MHT - CET 2025

General Instructions

- *This question booklet contains 150 Multiple Choice Questions (MCQs).*
  ***Section-A:** Physics & Chemistry - 50 Questions each and*
  ***Section-B:** Mathematics - 50 Questions.*
- *Choice and sequence for attempting questions will be as per the convenience of the candidate.*
- *Read each question carefully.*
- *Determine the one correct answer out of the four available options given for each question.*
- *Each question with correct response shall be awarded one (1) mark. There shall be no negative marking.*
- *No mark shall be granted for marking two or more answers of same question, scratching or overwriting.*
- *Duration of paper is 3 Hours.*

SECTION-A

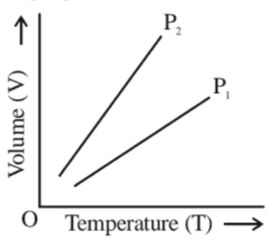
PHYSICS

1. What is the effect of humidity on sound waves when humidity increases?
(a) Speed of sound waves is more
(b) Speed of sound waves is less
(c) Speed of sound waves remains same
(d) Speed of sound waves becomes zero

2. If α, β and γ are coefficient of linear, area and volume expansion respectively, then
(a) $\gamma = 3\alpha$ (b) $\alpha = 3\gamma$
(c) $\beta = 3\alpha$ (d) $\gamma = 3\beta$

3. A liquid is filled upto a height of 20 cm in a cylindrical vessel. The speed of liquid coming out of a small hole at the bottom of the vessel is ($g = 10\ ms^{-2}$)
(a) $1.2\ ms^{-1}$ (b) $1\ ms^{-1}$
(c) $2\ ms^{-1}$ (d) $3.2\ ms^{-1}$

4. For a perfect gas, two pressures P_1 and P_2 are shown in figure. The graph shows:

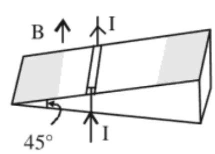


(a) $P_1 > P_2$
(b) $P_1 < P_2$
(c) $P_1 = P_2$
(d) Insufficient data to draw any conclusion

5. A body of mass 2 kg moving with a speed of 4 m/s. makes an elastic collision with another body at rest and continues to move in the original direction but with one fourth of its initial speed. The speed of the two body centre of mass is
(a) 2.5 m/s (b) 5 m/s
(c) 7.5 m/s (d) 10 m/s

6. According to law of equipartition of energy the molar specific heat of a diatomic gas at constant volume where the molecule has one additional vibrational mode is :-
(a) $\frac{9}{2}R$ (b) $\frac{5}{2}R$ (c) $\frac{3}{2}R$ (d) $\frac{7}{2}R$

7. As shown in the figure, a metallic rod of linear density $0.45\ kg\ m^{-1}$ is lying horizontally on a smooth incline plane which makes an angle of 45° with the horizontal. The minimum current flowing in the rod required to keep it stationary, when 0.15 T magnetic field is acting on it in the vertical upward direction, will be : {Use $g = 10\ m/s^2$}



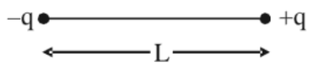
(a) 30 A (b) 15 A
(c) 10A (d) 3 A

8. A sphere of radius R carries charge density ρ proportional to the square of the distance (r) from the centre such that $\rho = Cr^2$, where C is a positive constant. At a distance $R/2$ from the centre, the magnitude of the electric field is

(a) $\frac{CR^3}{20 \epsilon_0}$ (b) $\frac{CR^3}{10 \epsilon_0}$

(c) $\frac{CR^3}{5 \epsilon_0}$ (d) None of these

9. Two point charges –q and +q are placed at a distance of L, as shown in the figure.



The magnitude of electric field intensity at a distance R(R>>L) varies as:

(a) $\frac{1}{R^3}$ (b) $\frac{1}{R^4}$

(c) $\frac{1}{R^6}$ (d) $\frac{1}{R^2}$

10. The work done in increasing the size of a soap film from 10 cm × 6 cm to 10 cm × 11 cm is 3×10^{-4}J. The surface tension of the film is

(a) 11×10^{-2} N/m (b) 6×10^{-2} N/m

(c) 3×10^{-2} N/m (d) 1.5×10^{-2} N/m

11. A sample of gas expands from volume V_1 to V_2. The amount of work done by the gas is greatest when the expansion is

(a) isothermal (b) isobaric

(c) adiabatic (d) equal in all cases

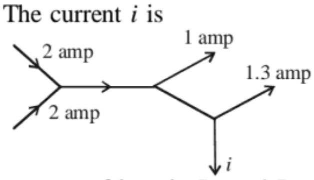
12. The figure below shows currents in a part of electric circuit. The current i is

(a) 1.7 amp

(b) 3.7 amp

(c) 1.3 amp

(d) 1 amp



13. Two discs of moment of inertia I_1 and I_2 and angular speeds ω_1 and ω_2 are rotating along collinear axes passing through their centre of mass and perpendicular to their plane. If the two are made to rotate combindly along the same axis the rotational KE of system will be

(a) $\frac{I_1\omega_1 + I_2\omega_2}{2(I_1 + I_2)}$

(b) $\frac{(I_1 + I_2)(\omega_1 + \omega_2)^2}{2}$

(c) $\frac{(I_1\omega_1 + I_2\omega_2)^2}{2(I_1 + I_2)}$

(d) None of these

14. If a current is passed in a spring, it

(a) gets compressed (b) gets expanded

(c) oscillates

(d) remains unchanged

15. A long solenoid carrying a current produces a magnetic field B along its axis. If the current is doubled and the number of turns per cm is halved, the new value of magnetic field will be equal to

(a) B (b) $2B$ (c) $4B$ (d) $\frac{B}{2}$

16. Hail stroms are observed to strike the surface of the frozen lake at 30° with the vertical and rebound at 60° with the vertical. Assume contact to be smooth, the coefficient of restitution is :

(a) $e = \frac{1}{\sqrt{3}}$ (b) $e = \frac{1}{3}$

(c) $e = \sqrt{3}$ (d) $e = 3$

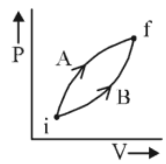
17. Following figure shows two processes A and B for a gas. If ΔQ_A and ΔQ_B are the amount of heat absorbed by the system in two cases, and ΔU_A and ΔU_B are changes in internal energies, respectively, then:

(a) $\Delta Q_A < \Delta Q_B, \Delta U_A < \Delta U_B$

(b) $\Delta Q_A > \Delta Q_B, \Delta U_A > \Delta U_B$

(c) $\Delta Q_A > \Delta Q_B, \Delta U_A = \Delta U_B$

(d) $\Delta Q_A = \Delta Q_B; \Delta U_A = \Delta U_B$



18. Two identical coils each of self-inductance L, are connected in series and are placed so close to each other that all the flux from one coil links with the other. The total self-inductance of the system is:

(a) L (b) 2L

(c) 3L (d) 4L

19. In a moving coil galvanometer, the deflection of the coil θ is related to the elecrical current i by the relation

(a) $i \propto \tan\theta$ (b) $i \propto \theta$

(c) $i \propto \theta^2$ (d) $i \propto \sqrt{\theta}$

20. Metals getting magnetised by orientation of atomic magnetic moments in external magnetic field are called

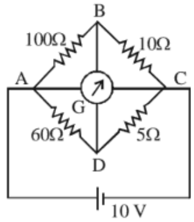
(a) diamagnetic (b) paramagnetic

(c) ferromagnetic (d) antimagnetic

21. A step up transformer operates on a 230 V line and supplies a current of 2 ampere. The ratio of primary and secondary winding is 1:25. The current in primary is

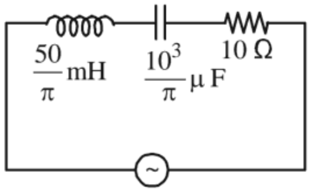
(a) 25 A (b) 50 A
(c) 15 A (d) 12.5 A

22. The four arms of a Wheatstone bridge have resistances as shown in the figure. A galvanometer of 15Ω resistance is connected across BD. Calculate the current through the galvanometer when a potential difference of 10 V is maintained across AC.



(a) 2.44 μA
(b) 4.87 μA
(c) 2.44 mA
(d) 4.87 mA

23. The net impedance of circuit (as shown in figure) will be



220 V, 50 Hz

(a) $10\sqrt{2}\,\Omega$ (b) $15\,\Omega$
(c) $5\sqrt{5}\,\Omega$ (d) $25\,\Omega$

24. Two conducting circular loops of radii R_1 and R_2 are placed in the same plane with their centres coinciding. If $R_1 >> R_2$, the mutual inductance M between them will be directly proportional to

(a) $\frac{R_2^2}{R_1}$ (b) $\frac{R_1}{R_2}$ (c) $\frac{R_2}{R_1}$ (d) $\frac{R_1^2}{R_2}$

25. In a circuit, L, C and R are connected in series with an alternating voltage source of frequency f. The current leads the voltage by 45°. The value of C is

(a) $\frac{1}{\pi f(2\pi fL - R)}$ (b) $\frac{1}{2\pi f(2\pi fL - R)}$
(c) $\frac{1}{\pi f(2\pi fL + R)}$ (d) $\frac{1}{2\pi f(2\pi fL + R)}$

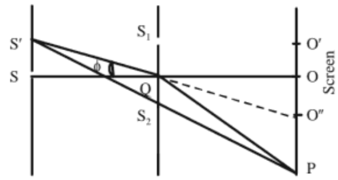
26. If a thin prism of glass is dipped in water then minimum deviation of light produced by prism will be $\left({}_a\mu_g = \frac{3}{2},\ {}_a\mu_w = \frac{4}{3}\right)$

(a) $\frac{1}{5}$ (b) $\frac{1}{8}$ (c) $\frac{1}{2}$ (d) $\frac{1}{3}$

27. A liquid does not wet the solid surface if angle of contact is

(a) zero (b) equal to 45°
(c) equal to 60° (d) greater than 90°

28. In the double slit experiment, the monochromatic source is shifted to a position S' at an angle ϕ above SQ. The position of central bright fringe will be



(a) at O'
(b) at O
(c) at O''
(d) at P

29. If the radius of a nucleus ^{256}X is 8 fermi, then the radius of ^{4}He nucleus will be

(a) 16 fermi (b) 2 fermi
(c) 32 fermi (d) 4 fermi

30. Four identical solid spheres each of mass 'm' and radius 'a' are placed with their centres on the four corners of a square of side 'b'. The moment of inertia of the system about one side of square where the axis of rotation is parallel to the plane of the square is :

(a) $\frac{4}{5}ma^2$ (b) $\frac{8}{5}ma^2 + mb^2$
(c) $\frac{8}{5}ma^2 + 2mb^2$ (d) $\frac{4}{5}ma^2 + 2mb^2$

31. Two sources of light emit X-rays of wavelength 1 nm and visible light of wavelength 500 nm, respectively. Both the sources emit light of the same power 200 W. The ratio of the number density of photons of X-rays to the number density of photons of the visible light of the given wavelengths is :

(a) $\frac{1}{500}$ (b) 250 (c) $\frac{1}{250}$ (d) 500

32. The capacitance of a parallel plate capacitor with air as medium is 6 μF. With the introduction of a dielectric medium, the capacitance becomes 30 μF. The permittivity of the medium is :
$(\epsilon_0 = 8.85 \times 10^{-12}\ C^2 N^{-1} m^{-2})$

(a) $1.77 \times 10^{-12}\ C^2 N^{-1} m^{-2}$
(b) $0.44 \times 10^{-10}\ C^2 N^{-1} m^{-2}$
(c) $5.00\ C^2 N^{-1} m^{-2}$
(d) $0.44 \times 10^{-13}\ C^2 N^{-1} m^{-2}$

33. Sodium and copper have work functions 2.3 eV and 4.5 eV respectively. Then the ratio of the wavelengths is nearest to

(a) 1 : 2 (b) 4 : 1 (c) 2 : 1 (d) 1 : 4

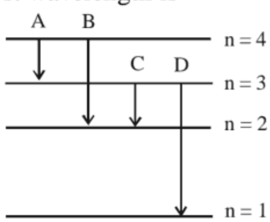
34. When the number of nucleons in nuclei increases, the binding energy per nucleon

(a) increases continuously with mass number
(b) decreases continuously with mass number
(c) remains constant with mass number
(d) first increases and then decreases with increase of mass number

35. Three capacitors 2 μF, 3 μF and 6 μF are joined in series with each other. The equivalent capacitance is-

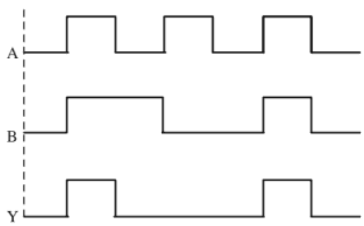
(a) 1/2 μF (b) 1 μF
(c) 2 μF (d) 11 μF

36. The energy levels of an hydrogen atom are shown below. The transition corresponding to emission of shortest wavelength is



(a) C
(b) D
(c) B
(d) A

37. A logic gate circuit has two inputs A and B and output Y. The voltage waveforms of A, B and Y are shown below



The logic gate circuit is

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

38. The ratio of frequencies of fundamental harmonic produced by an open pipe to that of closed pipe having the same length is

(a) 1 : 2 (b) 2 : 1
(c) 1 : 3 (d) 3 : 1

39. Consider the following statements and select the correct option.

(i) The ratio of C_P / C_V for a diatomic gas is more than that of a monoatomic gas.
(ii) The ratio of C_P / C_V is more for helium gas than for hydrogen

(a) (i) only (b) (ii) only
(c) (i) and (ii) (d) None of these

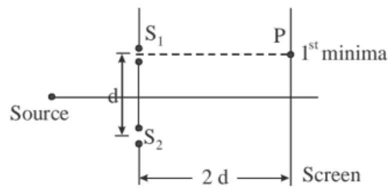
40. In an unbiased p-n junction electrons diffuse from n-region to p-region because :

(a) holes in p-region attract them
(b) electrons travel across the junction due to potential difference
(c) electron concentration in n-region is more compared to that in p-region
(d) none of these

41. A particle is travelling 4 times as fast as an electron. Assuming the ratio of de-Broglie wavelength of a particle to that of electron is 2 : 1, the mass of the particle is

(a) 16 times the mass of e^-
(b) 8 times the mass of e^-
(c) $\frac{1}{16}$ times the mass of e^-
(d) $\frac{1}{8}$ times the mass of e^-

42. Consider a Young's double slit experiment as shown in figure. What should be the slit separation d in terms of wavelength λ such that the first minima occurs directly in front of the slit (S_1)?



(a) $\frac{\lambda}{2(\sqrt{5}-2)}$ (b) $\frac{\lambda}{(\sqrt{5}-2)}$

(c) $\frac{\lambda}{2(5-\sqrt{2})}$ (d) $\frac{\lambda}{(5-\sqrt{2})}$

43. A simple pendulum performs SHM about $x = 0$ with an amplitude a and time period T. What is the speed of the pendulum at $x = a/2$?

(a) $\frac{a\pi\sqrt{3}}{T}$ (b) $\frac{a^2\pi^2\sqrt{3}}{T^2}$

(c) $\frac{a}{T}$ (d) $\frac{a\pi}{T}$

44. An astronomical telescope has a magnifying power 10, the focal length of the eyepiece is 20 cm. The focal length of the objective is

(a) $\frac{1}{200}$ cm (b) $\frac{1}{2}$ cm

(c) 200 cm (d) 2 cm

45. Find the torque about the origin when a force of $3\hat{j}$ N acts on a particle whose position vector is $2\hat{k}$ m.

(a) $6\hat{j}$ Nm (b) $-6\hat{i}$ Nm

(c) $6\hat{k}$ Nm (d) $6\hat{i}$ Nm

46. A planet of mass m moves around the sun of mass M in an elliptical orbit. The maximum and minimum distance of the planet from the sun are r_1 and r_2 respectively. The time period of planet is proportional to

(a) $r_1^{2/5}$ (b) $\left(\frac{r_1+r_2}{2}\right)^{3/2}$

(c) $\left(\frac{r_1-r_2}{2}\right)^{3/2}$ (d) $r^{3/2}$

47. Consider a planet in some solar system which has a mass double the mass of earth and density equal to the average density of earth. If the weight of an object on earth is W, the weight of the same object on that planet will be :

(a) 2W (b) W

(c) $2^{\frac{1}{3}}$W (d) $\sqrt{2}$ W

48. A bucket tied at the end of a 1.6 m long string is whirled in a vertical circle with constant speed. What should be the minimum speed so that the water from the bucket does not spill when the bucket is at the highest position?

(a) 4 m/sec (b) 6.25 m/sec

(c) 16 m/sec (d) None of these

49. The minimum velocity (in ms^{-1}) with which a car driver must traverse a flat curve of radius 150 m and coefficient of friction 0.6 to avoid skidding is

(a) 60 (b) 30

(c) 15 (d) 25

50. Mean free path of a gas molecule is

(a) inversely proportional to number of molecules per unit volume

(b) inversely proportional to diameter of the molecule

(c) directly proportional to the square root of the absolute temperature

(d) directly proportional to the molecular mass

CHEMISTRY

51. Identify the species having one π-bond and maximum number of canonical forms from the following :

(a) SO_3 (b) O_2

(c) SO_2 (d) CO_3^{2-}

52. The shortest wavelength of hydrogen atom in Lyman series is λ. The longest wavelength in Balmer series of He^+ is

(a) $\frac{5}{9\lambda}$ (b) $\frac{9\lambda}{5}$

(c) $\frac{36\lambda}{5}$ (d) $\frac{5\lambda}{9}$

53. Number of atoms in the following samples of substances is the largest in :

(a) 4.0 g of hydrogen

(b) 71.0 g of chlorine

(c) 127.0 g of iodine

(d) 48.0 g of magnesium

54. van der Waals equation for a gas is stated as,

$$P = \frac{nRT}{V-nb} - a\left(\frac{n}{V}\right)^2.$$

This equation reduces to the perfect gas equation,

$P = \frac{nRT}{V}$ when,

(a) temperature is sufficient high and pressure is low.

(b) temperature is sufficient low and pressure is high.

(c) both temperature and pressure are very high.

(d) both temperature and pressure are very low.

55. Copper crystallises in fcc with a unit length of 361pm. What is the radius of copper atom?

(a) 157 pm (b) 128 pm

(c) 108 pm (d) 181 pm

56. For an ideal solution of two components A and B, which of the following is true?

(a) $\Delta H_{mixing} < 0$ (zero)

(b) $\Delta H_{mixing} > 0$ (zero)

(c) A – B interaction is stronger than A – A and B – B interactions

(d) A– A, B – B and A – B interactions are identical.

57. Correct order of limiting molar conductivity for cations in water at 298 K is :

(a) $H^+ > Na^+ > K^+ > Ca^{2+} > Mg^{2+}$
(b) $H^+ > Ca^{2+} > Mg^{2+} > K^+ > Na^+$
(c) $Mg^{2+} > H^+ > Ca^{2+} > K^+ > Na^+$
(d) $H^+ > Na^+ > Ca^{2+} > Mg^{2+} > K^+$

58. The statement that is **not** true about ozone is :

(a) in the stratosphere, CFCs release chlorine free radicals ($\dot{C}l$) which reacts with O_3 to give chlorine dioxide radicals.
(b) in the atmosphere, it is depleted by CFCs.
(c) in the stratosphere, it forms a protective shield against UV radiation.
(d) it is a toxic gas and its reaction with NO gives NO_2.

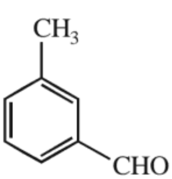
59. The density of 'x' M solution ('x' molar) of NaOH is 1.12 g mL^{-1}. while in molality, the concentration of the solution is 3 m (3 molal). Then x is
(Given : Molar mass of NaOH is 40 g/mol)

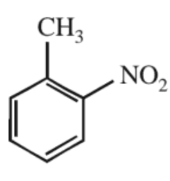
(a) 3.5 (b) 3.0
(c) 3.8 (d) 2.8

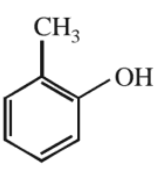
60. Identify the correct trend given below :
(Atomic No. = Ti : 22, Cr : 24 and Mo : 42)

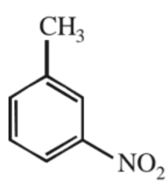
(a) Δ_o of $[Cr(H_2O)_6]^{2+} > [Mo(H_2O)_6]^{2+}$ and Δ_o of $[Ti(H_2O)_6]^{3+} > [Ti(H_2O)_6]^{2+}$
(b) Δ_o of $[Cr(H_2O)_6]^{2+} > [Mo(H_2O)_6]^{2+}$ and Δ_o of $[Ti(H_2O)_6]^{3+} < [Ti(H_2O)_6]^{2+}$
(c) Δ_o of $[Cr(H_2O)_6]^{2+} < [Mo(H_2O)_6]^{2+}$ and Δ_o of $[Ti(H_2O)_6]^{3+} > [Ti(H_2O)_6]^{2+}$
(d) Δ_o of $[Cr(H_2O)_6]^{2+} < [Mo(H_2O)_6]^{2+}$ and Δ_o of $[Ti(H_2O)_6]^{3+} < [Ti(H_2O)_6]^{2+}$

61. Halogenation of which one of the following will yield m-substituted product with respect to methyl group as a major product?

(a) 

(b) 

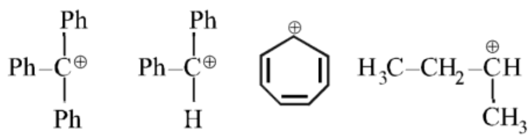
(c) 

(d) 

62. An element crystallises in a face-centred cubic (fcc) unit cell with cell edge a. The distance between the centres of two nearest octahedral voids in the crystal lattice is :

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

63. The correct order of stability of following carbocations is:



A B C D

(a) A > B > C > D (b) B > C > A > D
(c) C > B > A > D (d) C > A > B > D

64. The correct order of bond orders of C_2^{2-}, N_2^{2-} and O_2^{2-} is, respectively.

(a) $C_2^{2-} < N_2^{2-} < O_2^{2-}$
(b) $O_2^{2-} < N_2^{2-} < C_2^{2-}$
(c) $C_2^{2-} < O_2^{2-} < N_2^{2-}$
(d) $N_2^{2-} < C_2^{2-} < O_2^{2-}$

65. Oxidation number of potassium in K_2O, K_2O_2 and KO_2, respectively, is:

(a) +2, +1 and $+\frac{1}{2}$ (b) +1, +1 and +1
(c) +1, +4 and +2 (d) +1, +2 and +4

66. Sodium metal on dissolution in liquid ammonia gives a deep blue solution due to the formation of:

(a) sodium-ammonia complex
(b) sodamide
(c) sodium ion-ammonia complex
(d) ammoniated electrons

67. The emf of cell $Tl\left|\begin{matrix}Tl^+ \\ (0.001M)\end{matrix}\right|\left|\begin{matrix}Cu^{2+} \\ (0.01M)\end{matrix}\right|Cu$ is 0.83 V at 298 K. It could be increased by :

(a) increasing concentration of Tl^+ ions
(b) increasing concentration of both Tl^+ and Cu^{2+} ions
(c) decreasing concentration of both Tl^+ and Cu^{2+} ions
(d) increasing concentration of Cu^{2+} ions

68. The reaction at cathode in the cells commonly used in clocks involves.

(a) reduction of Mn from +4 to +3

(b) oxidation of Mn from +3 to +4

(c) reduction of Mn from +7 to +2

(d) oxidation of Mn from + 2 to +7

69. Which of the following complex is homoleptic?

(a) $[Ni(CN)_4]^{2-}$ (b) $[Ni(NH_3)_2Cl_2]$

(c) $[Fe(NH_3)_4Cl_2]^+$ (d) $[Co(NH_3)_4Cl_2]^+$

70. The complex that can show optical activity is :

(a) *trans*-$[Cr(Cl_2)(ox)_2]^{3-}$

(b) *trans*-$[Fe(NH_3)_2(CN)_4]^-$

(c) *cis*-$[Fe(NH_3)_2(CN)_4]^-$

(d) *cis*-$[CrCl_2(ox)_2]^{3-}$ (ox = oxalate)

71. A solution of Ni $(NO_3)_2$ is electrolysed between platinum electrodes using 0.1 Faraday electricity. How many mole of Ni will be deposited at the cathode?

(a) 0.05 (b) 0.20

(c) 0.15 (d) 0.10

72. In a first order decomposition reaction, the time taken for the decomposition of reactant to one fourth and one eighth of its initial concentration are t_1 and t_2 (s), respectively. The ratio $\frac{t_1}{t_2}$ will :

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

(c) $\frac{3}{4}$ (d) $\frac{2}{3}$

73. The strongest reducing agent among the following is:

(a) SbH_3 (b) NH_3

(c) BiH_3 (d) PH_3

74. $t_{1/4}$ can be taken as the time taken for the concentration of a reactant to drop to 3/4 of its initial value. If the rate constant for a first order reaction is k, the $t_{1/4}$ can be written as

(a) $0.75/k$ (b) $0.69/k$

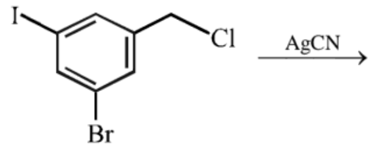
(c) $0.29/k$ (d) $0.10/k$

75. Which among the following is the most reactive ?

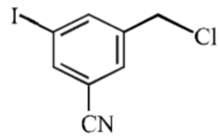
(a) I_2 (b) ICl

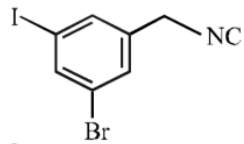
(c) Cl_2 (d) Br_2

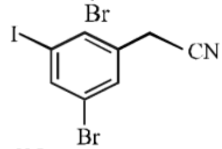
76. The structure of the major product formed in the following reaction is :

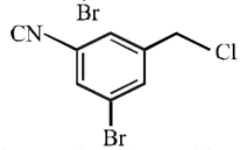


Major product

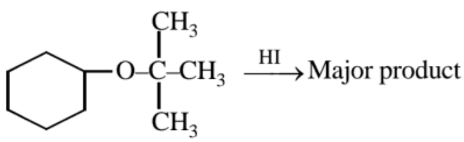
(a) 

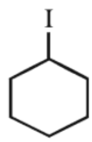
(b) 

(c) 

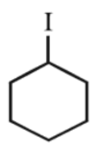
(d) 

77. Major product formed in the following reaction is a mixture of:

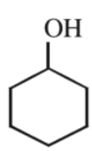


(a) 

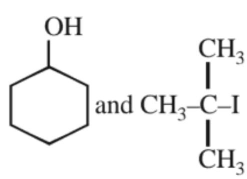
and $(CH_3)_3Cl$

(b) 

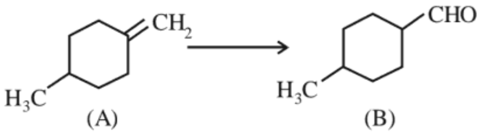
and $(CH_3)_3COH$

(c) 

and $(CH_3)_3COH$

(d) 

78. Which of the following reagents/ reactions will convert 'A' to 'B'?



(A) (B)

(a) PCC oxidation
(b) Ozonolysis
(c) BH_3, H_2O_2 / ^{-}OH followed by PCC oxidation
(d) HBr, hydrolysis followed by oxidation by $K_2Cr_2O_7$.

79. Which of the following salt solutions would coagulate the colloid solution formed when $FeCl_3$ is added to NaOH solution, at the fastest rate?
(a) 10 mL of 0.2 mol dm^{-3} $AlCl_3$
(b) 10 mL of 0.1 mol dm^{-3} Na_2SO_4
(c) 10 mL of 0.1 mol dm^{-3} $Ca_3(PO_4)_2$
(d) 10 mL of 0.15 mol dm^{-3} $CaCl_2$

80. The enthalpy change for the adsorption process and micelle formation respectively are
(a) $\Delta H_{ads} < 0$ and $\Delta H_{mic} > 0$
(b) $\Delta H_{ads} < 0$ and $\Delta H_{mic} < 0$
(c) $\Delta H_{ads} > 0$ and $\Delta H_{mic} < 0$
(d) $\Delta H_{ads} > 0$ and $\Delta H_{mic} > 0$

81. Sugar moiety in DNA and RNA molecules respectively are
(a) β-D-2-deoxyribose, β-D-deoxyribose
(b) β-D-2-deoxyribose, β-D-ribose
(c) β-D-ribose, β -D-2-deoxyribose
(d) β-D-deoxyribose, β -D-2-deoxyribose

82. Which one of the following is **NOT** a copolymer ?
(a) Buna-S
(b) Neoprene
(c) PHBV
(d) Butadiene-styrene

83. Calamine and Malachite, respectively, are the ores of :
(a) Nickel and Aluminium
(b) Zinc and Copper
(c) Copper and Iron
(d) Aluminium and Zinc

84. Which of the following is used as a stabilizer during the concentration of sulphide ores?
(a) Pine oils (b) Xanthates
(c) Fatty acids (d) Cresols

85. Vulcanization of rubber is carried out by heating a mixture of :
(a) isoprene and styrene
(b) neoprene and sulphur
(c) isoprene and sulphur
(d) neoprene and styrene

86. The reaction used for preparation of soap from fat is:
(a) reduction reaction
(b) alkaline hydrolysis reaction
(c) an addition reaction
(d) an oxidation reaction

87. Which of the following electronic configuration would be associated with the highest magnetic moment ?
(a) $[Ar]\,3d^7$ (b) $[Ar]\,3d^8$
(c) $[Ar]\,3d^3$ (d) $[Ar]\,3d^6$

88. The most common oxidation state of Lanthanoid elements is +3. Which of the following is likely to deviate easily from +3 oxidation state?
(a) Ce (At. No. 58) (b) La (At. No. 57)
(c) Lu (At. No. 71) (d) Gd (At. No. 64)

89. The increasing order of the reactivity of the following halides for the S_N1 reaction is

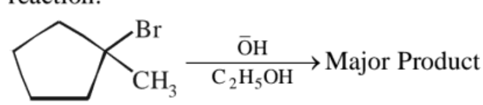
$CH_3CH(Cl)CH_2CH_3$ (I) $\quad$ $CH_3CH_2CH_2Cl$ (II)

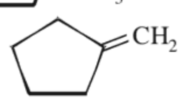
p-H_3CO–C_6H_4–CH_2Cl (III)

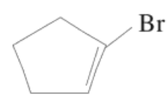
(a) (III) < (II) < (I) (b) (II) < (I) < (III)
(c) (I) < (III) < (II) (d) (II) < (III) < (I)

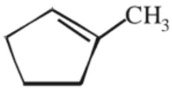
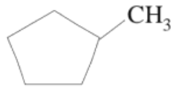
90. The difference in the reaction of phenol with bromine in chloroform and bromine in water medium is due to:
(a) Hyperconjugation in substrate
(b) Polarity of solvent
(c) Free radical formation
(d) Electromeric effect the substrate

91. Identify the major product in the following reaction.

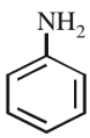
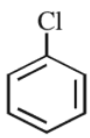
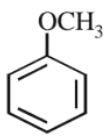
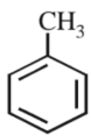


(a) 

(b) 

(c) 
(d) 

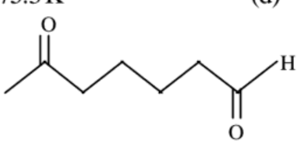
92. The increasing order of nitration of the following compounds is :

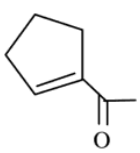
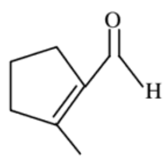
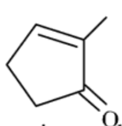
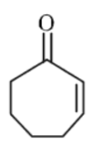

(A)

(B)

(C)

(D)

(a) (A) < (B) < (D) < (C)
(b) (A) < (B) < (C) < (D)
(c) (B) < (A) < (C) < (D)
(d) (B) < (A) < (D) < (C)

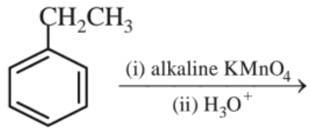
93. An element X has a body centred cubic (bcc) structure with a cell edge of 200 pm. The density of the element is 5 g cm^{-3}. How many number of atoms present in 300 g of the element
Given : Avogadro Constant, $N_A = 6.0 \times 10^{23}$ mol^{-1}.
(a) $5N_A$ (b) $6N_A$
(c) $15N_A$ (d) $25N_A$

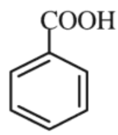
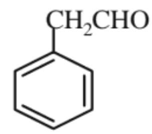
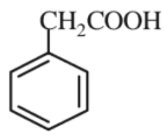
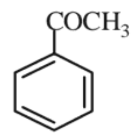
94. 2 moles each of ethylene glycol and glucose are dissolved in 500 g of water. The boiling point of the resulting solution is :
(Given : Ebullioscopic constant of water = 0.52 K kg mol^{-1})
(a) 379.2 K (b) 377.3 K
(c) 375.3 K (d) 277.3 K

95. When  undergoes intramolecular aldol condensation, the major product formed is :

(a) 
(b) 
(c) 
(d) 

96. The major product of the following reaction is:



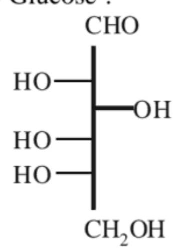
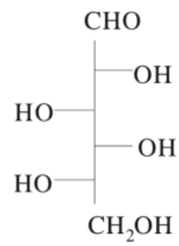
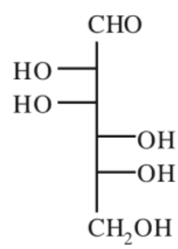
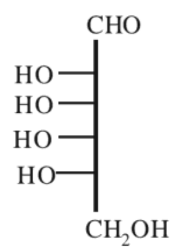
(a) 
(b) 
(c) 
(d) 

97. For 1 molal aqueous solution of the following compounds, which one will show the highest freezing point?
(a) $[Co(H_2O)_6]Cl_3$
(b) $[Co(H_2O)_5Cl]Cl_2.H_2O$
(c) $[Co(H_2O)_4Cl_2]Cl.2H_2O$
(d) $[Co(H_2O)_3Cl_3].3H_2O$

98. The correct order in aqueous medium of basic strength in case of methyl substituted amines is :
(a) $Me_2NH > MeNH_2 > Me_3N > NH_3$
(b) $Me_2NH > Me_3N > MeNH_2 > NH_3$
(c) $NH_3 > Me_3N > MeNH_2 > Me_2NH$
(d) $Me_3N > Me_2NH > MeNH_2 > NH_3$

99. Which of the following compounds is an example of hypnotic drug ?
(a) Seldane (b) Amytal
(c) Aspartame (d) Prontosil

100. Which of the following is the correct structure of L-Glucose ?

(a) 
(b) 
(c) 
(d) 

SECTION-B

MATHEMATICS

101. In a triangle ABC, BC = 7, AC = 8, AB = $\alpha \in N$ and $\cos A = \frac{2}{3}$. If $49\cos(3C) + 42 = \frac{m}{n}$, where gcd(m, n) = 1, them m + n is equal to

(a) 38 (b) 39 (c) 37 (d) 36

102. let the equation $x(x + 2)(12 - k) = 2$ have equal roots. Then the distance of the point $\left(k, \frac{k}{2}\right)$ from the line $3x + 4y + 5 = 0$ is

(a) 15 (b) $5\sqrt{3}$ (c) $15\sqrt{5}$ (d) 12

103. A circle C of radius 2 lies in the second quadrant and touches both the coordinate axes. Let r be the radius of a circle that has centre at the point (2, 5) and intersects the circle C at exactly two points. If the set of all possible values of r is the interval (α, β), then $3\beta - 2\alpha$ is equal to:

(a) 15 (b) 225 (c) 14 (d) 196

104. Let the mean and the standard deviation of the observation 2, 3, 3, 4, 5, 7, *a*, *b* be 4 and $\sqrt{2}$ respectively. Then the mean deviation about the mode of these observations is :

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

105. The probability, of forming a 12 persons committee from 4 engineers, 2 doctors and 10 professors containing at least 3 engineers and at least 1 doctor, is:

(a) $\frac{129}{182}$ (b) $\frac{103}{182}$ (c) $\frac{17}{26}$ (d) $\frac{19}{26}$

106. In how many ways can a bowler take four wickets in a single 6-ball over ?

(a) 6 (b) 15 (c) 20 (d) 30

107. Evaluate $\lim_{x\to 0}\frac{x}{\sqrt{1+x}-\sqrt{1-x}}$

(a) 1 (b) 2 (c) –1 (d) –2

108. The domain of the function $f(x) = \frac{1}{\sqrt{9 - x^2}}$ is

(a) $-3 \le x \le 3$ (b) $-3 < x < 3$
(c) $-9 \le x \le 9$ (d) $-9 < x < 9$

109. The amplitude of $\sin\frac{\pi}{5} + i\left(1 - \cos\frac{\pi}{5}\right)$ is

(a) $\frac{\pi}{5}$ (b) $\frac{2\pi}{5}$ (c) $\frac{\pi}{10}$ (d) $\frac{\pi}{15}$

110. If $f(x) = \frac{\sqrt{4+x}-2}{x}$, $x \neq 0$ be continuous at x = 0, then f(0) =

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

111. Let $A = \begin{bmatrix} \cos^2\theta & \sin\theta\cos\theta \\ \cos\theta\sin\theta & \sin^2\theta \end{bmatrix}$ and $B = \begin{bmatrix} \cos^2\phi & \sin\phi\cos\phi \\ \cos\phi\sin\phi & \sin^2\phi \end{bmatrix}$, then AB = O, if

(a) $\theta = n\phi$, n = 0, 1, 2, ...
(b) $\theta + \phi = n\pi$, n = 0, 1, 2, ...
(c) $\theta = \phi + (2n + 1)\frac{\pi}{2}$, n = 0, 1, 2, ...
(d) $\theta = \phi + \frac{n\pi}{2}$, n = 0, 1, 2, ...

112. If A is a square matrix of order 3, then $|Adj.A| =$

(a) $|A|^{-1}$ (b) $|A|$ (c) $|A|^3$ (d) $|A|^2$

113. For $A = \begin{bmatrix} 3 & 1 \\ -1 & 2 \end{bmatrix}$, then $14A^{-1}$ is given by :

(a) $14\begin{bmatrix} 2 & -1 \\ 1 & 3 \end{bmatrix}$ (b) $\begin{bmatrix} 4 & -2 \\ 2 & 6 \end{bmatrix}$

(c) $2\begin{bmatrix} 2 & -1 \\ 1 & -3 \end{bmatrix}$ (d) $2\begin{bmatrix} -3 & -1 \\ 1 & -2 \end{bmatrix}$

114. $\int \frac{\sin^2 x - \cos^2 x}{\sin^2 x \cos^2 x} dx =$

(a) tan x + cot x + c (b) cosec x + sce x + c
(c) tan x + sec x + c (d) tan x + cosec x + c

115. $\int \frac{e^x(1+x)}{\cos^2(e^x x)}dx$ equals

(a) $-\cot(ex^x)+C$ (b) $\tan(xe^x)+C$

(c) $\tan(e^x)+C$ (d) $\cot(e^x)+C$

116. $\int_{1/4}^{1/2}\frac{dx}{\sqrt{x-x^2}}$ is equal to :

(a) $\frac{\pi}{6}$ (b) $\frac{\pi}{3}$ (c) $\frac{\pi}{4}$ (d) 0

117. The value of the integral $\int_{-\frac{\pi}{4}}^{\frac{\pi}{4}}\frac{x+\frac{\pi}{4}}{2-\cos 2x}dx$ is :

(a) $\frac{\pi^2}{6\sqrt{3}}$ (b) $\frac{\pi^2}{6}$ (c) $\frac{\pi^2}{12\sqrt{3}}$ (d) $\frac{\pi^2}{3\sqrt{3}}$

118. If two straight lines whose direction cosines are given by the relations $l+m-n=0$, $3l^2+m^2+cnl=0$ are parallel, then the positive value of c is:

(a) 6 (b) 4 (c) 3 (d) 2

119. If the two lines $l_1: \frac{x-2}{3}=\frac{y+1}{-2}, z=2$ and $l_2: \frac{x-1}{1}=\frac{2y+3}{\alpha}=\frac{z+5}{2}$ perpendicular, then an angle between the lines l_2 and l_3: $\frac{1-x}{3}=\frac{2y-1}{-4}=\frac{z}{4}$ is :

(a) $\cos^{-1}\left(\frac{29}{4}\right)$ (b) $\sec^{-1}\left(\frac{29}{4}\right)$

(c) $\cos^{-1}\left(\frac{2}{29}\right)$ (d) $\cos^{-1}\left(\frac{2}{\sqrt{29}}\right)$

120. If the plane $x-3y+5z=d$ passes through the point (1, 2, 4), then the length of intercepts cut by it on the axes of X, Y, Z are respectively, is

(a) 15, –5, 3 (b) 1, –5, 3

(c) –15, 5, –3 (d) 1, –6, 20

121. The maximum vale of $P = x+3y$ such that $2x+y\le 20,\ x+2y\le 20\ x\ge 0, y\ge 0$ is

(a) 10 (b) 60 (c) 30 (d) None

122. Corner points of feasible region of inequalities gives

(a) optimal solution of L.P.P.

(b) objective function

(c) constraints.

(d) linear assumption

123. If $P(A)=\frac{1}{2}$, $P(B)=0$, then $P(A/B)$ is

(a) 0 (b) $\frac{1}{2}$

(c) not defined (d) 1

124. Under what condition do $\left\langle\frac{1}{\sqrt{2}},\frac{1}{2},k\right\rangle$ represent direction cosines of a line?

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

(c) $k=\pm\frac{1}{2}$ (d) k can take any value

125. The lines $x = ay + b$, $z = cy + d$ and $x = a'y + b'$, $z = c'y + d'$ are perpendicular if

(a) $aa' + bb' + cc' + 1 = 0$

(b) $aa' + bb' + 1 = 0$

(c) $bb' + cc' + 1 = 0$

(d) $aa' + cc' + 1 = 0$

126. Let X be a binomially distributed random variable with mean 4 and variance $\frac{4}{3}$. Then $54\,P(X\le 2)$ is equal to

(a) $\frac{73}{27}$ (b) $\frac{146}{27}$ (c) $\frac{146}{81}$ (d) $\frac{126}{81}$

127. The mean and variance of a random variable X having binomial distribution are 4 and 2 respectively, then $P(X=1)$ is

(a) $\frac{1}{4}$ (b) $\frac{1}{32}$ (c) $\frac{1}{16}$ (d) $\frac{1}{8}$

128. Four fair dice are thrown independently 27 times. Then the expected number of times, at least two dice show up a three or a five, is

(a) 1 (b) 3 (c) 11 (d) 7

129. The area bounded by the curve $y=\frac{3}{2}\sqrt{x}$, the line $x = 1$ and x-axis is _______ sq. units.

(a) 2 (b) 1 (c) 6 (d) None

130. The area bounded by $y-1=|x|$, $y=0$ and $|x|=\frac{1}{2}$ will be:

(a) $\frac{3}{4}$ (b) $\frac{3}{2}$ (c) $\frac{5}{4}$ (d) None

131. $\tan^{-1}x+\tan^{-1}y=c$ is the general solution of the differential equation

(a) $\frac{dy}{dx}=\frac{1+y^2}{1+x^2}$

(b) $\frac{dy}{dx}=\frac{1+x^2}{1+y^2}$

(c) $(1+x^2)\,dy+(1+y^2)\,dx=0$

(d) $(1+x^2)\,dx+(1+y^2)\,dy=0$

132. If y(x) is the solution of the differential equation

$(x+2)\frac{dy}{dx}=x^2+4x-9, x\neq -2$ and $y(0)=0$,

then

y (–4) is equal to :

(a) 0 (b) 2 (c) 1 (d) –1

133. If $\vec{a}, \vec{b}, \vec{c}$ are three non-coplanar vectors, then

$[\vec{a}+\vec{b}+\vec{c}\ \ \vec{a}-\vec{c}\ \ \vec{a}-\vec{b}]$ is equal to

(a) 0 (b) $2[\vec{a}\ \vec{b}\ \vec{c}]$

(c) $-3[\vec{a}\,\vec{b}\,\vec{c}]$ (d) $2[\vec{a}\,\vec{b}\,\vec{c}]$

134. The vectors $\vec{a}=\hat{i}+\hat{j}+m\hat{k}$,

$\vec{b}=\hat{i}+\hat{j}+(m+1)\hat{k}$ and $\vec{c}=\hat{i}-\hat{j}+m\hat{k}$

are coplanar if m is equal to

(a) 1 (b) 4 (c) 3 (d) None

135. If A,B and C are the vertices of a triangle whose position vectors are $\vec{a},\vec{b}$ and $\vec{c}$ respectively and G is the centroid of the ΔABC, then $\overrightarrow{GA}+\overrightarrow{GB}+\overrightarrow{GC}$ is

(a) $\vec{0}$ (b) $\vec{a}+\vec{b}+\vec{c}$

(c) $\frac{\vec{a}+\vec{b}+\vec{c}}{3}$ (d) $\frac{\vec{a}-\vec{b}-\vec{c}}{3}$

136. If $x=b\cos^{-1}\sqrt{\frac{y}{b}}+\sqrt{by-y^2}$, then $\frac{dy}{dx}=$

(a) $-\sqrt{\frac{b}{y}-1}$ (b) $\sqrt{1-\frac{b}{y}}$

(c) $\sqrt{by-y^2}$ (d) 0

137. If $y=e^{x^x}$, then $\frac{dy}{dx}=$

(a) $y(1+\log_e x)$ (b) $yx^x(1+\log_e x)$

(c) $ye^x(1+\log_e x)$ (d) None of these

138. If $f(1)=1, f'(1)=3$, then the derivative of $f(f(f(x)))+(f(x))^2$ at $x=1$ is :

(a) 33 (b) 12 (c) 15 (d) 9

139. Which of the following functions is differentiable at $x=0$?

(a) $\cos(|x|)+|x|$ (b) $\cos(|x|)-|x|$

(c) $\sin(|x|)+|x|$ (d) $\sin(|x|)-|x|$

140. Let $f(x)=|\sin x|$. Then

(a) f is everywhere differentiable

(b) f is everywhere continuous but not differentiable at $x=n\pi, n\in Z$

(c) f is everywhere continuous but not differentiable at $x=(2n+1)\frac{\pi}{2}, n\in Z$.

(d) None of these

141. The approximate values of $\sqrt{0.0037}$ is

(a) $\frac{37}{600}$ (b) $\frac{73}{1200}$ (c) $\frac{71}{1200}$ (d) None

142. If $f(x)=x^x$, then f (x) is decreasing in interval :

(a) $]0, e[$ (b) $]0, \frac{1}{e}[$

(c) $]0, 1[$ (d) None of these

143. If $x=a(\cos t+t\sin t)$ and $y=a(\sin t-t\cos t)$, then $\frac{d^2y}{dx^2}$ is

(a) $\sec^3 t$ (b) $at\sec^3 t$

(c) $\frac{\sec^3 t}{at}$ (d) $\sec^2 t$

144. The maximum value of $(\log x)/x$ is

(a) e (b) 2e (c) 1/e (d) 2/e

145. $\sim((\sim p)\wedge q)$ is equal to

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

(c) $p\wedge(\sim q)$ (d) $\sim p\wedge\sim q$

146. 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) $\sim q \leftrightarrow \sim p$

147. The angle between two lines represented by $2x^2 + 5xy + 3y^2 + 6x + 7y + 4 = 0$ is

(a) $\tan^{-1}\left(\frac{2}{5}\right)$ (b) $\frac{\pi}{4}$

(d) $\frac{3\pi}{4}$ (d) $\tan^{-1}\left(\pm\frac{1}{5}\right)$

148. If one of the lines of $6x^2 - xy + 4cy^2 = 0$ is given by $3x + 4y = 0$, then c equals

(a) –3 (b) –1 (c) 3 (d) 1

149. If $y = mx + 4$ is a tangent to both the parabolas, $y^2 = 4x$ and $x^2 = 2by$, then b is equal to:

(a) –32 (b) –64 (c) –128 (d) 128

150. The tangents to the hyperbola $x^2 - y^2 = 3$ are parallel to the st line $2x + y + 8 = 0$ at the following points

(a) (2, 1) or (1, 2) (b) (2, –1) or (–2, 1)

(c) (–1, –2) (d) (–2, –1)

ANSWER KEYS & SOLUTIONS

(MHT-CET 2025)

Answer Keys

SECTION-A																			
PHYSICS																			
1	(a)	**6**	(d)	**11**	(a)	**16**	(b)	**21**	(b)	**26**	(b)	**31**	(a)	**36**	(b)	**41**	(d)	**46**	(b)
2	(a)	**7**	(a)	**12**	(a)	**17**	(c)	**22**	(d)	**27**	(d)	**32**	(b)	**37**	(b)	**42**	(a)	**47**	(c)
3	(c)	**8**	(d)	**13**	(c)	**18**	(d)	**23**	(c)	**28**	(c)	**33**	(c)	**38**	(b)	**43**	(a)	**48**	(a)
4	(a)	**9**	(a)	**14**	(a)	**19**	(b)	**24**	(a)	**29**	(b)	**34**	(d)	**39**	(b)	**44**	(c)	**49**	(b)
5	(a)	**10**	(c)	**15**	(a)	**20**	(b)	**25**	(d)	**30**	(c)	**35**	(b)	**40**	(c)	**45**	(b)	**50**	(a)
CHEMISTRY																			
51	(d)	**56**	(d)	**61**	(c)	**66**	(d)	**71**	(a)	**76**	(b)	**81**	(b)	**86**	(b)	**91**	(c)	**96**	(a)
52	(b)	**57**	(b)	**62**	(a)	**67**	(d)	**72**	(d)	**77**	(d)	**82**	(b)	**87**	(d)	**92**	(a)	**97**	(d)
53	(a)	**58**	(a)	**63**	(d)	**68**	(a)	**73**	(c)	**78**	(c)	**83**	(b)	**88**	(a)	**93**	(d)	**98**	(a)
54	(a)	**59**	(b)	**64**	(b)	**69**	(a)	**74**	(c)	**79**	(a)	**84**	(d)	**89**	(b)	**94**	(b)	**99**	(b)
55	(b)	**60**	(c)	**65**	(b)	**70**	(d)	**75**	(b)	**80**	(a)	**85**	(c)	**90**	(b)	**95**	(a)	**100**	(a)
SECTION-B																			
MATHEMATICS																			
101	(b)	**106**	(b)	**111**	(c)	**116**	(a)	**121**	(d)	**126**	(b)	**131**	(c)	**136**	(b)	**141**	(b)	**146**	(c)
102	(a)	**107**	(a)	**112**	(d)	**117**	(a)	**122**	(a)	**127**	(b)	**132**	(a)	**137**	(b)	**142**	(b)	**147**	(d)
103	(a)	**108**	(b)	**113**	(b)	**118**	(a)	**123**	(c)	**128**	(c)	**133**	(c)	**138**	(a)	**143**	(c)	**148**	(a)
104	(a)	**109**	(c)	**114**	(a)	**119**	(b)	**124**	(c)	**129**	(b)	**134**	(d)	**139**	(d)	**144**	(a)	**149**	(c)
105	(a)	**110**	(b)	**115**	(b)	**120**	(a)	**125**	(d)	**130**	(c)	**135**	(a)	**140**	(b)	**145**	(a)	**150**	(b)

SECTION-A

PHYSICS

1. **(a)** Velocity of sound $= \sqrt{\frac{\gamma RT}{M}}$

When water vapour are present in air, average molecular weight of air decreases and hence velocity increases.

2. **(a)** $V + \Delta V = (L + \Delta L)^3 = (L + \alpha L\Delta T)^3$

$= L^3 + (1 + 3\alpha\Delta T + 3\alpha^2\Delta T^2 + \alpha^3\Delta T^3)$

$\Rightarrow$ α^2 and α^3 terms are neglected.

$\therefore$ $V(1 + \gamma\Delta T) = V(1 + 3\alpha\Delta T)$

$1 + \gamma\Delta T = 1 + 3\alpha\Delta T$

$\therefore \gamma = 3\alpha.$

3. **(c)** Velocity of efflux

$v = \sqrt{2gh} = \sqrt{2\times10\times0.2} = 2\ ms^{-1}$

4. **(a)** We have $PV = nRT \Rightarrow V = \frac{nR}{P}T$

$V = mT$, where m = slope of $v - T_{curve} = \frac{nR}{P}$

Now, as $m_2 > m_1 \Rightarrow \frac{nR}{P_2} > \frac{nR}{P_1} \Rightarrow P_2 < P_1$

5. **(a)** From law of conservation of linear momentum

$P_i = P_f \Rightarrow m_1 u_1 + m_2 u_2 = m_1 v_1 + m_2 v_2$ ...(i)

$2\times4 + 0 = 2\times1 + m_2 v_2$

In elastic collision coefficient of restitution, e = 1 and

$e = \frac{v_2 - v_1}{u_1 - u_2}$

$\Rightarrow v_2 - v_1 = e(u_1 - u_2) \Rightarrow v_2 - 1 = 1(4-0)$ or, $v_2 = 5$

Now from eq. (i)

$8 = 2 + m_2\times5 \Rightarrow m_2 = \frac{6}{5}$

Velocity of centre of mass

$$V_{cm} = \frac{m_1v_1 + m_2v_2}{m_1 + m_2} = \frac{2\times1 + \frac{6}{5}\times5}{2 + \frac{6}{5}} = 2.5\ m/s$$

6. **(d)** We know that $C_v = \frac{f}{2}R$

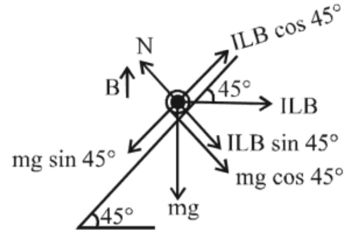
Here, $f = 5 + 2$ [$\because$ 1 Vib.mode = 2DOF]

$= 7$

So, $C_v = \frac{7}{2}R$

7. **(a)** Force, $F = ILB\sin\theta$

From figure, $mg\sin45° = ILB\cos45°$



$\therefore I = \left(\frac{m}{L}\right)\frac{g}{B} = \frac{(0.45)(10)}{0.15} = 30A$

8. **(d)** For, $r = R/2$

Using Gauss's law, we have

$\oint \vec{E}.d\vec{A} = \frac{q_{in}}{\epsilon_0}$

$\Rightarrow E\times4\pi R^2 = \frac{1}{\epsilon_0}\int_0^{R/2} Cr^2\times4\pi r^2 dr$

or $E = \frac{CR^3}{40\epsilon_0}$.

9. **(a)** If $R >> L_1$ it will behave like a dipole and in dipole we have, $E \propto \frac{1}{r^3}$

10. **(c)** Work done, W = S [2 × (Change in area)]

[$\because$ there are two free surface]

Surface tension, $S = \frac{W}{2\times(\text{change in area})}$

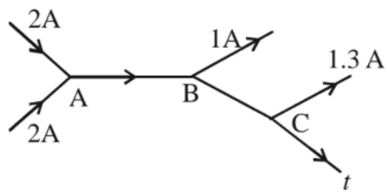
$= \frac{3\times10^{-4}}{2\times10(11-6)\times(10^{-2})^2} = 3\times10^{-2}\ N/m$

11. **(a)**

12. **(a)** According to Kirchhoff's first law

At junction A, $i_{AB} = 2 + 2 = 4\ A$

At junction B, $i_{AB} = i_{BC} - 1 = 3A$



At junction C, $i = i_{BC} - 1.3 = 3 - 1.3 = 1.7$ amp

13. **(c)** Child is at the internal part of the system, so velocity of centre of mass will not change due to his movement.

From law of conservation of angular momentum

$I_1\omega_1 + I_2\omega_2 = (I_1 + I_2)\omega$

Angular velocity of system $\omega = \dfrac{I_1\omega_1 + I_2\omega_2}{I_1 + I_2}$

$\therefore$ Rotaional kinetic energy $= \dfrac{1}{2}(I_1 + I_2)\omega^2$

$= \dfrac{1}{2}(I_1 + I_2)\left(\dfrac{I_1\omega_1 + I_2\omega_2}{I_1 + I_2}\right)^2 = \dfrac{(I_1\omega_1 + I_2\omega_2)^2}{2(I_1 + I_2)}$

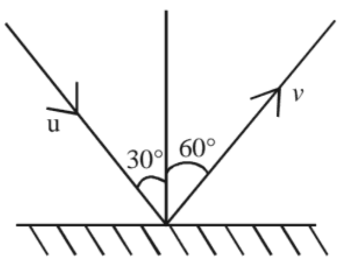
14. **(a)** The force between two neighbouring turns will be of attractive nature, and so spring will get compressed.

15. **(a)** Magnetic field due to solenoid is given by

$B = \mu_0 nI \quad \Rightarrow B \propto nI \Rightarrow \dfrac{B_2}{B_1} = \dfrac{n_2 I_2}{n_1 I_1}$

$\Rightarrow B_2 = \dfrac{n_2 I_2}{n_1 I_1} \times B_1 \quad \Rightarrow B_2 = \dfrac{1}{2} \times 2 \times B_1 \;\therefore B_2 = B$

16. **(b)** Parallel to surface velocity does not change



$u \sin 30° = v \sin 60°$

$\dfrac{u}{2} = \dfrac{\sqrt{3}v}{2} \Rightarrow v = \dfrac{u}{\sqrt{3}}$

Restitution, $e = \dfrac{v\cos 60°}{u\cos 30°} = \dfrac{\dfrac{u}{\sqrt{3}} \times \dfrac{1}{2}}{u \times \dfrac{\sqrt{3}}{2}} = \dfrac{1}{3}$

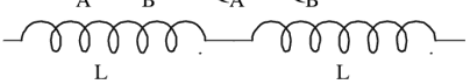
17. **(c)** Internal energy depends only on initial and final state

So, $\Delta U_A = \Delta U_B$

Also $\Delta Q = \Delta U + W$

As $W_A > W_B \Rightarrow \Delta Q_A > \Delta Q_B$

18. **(d)**



$M = k\sqrt{L_1 L_2} = L$

$\phi = LI + LI + 2\,MI = 4LI = L_{eq} I$

$L_{eq} = 4L$

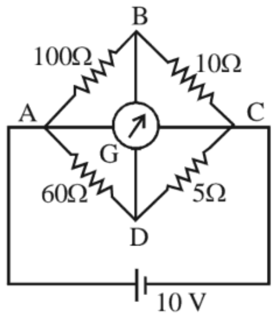
19. **(b)** $i = \dfrac{C\theta}{NAB} \Rightarrow i \propto \theta$

20. **(b)**

21. **(b)** $\dfrac{n_p}{n_s} = \dfrac{E_p}{E_s} = \dfrac{1}{25} \;\therefore E_s = 25\,E_p$

But $E_s I_s = E_p I_p \Rightarrow I_p = \dfrac{E_s \times I_s}{E_p} \Rightarrow I_p = 50A$

22. **(d)**



Current through the galvanometer,

$I_G = \dfrac{V_B - V_D}{R_{BD}}$

$\dfrac{V_B - V_A}{100} + \dfrac{V_B - V_D}{15} + \dfrac{V_B - V_C}{10} = 0$

$\Rightarrow \dfrac{V_B - 10}{100} + \dfrac{V_B - V_D}{15} + \dfrac{V_B - 0}{10} = 0$

$\Rightarrow \dfrac{V_B - 10}{20} + \dfrac{V_B - V_D}{3} + \dfrac{V_B}{2} = 0$

$\Rightarrow 3V_B - 30 + 20V_B - 20V_D + 30V_B = 0$

$\Rightarrow 53V_B - 20V_D = 30$ ...(i)

Similarly,

$\dfrac{V_D - 10}{60} + \dfrac{V_D - V_B}{15} + \dfrac{V_D - 0}{5} = 0$

$\Rightarrow V_D - 10 + 4V_D - 4V_B + 12V_D = 0$

$\Rightarrow -4V_B + 17V_D = 10$ ...(ii)

Solving equations (i) and (ii), we get

$V_B = 0.86$ V and $V_D = 0.79$ V

$\therefore I_G = \dfrac{V_B - V_D}{R_{BD}} = \dfrac{0.86 - 0.79}{15} = \dfrac{0.07}{15}$

$\therefore I_G = 4.87$ mA

23. **(c)** Inductance, $L = \frac{50}{\pi}$ mH

Resistance, $R = 10\,\Omega$

Capacitance, $C = \frac{10^3}{\pi} \times 10^{-6}$

Inductive reactance, $X_L = \omega L = 2\pi f L$

$= 2\pi \times 50 \times \frac{50}{\pi} \times 10^{-3} = 5\,\Omega$

Capacitive reactance, $X_C = \frac{1}{\omega C} = \frac{1}{2\pi f C}$

$= \frac{1 \times \pi}{2\pi \times 50 \times 10^3 \times 10^{-6}} = \frac{10^3}{100} = 10\,\Omega$

Impedance $Z = \sqrt{(X_C - X_L)^2 + R^2}$

$= \sqrt{(10-5)^2 + 10^2}$

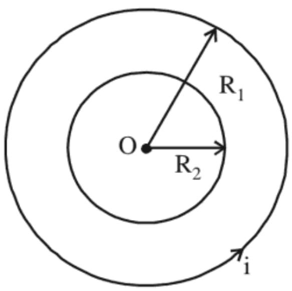
$\Rightarrow \quad Z = \sqrt{125} = 5\sqrt{5}\,\Omega$

24. **(a)** Let i be the current in outer loop

Magnetic field at centre $B = \frac{\mu_0 i}{2R_1}$

Magnetic flux through inner coil $\phi_i = B \times \pi R_2^2$

$\phi_i = \frac{\mu_0 i}{2R_1} \times \pi R_2^2$



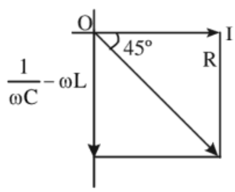
$\phi_i = \frac{\mu_0 i}{2} \times \frac{\pi R_2^2}{R_1}$

$\therefore \phi = Mi$

$\therefore M = \left(\frac{\mu_0 \pi}{2}\right)\frac{R_2^2}{R_1}$ or, $M \propto \frac{R_2^2}{R_1}$

25. **(d)** From figure,

$\tan 45° = \frac{\frac{1}{\omega C} - \omega L}{R}$



$\Rightarrow \frac{1}{\omega C} - \omega L = R$

$\Rightarrow \frac{1}{\omega C} = R + \omega L$

$C = \frac{1}{\omega(R + \omega L)} = \frac{1}{2\pi f(R + 2\pi f L)}$

26. **(b)** Minimum deviation of the prism when it is dipped in water $= \delta_m' = ({}_w\mu_g - 1)A$

$= \left(\frac{{}_a\mu_g}{{}_a\mu_\omega} - 1\right)A = \left(\frac{\frac{3}{2}}{\frac{4}{3}} - 1\right)A = \frac{1}{8}A$

27. **(d)** If angle of contact is greater than 90°, then liquid does not wet the solid surface.

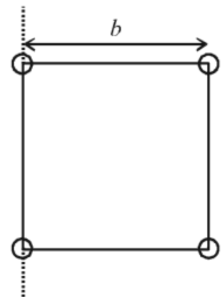
28. **(c)** When the source of light shifts by angle ϕ then central fringe appears at angle $-\phi$ as source S', the mid point Q, and the central fringe are in a straight line.

29. **(b)** $R = R_0(A)^{1/3}$

$\therefore \frac{R_1}{R_2} = \left(\frac{A_1}{A_2}\right)^{1/3} = \left(\frac{256}{4}\right)^{1/3} = 4$

$\Rightarrow R_2 = \frac{R_1}{4} = 2$ fermi

30. **(c)**



Moment of inertia of a sphere $= \frac{2}{5}ma^2$

Using the parallel axis theorem of moment of inertia, we have

$I = 2 \times \frac{2}{5}ma^2 + 2\left(\frac{2}{5}ma^2 + mb^2\right)$

$\Rightarrow \quad I = \frac{2}{5}ma^2 \times 4 + 2 \times mb^2 = \frac{8}{5}ma^2 + 2mb^2$

31. **(a)** $IA = P$

and, $I = \frac{Nh\nu}{At}$

$\frac{N}{t} = \frac{IA}{h\nu} \Rightarrow \frac{N}{t} = \frac{P}{E}$

$n = \frac{P}{E} = \frac{P}{h\nu} = \frac{P\lambda}{hc}$ $\quad (\because E = h\nu$ and $\nu = \frac{c}{\lambda})$

$\Rightarrow$ Clearly $n \propto \lambda$

$\Rightarrow \frac{n_1}{n_2} = \frac{\lambda_1}{\lambda_2} = \frac{1}{500}$

32. **(b)** Capacitance of a parallel plate capacitor with air is

$$C = \frac{\varepsilon_0 A}{d} \quad \ldots \text{(i)}$$

Here, A = area of plates of capacitor,
d = distance between the plates

Capacitance of a same parallel plate capacitor with introduction of dielectric medium of dielectric constant K is

$$C' = \frac{K\varepsilon_0 A}{d} \quad \ldots \text{(ii)}$$

Dividing (ii) by (i)

$$\Rightarrow \frac{C'}{C} = K \Rightarrow \frac{30}{6} = K \Rightarrow K = 5 \Rightarrow K = \frac{\varepsilon}{\varepsilon_0}$$

$$\Rightarrow \varepsilon = K\varepsilon_0 = 5 \times 8.85 \times 10^{-12}$$

$$= 0.44 \times 10^{-10}\ C^2N^{-1}m^{-2}$$

33. **(c)** $hc/\lambda_0 = W_0$;

$$\frac{(\lambda_0)_1}{(\lambda_0)_2} = \frac{(W_0)_2}{(W_0)_1} = \frac{4.5}{2.3} = 2:1.$$

34. **(d)** Average BE/nucleon increases first, and then decreases, as is clear from BE curve.

35. **(b)** $\frac{1}{C_{series}} = \frac{1}{C_1} + \frac{1}{C_2} + \frac{1}{C_3}$

$$\frac{1}{C_{series}} = \frac{1}{2} + \frac{1}{3} + \frac{1}{6}$$

$$\frac{3+2+1}{6} = \frac{6}{6}$$

$C_{series} = 1\ \mu F$

36. **(b)** $\Delta E = \frac{hc}{\lambda} \Rightarrow \lambda \propto \frac{1}{\Delta E}$

For minimum wavelength, energy gap must be maximum.

ΔE is maximum for transition from $n = 3$ to $n = 1$.

37. **(b)** When either of A or B is 1 i.e. closed then lamp will glow.

In this case, Truth table

Input		**Output**
A	**B**	**Y**
0	0	0
0	1	1
1	0	1
1	1	1

This represents OR gate.

38. **(b)** Fundamental harmonic produced by open pipe,

$$f_{\text{open pipe}} = \frac{v}{2l}$$

And by closed pipe, $f_{\text{closed pipe}} = \frac{v}{4l}$

$$\therefore \frac{f_0}{f_c} = \frac{v}{2l} \times \frac{4l}{v} = \frac{2}{1} \qquad \therefore f_0 : f_c = 2:1$$

39. **(b)** Helium is monoatomic and hydrogen is diatomic. Helium has smaller number of degrees of freedom than hydrogen. So C_P / C_V for helium is more than that for hydrogen.

40. **(c)** Electrons in an unbiased p-n junction, diffuse from n-region (higher electron concentration) to p-region (low electron concentration region).

41. **(d)** Given : $v_{\text{particle}} = 4v_{\text{electron}}$ and, $\lambda_{\text{particle}} = 2\lambda_{\text{electron}}$

Using $\lambda = \frac{h}{p} \Rightarrow \lambda p = \text{constant}$

$$\therefore \quad \lambda_{\text{particle}} \times p_{\text{particle}} = \lambda_{\text{electron}} \times p_{\text{electron}}$$

$$\Rightarrow \quad \lambda_{\text{particle}} \times m_{\text{particle}} \times v_{\text{particle}} = \lambda_{\text{electron}} \times m_{\text{electron}} \times v_{\text{electron}}$$

$$\therefore \quad m_{\text{particle}}\, v_{\text{particle}} = \frac{m_{\text{electron}} v_{\text{electron}}}{2}$$

$$\Rightarrow \quad m_{\text{particle}} = \frac{m_{\text{electron}}}{8}$$

42. **(a)** Here, $x_1 = 2d$ and $x_2 = \sqrt{5}d$

For, first minima, $\Delta x = \frac{\lambda}{2}$

$$\therefore \Delta x = x_2 - x_1 = \sqrt{5}d - 2d = \frac{\lambda}{2}$$

$$\Rightarrow d = \frac{\lambda}{2(\sqrt{5} - 2)}$$

43. **(a)** Speed $= v = \omega\sqrt{a^2 - x^2}$

$$= \frac{2\pi}{T}\sqrt{a^2 - a^2/4} = \frac{\sqrt{3}a\pi}{T}$$

44. **(c)** The magnifying power of telescope in normal adjustment is given by, $M = \frac{f_0}{f_e}$

$$\Rightarrow \quad 10 = \frac{f_0}{20} \Rightarrow f_0 = 200\,\text{cm}.$$

45. **(b)** Given :

Force, $\vec{F} = 3\hat{j}$ N

Position vector, $\vec{r} = 2\hat{k}$ m

Torque, $\vec{\tau} = \vec{r} \times \vec{F} = 2\hat{k} \times 3\hat{j} = 6(\hat{k} \times \hat{j}) = 6(-\hat{i})$

$\Rightarrow \vec{\tau} = -6\hat{i}$ Nm

46. **(b)** $T^2 \propto r^3$, where r = mean radius $= \frac{r_1 + r_2}{2}$

47. **(c)** As density is same, $2M_E = M_P$

$\Rightarrow \quad 2\rho \times \frac{4}{3}R_E^3 = \rho \times \frac{4}{3}\pi R_P^3$

$\Rightarrow \quad R_P = 2^{1/3} R_E$

Acceleration due to gravity on the surface of planet,

$$g_P = \frac{GM_P}{R_P^2}$$

$$\Rightarrow g_p = \frac{G2M_E}{\left(2^{1/3}R_E\right)^2} = \frac{G2M_E}{2^{2/3}R_E^2}$$

$\Rightarrow g_P = 2^{1/3}g_e$

Weight on planet = $2^{1/3}$ Weight on earth

$\Rightarrow \quad W_P = 2^{1/3}W$

48. **(a)** Since water does not fall down, therefore the velocity of revolution should be just sufficient to provide centripetal acceleration at the top of vertical circle. So,

$v = \sqrt{(g\,r)} = \sqrt{\{10 \times (1.6)\}} = \sqrt{(16)} = 4$ m/sec.

49. **(b)** For negotiating a circular curve on a levelled road, the maximum velocity of the car is

$v_{max} = \sqrt{\mu r g}$

Here $\mu = 0.6$, $r = 150$ m, $g = 9.8$

$\therefore v_{max} = \sqrt{0.6 \times 150 \times 9.8} \simeq 30$m / s

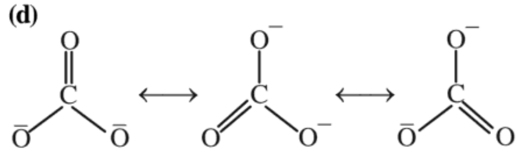
50. **(a)** Mean free path, $\lambda = \frac{1}{\sqrt{2}\pi d^2 n}$

where,

n = number of molecules per unit volume,
d = diameter of the molecules

CHEMISTRY

51. **(d)**



3 Canonical structures

52. **(b)** For H : $\frac{1}{\lambda} = R_H \times 1^2\left(\frac{1}{1^2} - \frac{1}{\infty^2}\right)$ ...(i)

$\frac{1}{\lambda_{He^+}} = R_H \times 2^2 \times \left(\frac{1}{2^2} - \frac{1}{3^2}\right)$ ...(ii)

From equation (i) & (ii) $\frac{\lambda_{He^+}}{\lambda} = \frac{9}{5}$

$\lambda_{He^+} = \lambda \times \frac{9}{5} \Rightarrow \lambda_{He^+} = \frac{9\lambda}{5}$

53. **(a)** 4 g of hydrogen (H_2) = 4 mole of hydrogen atoms

$= 4 \times 6.023 \times 10^{23}$ atoms

71.0 g of chlorine (Cl_2) = $\frac{71.0}{71.0}$ = 1 moles of chlorine

= 2 moles of Cl atom
$= 2 \times 6.023 \times 10^{23}$ atoms

127 g of iodine $(I_2) = \frac{127}{254}$ mol $= 6.023 \times 10^{23} \times \frac{1}{2}$ $\times 2$ atoms

$= 6.023 \times 10^{23}$

48.0 g of magnesium (Mg) = $\frac{48.0}{24.0}$ mol

$= 2 \times 6.023 \times 10^{23}$ atoms

$\therefore$ 4.0 g H_2 has largest number of atoms.

54. **(a)** Given $p = \frac{nRT}{V - nb} - a\left(\frac{n}{V}\right)^2$

Which can also be written

as, $\left[p + \frac{n^2 a}{V^2}\right](V - nb) = nRT$

At low pressure and high temperature, the effect of $\frac{a}{V^2}$ and b is negligible, hence $pV = nRT$.

55. **(b)** For fcc,

$$r = \frac{\sqrt{2}a}{4} = \frac{a}{2\sqrt{2}} = 0.3535a$$

Given, $a = 361$ pm

$r = 0.3535 \times 361 = 128$ pm

56. **(d)** Solutions in which solute - solute and solvent-solvent interactions are almost similar to solute-solvent interactions are known as ideal solution.

57. **(b)** Higher the charge of the metal cation higher is the molar conductivity. For same charge, higher is solvation lower will be the molar conductivity where $H^{\oplus}$ cation is a exceptional case.

58. **(a)** In presence of sunlight, CFC's molecule divides and release chlorine free radical, which react with ozone to give chlorine monoxide radical ($ClO^{\bullet}$) and oxygen.

$$CF_2Cl_2(g) \xrightarrow{UV} \dot{C}l(g) + \dot{C}F_2Cl(g)$$

$$\dot{C}l(g) + O_3(g) \longrightarrow \dot{C}lO(g) + O_2(g)$$

59. **(b)**

Molality =

$$\frac{1000 \times \text{Molarity}}{1000 \times \text{density} - \text{molarity} \times \text{molar mass of solute}}$$

$$3 = \frac{1000 \times x}{1000 \times 1.12 - (x \times 40)} \Rightarrow x = 3$$

60. **(c)** The splitting is affected by the oxidation state of the central metal ion. A higher oxidation state leads to larger splitting, hence,

$$\Delta_o \text{of}[Ti(H_2O)_6]^{3+} > \Delta_o \text{of}[Ti(H_2O)_6]^{2+}$$

Further Δ_o also depends of $Z_{eff.}$, and $Z_{eff.}$ of 4*d* series is more than 3*d* series.

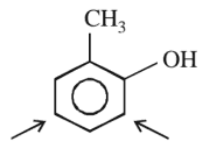
Hence, Δ_o of $[Cr(H_2O)_6]^{2+}$

$$< \Delta_o \text{ of } [Mo(H_2O)_6]^{2+}$$

61. **(c)** Electrophile will attack at ortho and para positions with respect to better electron releasing group (ERG)

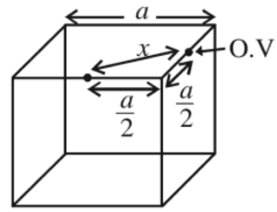
–OH donates through +M and $-CH_3$ donates through +H

ERG : $-OH > -CH_3$



Para position with respect to – OH group and it will be meta position with respect to $-CH_3$ group.

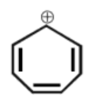
62. **(a)**



Distance between two octahedral voids

$$x = \sqrt{\left(\frac{a}{2}\right)^2 + \left(\frac{a}{2}\right)^2} = \sqrt{\frac{a^2}{4} + \frac{a^2}{4}} = \frac{a}{\sqrt{2}}$$

63. **(d)**

(A) $Ph-\overset{Ph}{\underset{Ph}{C^{\oplus}}}$ (B) $Ph-\overset{Ph}{\underset{H}{C^{\oplus}}}$ (C) 

(D) $H_3C-CH_2-\overset{\oplus}{C}H-CH_3$

Structure C is aromatic hence it is most stable.

Structure A has more resonance structures.

Structure B has less resonance structures compared to A.

Structure D have only hyperconjugation.

Preference order will be: Aromaticity > Resonance > Hyper conjugation

D < B < A < C

64. **(b)** $C_2 : kk'(\sigma 2s)^2(\sigma^* 2s)^2(\pi 2p_x)^2(\pi 2p_y)^2$

$C_2^{2-} : kk'(\sigma 2s)^2(\sigma^* 2s)^2(\pi 2p_x)^2(\pi 2p_y)^2(\sigma 2p_z)^2$

$$B.O. = \frac{N_b - N_a}{2} = \frac{10-4}{2} = 3$$

$N_2 : kk'(\sigma 2s)^2(\sigma^* 2s)^2(\pi 2p_x)^2(\pi 2p_y)^2(\sigma 2p_z)^2$

$N_2^{2-} : kk'(\sigma 2s)^2(\sigma^* 2s)^2(\pi 2p_x)^2(\pi 2p_y)^2(\sigma 2p_z)^2(\pi^* 2p_x)^1(\pi^* 2p_y)^1$

$$B.O. = \frac{10-6}{2} = 2$$

$O_2 : kk'(\sigma 2s)^2(\sigma^* 2s)^2(\sigma 2p_z)^2(\pi 2p_x)^2(\pi 2p_y)^2(\pi^* 2p_x)^1(\pi^* 2p_y)^1$

$O_2^{2-} : kk'(\sigma 2s)^2(\sigma^* 2s)^2(\sigma 2p_z)^2(\pi 2p_x)^2(\pi 2p_y)^2(\pi^* 2p_x)^2(\pi^* 2p_y)^2$

$$B.O. = \frac{10-8}{2} = 1$$

65. **(b)** Potassium shows +1 state in all its oxides, superoxides and peroxides.

66. **(d)** Sodium metal on dissolution in liquid ammonia gives a deep blue solution due to the formation of ammoniated electrons.

67. **(d)** Anodic Reaction at Anode :

$$[T\ell_{(s)} \rightarrow T\ell^{+}_{(aq)} + e^{-}]2$$

Reaction at Cathode :

$$Cu^{+2}(aq) + 2e^{-} \rightarrow Cu(s)$$

Overall Redox Reaction

$$2T\ell(s) + Cu^{+2}(aq) \rightarrow 2T\ell^{+}(aq) + Cu(s)$$

$$E_{cell} = E^{\circ}_{cell} - \frac{0.0591}{2}\log\frac{[T\ell^{+}]^{2}}{[Cu^{+2}]}$$

E_{cell} increases by increasing concentration of $[Cu^{+2}]$ ions.

68. **(a)** Reaction occurs at cathode is :

$$MnO_2 + NH_4^{+} + e^{-} \longrightarrow MnO(OH) + NH_3$$

In the cathode reaction manganese (Mn) is reduced from the +4 oxidation state to the +3 oxidation state.

69. **(a)** Complex having all ligands same are called homoleptic complex. $[Ni(CN)_4]^{2-}$ has only CN^- ligands.

70. **(d)** Only *cis*-$[CrCl_2(ox)_2]^{3-}$ shows optical isomerism while its *trans* form does not show optical isomerism due to presence of plane of symmetry.

71. **(a)** According to the Faraday's law of electrolysis, nF of current is required for the deposition of 1 mol.
According to the reaction,

$$Ni(NO_3)_2 \longrightarrow Ni^{2+} + 2NO_3^{-}$$

2 F of current deposits = 1 mol

$$\therefore\ 0.1\text{ F of current deposits} = \frac{0.1}{2} = 0.05\text{ mol}$$

72. **(d)** According to given conditions t_1 and t_2 can be given as

$$t_1 = t_{\frac{1}{4}} = \frac{1}{k}\ln\frac{A_0}{A_0} = \frac{1}{k}\ln 4$$

$$t_2 = t_{\frac{1}{8}} = \frac{1}{k}\ln\frac{A_0}{A_0} = \frac{1}{k}\ln 8$$

$\therefore$ Ratio t_1/t_2 will be given by

$$\frac{t_1}{t_2} = \frac{\ln 4}{\ln 8} = \frac{2\ln 2}{3\ln 2} = \frac{2}{3}$$

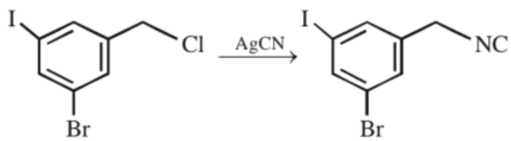
73. **(c)** The stability of hydrides decreases from NH_3 to BiH_3 but their reducing character increases down the group.

74. **(c)** $t_{1/4} = \frac{2.303}{k}\log\frac{1}{3/4} = \frac{2.303}{k}\log\frac{4}{3}$

$$= \frac{2.303}{k}(2\times 0.301 - 0.4771) = \frac{0.29}{k}$$

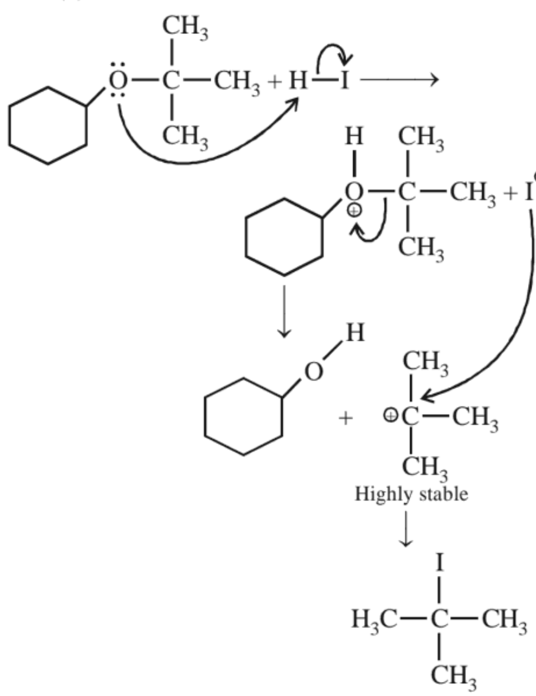
75. **(b)** Order of reactivity of halogens: $Cl_2 > Br_2 > I_2$
But the interhalogen compounds are generally more reactive than halogens (except F_2), since the bond between two dissimilar electronegative elements is weaker than the bond between two similar atoms, i.e, X – X.

76. **(b)**

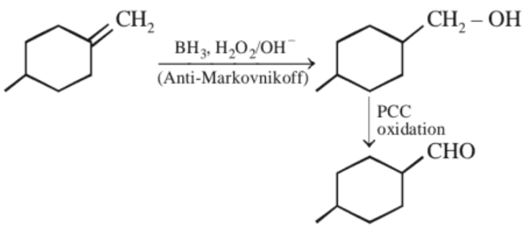


AgCN is predominantly covalent so it gives NC^- nucleophile and forms an isocyanide.

77. **(d)**



78. **(c)** BH_3, $H_2O_2/^{-}OH$ followed by PCC oxidation.



79. **(a)** Formed is negatively charged solution, therefore Al^{3+} has highest coagulating power.

80. **(a)** Adsorption is exothermic process due to decrease in surface energy. Micelle formation is endothermic at low temperatures.

81. **(b)** DNA contains $\Rightarrow$ β–D–2–deoxyribose
RNA contains $\Rightarrow$ β–D–ribose

82. **(b)** Copolymers are made up of two or more different monomer species.
Buna-S, PHBV and Butadiene-styrene are copolymers. Only neoprene is homopolymer.
Homopolymers contain one kind of monomer units.

83. **(b)** Calamine $\Rightarrow ZnCO_3$
Malachite $\Rightarrow Cu(OH)_2 \cdot CuCO_3$

84. **(d)** Cresol is used as stabilizer.

85. **(c)** Vulcanization of rubber is carried out by heating a mixture of isoprene & sulphur.

86. **(b)** Saponification: Alkaline hydrolysis.

87. **(d)** $\mu = \sqrt{n(n+2)}$ B.M.

	$3d^7$	$3d^8$	$3d^3$	$3d^6$
No. of unpaired e^-	3	2	3	4
Spin only magnetic moment	$\sqrt{15}$ BM	$\sqrt{8}$ BM	$\sqrt{15}$ BM	$\sqrt{24}$ BM

88. **(a)** $Ce = [Xe]\,4f^1\,5d^1\,6s^2$
$Ce^{3+} = [Xe]\,4f^1\,5d^0$
$Ce^{4+} = [Xe]\,4f^0\,5d^0$ (Noble gas configuration)
Ce^{3+} get easily oxidised to Ce^{4+} by acheiving noble gas configuration.

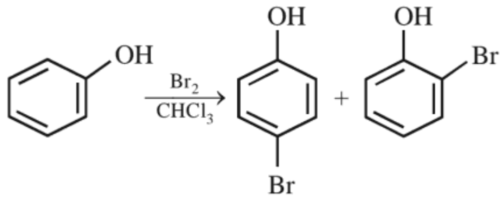
89. **(b)** S_N1 reactions involve the formation of carbocation. Hence higher the stability of a carbocation more will be its reactivity towards S_N1 reactions. Hence, reactivity order is :

$$\underset{1^\circ \text{ carbocation}}{CH_3 - CH_2 - \overset{\oplus}{C}H_2} < \underset{2^\circ \text{ carbocation}}{CH_3 - \overset{\oplus}{C}H - CH_2 - CH_3}$$

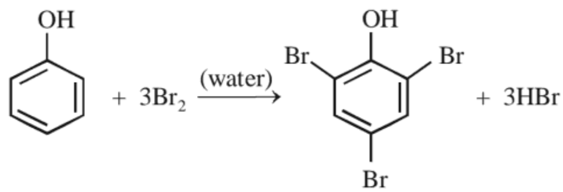
$$< p - H_3CO - C_6H_4 - \overset{\oplus}{C}H_2$$

Max. stable due to +M effect of $-OCH_3$ group.

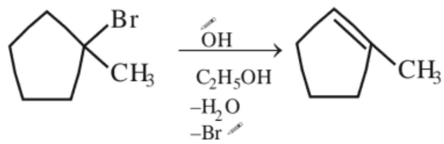
90. **(b)** Polarity of solvent
- Monosubstituted phenol is formed in case of low polarity solvent, viz. $CHCl_3$.



- In case of bromine water, water (high polarity solvent). ionises Br –Br easily.

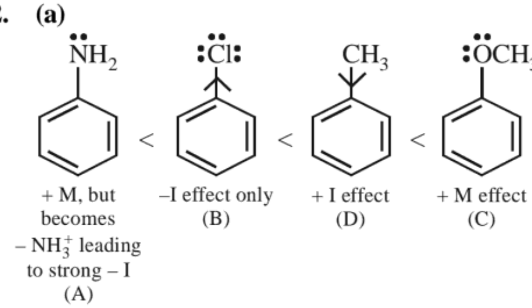


91. **(c)**



Elimination follow saytzeff's rule.

92. **(a)**



93. **(d)** $d = \dfrac{Z \times M}{a^3 \times N_A}$

$Z = 2$; for bcc

$$5\ g/cm^3 = \frac{2 \times M}{(200 \times 10^{-10}\ cm)^3 \times 6.0 \times 10^{23}}$$

$\Rightarrow M = 12$ g

12 g of element contain $= N_A$ atoms

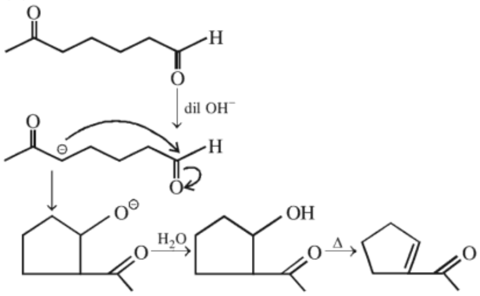
300 g of element contains $= N_A \times \dfrac{300}{12} = 25\,N_A$

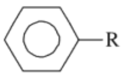
94. **(b)** $\Delta T_b = i_1 m_1 k_b + i_2 m_2 k_b$

$$= 1 \times \frac{2}{0.5} \times 0.52 + \frac{1 \times 2}{0.5} \times 0.52 = 4.16$$

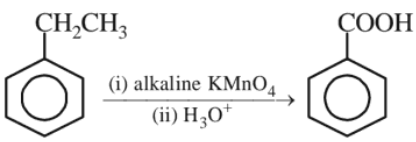
$(T_b)_{solution} = 373.16 + 4.16 = 377.3K$

95. **(a)**



96. **(a)** Alkaline $KMnO_4$ converts 

with a benzylic hydrogen into benzoic acid.



97. **(d)**

		Number of particles (*i*)
(a)	$[Co(H_2O)_6]Cl_3$	4
(b)	$[Co(H_2O)_5Cl]Cl_2 \cdot H_2O$	3
(c)	$[Co(H_2O)_4Cl_2]Cl \cdot 2H_2O$	2
(d)	$[Co(H_2O)_3Cl_3] \cdot 3H_2O$	1

Remember, greater the no. of particles, lower will be the freezing point. Compound (d) will have the highest freezing point due to least number of particles.

98. **(a)**

(i) In aqueous medium basic strength is dependent on donating ability of electron density on 'N'

(ii) As well as solvation of cation formed after accepting H^+. After considering all these factors overall basic strength order is $Me_2NH > MeNH_2 > Me_3N > NH_3$

99. **(b)** Amytal is a hypnotic drug.

100. **(a)** In L isomer –OH group is on left hand side of lowest asymmetric carbon.

SECTION-B

MATHEMATICS

101. **(b)** $\cos A = \dfrac{b^2 + c^2 - a^2}{2bc} \Rightarrow \dfrac{2}{3} = \dfrac{8^2 + c^2 - 7^2}{2 \times 8 \times c}$

$c = \alpha = 9 \Rightarrow \cos C = \dfrac{7^2 + 8^2 - 9^2}{2 \times 7 \times 8} = \dfrac{2}{7}$

$49 \cos 3C + 42$

$= 49(4\cos^3 C - 3\cos C) + 42$

$[\because \cos 3x = 4\cos^3 x - 3\cos x]$

$$= 49\left(4\left(\frac{2}{7}\right)^3 - 3\left(\frac{2}{7}\right)\right) + 42 = \frac{32}{7}$$

$m + n = 32 + 7 = 39$

102. **(a)** $(x^2 + 2x)(12 - k) = 2$

$\lambda x^2 + 2\lambda x - 2 = 0 \quad k \neq 12$ Let $12 - k = \lambda$

$D = 0$ (for equal roots)

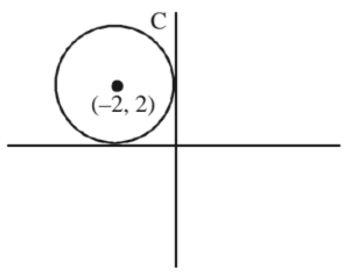
$4\lambda^2 + 8\lambda = 0 \Rightarrow \lambda = 0$ or $\lambda = -2$

$\Rightarrow 12 - k = -2 \Rightarrow k = 14$

So $P\left(k, \dfrac{k}{2}\right) = (14, 7)$

$$d = \left|\frac{3 \times 14 + 4 \times 7 + 5}{5}\right| = 15$$

103. **(a)**



$C : (x + 2)^2 + (y - 2)^2 = 2^2$

$C_1 : (x - 2)^2 + (y - 5)^2 = r^2$

If both circle intersect at two points

$\therefore |r_1 - r_2| < c_1c_2 < r_1 + r_2 \Rightarrow \quad |r - 2| < 5 < 2 + r$

$\Rightarrow 3 < r < 7 \Rightarrow r \in (3, 7) \quad \therefore \alpha = 3, \beta = 7,$
So, $3\beta - 2\alpha = 15$

104. (a) Mean $= \dfrac{24+a+b}{8} = 4$

$\Rightarrow a + b = 8$ ...(i)

$$\sigma^2 = 2 = \frac{4+1+1+0+1+9+(a-4)^2+(b-4)^2}{8}$$

$\Rightarrow 16 = 48 + a^2 + b^2 - 8a - 8b$

$\Rightarrow a^2 + b^2 = 32$ ...(ii)

From (i) and (ii), $a = 4, b = 4$
Mode = 4

Mean deviation $= \dfrac{2+1+1+0+1+3+0+0}{8} = 1.$

105. (a) 3 Engineers + 1 Doctor + 8 Prof. $\rightarrow {}^4C_3 \cdot {}^2C_1 \cdot {}^{10}C_8$
$= 360$
3 Engineers + 2 Doctors + 7 Prof. $\rightarrow {}^4C_3 \cdot {}^2C_2 \cdot {}^{10}C_7 = 480$
4 Engineers + 1 Doctor + 7 Prof. $\rightarrow {}^4C_4 \cdot {}^2C_1 \cdot {}^{10}C_7 = 240$
4 Engineers + 2 Doctors + 6 Prof. $\rightarrow {}^4C_4 \cdot {}^2C_2 \cdot {}^{10}C_6 = 210$
Total = 1290

Required probability $= \dfrac{1290}{{}^{16}C_{12}} = \dfrac{1290}{1820} = \dfrac{129}{182}$

106. (b) There are 6 balls in one over and 4 wickets are to be taken. So, 4 balls are to succeed. This can be done in ${}^6C_4$ ways.
$\Rightarrow$ Required number of ways

$= {}^6C_4 = \dfrac{6!}{4!2!} = \dfrac{6\times5}{2} = 15$

107. (a) Limit $= \lim\limits_{x\to0} \dfrac{x(\sqrt{1+x}+\sqrt{1-x})}{(1+x)-(1-x)}$

$= \lim\limits_{x\to0} \dfrac{\sqrt{1+x}+\sqrt{1-x}}{2} = 1$

108. (b) $f(x) = \dfrac{1}{\sqrt{9-x^2}}$ Clearly, $9 - x^2 > 0$

$\Rightarrow x^2 - 9 < 0 \Rightarrow (x+3)(x-3) < 0$
Thus, domain of f(x) is $x \in (-3, 3)$.

109. (c) $\sin\dfrac{\pi}{5} + i\left(1 - \cos\dfrac{\pi}{5}\right)$

$= 2\sin\dfrac{\pi}{10}\cos\dfrac{\pi}{10} + i\,2\sin^2\dfrac{\pi}{10}$

$= 2\sin\dfrac{\pi}{10}\left(\cos\dfrac{\pi}{10} + i\sin\dfrac{\pi}{10}\right)$

For amplitude, $\tan\theta = \dfrac{\sin\frac{\pi}{10}}{\cos\frac{\pi}{10}} = \tan\dfrac{\pi}{10}$

$\Rightarrow \theta = \dfrac{\pi}{10}.$

110. (b) $f(0) = \lim\limits_{x\to0} f(x) = \lim\limits_{x\to0} \dfrac{\sqrt{4+x}-2}{x}$

$= \lim\limits_{x\to0}\left(\dfrac{\sqrt{4+x}-2}{x} \times \dfrac{\sqrt{4+x}+2}{\sqrt{4+x}+2}\right)$

$= \lim\limits_{x\to0} \dfrac{\sqrt{4+x}-4}{x\left(\sqrt{4+x}+2\right)} = \lim\limits_{x\to0} \dfrac{x}{x\left(\sqrt{4+x}+2\right)}$

$= \lim\limits_{x\to0} \dfrac{1}{\sqrt{4+x}+2} = \dfrac{1}{2+2} = \dfrac{1}{4}$

111. (c) $AB = \begin{bmatrix} \cos^2\theta & \sin\theta\cos\theta \\ \cos\theta\sin\theta & \sin^2\theta \end{bmatrix} \begin{bmatrix} \cos^2\phi & \sin\phi\cos\phi \\ \cos\phi\sin\phi & \sin^2\phi \end{bmatrix}$

$= \begin{bmatrix} \cos^2\theta\cos^2\phi + \sin\theta\cos\phi\cos\phi\sin\phi & \cos^2\theta\sin\phi\cos\phi + \sin^2\phi\sin\theta\cos\theta \\ \cos^2\phi\cos\theta\sin\theta + \sin^2\theta\sin\phi\cos\phi & \cos\theta\sin\theta\sin\phi\cos\phi + \sin^2\theta\sin^2\phi \end{bmatrix}$

$= \begin{bmatrix} \cos\theta\cos\phi\cos(\theta-\phi) & \sin\phi\cos\theta\cos(\theta-\phi) \\ \sin\theta\cos\phi\cos(\theta-\phi) & \sin\theta\sin\phi\cos(\theta-\phi) \end{bmatrix}$

$\because AB = O$

$\Rightarrow \cos(\theta-\phi) = 0 \Rightarrow \cos(\theta-\phi) = \cos(2n+1)\dfrac{\pi}{2}$

$\Rightarrow \theta = (2n+1)\dfrac{\pi}{2} + \phi$, where n = 0, 1, 2, ...

112. (d) $|\text{Adj. } A| = |A|^2$

113. (b)

$|A| = 7, adjA = \begin{bmatrix} 2 & -1 \\ 1 & 3 \end{bmatrix}, A^{-1} = \dfrac{1}{7}\begin{bmatrix} 2 & -1 \\ 1 & 3 \end{bmatrix}$

$\therefore \quad 14A^{-1} = \begin{bmatrix} 4 & -2 \\ 2 & 6 \end{bmatrix}$

114. **(a)** Consider $\int \frac{\sin^2 x - \cos^2 x}{\sin^2 x \cos^2 x} dx$

$= \int \frac{\sin^2 x \, dx}{\sin^2 x \cos^2 x} - \int \frac{\cos^2 x \, dx}{\sin^2 x \cos^2 x}$

$= \int \sec^2 x \, dx - \int \operatorname{cosec}^2 x \, dx$

Let $I = \int (\sec^2 x - \operatorname{cosec}^2 x) dx$

$= \tan x - (-\cot x) + c = \tan x + \cot x + c.$

115. **(b)** $\int \frac{e^x (1+x)}{\cos^2 (e^x x)} dx$

Let $xe^x = t$

$\Rightarrow \left(xe^x + e^x\right) = \frac{dt}{dx} \Rightarrow dx = \frac{dt}{e^x (x+1)}$

$\because \int \frac{e^x (1+x)}{\cos^2 (e^x x)} dx = \int \frac{e^x (1+x)}{\cos^2 t} \times \frac{dt}{e^x (1+x)}$

$= \int \frac{1}{\cos^2 t} dt = \int \sec^2 t \, dt = \tan t + C = \tan\left(xe^x\right) + C$

116. **(a)** Let $I = \int_{1/4}^{1/2} \frac{dx}{\sqrt{x - x^2}}$

$\therefore I = \int_{1/4}^{1/2} \frac{dx}{\sqrt{\frac{1}{4} - \frac{1}{4} + x - x^2}}$

$\Rightarrow I = \int_{1/4}^{1/2} \frac{dx}{\sqrt{\left(\frac{1}{2}\right)^2 - \left(x - \frac{1}{2}\right)^2}}$

$\Rightarrow I = \left[\sin^{-1}\left(\frac{x - 1/2}{1/2}\right)\right]_{1/4}^{1/2}$

$= [\sin^{-1}(2x - 1)]\Big|_{1/4}^{1/2}$

$\Rightarrow I = \sin^{-1}(1-1) - \sin^{-1}\left(2.\frac{1}{4} - 1\right)$

$\Rightarrow I = 0 - \sin^{-1}\left(-\frac{1}{2}\right)$

$= \sin^{-1}\left(\frac{1}{2}\right) = \sin^{-1}\left(\sin\frac{\pi}{6}\right) \Rightarrow I = \frac{\pi}{6}$

117. **(a)** Let $I = \int_{-\pi/4}^{\pi/4} \frac{x + \frac{\pi}{4}}{2 - \cos 2x} dx$ ...(i)

Apply $\int_a^b f(x) dx = \int_a^b f(a + b - x) dx$

$\Rightarrow I = \int_{-\pi/4}^{\pi/4} \frac{-x + \frac{\pi}{4}}{2 - \cos 2x} dx$ ...(ii)

Add (i) & (ii).

$2I = \int_{-\pi/4}^{\pi/4} \frac{\frac{\pi}{2}}{2 - \cos 2x} dx$

$\Rightarrow I = \frac{\pi}{4} . 2\int_0^{\pi/4} \frac{dx}{2 - \cos 2x} dx$

$\Rightarrow I = \frac{\pi}{4} . 2\int_0^{\pi/4} \frac{\sec^2 dx}{2\sec^2 x - (1 - \tan^2 x)} dx$

$\Rightarrow I = \frac{\pi}{4} . 2\int_0^{\pi/4} \frac{\sec^2 dx}{2(1 + \tan^2 x) - (1 - \tan^2 x)} dx$

Let $\tan x = t \Rightarrow \sec^2 x \, dx = dt$

$\Rightarrow I = \frac{\pi}{4}\int_0^1 \frac{dt}{3t^2 + 1} dx \Rightarrow I = \frac{\pi}{2\sqrt{3}} \tan^{-1} \sqrt{3}$

$\Rightarrow I = \frac{\pi^2}{6\sqrt{3}}$

118. **(a)** Given equations are

$l + m - n = 0 \Rightarrow n = l + m$

Now, put the value of n in another equation then,

$3l^2 + m^2 + cl\,(l + m) = 0$

$3l^2 + m^2 + cl^2 + clm = 0$

$(3 + c)l^2 + clm + m^2 = 0$

$(3 + c)\left(\frac{l}{m}\right)^2 + c\left(\frac{l}{m}\right) + 1 = 0$ ...(i)

Given that lines are parallel.

Then, roots of (i) must be equal $\Rightarrow D = 0$

$c^2 - 4(3 + c) = 0 \Rightarrow c^3 - 4c - 12 = 0$

$(c - 6)\,(c + 2) = 0 \Rightarrow c = 6$ or $c = -2.$

Therefore, +ve value of $c = 6.$

119. **(b)** Given lines l_1, l_2 and l_3 are

$l_1 : \frac{x - 2}{3} = \frac{y + 1}{-2} = \frac{z - 2}{0}$

$l_2 : \frac{x - 1}{1} = \frac{y + \frac{3}{2}}{\frac{\alpha}{2}} = \frac{z + 5}{2}$

$l_3 : \frac{x-1}{-3} = \frac{y-\frac{1}{2}}{-2} = \frac{z-0}{4}$

$l_1 \perp l_2 \Rightarrow \frac{|3-\alpha+0|}{\sqrt{13}\sqrt{1+\frac{\alpha^2}{4}+4}} = 0 \Rightarrow \alpha = 3$

angle between l_2 & l_3

$$\cos\theta = \frac{\left|1\times(-3)+(-2)\left(\frac{\alpha}{2}\right)+2\times 4\right|}{\sqrt{1+4+\frac{\alpha^2}{4}}\sqrt{9+16+4}}$$

$$\cos\theta = \frac{|-3-\alpha+8|}{\sqrt{5+\frac{\alpha^2}{4}}\sqrt{29}}$$

put $\alpha = 3 \Rightarrow \cos\theta = \frac{2}{\sqrt{\frac{29}{4}}\sqrt{29}} = \frac{4}{29}$

$\theta = \cos^{-1}\left(\frac{4}{29}\right) \Rightarrow \theta = \sec^{-1}\left(\frac{29}{4}\right)$

120. (a) Given equation of plane is

$x - 3y + 5z = d$

Since, it passes through (1, 2, 4), then

$1-3(2)+5(4) = d$

$\Rightarrow 1-6+20 = d$

$d = 15$

Therefore, the equation of the plane will be

$x - 3y + 5z = 15$

$\Rightarrow \frac{x}{15} - \frac{3y}{15} + \frac{5z}{15} = 1 \Rightarrow \frac{x}{15} + \frac{y}{-5} + \frac{z}{3} = 1$

Hence, the intercept cut by the plane on axes X, Y, Z are 15, –5 and 3, respectively.

121. (d) Corner point

At (0, 0); P = 0; At (0, 10); P = 30

At (10, 0); P = 10;

At $\left(\frac{20}{3}, \frac{20}{3}\right)$; $P = \frac{80}{3} = 26.67$

122. (a) Feasible region of inequalities gives optional solution of LPP.

123. (c) $P(A) = \frac{1}{2}, P(B) = 0$

$P(A/B) = \frac{P(A\cap B)}{P(B)} = \frac{P(A\cap B)}{0}$ = Not defined

124. (c) For $\left(\frac{1}{\sqrt{2}}, \frac{1}{2}, k\right)$ to represent direction cosines, we should have

$\left(\frac{1}{\sqrt{2}}\right)^2 + \left(\frac{1}{2}\right)^2 + k^2 = 1$

or, $\frac{1}{2} + \frac{1}{4} + k^2 = 1 \Rightarrow k = \pm\frac{1}{2}$

125. (d) The equations of the given lines are not in symmetrical form. We first put them in symmetrical form. Equations of the first line are

$x = ay + b, z = cy + d.$

These equation can be written as

$\frac{x-b}{a} = y = \frac{z-b}{c}$ or $\frac{x-b}{a} = \frac{y-0}{1} = \frac{z-b}{c}$ ...(i)

Similarly, equation of second line

$x = a'y + b', z = c'y + d'$ can be written as

$\frac{x-b'}{a'} = \frac{y-0}{1} = \frac{z-b'}{c'}$ ...(ii)

Clearly, d.r'.s of the first line are a, 1, c and those of the second line are a′, 1, c′. Now lines (i) and (ii) are perpendicular if $aa' + cc' + 1 = 0$

126. (b) Given mean and variance is np = 4 and npq = 4/3 respectively

Here, n = 6, p = 2/3, q = 1/3

$54(P(X=2) + P(X=1) + P(X=0))$

$54\left({}^6C_2\left(\frac{2}{3}\right)^2\left(\frac{1}{3}\right)^4 + {}^6C_1\left(\frac{2}{3}\right)^1\left(\frac{1}{3}\right)^5 + {}^6C_0\left(\frac{2}{3}\right)^0\left(\frac{1}{3}\right)^6\right)$

$= \frac{146}{27}$

127. (b) $\left.\begin{array}{l} np = 4 \\ npq = 2 \end{array}\right\} \Rightarrow q = \frac{1}{2}, p = \frac{1}{2}, n = 8$

$P(X=1) = {}^8C_1\left(\frac{1}{2}\right)\left(\frac{1}{2}\right)^7 = 8.\frac{1}{2^8} = \frac{1}{2^5} = \frac{1}{32}$

128. (c) Probability of getting at least two 3's or 5's in one trial

$= {}^4C_2\left(\frac{2}{6}\right)^2\left(\frac{4}{6}\right)^2 + {}^4C_3\left(\frac{2}{6}\right)^3\left(\frac{4}{6}\right) + {}^4C_4\left(\frac{2}{6}\right)^4$

$= \frac{33}{3^4} = \frac{11}{27} \Rightarrow E(x) = np = 27\left(\frac{11}{27}\right) = 11.$

129. **(b)** Area $= \int_0^1 y\,dx = \int_0^1 \frac{3}{2}\sqrt{x}\,dx$

$$= \frac{3}{2}\left[\frac{2}{3}x^{3/2}\right]_0^1 = \left[x^{3/2}\right]_0^1$$

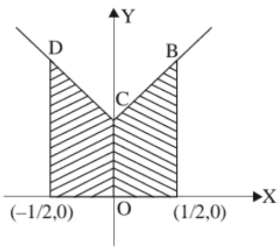
$$= 1^{3/2} - 0 = 1 \text{ sq. unit}$$

130. **(c)** The given lines are,

$y - 1 = x,\ x \ge 0;\quad y - 1 = -x,\ x < 0$

$y = 0;\qquad x = -\frac{1}{2},\ x < 0;\quad x = \frac{1}{2},\ x \ge 0$

so that the area bounded is as shown in the figure.



Required area

$$= 2\int_0^{1/2}(1+x)\,dx = 2\left(x + \frac{x^2}{2}\right)_0^{1/2} = \frac{5}{4}$$

131. **(c)** $\tan^{-1}x + \tan^{-1}y = c$

differentiating w.r.t. x

$$\frac{1}{1+x^2} + \frac{1}{1+y^2}\frac{dy}{dx} = 0 \Rightarrow \frac{dx}{1+x^2} + \frac{dy}{1+y^2} = 0$$

$\Rightarrow\ (1+y^2)dx + (1+x^2)\,dy = 0$

132. **(a)** $(x+2)\frac{dy}{dx} = x^2 + 4x - 9\quad x \ne -2$

$$\frac{dy}{dx} = \frac{x^2+4x-9}{x+2} \Rightarrow dy = \frac{x^2+4x-9}{x+2}dx$$

$$\int dy = \int \frac{x^2+4x-9}{x+2}dx$$

$$y = \int\left(x + 2 - \frac{13}{x+2}\right)dx$$

$$y = \int(x+2)\,dx - 13\int\frac{1}{x+2}dx$$

$$y = \frac{x^2}{2} + 2x - 13\log|x+2| + c$$

Given that $y = (0) = 0$

$0 = -13\log 2 + c$

$$y = \frac{x^2}{2} + 2x - 13\log|x+2| + 13\log 2$$

$y(-4) = 8 - 8 - 13\log 2 + 13\log 2 = 0$

133. **(c)** $(\vec{a}+\vec{b}+\vec{c}).[(\vec{a}-\vec{c})\times\vec{a}-\vec{b}] = -3[\vec{a}\,\vec{b}\,\vec{c}]$

134. **(d)** $\vec{a}.(\vec{b}\times\vec{c}) \ne 0$ for any value of m

135. **(a)** Let A, B, C are the vertices of a Δ whose position vectors are $\vec{a}, \vec{b}$ and $\vec{c}$ respectivety. Let G be the centroid of ΔABC. $\therefore$ Centroid of triangle (G) $= \frac{\vec{a}+\vec{b}+\vec{c}}{3}$

Consider, $\overrightarrow{GA} + \overrightarrow{GB} + \overrightarrow{GC}$

$$= \left(\vec{a} - \frac{\vec{a}+\vec{b}+\vec{c}}{3}\right) + \left(\vec{b} - \frac{\vec{a}+\vec{b}+\vec{c}}{3}\right) + \left(\vec{c} - \frac{\vec{a}+\vec{b}+\vec{c}}{3}\right)$$

$$= \frac{1}{3}[2\vec{a} - \vec{b} - \vec{c} + 2\vec{b} - \vec{a} - \vec{c} + 2\vec{c} - \vec{a} - \vec{b}] = 0.$$

136. **(b)** $x = b\cos^{-1}\sqrt{\frac{y}{b}} + \sqrt{by - y^2}$

$$\Rightarrow \frac{dx}{dy} = -b\frac{1}{\sqrt{1-\frac{y}{b}}}.\frac{1}{2\sqrt{\frac{y}{b}}}.\frac{1}{b} + \frac{b-2y}{2\sqrt{by-y^2}}$$

$$= \frac{-b}{2\sqrt{by-y^2}} + \frac{b}{2\sqrt{by-y^2}} - \frac{2y}{2\sqrt{by-y^2}}$$

$$\Rightarrow \frac{dy}{dx} = -\frac{\sqrt{by-y^2}}{y} = -\sqrt{\frac{b}{y} - 1}$$

137. **(b)** Now, $y = e^{x^x}$

Taking logarithms with base e, we get

$$\log_e y = \log_e e^{x^x}$$

$\log_e y = x^x.\log_e e = x^x,\quad \{\log_e e = 1\}.$

Again taking logarithms with base e, we get, $\log_e(\log_e y)$

$= \log_e x^x$ or $\log_e(\log_e y) = x\log_e x.$

Differentiating both sides with respect to x, we get

$$\text{or } \frac{1}{\log_e y}.\frac{1}{y}.\frac{dy}{dx} = 1.\log_e x + x.\frac{1}{x}$$

or $\frac{dy}{dx} = y \log_e y.(\log x + 1)$

$= e^{x^x}.x^x(\log_e x + 1). = y.x^x(1 + \log_e x)$

138. (a) Let $g(x) = f(f(f(x))) + (f(x))^2$

Differentiating both sides w.r.t. x, we get

$g'(x) = f'(f(f(x)))f'(f(x))f'(x) + 2f(x)f'(x)$

$g'(1) = f'(f(f(1)))f'(f(1))f'(1) + 2f(1)f'(1)$

$= f'(f(1))f'(1)f'(1) + 2f(1)f'(1)$

$= 3 \times 3 \times 3 + 2 \times 1 \times 3 = 27 + 6 = 33$

139. (d) $|x|$ is non-differentiable function at $x = 0$ as L.H.D $= -1$ and R.H. D $= 1$

$\because |x| = \begin{cases} x, & x \geq 0 \\ -x, & x < 0 \end{cases}$

But $\cos|h|$ is differentiable

$\therefore$ Any combination of two such functions will be non-differentiable . Hence option (a) and (b) are ruled out.

Now, consider $\sin|x| + |x|$

$L' = \lim_{h \to 0} \frac{\sin|-h| + |-h|}{-h}$

$= \lim_{h \to 0} \frac{\sin h}{-h} - 1 = -1 - 1 = -2$

$R' = \lim_{h \to 0} \frac{\sin|h| + |h|}{h} = \lim_{h \to 0} \frac{\sin h}{h} + 1 = 1 + 1 = 2$

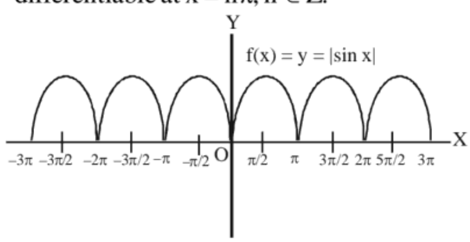
Consider $\sin|x| - |x|$

$L' = \lim_{h \to 0} \frac{\sin|-h| - |-h|}{-h} = \lim_{h \to 0} \frac{\sin h}{-h} + 1 = 0$

$R' = \lim_{h \to 0} \frac{\sin|h| - |h|}{h} = \lim_{h \to 0} \frac{\sin h}{h} - 1 = 0$

Hence, $\sin|x| - |x|$ is differentiable at $x = 0$.

140. (b) From the graph of f(x) = |sinx|, it is clear that f(x) is continuous everywhere but not differentiable at $x = n\pi, n \in Z$.



141. (b) We write $\sqrt{0.0037}$

$= \sqrt{0.00036 + 0.0001}$, because $\sqrt{0.0036} = 0.06$

Let $y = \sqrt{x} \Rightarrow y + \Delta y = \sqrt{x + \Delta x}$

Subtracting, we get $\Delta y = \sqrt{x + \Delta x} - \sqrt{x}$

$\left(\because dy = \left(\frac{dy}{dx}\right)\Delta x \text{ is approx equal to } \Delta y\right)$

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

Now, let $x = 0.0036$ and $\delta x = 0.0001$

142. (b) A function f(x) is said to be decreasing function in [a, b] if f '(x) > 0 in [a, b].

Given $f(x) = x^x$ .... (i)

Differentiate equation (i)

$f'(x) = x^x(1 + \log x)$

Put $f'(x) = 0$

$0 = x^x(1 + \log x)$

$\Rightarrow x = 0, \log x = -1 \Rightarrow x = e^{-1} \Rightarrow x = \frac{1}{e}, 0$

Now, in $]0, \frac{1}{e}[$, $f'(x) > 0$

$\therefore$ In interval $\left]0, \frac{1}{e}\right[$ f(x) is decreasing

143. (c) It is given that $x = a(\cos t + t \sin t)$ and $y = (\sin t - t \cos t)$. Therefore,

$\frac{dx}{dt} = a[-\sin t + \sin t + t \cos t] = at \cos t$

$\frac{dy}{dt} = a[\cos t - \{\cos t - t \sin t\}] = at \sin t$

$\therefore \frac{dy}{dx} = \frac{\left(\frac{dy}{dt}\right)}{\left(\frac{dx}{dt}\right)} = \frac{at \sin t}{at \cos t} = \tan t$

Then,

$\frac{d^2y}{dx^2} = \frac{d}{dx}\left(\frac{dy}{dx}\right) = \frac{d}{dx}(\tan t) = \frac{d}{dt}(\tan t)\frac{dt}{dx}$

$= \sec^2 t \cdot \frac{dt}{dx}$

$= \sec^2 t \cdot \frac{1}{at \cos t} = \frac{\sec^3 t}{at}$

144. **(a)** Let,

$$y=\frac{\log x}{x}\Rightarrow\frac{dy}{dx}=\frac{x\times\frac{d}{dx}\log x-\log x\frac{d}{dx}x}{x^2}$$

$$=\frac{x\times\frac{1}{x}-\log_e x}{x^2}=\frac{1-\log_e x}{x^2}$$

For maximum value, put

$$\frac{dy}{dx}=0\Rightarrow\frac{1-\log_e x}{x^2}=0,\quad\because\ x^2\neq 0$$

$$\log_e x=1\Rightarrow x=e$$

145. **(a)** $\sim((\sim p)\wedge q)\equiv\sim(\sim p)\vee\sim q\equiv p\vee(\sim q)$

146. **(c)** $\sim q\rightarrow\sim p$

147. **(d)** We know angle between the pair of lines

$ax^2+by^2+2hxy=0$ is given by

$$\theta=\tan^{-1}\left(\pm\frac{2\sqrt{h^2-ab}}{a+b}\right)$$

On comparing with given equation

$ax^2+by^2+2hxy=0$, we get

$$a=2,b=3,h=\frac{5}{2}$$

$$\therefore\quad\theta=\tan^{-1}\left(\pm\frac{2\sqrt{\frac{25}{4}-6}}{5}\right)=\tan^{-1}\left(\pm\frac{1}{5}\right)$$

148. **(a)** $3x+4y=0$ is one of the lines of the pair $6x^2-xy+4cy^2=0$.

Put $y=-\frac{3}{4}x$, we get

$$6x^2+\frac{3}{4}x^2+4c\left(-\frac{3}{4}x\right)^2=0$$

$$\Rightarrow 6+\frac{3}{4}+\frac{9c}{4}=0\Rightarrow c=-3$$

149. **(c)** $y=mx+4$ ...(i)

Tangent of $y^2=4x$ is

$$\Rightarrow\quad y=mx+\frac{1}{m}\qquad\text{...(ii)}$$

[Q Equation of tangent of $y^2=4\,ax$ is $y=mx+\frac{a}{m}$]

From (i) and (ii), $4=\frac{1}{m}\Rightarrow m=\frac{1}{4}$

So, line $y=\frac{1}{4}x+4$ is also tangent to parabola $x^2=2by$, so solve both equations.

$$x^2=2b\left(\frac{x+16}{4}\right)\Rightarrow 2x^2-bx-16b=0$$

$\Rightarrow\quad D=0$ [For tangent]

$\Rightarrow\quad b^2-4\times2\times(-16b)=0$

$\Rightarrow\quad b^2+32\times4b=0$

$b=-128$, $b=0$ (not possible)

150. **(b)** (2, –1) or (–2, 1)