x}\right) = \log x^4$, then $f(e^{-x})$ is
(a) $1+x$ (b) $1/x$
(c) x (d) $-x$

63. The value of $(A \cup B \cup C) \cap (A \cap B' \cap C')' \cap C'$ is
(a) $B \cap C'$ (b) $B' \cap C'$
(c) $B \cap C$ (d) $A \cap B \cap C$

SPACE FOR ROUGH WORK

64. If a, b are fixed non-zero constant, then the derivative of $\frac{a}{x^4}-\frac{b}{x^2}+\cos x$ is ma + nb – p, where

(a) $m=4x^3, n=\frac{-2}{x^3}, p=\sin x$

(b) $m=\frac{-4}{x^5}, n=\frac{2}{x^3}, p=\sin x$

(c) $m=\frac{-4}{x^5}, n=\frac{-2}{x^3}, p=-\sin x$

(d) $m=4x^3, n=\frac{2}{x^3}, p=-\sin x$

65. Which among the following is/are true statements?

I. $\frac{\sec 8\theta-1}{\sec 4\theta-1}=\frac{\tan 8\theta}{\tan 2\theta}$

II. $I-\cos 8\theta=2\sin^2 4\theta$

III. $\sin 8\theta=2\sin 4\theta\cdot\cos 4\theta$

(a) I is true (b) II is true

(c) III is true (d) All are true

66. If $\frac{1}{1!\times 11!}+\frac{1}{3!\times 9!}+\frac{1}{5!\times 7!}=\frac{2^m}{n!}$ and ${}^kP_3=9240$, then

(a) $m+n-k=0$ (b) $m+n+k=12$

(c) $m+k-n=0$ (d) $n+k-m=0$

67. If the quadratic equations

$ax^2+2cx+b=0$ and $ax^2+2bx+c=0\ (b\neq c)$

have a common root, then a + 4b + 4c is equal to

(a) –2 (b) –1

(c) 0 (d) 1

68. The value of x obtained by solving the equations $ax^2+by^2=1$ and $ax+by=1$ are equal if

(a) $a+b=1$ (b) $a+b=2$

(c) $a-b=1$ (d) $2a+3b=1$

69. For a complex number z, it is given that $\left|z+\frac{1}{z}\right|=2$. Which of the following is incorrect?

(a) $|z|\le\sqrt{2}+1$ (b) $|z|\ge\sqrt{2}-1$

(c) $|z|\ge 4$ (d) $\sqrt{2}-1\le\left|\frac{1}{z}\right|\le\sqrt{2}+1$

70. An A.P. whose first term is unity and in which the sum of first half of any even number of terms to that of second half of the same number of terms is a constant ratio, then the common difference is :

(a) 2 (b) 1

(c) 3 (d) None of these

71. The last term in the binomial expansion of $(2^{1/3}-1/\sqrt{2})^n$ is $(1/3.9^{1/3})^{\log_3 8}$. Then the 5th term from the beginning is

(a) ${}^{10}C_6$ (b) $2.{}^{10}C_4$

(c) $1/2.\ {}^{10}C_4$ (d) none of these

72. The sum of the series 3.6 + 4.7 + 5.8 + ...upto $(n-2)$ terms is

(a) n^3+n^2+n+2

(b) $\frac{1}{6}(2n^3+12n^2+10n-84)$

(c) n^3+n^2+n

(d) None of these

73. Locus of the points which are at equal distance from $3x+4y-11=0$ and $12x+5y+2=0$ and which is near the origin is

(a) $21x-27y+153=0$ (b) $99x+77y-133=0$

(c) $7x-11y=19$ (d) None of these

74. The coefficient of x^4 in the expansion of $\frac{1+2x+3x^2}{(1-x)^2}$ is-

(a) 13 (b) 14 (c) 20 (d) 22

75. If the latusrectum of an ellipse with axis along X-axis and centre at origin is 10 and distance between foci is length of minor axis, then the equation of the ellipse is

(a) $x^2+2y^2=50$ (b) $x^2+2y^2=100$

(c) $2x^2+y^2=50$ (d) $2x^2+y^2=100$

76. The coordinates of the points which trisect the line segment joining the points P(4, 2, – 6) and Q(10, – 16, 6), are

(a) (6, –4, –2) and (8, 10, – 2)

(b) (6, –4, –2) and (8, – 10, 2)

(c) (–6, 4, 2) and (–8, 10, 2)

(d) None of these

SPACE FOR ROUGH WORK

77. The coefficient of x^n in the expansion of $\frac{a-bx}{e^x}$ is

(a) $\frac{(-1)^n}{n!}(a-bn)$ (b) $\frac{(-1)^n}{n!}(a+bn)$

(c) $\frac{(-1)^n}{n!}(b+an)$ (d) None of these

78. Which of the following is always true ?

(a) $(\sim p \vee \sim q) \equiv (p \wedge q)$

(b) $(p \rightarrow q) \equiv (\sim q \rightarrow \sim p)$

(c) $\sim (p \rightarrow \sim q) \equiv (p \wedge \sim q)$

(d) $\sim (p \leftrightarrow q) \equiv (p \rightarrow q) \rightarrow (q \rightarrow p)$

79. Coefficient of variation of two distributions are 60 and 70, and their standard deviations are 21 and 16, respectively. Their arithmetic means are

(a) 35, 22.85 (b) 30, 20.85

(c) 13, 12.80 (d) 15, 12.23

80. Two dice are thrown together. Then the probability, that the sum of numbers appearing on them is a prime number, is

(a) $\frac{5}{12}$ (b) $\frac{7}{18}$ (c) $\frac{13}{36}$ (d) $\frac{11}{36}$

81. $\lim\limits_{x\to 0} \frac{x\sqrt[3]{z^2-(z-x)^2}}{\left(\sqrt[3]{8xz-4x^2}+\sqrt[3]{8xz}\right)^4}$ is equal to

(a) $\frac{z}{2^{11/3}}$ (b) $\frac{1}{2^{23/3}.z}$

(c) $2^{21/3}z$ (d) None of these

82. Let p: price increases, q: Demand falls

The symbolic statement of 'If demand does not fall then price does not increase' is

(a) $q \rightarrow p$ (b) $\sim q \rightarrow p$

(c) $\sim q \rightarrow \sim p$ (d) $\sim q \leftrightarrow \sim p$

83. Exactly 2 machines out of 4 are faulty. They are tested one by one in a random order till both the faulty machines are identified. Then, the probability that only two tests are required is :

(a) $\frac{1}{3}$ (b) $\frac{2}{3}$ (c) $\frac{1}{6}$ (d) $\frac{5}{6}$

84. Evaluate: $\lim\limits_{x\to \pi/6} \frac{2\sin^2 x+\sin x-1}{2\sin^2 x-3\sin x+1}$

(a) 3 (b) – 3

(c) 1 (d) – 1

85. A school has four sections of chemistry in class XII having 40, 35, 45 and 42 students. The mean marks obtained in Chemistry test are 50, 60, 55 and 45 respectively for the four sections, the over all average of marks per students is

(a) 53 (b) 45

(c) 55.3 (d) 52.25

86. An arch is in the form of semi-ellipse. It is 8m wide and 2m high at the centre. Then, the height of the arch at a point 1.5m from one end is

(a) 1.56m (b) 2.4375m

(c) 2.056m (d) 1.086m

87. Identify the statments as true (T) or false (F) and then choose the correct option

(i) A line is parallel to XY-plane, if all the points on the line have equal y-coordinates.

(ii) The equation x = b represents a plane perpendicular to YZ-plane at a unit distance b from the origin.

(iii) The point (4, 5, –6) lies in the VIth octant.

(iv) The X-axis is the intersection of two planes XY-plane and XZ-plane.

(a) T, T, T, F (b) F, F, F, T

(c) T, F, T, F (d) F, T, F, T

88. If $\sum\limits_{r=0}^{n} \frac{r+2}{r+1}\, {}^nC_r = \frac{2^8-1}{6}$, then n is

(a) 8 (b) 4 (c) 6 (d) 5

89. If the tangent to a circle $x^2 + y^2 = 5$ at point (1, –2) touches the circle $x^2 + y^2 - 8x + 6y + 20 = 0$, then its point of contact is -

(a) (–2, 1) (b) (3, –1) (c) (–1, –3) (d) (5, 0)

90. If $\frac{\sin(x+y)}{\sin(x-y)} = \frac{a+b}{a-b}$, then $\frac{\tan x}{\tan y}$ is equal to

(a) $\frac{b}{a}$ (b) ab

(c) $\frac{a}{b}$ (d) $(ab)^2$

SPACE FOR ROUGH WORK

JEE MAIN

SOLUTIONS MOCK TEST-1

PART A – PHYSICS

1. **(c)** Acceleration of mass at distance x

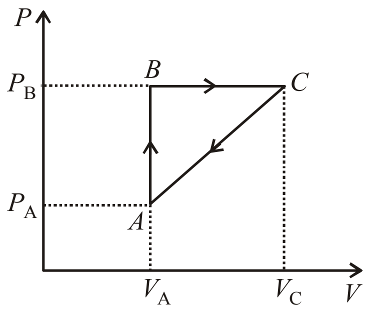
$a = g(\sin\theta - \mu_0 x\cos\theta)$

Speed is maximum, when $a = 0$

$g(\sin\theta - \mu_0 x\cos\theta) = 0$

$x = \dfrac{\tan\theta}{\mu_0}$

2. **(b)**



$W_{AB} = 0$

$\Delta Q_{AB} = \Delta V_{AB} + \Delta W_{AB}$

$600 = \Delta U_{AB}$

$\Delta Q_{BC} = \Delta U_{BC} + \Delta W_{BC}$

$200 = \Delta U_{BC} + 8\times10^5\times3\times10^{-4}$

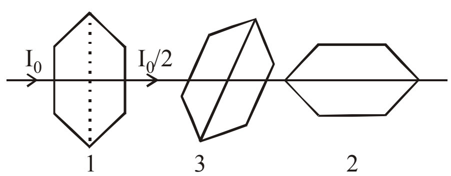
$\Delta U_{BC} = -40$ J

$\Delta U_{CA} = -560$ J

3. **(a)** $\dfrac{E}{B} = \text{velocity} = \text{m/s}$ and $\sqrt{LC} = \text{time period} = s$

$\therefore \dfrac{E\sqrt{LC}}{B} = m = \text{wavelength}$

4. **(a)**



The intensity of light transmitted through third polaroid,

$I = \dfrac{I_0}{2}\cos^2\theta$

$\therefore$ intensity of light transmitted through the last polaroid

$I' = \left(\dfrac{I_0}{2}\cos^2\theta\right).\cos^2(90-\theta)$

$= \dfrac{I_0}{2}\cos^2\theta.\sin^2\theta = \dfrac{I_0\times4\sin^2\theta.\cos^2\theta}{2\times4}$

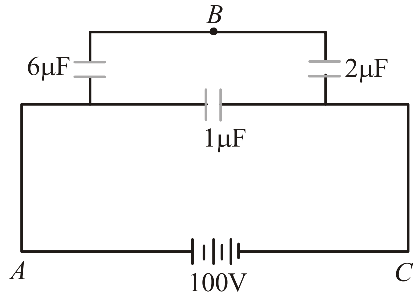
$= \dfrac{I_0}{8}\times(2\sin\theta\cdot\cos\theta)^2 = \left(\dfrac{I_0}{8}\right)\sin^2 2\theta$

5. **(c)** $C_{eq} = \dfrac{(3+3)\times(1+1)}{(3+3)+(1+1)} + 1 = \left(\dfrac{6\times2}{6+2}\right) + 1 = \dfrac{5}{2}\mu\text{F}$

$\therefore Q = C\times V = \dfrac{5}{2}\times100 = 250\mu C$

Charge in 6μF branch = $VC = \left(\dfrac{6\times2}{6+2}\right)100 = 150\mu C$

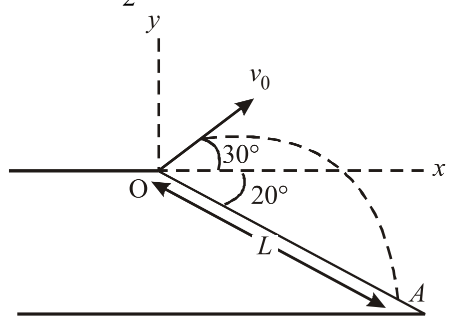
$V_{AB} = \dfrac{150}{6} = 25V$ and $V_{BC} = 100 - V_{AB} = 75V$



6. **(a)** We choose the launch point at the origin (figure). The equations of motion of the ball are

$x = v_0\cos30°t = (13.0\text{ m/s})\,t$

$y = v_0\sin30° - \dfrac{1}{2}gt^2 = (7.5\text{ m/s})\,t - (4.9\text{ m/s}^2)\,t^2$



The equation of the straight line incline is

$y = -x\tan20° = -0.364x$.

We want the time at which the (x, y) values for the ball satisfy this equation. We thus substitute the time expression for y and x.

$(7.5\text{ m/s})\,t - (4.9\,(\text{m/s}^2)\,t^2 = -0.364\,[(13.0\text{ m/s})\,t]$

or $12.2t = 4.9t^2$.

The solutions are $t = 0$ (corresponding to $x = y = 0$) and $t = 2.49$s.

7. **(b)** $\because$ The E.M. wave are transverse in nature i.e.,

$= \dfrac{\vec{k}\times\vec{E}}{\mu\omega} = \vec{H}$ ...(i)

where $\vec{H} = \dfrac{\vec{B}}{\mu}$

and $\dfrac{\vec{k}\times\vec{H}}{\omega\varepsilon} = -\vec{E}$ ...(ii)

$\vec{k}$ is $\perp$ $\vec{H}$ and $\vec{k}$ is also $\perp$ to $\vec{E}$

or In other words $\vec{X} \parallel \vec{E}$ and $\vec{k} \parallel \vec{E}\times\vec{B}$

8. **(c)** From momentum conservation,

$m_1v_1 + m_2v_2 = (m_1 + m_2)\,v$ .... (i)

$KE_f = \dfrac{1}{2}(m_1 + m_2)\,v^2$

$$= \frac{1}{2}(m_1 + m_2)\left(\frac{m_1 v_1 + m_2 v_2}{m_1 + m_2}\right)^2 \text{ from (i)}$$

$$= \frac{1}{2} M v_{com}^2$$

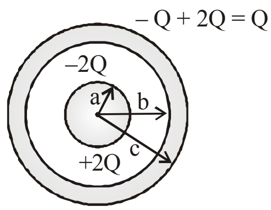
where, $M = m_1 + m_2$ and $v_{com} = \dfrac{m_1 v_1 + m_2 v_2}{m_1 + m_2}$.

9. **(b)** Magnetic field inside the superconductor is zero. Diamagnetic substances are repelled in external magnetic field.

10. **(a)** Surface charge density $(\sigma) = \dfrac{\text{Charge}}{\text{Surface area}}$

So $\sigma_{inner} = \dfrac{-2Q}{4\pi b^2}$

and $\sigma_{Outer} = \dfrac{Q}{4\pi c^2}$



11. **(d)** $F = -\dfrac{dU}{dx} = -20x$

$$a = \frac{F}{M} = \frac{-20x}{1} = -20x$$

$$-20x = -\omega^2 (x)$$

$$\therefore \quad \omega = \sqrt{20} = 2\sqrt{5}$$

$$f = \frac{\omega}{2\pi} = \frac{2\sqrt{5}}{2\pi} = \left(\frac{\sqrt{5}}{\pi}\right)$$

12. **(a)** $v = \omega R$

$g = g_0 - \omega^2 R$ [g = at equator, g_0 = at poles]

$$\frac{g_0}{2} = g_0 - \omega^2 R \;;\; \omega^2 R = \frac{g_0}{2} \;;\; v^2 = \frac{g_0 R}{2}$$

$$v_e = \sqrt{2 g_0 R} = \sqrt{4v^2} = 2v$$

13. **(a)** $\mathbf{B} = \dfrac{\mu_0}{4\pi}\left[\dfrac{\mathbf{I}}{\mathbf{r}} + \dfrac{\pi \mathbf{I}}{\mathbf{r}} + \dfrac{\mathbf{I}}{\mathbf{r}}\right] \dfrac{\mu_0}{4\pi}\left[\dfrac{2I}{r} + \dfrac{\pi I}{r}\right]$

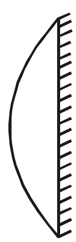
$$= \mu_0\left[\frac{I}{2\pi r} + \frac{I}{4r}\right]$$

(The direction of $\vec{B}$ is into the page.)

14. **(c)** The silvered plano convex lens behaves as a concave mirror; whose focal length is given by

$$\frac{1}{F} = \frac{2}{f_1} + \frac{1}{f_m}$$

If plane surface is silvered



$$f_m = \frac{R_2}{2} = \frac{\infty}{2} = \infty$$

$$\therefore \frac{1}{f_1} = (\mu - 1)\left(\frac{1}{R_1} - \frac{1}{R_2}\right)$$

$$= (\mu - 1)\left(\frac{1}{R} - \frac{1}{\infty}\right) = \frac{\mu - 1}{R}$$

$$\therefore \quad \frac{1}{F} = \frac{2(\mu - 1)}{R} + \frac{1}{\infty} = \frac{2(\mu - 1)}{R}$$

$$F = \frac{R}{2(\mu - 1)}$$

Here $R = 20$ cm, $\mu = 1.5$

$$\therefore \quad F = \frac{20}{2(1.5 - 1)} = 20\text{cm}$$

15. **(a)** $s_n = \dfrac{a}{2}(2n - 1)$;

$$s_{n+1} = \frac{a}{2}[2(n+1) - 1] = \frac{a}{2}(2n + 1)$$

$$\frac{s_n}{s_{n+1}} = \frac{2n - 1}{2n + 1}$$

16. **(d)** At high temperature for diatomic gas $f = 7$

$$C_p = \frac{fR}{2} + R = \frac{9R}{2}$$

17. **(a)**

A	0	1	1	0
B	0	0	1	1
C	1	1	1	1

OR gate

18. **(b)** For given transmission band 88-108 MHz

$(\Delta f)_{max} = 75$ kHz

given $(\Delta f)_{actual} = 18.75$ kHz

$$\therefore \text{ \% modulation } m = \frac{(\Delta f)_{actual}}{(\Delta f)_{max}} \times 100 = \frac{18.75}{75} = 25\%$$

19. **(c)** $T_{av} = \dfrac{T_\alpha T_\beta}{T_\alpha + T_\beta}$

If α and B are emitted simultaneously.

20. **(d)** Initially there is no D.C. current in inductive circuit and maximum D.C.current is in capacitive current. Hence, the current is zero in A_2 and maximum in A_1.

21. **(a)** Excitation energy $\Delta E = E_2 - E_1 = 13.6 Z^2 \left[\dfrac{1}{1^2} - \dfrac{1}{2^2}\right]$

$$\Rightarrow 40.8 = 13.6 \times \frac{3}{4} \times Z^2 \Rightarrow Z = 2.$$

Now required energy to remove the electron from ground state $= \dfrac{+13.6 Z^2}{(1)^2} = 13.6 (Z)^2 = 54.4$ eV.

22. **(c)** Young's modulus of rubber, Y_{rubber}

$$= \frac{F}{A} \times \frac{\ell}{\Delta \ell} \Rightarrow F = YA.\frac{\Delta \ell}{\ell}$$

On putting the values from question,

$$F = \frac{5 \times 10^8 \times 25 \times 10^{-6} \times 5 \times 10^{-2}}{10 \times 10^{-2}}$$

$$= 25 \times 25 \times 10^{2-1} = 6250\text{N}$$

kinetic energy = potential energy of rubber

$$\frac{1}{2} m v^2 = \frac{1}{2} F \Delta \ell$$

$v = \sqrt{\frac{F\Delta\ell}{m}} = \sqrt{\frac{6250 \times 5 \times 10^{-2}}{5 \times 10^{-3}}} = \sqrt{62500}$

$= 25 \times 10 = 250$ m/s

23. **(d)** $\phi = 6t^2 + 7t + 1 \Rightarrow \frac{d\phi}{dt} = 12t + 7$

At time, t = 2 sec.

$\frac{d\phi}{dt} = 24 + 7 = 31$ volt

Direction of current is from left to right according to Flemmings right hand rule.

24. **(a)** From Newton's law of cooling :–

$\frac{\theta_1 - \theta_2}{t} = k\left(\frac{\theta_1 + \theta_2}{2} - \theta_0\right)$

where θ_1 is higher temperature, θ_2 is lower temperature.

$\frac{80 - 64}{5} = k\ (72 - \theta_0)$ .... (i)

Where θ_0 is temperature of surroundings

$\frac{64 - 52}{10} = k\ (58 - \theta_0)$ .... (ii)

Dividing (i) and (ii) we get θ_0

$\frac{52 - \theta}{15} = k\left(\frac{52 + \theta}{2} - \theta_0\right)$ .... (iii)

Thus θ is found.

25. **(d)** For photon,

$E = h\nu$

$\Rightarrow \quad E = \frac{hc}{\lambda}$

$\Rightarrow \quad \lambda_2 = \frac{hc}{E}$ ...(i)

For proton, $E = \frac{1}{2} m v_p^2$

$E = \frac{1}{2}\frac{m^2 v_p^2}{m} = \frac{p^2}{2m} \quad \Rightarrow \; p = \sqrt{2mE}$

From de Broglie Eqn.

$p = \frac{h}{\lambda_1}$

$\Rightarrow \lambda_1 = \frac{h}{p} = \frac{h}{\sqrt{2mE}}$ ...(ii)

$\frac{\lambda_2}{\lambda_1} = \frac{hc}{E \times \frac{h}{\sqrt{2mE}}} \propto E^{-1/2}$

26. **(d)** From conservation of mechanical energy

$\frac{1}{2}mv^2 + \frac{1}{2}I\left(\frac{v^2}{R^2}\right) = mg\left(\frac{3v^2}{4g}\right)$

after solving $I = \frac{mR^2}{2}$ Which is for disc.

27. **(d)** **When the electric field is on**

Force due to electric field = weight

$qE = mg \Rightarrow qE = \frac{4}{3}\pi R^3 \rho g$

$\therefore q = \frac{4\pi R^3 \rho g}{3E}$ ... (i)

When the electric field is switched off

Weight = viscous drag force

mg = $6\pi\eta R v_t$

$\frac{4}{3}\pi R^3 \rho g = 6\pi\eta R v_t$

$\therefore R = \sqrt{\frac{9\eta v_t}{2\rho g}}$ ... (ii)

From (i) & (ii) $g = \frac{4}{3}\pi\left[\frac{9\eta v_t}{2\rho g}\right]^{\frac{3}{2}} \times \frac{\rho g}{E}$

$= \frac{4}{3} \times \pi\left[\frac{9 \times 1.8 \times 10^{-5} \times 2 \times 10^{-3}}{2 \times 900 \times 9.8}\right]^{\frac{3}{2}} \times \frac{900 \times 9.8 \times 7}{81\pi \times 10^5}$

$= 7.8 \times 10^{-19}$ C

28. **(d)** For constant current, $Q = it$ and for resistance,

$i^2Rt = 45$ and $i^2rt = 15$

$\Rightarrow i^2 (R + r)\, t = 60$ or $i\,(R + r)\,(it) = 60$ or $E\,(Q) = 60$

or $E = \frac{60}{Q} = \frac{60}{40} V$

29. **(c)** Maximum force by surface when friction works

$F = \sqrt{f^2 + R^2} = \sqrt{(\mu R)^2 + R^2} = R\sqrt{\mu^2 + 1}$

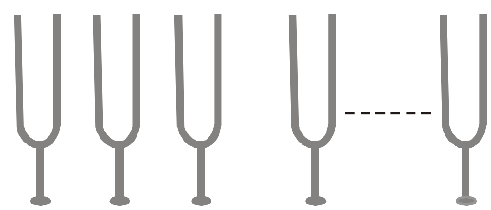
Minimum force = R when there is no friction

Hence ranging from R to $R\sqrt{\mu^2 + 1}$

30. **(c)** According to the question, frequencies of first and last tuning forks are 2n and n respectively.

Hence frequency in given arrangement are as follows.

1 2 3 21 ------ 25



2n (2n – 3) (2n – 6) (2n – 20 × 3) (2n – 24 × 3) = n

$\Rightarrow 2n - 24 \times 3 = n \Rightarrow n = 72$ Hz

So, frequency of 21st tuning fork

$n_{21} = (2 \times 72 - 20 \times 3) = 84$ Hz

PART B – CHEMISTRY

31. **(a)** Density increases as the molecular mass increases, i.e., (i) < (ii) < (iii) < (iv).

32. **(b)** $\alpha_1 = 0.005 = \sqrt{K_a/C}$ (C_1 = 1 mol L^{-1}); Molarity of diluted solution, $C_2 = \frac{2}{32} = \frac{1}{16}$ molL^{-1}

$\alpha_2 = \sqrt{\frac{K_a}{C_2}} = 0.005\sqrt{16} = 0.02$

$[H_3O^+] = C_2\alpha_2 = \frac{1 \times 0.02}{16} = 1.25 \times 10^{-3}$ M

33. (a) (i) Order of intermolecular attraction is
$CO_2 > CH_4 > O_2 > H_2$
In CO_2, intermolecular forces increases with number of electrons in a molecule.
(ii) Size increases in order of $H_2 < O_2 < CH_4 < CO_2$
Hence, H_2 will have lowest value of b.

34. (d) Lithium, sodium and potassium are highly electropositive and highly reactive metals. When any of these come in contact with water, the reaction is so swift and intense that the hydrogen evolved catches fire instantaneously. The reaction thus is highly exothermic, therefore using water to quinch fires caused by these metals makes it explosively dangerous. Also with these metals CO_2 and nitrogen too are reactive. Small fires can be quinched by asbestos blanket or by covering with dry sand, since these measures prevents contact with oxygen and water vapour and thus become effective.

35. (d) In a '*fcc*' crystal atoms are located at the centre of the 6 faces and at the 8 corners.
On each face their is 1 atom which is shared by 2 cells.
Hence, the no. of atoms/ unit cell = 6/2 = 3
Again the corner atom is shared by 8 other cells. Hence no. of atoms =8/8 = 1
No. of atoms/unit cell = 1 + 3 = 4

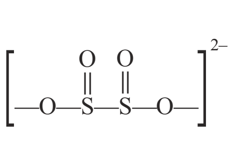
36. (c) Moissan boron, which is an amorphous low purity boron, is made by reduction of boric oxide with magnesium. Boron obtained has 86% purity and is amorphous.

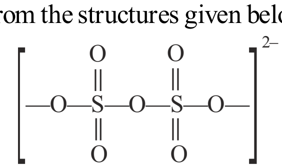
37. (a) Addition of a catalyst to a reaction mixture has the effect of lowering the activation energy of the reaction by changing the path or mechanism of the reaction. The reaction rate increases manifold. However, the equilibrium constant and the enthalpy (DH) of the reaction are unaffected.

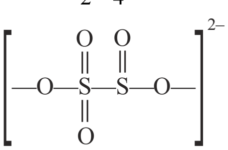
38. (c) (a) Weight of H_2 = mole × molecular wt. = 0.2 × 2 = 0.4 g
(b) $6.023 \times 10^{23} = 1$ mole
Thus $6.023 \times 10^{22} = 0.1$ mole
Weight of $N_2 = 0.1 \times 28 = 2.8$ g
(c) Weight of silver = 0.1 g
(d) Weight of oxygen = 32 × 0.1 = 3.2 g

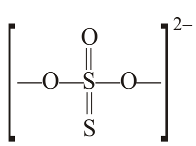
39. (b) Since the gas B turns $CuSO_4$ solution blue, it can be NH_3. Since formula of the given compound A is M_3N, A is either lithium or sodium nitride. Of the two, Li_3N is most likely since it is a stable, very high melting compound.

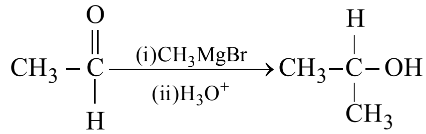
40. (d) In $S_2O_7^{2-}$ there is an S–O–S bond. Whereas S–S bond is absent as can be seen from the structures given below.

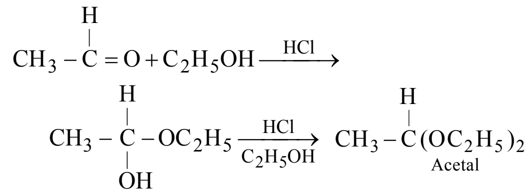

$S_2O_4^{2-}$


$S_2O_7^{2-}$


$S_2O_5^{2-}$


$S_2O_3^{2-}$

41. (c) (i)

2-Propanol

(ii)

Hemiacetal

42. (b) The temperature of 383° K is equal to 110°C. Although the salts will increase the boiling point of water, it should boil at or below this temperature.

43. (c) All the alkali metals when heated with oxygen form different types of oxides for example lithium forms lithium oxide (Li_2O), sodium forms sodium peroxide (Na_2O_2), while K, Rb and Cs form their respective superoxides.

$$2Li + \frac{1}{2}O_2 \rightarrow Li_2O$$

44. (b) Since each of (i), (ii) and (iii) are hexa- coordinated, in the case of (ii), one of the chlorines (chloride ions) is coordinated to the central cobalt ion and in (iii), two such chlorides are coordinately linked. Thus, the ionisable chlorides in (i) is three in (ii) it is two and in (iii) it is only one.
Primary valency means the valency of the complex cation.

45. (b) Nylon 6 is

$$\left[NH(CH_2)_5 - \overset{O}{\overset{\|}{C}} - NH - (CH_2)_5 - \overset{O}{\overset{\|}{C}} \right]_n$$

46. (a)

47. (c) More the s-character, more is the stability of the carbanion. hence the correct order is
$sp > sp^2 > sp^3$.

48. (a) $N_1V_1 = N_2V_2$

$N_{NaOH} = M_{NaOH} = 0.164$

$\Rightarrow 25 \times N = 32.63 \times 0.164$

$$N = \frac{32.63 \times 0.164}{25} = 0.214\, N$$

But $N_{H_2SO_4} = 2 \times M_{H_2SO_4}$

$$\Rightarrow M = \frac{\text{Normality}}{2} = \frac{0.214}{2} = 0.107$$

49. (c) In SiF_4 DM = zero due to symmetrical structure.

50. (d) Amongst the sets, it is (d) that is not arranged in the order of decreasing reactivity towards electrophilic substitution. Carboxylic acid group in the case of benzoic acid deactivates the benzene nucleus towards electrophilic substitution reaction and thus it can not have higher reactivity than phenol which has a highly activating phenolic group.

51. (b) $U=\sqrt{\frac{3RT}{M}} \Rightarrow \frac{U_1}{U_2}=\sqrt{\frac{T_1}{T_2}}=\sqrt{\frac{1200}{300}}=2;\ \therefore\ U_2=\frac{1}{2}U_1$

52. **(c)** $Be(OH)_2$ is amphoteric that means it can react with both acids and alkalies

53. **(b)** Ionization energy increases along a period but reduces down a group. Electron affinity increases along a period from left to right and deceases on moving down in a group.

54. **(d)** Mathematical expression of first law of thermodynamics $\Delta E = q + w$, ΔE is a state function.

55. **(b)** Average atomic weight $= 85\left(\frac{75}{100}\right)+87\left(\frac{25}{100}\right)=85.5$.

56. **(b)** Basic character of amines follow the order :
$2° > 1° > 3° > NH_3$
Now since 2° amines are strongest bases than the remaining. So $(C_2H_5)_2NH$ (N-ethylethanamine) is the most strongest base among the given compounds.

57. **(b)** Lassaigne's test is used for the detection of nitrogen given by all nitrogenous compound except diazo $(-N{=}N-)$ compounds.
This test is shown only by the compounds containing C and N both hence hydroxyl amine hydrochloride ($H_2NOH.HCl$) will not perform this test.

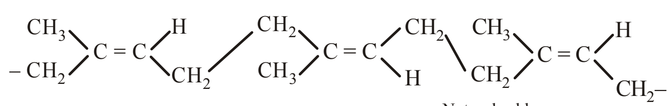
58. **(b)** NaCl is a salt of strong acid and strong base hence on dissolution will give neutral solution.
$NaCl + AgNO_3 \rightarrow AgCl^- + HNO_3$

59. **(c)** $3BaCl_2 + 2Na_3PO_4 \rightarrow 6NaCl + Ba_3(PO_4)_2$

Molar ratio	3	2	6	1
Initial moles	0.5	0.2	0	0

Limiting reagent is Na_3PO_4 hence it would be consumed, and the yield would be decided by it inital moles.
2 moles of Na_3PO_4 give 1 mole of $Ba_3(PO_4)_2$,
$\therefore$ 0.2 moles of Na_3PO_4 would give 0.1 mole of $Ba_3(PO_4)_2$

60. **(b)**



Natural rubber
(All cis configuration)

All statements except (b) are correct

PART C – MATHEMATICS

61. **(b)** Let $f(x) = \log(g(x))$
$\therefore\ f(x_1)+f(x_2) = \log(g(x_1))+\log(g(x_2))$
$= \log(g(x_1)\cdot g(x_2))$
$\therefore$ Option (b) is correct

62. **(d)** $3f(x)-f\left(\frac{1}{x}\right)=\log x^4$; put $x \equiv \frac{1}{x}$

$3f\left(\frac{1}{x}\right)-f(x)=\log\left(\frac{1}{x}\right)^4$
After solving we get $f(x) = \log x$
$f(e^{-x}) = \log_e e^{-x} = -x$

63. **(a)** $(A\cap B'\cap C')' = A'\cup(B')'\cup(C')'$
$= A'\cup B\cup C$
$\therefore\ (A\cup B\cup C)\cap(A\cap B'\cap C')'$
$=(A\cup B\cup C)\cap(A'\cup B\cup C)$
$=(A\cap A')\cup(B\cup C)$ (by distributive law)
$=\phi\cup(B\cup C)=B\cup C$
Hence, $(A\cup B\cup C)\cap(A\cap B'\cap C')'\cap C'$
$=(B\cup C)\cap C'$
$=(B\cap C')\cup(C\cap C')$ (by distributive law)
$=(B\cap C')\cup\phi=B\cap C'$

64. **(b)** Let $y=\frac{a}{x^4}-\frac{b}{x^2}+\cos x$
$\Rightarrow\ y = ax^{-4} - bx^{-2} + \cos x$
Differentiating y w.r.t. x, we get
$\frac{dy}{dx}=a\frac{d}{dx}(x^{-4})-b\frac{d}{dx}(x^{-2})+\frac{d}{dx}(\cos x)$
$= a(-4)x^{-4-1} - b(-2)x^{-2-1}(-\sin x)$
$=-\frac{4a}{x^5}+\frac{2b}{x^3}-\sin x \qquad \left[\because \frac{d}{dx}(x^n)=nx^{n-1}\right]$

65. **(d)** We have, $\frac{\sec 8\theta-1}{\sec 4\theta-1}=\frac{(1-\cos 8\theta)\cos 4\theta}{\cos 8\theta(1-\cos 4\theta)}$

$\left(\because \sec 8\theta-1=\frac{1-\cos 8\theta}{\cos 8\theta}\right)$

$=\frac{2\sin^2 4\theta\cos 4\theta}{\cos 8\theta(2\sin^2 2\theta)}$

$=\frac{\sin 4\theta(2\sin 4\theta\cos 4\theta)}{2\cos 8\theta\sin^2 2\theta}$

$=\frac{\sin 4\theta\sin 8\theta}{2\cos 8\theta\sin^2 2\theta}$ $(\because \sin 2\theta = 2\sin\theta\cdot\cos\theta)$

$=\frac{2\sin 2\theta\cos 2\theta\sin 8\theta}{2\cos 8\theta\sin^2 2\theta}=\frac{\tan 8\theta}{\tan 2\theta}$

66. **(a)** We have

$2\left[\frac{1}{1!11!}+\frac{1}{3!\times 9!}+\frac{1}{5!\times 7!}\right]$

$=\frac{1}{1!\times 11!}+\frac{1}{3!\times 9!}+\frac{1}{5!\times 7!}+\frac{1}{7!\times 5!}+\frac{1}{9!\times 3!}+\frac{1}{11!\times 1!}$

$=\frac{1}{12!}\left[\frac{12!}{1!\times 11!}+\frac{12!}{3!\times 9!}+\frac{12!}{5!\times 7!}+\frac{12!}{7!\times 5!}+\frac{12!}{9!\times 3!}+\frac{12!}{11!\times 1!}\right]$

$=\frac{1}{12!}[{}^{12}C_1+{}^{12}C_3+....+{}^{12}C_{11}]=\frac{2^{12-1}}{12!}=\frac{2^{11}}{12!}$

$\therefore\ 2\left(\frac{1}{1!\times 11!}+\frac{1}{3!\times 9!}+\frac{1}{5!\times 7!}\right)=\frac{2^{11}}{12!}$

$\Rightarrow\ \frac{1}{1!\times 11!}+\frac{1}{3!\times 9!}+\frac{1}{5!\times 7!}=\frac{2^{10}}{12!}$

$\Rightarrow\ \frac{2^m}{n!}=\frac{2^{10}}{12!}\ \Rightarrow\ m = 10, n = 12$

Given, ${}^kP_3 = 9240$

$\Rightarrow k(k-1)(k-2) = 9240 = 22 \times 21 \times 20 \Rightarrow k = 22$

$\therefore\ m + n - k = 10 + 12 - 22 = 0$

67. (c) Let α be the common root of given equations
Then, $a\alpha^2 + 2c\alpha + b = 0$ and, $a\alpha^2 + 2b\alpha + c = 0$
subtracting, we get

$\Rightarrow\ 2\alpha(c-b) + (b-c) = 0 \Rightarrow\ \alpha = \dfrac{1}{2}\ [\because b \neq c]$

Putting $\alpha = \dfrac{1}{2}$ in $a\alpha^2 + 2c\alpha + b = 0$,
we get $a + 4b + 4c = 0$

68. (a) Eliminating y from two equations, we get.

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

$\Rightarrow (ab + a^2)x^2 - 2ax + 1 - b = 0$
For equal values of x,

$D = 0 \Rightarrow 4a^2 - 4(ab + a^2)(1 - b) = 0$

$\Rightarrow a^2 - ab + ab^2 - a^2 + a^2b = 0$

$\Rightarrow ab(-1 + b + a) = 0 \Rightarrow a + b = 1$

69. (d) We know that if $\left|z + \dfrac{1}{z}\right| = a$.

Then $\dfrac{-a + \sqrt{a^2+4}}{2} \le |z| \le \dfrac{a + \sqrt{a^2+4}}{2}$

$\therefore\ |z + \dfrac{1}{z}| = 2 \Rightarrow \dfrac{-2 + \sqrt{4+4}}{2} \le |z| \le \dfrac{2 + \sqrt{4+4}}{2}$

$\Rightarrow\ \sqrt{2} - 1 \le |z| \le \sqrt{2} + 1$

Also

$\dfrac{1}{\sqrt{2}-1} \ge \dfrac{1}{|z|} \ge \dfrac{1}{\sqrt{2}+1} \Rightarrow\ \sqrt{2} + 1 \ge \dfrac{1}{|z|} \ge \sqrt{2} - 1$

$\therefore\ \sqrt{2} - 1 \le \left|\dfrac{1}{z}\right| \le \sqrt{2} + 1$

70. (a) Let S_n denote the sum of n terms of an A.P.
According to given condition

$\dfrac{S_n}{S_{2n} - S_n} = k\ \ \forall n \ge 1 \Rightarrow\ \dfrac{S_1}{S_2 - S_1} = \dfrac{S_2}{S_4 - S_2}$

$\Rightarrow S_1S_4 - S_1S_2 = S_2^2 - S_1S_2 \Rightarrow\ S_1S_4 = S_2^2$

$\Rightarrow a\dfrac{4}{2}[2a + (4-1)d] = (a + a + d)^2$

$\Rightarrow a(4a + 6d) = (2a + d)^2 \Rightarrow\ 2ad = d^2 \Rightarrow\ 2a = d$

Since $a = 1$, we get $d = 2$

71. (a) The last term $= {}^nC_n.(-1/\sqrt{2})^n = (1/3.\sqrt[3]{9})^{\log_3 8}$.

$\therefore\ \ (-1)^n.(1/2)^{n/2} = \left(\dfrac{1}{3^{5/3}}\right)^{\log_3 8.}$

$= 3^{-\frac{5}{3}.3\log_3 2} = 3^{-5\log_3 2} = 2^{-5}$

So, $t_5 = {}^{10}C_4\,(2^{1/3})^6\,(-1/\sqrt{2})^4 = {}^{10}C_4. = {}^{10}C_{10-4}$.

72. (b) S = 3.6 + 4.7 + ... upto $n - 2$ terms
$= (1.4 + 2.5 + 3.6 + 4.7 + \text{..... upto } n \text{ terms}) - 14$

$= \Sigma n(n+3) - 14 = \dfrac{1}{6}(2n^3 + 12n^2 + 10n) - 14$

$= \left(\dfrac{2n^3 + 12n^2 + 10n - 84}{6}\right)$, where $n = 3, 4, 5.....$

Trick : $S_1 = 18$, $S_2 = 46$
Now put in options $(n-2) = 1, 2$ i.e. $n = 3, 4$

73. (a) Let point be (x_1, y_1), then according to the condition

$\dfrac{3x_1 + 4y_1 - 11}{5} = \left(\dfrac{12x_1 + 5y_1 + 2}{13}\right)$

Since the given lines are on opposite sides with respect to origin, hence the required locus is $21x - 27y + 153 = 0$

74. (d) Given expansion is $(1 + 2x + 3x^2)(1-x)^{-2}$
$= (1 + 2x + 3x^2)(1 + 2x + 3x^2 + 4x^3 + 5x^4 + ...)$
$\therefore$ Coefficient of $x^4 = 5 + 8 + 9 = 22$

75. (b) Given that, $\dfrac{2b^2}{a} = 10$ and $2ae = 2b \Rightarrow b = ae$
Again, we know that $b^2 = a^2(1 - e^2)$

or $2a^2e^2 = a^2\ \Rightarrow\ e = \dfrac{1}{\sqrt{2}}$ (using b = ae)

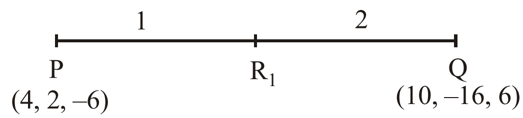
Thus, $a = b\sqrt{2}$

Again, $\dfrac{2b^2}{a} = 10$ or $b = 5\sqrt{2}$

Thus, we get a = 10
Therefore, the required equation of the ellipse is

$\dfrac{x^2}{100} + \dfrac{y^2}{50} = 1\ \Rightarrow\ x^2 + 2y^2 = 100$

76. (b) Let the point R_1 and R_2 trisects the line PQ i.e., R_1 divides the line in the ratio 1 : 2.

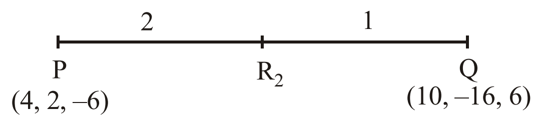


$\Rightarrow R_1 = \left(\dfrac{1\times10 + 2\times4}{1+2}, \dfrac{1\times(-16) + 2\times2}{1+2}, \dfrac{1\times6 + 2\times(-6)}{1+2}\right)$

$= \left(\dfrac{10+8}{3}, \dfrac{-16+4}{3}, \dfrac{6-12}{3}\right) = \left(\dfrac{18}{3}, \dfrac{-12}{3}, \dfrac{-6}{3}\right)$

$= (6, -4, -2)$

Again, let the point R_2 divides PQ internally in the ratio 2 : 1.
Then,



$\Rightarrow R_2 = \left(\dfrac{2\times10 + 1\times4}{2+1}, \dfrac{2\times(-16) + 1\times2}{2+1}, \dfrac{2\times6 + 1\times(-6)}{1+2}\right)$

$= \left(\dfrac{20+4}{3}, \dfrac{-32+2}{3}, \dfrac{12-6}{3}\right) = \left(\dfrac{24}{3}, \dfrac{-30}{3}, \dfrac{6}{3}\right)$

$= (8, -10, 2)$

Hence, required points are (6, –4, –2) and (8, –10, 2).

77. **(b)** We have, $\frac{a-bx}{e^x}=(a-bx)e^{-x}$

$$=(a-bx)\left[1-\frac{x}{1!}+\frac{x^2}{2!}-\frac{x^3}{3!}+\ldots +(-1)^{n-1}\frac{x^{n-1}}{(n-1)!}+\frac{(-1)^n x^n}{n!}+\ldots\right]$$

$\therefore$ Coefficient of $x^n=a\cdot\frac{(-1)^n}{n!}-b\frac{(-1)^{n-1}}{(n-1)!}$

$$=(-1)^n\cdot\frac{a}{n!}+\frac{(-1)^n b}{(n-1)!}=\frac{(-1)^n}{n!}(a+bn).$$

78. **(b)** Since $\sim(p\vee q)\equiv(\sim p\wedge\sim q)$ and $\sim(p\wedge q)\equiv(\sim p\vee\sim q)$
So option (a) and (d) are not true.
$(p\to q)\equiv p\wedge\sim q$, so option (c) is not true.
$p\to q\equiv\sim q\to\sim p$

79. **(a)** Given C.V. (1st distribution) = 60, $\sigma_1=21$
C.V. (2nd distribution) = 70, $\sigma_2=16$
Let $\bar{x}_1$ and $\bar{x}_2$ be the means of 1st and 2nd distribution, respectively. Then

C.V. (1st distribution) = $\frac{\sigma_1}{\bar{x}_1}\times 100$

Therefore $60=\frac{21}{\bar{x}_1}\times 100$ or $\bar{x}_1=\frac{21}{60}\times 100=35$

and C.V. (2nd distribution) = $\frac{\sigma_2}{\bar{x}_2}\times 100$

i.e. $70=\frac{16}{\bar{x}_2}\times 100$ or $\bar{x}_2=\frac{16}{70}\times 100=22.85$

80. **(a)** Event = {(1, 1), (1, 2), (1, 4), (1, 6), (2, 1), (2, 3), (2, 5), (3, 2), (3, 4), (4, 1), (4, 3), (5, 2), (5, 6), (6, 1), (6, 5),}

Probability $=\frac{15}{36}=\frac{5}{12}$

81. **(b)** $\lim\limits_{x\to 0}\frac{x\sqrt[3]{z^2-(z-x)^2}}{\left(\sqrt[3]{8xz-4x^2}+\sqrt[3]{8xz}\right)^4}$

$$=\lim_{x\to 0}\frac{x\sqrt[3]{2xz-x^2}}{(\sqrt[3]{x}\sqrt[3]{8z-4x}+\sqrt[3]{8z}\sqrt[3]{x})^4}$$

$$=\lim_{x\to 0}\frac{x^{4/3}\sqrt[3]{2z-x}}{x^{4/3}[\sqrt[3]{8z-4x}+\sqrt[3]{8z}]^4}$$

$$=\frac{\sqrt[3]{2z}}{\left[2\sqrt[3]{8z}\right]^4}=\frac{1}{2^{23/3}.z}$$

82. **(c)**

83. **(c)** Total no. of machines = 4
Two of them are faulty
No. of ways to choose two machines

$$={}^4C_2=\frac{4!}{2!\,2!}=6$$

If only two tests are required to identify faulty machines, then in first two tests faulty machines, are identified.
So favourable no. of ways = 1

$\therefore$ Required probability $=\frac{1}{6}$

84. **(b)** We have,

$$\lim_{x\to\pi/6}\frac{2\sin^2x+\sin x-1}{2\sin^2x-3\sin x+1}=\lim_{x\to\pi/6}\frac{(2\sin x-1)(\sin x+1)}{(2\sin x-1)(\sin x-1)}$$

$$=\lim_{x\to\pi/6}\frac{\sin x+1}{\sin x-1}=\frac{\frac{1}{2}+1}{\frac{1}{2}-1}=-3$$

85. **(d)** Total number of students = 40 + 35 + 45 + 42 = 162
Total marks obtained

$$=(40\times 50)+(35\times 60)+(45\times 55)+(42\times 45)$$
$$=8465$$

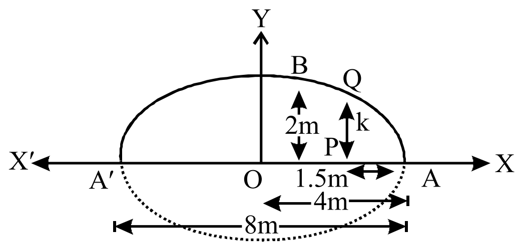
Overall average of marks per students $=\frac{8465}{162}=52.25$

86. **(a)** Clearly, equation of ellipse takes the form

$$\frac{x^2}{a^2}+\frac{y^2}{b^2}=1 \qquad \ldots(i)$$

Here, it is given 2a = 8 and b = 2 $\Rightarrow$ a = 4, b = 2
put the values of a and b in Eq. (i), we get

$$\frac{x^2}{16}+\frac{y^2}{4}=1$$



Given, AP = 1.5 m
$\Rightarrow$ OP = OA – AP = 4 – 1.5
$\Rightarrow$ OP = 2.5 m
Let PQ = k
$\therefore$ Coordinate Q = (2.5, k) will satisfy the equation of ellipse.

i.e., $\frac{(2.5)^2}{16}+\frac{k^2}{4}=1\Rightarrow\frac{6.25}{16}+\frac{k^2}{4}=1$

$\Rightarrow\frac{k^2}{4}=\frac{1}{1}-\frac{6.25}{16}=\frac{16-6.25}{16}$

$\Rightarrow\frac{k^2}{4}=\frac{9.75}{16}\Rightarrow k^2=\frac{9.75}{4}$

$\Rightarrow k^2=2.4375$

$\Rightarrow$ k = 1.56m (approx.)

87. **(b)** (i) (F), A line parallel to XY-plane, if all the points on line have equal z-coordinates.
(ii) (F), Since x = 0 represents YZ-plane. Therefore, x = b represents a plane parallel to YZ-plane at a unit distance b from the origin.
(iii) (F), The point (4, 5, –6) lies in V[th] octant.

(iv) (T), The X-axis is the intersection of two planes XY-plane and XZ-plane.

88. **(d)** $\sum_{r=0}^{n}\frac{r+2}{r+1}\,{}^{n}C_r = \sum_{r=0}^{n}\frac{r+1+1}{r+1}\,{}^{n}C_r$

$$= \sum_{r=0}^{n}{}^{n}C_r + \sum_{r=0}^{n}\frac{{}^{n}C_r}{r+1}$$

$$= 2^n + \sum_{r=0}^{n}\frac{{}^{n+1}C_{r+1}}{n+1}$$

$$= 2^n + \frac{1}{n+1}\sum_{r=0}^{n}{}^{n+1}C_{r+1}$$

$$= 2^n + \frac{1}{n+1}(2^{n+1}-1)$$

$$= \frac{1}{n+1}[(n+1)2^n + 2^{n+1} - 1]$$

$$= \frac{1}{n+1}[2^n(n+3) - 1]$$

Given, $\frac{(n+3)2^n - 1}{n+1} = \frac{2^8 - 1}{6} = \frac{(5+3).2^5 - 1}{5+1} \Rightarrow n = 5$

89. **(b)** Tangent at (1,–2) to $x^2 + y^2 = 5$ is $x - 2y = 5$

To find the point of contact with second circle, we solve this equation with the equation of the second circle, so we have

$(2y+5)^2 + y^2 - 8(2y+5) + 6y + 20 = 0$

$\Rightarrow\ 5y^2 + 10y + 5 = 0$

$\Rightarrow\ (y+1)^2 = 0$

$\Rightarrow\ y = -1$

Also then $x = 3$. So the required point is $(3, -1)$

90. **(c)** We have, $\frac{\sin(x+y)}{\sin(x-y)} = \frac{a+b}{a-b}$

Using componendo and divendo, we get

$$\frac{\sin(x+y)+\sin(x-y)}{\sin(x+y)-\sin(x-y)} = \frac{a+b+a-b}{a+b-a+b}$$

$$\Rightarrow \frac{2\sin\frac{x+y+x-y}{2}.\cos\frac{x+y-x+y}{2}}{2\cos\frac{x+y+x-y}{2}.\sin\frac{x+y-x+y}{2}} = \frac{2a}{2b}$$

$$\Rightarrow \frac{\sin x.\cos y}{\cos x.\sin y} = \frac{a}{b}$$

$$\Rightarrow \tan x\ .\ \cot y = \frac{a}{b}$$

$$\Rightarrow \frac{\tan x}{\tan y} = \frac{a}{b}$$