MANIPAL

Engineering Entrance Exam

Solved Paper 2018

Physics

1. At great distances from an electric dipole, the electric field strength due to the dipole varies with the distance as

(a) $\frac{1}{r}$ (b) $\frac{1}{r^2}$

(c) $\frac{1}{r^3}$ (d) $\frac{1}{r^4}$

2. A charged particle travels along a straight line with a speed v in a region where both electric field **E** and magnetic fields **B** are present. It follows that

(a) $|\mathbf{E}| = v|\mathbf{B}|$ and the two fields are parallel

(b) $|\mathbf{E}| = v|\mathbf{B}|$ and the two fields are perpendicular

(c) $|\mathbf{B}| = v|\mathbf{E}|$ and the two fields are parallel

(d) $|\mathbf{B}| = v|\mathbf{E}|$ and the two fields are perpendicular

3. A solenoid of length 50 cm and a radius of cross-section 1 cm has 1000 turns of wire wound over it. If the current carried is 5A, the magnetic field on its axis, near the centre of the solenoid is approximately (permeability of free space $\mu_0 = 4\pi \times 10^{-7}$ T-m/A)

(a) 0.63×10^{-2} T (b) 1.26×10^{-2} T

(c) 2.51×10^{-2} T (d) 6.3 T

4. A transformer of 100% efficiency has 200 turns in the primary and 40000 turns in secondary. It is connected to a 220 V main supply and secondary feeds to a 100 kΩ resistance. The potential difference per turn is

(a) 1.1 V (b) 25 V

(c) 18 V (d) 11 V

5. In a single slit diffraction pattern, the distance between the first minimum on the left and the first minimum on the right is 5 mm. The screen on which the diffraction pattern is displayed is at a distance of 80 cm from the slit. The wavelength is 6000 Å.The slit width in (mm) is about

(a) 0.576 (b) 0.348 (c) 0.192 (d) 0.096

6. When a ray is incident on a medium of refractive index n at Brewster's angle, it gets

(a) totally reflected (b) totally absorbed

(c) circularly polarised (d) plane polarised

7. The binding energy per nucleon is maximum in the case of

(a) ${}^4_2He$ (b) ${}_{26}Fe^{56}$

(c) ${}_{56}Ba^{141}$ (d) ${}_{92}U^{225}$

8. A thin convex lens of refractive index 1.5 has 20 cm focal length in air. If the lens is completely immersed in a liquid of refractive index 1.6, its focal length will be

(a) – 160 cm (b) – 100 cm

(c) + 10 cm (d) + 100 cm

9. A mass $3m$, initially at rest at the origin explodes into three fragments of equal mass. Two of the fragments have speed v each and move perpendicular to each other. The third fragment will move with a speed

(a) $\frac{v}{\sqrt{2}}$ (b) $\frac{v}{2}$

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

10. Standing waves are formed on a string when interference occurs between two waves having

(a) the same amplitude travelling in the same direction with no phase difference between them
(b) the same amplitude, travelling in the opposite direction with no phase difference between them
(c) different amplitudes travelling in the same direction
(d) different amplitudes travelling in the opposite direction

11. An open tank filled with water (density) ρ has a narrow hole at a depth of h below the water surface. The velocity of water flowing out is

(a) $h\rho g$ (b) $2gh$
(c) $\sqrt{2gh}$ (d) gh

12. Three concurrent forces of the same magnitude are in equilibrium. What is the angle between the forces ? Also, name the triangle formed by the forces as sides

(a) 60° equilateral triangle
(b) 120° equilateral triangle
(c) 120°, 30°, 30° an isosceles triangle
(d) 120° an obtuse triangle

13. A straight conductor carries a current of 5 A. An electron travelling with a speed of $5\times10^{6}\ \text{ms}^{-1}$ parallel to the wire at a distance of 0.1 m from the conductor, experiences a force of

(a) 8×10^{-20} N (b) 3.2×10^{-19} N
(c) 8×10^{-18} N (d) 1.6×10^{-19} N

14. A uniform wire of resistance $9\,\Omega$ is cut into 3 equal parts. They are connected in the form of equilateral triangle ABC. A cell of emf 2V and negligible inernal resistance is connected across B and C. Potential difference across AB is

(a) 1 V (b) 2 V
(c) 3 V (d) 0.5 V

15. In a potentiometer experiment two cells of emf E_1 and E_2 are used in series and in conjunction and the balancing length is found to be 58 cm of the wire. If the polarity of E_2 is reversed, then the balancing length becomes 29 cm. The ratio $\frac{E_1}{E_2}$ of the emfs of the two cells is

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

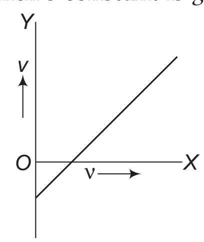
16. A spring balance is attached to the ceiling of a lift. A man hangs his bag on the spring and the spring reads 49 N, when the lift is stationary. If the lift moves downward with an acceleration of $5\ \text{m/s}^2$, the reading of the spring balance will be

(a) 49 N (b) 24 N
(c) 74 N (d) 15 N

17. A body cools in 7 min from 60°C to 40°C. What times (in min) does it take to cool from 40°C to 28°C, if surrounding temperature is 10°C ? (Assume Newton's law of cooling)

(a) 3.5 (b) 14 (c) 7 (d) 10

18. The stopping potential for photoelectric emission from a metal surface is plotted along Y-axis and frequency ν of incident light along X-axis. A straight line is obtained as shown. Planck's constant is given by

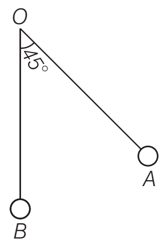


(a) slope of the line
(b) product of slope of the line and charge on the electron
(c) intercept along Y-axis divided by charge on the electron
(d) product of intercept along X-axis and mass of the electron

19. A parallel beam of monochromatic light is incident normally on a slit. The diffraction pattern is observed on a screen placed at the focal plane of a convex lens. If the slit width is increased, the central maximum of the diffraction pattern will

(a) become broader and fainter
(b) become broader and brighter
(c) become narrower and fainter
(d) become narrower and brighter

20. The bob A of a simple pendulum is released when the string makes an angle of 45° with the vertical. It hits an other bob B of the same material and same mass kept at rest on the table. If the collision is elastic



(a) both A and B rise to the same height
(b) both A and B come to rest at B
(c) both A and B move with the same velocity of A
(d) A comes to rest and B moves with the velocity of A

21. A battery of emf 12 V and internal resistance 2 Ω is connected in series with a tangent galvanometer of resistance 4 Ω. The deflection is 60° when the plane of the coil is along the magnetic meridian. To get a deflection of 30°, the resistance to be connected in series with the tangent galvanometer is

(a) 12 Ω (b) 20 Ω
(c) 10 Ω (d) 5 Ω

22. A transistor is used in common-emitter configuration. Given its $\alpha = 0.9$, calculate the change in collector current when the base current changes by 2 μA.

(a) 1 μA (b) 0.9 μF
(c) 30 μA (d) 18 μA

23. Energy needed in breaking a drop of radius R into n drops of radii r is given by

(a) $4\pi T(nr^2 - R^2)$
(b) $\frac{4}{3}\pi(r^3 n - R^2)$
(c) $4\pi T(R^2 - nr^2)$
(d) $4\pi T(nr^2 + R^2)$

24. A gas at the temperature 250 K is contained in a closed vessel. If the gas is heated through 1 K, then percentage increase in its pressure will be

(a) 0.4% (b) 0.2%
(c) 0.1% (d) 0.8%

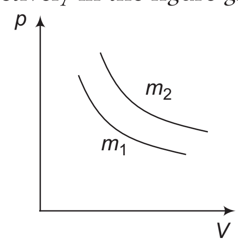
25. Voltage and current in an AC circuit are given by $V = 5\sin\left(100\pi t - \frac{\pi}{6}\right)$ and $I = 4\sin\left(100\pi t + \frac{\pi}{6}\right)$

(a) voltage leads the current by 30°
(b) current leads the voltage by 30°
(c) current leads the voltage by 60°
(d) voltage leads the current by 60°

26. A bar magnet is released into a copper ring directly below it. The acceleration of the magnet will be

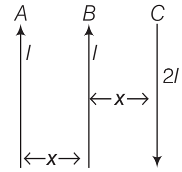
(a) equal to the acceleration due to gravity at that place
(b) less than the acceleration due to gravity at that place
(c) greater than the acceleration due to gravity at that place
(d) twice the acceleration due to gravity at that place

27. Two different isotherms representing the relationship between pressure p and volume V at a given temperature of the same ideal gas are shown for masses m_1 and m_2 of the gas respectively in the figure given, then



(a) $m_1 > m_2$ (b) $m_1 = m_2$ (c) $m_1 < m_2$ (d) $m_1 \gtrless m_2$

28. A, B and C are parallel conductors of equal lengths carrying currents I, I and $2I$ respectively. Distance between A and B is x.



Distance between B and C is also x. F_1 is the force exerted by B on A. F_2 is the force exerted by C on A. Choose the correct answer.

(a) $F_1 = 2F_2$ (b) $F_2 = 2F_1$
(c) $F_1 = F_2$ (d) $F_1 = -F_2$

29. The light ray is incident at angle of 60° on a prism of angle 45°. When the light rays falls on the other surface at 90°, the refractive index of the material of prism μ and the angle of deviation δ are given by

(a) $\mu = \sqrt{2}, \delta = 30°$ (b) $\mu = 1.5, \delta = 15°$

(c) $\mu = \frac{\sqrt{3}}{2}, \delta = 30°$ (d) $\mu = \sqrt{\frac{3}{2}}, \delta = 15°$

30. A plano-convex lens is made of refractive index of 1.6. The radius of curvature of the curved surface is 60 cm. The focal length of the lens is

(a) 400 cm (b) 200 cm (c) 100 cm (d) 50 cm

31. A body of mass 2 kg makes an elastic collision with another body at rest and continues to move in the original direction with one-fourth its original speed. The mass of the second body which collides with the first body is

(a) 2 kg (b) 1.2 kg (c) 3 kg (d) 1.5 kg

32. A research satellite of mass 200 kg circle the earth in an orbit of average radius $\frac{3R}{2}$, where R is the radius of the earth. Assuming the gravitational pull on a mass of 1 kg on the earth's surface to be 10 N, the pull on the satellite will be

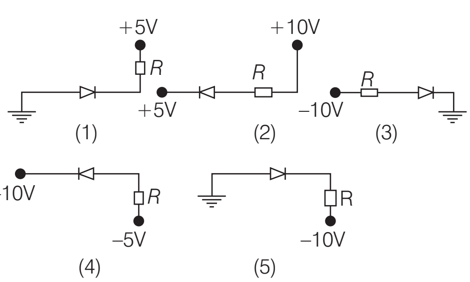
(a) 880 N (b) 889 N (c) 890 N (d) 892 N

33. A semiconductor has an electron concentration of $8 \times 10^{13}/\text{m}^3$ and hole concentration of $5.5 \times 10^{12}/\text{m}^3$. The semiconductor is

(a) *n*-type (b) *p*-type

(c) intrinsic semiconductor (d) *p*-*n* junction

34. In the figure shown below, which of the diodes are forward biased ?



(a) 1, 2, 3 (b) 2, 4, 5 (c) 1, 3, 4 (d) 2, 3, 4

35. The path difference between the two waves $y_1 = a_1 \sin\left(\omega t - \frac{2\pi x}{\lambda}\right)$ and $y_2 = a_2 \cos\left(\omega t - \frac{2\pi x}{\lambda} + \phi\right)$ is

(a) $\frac{\lambda}{2\pi}\phi$ (b) $\frac{\lambda}{2\pi}\left(\phi + \frac{\pi}{2}\right)$

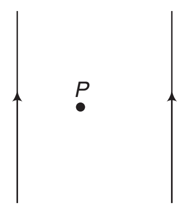
(c) $\frac{2\pi}{\lambda}\left(\phi - \frac{\pi}{2}\right)$ (d) $\frac{2\pi}{\lambda}\phi$

36. An electric motor operates on a 50 V supply and a current of 12 A. If the efficiency of the motor is 30%, what is the resistance of the winding of the motor ?

(a) 6 Ω (b) 4 Ω

(c) 2.9 Ω (d) 3.1 Ω

37. Two long straight wires are set parallel to each other. Each carries a current in the same direction and the separation between them is $2r$. The intensity of the magnetic field mid-way between them is



(a) $\frac{\mu_0 i}{r}$ (b) $\frac{4\mu_0 i}{r}$

(c) zero (d) $\frac{\mu_0 i}{4r}$

38. A galvanometer of resistance 20 Ω is to be converted into an ammeter of range 1 A. If a current of 1 mA produces full scale deflection, the shunt required for the purpose is

(a) 0.01 Ω (b) 0.05 Ω

(c) 0.02 Ω (d) 0.04 Ω

39. In a step-up transformer the voltage in the primary is 220 V and the current is 5 A. The secondary voltage is found to be 22000 V. The current in the secondary (neglect losses) is

(a) 5 A (b) 50 A

(c) 500 A (d) 0.05 A

40. In Young's double slit experiment, the intensity of light coming from one of the slits is double the intensity from the other slit.

The ratio of the maximum intensity to the minimum intensity in the interference fringe pattern observed is

(a) 34 (b) 40 (c) 25 (d) 38

41. The distance between charges 5×10^{-11} C and -2.7×10^{-11}C is 0.2 m. The distance at which is third charge should be placed from $4e$ in order that it will not experience any force along the line joining the two charges is

(a) 0.44 m (b) 0.65 m
(c) 0.556 m (d) 0.350 m

42. Small rain drops of the same size are charged to potential V volt each. If n such drops coalesce to form a single drop, then the potential of the bigger drop is

(a) $n^{1/3}\ V$ (b) $n^{2/3}\ V$
(c) nV (d) $n^{3/2}\ V$

43. A small sphere is charged to a potential of 50 V and a big hollow sphere is charged to potential of 100 V. Charge will flow from the smaller sphere to the bigger one when

(a) the smaller one is placed inside the bigger one and connected by a wire
(b) the bigger one is placed inside the smaller one and connected by means of a wire
(c) bigger one placed by the side of the smaller one and connected by a wire
(d) smaller one placed by the side of the bigger one

44. If refractive index of a material of equilateral prism is $\sqrt{3}$, then angle of minimum deviation of the prism is

(a) 30° (b) 45°
(c) 60° (d) 75°

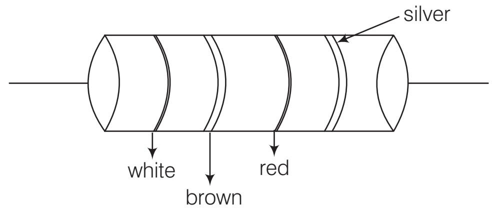
45. A long solenoid of length L has a mean diameter D. It has n layers of winding of N turns each. If it carries a current i, the magnetic field at its centre will be

(a) proportional to D
(b) inversely proportional to D
(c) independent of D
(d) proportional to L

46. A wire of length 100 cm is connected to a cell of emf 2 V and negligible internal resistance. The resistance of the wire is 3 Ω, the additional resistance required to produce a potential difference of 1 mV/cm is

(a) 60 Ω (b) 47 Ω (c) 57 Ω (d) 35 Ω

47. In the figure a carbon resistor has bands of different colours on its body as mentioned in the figure. The value of the resistance is



(a) 2.2 kΩ (b) 3.3 kΩ (c) 5.6 kΩ (d) 9.1 kΩ

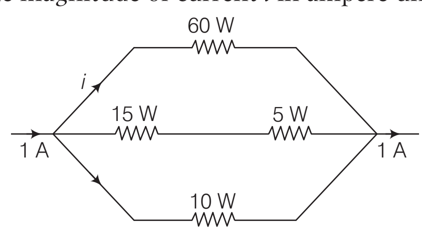
48. The mass defect in a particular nuclear reaction is 0.3 g. The amount of energy liberated in killowatt hour is (velocity of light $= 3\times 10^8$ m / s)

(a) 1.5×10^6 (b) 2.5×10^6
(c) 3×10^6 (d) 7.5×10^6

49. A photon and an electron have equal energy $E \cdot \lambda_{photon}/\lambda_{electron}$ is proportional to

(a) $\sqrt{E}$ (b) $\frac{1}{\sqrt{E}}$
(c) $\frac{1}{E}$ (d) does not depend upon E

50. The magnitude of current i in ampere unit is



(a) 0.1 (b) 0.3
(c) 0.6 (d) None of these

Chemistry

1. If 20 g of $CaCO_3$ is treated with 100 mL of 20% HCl solution, the amount of CO_2 produced is

(a) 22.4 L (b) 8.80 g (c) 4.40 g (d) 2.24 L

2. A certain amount of a metal whose equivalent mass is 28 displaces 0.7 L of H_2 at STP from an acid. Hence, mass of the element is

(a) 1.75 g (b) 0.875 g (c) 3.50 g (d) 7.00 g

3. In the atomic spectrum of hydrogen, the spectral lines pertaining to electronic transition of $n = 4$ to $n = 2$ refers to

(a) Lyman series (b) Balmer series
(c) Paschen series (d) Brackett series

4. The electron affinity of Be is almost similar to that of

(a) Li (b) B
(c) Na (d) Ne

5. For a process to be spontaneous

(a) ΔG must be –ve (b) ΔG should be +ve
(c) ΔH must be –ve (d) ΔS must be –ve

6. pH of an acid buffer is given by

(a) $pH = pK_a + \log \frac{[Salt]}{[Acid]}$

(b) $pH = pK_a - \log \frac{[Salt]}{[Acid]}$

(c) $pH = K_a + \log \frac{[Salt]}{[Acid]}$

(d) None of the above

7. In S_N1 reaction, the racemization takes place. It is due to

(a) inversion of configuration
(b) retention of configuration
(c) conversion of configuration
(d) Both (a) and (b)

8. When phenol is treated with excess of bromine water it gives

(a) *m*-bromophenol
(b) *o*- and *p*-bromophenol
(c) 2, 4-dibromophenol
(d) 2, 4, 6-tribromophenol

9. $CH_3COOH + NH_3 \longrightarrow X \xrightarrow{\Delta} Y$; Y is

(a) CH_3NH_2 (b) $CH_3CH_2NH_2$
(c) CH_3CONH_2 (d) CH_3COONH_4

10. Coordination number of Zn in ZnS is

(a) 4 (b) 6
(c) 2 (d) None of these

11. What is the order of the reaction which has a rate expression

$$\text{rate} = k[A]^{\frac{3}{2}}[B]^{-1} ?$$

(a) $\frac{3}{2}$ (b) $\frac{1}{2}$ (c) zero (d) None of these

12. 99% of a first order reaction was completed in 32 min. When will 99.9% of the reaction complete ?

(a) 50 min (b) 46 min
(c) 49 min (d) 48 min

13. Which one of the following solutions exhibits the maximum elevation in boiling point ?

(a) 0.1 m NaCl (b) 0.1 m $FeCl_3$
(c) 0.1m $CaCl_2$ (d) 0.1 m $BaCl_2$

14. The coefficients of I^-, IO_3^- and H^+ in the redox reaction,

$$I^- + IO_3^- + H^+ \longrightarrow I_2 + H_2O$$

in the balanced form respectively are

(a) 5, 1, 6 (b) 1, 5, 6
(c) 6, 1, 5 (d) 5, 6, 1

15. Lyophilic sols are more stable than lyophobic sols because

(a) the colloidal particles have negative charge
(b) the colloidal particles have positive charge
(c) the colloidal particles are solvated
(d) None of the above

16. Which of the following will give positive iodoform test ?

(a) HCHO (b) CH_3OCH_3
(c) $(CH_3)_2CO$ (d) CH_3CH_2Cl

17. Starch is the polymer of

(a) glucose (b) fructose
(c) Both (a) and (b) (d) None of these

18. The type of isomerism present in nitropentamine chromium (III) chloride is

(a) optical (b) coordination
(c) linkage (d) polymerisation

19. The standard reduction potentials for two half-cell reactions are given below.

$$Cd^{2+}(aq) + 2e^- \longrightarrow Cd(s); E^\circ = -0.40\text{ V}$$

$$Ag^+(aq) + e^- \longrightarrow Ag(s), E^\circ = 0.80\text{ V}$$

The standard free energy change for the reaction

$$2Ag^+(aq) + Cd(s) \longrightarrow 2Ag(s) + Cd^{2+}(aq)$$

is given by

(a) 115.8 kJ (b) – 115.8 kJ
(c) – 231.6 kJ (d) 231.6 kJ

20. Which of the following ions has the highest magnetic moment?

(a) Zn^{2+} (b) Ti^{3+} (c) Sc^{3+} (d) Mn^{2+}

21. Cane sugar charrs on treating with conc. H_2SO_4. It is because

(a) H_2SO_4 is oxidising agent
(b) H_2SO_4 is dehydrating agent
(c) H_2SO_4 is an acid
(d) H_2SO_4 is a catalyst

22. Which of the following sets of quantum numbers is impossible arrangement ?

(a) $n = 3, m = -2, s = +\frac{1}{2}$
(b) $n = 4, m = 3, s = +\frac{1}{2}$
(c) $n = 5, m = 2, s = -\frac{1}{2}$
(d) $n = 3, m = -3, s = -\frac{1}{2}$

23. The formation of oxide ion $O^{2-}(g)$ require first an exothermic and then an endothermic step as shown below :

$$O(g) + e^- \rightarrow O^-(g) ; \quad \Delta H^\circ = -142 \text{ kJ mol}^{-1}$$

$$O^-(g) + e^- \rightarrow O^{2-}(g) ; \Delta H^\circ = 844 \text{ kJ mol}^{-1}$$

This is because

(a) Oxygen is more electronegative
(b) O^- ion has comparatively larger size than oxygen atom
(c) O^- ion will tend to resist the addition of another electron
(d) Oxygen has high electron affinity

24. In the standardization of $Na_2S_2O_3$ using $K_2Cr_2O_7$ by iodometry, the equivalent weight of $K_2Cr_2O_7$ is

(a) molecular weight/2
(b) molecular weight/6
(c) molecular weight/3
(d) same as molecular weight

25. The coordination number of central metal atom in a complex is determined by

(a) the number of ligands around a metal ion bonded by sigma bonds
(b) the number of ligands around a metal ion bonded by π bonds
(c) the number of ligands around a metal ion bonded by sigma and π bonds both
(d) None of the above

26. Ethylene diamine is an example of

(a) monodentate ligand (b) bidentate ligand
(c) tridentate ligand (d) polydentate ligand

27. Deviation from the ideal gas behaviour of a gas can be expressed as

(a) $Z = \frac{p}{VRT}$ (b) $Z = \frac{pV}{nRT}$
(c) $Z = \frac{nRT}{pV}$ (d) $Z = \frac{VR}{pT}$

28. To a 4 L of 0.2 M solution of NaOH 2 L of 0.5 M NaOH are added. The molarity of resulting solution is

(a) 0.9 M (b) 0.3 M
(c) 1.8 M (d) 0.18 M

29. Reimer-Tiemann reaction involves

(a) carbonium ion intermediate
(b) carbene intermediate
(c) carbanion intermediate
(d) free radical intermediate

30. Aldol condensation will not observed in

(a) chloral
(b) phenylacetaldehyde
(c) nitroethanal
(d) hexanal

31. The entropy change for the fusion of 1 mol of a solid which melts at 27°C is (latent heat of fusion =600 cal mol^{-1})

(a) 2 cal K^{-1} (b) 22.2 cal K^{-1}
(c) 180 k cal K (d) 0.5 cal^{-1} K

32. The solubility product of $Al_2(SO_4)_3$ is given by the expression

(a) $[Al^{3+}][SO_4^{2-}]$ (b) $[Al^{3+}]^2[SO_4^{2-}]$

(c) $[Al^{3+}]^3[SO_4^{2-}]^2$ (d) $[Al^{3+}]^2[SO_4^{2-}]^3$

33. S_N1 reactions are favoured by

(a) non-polar solvents

(b) bulky groups on the carbon atom attached to the halogen atom

(c) small groups on carbon atom attached to the halogen atom

(d) None of the above

34. The order of relative bond strength of oxygen molecule, superoxide ion and peroxide ion is

(a) $O_2 < O_2^- < O_2^{2-}$ (b) $O_2 > O_2^- > O_2^{2-}$

(c) $O_2 < O_2^- > O_2^{2-}$ (d) $O_2 > O_2^- < O_2^{2-}$

35. 1.2 g of Mg (at. mass 24) will produce MgO equal to

(a) 0.05 mol (b) 40 g (c) 40 mg (d) 4 g

36. The enthalpy change for the transition of liquid water to steam is 40.8 kJ mol^{-1} at 373 K. Calculate the entropy of vaporisation of water.

(a) 109.4 JK^{-1} mol^{-1} (b) 10.94 JK^{-1} mol^{-1}

(c) 1.094 JK^{-1} mol^{-1} (d) 1009.4 JK^{-1} mol^{-1}

37. The function of $AlCl_3$ in the Friedel-Craft's reaction is

(a) to absorb water

(b) to absorb HCl

(c) to produce electrophile

(d) to produce nucleophile

38. Which of the following is paramagnetic ?

(a) O_2 (b) N_2 (c) O_2^{2-} (d) H_2

39. The number of stereoisomers for pent-3-en-2-ol is

(a) 2 (b) 4 (c) 3 (d) 5

40. When attraction between $A-B$ is more than that of $A-A$ and $B-B$, the solution will show

(a) positive deviation from Raoult's law

(b) negative deviation from Raoult's law

(c) no deviation from Raoult's law

(d) Cannot be predicted

41. The noble gas used for treatment of cancer is

(a) Helium (b) Argon

(c) Radon (d) Krypton

42. Among the following species, which has zero bond order ?

(a) H_2 (b) H_2^+

(c) He_2 (d) He_2^+

43. 0.16 g of dibasic acid requires 25 mL decimolar NaOH solution for complete neutralisation. The molecular mass of the acid is

(a) 256 (b) 64

(c) 32 (d) 128

44. The standard free energy change ($\Delta G°$) is related to equilibrium constant (K) as

(a) $\Delta G° = -2.303\, RT \ln K$

(b) $\Delta G° = 2.303\, RT \log K$

(c) $\Delta G° = RT \log K$

(d) $\Delta G° = -2.303\, RT \log K$

45. Degree of dissociation of an acid HCl is 95%. 0.192 g of the acid is present in 0.5 L of solution. The pH of the solution is

(a) 2 (b) 1

(c) 3 (d) 4

46. Molisch test is given by

(a) all carbohydrates (b) sucrose

(c) fructose (d) glucose

47. The number of amino acids in insulin is

(a) 21 (b) 574 (c) 51 (d) 5733

48. Low spin complexes are generally formed by elements of

(a) 3*d* series (b) 4*d* series

(c) 5*d* series (d) Both (b) and (c)

49. An optically active alkene with the M.F. C_6H_{12} which upon hydrogenation gives optically inactive alkane is

(a) 2-hexene (b) 3-methyl-2-pentene

(c) 2-methyl-2-pentene (d) 3-methyl-1-pentene

50. If uncertainty in position and velocity are equal, then uncertainty in momentum will be

(a) $\frac{1}{2}\sqrt{\frac{mh}{\pi}}$ (b) $\frac{1}{2}\sqrt{\frac{h}{\pi m}}$

(c) $\frac{h}{4\pi m}$ (d) $\frac{mh}{4\pi}$

Mathematics

1. The equation $3^{|3x+4|} = 9^{2x-2}, x > 0$ has the solution

(a) $\frac{7}{8}$ (b) $\frac{8}{7}$

(c) $\frac{-3}{4}$ (d) None of these

2. A parallelogram is constructed on the vectors $\mathbf{a} = 3\alpha - \beta$, $\mathbf{b} = \alpha + 3\beta$. If $|\alpha| = |\beta| = 2$ and the angle between α and β is $\frac{\pi}{3}$, then length of a diagonal of the parallelogram is

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

(c) $4\sqrt{7}$ (d) None of these

3. Every group of order 7 is

(a) not abelian (b) not cyclic

(c) cyclic (d) None of these

4. Let $U_n = 2 + 2^3 + 2^5 + ... + 2^{2n+1}$ and $V_n = 1 + 4 + 4^2 + ... + 4^{n-1}$. Then, $\lim_{n \to \infty} \frac{U_n}{V_n}$ is equal to

(a) 8 (b) 6 (c) $\frac{3}{4}$ (d) $\frac{3}{2}$

5. If $P(n): 1 + 3 + 5 + ... + (2n-1) = n^2$ is

(a) true for all $n \in N$ (b) true for $n > 1$

(c) true for no n (d) None of these

6. The minimum value of $x^2 + \frac{1}{1+x^2}$ is, at

(a) $x = 0$ (b) $x = 1$ (c) $x = 4$ (d) $x = 3$

7. The coefficient of x^{-9} in the expansion of $\left(\frac{x^2}{2} - \frac{2}{x}\right)^9$ is

(a) 512 (b) – 512

(c) 521 (d) 251

8. The sum to n terms of the series $\frac{1}{2} + \frac{3}{4} + \frac{7}{8} + \frac{15}{16} + ...$ is

(a) $2^n - 1$ (b) $1 - 2^n$

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

9. The value of $\begin{vmatrix} a & a+b & a+2b \\ a+2b & a & a+b \\ a+b & a+2b & a \end{vmatrix}$ is equal to

(a) $9a^2(a+b)$ (b) $9b^2(a+b)$

(c) $a^2(a+b)$ (d) $b^2(a+b)$

10. The negation of the compound proposition $p \vee (\sim p \vee q)$ is

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

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

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

(d) None of the above

11. In the group $[G = \{0, 1, 2, 3, 4\}, \times_5]$ the inverse of $(2 \times_5 2^{-1})$ is

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

12. The statement $P(n) = 9^n - 8^n$, when divided 8, always leaves the remainder

(a) 1 (b) 2 (c) 3 (d) 7

13. If $\tan^{-1} x + \tan^{-1} y + \tan^{-1} z = \pi$, then $x + y + z$ is

(a) xyz (b) 0 (c) 1 (d) $2xyz$

14. If $\left(\frac{1}{2}, \frac{1}{3}, n\right)$ are the direction cosines of a line, then the value of n is

(a) $\frac{\sqrt{23}}{6}$ (b) $\frac{23}{36}$ (c) $\frac{2}{3}$ (d) $\frac{3}{2}$

15. Derivative of x^x is

(a) $x^x(1 - \log x)$ (b) $1 + \log x$

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

16. If $(3 - x) \equiv (2x - 5) \pmod 4$, then one of the values of x is

(a) 3 (b) 4 (c) 18 (d) 5

17. The product of the perpendicular from $(-1, 2)$ to the pair of lines $2x^2 - 5xy + 2y^2 + 3x - 3y + 1 = 0$ is

(a) $\frac{5}{12}$ (b) $\frac{12}{5}$ (c) $\frac{6}{5}$ (d) $\frac{5}{6}$

18. If $\mathbf{a} = -\hat{\mathbf{i}} + 2\hat{\mathbf{j}} - \hat{\mathbf{k}}, \mathbf{b} = \hat{\mathbf{i}} + \hat{\mathbf{j}} - 3\hat{\mathbf{k}}$ and $\mathbf{c} = -4\hat{\mathbf{i}} - \hat{\mathbf{k}}$, then $\mathbf{a} \times (\mathbf{b} \times \mathbf{c}) + (\mathbf{a} \cdot \mathbf{b})\,\mathbf{c}$

(a) $5\hat{\mathbf{i}} + 5\hat{\mathbf{j}} - 15\hat{\mathbf{k}}$ (b) $\mathbf{0}$
(c) $12\hat{\mathbf{j}} + 4\hat{\mathbf{k}}$ (d) $-3\hat{\mathbf{i}} + 6\hat{\mathbf{j}} - 3\hat{\mathbf{k}}$

19. The work done by the force $4\hat{\mathbf{i}} - 3\hat{\mathbf{j}} + 2\hat{\mathbf{k}}$ in moving a particle along a straight line from the point $(3, 2, -1)$ to $(2, -1, 4)$ is

(a) 0 unit (b) 4 unit (c) 15 unit (d) 19 unit

20. The value of 'a' for which the function $f(x) = a \sin x + \left(\frac{1}{3}\right) \sin 3x$ has an extremum at $x = \frac{\pi}{3}$, is

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

21. If $|f(x)|$ is continuous at $x = a$, then $f(x)$ is

(a) continuous at $x = a$
(b) continuous at $x = -a$
(c) continuous at $x = \sqrt{a}$
(d) not be continuous at $x = a$

22. The general solution of $x(1 + y^2)^{1/2}\,dx + y(1 + x^2)^{1/2}\,dy = 0$ is

(a) $\sin^{-1} x + \sin^{-1} y = c$
(b) $x^2 + y^2 = (1 + x^2)^{1/2} + (1 + y^2)^{1/2} + c$
(c) $(1 + x^2)^{1/2} + (1 + y^2)^{1/2} = c$
(d) $\tan^{-1} x - \tan^{-1} y = c$

23. The area in square unit enclosed by the curve $x^2 y = 36$, the x-axis and the lines $x = 6$ and $x = 9$ is

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

24. $\int_0^{\frac{\pi}{2}} \frac{\sin^n \theta}{\sin^n \theta + \cos^n \theta}\, d\theta$ is equal to

(a) 1 (b) 0
(c) $\frac{\pi}{2}$ (d) $\frac{\pi}{4}$

25. Area of the triangle in the argand diagram formed by the complex numbers $z, iz, z + iz$, where $z = x + iy$ is

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

26. If $f(x) = \frac{\log(1 + ax) - \log(1 - bx)}{x}$ for $x \neq 0$ and $f(0) = k$ and $f(x)$ is continuous at $x = 0$, then k is equal to

(a) $a + b$ (b) $a - b$ (c) a (d) b

27. The least positive remainder when $123 \times 125 \times 127$ is divided by 124 is

(a) 4 (b) 120 (c) 121 (d) 130

28. By eliminating the arbitrary constants A and B from $y = Ax^2 + Bx$, we get the differential equation

(a) $\frac{d^3 y}{dx^3} = 0$ (b) $x^2 \frac{d^2 y}{dx^2} - 2x\frac{dy}{dx} + 2y = 0$
(c) $\frac{d^2 y}{dx^2} = 0$ (d) $x^2 \frac{d^2 y}{dx^2} + y = 0$

29. The equation $(\cos p - 1)x^2 + \cos px + \sin p = 0$ in the variable x, has real roots. Then, p can take any value in the interval

(a) $(0, \pi)$ (b) $(-\pi, 0)$
(c) $\left(-\frac{\pi}{2}, \frac{\pi}{2}\right)$ (d) $(-\pi, \pi)$

30. If $3\sin^{-1}\left(\frac{2x}{1 + x^2}\right) - 4\cos^{-1}\left(\frac{1 - x^2}{1 + x^2}\right) + 2\tan^{-1}\left(\frac{2x}{1 - x^2}\right) = \frac{\pi}{3}$, then x is equal to

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

31. If $\sin(\pi \cos \theta) = \cos(\pi \sin \theta)$, then which of the following is correct?

(a) $\cos \theta = \frac{3}{2\sqrt{2}}$
(b) $\cos\left(\theta - \frac{\pi}{2}\right) = \frac{1}{2\sqrt{2}}$
(c) $\cos\left(\theta - \frac{\pi}{4}\right) = \frac{1}{2\sqrt{2}}$
(d) $\cos\left(\theta + \frac{\pi}{4}\right) = -\frac{1}{2\sqrt{2}}$

32. If $f(x) = \begin{cases} x + 1, & x \leq 1 \\ 3 - ax^2, & x > 1 \end{cases}$ is continuous at $x = 1$, then the value of a is

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

33. The area bounded by $y = 1 + \frac{8}{x^2}$ and the ordinates $x = 2$ and $x = 4$ is

(a) 2 sq unit (b) 4 sq unit
(c) log 2 sq unit (d) log 4 sq unit

34. Everybody in a room shakes hands with everybody else. The total number of handshakes is 66. The number of persons in the room is

(a) 11 (b) 12 (c) 13 (d) 14

35. The condition that one root of the equation $ax^2 + bx + c = 0$ may be square of the other, is

(a) $a^2c + ac^2 + b^3 - 3abc = 0$
(b) $a^2c^2 + ac^2 + b^2 - 3abc = 0$
(c) $ac^2 + ac - b^3 - 3abc = 0$
(d) $a^2c + ac^2 - b^3 - 3abc = 0$

36. The value of $\sum_{r=1}^{\infty} [3 \cdot 2^{-r} - 2 \cdot 3^{1-r}]$ is

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

37. If $x(1 + y^2)\,dx + y(1 + x^2)\,dy = 0$ and $y(0) = 1$, then $x^2y^2 + x^2 + y^2$ is equal to

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

38. If $f(x) = \frac{x + \cos x}{x - \cos x}$, $f'\left(\frac{\pi}{2}\right)$ is equal to

(a) $\frac{2(x\sin x + \cos x)}{(x - \cos x)^2}$ (b) $\frac{2(x\cos x + \sin x)}{(x - \cos x)^2}$
(c) $\frac{-2(x\sin x + \cos x)}{(x + \cos x)^2}$ (d) None of these

39. If $A(-1, 2)$, $B(5, 1)$, $C(6, 5)$ are the vertices of a parallelogram $ABCD$. The equation to the diagonal through B is

(a) $x + y + 6 = 0$ (b) $x + y - 6 = 0$
(c) $x - y - 4 = 0$ (d) $x - 2y - 1 = 0$

40. $\int_0^1 x \sin \pi x \, dx$ is equal to

(a) 1 (b) 1/2 (c) π (d) $1/\pi$

41. If a, b, c are different integers such that $(a, b) = c$, which of the following statements is true ?

(a) $\frac{a}{c}$ (b) $\frac{c}{b}$
(c) $\frac{b}{a}$ (d) None of these

42. If a, b and c are negative and different real numbers, then $\Delta = \begin{vmatrix} a & b & c \\ b & c & a \\ c & a & b \end{vmatrix}$ is

(a) < 0 (b) 0 (c) > 0 (d) ≤ 0

43. The product of 'n' positive numbers is unity. Then, their sum is

(a) a positive integer (b) divisible by n
(c) equal to $n + \frac{1}{n}$ (d) never less than n

44. The function $\sin x(1 + \cos x)$, $0 \leq x \leq \frac{\pi}{2}$ has maximum value, when x is equal to

(a) 0 (b) $\frac{\pi}{2}$
(c) $\frac{\pi}{6}$ (d) None of these

45. Differential equations of the family of curves $y = a\cos\mu x + b\sin\mu x$, where a and b are arbitrary constants is given by

(a) $\frac{d^2y}{dx^2} + \mu y = 0$ (b) $\frac{d^2y}{dx^2} - \mu^2 y = 0$
(c) $\frac{d^2y}{dx^2} + \mu^2 y = 0$ (d) None of these

46. The area included between the curves $y^2 = 2x$ and $x^2 = 2y$ is

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

47. If $A \cdot \text{adj}(A) = O$, then $|A|$ is

(a) 0 (b) $\frac{1}{|\text{adj } A|}$ (c) 1 (d) -1

48. If $|\mathbf{a} + \mathbf{b}| = |\mathbf{a} - \mathbf{b}|$, then $\mathbf{a}$ and $\mathbf{b}$ are

(a) parallel
(b) perpendicular
(c) angle between $\mathbf{a}$ and $\mathbf{b}$ is 45°
(d) angle between $\mathbf{a}$ and $\mathbf{b}$ is 60°

49. $\lim_{x \to 0} \left(\frac{(2 + x)\sin(2 + x) - 2\sin 2}{x} \right)$ is equal to

(a) sin 2 (b) cos 2
(c) 1 (d) 2 cos 2 + sin2

50. $\int \frac{2dx}{(e^x + e^{-x})^2}$ is equal to

(a) $-\frac{e^{-x}}{(e^x + e^{-x})} + c$ (b) $-\frac{1}{(e^x + e^{-x})} + c$

(c) $\frac{1}{(e^x + 1)^2} + c$ (d) $\frac{1}{(e^x - e^{-x})^2} + c$

51. If the rate of change in the circumference of a circle of 0.3 cm/s, then the rate of change in the area of the circle when the radius is 5 cm, is

(a) 1.5 sq cm/s (b) 0.5 sq cm/s
(c) 5 sq cm/s (d) 3 sq cm/s

52. If ω is a cube root of unity, then $(1 + \omega - \omega^2)(1 - \omega + \omega^2)$ is

(a) 1 (b) 0 (c) 2 (d) 4

53. The complex number z which satisfy the equation $\left|\frac{i + z}{i - z}\right| = 1$ lies on

(a) a circle $x^2 + y^2 = 1$ (b) the x-axis
(c) the y-axis (d) the line $x + y = 1$

54. If $A + B + C = \pi$, then

$$\begin{vmatrix} \sin(A + B + C) & \sin B & \cos C \\ -\sin B & 0 & \tan A \\ \cos(A + B) & -\tan A & 0 \end{vmatrix}$$ is equal to

(a) $\sin A$ (b) $\sin A \cos B$
(c) 0 (d) None of these

55. The minimum value of $x \log x$ is equal to

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

56. If $f''(0) = k$, then $\lim_{x \to 0} \frac{2f(x) - 3f(2x) + f(4x)}{x^2}$ is equal to

(a) k (b) $2k$ (c) $3k$ (d) $4k$

57. If $\int_{-1}^{4} f(x)\, dx = 4$ and $\int_{2}^{4} [3 - f(x)]\, dx = 7$, then the value of $\int_{-1}^{2} f(x)\, dx$ is

(a) -2 (b) 3 (c) 5 (d) 8

58. The equation of a curve passing through the origin and satisfying the differential equation $\frac{dy}{dx} = (x - y)^2$ is

(a) $e^{2x}(1 - x + y) = 1 + x - y$
(b) $e^{2x}(1 + x - y) = 1 - x + y$
(c) $e^{2x}(1 - x + y) + (1 + x - y) = 0$
(d) $e^{2x}(1 + x + y) = 1 - x + y$

59. If $(\sqrt{3} - i)^{50} = 2^{48}(x - iy)$, then $x^2 + y^2$ is equal to

(a) 2 (b) 4 (c) 8 (d) 16

60. If the coefficients of the rth term and the $(r + 1)$th term in the expansion of $(1 + x)^{20}$ are in the ratio 1 : 2, then r is equal to

(a) 6 (b) 7 (c) 8 (d) 9

61. The area of a parallelogram with diagonals as $\mathbf{a} = 3\hat{\mathbf{i}} + \hat{\mathbf{j}} - 2\hat{\mathbf{k}}$ and $\mathbf{b} = \hat{\mathbf{i}} - 3\hat{\mathbf{j}} + 4\hat{\mathbf{k}}$ is

(a) $10\sqrt{3}$ (b) $\frac{10}{\sqrt{3}}$

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

62. The sum of infinite terms of the geometric progression $\frac{\sqrt{2} + 1}{\sqrt{2} - 1}, \frac{1}{2 - \sqrt{2}}, \frac{1}{2}, \ldots$ is

(a) $\sqrt{2}(\sqrt{2} + 1)^2$ (b) $(\sqrt{2} + 1)^2$
(c) $5\sqrt{2}$ (d) $3\sqrt{2} + \sqrt{5}$

63. The first three terms in the expansion of $(1 + ax)^n$ $(n \neq 0)$ are $1, 6x$ and $16x^2$. Then, the values of a and n are respectively

(a) 2 and 9 (b) 3 and 2
(c) $\frac{2}{3}$ and 9 (d) $\frac{3}{2}$ and 6

64. If $f(x) = \begin{cases} \frac{x^2 - 9}{x - 3}, & \text{if } x \neq 3 \\ 2x + k, & \text{otherwise} \end{cases}$ is continuous at $x = 3$, then k is equal to

(a) 3 (b) 0
(c) -6 (d) $\frac{1}{6}$

65. The area of the region $\{(x, y) : x^2 + y^2 \leq 1 \leq x + y\}$ is

(a) $\frac{\pi^2}{5}$ sq unit (b) $\frac{\pi^2}{2}$ sq unit

(c) $\left(\frac{\pi}{4} - \frac{1}{2}\right)$ sq unit (d) $\frac{\pi}{4}$ sq unit

66. $\left|\dfrac{x}{2}-1\right|<3$ implies that x lies in the interval

(a) (– 4, 8) (b) (– 3, 6)
(c) (– 4, 6) (d) (– 3, 8)

67. $\sin^{-1}\dfrac{1}{\sqrt{5}}+\cos^{-1}\dfrac{3}{\sqrt{10}}$ is equal to

(a) $\pi/6$ (b) $\pi/4$ (c) $\pi/3$ (d) $2\pi/3$

68. If $f(x)=\sec x-\cot x$, then $f'\left(\dfrac{\pi}{6}\right)$ is equal to

(a) – 3 (b) $\dfrac{14}{3}$ (c) $\dfrac{11}{3}$ (d) 5

69. If $\mathbf{a}$, $\mathbf{b}$, $\mathbf{c}$ are the position vectors of A, B, C respectively such that $3\mathbf{a}+4\mathbf{b}-7\mathbf{c}=\mathbf{0}$, then C divides AB in the ratio

(a) 4 : 3 (b) 4 :7
(c) 3 : 7 (d) 3 : 4

70. If $\begin{bmatrix} a & 2 & 3 \\ b & 5 & -1 \end{bmatrix}\times\begin{bmatrix} 1 & 2 \\ 3 & 4 \\ -1 & 1 \end{bmatrix}=\begin{bmatrix} 4 & 13 \\ 12 & 11 \end{bmatrix}$, (a, b) is

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

English & General Aptitude

Directions (Q. 1–5) : *Read the following passage carefully and answer the questions given below it.*

After submitting his resignation, Albert came out and took the long narrow road leading to the railway station which was one of the busiest roads in the city. Sad and depressed and worried about looking for a new job. Albert looked around for a cigarette shop. He walked up to the end of the road but found no tobacconist. It was odd that such a busy thoroughfare with thousands of people passing through did not even have a single cigarette shop. He suddenly felt that it was no longer necessary for him to hunt for a job. He decided to open a tobacco shop himself. It was bound to be profitable, he felt.

1. After submitting his resignation, Albert came out worried about

(a) a shelter (b) cigarettes
(c) a job (d) the next available train

2. Albert was sad and depressed because

(a) he had no money for the train journey
(b) he had to walk on a long road
(c) he was not able to buy cigarettes
(d) he was worried about finding a job

3. There was no cigarette shop on that road because

(a) smoking was banned in that area
(b) just by chance nobody had opened one on that road
(c) it was a very narrow road
(d) cigarette-shop owners do not make any profit

4. Albert decided not to look for a new job because

(a) the thought of having to look for a job greatly distressed him
(b) he did not want to work at all
(c) there was no hope of finding a job
(d) he saw the possibility of self- employment

5. A cigarette shop on a busy road was bound to be profitable because

(a) cigarette shops are known to make a great deal of profit
(b) any shop on a busy street would attract a large number of customers
(c) cigarettes are inexpensive items and people buy them willingly
(d) a cigarette shop on a busy road would attract a large number of customers

Directions (Q. 6–8) *In the following passage, there are blanks each of which has been numbered. These numbers are printed below the passage and against each, some words are suggested,one of which fits the blank appropriately. Find the appropriate word for each blank.*

Scientific psychology recognises a ...**6**... truth that no two individuals are...**7**... in this world even through. , equality is a fostered norm of civil society, the truth is that men...**8**...unequals in varying hues or degrees.

6. (a) clear (b) real (c) simple (d) direct

7. (a) alike (b) close (c) liked (d) equal

8. (a) will (b) are (c) is (d) was

Directions (Q. 9–10) : *In each of the following questions, choose the alternative which best expresses the meaning of the word given in capital letters.*

9. INDIGENOUS
(a) Normal
(b) Internal
(c) Natural
(d) Native

10. OPULENT
(a) Greedy
(b) Hungry
(c) Heavy
(d) Wealthy

Directions (Q. 11–12) : *In each of the following questions, choose the alternative which can be substituted for the given words/sentence.*

11. Science of printing
(a) Calligraphy
(b) Typography
(c) Topography
(d) Cryptography

12. Man whose wife has been unfaithful to him
(a) Dandy (b) Bastard
(c) Concubine (d) Cuckold

Directions (Q. 13–15) : *In each of the following questions, find out the part which has an error. If there is no error, your answer is (d).*

13. We grieve our loss and cry helplessly (a)/ while we should be fighting for our rights (b)/and die a noble death (c)/ No error. (d)

14. Work hard (a) / lest you will (b) / fail (c) / No error. (d)

15. My friend did not see me (a)/ for many years (b)/when I met him last week.
(c)/No error. (d)

Directions (Q. 16–25) : *In the following questions, choose the option which shows common feature in the relationship given in each question.*

16. Indira : Nehru : Benazir
(a) They were Presidents
(b) They were Prime Ministers
(c) They were sports persons
(d) They were Indian politicians

17. Mohinder : Gavaskar : Azaharuddin
(a) They were Indian Athlets
(b) They were Indian foreign ministers
(c) They were cicket umpires
(d) They are former Indian cricketers

18. Folketing : Stortling : Knesset
(a) They are the name of currencies
(b) They are the name of rivers
(c) They are the name of Parliaments
(d) They are the name of cities

19. Car : Bike : Bus
(a) They are accelerator
(b) They are mode of transport
(c) They have wheels
(d) They are run by a person

20. Irna : PTI : Xin-Era
(a) They are newspapers
(b) They are computer manufacturing companies
(c) They are news agencies
(d) They are publishing houses

21. Pitcher : Dusra : Bunker
(a) They are parliament's name
(b) They are dwelling places of animals
(c) They are sports terms
(d) They are terms related to cricket

22. Mamb : Krait : Viper
(a) They are insects
(b) They are haunting spirits
(c) These are boot polishes
(d) These are snakes

23. Metre : Mile : Kilometre
(a) They are units of electricity
(b) They are units of measuring anything
(c) They are units of distance
(d) They are units of weight

24. Crocodile : Whale : Hippopotamus
(a) They are animals
(b) They are domestic animals
(c) They are land animals
(d) They are water animals

25. Knot : Watt : Fathom
(a) The terms are used by sailors
(b) The terms are used for installing electricity
(c) The terms are connected with rope
(d) They are units of measurement

26. At which place has the Central Government decided to set up a sector specific SEZ in biotechnology ?

(a) Bengaluru (b) Hyderabad
(c) New Delhi (d) Cuttack

27. What is 'NSG'?

(a) National Service of Government
(b) Nuclear Supplier Group
(c) Non-Nuclear Supplier Group
(d) Non-Secular Group

28. Which is the tallest structure in the world ?

(a) Taipei Towers (b) Effel Tower
(c) Burj Dubai (d) Patronos Tower

29. Name the Country with which India has agreed to deepen security cooperation, bilaterally and in the multilateral fora, and strengthen terrorism in all its form and maifestations.

(a) France (b) Canada
(c) Russia (d) Nepal

30. Nepal Electricity Authority (NEA) has signed a joint venture agreement with CTGC to construct 750 MW west seti hydropower project. CTGC is a/an

(a) India company (b) Chinese company
(c) Russian company (d) American company

Answers

Physics

1.	*(b)*	2.	*(b)*	3.	*(b)*	4.	*(a)*	5.	*(c)*	6.	*(d)*	7.	*(b)*	8.	*(a)*	9.	*(d)*	10.	*(b)*
11.	*(c)*	12.	*(b)*	13.	*(c)*	14.	*(c)*	15.	*(c)*	16.	*(b)*	17.	*(c)*	18.	*(b)*	19.	*(d)*	20.	*(d)*
21.	*(a)*	22.	*(d)*	23.	*(a)*	24.	*(a)*	25.	*(c)*	26.	*(b)*	27.	*(c)*	28.	*(d)*	29.	*(d)*	30.	*(c)*
31.	*(b)*	32.	*(b)*	33.	*(a)*	34.	*(b)*	35.	*(b)*	36.	*(c)*	37.	*(a)*	38.	*(c)*	39.	*(d)*	40.	*(a)*
41.	*(c)*	42.	*(b)*	43.	*(a)*	44.	*(c)*	45.	*(c)*	46.	*(c)*	47.	*(d)*	48.	*(d)*	49.	*(b)*	50.	*(a)*

Chemistry

1.	*(b)*	2.	*(a)*	3.	*(b)*	4.	*(d)*	5.	*(a)*	6.	*(a)*	7.	*(d)*	8.	*(d)*	9.	*(c)*	10.	*(a)*
11.	*(b)*	12.	*(d)*	13.	*(b)*	14.	*(a)*	15.	*(c)*	16.	*(c)*	17.	*(a)*	18.	*(c)*	19.	*(c)*	20.	*(d)*
21.	*(b)*	22.	*(d)*	23.	*(c)*	24.	*(b)*	25.	*(a)*	26.	*(b)*	27.	*(b)*	28.	*(b)*	29.	*(b)*	30.	*(a)*
31.	*(a)*	32.	*(b)*	33.	*(b)*	34.	*(b)*	35.	*(a)*	36.	*(a)*	37.	*(c)*	38.	*(a)*	39.	*(b)*	40.	*(b)*
41.	*(b)*	42.	*(c)*	43.	*(c)*	44.	*(d)*	45.	*(a)*	46.	*(a)*	47.	*(c)*	48.	*(d)*	49.	*(d)*	50.	*(a)*

Mathematics

1.	*(d)*	2.	*(c)*	3.	*(c)*	4.	*(a)*	5.	*(a)*	6.	*(a)*	7.	*(b)*	8.	*(d)*	9.	*(b)*	10.	*(a)*
11.	*(b)*	12.	*(a)*	13.	*(a)*	14.	*(a)*	15.	*(c)*	16.	*(b)*	17.	*(b)*	18.	*(a)*	19.	*(c)*	20.	*(c)*
21.	*(d)*	22.	*(a)*	23.	*(d)*	24.	*(d)*	25.	*(d)*	26.	*(a)*	27.	*(c)*	28.	*(b)*	29.	*(a)*	30.	*(a)*
31.	*(c)*	32.	*(a)*	33.	*(b)*	34.	*(b)*	35.	*(a)*	36.	*(d)*	37.	*(b)*	38.	*(d)*	39.	*(b)*	40.	*(d)*
41.	*(b)*	42.	*(c)*	43.	*(a)*	44.	*(d)*	45.	*(c)*	46.	*(b)*	47.	*(a)*	48.	*(b)*	49.	*(d)*	50.	*(a)*
51.	*(a)*	52.	*(d)*	53.	*(b)*	54.	*(c)*	55.	*(c)*	56.	*(c)*	57.	*(c)*	58.	*(a)*	59.	*(d)*	60.	*(b)*
61.	*(c)*	62.	*(a)*	63.	*(c)*	64.	*(b)*	65.	*(c)*	66.	*(a)*	67.	*(b)*	68.	*(b)*	69.	*(a)*	70.	*(d)*

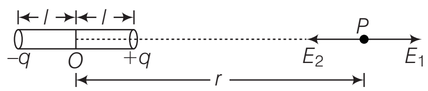
English & General Aptitude

1.	*(c)*	2.	*(d)*	3.	*(b)*	4.	*(d)*	5.	*(d)*	6.	*(c)*	7.	*(a)*	8.	*(b)*	9.	*(d)*	10.	*(d)*
11.	*(b)*	12.	*(d)*	13.	*(b)*	14.	*(b)*	15.	*(a)*	16.	*(b)*	17.	*(d)*	18.	*(c)*	19.	*(b)*	20.	*(c)*
21.	*(c)*	22.	*(d)*	23.	*(c)*	24.	*(d)*	25.	*(d)*	26.	*(b)*	27.	*(b)*	28.	*(c)*	29.	*(a)*	30.	*(b)*

Answer *with* Solutions

Physics

1. *(b)* For a dipole of length $2l$



$$E = \frac{1}{4\pi\varepsilon_0 K} \cdot \frac{2pr}{(r^2 - l^2)^2}$$

When $(l << r)$, then l^2 may be neglected in comparison to r^2.

$$\therefore \quad E = \frac{1}{4\pi\varepsilon_0 K} \frac{2pr}{r^4} = \frac{1}{4\pi\varepsilon_0 K} \frac{2p}{r^3} \text{ N/C}$$

$$\Rightarrow \quad E \propto \frac{1}{r^3}$$

2. *(b)* Force due to magnetic field is

$$F = qvB \sin\theta$$

when $\theta = 90°$

$$F = qvB \quad \ldots\text{(i)}$$

Force due to electric field E is

$$F = qE \quad \ldots\text{(ii)}$$

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

$$|\vec{\mathbf{E}}| = v|\vec{\mathbf{B}}|$$

3. *(b)* The magnetic field is given by

$$B = \mu_0 ni$$

where $\mu_0 = 4\pi \times 10^{-7}$ T mA^{-1},

$$n = \frac{1000}{50 \times 10^{-2}}, \; i = 5 \text{ A}$$

$$\therefore \quad B = 4\pi \times 10^{-7} \times \frac{1000 \times 10^{-2}}{50 \times 10^{-2}} \times 5$$

$$B = 1.26 \times 10^{-2} \text{ T}$$

4. *(a)* From transformer ratio

$$\frac{V_s}{V_p} = \frac{N_s}{N_p}$$

$$\Rightarrow \quad V_s = \frac{V_p \times N_s}{N_p} = \frac{220 \times 40000}{200} = 44000 \text{ V}$$

Potential difference per turn is

$$\frac{V_s}{N_s} = \frac{44000}{40000} = 1.1 \text{ V}$$

5. *(c)* Slit width, $w = \dfrac{D\lambda}{d}$

Given, $D = 80\text{cm} = 80 \times 10^{-2}$ m,

$$\lambda = 6000\text{Å} = 6000 \times 10^{-10} \text{ m},$$

$$d = \frac{5}{2}\text{mm} = \frac{5 \times 10^{-3}}{2} \text{ m}.$$

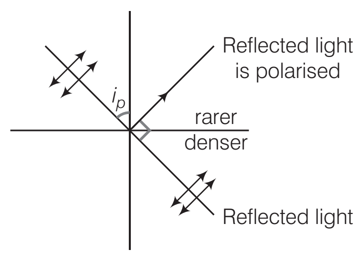
$$\therefore \quad w = \frac{80 \times 10^{-2} \times 6000 \times 10^{-10} \times 2}{5 \times 10^{-3}}$$

$$w = 0.192 \times 10^{-3} \text{m} = 0.192 \text{ mm}$$

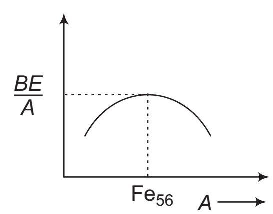
6. *(d)* According to Brewster's law, when unpolarised light is incident at polarising angle i_p on an interface separating a rarer medium from a denser medium of refractive index μ, such that

$$\mu = \tan i_p$$

then light reflected in the rarer medium is completely polarised.



7. *(b)* Binding energy per nucleon increases with atomic number and is maximum for iron, after that it decreases.



8. *(a)* From lens formula

$$\frac{1}{f} = ({}_a\mu_g - 1)\left(\frac{1}{R_1} - \frac{1}{R_2}\right)$$

$$= (1.5 - 1)\left(\frac{1}{R_1} - \frac{1}{R_2}\right) \quad \ldots\text{(i)}$$

Also, $\quad {}_l\mu_g = \dfrac{\mu_g}{\mu_l} = \dfrac{1.5}{1.6}$

$$\therefore \quad \frac{1}{f'} = ({}_l\mu_g - 1)\left(\frac{1}{R_1} - \frac{1}{R_2}\right)$$

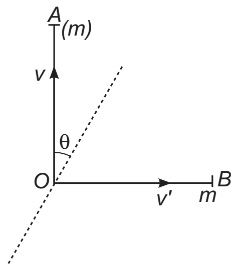
$$\frac{1}{f'} = \left(\frac{15}{16} - 1\right)\left(\frac{1}{R_1} - \frac{1}{R_2}\right) \quad \ldots(ii)$$

Dividing Eq. (i) by Eq. (ii), we get

$$\frac{f}{f'} = \frac{\left(\frac{15}{16} - 1\right)}{(1.5 - 1)} = -\frac{1}{16 \times 5}$$

$$\Rightarrow \quad f = -160 \text{ cm}$$

9. *(d)* From law of conservation of momentum



$$mv - mv'\cos\theta = 0 \quad \ldots(i)$$

$$mv - mv'\sin\theta = 0 \quad \ldots(ii)$$

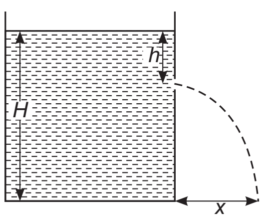
From Eqs. (i) and (ii), we get

$$\theta = 45^\circ$$

$$v' = \frac{v}{\cos\theta} = v\sqrt{2}$$

10. *(b)* When two identical transverse or longitudinal progressive waves travel in a bounded medium with the same speed, but in opposite directions, then by their superposition a new type of wave is produced which appears stationary in the medium. Thus, is called stationary wave.

11. *(c)* From Bernoulli's theorem



$$p + 0 + \rho g H = p + \frac{1}{2}\rho v^2 + \rho g (H - h)$$

$$\frac{1}{2}\rho v^2 = \rho g h$$

$$\Rightarrow \quad v = \sqrt{2gh}$$

12. *(b)* In N forces of equal magnitude works on a single point and their resultant is zero, then angle between any two forces is

$$\theta = \frac{360^\circ}{N} = \frac{360^\circ}{3} = 120^\circ$$

If these 3 vectors are represented by three sides of triangle, then they form equilateral triangle.

13. *(c)* $F = Bev$ and $B = \dfrac{\mu_0 i}{2\pi r}$

$$\therefore \quad F = \frac{\mu_0 i}{2\pi r} \times ev$$

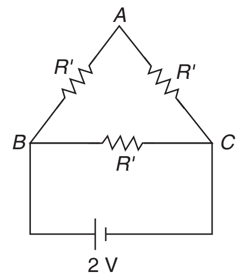
$$= \frac{4\pi \times 10^{-7} \times 5}{2\pi \times 0.1} \times 1.6 \times 10^{-19} \times 5 \times 10^6$$

$$= 8 \times 10^{-18} \text{ N}$$

14. *(c)* $R' = \dfrac{9}{3} = 3\Omega$

$$R_{\text{net}} = 2\,\Omega$$

PD across AB



$$V' = i \times R' = \frac{V}{R_{\text{net}}} \times R = \frac{2}{2} \times 3 = 3 \text{ V}$$

15. *(c)* $E_1 + E_2 = k \times 58 \quad \ldots(i)$

$$E_1 - E_2 = k \times 29 \quad \ldots(ii)$$

$$\therefore \quad \frac{E_1 + E_2}{E_1 - E_2} = 2$$

$$\Rightarrow \quad \frac{E_1}{E_2} = \frac{3}{1}$$

16. *(b)* When the lift is stationary $w = mg$

$$\Rightarrow \quad 49 = m \times 9.8$$

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

When the lift is moving downward with an acceleration

$$R = m(9.8 - a) = 5(9.8 - 5) = 24 \text{ N}$$

17. *(c)* From Newton's law of cooling

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

Therefore,

$$\frac{60^\circ - 40^\circ}{7} \propto \left(\frac{60^\circ + 40^\circ}{2} - 10^\circ\right) \quad \text{...(i)}$$

$$\frac{40^\circ - 28^\circ}{t} \propto \left(\frac{40^\circ + 28^\circ}{2} - 10^\circ\right) \quad \text{...(ii)}$$

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

$$t = 7 \text{ s}$$

18. *(b)* Einstein's equation is

$$V = \frac{h\nu}{e} - \frac{h\nu_0}{e}$$

Here, slope of line $= \frac{h}{e}$

$\Rightarrow h$ = Planck's constant = slope $\times\, e$

19. *(d)* Width of central maximum

$$\beta = \frac{D\lambda}{d}, \; d \text{ being slit width.}$$

If the slit width is increased the central maximum becomes narrower and more light reaches the region.

20. *(d)* Since, collision is elastic hence, velocities of bobs A and B get interchanged. Thus, A will come to rest and B will move with the velocity of A.

21. *(a)* $I = k\tan\theta$, k being reduction factor and $I \propto \frac{1}{R}$

$$\Rightarrow \quad \frac{R + r}{(R + r) + R'} = \frac{\tan\theta'}{\tan\theta}$$

$$\Rightarrow \quad \frac{4 + 2}{6 + R'} = \frac{\tan 30^\circ}{\tan 60^\circ}$$

$$\Rightarrow \quad R' = 12\,\Omega$$

22. *(d)*

$$\beta = \frac{\alpha}{1 - \alpha} = \frac{0.9}{1 - 0.9} = 9$$

$$\Rightarrow \quad \frac{\Delta I_c}{\Delta I_b} = 9$$

$$\Rightarrow \quad I_c = 9 \times 2$$

$$\Rightarrow \quad \Delta I_c = 18\,\mu\text{A}$$

23. *(a)* Energy needed = Increment in surface energy

= (surface energy of n small drops)

− (surface energy of one big drop)

$$= n\, 4\pi r^2 T - 4\pi R^2 T = 4\pi T(nr^2 - R^2)$$

24. *(a)*

$$p \propto T$$

$$\frac{p_1}{p_2} = \frac{T_1}{T_2}$$

$$\Rightarrow \quad \frac{p_2 - p_1}{p_1} = \frac{T_2 - T_1}{T_2}$$

$$\Rightarrow \quad \left[\frac{\Delta p}{p}\right]\% = \left[\frac{251 - 250}{250}\right] \times 100 = 0.4\%$$

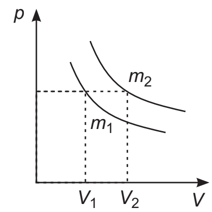
25. *(c)* Net phase difference between current and voltage

$$= \frac{\pi}{6} - \left(-\frac{\pi}{6}\right) = \frac{\pi}{3} = 60^\circ$$

Hence, current leads the voltage by 60°.

26. *(b)* According to Lenz's law acceleration of the magnet will be less than the acceleration due to gravity due to the fact that emf induced in the ring opposes the motion of magnet.

27. *(c)* $pV = nRT = \frac{m}{M} RT$



For 1st graph, $p = \frac{m_1}{M} \frac{RT}{V_1}$

For 2nd graph, $p = \frac{m_2}{M} \frac{RT}{V_2}$

Equating the two, we get

$$\frac{m_1}{m_2} = \frac{V_1}{V_2}$$

$$\Rightarrow \quad m \propto \frac{1}{V}$$

As $V_2 > V_1 \Rightarrow m_1 < m_2$

28. *(d)* $F_{BA} = \frac{\mu_0 I^2}{2\pi x}$ (attractive force)

and $\quad F_{CA} = \frac{\mu_0 (I)\,(2I)}{2\pi\,(2x)} = \frac{\mu_0 I^2}{2\pi x}$ (repulsive force)

Hence, $\quad F_{BA} = -F_{CA}$

$\Rightarrow \quad F_1 = -F_2$

29. *(d)* From the problem it is clear that $\angle e = \angle r_2 = 0$

From $A = r_1 + r_2$

$\Rightarrow \quad r_1 = A = 45^\circ$

$$\therefore \quad \mu = \frac{\sin i}{\sin r_1} = \frac{\sin 60^\circ}{\sin 45^\circ} = \sqrt{\frac{3}{2}}$$

Also, from $i + e = A + \delta$

$\Rightarrow \quad 60 + 0 = 45 + \delta$

$\Rightarrow \quad \delta = 15^\circ$

30. *(c)* $\frac{1}{f} = (\mu - 1)\left[\frac{1}{R_1} - \frac{1}{R_2}\right]$

$= (1.6 - 1)\left[\frac{1}{60} - \frac{1}{\infty}\right] = \frac{1}{100}$

$f = 100$ cm

31. *(b)* Conservation of linear momentum gives

$$m_1u_1 + m_2u_2 = m_1v_1 + m_2v_2$$

$\Rightarrow \quad m_2v_2 = \frac{3u}{2} \qquad \ldots(\text{i})$

Conservation of kinetic energy gives

$$\frac{1}{2}m_1u_1^2 + \frac{1}{2}m_2u_2^2 = \frac{1}{2}m_1v_1^2 + \frac{1}{2}m_2v_2^2$$

$\Rightarrow \quad m_2v_2^2 = \frac{15u^2}{8} \qquad \ldots(\text{ii})$

Hence, on solving Eqs. (i) and (ii), we get

$$m_2 = 1.2 \text{ kg}$$

32. *(b)* Given,

$$10 = \frac{G \times 6 \times 10^{24} \times 1}{(6.4 \times 10^6)^2}$$

$\Rightarrow \quad G = 6.82 \times 10^{-11} \text{ Nm}^2/\text{kg}^2$

Therefore,

$$F_{\text{satellite}} = \frac{6.82 \times 10^{-11} \times 6 \times 10^{24} \times 200}{\left(\frac{3 \times 6.4 \times 10^6}{2}\right)^2} = 889 \text{ N}$$

33. *(a)* Electron concentration is greater than hole concentration in *n*-type semiconductor.

34. *(b)* *p*-*n* junction diode will be forward biased, if greater positive potential is given to *p*-side. So, diodes 2, 4, 5 are forward biased.

35. *(b)* $y_1 = a_1 \sin\left(\omega t - \frac{2\pi x}{\lambda}\right)$ and

$y_2 = a_2 \cos\left(\omega t - \frac{2\pi x}{\lambda} + \phi\right)$

$= a_2 \sin\left(\omega t - \frac{2\pi x}{\lambda} + \phi + \frac{\pi}{2}\right)$

So, phase difference $= \phi + \frac{\pi}{2}$

and path difference $\Delta = \frac{\lambda}{2\pi}\left(\phi + \frac{\pi}{2}\right)$

36. *(c)* $I = \frac{E - e}{R} \qquad \ldots(\text{i})$

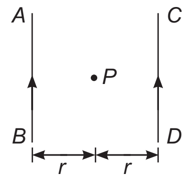
and $\eta \times 100 = \left(\frac{e}{E}\right) \times 100 \qquad \ldots(\text{ii})$

$\therefore \quad 30 = \frac{e}{50} \times 100 \qquad$ [from Eqs. (ii)]

$\Rightarrow \quad e = 15 \text{ V}$

Thus, $\quad R = \frac{50 - 15}{12} = 2.9\ \Omega$

37. *(a)* At point *P*,



$B_{\text{net}} = B_{AB} + B_{CD}$

$= \frac{\mu_0 i}{2r} + \frac{\mu_0 i}{2r} = \frac{\mu_0 i}{r}$

38. *(c)* $S = \frac{I_gG}{I - I_g} = \frac{10^{-3} \times 20}{1 - 1 \times 10^{-3}} = 0.02\ \Omega$

39. *(d)* $\frac{V_s}{V_p} = \frac{I_s}{I_p}$

$\Rightarrow \quad I_s = I_p \times \frac{V_s}{V_p} = 5 \times \frac{220}{22000} = 0.05 \text{ A}$

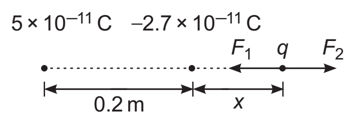
40. *(a)* $\frac{I_{\text{max}}}{I_{\text{min}}} = \frac{(\sqrt{2I} + \sqrt{I})^2}{(\sqrt{2I} - \sqrt{I})^2} = \left(\frac{\sqrt{2} + 1}{\sqrt{2} - 1}\right)^2$

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

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

$= \frac{9 + 8 + 12\sqrt{2}}{1} \approx 34$

41. *(c)* From the question $F_1 = F_2$



$\Rightarrow \frac{1}{4\pi\varepsilon_0} \times \frac{5 \times 10^{-11} \times q}{(0.2 + x)^2} = \frac{1}{4\pi\varepsilon_0} \times \frac{2.7 \times 10^{-11} \times q}{x^2}$

$\Rightarrow \quad x = 0.556$ m from IInd charge.

42. *(b)* $\frac{4}{3}\pi r^3 \times n = \frac{4}{3}\pi R^3$

$\Rightarrow \quad R = n^{1/3}\, r$

$\therefore \quad V_{\text{big}} = \frac{1}{4\pi\varepsilon_0} \times \frac{Q}{R} = \frac{1}{4\pi\varepsilon_0} \times \frac{nq}{n^{1/3} r} = n^{2/3}\, V$

43. *(a)* The charge will flow from the outer surface of smaller one to bigger one only in case (a).

44. *(c)* $\mu = \dfrac{\sin\left(\dfrac{A+\delta_m}{2}\right)}{\sin\dfrac{A}{2}}$

$$\sqrt{3} = \frac{\sin\left(\dfrac{60^\circ+\delta_m}{2}\right)}{\sin\dfrac{60^\circ}{2}} \Rightarrow \frac{\sqrt{3}}{2} = \sin\left[30^\circ + \frac{\delta_m}{2}\right]$$

$\Rightarrow \delta_m = 60^\circ$

45. *(c)* Magnetic field due to solenoid is independent of diameter (Because $B = \mu_0 ni$).

46. *(c)* Resistance per unit length of wire

$$x = \frac{3}{100} = 3\times10^{-2}\ \Omega\ \text{cm}^{-1}$$

Equivalent length of wire $l' = \dfrac{R+3}{3\times10^{-2}}$,

R being additional resistance

$$\frac{E}{k} = \frac{R+3}{3\times10^{-2}}$$

$$\Rightarrow \quad \frac{2}{1\times10^{-3}} = \frac{R+3}{3\times10^{-2}}$$

$$\Rightarrow \quad R = 57\ \Omega$$

47. *(d)*

White	Brown	Red	Silver
9	1	10^2	10%

$\therefore \quad R = 91\times10^2 \pm 10\%\ \Omega$

ie, $\quad R = 9.1\ \text{k}\Omega$ with tolerance $\pm$ 10%

48. *(d)*

$$E = \Delta mc^2$$

$$E = \frac{0.3}{1000}\times(3\times10^8)^2$$

$$= 2.7\times10^{13}\ \text{J}$$

$$= \frac{2.7\times10^{13}}{3.6\times10^6} = 7.5\times10^6\ \text{kWh}$$

49. *(b)*

$$\lambda_{\text{photon}} = \frac{hc}{E}$$

$$\lambda_{\text{photon}} = \frac{h}{\sqrt{2mE}}$$

$$\Rightarrow \quad \frac{\lambda_{\text{photon}}}{\lambda_{\text{electron}}} = c\sqrt{\frac{2m}{E}}$$

$$\frac{\lambda_{\text{photon}}}{\lambda_{\text{electron}}} \propto \frac{1}{\sqrt{E}}$$

50. *(a)* Applying Kirchhoff's law in the given figure.
At junction A

$$i + i_1 + i_2 = 1 \qquad \ldots\text{(i)}$$

For loop (1)

$$-60i + (15+5)\,i_1 = 0$$

$$\Rightarrow \quad i_1 = 3i \qquad \ldots\text{(ii)}$$

For loop (2)

$$-(15+5)\,i_1 + 10 i_2 = 0$$

$$\Rightarrow \quad i_2 = 2i_1 = 6i \qquad \ldots\text{(iii)}$$

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

$$i = 0.1\ \text{A}$$

Chemistry

1. *(b)*

$$\underset{100\text{ g}}{CaCO_3} + \underset{73\text{ g}}{2HCl} \longrightarrow CaCl_2 + \underset{44\text{ g}}{CO_2} + H_2O$$

100 mL of 20% HCl solution = 20 g HCl

Here $CaCO_3$ is the limiting reactant.

100 g of $CaCO_3$ gives = 44 g CO_2

$\therefore$ 20 g of $CaCO_3$ will give $= \dfrac{44}{100}\times 20$

$= 8.80$ g of CO_2

2. *(a)* Mass of $H_2 = \dfrac{0.7}{22.4}\times 2 = \dfrac{14}{224}\ \text{g} = 0.0625\ \text{g}$

$\therefore$ 0.0625 g of hydrogen is displaced by x g of metal.

$\therefore$ 1 g of hydrogen is displaced by $\dfrac{x}{0.0625}$ g of metal.

$$\therefore \quad \frac{x}{0.0625} = 28$$

$\therefore$ Mass of metal $(x) = 28\times0.0625 = 1.75$ g

3. *(b)* In Balmer series electrons transfer from higher orbits to 2nd orbit.

$$n_2 = 3, 4, 5, 6, \ldots.$$

$$n_1 = 2$$

4. *(d)* The electron affinity of Be is almost similar to that of Ne because they have stable (fully filled subshells) configuration.

5. *(a)* For a spontaneous process the value of ΔG must be negative.

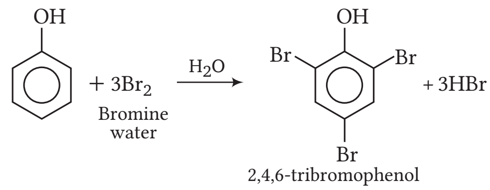
6. *(a)* pH of an acid buffer is given by Henderson equation.

$$\text{pH} = -\log K_a + \log\frac{[\text{Salt}]}{[\text{Acid}]}$$

or $$\text{pH} = \text{p}K_a + \log\frac{[\text{Salt}]}{[\text{Acid}]}$$

7. *(d)* In S_N1 reaction the racemization takes place due to inversion and retention of configuration.

8. *(d)* Phenol reacts with excess of bromine water to give 2, 4, 6-tribromophenol.



9. *(c)* $\underset{\text{Acetic acid}}{CH_3COOH} + NH_3 \longrightarrow \underset{\text{Ammonium acetate}}{CH_3COONH_4}$

$$\xrightarrow{\Delta} \underset{\text{Acetamide}}{CH_3CONH_2} + H_2O$$

10. *(a)* In ZnS, S^- ions adopt fcc lattice in which Zn^{2+} ions are present at alternate tetrahedral sites. Hence, coordination number of S^{2-} is equal to coordination number of Zn^{2+} *i.e.* 4.

11. *(b)* $\because$ Rate $= k[A]^{3/2}[B]^{-1}$

$\therefore$ Order of reaction $= \frac{3}{2} - 1 = \frac{1}{2}$

12. *(d)* $k = \frac{2.303}{32} \log \frac{a}{a - 0.99a} = 0.1439 \text{ min}^{-1}$

$t = \frac{2.303}{0.1439} \log \frac{a}{a - 0.999a} = 48 \text{ min}$

13. *(b)* Greater the number of ions, greater will be elevation in boiling point. Hence, 0.1m $FeCl_3$ exhibits the maximum elevation in boiling point among these.

14. *(a)* The balanced equation is as

$$5I^- + IO_3^- + 6H^+ \longrightarrow 3I_2 + 3H_2O$$

15. *(c)* Lyophilic sols are more stable than lyophobic sols because the colloidal particles are solvated.

16. *(c)* The compounds which contain either $CH_3—\underset{|}{C}O$ or $CH_3—\underset{\underset{OH}{|}}{CH^-}$ group exhibit positive iodoform test. $(CH_3)_2CO$ due to presence of $CH_3—\underset{|}{C}=O$ group gives positive iodoform test

$$(H_3C)_2C=O + NaOH + I_2 \longrightarrow CHI_3 + CH_3COONa + H_2O$$

17. *(a)* Starch is the main storage polysaccharide of plants. It is a polymer of α-D-glucose.

$$\underset{\text{Starch}}{(C_6H_{10}O_5)_n} \xrightarrow{H^+} \underset{\text{Maltose}}{C_{12}H_{22}O_{11}} \xrightarrow{H^+} \underset{\text{D-glucose}}{C_6H_{12}O_6}$$

18. *(c)* The nitro group can attach to metal through nitrogen as ($-NO_2$) or through oxygen as nitro ($-ONO$), hence nitropentamine chromium (III) chloride shows linkage isomerism.

19. *(c)* $2Ag^+(aq) + 2e^- \longrightarrow 2Ag(s); E° = 0.80$ V

$Cd(s) \longrightarrow Cd^{2+}(aq) + 2e^-; E° = 0.40$ V

$2Ag^+(aq) + Cd(s) \longrightarrow Cd^{2+}(aq) + 2Ag(s)$

$E° = 1.20$ V

$$\Delta G = -nFE°$$
$$= -2 \times 96500 \times 1.20$$
$$= -231.6 \text{ kJ}$$

20. *(d)* $\mu = \sqrt{n(n+2)}$

where, n = no. of unpaired electrons. Hence, the ion which has the maximum number of unpaired electron, will show the highest magnetic moment. Mn^{2+} has maximum 5 unpaired electrons, hence it shows the highest magnetic moment.

21. *(b)* Cane sugar reacts with conc. H_2SO_4 to give charrs. It is because H_2SO_4 acts as a dehydrating agent.

$$C_{12}H_{22}O_{11} + H_2SO_4(\text{conc.}) \longrightarrow 12C + 11H_2O + H_2SO_4$$

22. *(d)* For the value $n = 3$, the value of l are 0,1 and 2. Hence, m cannot have value 3.

23. *(c)* The formation of oxide ion $O^{2-}(g)$ require first an exothermic and then an endothermic step because the O^- ion will tend to resist the addition of another electron.

24. *(b)* Potassium dichromate acts like an oxidising agent in the presence of dilute H_2SO_4 as :

$$Cr_2O_7^{2-} + 14H^+ + 6e^- \longrightarrow 2Cr^{3+} + 7H_2O$$

$\therefore$ Equivalent mass of $K_2Cr_2O_7$

$$= \frac{\text{molecular mass of } K_2Cr_2O_7}{6}$$

25. *(a)* The number of atoms of the ligands that are directly bound to the central metal atom or ion by coordinate bond is known as the coordination number of the metal atom or ion.

Coordination number of metal = number of σ bonds formed by metal with ligands.

26. *(b)* Ethylene diamine is an example of bidentate ligand. Its structure is as :

$$\begin{array}{l} CH_2—NH_2 \\ | \\ CH_2—NH_2 \end{array}$$

27. *(b)* Deviation from ideal gas behaviour of a gas is expressed in terms of compressibility factor, Z

$$Z = \frac{pV}{nRT}$$

28. *(b)* Total moles of NaOH $= 4 \times 0.2 + 2 \times 0.5$

$$= 0.8 + 1.0 = 1.8$$

Total volume $= 4 + 2 = 6$ L

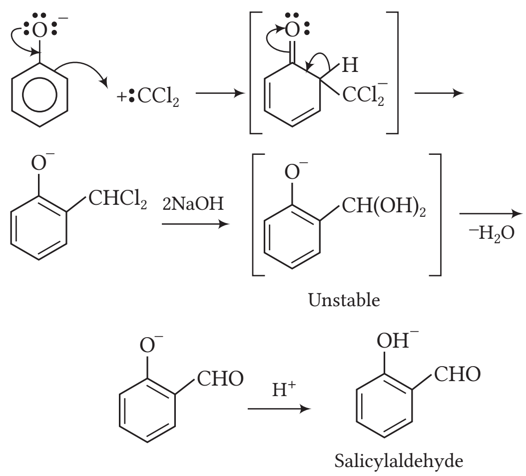
$\therefore$ Molarity $= \frac{1.8}{6}$

$$= 0.3 \text{ M}$$

29. *(b)* In the Reimer-Tiemann reaction carbene intermediate is formed

$$CHCl_3 + OH^- \longrightarrow H_2O + CCl_3^-$$

$$\longrightarrow Cl^- + \underset{\text{Dichlorocarbene}}{:CCl_2}$$



30. *(a)* Chloral (CCl_3CHO) does not contain any α-hydrogen atom, hence it will not give aldol condensation reaction.

31. *(a)* $\Rightarrow \Delta S_{fus} = \frac{\Delta H_{fus}}{T}$

Given, $T = 27 + 273$

$= 300$ K

$\therefore \quad \Delta S_{fus} = \frac{600}{300} = 2 \text{ cal deg}^{-1}$

32. *(d)* $Al_2(SO_4)_3 \rightleftharpoons 2Al^{3+} + 3SO_4^{2-}$

$$K_{sp} = [Al^{3+}]^2 [SO_4^{2-}]^3$$

33. *(b)* Bulky groups on the carbon atom attached to the halogen atom will hinder attack by S_N2 mechanism due to steric hindrance and hence, would favour S_N1 mechanism.

34. *(b)* Bond strength depends on bond order. More is the bond order, more is the strength.

Species	**Bond order**
O_2	2
O_2^-	1.5
O_2^{2-}	1.0

Hence, the order of bond strength is as :

$$O_2 > O_2^- > O_2^{2-}$$

35. *(a)* $\because$ 24 g of Mg produce MgO = 1 mol

$\therefore$ 1.2 g of Mg will produce MgO $= \frac{1 \times 1.2}{24}$

$= 0.05$ mol

36. *(a)* $\Delta S_{vap} = \frac{\Delta H_{vap}}{T}$

$\because \Delta H_{vap} = 40.8 \text{ kJ mol}^{-1}, T = 373 \text{ K}$

$$\Delta S_{vap} = \frac{40.8 \times 10^3}{373} = 109.4 \text{ JK}^{-1} \text{ mol}^{-1}$$

37. *(c)* The function of $AlCl_3$ in Friedel-Craft's reaction is to produce electrophile.

$$R—Cl + AlCl_3 \longrightarrow \underset{\text{Electrophile}}{R^+} + AlCl_4^-$$

38. *(a)* O_2 has two unpaired electrons in $\overset{*}{\pi}$ molecular orbitals, hence it is paramagnetic in nature.

39. *(b)* Pent-3-en-2-ol shows both optical as well as geometrical isomerism and hence, four stereoisomers are possible.

$$CH_3—\underset{\underset{OH}{|}}{\overset{*}{C}H}—CH=CH—CH_3$$

40. *(b)* When *A–B* attractions are greater than *A–A* and *B–B*, then less vapours are formed and hence, solution shows negative deviation.

41. *(c)* Radon is radioactive with half-life period of 3.8 days and is used for the treatment of cancer.

42. *(c)* $He_2 : (\sigma 1s)^2 \, (\overset{*}{\sigma} 1s)^2$

$$\text{Bond order} = \frac{N_b - N_a}{2} = \frac{2-2}{2} = 0$$

43. *(d)* 0.16 g of dibasic acid is neutralised by

= 25mL of 0.1M NaOH

$$H_2X + 2NaOH = Na_2X + H_2O$$

$$\text{Millimoles of acid} = \frac{1}{2} \times \text{millimoles of NaOH}$$

$$= \frac{1}{2} \times 25 \times 0.1$$

$$= 1.25$$

$$\because \quad \text{Millimoles} = \frac{W\ (\text{mg})}{\text{mol. mass}}$$

$$\therefore \text{Mol. mass} = \frac{W\ (\text{mg})}{\text{millimoles}} = \frac{0.16 \times 1000}{1.25} = 128$$

44. *(d)* The relationship between the standard free energy ($\Delta G°$) and equilibrium constant (K) is as

$$\Delta G° = -2.303\, RT \log K$$

45. *(a)* Number of moles of HCl $= \frac{0.192}{36.5} = 0.0053$

Volume = 0.5L

$$\text{Molarity of HCl} = \frac{0.0053}{0.5} = 1.06 \times 10^{-2}\ \text{M}$$

$$[H^+] \text{ in HCl solution} = 1.06 \times 10^{-2} \times \frac{95}{100} \approx 1 \times 10^{-2}$$

$$pH = -\log [H^+] = -\log (1 \times 10^{-2}) = 2$$

46. *(a)* Molisch test is given by all carbohydrates.
Molisch test : Carbohydrate solution + 10% alco. solution of α-naphthol + conc. H_2SO_4 along the side of test tube $\longrightarrow$ A reddish violet ring at the junction of two layers shows the presence of carbohydrate.

47. *(c)* Insulin is a peptide hormone. It is secreted from pancreas. It has 51 amino acids.

48. *(d)* As the crystal field splitting in case of complexes of metal ions in 4*d* and 5*d* transition series are much larger, the electrons of the metal ion are paired up first in lower energy set of orbitals before going to the higher energy set within the same *d*-subshell causing maximum pairing and thus, low spin (or spin paired) complexes are formed.

49. *(d)* $CH_2{=}CH{-}\overset{*}{C}H(CH_3){-}CH_2CH_3 \xrightarrow{H_2/Pt} CH_3CH_2{-}CH(CH_3){-}CH_2CH_3$

optically active 3-methyl-1-pentene → optically inactive

50. *(a)* $\because$ $\Delta x = \Delta v$

$$\Delta x \times \Delta p \geq \frac{h}{4\pi}$$

$$\Delta x \times m \cdot \Delta v = \frac{h}{4\pi}$$

$$(\Delta v)^2 = \frac{h}{4\pi m} \qquad (\because \Delta x = \Delta v)$$

$$\therefore \quad \Delta p = m \cdot \Delta v = m\sqrt{\frac{h}{4\pi m}} = \sqrt{\frac{mh}{4\pi}}$$

$$\Delta p = \frac{1}{2}\sqrt{\frac{mh}{\pi}}$$

Mathematics

1. *(d)* $3^{|3x+4|} = 9^{2x-2}, x > 0$

When $x > 0$, then

$$|3x + 4| = 3x + 4$$

$\therefore \quad 3^{3x+4} = 3^{2(2x-2)}$

$\Rightarrow \quad 3x + 4 = 4x - 4$

$\Rightarrow \quad x = 8$

2. *(c)* Given, $\vec{\mathbf{a}} = 3\vec{\alpha} - \vec{\beta}, \vec{\mathbf{b}} = \vec{\alpha} + 3\vec{\beta}$ and

$|\vec{\alpha}| = |\vec{\beta}| = 2$

$\therefore \; |\vec{\mathbf{a}} + \vec{\mathbf{b}}|^2 = |4\vec{\alpha} + 2\vec{\beta}|^2$

$= 16|\vec{\alpha}|^2 + 4|\vec{\beta}|^2 + 16|\vec{\alpha}||\vec{\beta}|\cos\frac{\pi}{3}$

$= 16(4) + 4(4) + 16(2 \times 2) \times \frac{1}{2}$

$= 64 + 16 + 32 = 112$

$\Rightarrow \quad |\vec{\mathbf{a}} + \vec{\mathbf{b}}| = 4\sqrt{7}$

3. *(c)* Since, every group of prime order is cyclic. Here, given number is prime. So, it is cyclic.

4. *(a)* Given, $U_n = 2 + 2^3 + 2^5 + 2^7 + \ldots + 2^{2n+1}$

and $V_n = 1 + 4 + 4^2 + \ldots + 4^{n-1}$

$\therefore \quad U_n = \frac{lr - a}{r - 1} = \frac{2^{2n+1} \cdot 4 - 2}{4 - 1} = \frac{2^{2n} \cdot 8 - 2}{3}$

and $\quad V_n = \frac{lr - a}{r - 1} = \frac{4^{n-1} \cdot 4 - 1}{4 - 1} = \frac{2^{2n} - 1}{3}$

Now, $\quad \frac{U_n}{V_n} = \frac{2^{2n} \cdot 8 - 2}{2^{2n} - 1} = \frac{8 - \frac{2}{2^{2n}}}{1 - \frac{1}{2^{2n}}}$

$\therefore \quad \lim_{n \to \infty} \frac{U_n}{V_n} = \lim_{n \to \infty} \frac{8 - \frac{2}{2^{2n}}}{1 - \frac{1}{2^{2n}}} = \frac{8 - 0}{1 - 0} = 8$

5. *(a)* Since, $P(1) : 1 = 1$ (true)

Let $\quad P(k) \equiv 1 + 3 + 5 + \ldots + (2k - 1) = k^2$

$\therefore \; P(k+1) \equiv 1 + 3 + 5 + \ldots + (2k - 1) + 2k + 1$

$= k^2 + 2k + 1 = (k + 1)^2$

So, it holds for all n.

6. *(a)* Let $f(x) = x^2 + \frac{1}{1 + x^2}$

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

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

For a minimum, put $f'(x) = 0$

$\Rightarrow \quad x = 0$

So, the function has minimum value at $x = 0$.

7. *(b)* Let the coefficient of x^{-9} is in the $(r + 1)$th term in the expansion of $\left(\frac{x^2}{2} - \frac{2}{x}\right)^9$, then

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

$$= {}^9C_r \frac{x^{18-2r}}{2^{9-r}} \cdot \frac{(-1)^r \cdot 2^r}{x^r}$$

$$= {}^9C_r \frac{x^{18-3r}}{2^{9-2r}} (-1)^r$$

For coefficient of x^{-9}, put

$x^{18-3r} = x^{-9}$

$\Rightarrow \quad 18 - 3r = -9 \Rightarrow 27 = 3r$

$\Rightarrow \quad r = 9$

$\therefore$ Coefficient of $x^{-9} = {}^9C_9 \frac{1}{2^{-9}} (-1)^9 = -2^9 = -512$

8. *(d)* $\frac{1}{2} + \frac{3}{4} + \frac{7}{8} + \frac{15}{16} + \ldots$upto n terms

$= \left(1 - \frac{1}{2}\right) + \left(1 - \frac{1}{4}\right) + \left(1 - \frac{1}{8}\right) \ldots$upto n terms

$= (1 + 1 + 1 + \ldots n \text{ terms})$

$- \left(\frac{1}{2} + \frac{1}{2^2} + \frac{1}{2^3} + \ldots n \text{ terms}\right)$

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

9. *(b)* $\begin{vmatrix} a & a+b & a+2b \\ a+2b & a & a+b \\ a+b & a+2b & a \end{vmatrix}$

$= \begin{vmatrix} 3(a+b) & 3(a+b) & 3(a+b) \\ a+2b & a & a+b \\ a+b & a+2b & a \end{vmatrix} (R_1 \to R_1 + R_2 + R_3)$

$= 3(a+b) \begin{vmatrix} 1 & 0 & 0 \\ a+2b & -2b & -b \\ a+2b & b & -b \end{vmatrix} \quad \begin{pmatrix} C_2 \to C_2 - C_1 \\ C_3 \to C_3 - C_1 \end{pmatrix}$

$= 3(a+b) \begin{vmatrix} -2b & -b \\ b & -b \end{vmatrix}$

$= 3b^2 (a+b) \begin{vmatrix} 2 & 1 \\ -1 & 1 \end{vmatrix} = 3b^2 (a+b)(2+1) = 9b^2 (a+b)$

10. *(a)* $\sim[p \vee (\sim p \vee q)] \equiv \sim p \wedge \sim(\sim p \vee q)$

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

11. *(b)* Since, $2 \times_5 2^{-1}$ = Identity element 1

Therefore, $(2 \times_5 2^{-1})^{-1} = 1$

12. *(a)* Given, $P(n) = 9^n - 8^n$

$\therefore \quad P(1) = 9 - 8 = 1$

$\therefore \quad P(1) - 1 = 0$, which is divisible by 8.

Now, $P(2) = 9^2 - 8^2 = 17$

When divided by 8, it leaves the remainder 1.

13. *(a)* $\tan^{-1} x + \tan^{-1} y + \tan^{-1} z = \pi$

$\Rightarrow \quad \tan^{-1}\left\{\dfrac{x + y + z - xyz}{1 - xy - yz - zx}\right\} = \pi$

$\Rightarrow x + y + z - xyz = 0 \Rightarrow x + y + z = xyz$

14. *(a)* Since, $\left(\dfrac{1}{2}, \dfrac{1}{3}, n\right)$ are the direction cosines of a line, then $\left(\dfrac{1}{2}\right)^2 + \left(\dfrac{1}{3}\right)^2 + n^2 = 1 \Rightarrow \dfrac{1}{4} + \dfrac{1}{9} + n^2 = 1$

$\Rightarrow n^2 = 1 - \dfrac{1}{4} - \dfrac{1}{9} = \dfrac{23}{36} \Rightarrow n = \dfrac{\sqrt{23}}{6}$

15. *(c)* Let $y = x^x$

Taking log on both sides, we get

$$\log y = x \log x$$

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

$$\frac{1}{y}\frac{dy}{dx} = \frac{x}{x} + \log x$$

$\Rightarrow \quad \dfrac{dy}{dx} = y(1 + \log x) = x^x (1 + \log x)$

16. *(b)* $(3 - x) \equiv (2x - 5) \pmod 4$

$\Rightarrow \quad 3 - x - 2x + 5$ is divisible by 4

$\Rightarrow \quad 8 - 3x$ is divisible by 4

$\therefore \quad x = 4$

17. *(b)* $2x^2 - 5xy + 2y^2 + 3x - 3y + 1 = 0$

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

$\therefore$ Two equations are $x - 2y + 1 = 0$ and $2x - y + 1 = 0$.

Length of perpendiculars from $(-1, 2)$ are

$p_1 = \left|\dfrac{-1 - 4 + 1}{\sqrt{1 + 4}}\right| = \dfrac{4}{\sqrt{5}}$ and $p_2 = \left|\dfrac{-2 - 2 + 1}{\sqrt{5}}\right| = \dfrac{3}{\sqrt{5}}$

$\therefore \quad$ Product $= p_1 \cdot p_2 = \dfrac{12}{5}$

18. *(a)* $\mathbf{a} = -\hat{\mathbf{i}} + 2\hat{\mathbf{j}} - \hat{\mathbf{k}}$,

$\mathbf{b} = \hat{\mathbf{i}} + \hat{\mathbf{j}} - 3\hat{\mathbf{k}}$, $\mathbf{c} = -4\hat{\mathbf{i}} - \hat{\mathbf{k}}$

$\therefore \quad \mathbf{a} \times (\mathbf{b} \times \mathbf{c}) + (\mathbf{a} \cdot \mathbf{b})\mathbf{c} = (\mathbf{a} \cdot \mathbf{c})\mathbf{b}$

$= (4 + 1)(\hat{\mathbf{i}} + \hat{\mathbf{j}} - 3\hat{\mathbf{k}}) = 5\hat{\mathbf{i}} + 5\hat{\mathbf{j}} - 15\hat{\mathbf{k}}$

19. *(c)* Work done = (Force · displacement)

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

$= (-4 + 9 + 10) = 15$ unit

20. *(c)* $f(x) = a \sin x + \dfrac{1}{3} \sin 3x$

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

$f'(x) = a \cos x + \dfrac{3}{3} \cos 3x = 0$, at $x = \dfrac{\pi}{3}$,

$a \cos \dfrac{\pi}{3} + \cos \dfrac{\pi}{3} \cdot 3 = 0 \Rightarrow a \cdot \dfrac{1}{2} + (-1) = 0$

$\therefore \quad a = 2$

21. *(d)* $|f(x)|$ is continuous at $x = a$, $f(x)$ is not be continuous at $x = a$.

$\therefore \quad |f(x)| = \begin{cases} f(x), & x > a \\ -f(x), & x < a \end{cases}$

22. *(a)* Given equation can be rewritten as

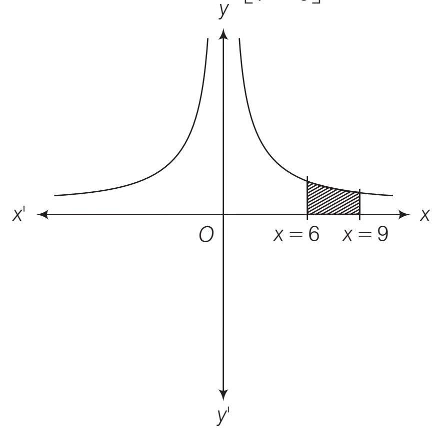
$$\frac{x}{(1 + x^2)^{1/2}} dx + \frac{y}{(1 + y^2)^{1/2}} dy = 0$$

On integrating, we get

$$\sqrt{1 + x^2} + \sqrt{1 + y^2} = c$$

23. *(d)* Required area $= \displaystyle\int_6^9 \frac{36}{x^2} dx = \left[-\frac{36}{x}\right]_6^9$

$= -36\left[\dfrac{1}{9} - \dfrac{1}{6}\right] = 3$ sq unit



24. **(d)** Let $I = \int_0^{\pi/2} \frac{\sin^n \theta}{\sin^n \theta + \cos^n \theta} d\theta$ ...(i)

$$= \int_0^{\pi/2} \frac{\sin^n(\pi/2 - \theta)}{\sin^n(\pi/2-\theta) + \cos^n(\pi/2-\theta)} d\theta$$

$$= \int_0^{\pi/2} \frac{\cos^n \theta}{\cos^n \theta + \sin^n \theta} d\theta \quad \text{...(ii)}$$

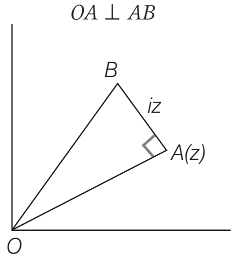
On adding Eqs. (i) and (ii), we get

$$2I = \int_0^{\pi/2} \frac{\sin^n \theta + \cos^n \theta}{\cos^n \theta + \sin^n \theta} d\theta = \int_0^{\pi/2} d\theta = \frac{\pi}{2} \Rightarrow I = \frac{\pi}{4}$$

25. **(d)** Since, $iz = ze^{i\pi/2}$

This implies that iz is the vector obtained by rotating vector z in anticlock wise direction through 90°.

$\therefore \quad OA \perp AB$



So, area of $\Delta OAB = \frac{1}{2} OA \times OB = \frac{1}{2}|z||iz| = \frac{1}{2}|z|^2$

26. **(a)** Given, $f(x) = \frac{\log(1+ax) - \log(1-bx)}{x}$

$f(x)$ is continuous at $x = k$ and $f(0) = k$.

$$\therefore \lim_{x \to 0} f(x) = \lim_{x \to 0} \frac{\log(1+ax) - \log(1-bx)}{x} \quad \left(\frac{0}{0} \text{ form}\right)$$

$$= \lim_{x \to 0} \left(\frac{1}{1+ax} \cdot a + \frac{b}{1-bx}\right) = a + b$$

$\therefore \quad a + b = f(0) = k$

27. **(c)** Since, $123 = -1 \pmod{124}$

$125 = 1 \pmod{124}$

$127 = 3 \pmod{124}$

$\therefore \quad 123 \times 125 \times 127 = (-1)(1)(3) \bmod (124)$

$= -3 \bmod (124) = 121 \bmod (124)$

28. **(b)** Given, $y = Ax^2 + Bx$ ...(i)

On differentiating, we get

$$\frac{dy}{dx} = 2Ax + B$$

$$\Rightarrow \quad \frac{d^2y}{dx^2} = 2A$$

$$\therefore \quad \frac{dy}{dx} - \frac{d^2y}{dx^2} x = B$$

From Eq. (i),

$$y = \frac{1}{2}\frac{d^2y}{dx^2} x^2 + x\left[\frac{dy}{dx} - \frac{d^2y}{dx^2} x\right]$$

$$\Rightarrow \quad y = -\frac{1}{2} x^2 \frac{d^2y}{dx^2} + x\frac{dy}{dx}$$

$$\therefore \quad x^2 \frac{d^2y}{dx^2} - 2x\frac{dy}{dx} + 2y = 0$$

29. **(a)** Since, the given equation has real roots.

$\therefore$ Discriminant,

$$D = \cos^2 p - 4(\cos p - 1)\sin p \ge 0$$

$$\Rightarrow \quad D = (\cos p - 2\sin p)^2 + 4\sin p(1 - \sin p) \ge 0$$

$$\Rightarrow \quad 0 < p < \pi$$

30. **(a)** Given,

$$3\sin^{-1}\left(\frac{2x}{1+x^2}\right) - 4\cos^{-1}\left(\frac{1-x^2}{1+x^2}\right) + 2\tan^{-1}\left(\frac{2x}{1-x^2}\right) = \frac{\pi}{3}$$

$$\Rightarrow 6\tan^{-1} x - 8\tan^{-1} x + 4\tan^{-1} x = \frac{\pi}{3}$$

$$\Rightarrow \quad 2\tan^{-1} x = \frac{\pi}{3}$$

$$\Rightarrow \quad \tan^{-1} x = \frac{\pi}{6}$$

$$\Rightarrow \quad x = \tan\frac{\pi}{6} = \frac{1}{\sqrt{3}}$$

31. **(c)** We have, $\sin(\pi\cos\theta) = \cos(\pi\sin\theta)$

$$\Rightarrow \quad \cos\left(\frac{\pi}{2} - \pi\cos\theta\right) = \cos(\pi\sin\theta)$$

$$\Rightarrow \quad \frac{\pi}{2} - \pi\cos\theta = 2n\pi \pm \pi\sin\theta$$

$$\Rightarrow \quad \frac{1}{2} - \cos\theta = 2n \pm \sin\theta$$

Taking '+' sign,

$$\Rightarrow \quad \frac{1}{2} - \cos\theta = 2n + \sin\theta$$

$$\Rightarrow \quad \frac{1}{\sqrt{2}}\cos\theta + \frac{1}{\sqrt{2}}\sin\theta = \frac{1}{2\sqrt{2}} - \sqrt{2}n$$

$$\Rightarrow \quad \cos\left(\theta - \frac{\pi}{4}\right) = \frac{1}{2\sqrt{2}} \quad (\text{for } n = 0)$$

32. **(a)** Since, $f(x)$ is continuous at $x = 1$.

$$\therefore \quad \lim_{h \to 0^+} f(1+h) = f(1)$$

$$\Rightarrow \quad \lim_{h \to 0} 3 - a(1+h)^2 = 2$$

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

$\Rightarrow \quad a = 1$

33. *(b)* Required area $= \int_2^4 \left(1 + \frac{8}{x^2}\right) dx$

$$= \left[x - \frac{8}{x}\right]_2^4 = 4 - \frac{8}{4} - 2 + \frac{8}{2}$$

$$= 4 - 2 - 2 + 4$$

$= 4$ sq unit

34. *(b)* Let the number of persons in the room be n, then

$$^nC_2 = 66$$

$$\Rightarrow \quad \frac{n(n-1)}{2} = 66$$

$$\Rightarrow \quad n^2 - n - 132 = 0$$

$$\Rightarrow \quad (n - 12)(n + 11) = 0$$

$$\Rightarrow \quad n = 12 \qquad (\because n \neq -11)$$

35. *(a)* Let one root of equation $ax^2 + bx + c = 0$ is α, then another root will be α^2.

$$\therefore \quad \alpha + \alpha^2 = -\frac{b}{a} \qquad \ldots(\text{i})$$

and $\quad \alpha \cdot \alpha^2 = \frac{c}{a}$

$$\Rightarrow \quad \alpha^3 = \frac{c}{a} \qquad \ldots(\text{ii})$$

From Eq. (i),

$$(\alpha + \alpha^2)^3 = -\frac{b^3}{a^3}$$

$$\Rightarrow \quad \alpha^3 + \alpha^6 + 3\alpha^3(\alpha + \alpha^2) = -\frac{b^3}{a^3}$$

$$\Rightarrow \quad \frac{c}{a} + \frac{c^2}{a^2} + 3\frac{c}{a}\left(-\frac{b}{a}\right) = -\frac{b^3}{a^3}$$

$$\Rightarrow \quad a^2c + ac^2 - 3abc + b^3 = 0$$

36. *(d)* $\sum_{r=1}^{\infty} [3 \cdot 2^{-r} - 2 \cdot 3^{1-r}]$

$$= 3\sum_{r=1}^{\infty} \frac{1}{2^r} - 2\sum_{r=1}^{n} 3^{1-r}$$

$$= 3\left[\frac{1}{2} + \frac{1}{2^2} + \ldots \infty\right] - 2\left[1 + \frac{1}{3} + \frac{1}{3^2} + \ldots \infty\right]$$

$$= \frac{3}{2}\left[1 + \frac{1}{2} + \frac{1}{2^2} + \ldots\right] - 2\left[1 + \frac{1}{3} + \frac{1}{3^2} + \ldots \infty\right]$$

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

$$= \frac{3}{2} \times 2 - \frac{2 \times 3}{2} = 0$$

37. *(b)* Given that,

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

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

On integrating both sides, we get

$$\frac{1}{2}\log(1 + x^2) + \frac{1}{2}\log(1 + y^2) = c$$

Now,

$$y(0) = 1 \Rightarrow c = \frac{1}{2}\log(1 + 1) = \frac{1}{2}\log 2$$

$$\therefore \quad \sqrt{1 + x^2}\,\sqrt{1 + y^2} = \sqrt{2}$$

$$\Rightarrow \quad (1 + x^2)(1 + y^2) = 2$$

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

38. *(d)* Given, $f(x) = \dfrac{x + \cos x}{x - \cos x}$

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

$$f'(x) = \frac{\left[\begin{array}{l}(x - \cos x)(1 - \sin x) \\ \qquad -(x + \cos x)(1 + \sin x)\end{array}\right]}{(x - \cos x)^2}$$

$$= \frac{-2x\sin x - 2\cos x}{(x - \cos x)^2}$$

39. *(b)* Diagonals of parallelogram bisects each other.

$\Rightarrow$ Diagonal BD passes through mid point of AC.

i.e. $\quad \left(\frac{5}{2}, \frac{7}{2}\right)$.

$\therefore$ Equation of diagonal passing through $(5, 1)$ and $\left(\frac{5}{2}, \frac{7}{2}\right)$ is

$$y - 1 = \frac{\frac{7}{2} - 1}{\frac{5}{2} - 5}(x - 5)$$

$$\Rightarrow \quad y - 1 = -1(x - 5)$$

$$\Rightarrow \quad y + x - 6 = 0$$

40. *(d)* $\int_0^1 x \sin \pi x \, dx$

$$= \left[-x\frac{\cos \pi x}{\pi}\right]_0^1 + \int_0^1 \frac{\cos \pi x}{\pi}\,dx$$

$$= \left[-x\frac{\cos \pi x}{\pi} + \frac{\sin \pi x}{\pi^2}\right]_0^1 = \left[\frac{-(-1)}{\pi}\right] = \frac{1}{\pi}$$

41. *(b)* Since, $(a, b) = c$

$\therefore c$ is the GCD of a and b.

$$\therefore \qquad \frac{c}{b}$$

42. *(c)* Given, $\Delta = \begin{vmatrix} a & b & c \\ b & c & a \\ c & a & b \end{vmatrix}$

Applying, $C_1 \to C_1 + C_2 + C_3$ and taking common from C_1

$$\Delta = (a+b+c)\begin{vmatrix} 1 & b & c \\ 1 & c & a \\ 1 & a & b \end{vmatrix}$$

$$= -(a+b+c)[a^2+b^2+c^2-ab-bc-ca]$$

$$= -\frac{(a+b+c)}{2}[(a-b)^2+(b-c)^2+(c-a)^2]$$

> 0 as $a, b, c < 0$

43. *(a)* The product of 'n' positive integers is unity. Then their sum is a positive integer.

44. *(d)* Let $z = \sin x(1+\cos x)$

or $z = \sin x + \frac{1}{2}\sin 2x$

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

$$\frac{dz}{dx} = \cos x + \cos 2x$$

For maximum or minimum, put $\frac{dz}{dx} = 0$

$\Rightarrow \quad \cos x + \cos 2x = 0$

$\Rightarrow \quad 2\cos^2 x - 1 + \cos x = 0$

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

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

$\Rightarrow \quad x = \frac{\pi}{3}, \pi$

But $0 \le x \le \frac{\pi}{2}$, therefore we take only $x = \frac{\pi}{3}$.

$\therefore \frac{d^2z}{dx^2} = -\sin x - 2\sin 2x = -$ ve, for $x = \pi/3$

$\therefore$ It is maximum at $x = \pi/3$.

45. *(c)* Given,

$$y = a\cos\mu x + b\sin\mu x \quad \ldots(i)$$

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

$$\frac{dy}{dx} = -a\mu\sin\mu x + b\mu\cos\mu x$$

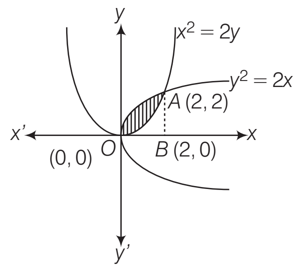
Again, differentiating, we get

$$\frac{d^2y}{dx^2} = -a\mu^2\cos\mu x - b^2\mu\sin\mu x$$

$$= -\mu^2 y \quad \text{[from Eq. (i)]}$$

$\Rightarrow \quad \frac{d^2y}{dx^2} + \mu^2 y = 0$

46. *(b)* The point of intersection of the curves $y^2 = 2x$ and $x^2 = 2y$ are $O(0, 0)$, $A(2, 2)$.



$\therefore$ Required area $= \int_0^2 \left(\sqrt{2x} - \frac{x^2}{2}\right) dx$

$$= \left[\sqrt{2}\frac{x^{3/2}}{3/2} - \frac{x^3}{6}\right]_0^2$$

$$= \left[\frac{2}{3}.2^2 - \frac{2^3}{6}\right] = \left[\frac{8}{3} - \frac{4}{3}\right]$$

$$= \frac{4}{3} \text{ sq unit}$$

47. *(a)* $A \cdot \text{adj}(A) = O \Rightarrow |A| I_n = O$

where n is order of A

$\Rightarrow \quad |A| = 0$

48. *(b)* Given, $|\mathbf{a}+\mathbf{b}| = |\mathbf{a}-\mathbf{b}|$

$\Rightarrow \quad |\mathbf{a}+\mathbf{b}|^2 = |\mathbf{a}-\mathbf{b}|^2$

$\Rightarrow \quad |\mathbf{a}|^2 + |\mathbf{b}|^2 + 2\mathbf{a}\cdot\mathbf{b} = |\mathbf{a}|^2 + |\mathbf{b}|^2 - 2\mathbf{a}\cdot\mathbf{b}$

$\Rightarrow \quad 4\mathbf{a}\cdot\mathbf{b} = 0$

Hence, $\mathbf{a}$ is perpendicular to $\mathbf{b}$.

49. *(d)* $\lim_{x\to 0} \frac{(2+x)\sin(2+x) - 2\sin 2}{x} \left(\frac{0}{0} \text{ form}\right)$

$$= \lim_{x\to 0} \frac{\sin(2+x) + (2+x)\cos(2+x)}{1}$$

$$= \sin 2 + 2\cos 2$$

50. *(a)* Let $I = \int \frac{2dx}{(e^x + e^{-x})^2} = \int \frac{2dx}{e^{2x} + e^{-2x} + 2}$

$$= \int \frac{2e^{2x}\,dx}{e^{4x} + 2e^{2x} + 1}$$

Put $e^{2x} = t$

$\Rightarrow \quad 2e^{2x}\,dx = dt$

$\therefore \quad I = \int \frac{dt}{t^2 + 2t + 1} = \int \frac{dt}{(t+1)^2} = -\frac{1}{t+1} + c$

$$= -\frac{1}{e^{2x}+1} = -\frac{e^{-x}}{e^x + e^{-x}} + c$$

51. *(a)* Circumference of circle, $C = 2\pi r$

$$\Rightarrow \quad \frac{dC}{dt} = 2\pi \frac{dr}{dt}$$

$$\Rightarrow \quad \frac{0.3}{2\pi} = \frac{dr}{dt} \qquad \left(\because \frac{dC}{dt} = 0.3 \text{ cm / s given}\right)$$

Now, $\quad A = \pi r^2$

$$\frac{dA}{dt} = 2\pi r \frac{dr}{dt} \quad \Rightarrow \quad \frac{dA}{dt} = r \times 0.3$$

$$\Rightarrow \quad \left[\frac{dA}{dt}\right]_{r=5} = 5 \times 0.3 = 1.5 \text{ sq cm/s}$$

52. *(d)* If ω is a cube root of unity, then

$1 + \omega + \omega^2 = 0$ and $\omega^3 = 1$.

$$\therefore (1 + \omega - \omega^2)(1 - \omega + \omega^2) = (-\omega^2 - \omega^2)(-\omega - \omega)$$
$$= 2\omega^2 \cdot 2\omega = 4$$

53. *(b)* Let $z = x + iy$

$$\therefore \quad i + z = x + i(1 + y)$$

and $\quad i - z = -x + i(1 - y)$

$$\because \quad \left|\frac{i + z}{i - z}\right| = 1 \Rightarrow |i + z| = |i - z|$$

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

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

$$\Rightarrow \quad 4y = 0$$

$$\Rightarrow \quad y = 0$$

i.e. x-axis.

54. *(c)* In a triangle ABC,

$$A + B + C = \pi,$$

$$\Rightarrow \sin(A + B + C) = 0, \cos(A + B) = -\cos C$$

$$\therefore \begin{vmatrix} \sin(A + B + C) & \sin B & \cos C \\ -\sin B & 0 & \tan A \\ \cos(A + B) & -\tan A & 0 \end{vmatrix}$$

$$= \begin{vmatrix} 0 & \sin B & \cos C \\ -\sin B & 0 & \tan A \\ -\cos C & -\tan A & 0 \end{vmatrix}$$

$$= 0$$

($\because$ It is the determinant of a skew symmetric matrix of odd order.)

55. *(c)* Let $y = x \log_e x$

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

$$\frac{dy}{dx} = x \cdot \frac{1}{x} + \log x = (1 + \log x)$$

Again, differentiating, we get

$$\frac{d^2y}{dx^2} = \frac{1}{x}$$

Put, $\frac{dy}{dx} = 0$ for maxima or minima.

$$\Rightarrow \quad 1 + \log x = 0$$

$$\Rightarrow \quad x = \frac{1}{e}$$

$$\therefore \quad \left(\frac{d^2y}{dx^2}\right)_{(x = 1/e)} = e$$

$\therefore \quad y$ is minimum at $x = \frac{1}{e}$

$$\therefore \quad y_{\min} = \frac{1}{e} \log_e \left(\frac{1}{e}\right) = -\frac{1}{e}$$

56. *(c)* $\because f''(0) = k$ and

$$\lim_{x \to 0} \frac{2f(x) - 3f(2x) + f(4x)}{x^2}$$

Using L'Hospital's rule,

$$= \lim_{x \to 0} \frac{2f'(x) - 6f'(2x) + 4f'(4x)}{2x}$$

Again, using L'Hospital's rule,

$$= \lim_{x \to 0} \frac{2f''(x) - 12f''(2x) + 16f''(4x)}{2}$$

$$= \frac{1}{2}[2f''(0) - 12f''(0) + 16f''(0)]$$

$$= \frac{1}{2}[2k - 12k + 16k] = 3k$$

57. *(c)* $\int_2^4 [3 - f(x)]\, dx = 7$

$$\Rightarrow \quad [3x]_2^4 - \int_2^4 f(x)\, dx = 7$$

$$\Rightarrow \quad 6 - \int_2^4 f(x)\, dx = 7$$

$$\Rightarrow \quad \int_2^4 f(x)\, dx = -1 \qquad \ldots \text{(i)}$$

and $\quad \int_{-1}^4 f(x)\, dx = 4 \qquad \ldots$(ii)

$$\int_{-1}^4 f(x)\, dx = \int_{-1}^2 f(x)\, dx + \int_2^4 f(x)\, dx$$

$$\Rightarrow \quad 4 = \int_{-1}^2 f(x)\, dx - 1$$

$$\Rightarrow \quad \int_{-1}^2 f(x)\, dx = 5$$

58. *(a)* The given differential equation is

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

Put $\quad x - y = t$

$$\Rightarrow \quad 1 - \frac{dy}{dx} = \frac{dt}{dx}$$

$$\Rightarrow \quad \frac{dy}{dx} = 1 - \frac{dt}{dx}$$

$$\therefore \quad 1 - \frac{dt}{dx} = t^2$$

$$\Rightarrow \quad (1 - t^2) = \frac{dt}{dx}$$

On integrating both sides, we get

$$\int \frac{1}{1 - t^2}\, dt = \int 1\, dx$$

$$\Rightarrow \quad \frac{1}{2} \log \left(\frac{1 + t}{1 - t}\right) = x + c$$

$$\Rightarrow \quad \left(\frac{1 + t}{1 - t}\right) = e^{2x + 2c}$$

$$\Rightarrow \quad \frac{1 + x - y}{1 - x + y} = Ae^{2x}$$

$\because$ It passes through origin.

$$\therefore \quad A = 1$$

$\therefore$ Required curve is

$$(1 + x - y) = e^{2x} \, (1 - x + y)$$

59. *(d)* $\because \quad (\sqrt{3} - i) = 2\left(\cos \frac{\pi}{6} - i \sin \frac{\pi}{6}\right)$

$$\therefore \quad (\sqrt{3} - i)^{50} = 2^{50} \left(\cos \frac{\pi}{6} - i \sin \frac{\pi}{6}\right)^{50}$$

$$= 2^{50} \left(\cos \frac{\pi}{3} - i \sin \frac{\pi}{3}\right)$$

$$= 2^{50} \left(\frac{1}{2} - i \frac{\sqrt{3}}{2}\right)$$

But $\quad (\sqrt{3} - i)^{50} = 2^{48} (x - iy)$

$$\therefore \quad x = 2 \text{ and } y = 2\sqrt{3}$$

$$\therefore \quad x^2 + y^2 = 4 + 12 = 16$$

60. *(b)* $T_r = T_{(r-1)+1} = {}^{20}C_{r-1} \cdot x^{r-1}$

$\therefore$ Coefficient of the rth term $= {}^{20}C_{r-1}$

and coefficient of the $(r + 1)$th term $= {}^{20}C_r$

$$\therefore \quad \frac{{}^{20}C_{r-1}}{{}^{20}C_r} = \frac{1}{2}$$

$$\Rightarrow \quad \frac{r}{21 - r} = \frac{1}{2}$$

$$\Rightarrow \quad r = 7$$

61. *(c)* Now, $\mathbf{a} \times \mathbf{b} = \begin{vmatrix} \hat{\mathbf{i}} & \hat{\mathbf{j}} & \hat{\mathbf{k}} \\ 3 & 1 & -2 \\ 1 & -3 & 4 \end{vmatrix}$

$$= \hat{\mathbf{i}} \, (4 - 6) - \hat{\mathbf{j}} \, (12 + 2) + \hat{\mathbf{k}} \, (-9 - 1)$$

$$= -2\hat{\mathbf{i}} - 14\hat{\mathbf{j}} - 10\hat{\mathbf{k}}$$

$\therefore$ Area of required parallelogram

$$= \frac{1}{2} |\mathbf{a} \times \mathbf{b}| = \frac{1}{2} \sqrt{4 + 196 + 100} = \frac{10\sqrt{3}}{2} = 5\sqrt{3}$$

62. *(a)* In the given series

$$a = \frac{\sqrt{2} + 1}{\sqrt{2} - 1} \text{ and } r = \frac{1}{2 + \sqrt{2}} = \frac{2 - \sqrt{2}}{2}$$

$$\therefore \quad S_\infty = \frac{a}{1 - r} = \frac{\frac{\sqrt{2} + 1}{\sqrt{2} - 1}}{1 - \frac{2 - \sqrt{2}}{2}}$$

$$= \frac{\frac{\sqrt{2} + 1}{\sqrt{2} - 1}}{\frac{\sqrt{2}}{2}} = \frac{\sqrt{2}\,(\sqrt{2} + 1)}{\sqrt{2} - 1} \times \frac{\sqrt{2} + 1}{\sqrt{2} + 1}$$

$$= \sqrt{2}\,(\sqrt{2} + 1)^2$$

63. *(c)* $\because (1 + ax)^n = 1 + axn + \frac{n\,(n - 1)}{2!} (ax)^2 + \ldots$

Given that,

$$axn = 6x$$

$$\Rightarrow \quad an = 6 \quad \ldots\text{(i)}$$

$$\text{and} \quad \frac{a^2 n\,(n - 1)}{2} = 16 \quad \ldots\text{(ii)}$$

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

$$a = \frac{2}{3} \text{ and } n = 9$$

64. *(b)* Since, $f(x)$ is continuous at $x = 3$, then

$$\lim_{x \to 3} f(x) = f(3) \quad \ldots\text{(i)}$$

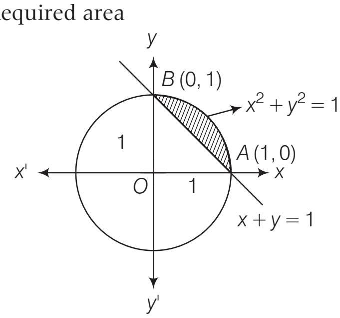
$$\therefore \lim_{x \to 3} \frac{x^2 - 9}{x - 3} = \lim_{x \to 3} x + 3 = 3 + 3 = 6$$

and $\quad f(3) = 2 \times 3 + k = k + 6$

$\therefore$ From Eq. (i),

$$6 = k + 6 \Rightarrow k = 0$$

65. *(c)* Required area



$$= \frac{1}{4} \text{(Area of circle)} - \text{(Area of } \Delta \, AOB)$$

$$= \frac{\pi (1)^2}{4} - \frac{1}{2} \times OA \times OB$$

$$= \left(\frac{\pi}{4} - \frac{1}{2}\right) \text{sq unit}$$

66. *(a)* $\left|\frac{x}{2} - 1\right| < 3 \Rightarrow -3 < \frac{x}{2} - 1 < 3$

$$\Rightarrow \quad -3 + 1 < \frac{x}{2} < 3 + 1$$

$$\Rightarrow \quad -2 < \frac{x}{2} < 4$$

$$\Rightarrow \quad -4 < x < 8$$

$$\therefore \quad x \in (-4, 8)$$

67. *(b)* $\sin^{-1} \frac{1}{\sqrt{5}} + \cos^{-1} \frac{3}{\sqrt{10}}$

Now, $\sin^{-1} \frac{1}{\sqrt{5}} = \tan^{-1} \left(\frac{1/\sqrt{5}}{\sqrt{1 - \frac{1}{5}}} \right) = \tan^{-1} \frac{1}{2}$

and $\cos^{-1} \frac{3}{\sqrt{10}} = \tan^{-1} \left(\frac{\sqrt{1 - \frac{9}{10}}}{\frac{3}{\sqrt{10}}} \right) = \tan^{-1} \frac{1}{3}$

$\therefore \quad \tan^{-1} \frac{1}{2} + \tan^{-1} \frac{1}{3} = \tan^{-1} \left(\frac{\frac{1}{2} + \frac{1}{3}}{1 - \frac{1}{6}} \right) = \tan^{-1} (1) = \frac{\pi}{4}$

68. *(b)* Given, $f(x) = \sec x - \cot x$

$$\therefore \quad f'(x) = \sec x \tan x + \operatorname{cosec}^2 x$$

$$\Rightarrow \quad f'\left(\frac{\pi}{6}\right) = \sec \frac{\pi}{6} \tan \frac{\pi}{6} + \operatorname{cosec}^2 \frac{\pi}{6}$$

$$= \frac{2}{\sqrt{3}} \cdot \frac{1}{\sqrt{3}} + 4 = \frac{14}{3}$$

69. *(a)* Let C divides AB in the ratio $m : 1$. Then

$$\mathbf{c} = \frac{m\mathbf{b} + \mathbf{a}}{m + 1}$$

$$\Rightarrow \quad m\mathbf{c} + \mathbf{c} = m\mathbf{b} + \mathbf{a}$$

$$\Rightarrow \quad \mathbf{a} + m\mathbf{b} - m\mathbf{c} - \mathbf{c} = \mathbf{0}$$

$$\Rightarrow \quad \mathbf{a} + m\mathbf{b} + (-m - 1)\,\mathbf{c} = \mathbf{0} \quad \ldots\text{(i)}$$

Given, $\quad 3\mathbf{a} + 4\mathbf{b} - 7\mathbf{c} = \mathbf{0}$

$$\Rightarrow \quad \mathbf{a} + \frac{4}{3}\mathbf{b} - \frac{7}{3}\mathbf{c} = \mathbf{0} \quad \ldots\text{(ii)}$$

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

$$m = \frac{4}{3}$$

$\therefore$ Required ratio is 4 : 3

70. *(d)* $\begin{bmatrix} a & 2 & 3 \\ b & 5 & -1 \end{bmatrix} \begin{bmatrix} 1 & 2 \\ 3 & 4 \\ -1 & 1 \end{bmatrix}$

$$= \begin{bmatrix} a + 6 - 3 & 2a + 8 + 3 \\ b + 15 + 1 & 2b + 20 - 1 \end{bmatrix}$$

$$\Rightarrow \quad \begin{bmatrix} a + 3 & 2a + 11 \\ b + 16 & 2b + 19 \end{bmatrix} = \begin{bmatrix} 4 & 13 \\ 12 & 11 \end{bmatrix} \quad \text{(given)}$$

$$\Rightarrow \quad a + 3 = 4 \Rightarrow a = 1$$

and $\quad b + 16 = 12 \Rightarrow b = 12 - 16 = -4$

$$\therefore \quad (a, b) = (1, -4)$$

English & General Aptitude

16. (*b*) Indira and Nehru were the Prime Ministers of India, while Benazir was the Prime Minister of Pakistan.

17. (*d*) All are former Indian cricketers.

18. (*c*) 'Folketing' is the parliament of 'Denmark'; 'Stortling' is the parliament of 'Norway', 'Knesset' is the parliament of Israel.

19. (*b*) They all are modes of transport.

20. (*c*) 'PTI' is an Indian news agency; 'Irna' is a news agency in Iran while 'Xin-Era' is a news agency in China.

21. (*c*) 'Pitcher' is a term used in Baseball; 'Dusra' is a term used in cricket and 'Bunker' is a term used in polo.

22. (*d*) These all are snakes.

23. (*c*) These all are units of distance.

24. (*d*) These all are water animals.