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MHT CET 2017 Question Paper with Solution

Maharashtra Common Entrance Test

MHT-CET 2017

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. The frequencies for series limit of Balmer and Paschen series respectively are 'v_1' and 'v_3'. If frequency of first line of Balmer series is 'v_2' then the relation between 'v_1', 'v_2' and 'v_3' is
(a) $v_1 - v_2 = v_3$ (b) $v_1 + v_3 = v_2$
(c) $v_1 + v_2 = v_3$ (d) $v_1 - v_3 = 2v_1$

2. When three capacitors of equal capacities are connected in parallel and one of the same capacity is connected in series with its combination. The resultant capacity is 3.75μF. The capacity of each capacitor is
(a) 5 μF (b) 6 μF (c) 7 μF (d) 8 μF

3. Sensitivity of moving coil galvanometer is 'S'. If shunt of $\frac{1}{8}$ th of the resistance of galvanometer is connected to moving coil galvanometer, its sensitivity becomes
(a) $\frac{S}{3}$ (b) $\frac{S}{6}$ (c) $\frac{S}{9}$ (d) $\frac{S}{12}$

4. Two unknown resistances are connected in two gaps of a meter-bridge. The null point is obtained at 40 cm from left end. A 30 Ω resistance is connected in series with the smaller of the two resistances, the null point shifts by 20 cm to the right end. The value of smaller resistance in Ω is
(a) 12 (b) 24 (c) 36 (d) 48

5. In Fraunhofer diffraction pattern, slit width is 0.2 mm and screen is at 2 m away from the lens. If wavelength of light used is 5000Å, then the distance between the first minimum on either side of the central maximum is (θ is small and measured in radian)
(a) 10^{-1}m (b) 10^{-2}m
(c) 2×10^{-2}m (d) 2×10^{-1}m

6. In series LCR circuit R= 18 Ω and impedance is 33 Ω An rms voltage 220V is applied across the circuit. The ture power consumed in AC circuit is
(a) 220w (b) 400w (c) 600w (d) 800w

7. Two parallel plate air capacitors of same capacity C are connected in series to a battery of emf E. Then one of the capacitors is completely filled with dielectric material of constant K. The change in the effective capacity of the series combination is
(a) $\frac{C}{2}\left[\frac{K-1}{K+1}\right]$ (b) $\frac{2}{C}\left[\frac{K-1}{K+1}\right]$
(c) $\frac{C}{2}\left[\frac{K+1}{K-1}\right]$ (d) $\frac{C}{2}\left[\frac{K-1}{K+1}\right]^2$

8. The polarising angle for transparent medium is 'θ' and 'v' is the speed of light in that medium. Then relation between 'θ' and 'v' is
(c = velocity if light in air)
(a) $\theta = \tan^{-1}\left(\frac{v}{c}\right)$ (b) $\theta = \cot^{-1}\left(\frac{v}{c}\right)$
(c) $\theta = \sin^{-1}\left(\frac{v}{c}\right)$ (d) $\theta = \cos^{-1}\left(\frac{v}{c}\right)$

9. Two identical light waves having phase difference 'ϕ' propagate in same direction. When they superpose, the intensity of resultant wave is proportional to

(a) $\cos^2 \phi$ (b) $\cos^2\left(\frac{\phi}{2}\right)$

(c) $\cos^2\left(\frac{\phi}{3}\right)$ (d) $\cos^2\left(\frac{\phi}{4}\right)$

10. For a transistor, α_{dc} and β_{dc} are the current ratios, then the value of $\frac{\beta_{dc}-\delta_{dc}}{\alpha_{dc}.\beta_{dc}}$

(a) 1 (b) 1.5 (c) 2 (d) 2.5

11. A radioactive element has rate of disintegration 10,000 disintegrations per minute at a particular instant. After four minutes it become 2500 disintegrations per minute. The decay constant per minute is

(a) $0.2 \log_e 2$ (b) $0.5 \log_e 2$

(c) $0.6 \log_e 2$ (d) $0.8 \log_e 2$

12. When the same monochromatic ray of light travels through glass slab and through water, the number of waves in glass slab of thickness 6cm is same as in water column of height 7cm. If refractive index of glass is 1.5, then refractive index of water is

(a) 1.258 (b) 1.269 (c) 1.286 (d) 1.310

13. If the electron in hydrogen atom jumps from second Bohr orbit to ground state and difference between energies of the two states is radiated in the form of photons. If the work function of the material is 4.2 eV, then stopping potential is

[Energy of electron in nth orbit = $-\frac{13.6}{n^2}$ eV]

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

14. The magnetic moment of electron due to orbital motion is proportional to
(n = principal quantum numbers)

(a) $\frac{1}{n^2}$ (b) $\frac{1}{n}$ (c) n^2 (d) n

15. Photodiode is a device

(a) which is always operated in reverse bias
(b) which is always operated in forward bias
(c) in which photo curent is independent of intensity of incident radiation
(d) which may be operated in forwad or revese bias.

16. A wheel of moment of inertia 2 kg m^2 is rotating about an axis passing through centre and perpendicular to its plane at a speed 60 rad/s. Due to friction, it comes to rest in 5 minutes. The angular momentum of the wheel three minutes before it stops rotating is

(a) 24 kg m^2/s (b) 48 kg m^2/s
(c) 72 kg m^2/s (d) 96 kg m^2/s

17. The equation of the progressive wave is y = $3\sin\left[\pi\left(\frac{t}{3}-\frac{x}{5}\right)+\frac{\pi}{4}\right]$, where x and y are in metre and time in second. Which of the following is correct?

(a) Velocity v = 1.5 m/s
(b) Amplitude A = 3cm
(c) Frequency f = 0.2Hz
(d) Wavelength λ = 10m

18. Two spherical black bodies have radii 'r_1' and 'r_2'. Their surface temperature are 'T_1' and 'T_2'. If they radiate same power, then $\frac{r_2}{r_1}$ is

(a) $\frac{T_1}{T_2}$ (b) $\frac{T_2}{T_1}$

(c) $\left(\frac{T_1}{T_2}\right)^2$ (d) $\left(\frac{T_2}{T_1}\right)^2$

19. The closed and open organ pipes have same length. When they are vibrating simultaneously in first overtone, produce three beats. The lenght of open pipe is made $\frac{1}{3}$rd and closed pipe is made three times the original, the number of beats produced will be

(a) 8 (b) 14 (c) 17 (d) 20

20. A lift of mass 'm' is connected to a rope which is moving upward with maximum acceleration 'a'. For maximum safe stress, the elastic limit of the rope is 'T'. The minimum diameter of the rope is
(g = gravitational acceleration)

(a) $\left[\frac{2m(g+a)}{\pi T}\right]^{\frac{1}{2}}$ (b) $\left[\frac{4m(g+a)}{\pi T}\right]^{\frac{1}{2}}$

(c) $\left[\frac{m(g+a)}{\pi T}\right]^{\frac{1}{2}}$ (d) $\left[\frac{m(g+a)}{2\pi T}\right]^{\frac{1}{2}}$

21. A solid sphere of mass 2 kg is rolling on a frictionless horizontal surface with velocity 6m/s. It collides on the free end of an ideal spring whose other end is fixed. The maximum compression produced in the spring will be (Force constant of the spring = 36 N/m)

(a) $\sqrt{14m}$ (b) $\sqrt{2.8m}$

(c) $\sqrt{14m}$ (d) $\sqrt{0.7m}$

22. A flywheel at rest is to reach an angular velocity of 24rad/s in 8 second with constant angular acceleration. The total angle turned through during this interval is

(a) 24 rad (b) 48 rad (c) 72 rad (d) 96 rad

23. Two uniform wires of the same material are vibrating under the same tension. If the first overtone of the first wire is equal to the second overtone of the second wire and radius of the first wire is the twice the radius of the second wire, then the ratio of the lengths of the first wire to second wire is

(a) $\frac{1}{3}$ (b) $\frac{1}{4}$ (c) $\frac{1}{5}$ (d) $\frac{1}{6}$

24. When one end of the capillary is dipped in water, the height of water column is 'h'. The upward force of 105 dyne due to surface tension is balanced by the force due to the weight of water column. The inner circumference of capillary is (Surface tension of water = 7×10^{-2} N/m)

(a) 1.5 cm (b) 2 cm (c) 2.5 cm (d) 3 cm

25. For a rigid diatomic molecule, universal gas constant $R = nC_p$, where 'C_P' is the molar specific heat at constant pressure and 'n' is a number. Hence 'n' is equal to

(a) 0.2257 (b) 0.4 (c) 0.2857 (d) 0.3557

26. An ideal gas has pressure 'p' volume 'V' and absolute temperature 'T'. If 'm' is the mass of each molecules and 'K' is the Boltzmann constant, then density of the gas is

(a) $\frac{pm}{KT}$ (b) $\frac{KT}{pm}$ (c) $\frac{Km}{pT}$ (d) $\frac{pK}{Tm}$

27. A big water drop is formed by the combination of 'n' small water drops of equal radii. The ratio of the surface energy of 'n'drops to the surface energy of big drop is

(a) $n^2 : 1$ (b) $n : 1$ (c) $\sqrt{n} : 1$ (d) $\sqrt[3]{n} : 1$

28. The ratio of binding energy of a satellite at rest on earth's surface to the binding energy of a satellite of same mass revolving around the earth at a height h above the earth's surface is (R = radius of the earth).

(a) $\frac{2(R+h)}{R}$ (b) $\frac{R+h}{2}$

(c) $\frac{R+h}{R}$ (d) $\frac{R}{R+h}$

29. A particle performing SHM starts equilibrium position and its time period is 16 seconds. After 2 seconds its velocity is π m/s. Amplitude of oscillation is $\left(\cos 45° = \frac{1}{\sqrt{2}}\right)$

(a) $2\sqrt{2}$m (b) $4\sqrt{2}$m

(c) $6\sqrt{2}$m (d) $8\sqrt{2}$m

30. In sonometer experiment, the string of length 'L' under tension vibrates in second overtone between two bridges. The amplitude of vibration is maximum at

(a) $\frac{L}{3}, \frac{2L}{3}, \frac{5L}{6}$ (b) $\frac{L}{8}, \frac{L}{4}, \frac{L}{2}$

(c) $\frac{L}{2}, \frac{L}{4}, \frac{L}{6}$ (d) $\frac{L}{6}, \frac{L}{2}, \frac{5L}{6}$

31. The depth 'd' at which the value of acceleration due to gravity becomes $\frac{1}{n}$ times the value at the earth's surface is (R = radius of earth)

(a) $d = R\left(\frac{n}{n-1}\right)$ (b) $d = R\left(\frac{n-1}{2n}\right)$

(c) $d = R\left(\frac{n-1}{n}\right)$ (d) $d = R^2\left(\frac{n-1}{n}\right)$

32. A particle is performing SHM starting extreme position, graphical representation shows that between displacement and acceleration there is a phase difference of

(a) 0 rad (b) $\frac{\pi}{4}$ rad

(c) $\frac{\pi}{2}$ rad (d) π rad

33. The fundamental frequency of an air column is a pipe closed at one end is 100 Hz. If the same pipe is open at both the ends, the frequencies produced in Hz are

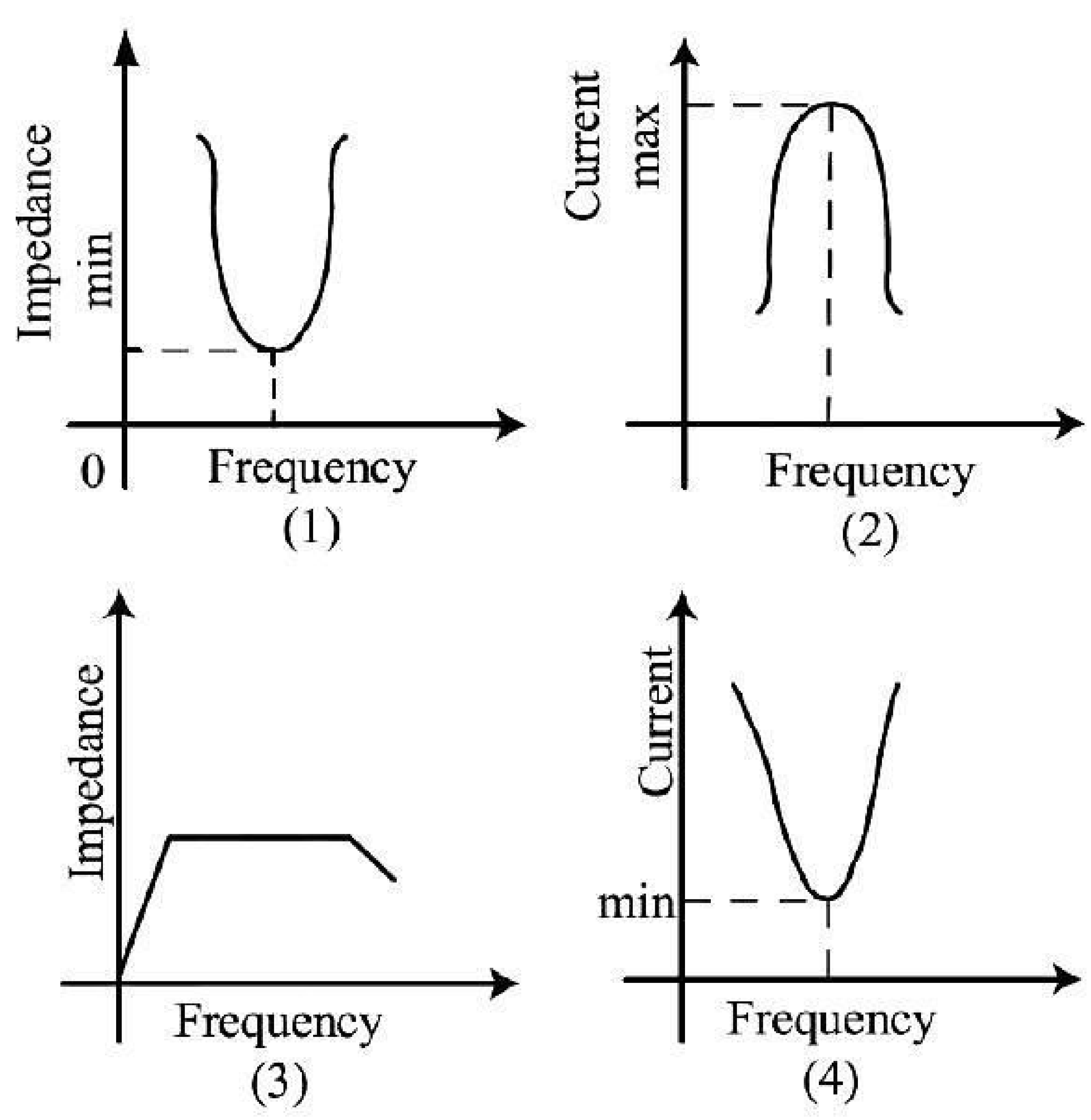
(a) 100, 200, 300, 400...
(b) 100, 300, 500, 700...
(c) 200, 300, 400, 500...
(d) 200, 400, 600, 800

34. For a particle moving in vertical circle, the total energy at different positions along the path
(a) is conserved
(b) increases
(c) decreases
(d) may increase or decrease

35. A simple pendulum of length 'L' has mass 'M' and it oscillates freely with amplitude 'A'. At extreme position, its potential energy is (g=acceleration due to gravity)
(a) $\frac{MgA^2}{2L}$ (b) $\frac{MgA}{2L}$
(c) $\frac{MgA^2}{L}$ (d) $\frac{2MgA^2}{L}$

36. On a photosensitive material when frequency of incident radiation is increased by 30%, kinetic energy of emitted photoelectrons increases from 0.4 eV. The work function of the surface is
(a) 1 eV. (b) 1.267 eV
(c) 1.4 eV (d) 1.8 eV

37. Out of the following graphs, which graphs shows the correct relation (graphical representation) for LC parallel resonant circuit



(a) 1 (b) 2 (c) 3 (d) 4

38. According to de-Broglie hypothesis, the wavelength associated with moving electron of mass 'm' is 'λ_e'. Using mass energy relation and Planck's quantum theory, the wavelength associated with photon is 'λ_p'. If the energy (E) of electron and photon is same, then relation between 'λ_e' and 'λ_p' is
(a) $\lambda_p \propto \lambda_e$ (b) $\lambda_p \propto \lambda_e^2$
(c) $\lambda_p \propto \sqrt{\lambda_e}$ (d) $\lambda_p \propto \frac{1}{\lambda_e}$

39. A parallel plate air capacity 'C' farad, potential 'V' volt and energy 'E' joule. When the gap between the plastes is completely filled with dielectric
(a) both V and E increase
(b) both V and E decrease
(c) V decrease, E increases
(d) V increases, E decrease

40. The resistivity of potentiometer wire is 40×10^{-8} ohm-metre and its area of cross- section is 8×10^{-6}m^2. If 0.2 ampere current is flowing through the wire, then the potential gradient of the wire is
(a) 10^{-1} V/m (b) 10^{-2} V/m
(c) 10^{-3} V/m (d) 10^{-4} V/m

41. A ceiling fan rotates about its own axis with some angular velocity. When the fan is switched off the angular velocity becomes $\left(\frac{1}{4}\right)$th of the original in time 't' and 'n' revolutions are made in that time. The number of revolutions made by the fan during the time interval between switch off and rest are (Angular retardation is uniform)
(a) $\frac{4n}{15}$ (b) $\frac{8n}{15}$ (c) $\frac{16n}{15}$ (d) $\frac{32n}{15}$

42. A disc of moment of inertia 'I_1' is rotating in horizontal plane about an axis passing through a centre and perpendicular to its plane with constant angular speed 'ω_1'. Another disc of moment of inertia 'I_2' having zero angular speed is placed co-axially on a rotating disc. Now, both the discs are rotating with constant angular speed 'ω_2'. The energy lost by the initial rotating disc is
(a) $\frac{1}{2}\left[\frac{I_1+I_2}{I_1I_2}\right]\omega_1^2$ (b) $\frac{1}{2}\left[\frac{I_1I_2}{I_1-I_2}\right]\omega_1^2$
(c) $\frac{1}{2}\left[\frac{I_1-I_2}{I_1I_2}\right]\omega_1^2$ (d) $\frac{1}{2}\left[\frac{I_1I_2}{I_1+I_2}\right]\omega_1^2$

43. A particle performs linear SHM at a particular instant, velocity of the particle is 'u' and acceleration is α while at another instant velocity is 'v' and acceleration is 'β' ($0 < \alpha < \beta$). The distance between the two position is
(a) $\frac{u^2-v^2}{\alpha+\beta}$ (b) $\frac{u^2+v^2}{\alpha+\beta}$
(c) $\frac{u^2-v^2}{\alpha-\beta}$ (d) $\frac{u^2+v^2}{\alpha-\beta}$

44. The observer is moving with velocity 'v_0' towards the stationary source of sound and then after crossing moves away from the source with velocity 'v_0'. Assume that the medium through which the sound waves travel is at rest. If v is the velocity of sound and n is the frequency emitted by the source, then the difference between apparent frequencies heard by the observer is

(a) $\frac{2nv_0}{v}$ (b) $\frac{nv_0}{v}$ (c) $\frac{v}{2nv_0}$ (d) $\frac{v}{nv_0}$

45. A metal rod of length 'L' and cross-sectional area 'A' is heated through 'T°C'. What is the force required to prevent the expansion of the rod lengthwise

(a) $\frac{YA\alpha T}{(1-\alpha T)}$ (b) $\frac{YA\alpha T}{(1+\alpha T)}$

(c) $\frac{(1-\alpha T)}{YA\alpha T}$ (d) $\frac{(1+\alpha T)}{YA\alpha T}$

46. Two coils P and Q are kept near each other. When no current flows through coil P and current increase in coil Q at the rate 10A/s, the emf in coil P is 15mV. When coil Q carries no current and current of 1.8A flows through coil P, the magnetic flux linked with the coil Q is

(a) 1.4 m Wb (b) 2.2 mWb
(c) 2.7 m Wb (d) 2.9 m Wb

47. In Young's double experiment, in air interference pattern second minimum is observed exactly in front of one slit. The distance between the two coherent source is 'd' and the distance between source and screen is 'D'. The wavelength of light source used is

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

48. In communication system, the process of superimposing a low frequency signal on a high frequency wave is know n as

(a) repeater (b) attenuation
(c) modulation (d) demodulation

49. A bar magnet has length 3 cm, cross-sectional area 2 cm^3 and magnetic moment 3 Am^2. The intensity of magnetisation of bar magnet is

(a) 2×10^5 A/m (b) 3×10^5 A/m
(c) 4×10^5 A/m (d) 5×10^5 A/m

50. The magnetic flux near the axis and inside the air core solenoid of length 60cm carrying current 'I' is 157×10^{-6} Wb. Its magnetic moment will be (cross-sectional area of a solenoid is very small as compared to its length, $\mu_0 = 4\pi \times 10^{-7}$ SI unit)

(a) 0.25 A (b) 0.50 A (c) 0.75 A (d) 1 A

CHEMISTRY

51. The work done during combustion of 9×10^{-2} kg of ethane, $C_2H_6(g)$ at 300 K is
(Given R = 8.314 J deg^{-1}, atomic mass C = 12, H = 1

(a) 6.236 kJ (b) – 6.236 kJ
(c) 18.71 kJ (d) –18.71 kJ

52. What type of sugar molecule is present is DNA?

(a) D-3-deoxyribose (b) D-ribose
(c) D-2-deoxyribose (d) D-glucopyranose

53. The molality of solution containing 15.20 g of urea, (molar mass = 60) dissolved in 150 g or water is

(a) 1.689 mol kg^{-1} (b) 0.1689 mol kg^{-1}
(c) 0.5922 mol kg^{-1} (d) 0.2533 mol kg^{-1}

54. The acid, which contains both –OH and –COOH groups is

(a) phthalic acid (b) adipic acid
(c) glutaric acid (d) salicylic acid

55. Identify the compound, in which phosphorus exists in the oxidation state of +1.

(a) Phosphonic acid (H_3PO_3)
(b) Phosphinic acid (H_3PO_2)
(c) Pyrophosphorus acid ($H_4P_2O_5$)
(d) Orthophosphoric acid (H_3PO_4)

56. Identify the weakest oxidising agent among the following.

(a) Li^+ (b) Na^+ (c) Cd^{2+} (d) I_2

57. The monomers used in preparation of dextron are

(a) lactic acid and glycolic acid
(b) 3-hydroxy butanoic acid and 3-hydroxy pentanoic acid
(c) styrene and 1, 3-butadiene
(d) hexamethylenediamine and adipic acid

58. Which among the following compounds does not act as reducing agent?

(a) H_2O (b) H_2S (c) H_2Se (d) H_2Te

59. Which of the following processes is not used to preserve the food?

(a) Irradiation (b) Addition of salts
(c) Addition of heat (d) Hydration

60. In case of substituted aniline the group which decreases the basic strength is

(a) $-OCH_3$ (b) $-CH_3$
(c) $-NH_2$ (d) $-C_6H_5$

61. (+2) 2-methylbutan-1-ol (-) 2-methylbutan-1-ol have different values for which property?

(a) Boiling point (b) Relative density
(c) Refraction index (d) Specific rotation

62. Which among the following is not mineral of iron?

(a) Haematite (b) Magnesite
(c) Magnetite (d) Siderite

63. Nitration of which among the following compounds yields cyclonite?
(a) Formaldehyde
(b) Benzaldehyde
(c) Urotropine
(d) Acetaldehyde ammonia

64. Calculate the work done during compression of 2 mol of an ideal gas from a volume of $1m^3$ to $10\ dm^3$ 300K against a pressure of 100 KPa.
(a) –99 kJ (b) + 99 kJ
(c) +22.98 kJ (d) –22.98 kJ

65. Which element among the following does form $p\pi - p\pi$ multiple bonds?
(a) Arsenic (b) Nitrogen
(c) Phosphorus (d) Antimony

66. Which of the following statement(s) is/are incorrect in case of Hofmann bromamide degradation?
(a) Reaction is useful for decreasing length of carbon chain by one carbon atom
(b) It gives tertiary amine
(c) It gives primary amine
(d) Aqueous or alco. KOH is used with bromine

67. Which of the following statement (s) is/are incorrect for pair of elements Zr-Hf ?
(a) Both possess same number of valence electrons.
(b) Both have identical sizes.
(c) Both have almost identical radii.
(d) Both of these belong to same period of periodic table.

68. Aldehyde or ketones when treated with $C_6H_5 – NH–NH_2$, the product formed is
(a) semicarbazone (b) phenlhydrazone
(c) hydrazone (d) oxime

69. Solubility of which among the following solids in water changes slightly with temperature?
(a) KNO_3 (b) $NaNO_3$
(c) KBr (d) NaBr

70. What is the quantity of hydrogen gas liberated when 46 g sodium reacts with excess ethanol?
(a) 2.4×10^{-3} kg (b) 2.0×10^{-3} kg
(c) 4.0×10^{-3} kg (d) 2.4×10^{-2} kg

71. *Tert*-butyl methyl ether on treatment with hydrogen iodide in cold gives
(a) *tert*-butyl iodide and methyl iodide
(b) *tert*-butyl alcohol and methyl alcohol
(c) *tert*-butyl alcohol and methyl iodide
(d) *tert*-butyl iodide and methyl alcohol

72. Name the process that is employed to refine aluminium.
(a) Hall's process (b) Mond process
(c) Hoope's process (d) Serperck's process

73. The colour and magnetic nature of manganate ion (MnO_4^{2-}) is
(a) green, paramagnetic
(b) purple, diamagnetic
(c) green, diamagnetic
(d) purple, paramagnetic

74. The osmotic pressure of solution containing 34.2 g of cane sugar (molar mass = 342 g mol^{-1}) in 1 L of solution at 20°C is (Given R = 0.082 L atm $K^{-1}\ mol^{-1}$)
(a) 2.40 atm (b) 3.6 atm
(c) 24 atm (d) 0.0024 atm

75. In assigning R-S configuration, which among the following groups has highest priority?
(a) $–SO_3H$ (b) – COOH
(c) –CHO (d) $–C_6H_5$

76. Which of the following is used as antiseptic?
(a) Chloramphenicol (b) Bithional
(c) Cimetidine (d) Chlordiazepoxide

77. In preparation of sulphuric acid from sulphur dioxide in lead chamber process. What substance is used as a catalyst?
(a) Manganese dioxide
(b) Vanadium pentoxide
(c) Nitric oxide
(d) Raney nickel

78. The correct charge on and co-ordination number of 'Fe' in $K_3[Fe(CN)_6]$ is
(a) +2, 4 (b) +3, 6 (c) +2, 6 (d) +3, 3

79. Which among the following reactions is an example of pseudo first order reaction?
(a) Inversion of cane sugar
(b) Decomposition of H_2O_2
(c) Conversion of cyclopropane to propene
(d) Decomposition of N_2O_5

80. The amine, which reacts with *p*-toluenesulphonyl chloride to give a clear solution, which on acidification gives insoluble compound is
(a) $C_2H_5NH_2$ (b) $(C_2H_5)_2NH$
(c) $(C_2H_5)_3N$ (d) $CH_3NHC_2H_5$

81. Which among the following equation represents Arrhenius equation?
(a) $k = A_e^{\frac{E_a}{RT}}$ (b) $k = A.e^{\frac{RT}{E_a}}$
(c) $k = \frac{A}{e^{E_a/RT}}$ (d) $k = \frac{A}{e^{RT/E_a}}$

82. Which of the following compound will give positive iodoform test?
(a) Isopropyl alcohol
(b) Propionaldehyde
(c) Ethylphenyl ketone
(d) Benzyl alcohol

83. The first law of thermodynamics for isothermal process is
(a) $q = -W$ (b) $\Delta U = W$
(c) $\Delta U = q_v$ (d) $\Delta U = q_v$

84. The conversion of ethyl bromide using sodium iodide and dry acetone, this reaction is know as
(a) Swarts reaction
(b) Finkelstein reaction
(c) Sandmeyer reaction
(d) Stephen reaction

85. What is the hybridisation of carbon atoms in fullerene?
(a) sp^3 (b) sp (c) sp^2 (d) dsp^3

86. What is the SI unit of conductivity?
(a) Sm (b) Sm^{-1} (c) Sm^2 (d) Sm^{-2}

87. Which of the following in Baeyer's reagent?
(a) Alkaline $KMnO_4$ (b) Acidic $K_2Cr_2O_7$
(c) Alkaline $Na_2Cr_2O_7$ (d) MnO_2

88. What is the chief constituent of pyrex glass?
(a) B_2O_3 (b) SiO_2 (c) AI_2O_3 (d) Na_2O

89. Which of the following compounds has lowest boiling point?
(a) *n*-butyl alcohol (b) Iso-butyl alcohol
(c) *Tert*-butyl alcohol (d) *Sec*-butyl alcohol

90. Identify the invalid equation
(a) $\Delta H = \Sigma H_{\text{products}} - \Sigma H_{\text{reactants}}$
(b) $\Delta H = \Delta U + p\Delta V$
(c) $\Delta H^\circ_{(\text{reaction})} = \Sigma H^\circ_{(\text{product bonds})} - \Sigma H^\circ_{(\text{reactant bonds})}$
(d) $\Delta H = \Delta U + \Delta nRT$

91. The rate constant for a first order reaction is $7.0 \times 10^{-4}\ s^{-1}$. If initial concentration of reactant is 0.080 M, what is the half life of reaction?
(a) 990 s (b) 79.2 s
(c) 12375 s (d) 10.10×10^{-4} s

92. The polymer used in making handles of cookers and frying pans is
(a) bakelite (b) nylon-2-nylon-6
(c) orlon (d) Polyvinyl chloride

93. Which halogen has the highest value of negative electron gain enthalpy?
(a) Fluorine (b) Chlorine
(c) Bromine (d) Iodine

94. What is the actual volume occupied by water molecules present in 20 cm^3 of water?
(a) 20 cm^3 (b) 10 cm^3
(c) 40 cm^3 (d) 24.89 cm^3

95. Which of the following co-ordinate complexes if an exception to EAN rule? (Given atomic number Pt = 78, Fe = 26, Zn = 30, Cu = 29)
(a) $[Pt(NH_3)_6]^{4+}$ (b) $[Fe(CN)_6]^{4-}$
(c) $[Zn(NH_3)_4]^{2+}$ (d) $[Cu(NH_3)_4]^{2+}$

96. Which among the following equations represents the reduction reaction taking place in lead accumulator at positive electrode, while it is being used as a source of electrical energy?
(a) $Pb \rightarrow Pb^{2+}$ (b) $Pb^{4+} \rightarrow Pb$
(c) $Pb^{2+} \rightarrow Pb$ (d) $Pb^{4+} \rightarrow Pb^{2+}$

97. For which among the following equimolar aqueous solutions Van't Hoff factor has the lowest value?
(a) Aluminium chloride
(b) Potassium sulphate
(c) Ammonium chloride
(d) Urea

98. The amino acid, which is basic in nature is
(a) histidine (b) tyrosine
(c) proline (d) valine

99. Which element among the following does not form diatomic molecules?
(a) Argon (b) Oxygen
(c) Nitrogen (d) Bromine

100. A molecule of stachyose contains how many carbon atoms?
(a) 6 (b) 12 (c) 18 (d) 24

SECTION-B

MATHEMATICS

1. The number of principal solutions of $\tan 2\theta = 1$ is
(a) one (b) two (c) three (d) four

2. The object function $z = 4x_1 + 5x_2$, subject to $2x_1 + x_2 \geq 7$, $2x_1 + 3x_2 \leq 15$, $x_2 \leq 3$, $x_1, x_2 \geq 0$ has minimum value at the point
(a) on X-axis
(b) on Y-axis
(c) at the origin
(d) on the line parallel to X-axis

3. If z_1 and z_2 are z-coordinates of the points of trisection of the segment joining the points $A(2, 1, 4,)$, $B(-1, 3, 6)$, then $z_1 + z_2 =$
(a) 1 (b) 4 (c) 5 (d) 10

4. The maximum value of

$$f(x) = \frac{\log x}{x} (x \neq 0, x \neq 1) \text{ is}$$

(a) e (b) $\frac{1}{e}$ (c) e^2 (d) $\frac{1}{e^2}$

5. $\int_0^1 x \tan^{-1} x \, dx =$

(a) $\frac{\pi}{4}+\frac{1}{2}$ (b) $\frac{\pi}{4}-\frac{1}{2}$

(c) $\frac{1}{2}-\frac{\pi}{4}$ (d) $-\frac{\pi}{4}-\frac{1}{2}$

6. The statement pattern $(\sim p \wedge q)$ is logically equivalent to

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

(c) $(p \wedge q) \rightarrow p$ (d) $(p \vee q) \rightarrow p$

7. If $g(x)$ is the inverse function of $f(x)$ and $f'(x)=\frac{1}{1+x^4}$, then $g'(x)$ is

(a) $1+[g(x)]^4$ (b) $1-[g(x)]^4$

(c) $1+[f(x)]^4$ (d) $\frac{1}{1+[g(x)]^4}$

8. The inverse of the matrix $\begin{bmatrix} 1 & 0 & 0 \\ 3 & 3 & 0 \\ 5 & 2 & -1 \end{bmatrix}$ is

(a) $-\frac{1}{3}\begin{bmatrix} -3 & 0 & 0 \\ 3 & 1 & 0 \\ 9 & 2 & -3 \end{bmatrix}$ (b) $-\frac{1}{3}\begin{bmatrix} -3 & 0 & 0 \\ 3 & -1 & 0 \\ -9 & -2 & 3 \end{bmatrix}$

(c) $-\frac{1}{3}\begin{bmatrix} 3 & 0 & 0 \\ 3 & -1 & 0 \\ -9 & -2 & 3 \end{bmatrix}$ (d) $-\frac{1}{3}\begin{bmatrix} -3 & 0 & 0 \\ -3 & -1 & 0 \\ -9 & -2 & 3 \end{bmatrix}$

9. If $\int \frac{1}{\sqrt{9-16x^2}} dx = \alpha \sin^{-1}(\beta x)+c$, then $\alpha+\frac{1}{\beta}=$

(a) 1 (b) $\frac{7}{12}$ (c) $\frac{19}{12}$ (d) $\frac{9}{12}$

10. O(0,0), A(1, 2), B(3, 4) are the vertices of ΔOAB The joint equation of the altitude and median drawn from O is

(a) $x^2+7xy-y^2=0$ (b) $x^2+7xy+y^2=0$

(c) $3x^2-xy-2y^2=0$ (d) $3x^2+xy-2y^2=0$

11. If the function $f(x)=\left[\tan\left(\frac{\pi}{4}+x\right)\right]^{\frac{1}{x}}$ for $x \neq 0$ is $=K$ for $x=0$ continuous at $x=0$, then K = ?

(a) e (b) e^{-1} (c) e^2 (d) e^{-2}

12. For a invertible matrix A if $A(\text{adj}A)=\begin{bmatrix} 10 & 0 \\ 0 & 10 \end{bmatrix}$, then $|A|=$

(a) 100 (b) −100 (c) 10 (d) −10

13. The solution of the differential equation $\frac{dy}{dx}=\tan\left(\frac{y}{x}\right)+\left(\frac{y}{x}\right)$ is

(a) $\cos\left(\frac{y}{x}\right)=cx$ (b) $\sin\left(\frac{y}{x}\right)=cx$

(c) $\cos\left(\frac{y}{x}\right)=cy$ (d) $\sin\left(\frac{y}{x}\right)=cy$

14. In ΔABC, if $\sin^2 A+\sin^2 B=\sin^2 C$ and $l(AB)=10$, then the maximum value of the area of ΔABC is

(a) 50 (b) $10\sqrt{2}$

(c) 25 (d) $25\sqrt{2}$

15. If x = f (t) and y = g (t) are differentiable functions of t, then $\frac{d^2y}{dx^2}$ is

(a) $\frac{f'(t).g''(t)-g'(t).f''(t)}{[f'(t)]^3}$

(b) $\frac{f'(t).g''(t)-g'(t).f''(t)}{[f'(t)]^2}$

(c) $\frac{g'(t).f''(t)-f'(t).g''(t)}{[f'(t)]^3}$

(d) $\frac{g'(t).f''(t)+f'(t).g''(t)}{[f'(t)]^3}$

16. The equation of line equality inclined to coordinate axes and passing through (−3, 2, −5) is

(a) $\frac{x+3}{1}=\frac{y-2}{1}=\frac{z+5}{1}$

(b) $\frac{x+3}{-1}=\frac{y-2}{1}=\frac{5+z}{-1}$

(c) $\frac{x+3}{-1}=\frac{y-2}{1}=\frac{z+5}{1}$

(d) $\frac{x+3}{-1}=\frac{2-y}{1}=\frac{z+5}{-1}$

17. If $\int_0^{\frac{\pi}{2}} \log \cos x \, dx = \frac{\pi}{2} \log\left(\frac{1}{2}\right)$, then

$\int_0^{\frac{\pi}{2}} \log \sec dx =$

(a) $\frac{\pi}{2}\log\left(\frac{1}{2}\right)$ (b) $1-\frac{\pi}{2}\log\left(\frac{1}{2}\right)$

(c) $1+\frac{\pi}{2}\log\left(\frac{1}{2}\right)$ (d) $\frac{\pi}{2}\log 2$

18. A boy tosses fair coin 3 times. If he gets $2X$ for X heads, then his expected gain equals to ....

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

19. Which of the following statement pattern is a tautology?

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

(c) $(q \to p) \vee (\sim p \leftrightarrow q)$(d) $p \wedge \sim p$

20. If the angle between the planes

$r.(m\hat{i} - \hat{j} + 2\hat{k}) + 3 = 0$ and

$r.(2\hat{i} - m\hat{j} - \hat{k}) - 5 = 0$ is $\frac{\pi}{3}$, then $m =$

(a) 2 (b) ± 3 (c) 3 (d) -2

21. If the origin and the points $P(2, 3, 4)$, $Q(1, 2, 3)$ and $R(x, y, z)$ are coplanar, then

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

(c) $x-2y+z=0$ (d) $2x-2y+z=0$

22. If lines represented by equation $px^2 - qy^2 = 0$ are distinct, then

(a) $pq > 0$ (b) $pq < 0$

(c) $pq = 0$ (d) $p + q = 0$

23. Let □ $PQRS$ be a quadrilateral. If M and N are the mid-points of the sides PQ and RS respectively, then PS + QR =

(a) 3 MN (b) 4MN (c) 3 MN (d) 2NM

24. If slopes of lines represented by $kx^2 + 5xy + y^2 = 0$ differ by 1, then k =

(a) 2 (b) 3 (c) 6 (d) 8

25. If vector r with dc's l, m, n is equally inclined to the coordinate axes, then the total number of such vectorse is

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

26. If $\int \frac{1}{(x^2+4)(x^2+9)} dx = A \tan^{-1}\frac{x}{2}$

$+ B\tan^{-1}\left(\frac{x}{3}\right)$ + C, then A – B =

(a) $\frac{1}{6}$ (b) $\frac{1}{30}$ (c) $-\frac{1}{30}$ (d) $-\frac{1}{6}$

27. If α and β are roots of the equation $x^2 + 5|x| - 6 = 0$, then the value of $|\tan^{-1}\alpha - \tan^{-1}\beta|$ is

(a) $\frac{\pi}{2}$ (b) 0 (c) π (d) $\frac{\pi}{4}$

28. If $x = a\left(t - \frac{1}{t}\right)$, $y = a\left(t + \frac{1}{t}\right)$, where t is the parameter, then $\frac{dy}{dx}$ =?

(a) $\frac{y}{x}$ (b) $\frac{-x}{y}$ (c) $\frac{x}{y}$ (d) $\frac{-y}{x}$

29. The point on the curve $y = \sqrt{x-1}$, where the tangent is perpendicular to the line $2x + y - 5 = 0$ is

(a) (2,–1) (b) (10, 3)

(c) (2, 1) (d) (5,–2)

30. If $\int \sqrt{\frac{x-5}{x-7}} dx = A\sqrt{x^2-12x+35} + \log|x| - 6$

$+ \sqrt{x^2-12x+35} + C|$, then A =

(a) –1 (b) $\frac{1}{2}$

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

31. At random variable $X \sim B(n, p)$, if values of mean and variance of X are 18 and 12 respectively, then total number of possible values of X are

(a) 54 (b) 55 (c) 12 (d) 18

32. The area of the region bounded by the lines $y = 2x + 1$, $y = 3x + 1$ and $x = 4$ is

(a) 16 sq unit (b) $\frac{121}{3}$ sq unit

(c) $\frac{121}{6}$ sq unit (d) 8 sq unit

33. A box contains 6 pens, 2 of which are defective. Two pens are taken randomly from the box. If r.v. X : number of defective pens obtained, then standard deviation of X =

(a) $\pm\frac{4}{3\sqrt{5}}$ (b) $\frac{8}{3}$

(c) $\frac{16}{45}$ (d) $\frac{4}{3\sqrt{5}}$

34. If the volume of spherical ball is increasing at the rate of 4π cm^3/s, then the rate of change of its surface area when the volume is 288π cm^3, is

(a) $\frac{4}{3}\pi$ cm^2/s (b) $\frac{2}{3}\pi$ cm^2/s
(c) 4π cm^2/s (d) 2π cm^2/s

35. If $f(x) = \log(\sec^2 x)^{\cot^2 x}$ for $x \neq 0 = K$ for $x = 0$ is continuous at $x = 0$, then K is

(a) e^{-1} (b) 1 (c) e (d) 0

36. If c denotes the contradiction, then dual of the compound statement $\sim p \wedge (q \vee c)$ is

(a) $\sim p \vee (q \wedge t)$ (b) $\sim p \wedge (q \vee t)$
(c) $p \vee (\sim q \vee t)$ (d) $\sim p \vee (q \wedge c)$

37. The differential equation of all parabolas whose axis is Y-axis, is

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

38. $\int_0^3 [x]\, dx =$ ...., where $[x]$ is greatest integer function.

(a) 3 (b) 0 (c) 2 (d) 1

39. The objective function of LPP defined over the convex set attains it optimum value at

(a) atleast two of the corner points
(b) all the corner points
(c) atleast one of the corner points
(d) None of the corner points

40. If the inverse of the matrix $\begin{bmatrix} \alpha & 14 & -1 \\ 2 & 3 & 1 \\ 6 & 2 & 3 \end{bmatrix}$ does not exist, then the value of α is

(a) 1 (b) –1 (c) 0 (d) –2

41. If $f(x) = x$ for $x \le 0 = 0$ for $x > 0$, then $f(x)$ at $x = 0$ is

(a) continuous but not differentiable
(b) not continuous but differentiable
(c) continuous and differentiable
(d) not continuous and not differentiable

42. The equation of plane through (–1, 1, 2), whose normal makes equal acute angles with coordinate axes is

(a) $r \cdot (\hat{i} + \hat{j} + \hat{k}) = 2$ (b) $r \cdot (\hat{i} + \hat{j} + \hat{k}) = 6$
(c) $r \cdot (3\hat{i} - 3\hat{j} + 3\hat{k}) = 2$ (d) $r \cdot (\hat{i} - \hat{j} + \hat{k}) = 3$

43. Probability that a person will develop immunity after vaccinations is 0.8. if 8 people are given the vaccine, then probability that all develop immunity is =

(a) $(0.2)^8$ (b) $(0.8)^8$
(c) 1 (d) $^8C_6 (0.2)^6 (0.8)^2$

44. If the distance of points $2\hat{i} + 3\hat{j} + \lambda\hat{k}$ from the plane $r \cdot (3\hat{i} + 2\hat{j} + 6\hat{k}) = 13$ is 5 units, then $\lambda =$

(a) $6, -\frac{17}{3}$ (b) $6, \frac{17}{3}$
(c) $-6, -\frac{17}{3}$ (d) $-6, \frac{17}{3}$

45. The value of $\cos^{-1}\left(\cot\left(\frac{\pi}{2}\right)\right) + \cos^{-1}\left(\sin\left(\frac{2\pi}{2}\right)\right)$ is

(a) $\frac{2\pi}{3}$ (b) $\frac{\pi}{3}$
(c) $\frac{\pi}{2}$ (d) π

46. The particular solution of the differential equation $x\, dy + 2y\, dx = 0$, when $x = 2$, $y = 1$ is

(a) $xy = 4$ (b) $x^2y = 4$
(c) $xy^2 = 4$ (d) $x^2y^2 = 4$

47. ΔABC has vertices at $A = (2, 3, 5)$, $B = (-1, 3, 2)$ and $C = (\lambda, 5, \mu)$. If the median through A is equally inclined to the axes, then the values of λ and μ respectively are

(a) 10, 7 (b) 9, 10
(c) 7, 9 (d) 7, 10

48. For the following distribution function F (x) of a r.v.x.

x	1	2	3	4	5	6
$F(x)$	0.2	0.37	0.48	0.62	0.85	1

$P(3 < x < 5) =$

(a) 0.48 (b) 0.37 (c) 0.27 (d) 1.47

49. The lines $\frac{x-1}{2} = \frac{y+1}{2} = \frac{z-1}{4}$ and $\frac{x-3}{1} = \frac{y-k}{2} = \frac{z}{1}$ intersect each other at point

(a) (–2, –4, 5) (b) (–2, –4, –5)
(c) (2, 4, –5) (d) (2, –5)

50. $\int \frac{\sec^8 x}{\operatorname{cosec} x} dx =$

(a) $\frac{\sec^8 x}{8} + c$ (b) $\frac{\sec^7 x}{7} + c$
(c) $\frac{\sec^6 x}{6} + c$ (d) $\frac{\sec^9 x}{9} + c$

ANSWER KEYS & SOLUTIONS

(MHT-CET 2017)

Answer KEYS

SECTION-A																			
PHYSICS																			
1	(a)	**6**	(d)	**11**	(b)	**16**	(c)	**21**	(b)	**26**	(a)	**31**	(c)	**36**	(b)	**41**	(c)	**46**	(c)
2	(a)	**7**	(a)	**12**	(c)	**17**	(d)	**22**	(d)	**27**	(d)	**32**	(d)	**37**	(d)	**42**	(d)	**47**	(c)
3	(c)	**8**	(b)	**13**	(c)	**18**	(c)	**23**	(a)	**28**	(a)	**33**	(d)	**38**	(a)	**43**	(a)	**48**	(c)
4	(b)	**9**	(b)	**14**	(d)	**19**	(c)	**24**	(a)	**29**	(d)	**34**	(a)	**39**	(b)	**44**	(a)	**49**	(d)
5	(b)	**10**	(a)	**15**	(a)	**20**	(b)	**25**	(c)	**30**	(d)	**35**	(a)	**40**	(b)	**45**	(b)	**50**	(c)
CHEMISTRY																			
51	(c)	**56**	(a)	**61**	(d)	**66**	(b)	**71**	(d)	**76**	(b)	**81**	(c)	**86**	(b)	**91**	(a)	**96**	(d)
52	(c)	**57**	(a)	**62**	(b)	**67**	(d)	**72**	(c)	**77**	(c)	**82**	(a)	**87**	(a)	**92**	(a)	**97**	(d)
53	(a)	**58**	(a)	**63**	(c)	**68**	(b)	**73**	(a)	**78**	(b)	**83**	(a)	**88**	(b)	**93**	(b)	**98**	(a)
54	(d)	**59**	(d)	**64**	(b)	**69**	(d)	**74**	(a)	**79**	(a)	**84**	(b)	**89**	(c)	**94**	(b)	**99**	(a)
55	(b)	**60**	(d)	**65**	(b)	**70**	(b)	**75**	(a)	**80**	(a)	**85**	(c)	**90**	(c)	**95**	(d)	**100**	(d)
SECTION-B																			
MATHEMATICS																			
1	(b)	**6**	(b)	**11**	(c)	**16**	(b)	**21**	(c)	**26**	(a)	**31**	(b)	**36**	(a)	**41**	(a)	**46**	(b)
2	(a)	**7**	(a)	**12**	(c)	**17**	(d)	**22**	(a)	**27**	(a)	**32**	(d)	**37**	(a)	**42**	(a)	**47**	(d)
3	(d)	**8**	(b)	**13**	(b)	**18**	(c)	**23**	(c)	**28**	(c)	**33**	(d)	**38**	(a)	**43**	(b)	**48**	(b)
4	(b)	**9**	(a)	**14**	(c)	**19**	(c)	**24**	(c)	**29**	(c)	**34**	(a)	**39**	(c)	**44**	(a)	**49**	(b)
5	(b)	**10**	(d)	**15**	(a)	**20**	(c)	**25**	(c)	**30**	(d)	**35**	(b)	**40**	(d)	**45**	(a)	**50**	(b)

SECTION-A

PHYSICS

1. **(a)** Using $v = n\lambda, \frac{1}{\lambda} = \frac{n}{v}$

$$\Rightarrow \frac{1}{\lambda} = R\left(\frac{1}{n_1^2} - \frac{1}{n_2^2}\right)$$

$$\Rightarrow v = Rc\left(\frac{1}{n_1^2} - \frac{1}{n_2^2}\right)$$

$$\therefore v_2 = Rc\left(\frac{1}{2^2} - \frac{1}{3^2}\right) = Rc\left(\frac{1}{4} - \frac{1}{9}\right) \quad ..(i)$$

$$v_1 = Rc\left(\frac{1}{2^2}\right) = \frac{Rc}{4}$$

$$v_3 = Rc\left(\frac{1}{3^2}\right) = \frac{Rc}{9}$$

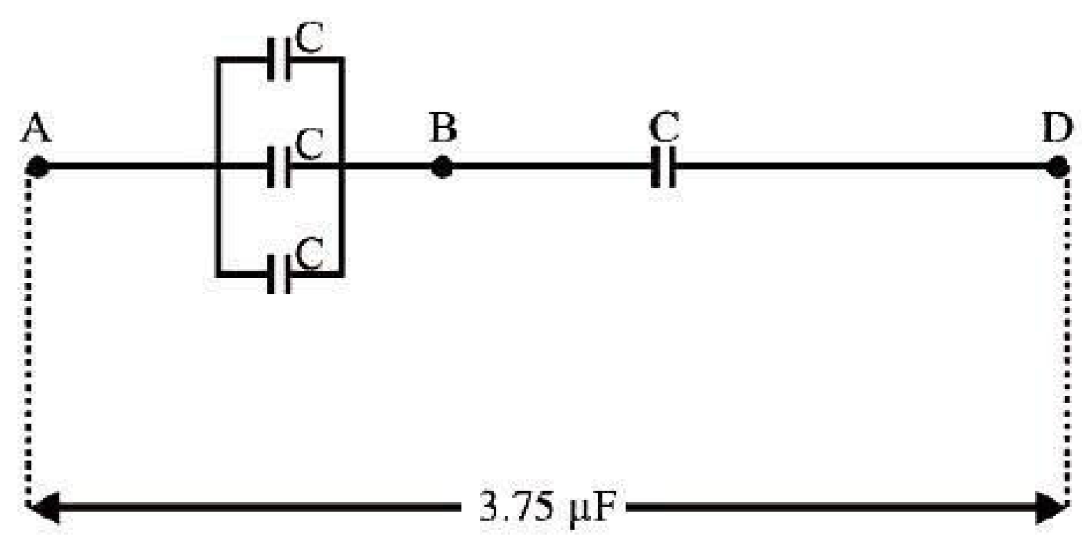
$$\Rightarrow v_1 - v_3 = Rc\left(\frac{1}{4} - \frac{1}{9}\right) \quad ...(ii)$$

From eqs. (i) and (ii),

$$v_1 - v_3 = v_2 \Rightarrow v_1 - v_2 = v_3$$

2. **(a)** Net capacitance between A and B

$C' = C + C + C = 3C$



Net capacitance between A and D

$$C_{eq} = \frac{3C \times C}{3C + C} = \frac{3C}{4}$$

$$\therefore C = \frac{4C_{eq}}{3} = \frac{4 \times 3.75}{3} = 5.00\,\mu F$$

3. **(c)** $S = \frac{G}{8}$ (Given) ...(i)

And, $S = \frac{G}{n-1}$ ...(ii)

From eqs. (i) and (ii),

$$\frac{G}{8} = \frac{G}{n-1} \Rightarrow 8 = n - 1$$

$\therefore n = 8 + 1 = 9$

Since, the range of galvanometer is increased by 9 times, therefore its sensitivity reduces to $\frac{S}{9}$

4. **(b)** From question, $1_X = 40$ cm, $I_R = 60$ cm. using principle of metre-bridge,

$$\frac{X}{R} = \frac{I_X}{I_R} = \frac{40}{60} = \frac{2}{3} \quad ...(i)$$

When 30Ω resistance is connected in series with the smaller of the two resistances

$$\frac{X+30}{R} = \frac{60}{40} = \frac{3}{2}$$

$$\Rightarrow R = \frac{2(X+30)}{3} \quad ...(ii)$$

From eqs. (i) and (ii),

$$\frac{X}{2\left(\frac{X+30}{3}\right)} = \frac{2}{3} \Rightarrow \frac{3X}{2(X+30)} = \frac{2}{3}$$

or, $9X = 4X + 120 \Rightarrow 5X = 120$

$\therefore X = 24\Omega$

5. **(b)** Given $d = 0.2 \times 10^{-3}$m, $D = 2$m and $\lambda = 5 \times 10^{-7}$m

From $B = \frac{\lambda D}{d} = \frac{5 \times 10^{-7} \times 2}{0.2 \times 10^{-3}} = \frac{5 \times 10^{-7}}{10^{-4}}$

$\therefore B = 510^{-3}$m

Distance between 1st minima on either side

$= 5 \times 10^{-3} + 5 \times 10^{-3} = 10 \times 10^{-3} = 10^{-2}$ m

6. **(d)** Given, $R = 18\Omega$, $Z = 33\Omega$, $V_{rms} = 220$V

$\lambda = 5 \times 10^{-7}$ m

Power consumed in an AC circuit

$$P = e_{rms}.i_{rms}.\cos\phi = e_{rms}.\frac{e_{rms}}{Z}.\frac{R}{Z}$$

$$\left[\because \cos\phi = \frac{R}{Z}\right]$$

$$= \frac{220 \times 220 \times 18}{33 \times 33} = 20 \times 20 \times 2 = 800\text{W}$$

7. **(a)** Effective capacity of the series combination of capacitors

$$\frac{1}{C_1} = \frac{1}{C} + \frac{1}{C} = \frac{2}{5} \text{ or, } C_1 = \frac{C}{2}$$

Effective capacity of the series combination of capacitors with dielectric material

$$\frac{1}{C_1} = \frac{1}{C} + \frac{1}{KC}; \frac{1}{C_2} = \frac{1}{C}\left[1 + \frac{1}{K}\right]$$

$$\text{or, } C_2 = \frac{C}{\left(1+\frac{1}{K}\right)} = \frac{CK}{(K+1)}$$

$\therefore$ Change in effective capacitance

$\Delta C = C_2 - C_1$

$$= \frac{CK}{(K+1)} - \frac{C}{2} = C\left[\frac{K}{K+1} - \frac{1}{2}\right]$$

$$= C\left[\frac{2K - K - 1}{2(K+1)}\right] = \frac{C}{2}\left[\frac{K-1}{K+1}\right]$$

8. **(b)** Polarising angle, $\tan\theta = \mu$

Also, $M = \frac{C}{V}$

or, $\cot\theta = \frac{v}{c}$ $\therefore \theta = \cot^{-1}\frac{v}{c}$

9. **(b)** Resultant intensity for two coherent sources,

$$I_R = I_1 + I_2 + 2\sqrt{I_1 I_2}\cos\phi$$

For two identical light waves, $I_1 = I_2 = I$

$$\therefore I_R = 4I\cos^2\frac{\phi}{2} \text{ or, } 1_R \propto \cos^2\frac{\phi}{2}$$

10. (a) As we know, $\beta_{dc} = \frac{\alpha_{dc}}{1-\alpha_{dc}}$

$$\therefore \left(1-\alpha_{dc}\right) = \frac{\alpha_{dc}}{\beta_{dc}} \qquad \text{...... (i)}$$

Also, $\frac{\beta_{dc}-\alpha_{dc}}{\alpha_{dc}.\beta_{dc}} = \frac{\beta_{dc}\left(1-\frac{\alpha_{dc}}{\beta_{dc}}\right)}{\alpha_{dc}.\beta_{dc}}$

From equation (i)

$$\frac{1-\frac{\alpha_{dc}}{\beta_{dc}}}{\alpha_{dc}} = \frac{1-\left(1-\alpha_{dc}\right)}{\alpha_{dc}}$$

$$= \frac{1-1+\alpha_{dc}}{\alpha_{dc}} = 1$$

11. (b) According to question,
N_0=10,000 disintegeration/min
N_t = 2500 disintegeration/min
t = 4 min
From the radioactive decay law,

$$\frac{Nt}{N_0} = e^{-\lambda t}$$

or, $\frac{2500}{10000} = e^{-\lambda\times 4}$

$$\Rightarrow \frac{1}{4}e^{-4\lambda} \Rightarrow e^{4\lambda} = 4$$

$$\Rightarrow 4\lambda = \log_e 4 \Rightarrow 4\lambda = \log_e 2^2$$

$$\Rightarrow 4\lambda = 2\log_e 2$$

$$\therefore \lambda = 0.5\log_e 2$$

12. (c) $\because$ Number of waves in glass slab
= number of waves in water column

$$\therefore \mu_g.h_g = \mu_w.h_w$$

h_g = thickness of slab and h_w = height of water column.

or, $\mu_w = \frac{\mu_g.h_g}{hw} = \frac{1.5\times 6}{7} = 1.286$

13. (c) Energy difference between two states

$$\Delta E = E_2 - E_1 = \frac{-13.6}{2^2} - \left(\frac{-13.6}{1^2}\right)$$

$$\Delta = \frac{13.6}{1^2} - \frac{13.6}{2^2}$$

$$\Delta = 13.6\left[\frac{4-1}{4}\right] = 13.6\times\frac{3}{4}$$

$$\therefore \Delta E = 10.2\text{eV}$$

Since, the energy is radiaed in form of photons,
$\therefore$ Energy of photons = $h\nu$ = 10.2 eV
From Einstein's photoelectric equation,

$$h\nu = \phi_0 + eV_s$$

$$10.2\text{eV} = 4.2\text{eV} + eV_s$$

$$\Rightarrow 6\text{eV} = eV_s$$

$$\therefore V_s = 6\text{V}$$

14. (d) Magnetic moment $\left(M_0\right) = \frac{e}{2me}\times L$
Where, L = orbital angular momentum.

And $L = \frac{nh}{2\pi}$ ..... (i)

$\Rightarrow L \propto n$ ..... (ii)

n = principal quantum number
h = planck's constant.

$\therefore M_0 \propto n.$

15. (a) Photodiode is a reversed biased p-n junction.

16. (c) According to question, $I = 2\text{kg m}^2$

$$\omega_0 = 60\,\text{rad/s},\ \omega = 0$$

$$t = 5\text{min} = 5\times 60 = 300\text{s}$$

using, $\omega = \omega_0 + \alpha t \Rightarrow \alpha = \frac{\omega-\omega_0}{t}$

$$= \frac{0-60}{300} = \frac{-60}{300} = \frac{-1}{5}\text{rad/s}^2$$

For t = 2 min

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

$$= 60 - \frac{1}{5}\times 120 = 60 - 24 \Rightarrow \omega = 36\text{ rad/s}$$

Angular momentum,

$$L = I\omega = 2\times 36 = 72\,\text{kg m}^2/\text{s}$$

17. (d) Standard equation of wave motion,

$$Y = A\sin\left[2\pi\left(\frac{t}{T}-\frac{x}{\lambda}\right)+\frac{\pi}{4}\right]$$

When compare the given equation with standard equation we get,
Amplitude, A = 3m
Wavelength, λ = 10 m

18. (c) Rate of energy radiation.

$\frac{Q}{t} = \sigma A T^4$ i.e., power, $P = \sigma A T^4$

$\therefore\ A \propto \frac{1}{T^4}$

If body radiates same power, then

$\frac{A_2}{A_1} = \frac{T_1^4}{T_2^4} \Rightarrow \frac{4\pi r_2^2}{4\pi r_1^2} = \frac{T_1^4}{T_2^4}$

$\therefore \frac{r_2}{r_1} = \left(\frac{T_1}{T_2}\right)^2$

19. (c) For open pipe first overtone, $v_1 = \frac{v}{L}$

For closed pipe first overtone, $v_1 = \frac{3v}{4L}$

$\therefore\ v_1 - v_1 = \frac{V}{L} - \frac{3V}{4L} = 3$

or, $\frac{V}{4L} = 3\ \ \therefore \frac{V}{L} = 12$

When length of open pipe is made $\frac{L}{3}$,

Fundamental frequency $v = \frac{V}{2\left(\frac{L}{3}\right)} = \frac{3V}{2L}$

When length of closed pipe is made 3 times,

Fundamental frequency $v' = \frac{V}{4(3L)} = \frac{V}{12L}$

Beats produced = v – v'

$= \frac{3V}{2L} - \frac{V}{12L} = \frac{17}{12}, \frac{V}{L}\qquad \left[\because\ \frac{V}{L} = 12\right]$

$= \frac{17}{12} \times 12 = 17$

20. (b) Maximum tension in the rope = $m(g+a)$

Stress in the rope, $T = \frac{m(g+a)}{\pi r^2}$

$\therefore T = \frac{m(g+a)}{\pi r^2} = \frac{m(g+a)}{\pi\left(\frac{d}{2}\right)^2}$

or, $T = \frac{4m(g+a)}{\pi d^2} \Rightarrow d^2 = \frac{4m(g+a)}{\pi T}$

$\therefore\ d = \left[\frac{4m(g+a)}{\pi T}\right]^{1/2}$

21. (b) Given, mass, $m = 2$ kg, $v = 6$ m/s and force constant $K = 36$ N/m Kinetic energy of rolling solid sphere

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

$= \frac{1}{2}mv^2 + \frac{1}{2} \times \frac{2}{5}mr^2\omega^2$

$= \frac{1}{2}mv^2 + \frac{1}{5}mv^2 = \frac{7}{10}mv^2$

The potential energy of the spring on maximum compression $x = \frac{1}{2}kx^2$

$\therefore \frac{1}{2}kx^2 = \frac{7}{10}mv^2$

$\Rightarrow x^2 = \frac{14}{10}\frac{mv^2}{k} = \frac{14}{10} \times \frac{2 \times (6)^2}{36} = 2.8$

or, $x = \sqrt{2.8}$ m

22. (d) According to question,

$\omega_0 = 0,\ \omega = 24\,\text{rad/s}$ and $t = 8\,\text{s}$

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

$\alpha = \frac{\omega - \omega_0}{t} = \frac{24}{8} = 3\,\text{rad/s}^2$

Substituting the given values, we get

Now using,

$\theta = \omega_0 t + \frac{1}{2}\alpha t^2 = 0 + \frac{1}{2} \times 3 \times (8)^2$

$= \frac{3 \times 64}{2} = 96\,\text{rad}$

23. (a) Fundamental frequency of the wire

$f = \frac{1}{2L_1}\sqrt{\frac{T}{m}} = \frac{1}{2L_1}\sqrt{\frac{T}{\pi r_1^2 \rho}} = \frac{1}{2L_1 r_1}\sqrt{\frac{T}{\pi\rho}}$

First overtone of the first wire,

$f_1 = 2f = \frac{2}{2L_1 r_1}\sqrt{\frac{T}{\pi\rho}} = \frac{1}{L_1 r_1}\sqrt{\frac{T}{\pi\rho}}$ ...(i)

Second overtone of the second wire

$$f_2 = \frac{3}{2L_2r_2}\sqrt{\frac{T}{\pi\rho}} \quad ...(ii)$$

$\because f_1 = f_2$

$$\therefore \frac{1}{L_1r_1}\sqrt{\frac{T}{\pi\rho}} = \frac{3}{2L_2r_2}\sqrt{\frac{T}{\pi\rho}}$$

$\because f_1 = f_2$

$\therefore 3L_1r_1 = 2L_2r_2$

$$\Rightarrow \frac{L_1}{L_2} = \frac{2}{3}.\frac{r_2}{r_1} = \frac{2}{3}.\frac{r_2}{2r_2} = \frac{1}{3} \quad [\because r_1 = 2r_2]$$

24. **(a)** According to question,

force $F = 150$ dyne 105×10^{-5} N and

Surface tension $T = 7\times10^{-2}$ N/m

$\because$ Circumference of the capillary × surface tension = upward force

$\therefore 2\pi rT = F$

$$\text{or, } 2\pi r = \frac{F}{T} = \frac{105\times10^{-5}}{7\times10^{-2}} = 15\times10^{-3}\text{m}$$

$= 1.5\times10^{-2} = 1.5$cm

25. **(c)** For rigid diatomic molecule, $\frac{C_p}{C_v} = \frac{7}{5}$

$$\therefore C_v = \frac{5}{7}C_p \quad ...(i)$$

Also, $C_p - C_v = R$

$$\text{or, } C_p - \frac{5}{7}C_p = R \Rightarrow \frac{2}{7}C_p = R$$

$$n = \frac{2}{7} = 0.2857$$

26. **(a)** Ideal gas equation, $pV = nRT$

$pV = \frac{m'}{M}RT$ here, m' is the mass of the gas

and M molecular weight $p = \frac{m'}{V}\frac{RT}{M}$

$$\therefore p = \frac{\rho RT}{M}$$

$\therefore \rho = \frac{m'}{V}$ density of the gas

$\rho = \frac{pM}{RT} = \frac{pM}{NkT}$, N is Avogadro, number

$\rho = \frac{pm}{KT}$, where $m = \frac{M}{N}$ mass of each molecule.

27. **(d)** Let radius of big drop = R

and of small drop = r

Volume of big drop = n (Volume of small drop)

$$\frac{4}{3}\pi R^3 = n.\frac{4}{3}\pi r^3$$

$$R^3 = nr^3 \Rightarrow R = n^{1/3}.r$$

Surface energy of n drops,

$$E_2 = n\times4\pi r^2\times T$$

Surface energy of big drop,

$$E_1 = 4\pi R^2T$$

$$\therefore \frac{E_2}{E_1} = \frac{nr^2}{R^2} = \frac{nr^2}{\left(n^{1/3}.r\right)^2}$$

$$= \frac{nr^2}{n^{2/3}.r^2} = n^{1/3} \quad [\because R = n^{1/3}.r]$$

or, ratio of energy, $E_2 : E_1 = \sqrt[3]{n} : 1$

28. **(a)** Binding energy on the surface of the earth

$$E_1 = \frac{GMm}{R} \quad ..... (i)$$

Binding energy of revolving satellite at a height h from the earth surface,

$$E_2 = \frac{GMm}{2(R+h)} \quad .... (ii)$$

From eqs. (i) and (ii),

$$\frac{E_1}{E_2} = \frac{2(R+h)}{R}$$

29. **(d)** Given, particle velocity, $v = \pi$ m/s and time period $T = 16$ s

Displacement of the particle, $x = A\sin\omega t$

Velocity of the particle,

$$v - \frac{dx}{dt} - A\omega\cos\omega t \quad ...(i)$$

Angular velocity,

$$\omega = \frac{2\pi}{T} = \frac{2\pi}{16} = \frac{\pi}{8} = \text{rad/s}$$

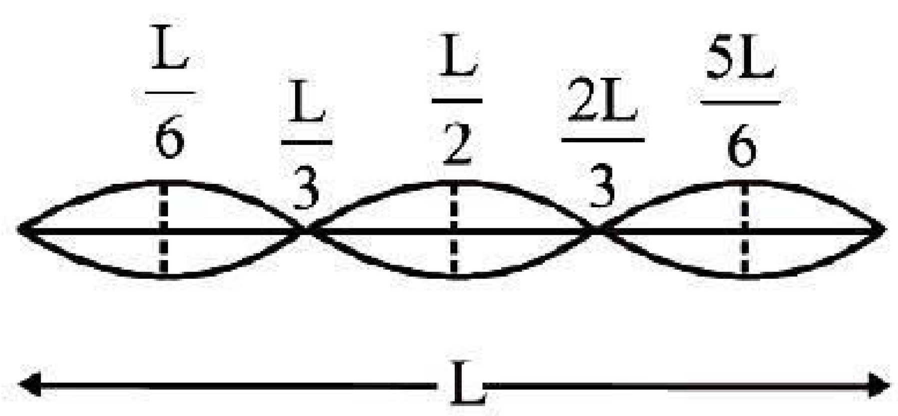
Now from eq. (i),

$$\pi = A\times\frac{\pi}{8}\times\cos\frac{\pi}{8}\times2$$

$$1 = \frac{A}{8}\cos\frac{\pi}{4} = \frac{A}{8}.\frac{1}{\sqrt{2}}$$

$\therefore\ A = 8\sqrt{2}$ m

30. (d) The figure represents string vibrating in second overtone between two bridges



Clearly, amplitude of vibration is maximum at

$$\frac{L}{6}, \frac{L}{2}, \frac{5L}{6}$$

31. (c) Acceleration due to gravity varies with depth d as,

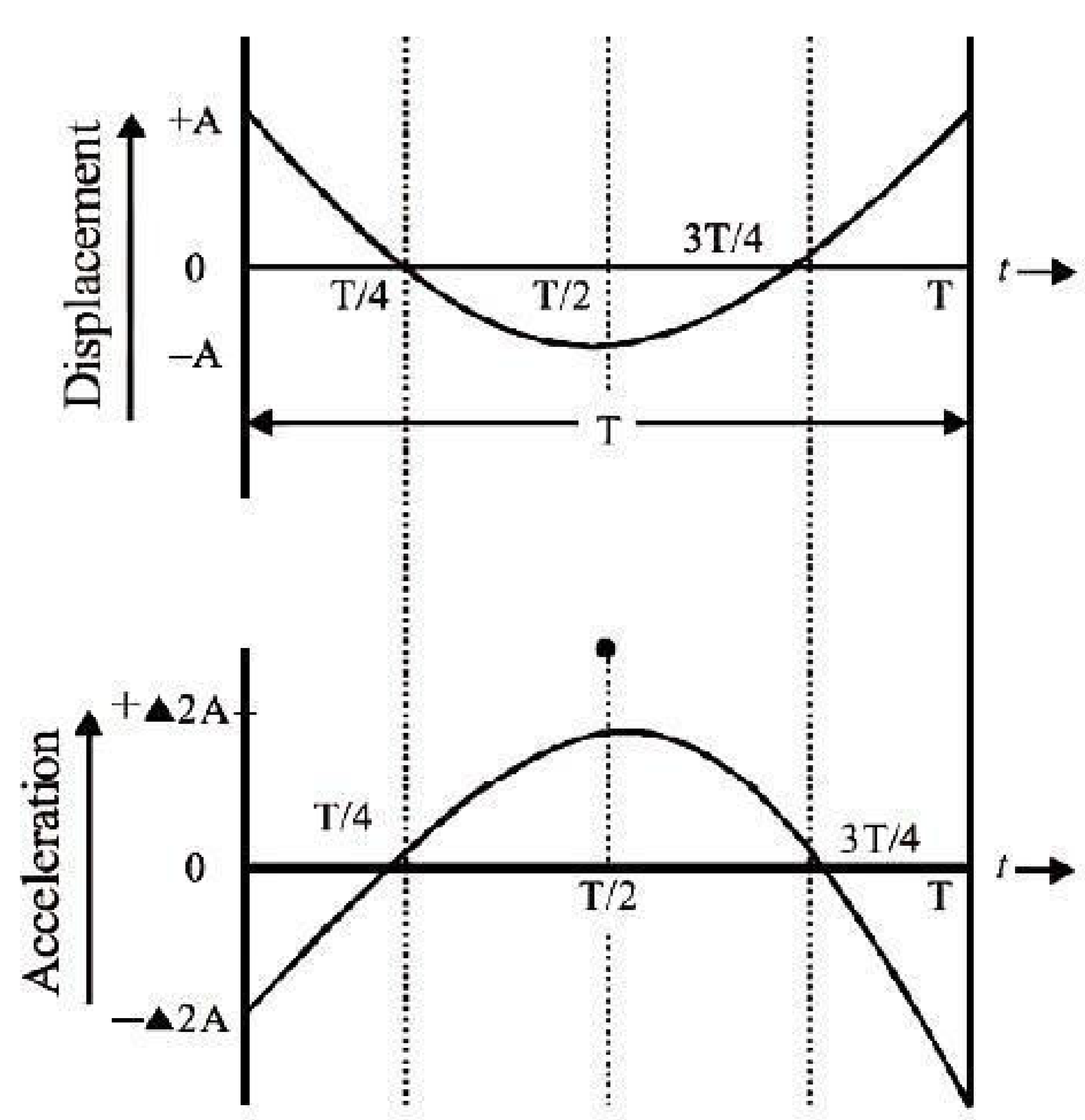
$$g' = g\left(1 - \frac{d}{R}\right)$$

And according to question, $g' = \frac{g}{n}$

$$g' = \frac{g}{n} = g\left(1 - \frac{d}{R}\right) \Rightarrow \frac{1}{n} = 1 - \frac{d}{R}$$

or, $\frac{d}{R} = 1 - \frac{1}{n} = \frac{n-1}{n}\ \therefore d = R\left(\frac{n-1}{n}\right)$

32. (d) The relation of displacement and acceleration with time in SHM are shown below,



Clearly, the phase difference between displacement and acceleration is π.

33. (d) Fundamental frequency, for a closed pipe

$$v_1 = \frac{V}{4L} = 100\,\text{Hz}$$

Fundamental frequency, for an open pipe

$$v_1 = \frac{V}{2L} = 200\,\text{Hz}$$

In a pipe open at both the ends, all multiples of the fundamental frequency are produced.

$\therefore\ 1\times200, 2\times200, 3\times200...$

i.e., 200, 400, 600...

34. (a) The total mechanical energy remains conserved, kinetic energy changes into potential energy and vice-versa. At the highest point potential energy is maximum and at the lowest point its velocity and hence kinetic energy is maximum.

35. (a) Potential energy of a simple pendulum

$$= \frac{1}{2}M\omega^2A^2 = \frac{1}{2}M.\frac{g}{L}.A^2\ \left(\because \omega = \sqrt{\frac{g}{L}}\right)$$

36. (b) According to the Einstein's photoelectric equation,

$KE_{max} = hv_0 - \phi_0$

Initially, $hv = 0.4 + \phi_0$ ...(i)

and when the frequency of incident radiation is increased by 30% then

$1.3\,hv = 0.9 + \phi_0$ ...(ii)

From eqs. (i) and (ii)

$$0.3\phi_0 = 0.9 - 1.3(0.4)$$

$$\therefore\ \phi_0 = \frac{0.38}{0.3} = 1.267\,\text{eV}$$

37. (d) In LC parallel resonant circuit, at resonating frequency, current is minimum graph (4) correctly depicts.

38. (a) Energy of photon

$$E_p = \frac{hc}{\lambda_p} \Rightarrow \lambda_p = \frac{hc}{E_p}$$

$$E_e = mc^2 = pc \Rightarrow p = \frac{E_p}{c}\ [\because mc = p]$$

$$\therefore\ \lambda_e = \frac{h}{p} = \frac{hc}{E_e}$$

$\therefore E_p = E_e$ (Given)

$\therefore\ \lambda_p \propto \lambda_e.$

39. **(b)** Note : We have considered that the battery is kept disconnected from the capacitor. When dielectric is introduced inside the parallel plate capacitor, then potential difference.

$$V = \frac{V_0}{K}$$

Also, energy decreases, i.e., $U = \frac{U_0}{K}$

40. **(b)** According to question,

$$\rho = 40 \times 10^{-8} \Omega m$$

$$A = 8 \times 10^{-6} m^2; \; I = 0.2A$$

Resistance, $R = \frac{pI}{A}$

$$\Rightarrow \frac{R}{I} = \frac{\rho}{A} = \frac{40 \times 10^{-8}}{8 \times 10^{-6}} = 5 \times 10^{-2}$$

$\therefore$ potential gradient of the were

$$\frac{V}{I} = \frac{IR}{I} = 0.2 \times 5 \times 10^{-2} = 10^{-2} \text{ V/m}$$

41. **(c)** According to question,

$$\omega_0 = \omega, \, \omega = \frac{\omega}{4}; \; \theta = 2\pi n$$

using, $\omega^2 = \omega_0^2 - 2\alpha\theta$

Putting the given values

$$\left(\frac{\omega}{4}\right)^2 = \omega^2 - 2\alpha n(2\pi)$$

$$2\alpha n(2\pi) = \omega^2 - \frac{\omega^2}{16} \Rightarrow 2\pi n = \frac{15}{16}\left(\frac{\omega^2}{2\alpha}\right)$$

When the fan is switched off,

$$\omega = 0, \; \omega_0 = \omega, \; \theta = 2\pi n'$$

$$\Rightarrow 0 = \omega^2 - 2\alpha n'(2\pi)$$

$$\therefore 2\pi n' = \frac{\omega^2}{2\alpha} \text{ or, } n' = \frac{16}{15} n$$

42. **(d)** From conservation of angular momentum, as net torque on the system is zero

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

$$\Rightarrow \frac{\omega_2}{\omega_1} = \frac{I_1}{I_1 + I_2}$$

Energy lost $\Delta E = E_1 - E_2$

$$= \frac{1}{2} I_1 \omega_1^2 - \frac{1}{2}(I_1 + I_2)\omega_2^2$$

$$= \frac{1}{2}\omega_1^2 \left[I_1 - (I_1 + L_2)\frac{\omega_2^2}{\omega_1^2} \right]$$

$$= \frac{1}{2}\omega_1^2 \left[I_1 - (I_1 + I_2)\frac{I_1^2}{(I_1 + I_2)^2} \right]$$

$$\left[\because \frac{\omega_2}{\omega_1} = \frac{I_1}{I_1 + I_2} \right]$$

$$= \frac{1}{2}\omega_1^2 \left[\frac{I_1^2 + I_1 I_2 - I_1^2}{I_1 + I_2} \right]$$

$$\text{or, } \Delta E = \frac{1}{2}\left[\frac{I_1 I_2}{I_1 + I_2} \right]\omega_1^2$$

43. **(a)** Let the distance be x when velocity is u and acceleration α.

And the distance y when velocity is v and acceleration β.

If ω is the angular frequency, then

$\alpha = \omega^2 x$ and $\beta = \omega^2 y$

$\therefore \alpha + \beta = \omega^2 (x + y)$ ... (i)

Also, $u^2 = \omega^2 A^2 - \omega^2 x^2$

and $v^2 = \omega^2 A^2 - \omega^2 y^2$

$\Rightarrow v^2 - u^2 = \omega^2 (x^2 - y^2)$

$v^2 - u^2 = \omega^2 (x - y)(x + y)$ ...(ii)

From eqs. (i) and (ii),

$v^2 - u^2 = (x - y)(\alpha + \beta)$

$$\therefore x - y = \frac{v^2 - u^2}{\alpha + \beta} \text{ or } y - x = \frac{u^2 - v^2}{\alpha + \beta}$$

44. **(a)** From Doppler's effect, when the observer is moving towards the source and source is stationary, then the apparent frequency

$$n' = n\left(\frac{v + v_0}{v}\right) \quad \text{...(i)}$$

When the observer is moving away from the source and the source is stationary, then the apparent frequency.

$$n'' = -n\left(\frac{v - v_0}{v}\right) \quad \text{... (ii)}$$

From eqs. (i) and (ii),

$$n' - n'' = \frac{n}{v}(v + v_0 - v + v_0) = \frac{2nv_0}{v}$$

45. (b) Let L_0 be the original length of the wire, after heating temperature T length becomes 'L'. α be the coefficient of thermal expension. Increase in the length of the rod

$\Delta L = \alpha L_0 T$

$L = L_0[1+\alpha T]$ ..... (i)

Also, Young's modulus,

$Y = \frac{FL_0}{A\Delta L}$ ..... (ii)

Using equation (i) and substituting in equation (ii), we get

$Y = \frac{F}{A}.\frac{L_0(1+\alpha T)}{\Delta L}$

or, $\Delta L = \frac{FL_0(1+\alpha T)}{A.Y}$ ...(iii)

From eqs. (i) and (ii),

$\frac{FL_0(1+\alpha t)}{AY} = \alpha L_0 T$

$\therefore$ F = $\frac{YA\alpha T}{(1+\alpha T)}$

46. (c) Induced emf in coil P

$|e_p| = M.\frac{dI_Q}{dt}$

Putting $e_p = 15 \text{ mV} = 15 \times 10^{-2}$ V

and $\frac{dI_Q}{dt} = 10$ A/s

$15 \times 10^{-3} = M \times 10$

or, $M = 15 \times 10^{-4}$H

Magnetic flux linked with coil Q

$\phi_Q = MI_p = 15\times10^{-4}\times 1.8$

$[\because I_p = 1.8 \text{ A}]$

$= 27.0 \times 10^{-4}$

$= 2.7\times10^{-3} = 2.7\text{mWb}$

47. (c) In YDSE, position of a minima

$y = \frac{(2n-1)\lambda D}{d}$ ..... (i)

Here, $y = \frac{d}{2}, n = 2$

Substituting $y = \frac{d}{2}$ and $n = 2$ in eq. (i)

$\frac{d}{2} = \frac{D}{d}\left(\frac{2\times2-1}{2}\right)\lambda \Rightarrow \frac{d}{2} = \frac{D}{d}\frac{3}{2}\lambda$

$\therefore \lambda = \frac{d^2}{3D}$

48. (c) The process of superimposing the low frequency signal on a high frequency wave is called modulation.

49. (d) From question, $L = 3 \text{ cm} = 3 \times 10^{-2}$ m

$A = 2 \text{ cm}^2 = 2 \times 10^4 \text{ m}^2$

$M = 3 \text{ Am}^2$

Intensity of magnetisation, Im = $\frac{M}{L\times A}$

$= \frac{3\text{A-m}^2}{3\times2\times10^{-6}\text{m}^3}$

$= \frac{1}{2}\times10^6 \text{ A/m} = 5\times10^5 \text{ A/m}$

50. (c) Magnetic inducion inside the solenoid

$B = \frac{\mu_0 NI}{L}$ ..... (i)

Magnetic flux, $\phi = BA$

or, $\phi = \frac{\mu_0 NI.A}{L}$

Magnetic moment = $NIA = \frac{\phi L}{\mu_0}$

From question,

$L = 60$ cm and $\phi = 1.57\times10^{-6}$ Wb (given)

$M = \frac{1.57\times10^{-6}\times0.6}{4\times3.14\times10^{-7}} = 0.75 A$

$\left[\because \mu_0 = 4\pi\times10^{-7}\right]$

CHEMISTRY

51. (c) Work done in a chemical reaction,

$W = -\Delta n_g RT$

Where, Δn_g = number of moles of gaseous products – number of moles of gaseous reactants.

Reaction involved in combustion of ethane is,

$$C_2H_6(g)+\frac{7}{2}O_2(g) \longrightarrow 2CO_2(g)+3H_2O(l)$$

$\therefore \quad \Delta n_g = 2 - 4.5 = -2.5$

$W = (2.5 \text{ mol})(8.314 \text{ JK}^{-1}\text{mol}^{-1}) \times 300 \text{ K}$

$= 6235.5 \text{ J} = 6.2355 \text{ KJ}$

1 mole of C_2H_6 = 30g of C_2H_6

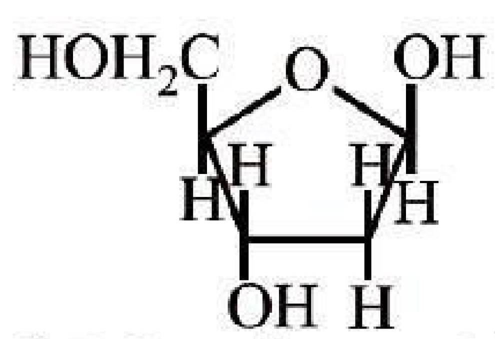
Work done during combustion of 30 g of C_2H_6 = 6.2355 kJ

$\therefore$ Work done during combustion of 90g of

$$C_2H_6 = \frac{6.2355 \times 90}{30} = 18.7065 \text{ kJ}$$

$= 18.71$ kJ

52. (c) The sugar molecule present in DNA is 2′-deoxyribose.



β-D-deoxyribose used in DNA
or
D-2-deoxyribose

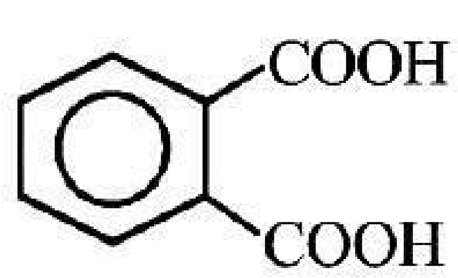
53. (a) Molality

$$(m) = \frac{\text{Number of moles of solute}}{\text{Mass of solvent (in kg)}}$$

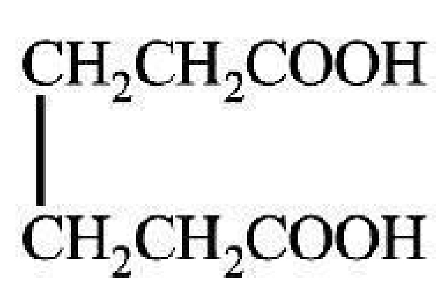
$$\Rightarrow \frac{\frac{15.2}{60}}{0.150} = \frac{0.2533}{0.15}$$

$\Rightarrow 1.689 \text{ mol kg}^{-1}$

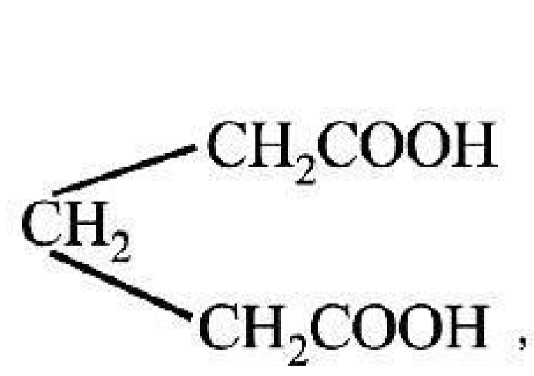
54. (d)



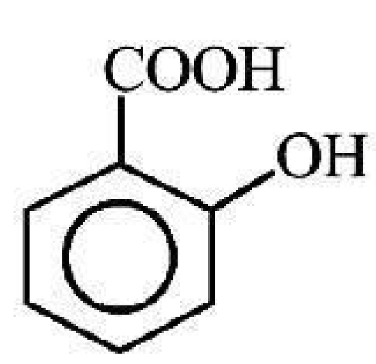
Phthalic acid



Adipic acid



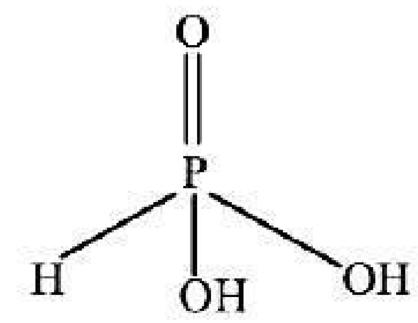
Glutaric acid



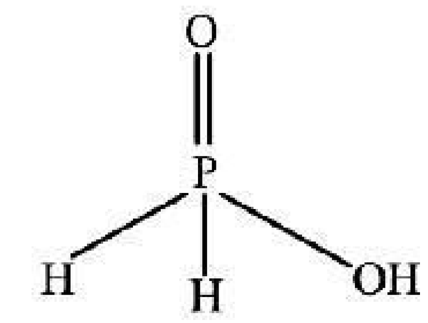
Salicylic acid

$\therefore$ Salicylic acid contains both –OH and –COOH groups.

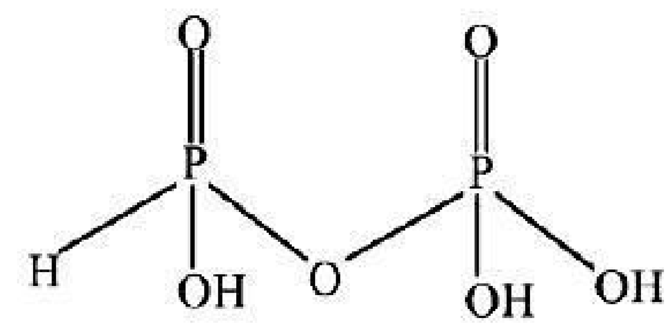
55. (b)



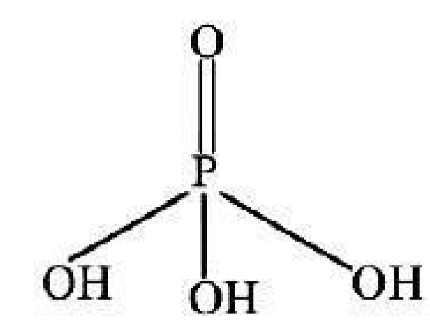
Orthophosphorus acid or phosphonic acid (H_3PO_3)
Oxidation state : +3



Hypophosphorus acid or phosphinic acid (H_3PO_2)
Oxidation state : +1



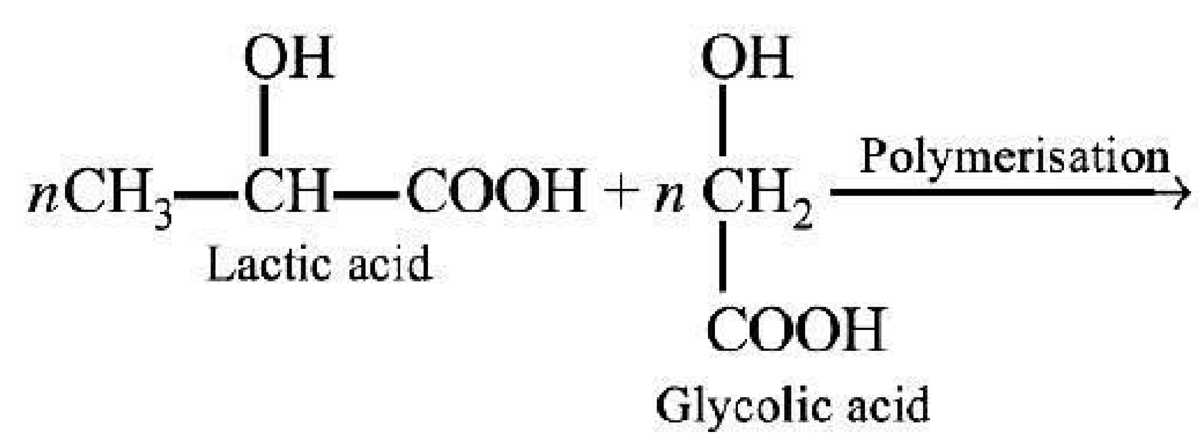
Pyrophosphorus acid ($H_4P_2O_5$)
Oxidation state : +3

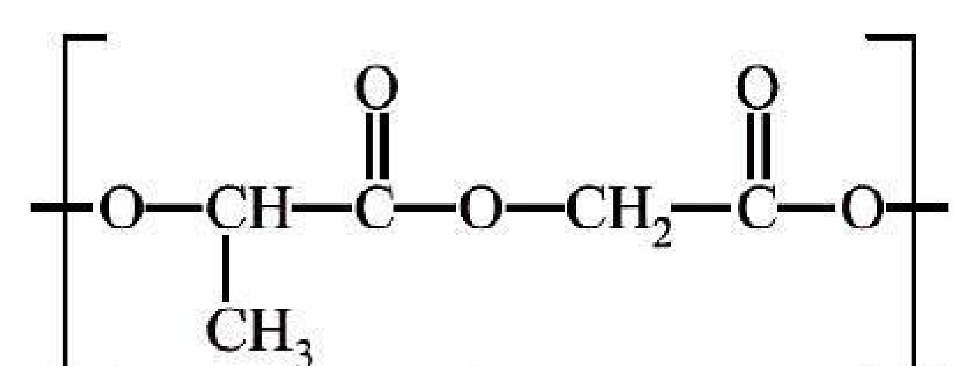


Orthophosphoric acid (H_3PO_4)
Oxidation state : +5

56. (a) Due to the smaller size of lithium, it has the highest Hydration Enthalpy which compensate its I.E. and shows negative E° value. Therefore it acts as powerful reducing agent and hence weakest oxidising agent.

57. (a) Monomers used in preparation of dextron are lactic acid and glycolic acid.





Dextron

58. (a) All the hydrides, except water (H_2O) of group 16 elements acts as a reducing agents.

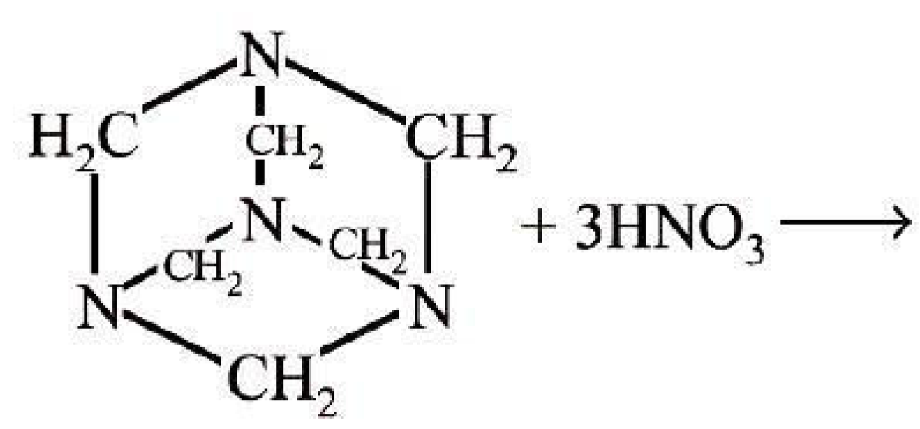
59. (d) Processes such as irradiation, addition of salts and heat, antioxidants, emulsifiers are used to preserve the food.

60. (d) Electron releasing groups increase electron density at N-atom hence, such substituents increase basic nature of aromatic amines. Option (a), (b), (c) are electron releasing group whereas (d) : C_6H_5 is EWG, thus decreases the basic strength.

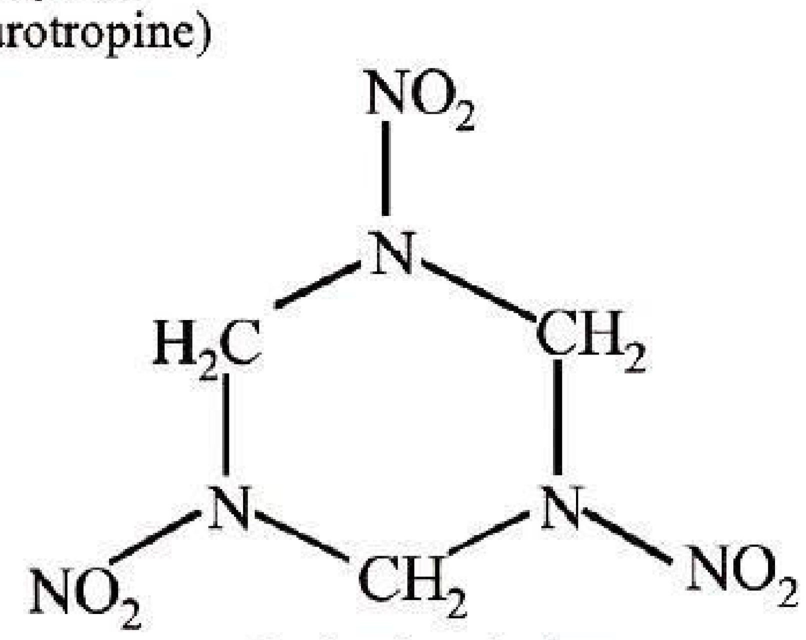
61. (d) (+) 2–methyl butane–1–ol and (–) 2–methyl butan–1–ol are enantiomer. They are non-superimposable mirror images of each other. Hence, they are optically active. The optical activity of a compound can be confirmed by the value of specific rotation.

62. (b) Haematite – Fe_2O_3
Magnesite – $MgCO_3$
Magnetite – Fe_3O_4
Siderite – $FeCO_3$
∴ Magnesite is the mineral of magnesium (Mg).

63. (c) Urotropine gives highly explosive cyclonite on nitration.



Hexamethylene tetramine (urotropine)


Cyclotrimethylene trinitramine (cyclonite)

$+ 3CH_2O + NH_3$

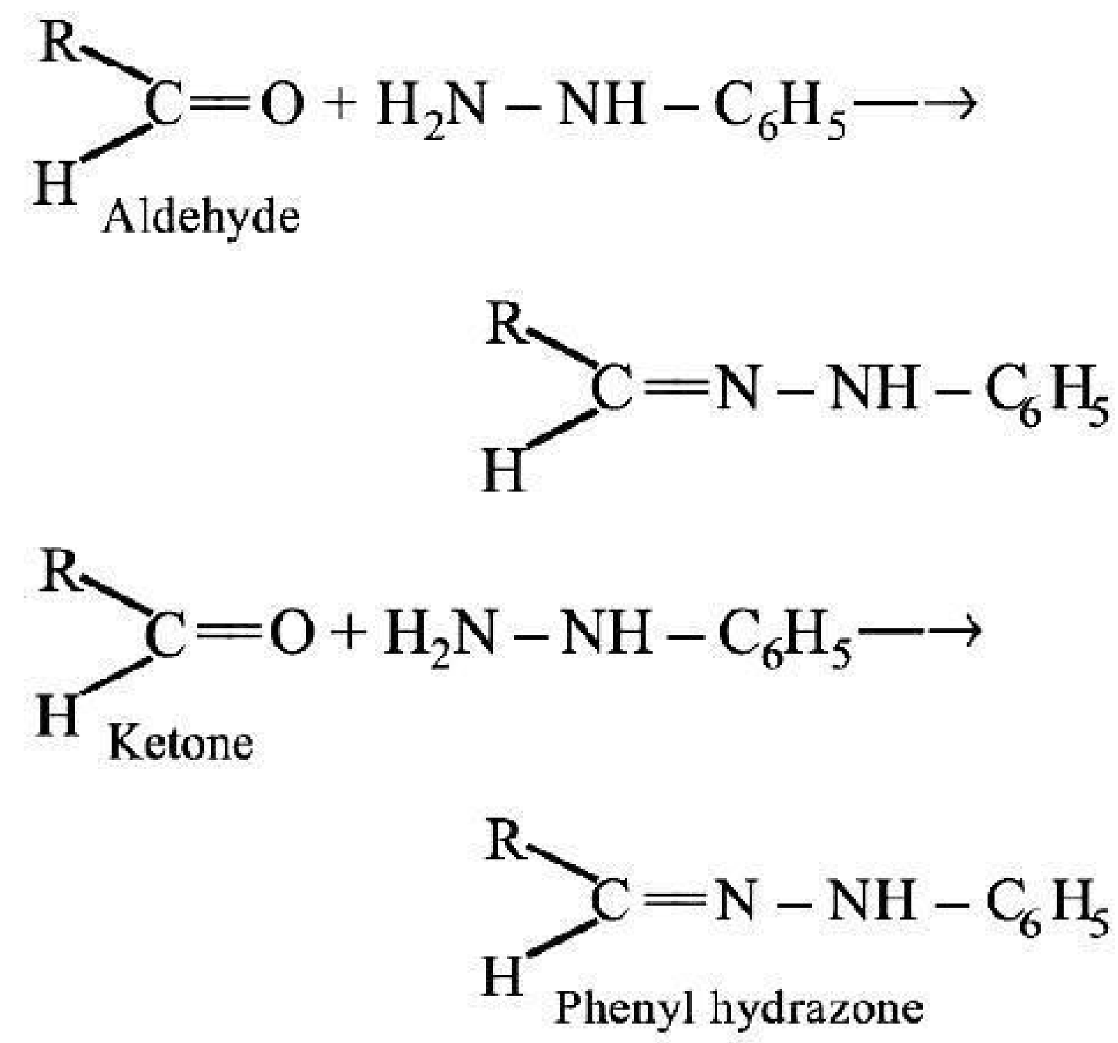
64. (b) Work done during compression,
$W = p_{ext}\Delta V$
Given, $p_{ext} = 100$ KPa, T = 300 K
$\Delta V = V_2 - V_1$
$= (10 - 1)\ dm^3 = 9\ dm^3$
$= 0.99\ m^3$
∴ $W = 100\ KPa\ (0.99)\ m^3$
$= 99$ kJ.

65. (b) Nitrogen because of its small size, high electronegativity, high ionisation energy, absence of vacant *d*–orbitals has tendency to form $p\pi - p\pi$ multiple bonds $N{=}N$

66. (b) Statement (B) is incorrect. Hoffmann bromamide degradation is used to synthesise primary amine.

67. (d) Zirconium (Zr) with atomic number 40 and Hafnium (Hf) with atomic number 72 belongs to period 5th and 6th respectively.

68. (b) Aldehydes or ketones on treatment C_6H_5—NH—NH_2 (phenylhydrazine) gives phenylhydrazone. This is a nucleophilic addition reaction.



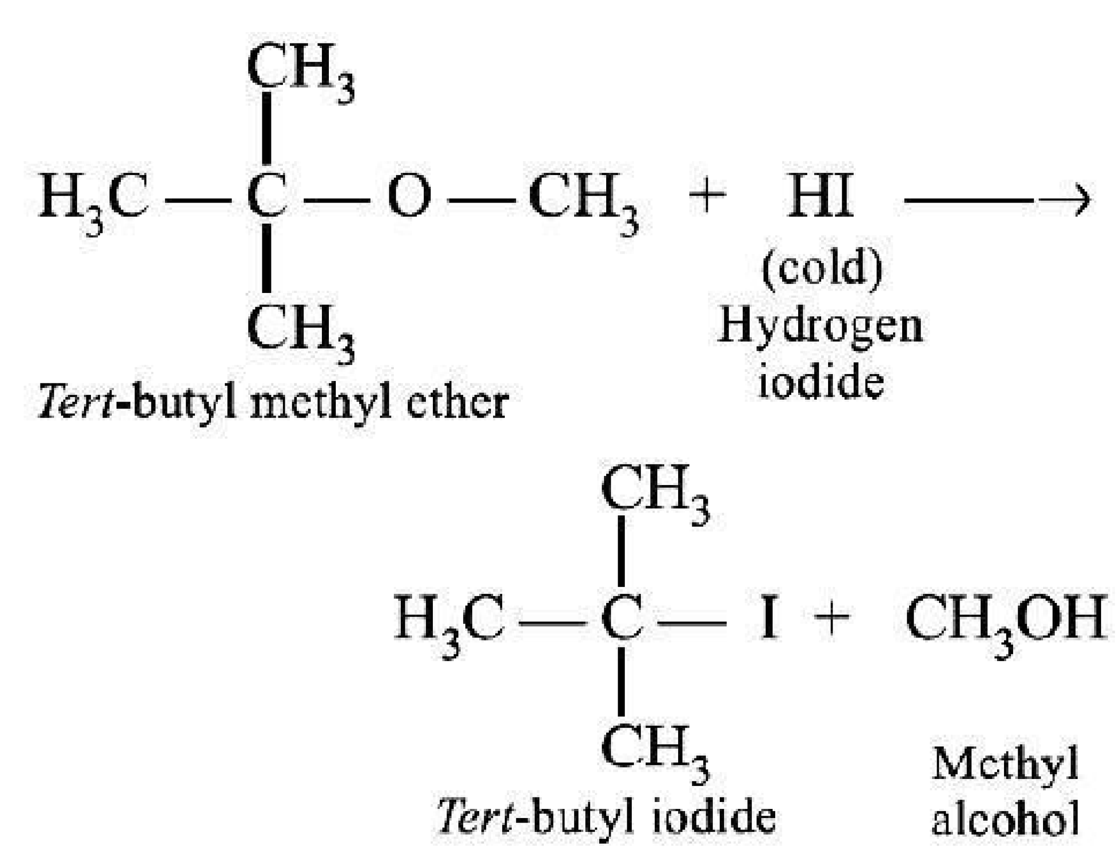
69. (d) The solubility of NaBr changes slightly with temperature.

70. (b) The reaction of ethanol with water:

$$2C_2H_5OH(l) + 2Na(s) \longrightarrow 2C_2H_5\bar{O}Na^+ + H_2(g)\uparrow$$

2 mole of Na (46 g) = 1 mole of H_2
$= 2\ g = 2 \times 10^{-3}$ kg

71. (d) The reaction between *tert*-butyl methyl ether with hydrogen iodide:



72. (c) Aluminium is refined by Hoope's process.

73. (a) Oxidation state of Mn in MnO_4^{2-} is +6.
$Mn(+6) = 1s^2\, 2s^2\, 2p^6, 3s^2\, 3p^6\, 3d^1, 4s^0$
Hence, manganate ion MnO_4^{2-} is paramagnetic due to presence of unpaired electron. Also, MnO_4^{2-} is green in colour.

74. **(a)** Osmotic pressure, $\pi = CRT$ or $\pi = \frac{w}{MV}RT$
where, C = concentration of solution.
Given, w = 34.2 g, V = 1L, M = 342 g mol^{-1}
T = 20 °C, C = 20 + 273 = 293 °K

$$\therefore \ \pi = \frac{w}{MV}RT$$

$$= \frac{342.2 \text{ g}}{342 \text{ g mol}^{-1}} \times \frac{0.082 \text{ L atm K}^{-1}\text{mol}^{-1} \times 293 \text{ K}}{1 \text{ L}}$$

= 2.40 atm.

75. **(a)** In R–S configuration, priority sequence is decided by the atoms directly attached to the chiral carbon are arranged in decreasing atomic number.
From the given groups, sulphur (S) has the highest atomic number i.e., 16 therefore it has highest priority.

76. **(b)** Bithional is an antiseptic, which is mixed to medication soaps to impart antiseptic properties.
Whereas chloramphenicol is antibiotic, cimetidine is antacid and chlordiazepoxide is transquilizer.

77. **(c)** In the preparation of sulphuric acid (H_2SO_4) by lead chamber process, mixture containing SO_2 air and NO is treated with steam (H_2O). In this reaction, NO acts as a catalyst.

$$2SO_2 + \underset{\text{(from air)}}{O_2} + 2H_2O + \underset{\text{Catalyst}}{[NO]} \longrightarrow 2H_2SO_4 + \underset{\text{Catalyst}}{[NO]}$$

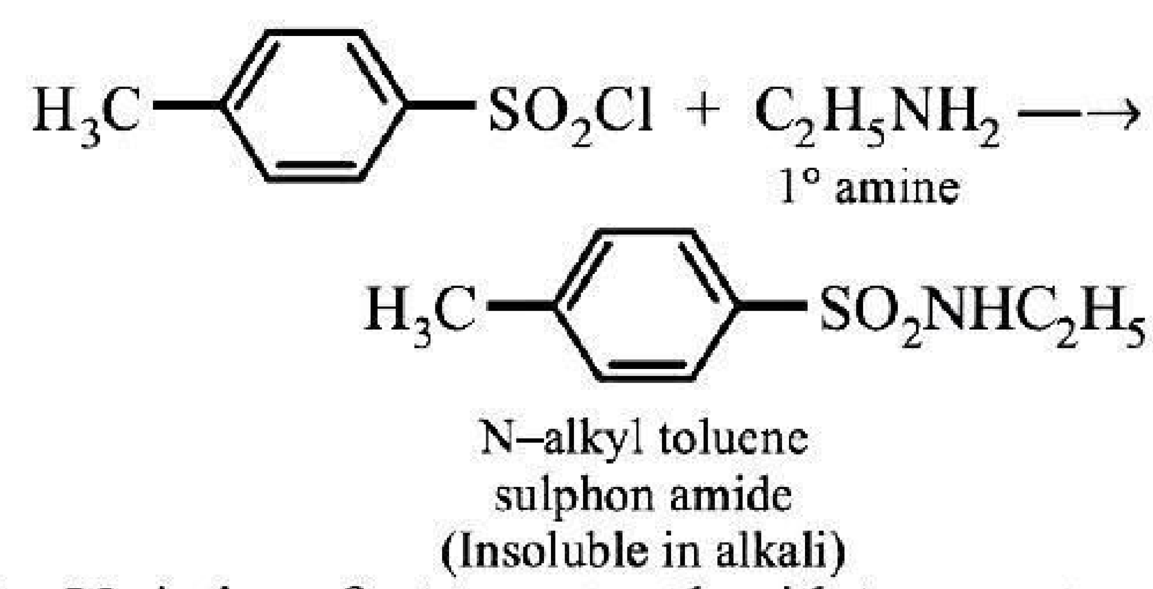
78. **(b)** Coordination number of Fe in $K_3[Fe(CN)_6]$ is 6 as it is bonded with six CN ligands.
Let x be the oxidation state of Cr
$\therefore$ x + 6 (–1) = –3
$\therefore$ x = + 3

79. **(a)** Pseudo first order reaction e.g., inversion of cane sugar is an example of

$$\underset{\substack{\text{Sucrose} \\ \text{(Cane sugar)}}}{C_{12}H_{22}O_{11}} + H_2O \xrightarrow{H^+} \underset{\text{Glucose}}{C_6H_{12}O_6} + \underset{\text{Fructose}}{C_6H_{12}O_6}$$

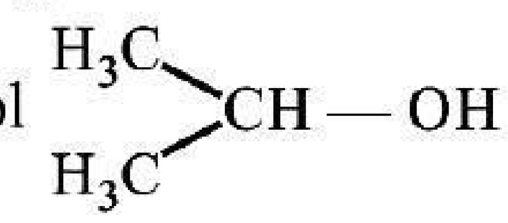
The concentration of water remains constant

80. **(a)** 1°, 2° and 3° amines can be distinguished from each other by *p*-toluenesulphonyl chloride (Hinsberg reagent). Among which 1° amine on sulphonation gives a product, which is insoluble in acid.



81. **(c)** Variation of rate constant k with temperature T(K) is given by Arrhenius equation.

$$k = Ae^{-E_a/RT} = \frac{A}{e^{Ea/RT}} \quad \text{...(i)}$$

82. **(a)** Isopropyl alcohol  will give positive iodoform test.

83. **(a)** According to first law of thermodynamics,
$\Delta U = q + W$
where, ΔU = Internal energy
q = Heat ; w = Work done
For isothermal process, $\Delta T = 0$, $\Delta U = 0$
$\therefore$ q = –W

84. **(b)** Alkyl chlorides or bromides reacts with NaI in dry acetone to give alkyl iodide. This reaction is known as Finkelstein reaction.
$R—X + NaI \longrightarrow RI + NaX$ [X = Cl, Br]
e.g., $C_2H_5Br + NaI \longrightarrow C_2H_5I + NaBr$

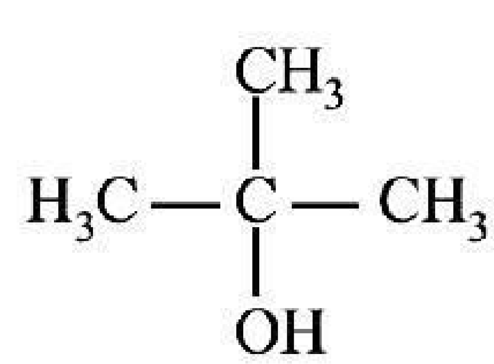
85. **(c)** Fullerenes are the allotropes of carbon structure having cage like with general formula, C_{2n} (e.g., C_{60}, C_{70} etc). C_{60} or the bucky ball consists of 60 C-atoms in which each C-atom in C_{60} is sp^2-hybridised.

86. **(b)** S.I Unit of conductivity (κ) is Sm^{-1}

87. **(a)** Alk. $KMnO_4$ is called Baeyer's reagent.

88. **(b)** The chief consitituent of pyrex glass is SiO_2.

89. **(c)** For isomeric alcohols, the boiling point decreases with increase in branching of carbon chain. Therefore, tert butyl alcohol has lowest boiling point.



Tert-butyl alcohol

90. **(c)** Relation between heat of reaction ($\Delta Hr°$) and bond enthalpies of reactants and products is

$\Delta H_r = \Sigma BE_{reactants} - \Sigma BE_{products}$

$\therefore \Delta H°_{reaction} = \Sigma H°_{product\ bonds} - \Sigma H°_{reactant\ bonds}$

91. **(a)** Given, $k = 7 \times 10^{-4}\ s^{-1}$, $[A]_0 = 0.08\ M$

$$t_{1/2} = \frac{0.693}{k} = \frac{0.0693}{7 \times 10^{-4}\ s} = 990\ s$$

92. **(a)** Bakelite is highly cross linked polymer. Which is used in making handles of cookers and frying pans, electrical goods, etc.

93. **(b)** Electron gain enthalpy becomes less negative on moving from chlorine to iodine. However, negative electron gain enthalpy of fluorine is less than that of chlorine due to small sized of fluorine atom. It has very high inter electronic repulsion in the relatively small 2*p* orbitals. Hence, incoming electron experience less attraction from the nucleus.

$\therefore$ Chlorine has the highest value of electron gain enthalpy.

94. **(b)** Half of the volume occupied in water is empty or unoccupied. Therefore, 10 cm^3 of the actual volume is occupied by water molecules present in 20 cm^3 of water.

95. **(d)** EAN = Z (atomic number of the metal) – number of electrons lost in the ion formation + number of electrons gained from the donor atoms of the ligands.

Complex	Oxidation state of metal ion	Atomic no.	Coordination no.	EAN
$[Pt(NH_3)_6]^{4+}$	+ 4	76	6	(78 – 4) + (6 × 2) = 86 (Rn)
$[Fe(CN)_6]^{4-}$	+ 2	26	6	(26 – 2) + (6 × 2) = 36 (Kr)
$[Zn(NH_3)_4]^{2+}$	+ 2	30	4	(30 – 2) + (4 × 2) = 36 (Kr)
$[Cu(NH_3)_4]^{2+}$	+ 2	29	4	(29 – 2) + (4 × 2) = 35 (Br)

$[Cu(NH_3)_4]^{2+}$ is an exception to EAN rule.

96. **(d)** The reaction involved for lead accumulator during discharging i.e., when cell is in the use are

At anode : $Pb(s) + HSO_4^-(aq) \longrightarrow PbSO_4(s) + H^+ + 2e^-$

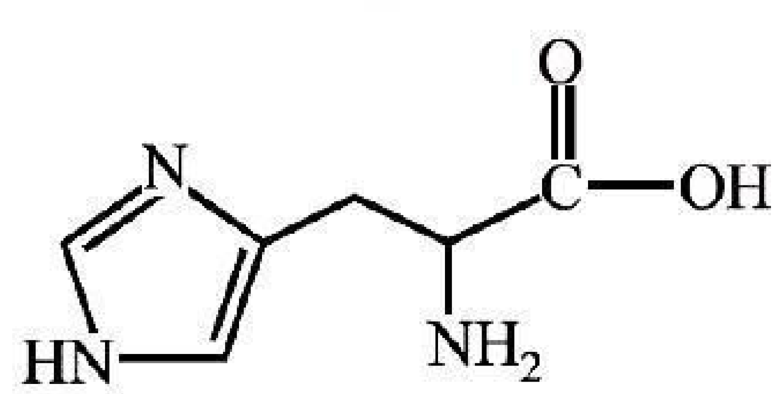
At cathode : $PbO_2(s) + 3H^+(aq) + HSO_4^-(aq) + 2e^- \longrightarrow PbSO_4(s) + 2H_2O(l)$

Overall reaction : $Pb(s) + PbO_2(s) + 2H^+ + 2HSO_4^-(aq) \longrightarrow 2PbSO_4(s) + 2H_2O(l)$

97. **(d)** Number of total ions present in the solution is known as van't Hoff factor.

Urea is a molecular solid hence, does not undergo association or dissociation therefore, has the lowest value of van't Hoff factor (i).

98. **(a)**



Histidine

It is basic in nature as it contains more number of $-NH_2$ groups than $-COOH$ groups.

99. **(a)** Ar (Noble gas) does not form diatomic molecules. Due to presence of completely filled valence shell, these gases are highly stable.

100. **(d)** Stachyose contains 24 carbon atoms in its structure.

SECTION-B

MATHEMATICS

1. **(b)** We have, $\tan 2\theta = 1$.

$\Rightarrow \tan 2\theta = \tan \frac{\pi}{4}$. $\Rightarrow 2\theta = n\pi + \frac{\pi}{4}$.

$\Rightarrow \theta = \frac{n}{2}\pi + \frac{\pi}{8}$.

Also, the value of $\tan 2\theta$ is positive. So, θ lies in 1st and 3rd quadrants.

$\therefore \theta = \frac{\pi}{8} \& \frac{9\pi}{8}$, are the two principal solutions.

2. **(a)** The objective function is given as, minimize, $z = 4x_1 + 5x_2$

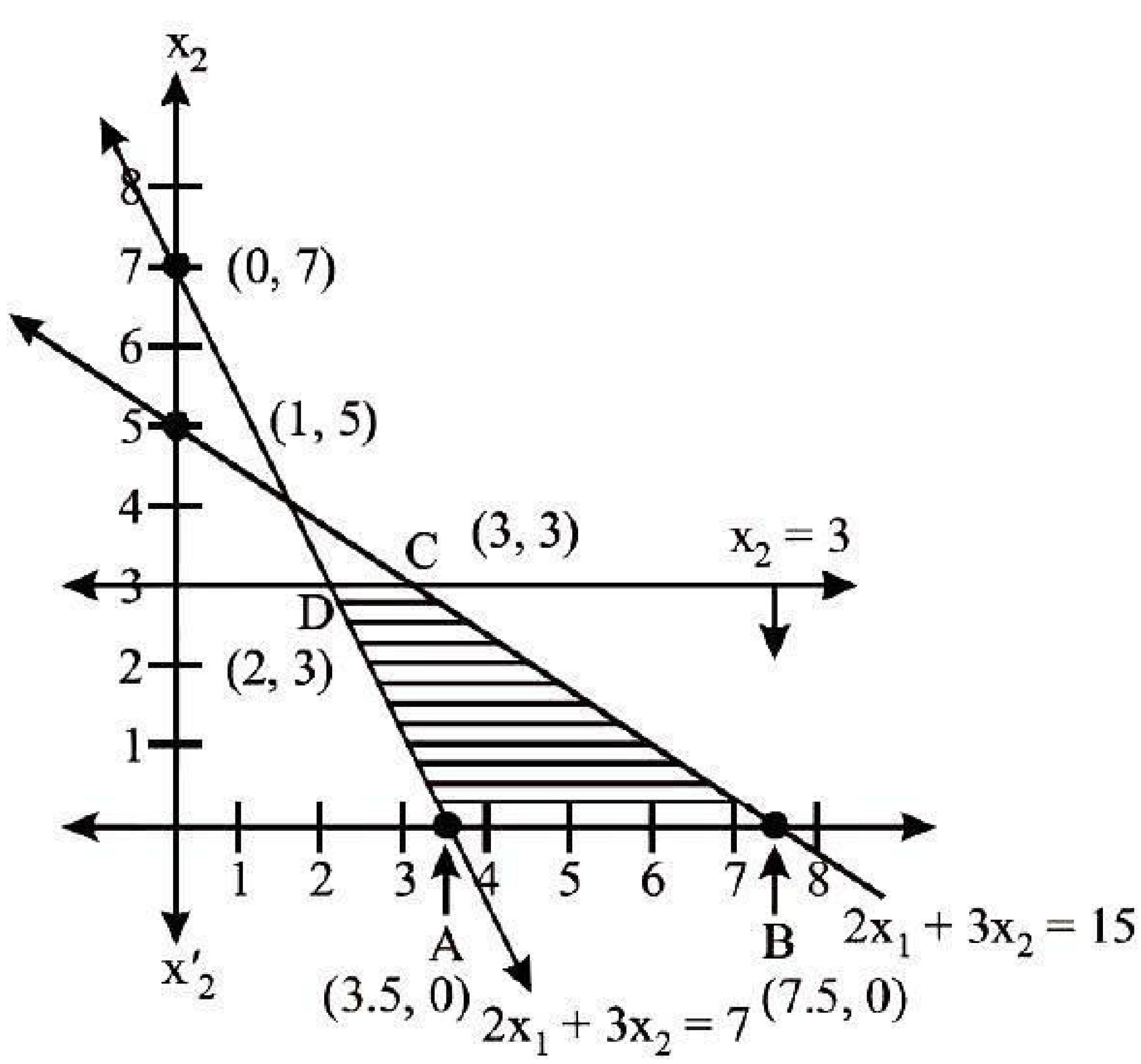
Subject to constraints, $2x_1 + x_2 \geq 7$, $2x_1 + 3x_2 \leq 15$, $x_2 \leq 3$ and $x_1, x_2 \geq 0$

For line $2x_1 + x_2 = 7$

x_1	0	1	2	3
x_2	7	5	3	1

For line $2x_1 + 3x_2 = 15$

x_1	0	3	6
x_2	5	3	1

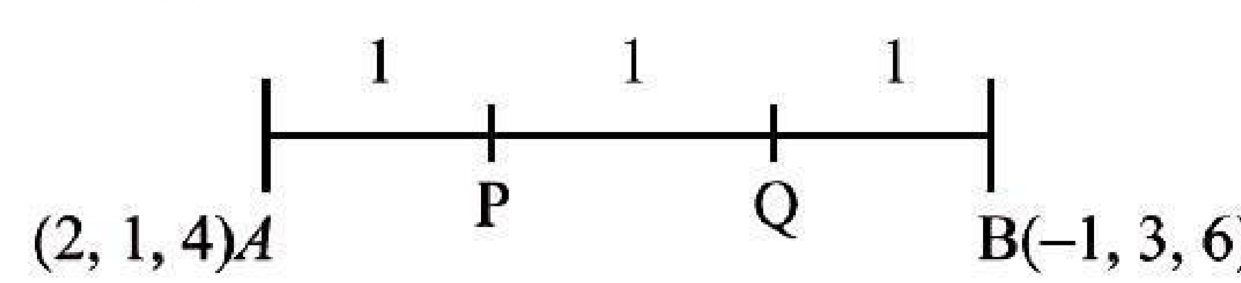


Now, the value of z at corner points are calculated as:

Corner points	$z = 4x_1 + 5x_2$
A(3.5, 0)	$z = 4 \times 3.5 + 5 \times 0 = 14$ (minimum)
B(7.5, 0)	$z = 4 \times 7.5 + 5 \times 0 = 30$
C(3, 3)	$z = 4 \times 3 + 5 \times 3 = 27$
D(2, 3)	$z = 4 \times 2 + 5 \times 3 = 23$

Hence, the minimum value of z is 14 at point (3.5, 0) which lies on X-axis.

3. **(d)** Let P & Q are the points with z-coordinates as z_1 and z_2 respectively which trisect the line segment AB.



Then, coordinates of P

$$= \left(\frac{1\times(-1)+2\times2}{1+2}, \frac{1\times3+2\times1}{1+2}, \frac{1\times6+2\times4}{1+2}\right)$$

Now, z-coordinate of $P = \frac{1\times6+2\times4}{1+2}$

i.e. $z_1 = \frac{6+8}{3} = \frac{14}{3}$

And coordinates of Q

$$= \left(\frac{2\times(-1)+1\times2}{2+1}, \frac{2\times3+1\times1}{2+1}, \frac{2\times6+1\times4}{2+1}\right)$$

So, z-coordinate of $Q = \frac{2\times6+1\times4}{2+1}$

i.e. $z_2 = \frac{12+4}{3} = \frac{16}{3}$

Hence, $z_1 + z_2 = \frac{14}{3} + \frac{16}{3} = \frac{30}{3} = 10$

4. **(b)** Since, $f(x) = \frac{\log x}{x}$

After differentiating on both sides w.r.t.x, we get

$$f'(x) = \frac{x.\frac{1}{x} - \log x.1}{x^2} = \frac{1-\log x}{x^2}$$

For maximum or minimum value of $f(x)$, put $f'(x) = 0$

$$\Rightarrow \quad \frac{1-\log x}{x^2} = 0 \Rightarrow \log x = 1 \Rightarrow \quad x = e$$

Now, $f''(x) = \dfrac{3+2\log x}{x^3}$

$\therefore \quad f''(e) = -\dfrac{1}{e^3} < 0$

After substituting x = e in eq. (i), we get

$$f(e) = \frac{\log e}{e} = \frac{1}{e}$$

Hence, maximum value of f(x) is $\dfrac{1}{e}$ at x = e.

5. **(b)** $\displaystyle\int_0^1 x\tan^{-1} x\,dx$

$$= \left[\tan^{-1} x \int x\,dx\right]_0^1 - \int_0^1 \left(\frac{d}{dx}(\tan^{-1} x)\int x\,dx\right)dx$$

$$= \left[\tan^{-1} x\,\frac{x^2}{2}\right]_0^1 - \int_0^1 \left(\frac{1}{1+x^2}\cdot\frac{x^2}{2}\right)dx$$

$$= \left(\frac{1}{2}\tan^{-1}1 - 0\right) - \frac{1}{2}\int_0^1 \frac{1+x^2-1}{1+x^2}dx$$

$$= \frac{1}{2}\left(\frac{\pi}{4}\right) - \frac{1}{2}\int_0^1 \left(1-\frac{1}{1+x^2}\right)dx$$

$$= \frac{\pi}{8} - \frac{1}{2}\left[x - \tan^{-1} x\right]_0^1$$

$$= \frac{\pi}{8} - \frac{1}{2}\left[1 - \tan^{-1}1 - 0 + 0\right]$$

$$= \frac{\pi}{8} - \frac{1}{2}\left[1 - \frac{\pi}{4}\right] = \frac{\pi}{4} - \frac{1}{2}$$

6. **(b)** The truth table is given below

p	q	~p	p ∨ q	~p ∧ q	(p ∨ q) ∧ ~q
T	T	F	T	F	F
T	F	F	T	F	F
F	T	T	T	T	T
F	F	T	F	F	F

$\therefore \quad (\sim p \wedge q) \equiv (p \vee q) \wedge \sim p$

7. **(a)** Given, $g(x) = f^{-1}(x)$

$f(g(x)) = x$

On differentiating both sides w.r.t. 'x', we get

$f'(g(x)).g'(x) = 1$

$$\therefore \quad \frac{1}{1+(g(x))^4}g'(x) = 1 \quad \left[\because f'(x) = \frac{1}{1+x^4}\right]$$

$\Rightarrow \quad g'(x) = 1 + [g(x)]^4$

8. **(b)** Consider $A = \begin{bmatrix} 1 & 0 & 0 \\ 3 & 3 & 0 \\ 5 & 2 & -1 \end{bmatrix}$

So, $|A| = \begin{vmatrix} 1 & 0 & 0 \\ 3 & 3 & 0 \\ 5 & 2 & -1 \end{vmatrix}$

$= 1(3\times(-1)-0) - 0(3\times(-1)-0-0) + 0(3\times2-5\times3)$

$= 1\times(-3) - 0 - 0 = -3$

Now, adj A

$$= \begin{bmatrix} (3\times(-1)-0) & -3\times(-1)-0) & (3\times2-5\times3) \\ -(0-0) & (1\times(-1)-0) & -(2\times1-5\times0) \\ (3\times0-0) & -(1\times0-0) & (3\times1-0) \end{bmatrix}^T$$

$$= \begin{bmatrix} -3 & 3 & -9 \\ 0 & -1 & -2 \\ 0 & 0 & 3 \end{bmatrix}$$

$$\text{adj } A = \begin{bmatrix} -3 & 0 & 0 \\ 3 & -1 & 0 \\ -9 & -2 & 3 \end{bmatrix}$$

Hence, $A^{-1} = \dfrac{1}{|A|}\text{adj } A = \dfrac{1}{-3}\begin{vmatrix} -3 & 0 & 0 \\ 0 & -1 & 0 \\ -9 & -2 & 3 \end{vmatrix}$

9. **(a)** $\displaystyle\int \frac{1}{\sqrt{9-16x^2}}dx$

$$= \int \frac{1}{\sqrt{3^2-(4x)^2}}dx = \frac{1}{4}\int \frac{1}{\sqrt{\left(\frac{3}{4}\right)^2-(x)^2}}dx$$

$= \frac{1}{4}\sin^{-1}\frac{4x}{3} + c$

$$\left[\because \int \frac{1}{\sqrt{a^2 - x^2}} dx = \sin^{-1}\frac{x}{a} + c\right]$$

As, $\int \frac{1}{\sqrt{9 - 16x^2}} dx = \alpha \sin^{-1(\beta x)} + c$

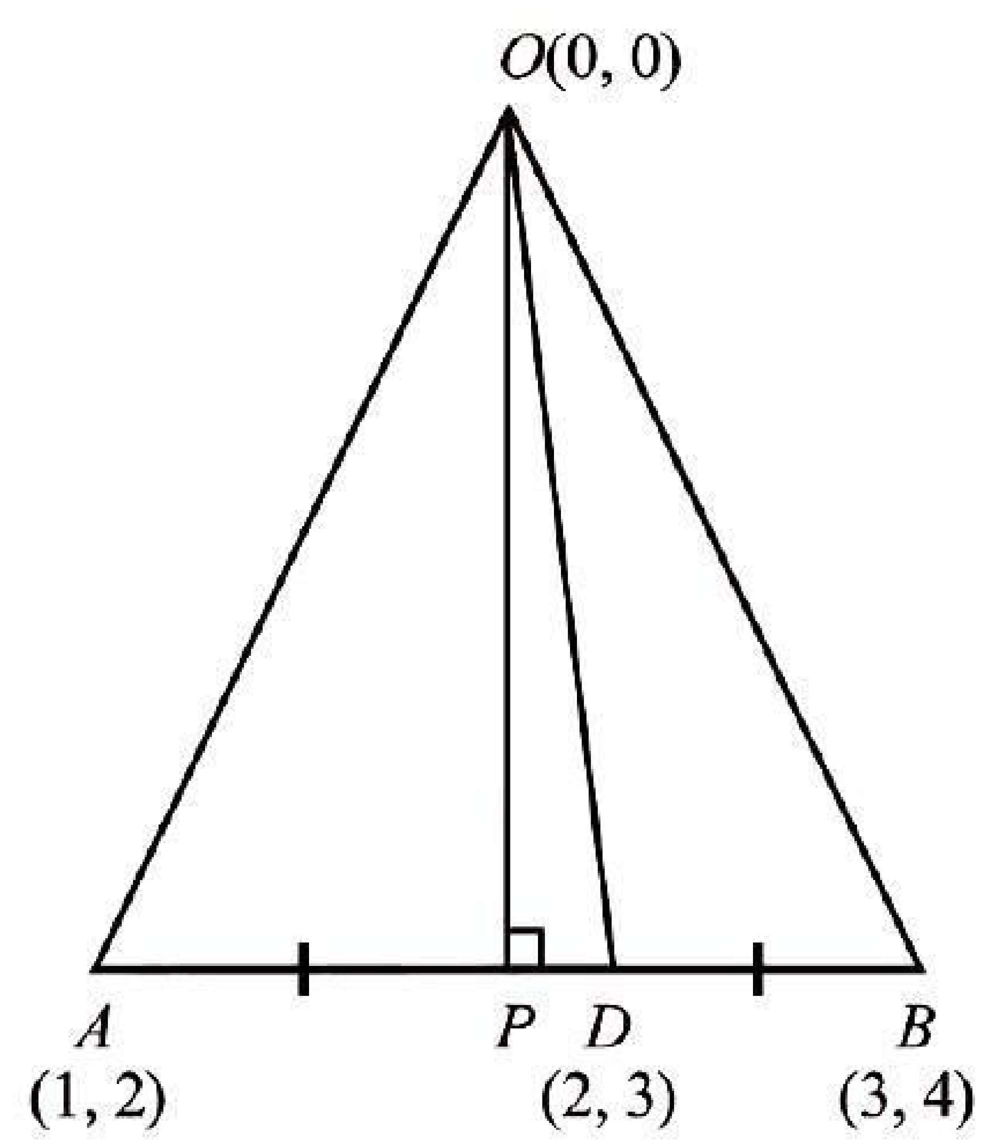
$\therefore \quad \alpha \sin^{-1}(\beta x) + c = \frac{1}{4}\sin^{-1}\left(\frac{4}{3}x\right) + c$

After comparing on both sides, we get

$\alpha = \frac{1}{4}$ and $\beta = \frac{4}{3}$

Hence, $\alpha + \frac{1}{\beta} = \frac{1}{4} + \frac{1}{\frac{4}{3}} = \frac{1}{4} + \frac{3}{4} = 1$

10. **(d)**



Since, O(0, 0), A(1, 2) and B(3, 4) are the vertices of ΔOAB.

Consider that OP and OD are altitude and median of ΔOAB, respectively.

Then, Coordinates of D

$= \left(\frac{1+3}{2}, \frac{2+4}{2}\right) = (2,3)$

So, equation of OD is $(y - 0) = \left(\frac{3-0}{2-0}\right)(x - 0)$

Hence, $y = \frac{3}{2}x \quad \Rightarrow 3x - 2y = 0$

Now, slope of OP $= \frac{-1}{\text{Slope of AB}}$

$$\frac{-1}{\left(\frac{3-1}{4-2}\right)} = -1 \text{ [As, OP} \perp \text{AB]}$$

$$= \frac{1}{\left(\frac{3-1}{4-2}\right)} = -1$$

$\therefore$ Equation of OP is $(y - 0) = -1(x - 0)$

$\therefore$ $y = -x \quad \Rightarrow x + y = 0$

Hence, joint equation of OP and OD is:

$$(x + y)(3x - 2y) = 0$$

$\Rightarrow 3x^2 + xy - 2y^2 = 0$

11. **(c)** Given, $f(x) = \left[\tan\left(\frac{\pi}{4} + x\right)\right]^{1/x} = K$

As, f(x) is continuous at x = 0,

$\therefore \quad f(0) = \lim_{x\to 0} f(x)$

$$= \lim_{x\to 0}\left[\tan\left(\frac{\pi}{4} + x\right)\right]^{1/x}$$

So, $K = \lim_{x\to 0}\left[\frac{1 + \tan x}{1 - \tan x}\right]^{1/x} \quad [1^\infty \text{ form}]$

$$= e^{\lim_{x\to 0}\left[\frac{1+\tan x}{1-\tan x} - 1\right]\frac{1}{x}}$$

$$= e^{\lim_{x\to 0}\left(\frac{2\tan x}{1-\tan x}\right)\frac{1}{x}} \quad \left[\because \lim_{x\to 0}\frac{\tan x}{x} = 1\right]$$

Hence $K = e^{2.1\left(\frac{1}{1-0}\right)} = e^2$

12. **(c)** We have,

$$A(\text{adj}A) = \begin{bmatrix} 10 & 0 \\ 0 & 10 \end{bmatrix} = 10\begin{bmatrix} 1 & 0 \\ 0 & 1 \end{bmatrix} = 10I$$

As, $A(\text{adj}A) = |A|\,I$

After comparing on both sides, we get

$$|A| = 10$$

13. **(b)** We have, $\frac{dy}{dx} = \tan\left(\frac{y}{x}\right) + \left(\frac{y}{x}\right)$ ...(i)

Since, it is homogeneous differential equation
After putting, y = Vx, we get

$$\frac{dy}{dx} = V + x\frac{dV}{dx}$$

$$V + x\frac{dV}{dx} = \tan V + V \quad \text{[From (i)]}$$

$$\Rightarrow \quad x\frac{dV}{dx} = \tan V$$

$$\Rightarrow \quad \frac{1}{\tan V}dV = \frac{1}{x}dx$$

After integrating on both sides, we get

$$\int \frac{1}{\tan V}dV = \int \frac{1}{x}dx$$

$$\Rightarrow \quad \int \cot V\, dV = \log x + \log c$$

$$\Rightarrow \quad \log \sin V = \log(xc)$$

$$\Rightarrow \quad \sin v = xc$$

Hence, $\sin\left(\frac{y}{x}\right) = xc$

14. **(c)** We have, $\sin^2 A + \sin^2 B = \sin^2 C$

$\Rightarrow$ $a^2 + b^2 = c^2$ (From Sine rule)

$\therefore$ ΔABC is right angled triangle and $\angle ACB = 90°$

So, area of $(\Delta ACB) = \frac{1}{2}ab$

By Sine rule's we get

$$\frac{a}{\sin A} = \frac{b}{\sin B} = \frac{c}{\sin C}$$

$$\Rightarrow \quad \frac{a}{\sin A} = \frac{b}{\sin B} = \frac{10}{1}$$

Hence, a = 10 sin A
and b = 10 sin B

Area of $\Delta ACB = \frac{1}{2}(10 \sin A)(10 \sin B)$ [From (i)]

$= 50 \sin A \sin B$

As, maximum value of $\sin A \sin B = \frac{1}{2}$

Hence, maximum value of area of ΔACB

$$= 50 \times \frac{1}{2} = 25$$

15. **(a)** We have x = f(t) and y = g(t)
After differentiating on both sides w.r.t 't', we get

$$\frac{dx}{dt} = f'(t) \text{ and } \frac{dy}{dt} = g'(t)$$

As, $\frac{dy}{dx} = \frac{\frac{dy}{dt}}{\frac{dx}{dt}}$

$$\Rightarrow \quad \frac{dy}{dx} = \frac{g'(t)}{f'(t)}$$

Now, differentiating again both sides w.r.t. 'x', we get

$$\frac{d^2y}{dx^2} = \frac{f'(t).g''(t) - g'(t).f''(t)}{(f'(t))^2} \cdot \frac{dt}{dx}$$

$$= \frac{f'(t).g''(t) - g'(t).f''(t)}{(f'(t))^2} \cdot \frac{1}{f'(t)}$$

$$= \frac{f'(t).g''(t) - g'(t).f''(t)}{(f'(t))^3}$$

16. **(b)** Consider $(x_1, y_1, z_1) \equiv (-3, 2, -5)$
As, the line is equally inclined to coordinate axes.
$l = -1$, m = 1 and n = –1
Since, the equation of line passing through (x_1, y_1, z_1) and direction cosines l, m, n is

$$\frac{x - x_1}{l} = \frac{y - y_1}{m} = \frac{z - z_1}{n}$$

Hence, $\frac{x+3}{-1} = \frac{y-2}{1} = \frac{z+5}{-1}$

17. **(d)** We have, $\int_0^{\frac{\pi}{2}} \log \cos x\, dx = \frac{\pi}{2}\log\frac{1}{2}$ ...(i)

$$= \int_0^{\frac{\pi}{2}} \log \sec x\, dx = \int_0^{\frac{\pi}{2}} \log\left(\frac{1}{\cos x}\right)dx$$

$$= -\int_0^{\frac{\pi}{2}} \log(\cos x)\,dx = -\int_0^{\frac{\pi}{2}} \log(\cos x)\,dx$$

$$= -\frac{\pi}{2}\log\left(\frac{1}{2}\right) \qquad \text{[From (i)]}$$

$$= \frac{\pi}{2}\log 2$$

18. **(c)** Suppose X be a random variable which denotes the no. of heads in tossing a coin three times. X can take value 0, 1, 2, 3.

As, y = ₹2x. So, Y can take the values ₹0, ₹2, ₹4 and ₹6

$$\therefore \quad P(y=0) = P(0 \text{ head}) = \frac{1}{8}$$

$$P(y=2) = P(1 \text{ head}) = \frac{3}{8}$$

$$P(y=4) = P(2 \text{ heads}) = \frac{3}{8}$$

$$P(y=6) = P(3 \text{ heads}) = \frac{1}{8}$$

Hence, expected gain

$$= 0\left(\frac{1}{8}\right) + 2\left(\frac{3}{8}\right) + 4\left(\frac{1}{8}\right) + 6\left(\frac{1}{8}\right)$$

$$= \frac{6+12+6}{8} = 3$$

19. **(c)** The truth table is given below:

p	q	$\sim p$	$\sim q$	$\sim p \leftrightarrow p$	$q \to p$	$\sim q \to \sim p$	$p \vee (q \to p)$	$p \wedge \sim p$	$(q \to p) \vee (\sim p \leftrightarrow q)$
T	T	F	F	F	T	F	T	F	T
T	F	F	T	T	T	F	T	F	T
F	T	T	F	T	F	T	T	F	T
F	F	T	T	F	T	T	F	F	T

Hence, $(q \to p) \vee (\sim p \to q)$ is a tautology.

20. **(c)** Let $\mathbf{n}_1$ and $\mathbf{n}_2$ are normals to the planes

$\mathbf{r}.(m\hat{\mathbf{i}} - \hat{\mathbf{j}} + 2\hat{\mathbf{k}}) + 3 = 0$ and

$\mathbf{r}.(2\hat{\mathbf{i}} - m\hat{\mathbf{j}} - \hat{\mathbf{k}}) - 5 = 0,$ respectively.

Now, $\theta = \frac{\pi}{3}$ is angle between the planes.

$$\text{As,} \quad \cos\theta = \left|\frac{\mathbf{n}_1.\mathbf{n}_2}{|\mathbf{n}_1||\mathbf{n}_2|}\right|$$

$$\text{So,} \quad \cos\frac{\pi}{3} = \frac{(m\hat{i} - \hat{j} + 2\hat{k}).(2\hat{i} - m\hat{j} - \hat{k})}{\left(\sqrt{m^2 + (-1)^2 + 2^2}\right)\left(\sqrt{2^2 + (-m)^2 + (-1)^2}\right)}$$

$$\Rightarrow \quad \frac{1}{2} = \left|\frac{2m + m - 2}{\sqrt{m^2+1+4}\sqrt{4+m^2+1}}\right| = \left|\frac{3m-2}{\sqrt{(m^2+5)^2}}\right|$$

$$\Rightarrow \quad \pm\frac{1}{2} = \frac{3m-2}{m^2+5}$$

$\Rightarrow \quad m^2 + 5 = 6m - 4 \quad$ or $\quad -m^2 - 5 = 6m - 4$

$\Rightarrow \quad m^2 - 6m - 9 = 0 \quad$ or $\quad m^2 + 6m + 1 = 0$

$\Rightarrow \quad (m-3)^2 = 0 \quad$ or $\quad m^2 + 6m + 1 = 0$

As $m^2 + 6m + 1 = 0$ does not give any real values.

Hence, $(m-3)^2 = 0 \;\Rightarrow\; m = 3$

21. **(c)** We have, O (0, 0, 0), P(2, 3, 4), Q (1, 2, 3) and R (x, y, z) are coplanar.

$$\text{So,} \quad \begin{vmatrix} x-0 & y-0 & z-0 \\ 2-0 & 3-0 & 4-0 \\ 1-0 & 2-0 & 3-0 \end{vmatrix} = 0$$

$$\Rightarrow \quad \begin{vmatrix} x & y & z \\ 2 & 3 & 4 \\ 1 & 2 & 3 \end{vmatrix} = 0$$

$\Rightarrow \quad x(9-8) - y(6-4) + z(4-3) = 0$

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

22. **(a)** We have, pair of line is $px^2 - qy^2 = 0$ ...(i)

After comparing eq. (i) with $ax^2 + 2hxy + by^2 = 0$, we get $a = p$, $b = -q$, $h = 0$

As slopes of pair of lines represented by

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

are real and distinct iff $h^2 - ab > 0$

So, $0 + pq > 0$

Hence, $pq > 0$

23. **(c)** Consider **p, q, r, s, m** and **n** are the position vectors of P, Q, R, S, M and N be respectively.

As, M and N are mid-points of **PQ** and **RS** respectively

$$\text{So,} \quad \mathbf{m} = \frac{\mathbf{p}+\mathbf{q}}{2} \text{ and } \mathbf{n} = \frac{\mathbf{r}+\mathbf{s}}{2} \qquad \text{...(i)}$$

Now, **PS** + **QR**

$= \mathbf{s} - \mathbf{p} + \mathbf{r} - \mathbf{q} = (\mathbf{r} + \mathbf{s}) - (\mathbf{p} + \mathbf{q})$

$= 2\mathbf{n} - 2\mathbf{m} = 2\,\mathbf{MN}$ [From eq. (i)]

24. **(c)** We have, pair of lines

$$kx^2 + 5xy + y^2 = 0 \quad ...(i)$$

After comparing eq. (i) with

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

$a = k, b = 1$ and $2h = 5$

Suppose m_1 and m_2 are two slopes of pair of lines.

Then $m_1 + m_2 = \frac{-2h}{b} = -5$ and $m_1 m_2 = \frac{a}{b} = k$

As, $(m_1 - m_2)^2 = (m_1 + m_2)^2 - 4m_1 m_2$

$\Rightarrow \quad (1)^2 = (-5)^2 - 4k$

$\Rightarrow \quad 4k = 24 \Rightarrow k = 6$

25. **(c)** We have, vector **r** with dc's l, m, n is equally inclined to the coordinate axes.

So, $l = m = n \quad ...(i)$

As, $l^2 + m^2 + n^2 = 1$

$\therefore \quad l^2 + l^2 + l^2 = 1 \quad$ [from eq. (i)]

$\Rightarrow \quad 3l^2 = 1$

$\Rightarrow \quad l = \pm \frac{1}{\sqrt{3}}$

Therefore, $l = m = n = \pm \frac{1}{\sqrt{3}}$

$\therefore$ vector $\mathbf{r} = |\mathbf{r}| \left(\pm \frac{1}{\sqrt{3}} \hat{\mathbf{i}} \pm \frac{1}{\sqrt{3}} \hat{\mathbf{j}} \pm \frac{1}{\sqrt{3}} \hat{\mathbf{k}} \right)$

Hence, total number of required vectors $= 2^3 = 8$

26. **(a)** Consider $I = \int \frac{1}{(x^2+4)(x^2+9)} dx$

$$= \int \frac{1}{5} \left(\frac{1}{x^2+4} - \frac{1}{x^2+9} \right) dx$$

$$= \frac{1}{5} \left[\int \frac{1}{x^2+2^2} dx - \int \frac{1}{x^2+3^2} dx \right]$$

$$= \frac{1}{5} \left[\frac{1}{2} \tan^{-1} \frac{x}{2} - \frac{1}{3} \tan^{-1} \frac{x}{3} \right] + C$$

$$= \frac{1}{10} \tan^{-1} \frac{x}{2} - \frac{1}{15} \tan^{-1} \frac{x}{3} + C$$

We have, $I = A \tan^{-1} \frac{x}{2} + B \tan^{-1} \frac{x}{3} + C$

So, $A \tan^{-1} \frac{x}{2} + B \tan^{-1} \frac{x}{3} + C$

$$= \frac{1}{10} \tan^{-1} \frac{x}{2} - \frac{1}{15} \tan^{-1} \frac{x}{3} + C$$

After comparing on both sides, we get

$$A = \frac{1}{10} \text{ and } B = \frac{-1}{15}$$

Hence, $A - B = \frac{1}{10} + \frac{1}{15} = \frac{15+10}{150} = \frac{1}{6}$

27. **(a)** It is given that, α and β are the roots of the equation

$x^2 + 5|x| - 6 = 0$

Here, $|x|^2 + 6|x| - |x| - 6 = 0$

$\Rightarrow |x|(|x| + 6) - 1(|x| + 6) = 0$

$\Rightarrow (|x| + 6)(|x| - 1) = 0$

$|x| = -6, 1$

As, modulus is always positive.

Therefore, $|x| = 1 \Rightarrow x = \pm 1$

Consider, $\alpha = 1$ and $\beta = -1$

Hence,

$\left| \tan^{-1} \alpha - \tan^{-1} \beta \right| = \left| \tan^{-1} 1 - \tan^{-1}(-1) \right|$

$$= \left| \frac{\pi}{4} - \left(-\frac{\pi}{4} \right) \right| = \left| \frac{\pi}{2} \right|$$

28. **(c)** We have, $x = a\left(t - \frac{1}{t}\right)$ and $y = a\left(t + \frac{1}{t}\right)$

Then, $y^2 - x^2 = \left[a^2 \left(t + \frac{1}{t} \right)^2 - a^2 \left(t - \frac{1}{t} \right)^2 \right]$

$\Rightarrow \quad y^2 - x^2 = 4a^2$

After differentiating on both sides w.r.t. 'x', we get

$2y \frac{dy}{dx} - 2x = 0 \Rightarrow 2\left(y \frac{dy}{dx} - x \right) = 0$

Hence, $\frac{dy}{dx} = \frac{x}{y}$

29. **(c)** Suppose that slope of the curve $y=\sqrt{x-1}$ is m_1

$$\therefore m_1=\frac{dy}{dx}=\frac{d}{dx}\sqrt{x-1}\frac{1}{2\sqrt{x-1}}$$

slope of the line $2x+y-5=0$ is m_2

$$\therefore m_2=\frac{dy}{dx}=\frac{d}{dx}(5-2x)=-2$$

As, lines are perpendicular if $m_1m_2=-1$

So, $\frac{1}{2\sqrt{x-1}}.(-2)=-1 \Rightarrow \sqrt{x-1}=1$

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

After substituting $x=2$ in $y=\sqrt{x-1}$, we get $y=1$

Hence, required point is (2, 1).

30. **(d)** Consider, $I=\int\sqrt{\frac{x-5}{x-7}}dx$

$$=\int\sqrt{\frac{(x-5)(x-5)}{(x-7)(x-5)}}dx$$

$$=\int\frac{x-5}{\sqrt{x^2-12x+35}}dx$$

$$=\frac{1}{2}\int\frac{2x-12+2}{\sqrt{x^2-12x+35}}$$

$$=\frac{1}{2}\int\frac{2x-12}{\sqrt{x^2-12x+35}}dx+\int\frac{1}{\sqrt{x^2-12x+35}}dx$$

$$=\sqrt{x^2-12x+35}+\int\frac{1}{\sqrt{(x^2-12x+36-1)}}dx+C$$

$$=\sqrt{x^2-12x+35}+\int\frac{1}{\sqrt{(x-6)^2-1^2}}dx+C$$

$$I=\sqrt{x^2-12x+35}+\log\left|x-6+\sqrt{x^2-12x+35}\right|+C$$

As,

$$I=A\sqrt{x^2-12x+35}+\log\left|x-6+\sqrt{x^2-12x+35}+C\right|$$

Hence, $A=1$

31. **(b)** We have, mean = 18 and variance = 12

So, np = 18 and np q = 12

$$\therefore \frac{npq}{np}=\frac{12}{18}\Rightarrow q=\frac{2}{3}$$

Therefore, $p=1-q=1-\frac{2}{3}=\frac{1}{3}$

After putting, $p=\frac{1}{3}$ in $np=8$, we get

$$n\left(\frac{1}{3}\right)=18\Rightarrow n=54$$

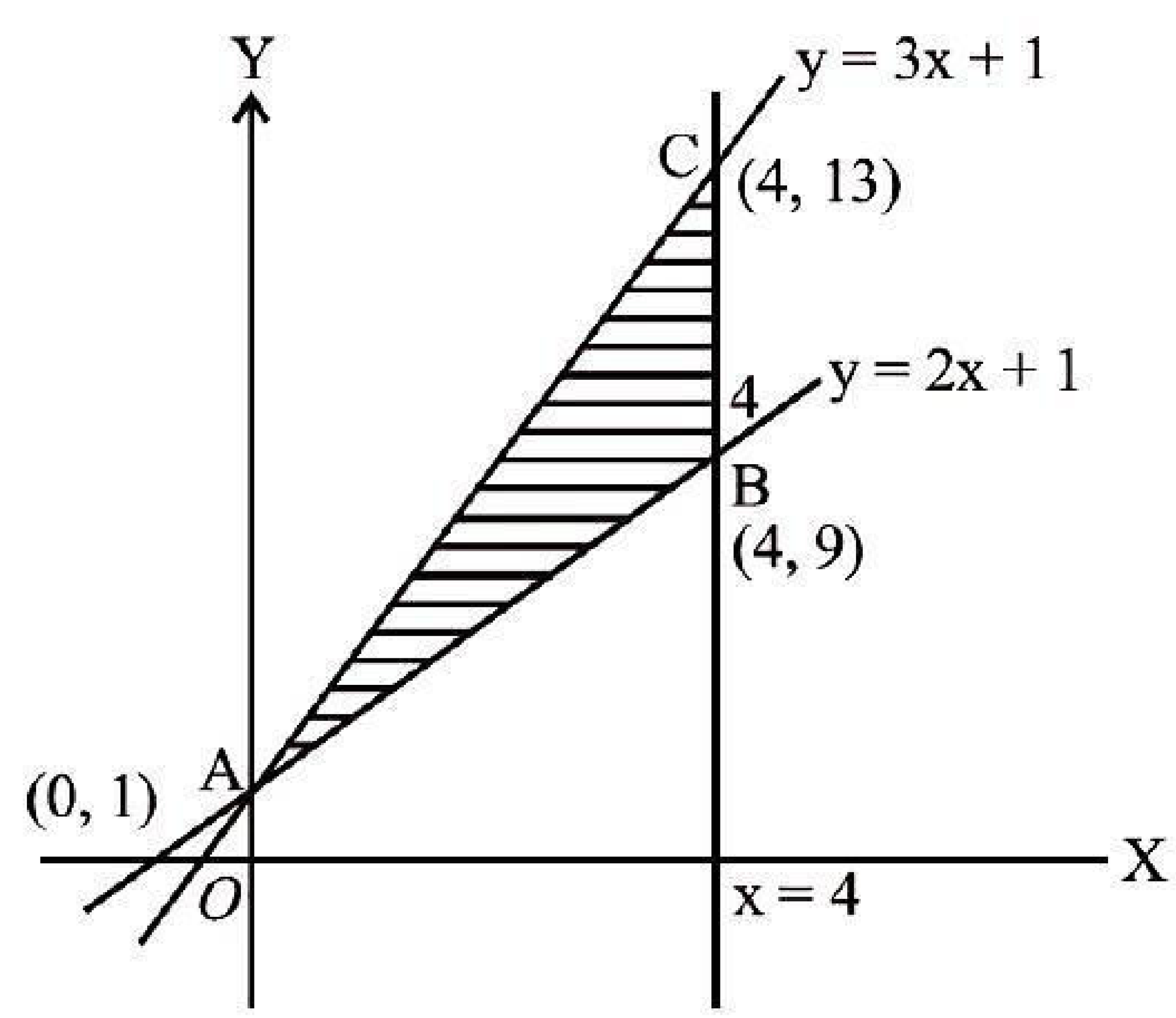
Hence, total number of possible value of X $=n+1=54+1=55$

32. **(d)** For line $y=2x+1$,

two points arc (0, 1) and (4, 9)

For line $y=3x+1$,

two points are (0, 1) and (4, 13)



Hence, area of shaded region

$$=\frac{1}{2}\begin{vmatrix}x_1 & y_1 & 1\\ x_2 & y_2 & 1\\ x_3 & y_3 & 1\end{vmatrix}=\frac{1}{2}\begin{vmatrix}0 & 1 & 1\\ 4 & 9 & 1\\ 4 & 13 & 1\end{vmatrix}$$

$$=\frac{1}{2}[0-0+4(13-9)]=8 \text{ sq units}$$

33. **(d)** Given, X is the number of defective pens obtained. Two pens are defective.

So, X have possible values 0, 1, 2

Now, $P(X=0)=\frac{{}^4C_2}{{}^6C_2}=\frac{4\times3}{6\times5}=\frac{6}{15}$

$P(X=1)=\frac{{}^2C_1\times{}^4C_1}{{}^6C_2}=\frac{8}{15}$

$P(X=2)=\frac{{}^2C_2}{{}^6C_2}=\frac{1\times2}{6\times5}=\frac{1}{15}$

$E(X^2)=\frac{8}{15}+\frac{2^2}{15}=\frac{12}{15}=\frac{4}{5}$

Standard deviation $=\sqrt{E(X^2)-[E(X)]^2}$

$=\sqrt{\left(\frac{4}{5}\right)-\left(\frac{2}{3}\right)^2}$

$=\sqrt{\frac{16}{45}}=\frac{4}{3\sqrt{5}}$

34. **(a)** Let r be the radius of spherical ball

$\because$ Volume of spherical ball $V=\frac{4}{3}\pi r^3$ ...(i)

Now, $288\pi=\frac{4}{3}\pi r^3$

$\Rightarrow r^3=72\times3=8\times27$

$\Rightarrow r=6$

After differentiating eq. (i) w.r.t. 't', we get

$\frac{dV}{dt}=4\pi r^2\frac{dr}{dt}$

$\Rightarrow 4\pi=4\pi r^2\frac{dr}{dt}$ $\left[\because\frac{dV}{dt}=4\pi\,cm^3/s\right]$

$\Rightarrow 1=(6)^2\frac{dr}{dt}$

$\Rightarrow \frac{dr}{dt}=\frac{1}{36}$

$\because$ Surface area of spherical ball, $s=4\pi r^2$

After differentiating on both sides, w.r.t. 't', we get

$\frac{ds}{dt}=4\times2\pi r\frac{dr}{dt}$

$\Rightarrow \frac{ds}{dt}=8\times\pi\times6\times\frac{1}{36}$

Hence, $\frac{ds}{dt}=\frac{4\pi}{3}cm^2/s$

35. **(b)** We have, $f(x)=\begin{cases}\log(\sec^2 x)^{\cot^2 x}, & \text{for } x\neq0\\ k, & \text{for } x=0\end{cases}$

As, $f(x)$ is continuous at $x=0$

So, $f(0)=\lim_{x\to0}\left[\log(\sec^2 x)^{\cot^2 x}\right]$

$=\lim_{x\to0}\left[\cot^2 x\log(\sec^2 x)\right]$

$=\lim_{x\to0}\frac{\log(1+\tan^2 x)}{\tan^2 x}=\lim_{x\to0}\frac{1}{1+\tan^2 x}=1$

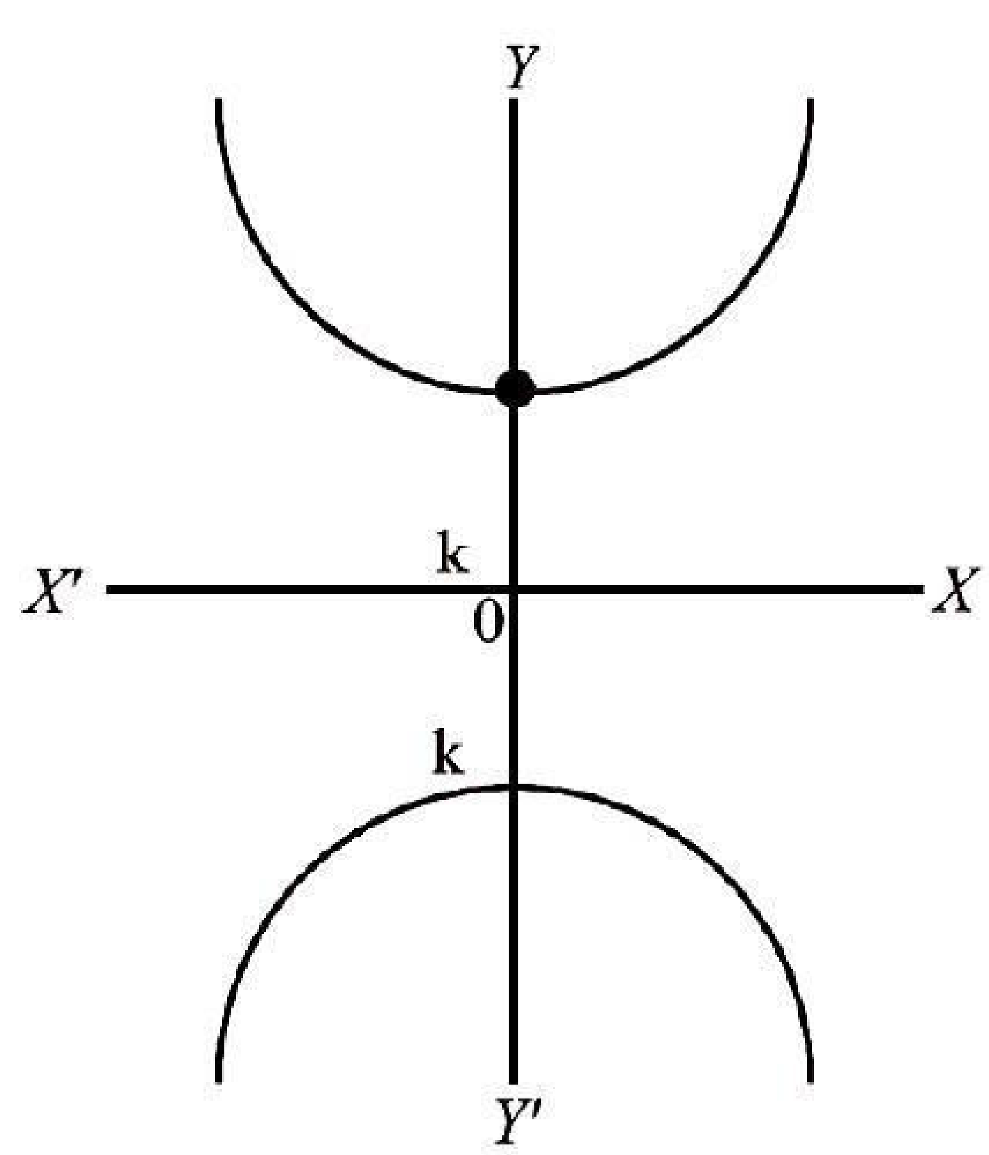
36. **(a)** After replacing '$\vee$' by '$\wedge$' and '$\wedge$' by '$\vee$', we get dual of the statement $\sim p\wedge(q\vee c)$ is $\sim p\vee(q\wedge t)$

37. **(a)** Let vertex of parabola be (0, k) as axis of parabola is Y-axis

So, equation of parabola is

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

$\Rightarrow x^2=4ay-4ak$



After, differentiating both sides w.r.t., 'x', we get

$$2x = 4a\frac{dy}{dx}$$

Therefore, $\frac{1}{2a} = \frac{1}{x}\frac{dy}{dx}$

Again differentiating on both sides w.r.t. 'x', we get

$$\frac{d}{dx}\left(\frac{1}{x}.\frac{dy}{dx}\right) = \frac{d}{dx}\left(\frac{1}{2a}\right)$$

$$\Rightarrow \frac{1}{x}.\frac{d^2y}{dx^2} + \frac{dy}{dx}\left(-\frac{1}{x^2}\right) = 0$$

Hence, $x\frac{d^2y}{dx^2} - \frac{dy}{dx} = 0$

38. **(a)** $\int_0^3 [x]dx = \int_0^1 0\,dx + \int_1^2 1dx + \int_2^3 2dx$

$= [x]_1^2 + 2[x]_2^3$

$= (2-1) + 2(3-2) = 3$

39. **(c)** Objective function of a LPP defined over convex set attains its optimum value at atleast one of the corner points.

40. **(d)** Consider, $A = \begin{bmatrix} \alpha & 14 & -1 \\ 2 & 3 & 1 \\ 6 & 2 & 3 \end{bmatrix}$

So,

$$|A| = \begin{bmatrix} \alpha & 14 & -1 \\ 2 & 3 & 1 \\ 6 & 2 & 3 \end{bmatrix} = \alpha(9-2) - 14(6-6) - 1(4-18)$$

$= 7\alpha + 14$

As, inverse of matrix A does not exists.

Therefore, $|A| = 0$

$\Rightarrow \quad 7\alpha + 14 = 0$

Hence, $\alpha = -2$

41. **(a)** We have, $f(x) = \begin{cases} x, & \text{for } x \le 0 \\ 0, & \text{for } x > 0 \end{cases}$

LHL at $x = 0 = \lim_{x\to 0^-} f(x) = \lim_{x\to 0} x$

and RHL at $x = 0 = \lim_{x\to 0^+} f(x) = \lim_{x\to 0} 0 = 0$

Now, $f(0) = 0$

So, LHL = RHL = f(0)

Hence, f(x) is continuous at x = 0

Here, $f'(x) = 1$ for $x \le 0$,

0 for $x > 0$

Thus, f(x) is not differentiable at x = 0

42. **(a)** Equation of plane which passes through $\vec{a} = -\hat{i} + \hat{j} + 2\hat{k}$ as it is perpendicular to $\hat{n} = \hat{i} + \hat{j} + \hat{k}$ will be $\vec{r}.\hat{n} = \vec{a}.\hat{n}$

$\vec{r}.(\hat{i} + \hat{j} + \hat{k}) = (-\hat{i} + \hat{j} + 2\hat{k}).(\hat{i} + \hat{j} + \hat{k})$

$= -1 + 1 + 2 = 2$

Hence, $\vec{r}.(\hat{i} + \hat{j} + \hat{k}) = 2$

43. **(b)** We have, probability that a person will develop immunity after vaccination is 0.8

Hence, probability that all 8 persons develop immunity $= (0.8)^8$

44. **(a)** The coordinates of given point is (2, 3, λ).

So, equation of the plane is

$$\vec{r}.(3\hat{i} + 2\hat{j} + 6\hat{k}) = 13$$

$\Rightarrow (x\hat{i} + y\hat{j} + z\hat{k}).(3\hat{i} + 2\hat{j} + 6\hat{k}) = 13$

$\Rightarrow 3x + 2y + 6z - 13 = 0$

Therefore, distance of the plane from the given point (2, 3, λ) will be

$$\left|\frac{3\times 2 + 2\times 3 + 6\times\lambda - 13}{\sqrt{3^2 + 2^2 + 6^2}}\right| = 5[\text{Given}]$$

$\Rightarrow \pm 5 = \frac{6\lambda - 1}{\sqrt{49}}$

$\Rightarrow \pm 35 = 6\lambda - 1$

$\Rightarrow 35 = 6\lambda - 1$ or $-35 = 6\lambda - 1$

Hence, $\lambda = 6, -\frac{17}{3}$

45. **(a)** $\cos^{-1}\left(\cot\frac{\pi}{2}\right) + \cos^{-1}\left(\sin\frac{2\pi}{3}\right)$

$= \cos^{-1}(0) + \cos^{-1}\left(\frac{\sqrt{3}}{2}\right)$

$= \cos^{-1}\left(\cos\frac{\pi}{2}\right) + \cos^{-1}\left(\cos\frac{\pi}{6}\right)$

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

46. **(b)** Given, $x\,dy + 2y\,dx = 0$

$\therefore \quad \frac{dy}{dy} + \frac{2dx}{x} = 0$

After integrating on both sides, we get

$\int \frac{1}{y} dy + 2\int \frac{1}{x} dx = \log C$

$\Rightarrow \quad \log y + 2\log x = \log C$

$\Rightarrow \quad yx^2 = C$

If $x = 2$ then $y = 1$,

So, $C = 1 \times 2^2 = 4$

Hence, particular solution will be $x^2y = 4$.

47. **(d)** It is given that, A(2, 3, 5), B(–1, 3, 2) and C(λ, 5, μ) are three vertices of ΔABC.

Let D be the mid-point of BC

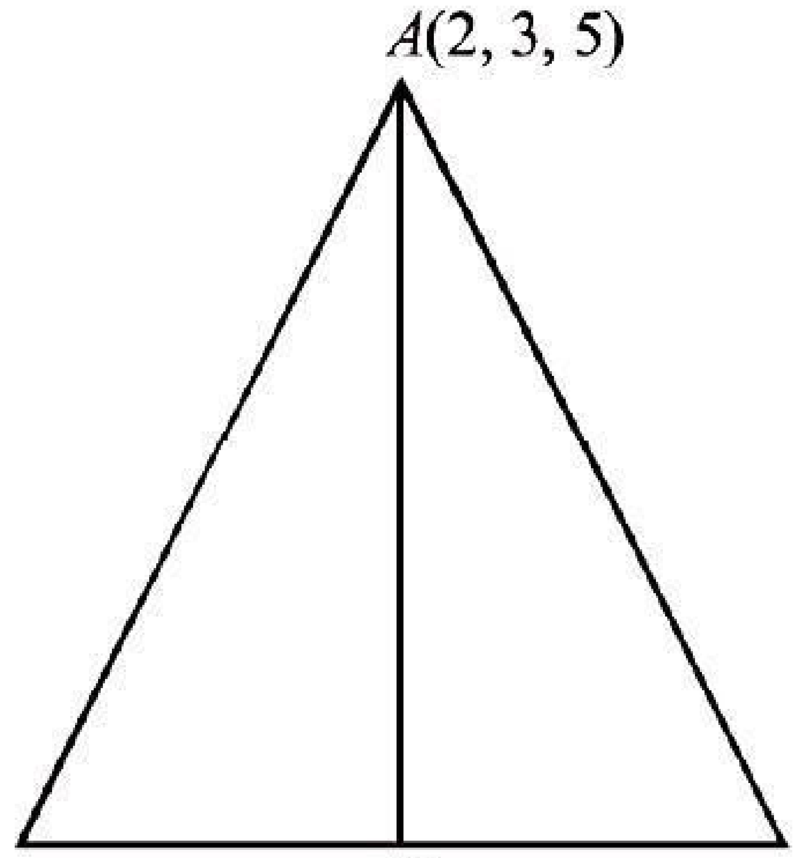
So, coordinates of D $= \left(\frac{\lambda-1}{2}, \frac{5+3}{2}, \frac{\mu+2}{2}\right)$

$= \left(\frac{\lambda-1}{2}, 4, \frac{\mu+2}{2}\right)$

So, direction ratios of

$AD = \left(\frac{\lambda-1}{2} - 2, 4-3, \frac{\mu+2}{2} - 5\right)$

$= \left(\frac{\lambda-5}{2}, 1, \frac{\mu-8}{2}\right)$



As, AD is equally inclined to both the coordinates axes.

Therefore, $\frac{\lambda-5}{2} = 1 = \frac{\mu-8}{2}$

$\Rightarrow \quad \frac{\lambda-5}{2} = 1 \quad \Rightarrow \quad \lambda = 7$

And, $1 = \frac{\mu-8}{2} \quad \Rightarrow \quad \mu = 10$

48. **(b)** $p(3 < x \le 5) = p(x=4) + p(x=5)$

$= (0.62 - 0.48) + (0.85 - 0.62)$

$= 0.14 + 0.23 = 0.37$

49. **(b)** Since, $\frac{x-1}{2} = \frac{y+1}{2} = \frac{z-1}{4} = \lambda$ ...(i)

and $\frac{x-3}{1} = \frac{y-6}{2} = \frac{z}{1}$ ...(ii)

Now, any point on the line (i) is $P(2\lambda+1, 2\lambda-1, 4\lambda+1)$

$\therefore \quad \frac{2\lambda+1-3}{1} = \frac{2\lambda-1-6}{2} = \frac{4\lambda+1}{1}$ [from (ii)]

So, $\quad 4\lambda - 4 = 2\lambda - 7 \quad \Rightarrow \quad 2\lambda = -3$

Hence, point of intersection P is

$= \left(2\times\left(-\frac{3}{2}\right) + 1, 2\times\left(-\frac{3}{2}\right) - 1, 4\times\left(-\frac{3}{2}\right) + 1\right)$

$\equiv (-2, -4, -5)$

50. **(b)** Consider, $I = \int \frac{\sec^8 x}{\operatorname{cosec} x} dx = \int \frac{\sin x}{\cos^8 x} dx$

$= \int \tan x . \sec^7 x \, dx$

$= \int \sec^6 x . \sec x \tan x \, dx$

Let $\sec x = t \quad \Rightarrow \quad \sec x . \tan x \, dx = dt$,

So, $\quad I = \int t^6 dt = \frac{t^7}{7} + c = \frac{\sec^7 x}{7} + c$