

Explanations

Physics

1. (a) For electron,

$$\lambda_e = \frac{h}{p} = \frac{h}{mv}$$

$$= \frac{h}{2mv^2} = \frac{hv}{2E_e}$$

$$= \frac{h}{2v}$$

For photon,

$$\lambda_{ph} = \frac{hc}{E_{ph}}$$

$$\lambda_{ph} = \frac{hc}{E_{ph}}$$

$$\frac{\lambda_{ph}}{\lambda_e} = \frac{E_{ph}}{hv} = \frac{2c}{v} \quad [\because E_{ph} = E_e]$$

Since, $c \gg v$

$$\therefore \frac{\lambda_{ph}}{\lambda_e} > 1$$

$$\Rightarrow \lambda_{ph} > \lambda_e$$

2. (a) Here,

$$\mathbf{v}_{BG} = 3\hat{i} + 4\hat{j}$$

$$\mathbf{v}_{WG} = -3\hat{i} - 4\hat{j}$$

$$\therefore \mathbf{v}_{BW} = \mathbf{v}_{BG} - \mathbf{v}_{WG}$$

$$= (3\hat{i} + 4\hat{j}) - (-3\hat{i} - 4\hat{j})$$

$$= 6\hat{i} + 8\hat{j}$$

3. (c) Given, $I_1 = I, I_2 = 4I$

$$I_{\max} = (\sqrt{I_1} + \sqrt{I_2})^2 = (\sqrt{I} + \sqrt{4I})^2$$

$$= (3\sqrt{I})^2 = 9I$$

$$I_{\min} = (\sqrt{I_2} - \sqrt{I_1})^2$$

$$= (\sqrt{4I} - \sqrt{I})^2 = (\sqrt{I})^2 = I$$

4. (b) Here, $\rho_A = \rho_0$

From $pV = \frac{m}{M} RT$, we get

$$\frac{m}{V} = \frac{pM}{RT} \quad \text{and} \quad \rho = \frac{m}{V} = \frac{pM}{RT}$$

$$\therefore \frac{\rho_B}{\rho_A} = \frac{p_B T_A}{T_B p_A} = \frac{3p_0 \cdot T_0}{2T_0 \cdot p_0} = \frac{3}{2}$$

$$\rho_B = \frac{3}{2} \rho_0$$

$$5. (d) V = \left(\frac{e}{R+r} \right) R = \left(\frac{10}{90+10} \right) 90 = \frac{10}{100} \times 90 = 9V$$

$$6. (c) \text{ As we know, } \mathbf{v}_{CM} = \frac{m_1 \mathbf{v}_1 + m_2 \mathbf{v}_2}{m_1 + m_2}$$

$$= \frac{10(-2\hat{i} + 7\hat{j} + 3\hat{k}) + 2(10\hat{i} - 35\hat{j} + 3\hat{k})}{10 + 2}$$

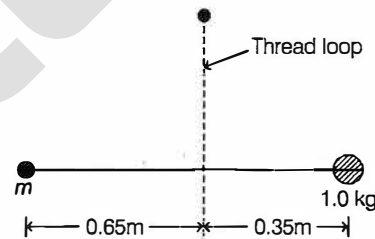
$$= \frac{30\hat{k} + 6\hat{k}}{12} = \frac{36\hat{k}}{12} = 3\hat{k} \text{ ms}^{-1}$$

$$7. (b) \text{ Fringe width, } \beta = \frac{D\lambda}{d}$$

$$\text{or } \beta \propto \lambda$$

If the experiment is performed in water, wavelength λ decreases, so fringe width also decreases.

8. (c)



Using the principle of moments of masses,

$$mg \times 0.65 = 1g \times 0.35$$

$$m = \frac{35}{65} = 0.54 \text{ kg}$$

9. (c) As heights are same,

i.e.

$$H_P = H_Q$$

$$\Rightarrow \frac{u_P^2 \sin^2 30^\circ}{2g} = \frac{u_Q^2 \sin^2 \theta}{2g}$$

$$\Rightarrow \frac{\sin^2 \theta}{\sin^2 30^\circ} = \left(\frac{u_P}{u_Q} \right)^2 = \frac{9}{1}$$

$$\text{or } \sin^2 \theta = \frac{9}{1} \times \sin^2 30^\circ = \frac{9}{4}$$

$$\Rightarrow \theta = \sin^{-1} \left(\frac{3}{2} \right)$$

10. (d) Speed of light in vacuum,

$$c = \frac{1}{\sqrt{\mu_0 \epsilon_0}}$$

$$\text{and in another medium, } v = \frac{1}{\sqrt{\mu \epsilon}}$$

$$\therefore \frac{c}{v} = \sqrt{\frac{\mu E}{\mu_0 \epsilon_0}} = \sqrt{\mu_r K}$$

$$\Rightarrow v = \frac{c}{\sqrt{\mu_r K}}$$

11. (c) On going above the surface of earth at height h , the value of acceleration due to gravity (g_h) is given as

$$g_h = \frac{g}{\left(1 + \frac{h}{R}\right)^2}$$

$$\Rightarrow \frac{g}{4} = \frac{g}{\left(1 + \frac{h}{R}\right)^2} \quad \left[\text{Given, } g_h = \frac{g}{4} \right]$$

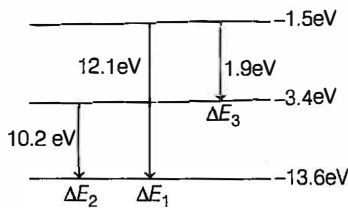
$$\Rightarrow \left(\frac{1}{2}\right)^2 = \frac{1}{\left(1 + \frac{h}{R}\right)^2}$$

$$\Rightarrow \frac{1}{2} = \frac{1}{1 + \frac{h}{R}}$$

$$\Rightarrow 1 + \frac{h}{R} = 2$$

$$\Rightarrow h = R$$

12. (c) As, $\lambda_1 < \lambda_2 < \lambda_3$



$$\Delta E_1 = \Delta E_2 + \Delta E_3$$

$$\therefore \frac{hc}{\lambda_1} = \frac{hc}{\lambda_2} + \frac{hc}{\lambda_3}$$

$$\Rightarrow \frac{1}{\lambda_1} = \frac{1}{\lambda_2} + \frac{1}{\lambda_3}$$

13. (c) As, $U = \frac{A}{x^2} - \frac{B}{x}$

$$\text{For equilibrium, } \frac{dU}{dx} = 0$$

$$\Rightarrow \frac{d}{dx} \left(\frac{A}{x^2} - \frac{B}{x} \right) = -\frac{2A}{x^3} + \frac{B}{x^2} = 0$$

$$\Rightarrow x = \frac{2A}{B}$$

$$\text{For stable equilibrium, } \frac{d^2U}{dx^2} > 0$$

$$\therefore \frac{d^2U}{dx^2} = \frac{d}{dx} \left(-\frac{2A}{x^3} + \frac{B}{x^2} \right) = \frac{6A}{x^4} - \frac{2B}{x^3}$$

$$\therefore \left(\frac{d^2U}{dx^2} \right)_{x = \frac{2A}{B}} = \frac{B^4}{8A^3} > 0$$

The distance at which both the particles will be in stable equilibrium is $x = \frac{2A}{B}$.

14. (d) Pressure in spherical drop, $p = \frac{2T}{R}$

$$\frac{2T}{R_1} = 5 \times \frac{2T}{R_2} \quad (\because \text{Given, } p_1 = 5p_2)$$

$$\Rightarrow R_2 = 5R_1$$

$$\text{and } \frac{m_1}{m_2} = \frac{(4/3)\pi R_1^3 d_1}{(4/3)\pi R_2^3 d_2} = \frac{1}{125} \quad [\because d_1 = d_2]$$

15. (a) As the gravitational force of attraction between sun and jupiter provide the necessary centripetal force to jupiter to move in a circular orbit.

$$\text{So, } F = \frac{mv^2}{r} = \frac{GMm}{r^2} \Rightarrow v = \sqrt{\frac{GM}{r}}$$

$$= \sqrt{\frac{6.67 \times 10^{-11} \times 1.99 \times 10^{30}}{7.8 \times 10^{11}}}$$

$$= 13 \times 10^4 \text{ ms}^{-1}$$

16. (c) $I_g = \frac{V}{G}$

$$\text{and } R = \frac{nV}{I_g} - G = \frac{nV}{V/G} - G = (n-1)G$$

17. (a) When the phase difference between the two sources varies continuously, then positions of bright and dark fringes will change rapidly. Such rapid changes cannot be detected by our eyes. Thus, a uniform illumination is seen on the screen, i.e., interference pattern disappears. Hence, Statement I is correct.

The light waves emitted by two different lamps cannot be coherent. So the conditions of maxima and minima of intensity will change rapidly on the screen, producing uniform illumination and thus, no interference pattern will be observed. Hence, Statement II is also correct.

18. (b) When an α -particle enters into a uniform magnetic field perpendicular to its direction, then it moves on circular path in magnetic field i.e., it performs uniform circular motion in magnetic field.

In uniform circular motion of α -particle, its momentum changes due to change in its velocity but kinetic energy remains unchanged because magnitude of velocity (i.e., speed) always remains constant.



19. (a) In the given circuit, diode is in reverse biasing, so it acts as open circuit. Hence, potential difference between A and B is 6V.

20. (c) Given, resistance is in a parallel combination

$$\text{So, } \frac{1}{R_{AB}} = \frac{1}{2} + \frac{1}{2} + \frac{1}{2} + \frac{1}{2} + \frac{1}{2} = \frac{5}{2}$$

$$\therefore R_{AB} = 0.4 \Omega$$

21. (b) The energy of the photon

$$\begin{aligned} &= Rhc \left(\frac{1}{1} - \frac{1}{n^2} \right) \\ &= 13.6 \left(\frac{1}{1} - \frac{1}{4} \right) \quad (\because n = 2) \\ &= 13.6 \left(\frac{4-1}{4} \right) \\ &= 13.6 \times \frac{3}{4} = \frac{40.8}{4} = 10.2 \text{ eV} \end{aligned}$$

Problem Solving Tactics

To better understand this concept, review the Bohr's model of the hydrogen atom and the energy levels associated with different quantum number (n).

22. (b) Ratio of work done,

$$\begin{aligned} \frac{W_2}{W_1} &= \left(\frac{\Delta V_2}{\Delta V_1} \right)^2 \\ &= \frac{(40-30)^2}{(20-10)^2} = 1 \end{aligned}$$

$$\therefore W_2 = W_1 = W.$$

23. (d) At steady state, the inductor behaves as a closed circuit. So, whole current will pass through the inductor and current in 10Ω resistor is zero.

24. (b) In n -type semiconductor, the pentavalent impurity atom shares four of its valence electrons with four Si or Ge atoms, while its fifth electron remains free. Thus, n -type semiconductor has an excess of negative charge carriers (electrons). Since, amount of positive and negative charges in n -type semiconductor are equal, thus net charge on n -type semiconductor is zero. Hence, n -type semiconductor is electrically neutral.

25. (c) According to Jurin's law, the rise in capillary tube is inversely proportional to the radius of capillary tube.

$$\text{or } h \propto \frac{1}{r} \text{ or } \frac{h_2}{h_1} = \frac{r_1}{r_2} = \frac{d_1}{d_2}$$

$$\text{Given, } d_2 = \frac{d_1}{2}$$

$$\therefore \frac{h_2}{h_1} = \frac{d_1}{\frac{d_1}{2}} = 2$$

$$\text{or } h_2 = 2h_1 = 2h$$

26. (a) For a transformer, $\frac{N_s}{N_p} = \frac{E_s}{E_p}$

$$\Rightarrow 10 = \frac{E_s}{20} \quad \left[\because \frac{N_s}{N_p} = 10 \right]$$

$$\Rightarrow E_s = 200 \text{ V}$$

Frequency will be same as 50 Hz.

27. (b) Speed of wave over string, $v = \sqrt{\frac{F}{\mu}}$

$$f \cdot \lambda = \sqrt{\frac{F}{\mu}} \Rightarrow f = \frac{1}{\lambda} \sqrt{\frac{F}{\mu}}$$

$$\text{As for a string, } \lambda = \frac{2l}{n}$$

where, n = number of harmonic = 1, 2, 3,

$$\text{So, } f = \frac{n}{2l} \sqrt{\frac{F}{\mu}} = \frac{k}{l} \sqrt{\frac{F}{\mu}} \quad \left[\because k = \frac{n}{2} \right]$$

28. (c) Given, $\phi = 4t^2 + 3t - 4$

$$\therefore |e| = \left| \frac{d\phi}{dt} \right| = \frac{d}{dt} (4t^2 + 3t - 4) = 8t + 3$$

$$\text{At } t = 2 \text{ s, } |e| = 8 \times 2 + 3 = 19 \text{ V}$$

$$\begin{aligned} \text{29. (d) [Pressure gradient]} &= \frac{[\text{Pressure}]}{[\text{Distance}]} \\ &= \frac{[\text{ML}^{-1} \text{T}^{-2}]}{[\text{L}]} = [\text{ML}^{-2} \text{T}^{-2}] \end{aligned}$$

$$[\text{Velocity gradient}] = \frac{[\text{Velocity}]}{[\text{Distance}]} = \frac{[\text{LT}^{-1}]}{[\text{L}]} = [\text{T}^{-1}]$$

$$\begin{aligned} [\text{Potential gradient}] &= \frac{[\text{Potential difference}]}{[\text{Distance}]} = \frac{[W]}{[Q][x]} \\ &= \frac{[\text{ML}^2 \text{T}^{-2}]}{[\text{AT}][\text{L}]} \\ &= [\text{MLT}^{-3} \text{A}^{-1}] \end{aligned}$$

$$\begin{aligned} [\text{Energy gradient}] &= \frac{[\text{Energy}]}{[\text{Distance}]} = \frac{[\text{ML}^2 \text{T}^{-2}]}{[\text{L}]} \\ &= [\text{MLT}^{-2}] \end{aligned}$$

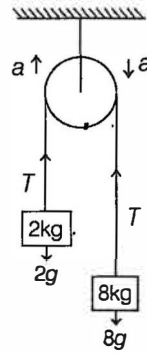
Thus, option (d) is correct.

30. (d) Given, $P = \frac{a^2 b^{1/2}}{c^{3/2}}$

$$\begin{aligned} \Rightarrow \frac{\Delta P}{P} \times 100 &= 2 \frac{\Delta a}{a} \times 100 + \frac{1}{2} \times \frac{\Delta b}{b} \times 100 + \frac{3}{2} \times \frac{\Delta c}{c} \times 100 \\ &= 2 \times 2\% + \frac{1}{2} \times 4\% + \frac{3}{2} \times 6\% \\ &= 4\% + 2\% + 9\% = 15\% \end{aligned}$$



31. (b) From the figure,



For mass 2 kg, $T - 2g = 2a$... (i)

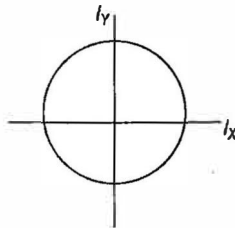
For mass 8 kg, $8g - T = 8a$... (ii)

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

$$6g = 10a$$

$$\Rightarrow a = \frac{6g}{10} = \frac{3g}{5}$$

32. (b)



Moment of inertia of circular wire about its axis,

$$I_{CM} = 2M \cdot (2R)^2 = 8MR^2$$

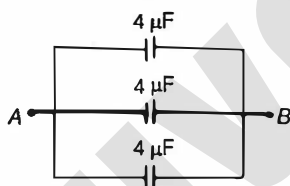
According to perpendicular axes theorem, moment of inertia about its diameter,

$$\Rightarrow I_X + I_Y = I_{CM}$$

$$\Rightarrow I_D + I_D = I_{CM} \quad [\because I_X = I_Y = I_D]$$

$$\Rightarrow I_D = \frac{I_{CM}}{2} = \frac{8MR^2}{2} = 4MR^2$$

33. (b) The given circuit diagram can be represented as



$$\therefore C_{AB} = 4 + 4 + 4 = 12 \mu F$$

34. (b) We know that, $v = \frac{dx}{dt}$

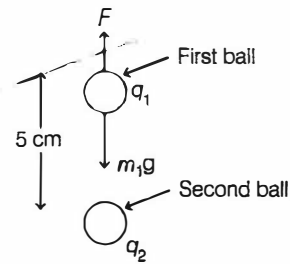
So, position x is given by $x = \int v dt$

$$= \int_{t=0}^{t=2} (2t + 3t^2) dt = \left[\frac{2t^2}{2} + \frac{3t^3}{3} \right]_{t=0}^{t=2} = [t^2 + t^3]_{t=0}^{t=2}$$

$$x = (2)^2 + (2)^3 = 4 + 8 = 12 \text{ m}$$

Position of object is 12 m from the origin at $t = 2$ s

35. (a) The given situation is shown below



When the upper ball remains stationary, then

$$F = m_1 g$$

$$\Rightarrow \frac{1}{4\pi\epsilon_0} \cdot \frac{q_1 q_2}{r^2} = m_1 g$$

Here, $m_1 = 8g = 8 \times 10^{-3} \text{ kg}$

$$q_1 = 5 \times 10^{-8} \text{ C}$$

$$r = 5 \text{ cm} = 5 \times 10^{-2} \text{ m}$$

$$\therefore \frac{9 \times 10^9 \times 5 \times 10^{-8} \times q_2}{(5 \times 10^{-2})^2} = 8 \times 10^{-3} \times 9.8,$$

$$\Rightarrow q_2 = 0.44 \times 10^{-6} \text{ C}$$

$$= 0.44 \mu \text{C}$$

36. (c) Given, $m = 1500$ quintals

$$= 15 \times 10^4 \text{ kg},$$

$$\sin \theta = \frac{1}{75}, a = 4 \text{ ms}^{-2}$$

Total force of friction = $0.2 \times 1500 = 300 \text{ N}$

Force required against gravity in moving the train up the inclined plane = $mg \sin \theta$

$$= 15 \times 10^4 \times 9.8 \times \frac{1}{75} = 19600 \text{ N}$$

Force required to produce an acceleration of 4 ms^{-2}

$$= ma$$

$$= 15 \times 10^4 \times 4 = 600000 \text{ N}$$

Total force required

$$= 300 + 19600 + 600000$$

$$= 619900 \text{ N}$$

37. (b) As we know,

$$\mu = iA = \frac{e\pi r^2}{\left(\frac{2\pi r}{v}\right)} = \frac{evr}{2}$$

$$\therefore \mu \propto r$$

38. (b) Rate of heat flow,

$$H = \frac{\text{Temperature difference}}{\text{Thermal resistance}}$$

where, $R = \frac{l}{KA}$



here, K = thermal conductivity of the rod,

l = length of the rod

and A = area of cross-section.

Let x be the temperature of the junction

$$\frac{90-x}{R} + \frac{90-x}{R} = \frac{x}{R}$$

$$180 - 2x = x \Rightarrow x = 60^\circ\text{C}$$

39. (b) Velocity at displacement y ,

$$v = \omega\sqrt{A^2 - y^2}$$

Angular frequency,

$$\omega = \frac{2\pi}{T} = \frac{2\pi}{2} = \pi \text{ rad s}^{-1}$$

When $y = 2 \text{ cm}$,

$$v = \omega\sqrt{10^2 - 2^2} = \sqrt{96} \pi \text{ cms}^{-1}$$

$$\text{KE} = \frac{1}{2}mv^2 = \frac{1}{2} \times 10 \times 96 \times \pi^2 = 480\pi^2 \text{ erg}$$

When $y = 5 \text{ cm}$,

$$v = \omega\sqrt{10^2 - 5^2} = \sqrt{75}\pi^2 \text{ cms}^{-1}$$

$$\text{KE} = \frac{1}{2}mv^2 = \frac{1}{2} \times 10 \times 75 \times \pi^2 = 375\pi^2 \text{ erg}$$

$$\text{Difference in KE} = 480\pi^2 - 375\pi^2 = 105\pi^2 \text{ erg}$$

40. (d) For first bubble, $p_1 = \frac{8T}{d_A}$ and $p_2 = \frac{8T}{d_B}$

where, T = surface tension.

Under isothermal condition, temperature remains constant.

So, equating number of moles,

$$pV = p_1V_1 + p_2V_2$$

$$\frac{8T}{D} \left[\frac{4}{3} \pi \left(\frac{D}{2} \right)^3 \right] = \frac{8T}{d_A} \left[\frac{4}{3} \pi \left(\frac{d_A}{2} \right)^3 \right] + \frac{8T}{d_B} \left[\frac{4}{3} \pi \left(\frac{d_B}{2} \right)^3 \right]$$

$$\Rightarrow D^2 = d_A^2 + d_B^2$$

$$\Rightarrow D = \sqrt{d_A^2 + d_B^2}$$

Problem Solving Tactics

To find the new radius of the combined bubble after they merge, the law of conservation of volume is applied which states that the total volume of the combined bubbles remains constant.

41. (c) Torque of solenoid is given by

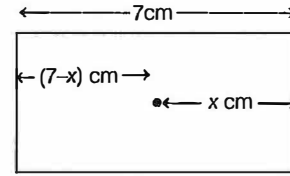
$$\tau = MB \sin \theta$$

$$= (NiA)B \sin \theta \left(\because N = nl = 1000 \times \frac{50}{100} = 500 \right)$$

$$= 500 \times 2 \times 2 \times 10^{-4} \times 0.32 \times \frac{1}{2}$$

$$= 0.032 \text{ N-m}$$

42. (c)



Refractive index,

$$\mu = \frac{\text{Real depth}}{\text{Apparent depth}}$$

$$\mu = \frac{7-x}{3.5} \quad \dots \text{(i) [For first face]}$$

and $\mu = \frac{x}{1.5} \quad \dots \text{(ii) [For opposite face]}$

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

$$\frac{7-x}{3.5} = \frac{x}{1.5}$$

$$\Rightarrow 1.5(7-x) = 3.5x$$

$$\Rightarrow 10.5 - 1.5x = 3.5x$$

$$\Rightarrow 10.5 = 3.5x + 1.5x$$

$$\Rightarrow 10.5 = 5x$$

$$\Rightarrow x = \frac{10.5}{5} = 2.1 \text{ cm}$$

43. (a) Given,

$$R_a = 30 \Omega, R_m = R_a - \frac{5}{100} \times R_a = 0.95 R_a$$

$$\text{As, } 0.95 R_a = \frac{R_a r_v}{(R_a + R_v)}$$

$$0.95 R_a + 0.95 r_v = r_v$$

$$0.95 R_a = 0.05 r_v$$

$$r_v = 19 R_a = 19 \times 30$$

$$= 570 \Omega$$

44. (a) Phase difference between voltage and current,

$$\phi = \frac{\pi}{12} - \left(-\frac{\pi}{6} \right) = \frac{\pi}{4}$$

$$\Rightarrow \text{Power factor} = \cos \phi = \frac{1}{\sqrt{2}}$$

$$\text{Average power dissipated} = \frac{E_m I_m}{2} \cos \phi$$

$$= \frac{10 \times 2}{2} \times \frac{1}{\sqrt{2}}$$

$$= 5\sqrt{2} \text{ W}$$



45. (a) As we know that, magnetic field at the axis,

$$B_1 = \frac{\mu_0}{4\pi} \cdot \frac{2\pi I r^2}{(r^2 + r^2)^{3/2}}$$

$$= \frac{\mu_0}{4} \cdot \frac{I}{\sqrt{2}r} = \frac{\mu_0 I}{4\sqrt{2}r}$$

Magnetic field at the centre, $B_2 = \frac{\mu_0 I}{2r}$

So, $B_1 : B_2 = 1 : 2\sqrt{2}$

46. (d) Given, $l = 150$ m, $v_1 = 10$ ms⁻¹

and $v_2 = 5$ ms⁻¹

Relative velocity of the parrot w.r.t. the train
 $= [10 - (-5)]$ ms⁻¹ = 15 ms⁻¹

Time taken by the parrot to cross the train,

$$t = \frac{s}{v} = \frac{150}{15} = 10 \text{ s}$$

47. (a) Given question satisfies the condition of Wheatstone's bridge principle, hence

$$R_{PQ} = (5 + 5) || (5 + 5) = \frac{10 \times 10}{10 + 10} = 5 \Omega$$

48. (c) Here, $O_1 = \overline{A \cdot B}$

$$O_2 = \overline{A \cdot (\overline{A \cdot B})}$$

and $O_3 = \overline{B \cdot (\overline{A \cdot B})}$

So, $Y = \overline{\overline{\overline{A \cdot (\overline{A \cdot B}) \cdot B \cdot (\overline{A \cdot B})}}}$

$$= \overline{A \cdot (\overline{A \cdot B}) + B \cdot (\overline{A \cdot B})} \quad [\because \overline{\overline{M}} = M]$$

$$= \overline{A \cdot (\overline{A} + \overline{B}) + B \cdot (\overline{A} + \overline{B})}$$

$$= \overline{A \cdot \overline{A} + A \cdot \overline{B} + \overline{A} \cdot B + B \cdot \overline{B}} \quad [\because \overline{M \overline{M}} = 0]$$

$$= \overline{\overline{A} \cdot B + \overline{B} \cdot A}$$

49. (c) The two condensers in the circuit are in parallel combination, hence $C' = C + \frac{C}{2} = \frac{3C}{2}$

The work done in charging the equivalent capacitor is stored in the form of potential energy.

$$\text{Hence, } W = U = \frac{1}{2} C' V^2$$

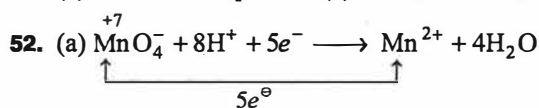
$$= \frac{1}{2} \left(\frac{3C}{2} \right) V^2$$

$$= \frac{3}{4} C V^2$$

50. (b) Here, $\lambda = \frac{c}{v} = \frac{3 \times 10^8}{8.2 \times 10^6} = 36.6$ m

Chemistry

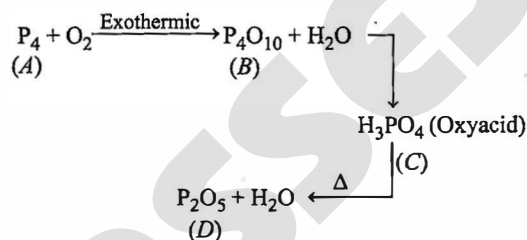
51. (a) The correct option is (a) A-III, B-I, C-II, D-IV.



$\therefore n = 5$

53. (b) All the tetrahalides of group 14 elements are covalent in nature and sp^3 -hybridised with tetrahedral geometry. Exception are SnF_4 and PbF_4 which are ionic in nature. Thus, statement II is false while statement I is true.

54. (b)



So, option (b) is correct.

55. (c) From first order equation,

$$\log [A] = \log [A_0] - \frac{kt}{2.303}$$

On comparing this equation with equation of straight line.

$$y = mx + c \text{ and } m = \frac{-k}{2.303} = X$$

$$\therefore \text{Slope } (X) = \frac{-k}{2.303}$$

Intercept (c) = $\log[A_0]$.

56. (a) Aniline is basic in nature and HCl is acidic in nature.

So, acid-base reaction will take place.

57. (c) Given, initial temperature,

$$T_1 = 20 + 273 = 293 \text{ K}$$

Final temperature,

$$T_2 = 35 + 273 = 308 \text{ K}$$

$$R = 8.314 \text{ J mol}^{-1} \text{ K}^{-1}$$

Since, rate becomes double on raising temperature,

$$\therefore r_2 = 2r_1 \text{ or } \frac{r_2}{r_1} = 2$$

As rate constant, $k \propto r$

$$\therefore \frac{k_2}{k_1} = 2$$



From Arrhenius equation, we know that

$$\log \frac{k_2}{k_1} = -\frac{E_a}{2.303 R} \left[\frac{T_1 - T_2}{T_1 T_2} \right]$$

$$\log 2 = -\frac{E_a}{2.303 \times 8.314} \left[\frac{293 - 308}{293 \times 308} \right]$$

$$0.3010 = -\frac{E_a}{2.303 \times 8.314} \left[\frac{-15}{293 \times 308} \right]$$

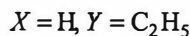
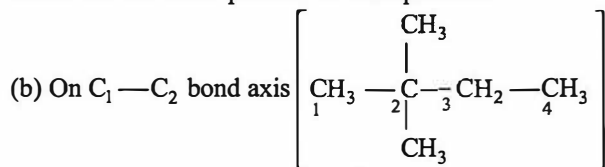
$$\therefore E_a = \frac{0.3010 \times 2.303 \times 8.314 \times 293 \times 308}{15}$$

$$= 34673.48 \text{ J mol}^{-1}$$

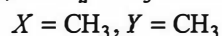
$$\approx 34.7 \text{ kJ mol}^{-1}$$

58. (d) Correct options are (b) and (c), i.e. (d) is the answer.

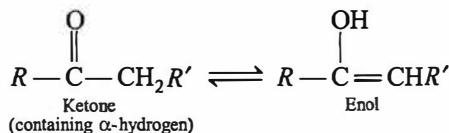
There are two cases possible in this question:



(c) On C₂—C₃ bond axis



59. (c) In keto-enol tautomerism, a carbonyl compound with a hydrogen atom on its alpha-carbon rapidly equilibrates with its corresponding enol.



60. (d) From Faraday's second law of electrolysis,

$$W = Z \times i \times t$$

where, Z = electrochemical equivalent

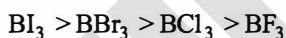
i = current (Amp)

t = time (sec)

$$W = \frac{63.6}{2 \times 96500} \times 0.5 \times 60 \times 60$$

$$W = 0.59 \text{ g}$$

61. (d) Order of adduct formation



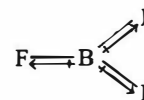
As in BF₃, strong back-bonding is present which decreases the rate of adduct formation.

i.e. Back-bonding $\propto \frac{1}{\text{adduct formation}}$

Hence, for BI₃ ΔH will be maximum.

62. (d) BF₃ molecule has a symmetrical trigonal planar geometry. In such a structure, the resultant moment of any two B—F dipoles is equal in magnitude but

opposite in direction to the moment of the third one. Hence, the net dipole moment of BF₃ molecule is zero.



63. (d) E.C of N = 1s² 2s² 2p³

↓
More stable

E.C of O = 1s² 2s² 2p⁴

↓
Less stable

E.C of N (After 1st I.E) = 1s² 2s² 2p²

↓
Less stable

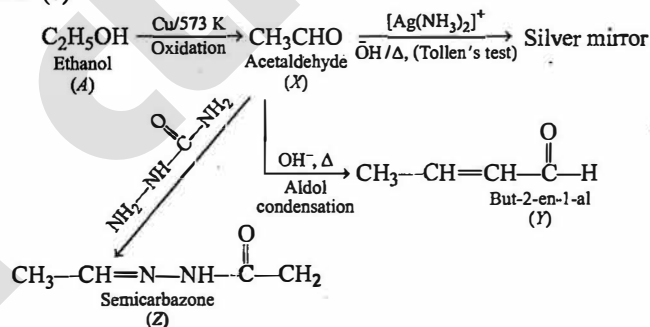
E.C of O (After 1st I.E)

$$= 1s^2 2s^2 2p^3$$

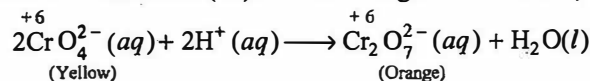
↓
More stable

More stable the electronic configuration, higher the ionisation energy. Hence, both statements I and II are correct.

64. (c)



65. (b) When dilute acid is added to an aqueous solution of potassium chromate (VI). Colour changes are observed,



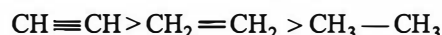
66. (a) CH≡CH, CH₂=CH₂, CH₃-CH₃



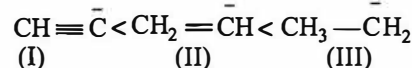
Order of electronegativity of carbon atom is

$$sp > sp^2 > sp^3$$

∴ Acidic character follows the order

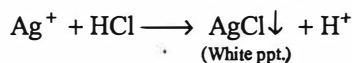
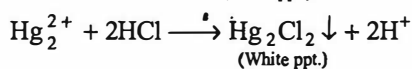
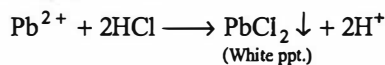


Hence, order of basic strength is



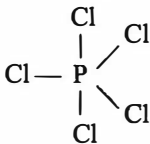
67. (c) Pb^{2+} , Ag^+ and Hg_2^{2+} will give white precipitate in dil. HCl.

The reaction are as follow

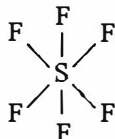


68. (b) The correct match is A-(iv), B-(iii), C-(i), D-(ii).

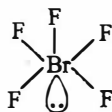
(A) PCl_5 has 5 bond pairs. It has trigonal bipyramidal geometry and shape.



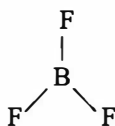
(B) SF_6 has 6 bond pairs and has octahedral geometry and shape.



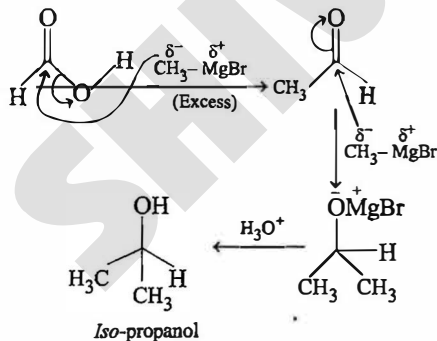
(C) BrF_5 has 5 bond pairs and 1 lone pair and has square pyramidal geometry.



(D) BF_3 has 3 bond pairs and has trigonal planar geometry and shape.



69. (a) Methanoic acid reacts with Grignard's reagent to give *iso*-propanol as a major product.



70. (d)

- (a) Pu^{4+} disproportionates to Pu^{3+} and PuO_2^{2+} in acidic medium. In strongly acidic mediums it stabilizes by forming complex with H^+ ions.
- (b) Np shows oxidation states ranging between +3 and +7, +7 being the maximum.
- (c) UO_2^{2+} , uranium dioxide, is a linear shaped stable oxide which exists in a powdered crystalline form.

All given statements are correct.

71. (a) $[\text{H}^+] = \sqrt{CK_a} = \sqrt{0.5 \times 2 \times 10^{-4}} = \sqrt{1.0} \times 10^{-2}$
 $[\text{H}^+] = 10^{-2}$

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

72. (a) CH_4 is regular tetrahedral and the electronegativity (EN) difference between C and H is negligible, which cancel out. Hence, dipole moment of CH_4 is zero.

NF_3 has less EN difference between N and F as compared to N and H in NH_3 , therefore will have a lower dipole moment.

H_2O has maximum EN difference between H and O therefore will have a maximum dipole moment.

CH_4 (0) < NF_3 (0.24) < NH_3 (1.46) < H_2O (1.85)

73. (a) Number of moles of Cl^- ions ionised from one mole of $\text{CrCl}_3 \cdot 6\text{H}_2\text{O}$.

$$= \frac{2.665}{266.5} = 0.01$$

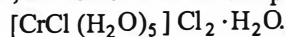
[\because Molecular mass of $\text{CrCl}_3 \cdot 6\text{H}_2\text{O} = 266.5$]

\therefore Moles of AgCl obtained = Moles of Cl^- ionised

$$= \frac{2.87}{143.5} = 0.02$$

\therefore 0.01 mole of complex $\text{CrCl}_3 \cdot 6\text{H}_2\text{O}$ gives 0.02 moles of Cl on ionisation.

Thus, the formula of the complex is



Problem Solving Tactics

To solve this problem, we need to recall Werner's theory postulates and observe specifically the primary and secondary valancies.

74. (a) The number of lines in transition $n_2 \rightarrow n_1$ will be $\frac{(n_2 - n_1)(n_2 - n_1 + 1)}{2}$

The transition $n = 6 \rightarrow n = 3$ corresponds to 6 lines in the spectrum.

$n = 5 \rightarrow n = 3$ corresponds to 3 lines in the spectrum.

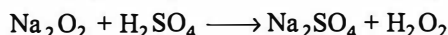
$n = 5 \rightarrow n = 1$ corresponds to 10 lines in the spectrum.

$n = 4 \rightarrow n = 3$ corresponds to 1 lines in the spectrum.

Hence, the correct match is A-(iii), B-(i), C-(ii), D-(iv).



75. (b) CHCl_3 undergoes oxidation in presence of sunlight. Hence, statement I is true but statement II is false.
76. (d) Sodium peroxide gives only hydrogen peroxide with water as well as with sulphuric acid.



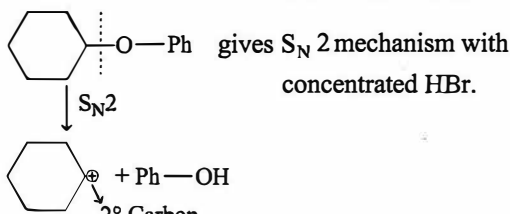
77. (a) Generally metal oxides are basic in nature while non-metal oxides are acidic in nature.

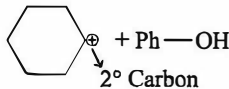
Thus, BaO is basic and Cl_2O_7 is acidic in nature.

Neutral oxides are oxides which are neither acidic nor basic. CO is neutral oxide.

Amphoteric oxide, i.e. Al_2O_3 reacts with both acids and alkalis to form salt and water.

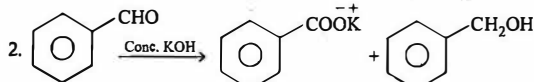
Hence, the correct match is A-(ii), B-(i), C-(iv), D-(iii).

78. (c)  gives $\text{S}_{\text{N}}2$ mechanism with concentrated HBr .



Hence, by the formation of secondary carbocation which is more stable it gives $\text{S}_{\text{N}}2$ reaction.

79. (a) Aldehyde having no α -hydrogen undergoes Cannizzaro reaction in presence of base



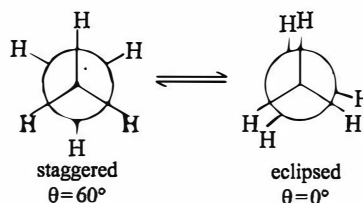
Benzaldehyde

Problem Solving Tactics

Cannizzaro reaction involves the base induced disproportionation of two molecules of a non-enolisable aldehyde to yield a carboxylic acid and a primary alcohol.

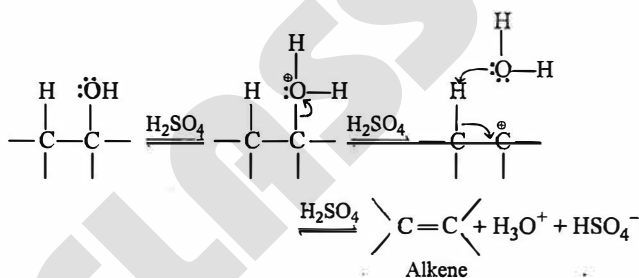
80. (c) $[\text{Co}(\text{NH}_3)_3\text{Cl}_3]$ is a $[\text{MA}_3\text{B}_3]$ type complex which, do not show optical isomerism, because this compound has symmetrical geometry (octahedral), co-ordination number is 6. It also does not contain any bidentate ligand.
81. (b) Due to high electronegativity and small size, F only forms one oxyacid that is HOF. Only in HOF, F is in +1 oxidation state. All show oxidising properties. Chlorine has the highest electron gain enthalpy. Hence, only (b) is false.
82. (d) Because of higher effective nuclear charge and smaller size of atoms, the actinides have higher charge density and because of that they have greater tendency to form complexes than the lanthanides.
83. (d) The staggered conformation of ethane is more stable than eclipsed conformation. Since, eclipsed

conformation has greater potential energy due to torsional strain, it is less stable than the staggered conformation.

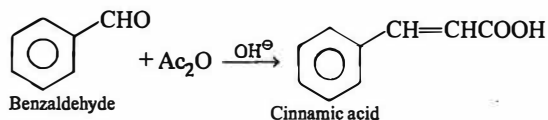


84. (d) Alcohols on dehydration can produce ether as well as alkene under different conditions.

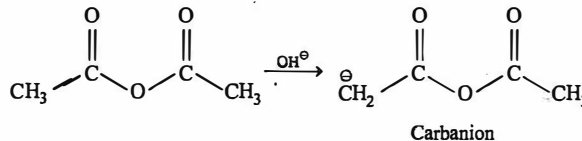
Dehydration of alcohol proceeds through the formation of carbonium ion. The carbonium ion can lose a proton to form alkene. The carbonium ion may be attacked by a fresh molecule of alcohol and form an oxonium ion which can then lose a proton to form ether. Usually, secondary and tertiary alcohols form alkene.

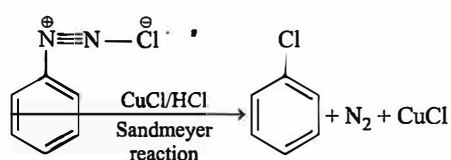


85. (a) Hydrolysis of a nitrile to a carboxylic acid involves the formation of amide intermediate.
86. (a) $\text{CH}_3\text{CH}_2\text{MgBr} + \text{H}-\text{O}-\text{CH}_3 \longrightarrow \text{C}_2\text{H}_6 + \text{CH}_3\text{OMgBr}$
Ethyl magnesium bromide Methanol Ethane
87. (b) Base catalysed condensation of acid anhydride and aromatic aldehyde is known as Perkin reaction.



Reaction starts with the formation of carbanion.



88. (a) 

This reaction is known as Sandmeyer reaction. In this reaction diazonium group is replaced by chloro group.



89. (a) $\Delta G = \Delta H - T\Delta S$

Temperature is constant

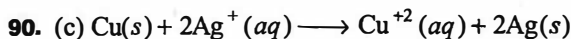
$$\Delta G = 0$$

$$\Delta H = T\Delta S$$

$$40000 = T \times 80$$

$$T = 500 \text{ K}$$

So, $T > 500$ so that ΔG value comes (-ve) and reaction becomes spontaneous.

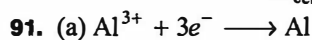


Equilibrium constant (K) = 4×10^{15}

$$E_{\text{cell}}^{\circ} = \frac{0.0591}{2} \log K$$

$$= \frac{0.0591}{2} \log [4 \times 10^{15}]$$

$$E_{\text{cell}}^{\circ} = 0.46 \text{ V}$$



From Faraday's laws of electrolysis, we know that

$$W = \frac{EQ}{96500}$$

$$\frac{Q}{96500} = \frac{W}{E}$$

$$E = 27 / 3 = 9$$

$$\frac{Q}{96500} = 27 / 9 = 3F$$

92. (d) The relative lowering of vapour pressure = $\frac{p^{\circ} - p}{p^{\circ}}$

p° is the vapour pressure of pure solvent and p is the vapour pressure of the solution.

Given that, $p^{\circ} = 90 \text{ mm}$ and $p = 81 \text{ mm}$

The relative lowering of vapour pressure

$$\frac{p^{\circ} - p}{p^{\circ}} = \frac{90 - 81}{90} = 0.1$$

93. (d) I, II and III statements are true.

During the decomposition of an oxide into oxygen and metal vapour, entropy increases as gas is produced in the reaction.

Decomposition of an oxide is an endothermic change. This is because it is reverse of combustion reaction and all combustion reactions are exothermic in nature.

Since both ΔH° and ΔS° are positive, the temperature should be high enough so that $T\Delta S^{\circ} > \Delta H^{\circ}$ and hence, ΔG° is negative.

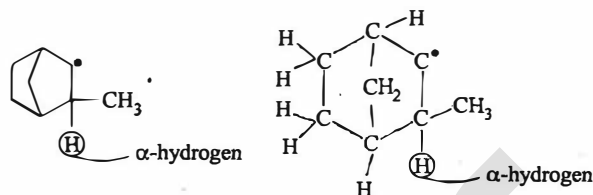
94. (c) Stability of halous acids $\propto \frac{1}{\text{Molar mass}}$

So, as the molar mass increases, the stability decreases.



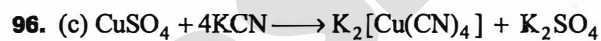
95. (c) Hyperconjugation occurs through the H-atoms present on the carbon atom next to the double bond/radical/carbocation, i.e. α -hydrogen atoms. There is no α -H in the structures I and II.

So, hyperconjugation occurs in only III structure, i.e.



Problem Solving Tactics

Hyperconjugation is the stabilising interaction that results from the interaction of the electrons in a σ -bond (usually C—H or C—C) with an adjacent empty or partially filled p -orbital or π -orbital to give an extended molecular orbital that increases the stability of the system.



$[\text{Cu}(\text{CN})_4]^{2-}$ is stable complex.

97. (d) The two most common pyrimidines of DNA are cytosine (C) and thymine (T) and the two most common purines of DNA are adenine (A) and guanine (G).

98. (d) The correct option is (d) A-II, B-I, C-IV, D-III.

99. (a) Depression in freezing point, $\Delta T_f = i \times K_f \times m$

where, K_f = cryoscopic constant

m = molality of solution and, i is van't Hoff factor

$$\Delta T_f = iK_f \times \frac{\text{Weight of naphthoic acid}}{\text{Molar mass of naphthoic acid}} \times \frac{1000}{\text{Weight of benzene}}$$

$$2 = i \times 1.72 \times \frac{20}{(12 \times 11 + 1 \times 8 + 16 \times 2)} \times \frac{1000}{50}$$

$$2 = i \times \frac{34.4}{172} \times \frac{1000}{50}, 2 = i \times 4$$

$$\frac{2}{4} = i$$

$$0.5 = i$$

100. (b) Weight of sulphur is 32 u and weight of BaSO_4 is 233 u.

So, weight of sulphur in BaSO_4

$$= \frac{\text{Weight of sulphur}}{\text{Weight of BaSO}_4} \times \text{BaSO}_4 \text{ in organic compound}$$

$$= \frac{32}{233} \times 0.4813 = 0.0661$$



$$\begin{aligned} & \text{Percentage of sulphur} \\ &= \frac{\text{Weight of sulphur in BaSO}_4}{\text{Weight of organic compound}} \times 100 \\ &= \frac{0.0661}{0.157} \times 100 = 42.10\% \end{aligned}$$

Biology

Botany

101. (c) Tryptophan operon is an example of repressible operon. In negative repressible operons, transcription of the operon normally takes place. Repressor proteins are produced by a regulator gene, but they are unable to bind to the operator in their normal conformation.
102. (d) Statements I, II and V are correct, whereas statements III and IV are incorrect. These can be corrected as
- The ribosomes of chloroplasts (70S) are smaller than the cytoplasmic ribosomes (80S).
 - The mesosomes are the specialised differentiated form of cell membrane which is the characteristic of prokaryotes.
103. (b) Statement I is true, but statement II is false. The false statement can be corrected as
Sucker arises from the axillary bud of underground part of stem. While the offsets arise as lateral branch with short internodes and each node bearing a rosette of leaves.
104. (a) *Aspergillus*, *Claviceps* and *Neurospora* belongs to Ascomycetes. *Ustilago* are member of Basidiomycete. *Alternaria* belongs to Deuteromycetes.
105. (d) Both statement I and statement II are true.
The cleistogamous flowers do not open at all. These flowers are invariably autogamous as there is no chance of pollen from different flower landing on the stigma.
106. (a) Both A and R are true, but R is not the correct explanation of A.
The growth rate shows an increase that may be arithmetic or geometrical. In arithmetic growth, following mitotic cell division, only one daughter cell continues to divide while the other differentiates and matures. The simplest expression of arithmetic growth is exemplified by a root elongating at a constant rate.
107. (b) The prosthetic groups are organic compounds, they differ from other co-factors, because they are tightly bound to apoenzymes. Whereas coenzymes are associated with the apoenzyme for a short period of time.
108. (b) Statements I and V are correct and statements II, III and IV are incorrect. They can be corrected as
The first amino acid is also called N-terminal amino acid, whereas the last amino acid is also called C-terminal amino acid.

- The exoskeleton of arthropods containing polysaccharide chitin are mostly homopolymers.
- Starch is a homopolymer and not a heteropolymer.

109. (d) The two kingdom system of classification was discarded because this system did not distinguish between the eukaryotes and prokaryotes, unicellular and multicellular and photosynthetic and non-photosynthetic organisms.
110. (a) Both statement I and statement II are true.
Hugo de Vries, based on his work on *Oenothera lamarckiana*, proposed the mutation theory. In this theory, he explained that new species evolve by sudden and distinct heritable changes called mutations. These mutations can occur at any time, hence are random and can be useful, harmful or have no effects at all, hence are directionless. On the other hand, Darwinian variations were considered small and directional.
111. (d) An enhancer is a short sequence of segment of DNA that can be bound to activators to stimulate the transcription of a particular gene. They are usually referred to as transcription factors.
112. (b) The probability of obtaining progeny containing green round seeds from a cross between a parent with yellow round seeds and another parent with yellow wrinkled seeds is 1/8.

		YyRr (Yellow round)		×	Yyrr (Yellow wrinkled)	
		↓				
♀	♂	YR	Yr	yR	yr	
Yr		YYRr	YYrr	YyRr	Yyrr	
yr		YyRr	Yyrr	yyRr	yyrr	
Yr		YYRr	YYrr	YyRr	Yyrr	
yr		YyRr	Yyrr	yyRr	yyrr	

Thus, progeny with green round seeds is $2/16 = 1/8$.

113. (c) An operon is a unit of genetic expression consisting of one or more related genes including the operator and promoter sequences that have regulatory function.
114. (b) Statement in option (b) is correct, while rest of the other statements are false and can be corrected as
Endosperm in angiosperm is triploid in nature and form after fertilisation.
The cylindrical portion below the level of cotyledons is hypocotyl that terminates at its lower end in the radicle or root tip.
The cotyledon of gram family is called scutellum.



- 115.** (d) The correct matches are A-1, B-2, C-3, D-4.
- Endangered species are species facing a very high risk of extinction in the wild in near future.
 - A threatened species is one which is liable to become extinct if not allowed to realise its full biotic potential.
 - Extinct species are ones with no surviving individual on earth.
 - Vulnerable species are the ones which are not critically endangered, but are facing a high risk of extinction in the wild.
- 116.** (a) Matched pair in option (a) is not correct, it can be corrected as
J-shaped curve is called exponential growth curve. It occurs when the resources are unlimited. This type of curve represents the population growing exponentially or geometrically until there is a resource limitation or limitation of population growth by other factors. Growth of the population declines rapidly until a favourable period is restored.
- 117.** (b) Productivity at second trophic level is always less than the productivity at first trophic level. This is because only 10% of energy is transferred from one trophic level to another. Thus, decrease in energy would result in decrease in productivity too.
- 118.** (d) *Cheiranthus cheiri* also called as wall flower belong to family—Cruciferae. These flowers are very useful in bronchitis and fever.
- Other options can be corrected as
- *Raphanus sativus* (muli) belongs to family—Cruciferae also known as Brassicaceae. It is consumed as vegetable.
 - *Vetiveria zizanioides* belongs to family—Graminae (Poaceae). It produce volatile scented oil used in perfumery.
 - *Iberis amara* (chandni) belongs to family—Cruciferae. It also has medicinal property. It is useful for patient suffering from gout and rheumatism.
- 119.** (c) Statements III, IV and V are correct. Rest statements are incorrect and can be corrected as
- In monocots (grass family) the cotyledon is called scutellum and is situated on the lateral side of embryonal axis.
 - Among animals, insects particularly bees are the dominant biotic pollinating agents.
- 120.** (a) In the given options, *Euglena* shows myxotrophic nutrition being both holozoic or animal-like and autotrophic. i.e. plant-like nutrition.
- 121.** (b) The living differentiated cells, that have lost the capacity to divide can regain the capacity of division under certain conditions. This phenomenon is known as dedifferentiation.
- 122.** (d) Some organisations exploit biological resources of other nations without proper authorisation from the countries concerned. This is known as biopiracy. The plants such as basmati rice, turmeric, neem, etc., are related with biopiracy. However, *Bacillus anthracis* is the only organism which is not linked with biopiracy.
- 123.** (d) *Nepenthes* (pitcher plant) is an insectivorous plant, thus it does not require nitrogen from soil to survive. They capture and digest insects to get nutrients like nitrogen and so can live in nitrogen-deficient soil.
- 124.** (c) The number of chromosomes are equal to the number of functional centromere. And the number of chromatids are equal to the number of DNA molecules. During prophase, the number of chromatids are 100 and the number of chromosomes are 50. But during anaphase the number of chromosomes separate from each other, thus the number of chromatids will be 100 and number of chromosome will also become 100. Hence, option (c) is correct.
- 125.** (a) Statement in option (a) is correct, rest incorrect statements can be corrected as
- The ability of unlimited growth in plant is due to the presence of meristems.
 - GA_3 is used to speed up the malting process in brewing industry.
 - Kinetin does not occur naturally in plants.
- 126.** (d) In CAM plants, the stomata remain close during the day in order to reduce evaporation. CAM or Crassulacean Acid Metabolism, is a carbon-fixation pathway that is evolved in some plants as an adaptation to arid conditions.
- 127.** (b) Statement I is true, but statement II is false and it can be corrected as
Protons in thylakoid lumen increases in number when sunlight is received by the chloroplast.
- 128.** (d) The correct matches are A-3, B-2, C-4, D-1
- Deuteromycetes are commonly known as imperfect fungi because only the asexual or vegetative phases of these fungi are known.
 - Ascomycetes are commonly known as sac-fungi. Here the sexual spores are called ascospores, which are produced endogenously in sac like asci.
 - Basidiomycetes include mushrooms. Members of this group lack sex organs, but plasmogamy is brought about by fusion of two vegetative or somatic cells of different strains or genotypes.
 - Phycomycetes are commonly found in aquatic habitats and on decaying wood in moist and damp places. Gametes of these can be similar in morphology (isogamous) or dissimilar (anisogamous or oogamous).



129. (b) Gulmohar and *Cassia* belong to Leguminosae family and have imbricate aestivation.

Imbricate aestivation is the arrangement of five petals in such a way that one petal is completely external and other one petal is completely internal, while three petals are partially external and partially internal.

130. (d) Statements II and III are correct. Rest all are incorrect statements and these can be corrected as
Replication of DNA occurs in S-phase. During this time the amount of DNA per cell doubles.
Recombinase enzyme is involved in crossing over.
The G_2 -phase is the period of cytoplasmic growth.
131. (b) The given condition is known as cleistogamy. It is an adaptation for self-pollination in which the flowers never open. The pollen grains from anther lobe pollinates the stigma of same flower, e.g. *Commelina benghalensis*.
132. (d) GMOs developed by rDNA technology and genetic engineering are useful in enhancing the nutritional value of food. They reduce the post-harvest losses. They are also useful in increasing the tolerance power of crops against the abiotic stresses.
133. (d) When N/K is exactly one, the growth rate of a population following the logistic growth model is equals to zero.

The logistic model is given as

$$\frac{dN}{dt} = rN \left(\frac{1-N}{K} \right)$$

Where, N = population density at time 't'

r = intrinsic rate of natural increase

K = carrying capacity

$$\text{when, } \frac{N}{K} = 1, \text{ then } \frac{1-N}{K} = 0$$

$$\text{Therefore, } \frac{dN}{dt} = 0$$

134. (b) The structure involved in the formation of spindle fibres are centrioles. They exist in a pair close to the nucleus and are present only in the animal cell.
135. (b) To produce 104 pollen grain, 26 meiotic divisions are required.

$$\text{Formation of } n \text{ number of pollen grain} = \frac{n}{4}$$

$$n = 104 \Rightarrow \frac{104}{4} = 26$$

136. (c) *Calotropis* shows opposite type of phyllotaxy, where a pair of leaves arise at each node and lie opposite to each other.

137. (d) The five kingdom system of classification is based on cell structure (prokaryotic or eukaryotic), body structure (unicellular or multicellular), nutrition (autotrophic or heterotrophic) and lifestyle (producers, consumers or decomposers).

138. (d) The option (d) is a incorrectly matched pair. It can be corrected as
Creutzfeldt-Jacob disease is caused by prions.
Virus is a nucleoprotein entity. It is capable of multiplication by taking over cellular machinery of the host cell. Prions are modified hydrophobic glycoproteins.
Viroids are RNA entities consisting of 250-370 nucleotides.

139. (d) Carolus Linnaeus was a Swedish naturalist. He is considered as the father of taxonomy. *Species Plantarum* is a famous publication of Linnaeus (1753), which lists every species of plant known at that time, classified into genera. It is also the first work to consistently apply binomial names.

140. (a) In the members of Phaeophyceae or brown algae food is stored as complex carbohydrates, in the form of laminarin, e.g. *Dictyota*, *Ectocarpus*, etc.

141. (d) Bulliform cells are found in monocot leaves. They are also known as motor cells and help in rolling of leaves in dry weather. Hence, all the statements are correct regarding bulliform cells.

142. (d) In dicotyledons, the seed coat has two covering the outer testa and the inner tegma. The seed coat consist of a scar called hilum through which the developing seeds were attached to the fruits.

Hence, statements (d) is incorrect regarding dicotyledons.

143. (a) *Spirogyra* is isogamous and non-flagellated (non-motile). *Spirogyra*, commonly known as water silk, possess non-flagellated gametes. Thus, the gametes are non-motile.

144. (d) The correct option is (d) as
When the number of chromosome in flowering plant is $2n = n$

$$\text{Antipodal cell} \Rightarrow n = 20$$

$$\text{Embryo} \Rightarrow 2n = 40$$

$$\text{Integuments} \Rightarrow 2n = 40$$

$$\text{Endosperms} \Rightarrow 3n = 60$$

$$\text{Nucellus} \Rightarrow 2n = 40$$

145. (b) Statement in option (b) correctly describes a tracheid. Tracheid is a type of cell in the xylem. Their main function is conduction of sap. These are elongated or tube-like cells with thick and lignified walls and tapering ends. These are dead and the inner layer of the cell walls have thickenings.

146. (b) Both A and R are true, but R is not the correct explanation of A.

Substrate level phosphorylation is the direct formation of ATP or GTP by transferring a phosphate group from a



high energy compound to an ADP or GDP molecule. There are two reactions in glycolysis that involve substrate level phosphorylation.

147. (a) Both A and R are true, but R is not the correct explanation of A.

Two Krebs' cycles occur per glucose molecule because glycolysis results in the formation of 2 pyruvic acid molecules by glucose breakdown. Each turn of Krebs' cycle produces 3 NADH, 1 FADH₂ and 1 ATP molecule. On oxidation, NADH produces 3 ATP molecules and 1 FADH₂ produces 2 ATP molecules. Thus, in each turn of Krebs' cycle 12 ATP molecules are produced.

148. (c) In collenchyma, the corners of cells are deposited with cellulose and pectin substances. It is mechanical tissue which provides support, flexibility and elasticity to the plant organs.

149. (d) Statement IV is correct, while the other statements are incorrect and can be corrected as

- The bundle sheath of C₄ plants has thick cell walls impervious to gaseous exchange.
- These plants have large agranal chloroplasts which fix carbon dioxide into sugar with the help of RuBisCO enzyme.
- The glucose formation in C₄ plant takes place by Calvin cycle.
- These cells lack PEP carboxylase.

150. (d) The correct matches is A-4, B-1, C-2, D-3.

- Dicot stem have an outer epidermis followed by a layer of collenchymatous cells called hypodermis.
- Hypodermis is made up of a few layers of sclerenchymatous cells in monocot stem.
- In monocot roots, the pericycle give rise to lateral roots only.
- In dicot root, the pericycle gives rise to lateral roots and secondary meristem.

Zoology

151. (b) The first clinical gene therapy was given in 1990 to a 4 year old girl with Adenosine Deaminase (ADA) deficiency. This enzyme is crucial for the immune system to function.

152. (c) Statements II, III and V are correct. Rest statements are incorrect and can be corrected as

- Lysozyme acts as a cell wall degrading enzyme for bacteria.
- When a protein encoding gene is expressed in a heterologous host, it is known as **recombinant protein**.

153. (b) Statements III and V are incorrect. These can be corrected as

- The transformation of spermatids into sperms is termed as **spermiogenesis**.

- The oestrogen level in blood increases, resulting in strong sex urge in the female.

Rest statements are correct.

154. (c) The discontinuously synthesised fragments are joined by the enzyme **DNA ligase**. This is why the enzyme is also known as molecular glue.

155. (a) Micro-injection is the method used to introduce alien DNA into host cells in animals. While biolistics or gene gun method is suitable for plants.

156. (d) The host cells are treated with a specific concentration of divalent cations, such as calcium to increase the efficiency with which DNA enters the bacterium (host).

157. (d) In 1928, Sir Alexander Fleming extracted penicillin from the fungus *P. notatum*. This fungus is extensively used for the production of penicillin.

158. (b) In 1997, the first transgenic cow, Rosie, produced human protein enriched milk (2.4 grams per litre). The milk contained the human alpha-lactalbumin and was nutritionally a more balanced product for human babies.

159. (b) In protein structure, covalent bonds are the strongest. They are of two types, peptide bonds and -S-S (disulphide) bonds.

160. (c) In addition to having more than one allele at a specific locus, each allele must also occur in the population at a rate of at least 1% to generally be considered multiple allelism.

161. (c) Myosin filaments are constituted by monomeric proteins 'meromyosin', which has two important parts, a globular head with short arm (HMM) and a tail (LMM).

162. (a) The DNA-dependent DNA polymerases catalyse polymerisation only in one direction, i.e. 5' - 3' direction.

163. (c) The correct matches are A-4, B-2, C-1, D-3.

- By the end of 500 mya invertebrates were formed.
- Fish like reptile, i.e. *Ichthyosaurs* evolved around 200 mya.
- Jawless fish probably evolved around 350 mya.
- Sea weeds and few plants existed probably around 320 mya.

164. (a) The correct matches are A-4, B-3, C-2, D-1.

- Turner's syndrome is caused due to the absence of one of the X-chromosome, leading to 45+ XO. People suffering from this syndrome are short statured and have webbed neck.
- Down's syndrome also called trisomy of 21, is a genetic disorder causing slow motor development.
- Klinefelter's syndrome is also called XXY syndrome, since the affected male is born with an additional copy of X-chromosome.



- Phenylketonuria is an autosomal recessive disorder. This disorder is caused due to the presence of defective gene of phenylalanine hydroxylase.
- 165. (d)** Both statement I and statement II are true.
The chorionic villi and uterine tissue interlink with each other and jointly form a structural and functional unit between developing embryo (foetus) and maternal body called placenta. It helps in the transport of substances to and from the embryo. It also acts as an endocrine tissue and produces several hormones like human Chronic Gonadotropin (hCG), human Placental Lactogen (hPL), oestrogen, progestogens, etc.
- 166. (c)** Statements II, III, IV and V are correct statements. Whereas statement I is incorrect and can be corrected as
The UTRs are present at both 5' end before start codon and 3' end after stop codon.
- 167. (a)** Statements II, IV and V are correct. Rest statement are incorrect and can be corrected as
- Cyclosporin-A has immunosuppressive property and it is commonly used in organ transplants to prevent rejections.
 - Lactic acid was the first acid to be produced by industrial fermentation.
- 168. (b)** When alien species (Nile perch) was introduced deliberately for whatever purpose, some of them turn invasive and caused extinction of indigenous species (cichlid fish). This is known as alien species invasions.
- 169. (a)** The techniques vasectomy and tubectomy are highly effective for birth control. In vasectomy, a small part of the vas deferens is removed or tied up in males. In tubectomy, a small part of the Fallopian tube is removed or tied up in female.
- 170. (b)** A large number of primary follicles degenerate during the phase from birth to puberty. Therefore, at puberty only 60,000 to 80,000 primary follicles are left in each ovary.
- 171. (c)** The correct matches are A-3, B-4, C-1, D-2.
- Neanderthal man lived in Eurasia until about 40,000 years ago. They had a cranial capacity of 1400 cc.
 - *Homo habilis* had a cranial capacity of 650 cc.
 - *Homo erectus* had a cranial capacity of 900 cc.
 - Cro-Magnon man are evolved 10,000 years ago and had a cranial capacity of 1360 cc.
- 172. (b)** The correct sequence for the transmission of an electrical impulse through a neuron is as follows
Dendrites → Cell body → Axon → Axon terminal
- The dendrites receives the signals.
 - The cell body integrates the signals.
 - The axon conducts the impulses.
 - The axon terminal releases neurotransmitters for signal transmission.
- 173. (a)** Bioluminescence is the production and emission of light by some living organisms. It is well marked in ctenophores, e.g. *Pleurobrachia* and *Ctenoplana*.
- 174. (d)** *Mycoplasma* are organisms that completely lack a cell wall. They are smallest living cells known and can survive without oxygen.
- 175. (d)** The correct matches are A-2, B-3, C-1, D-4.
- '+' sign indicates beneficial interaction and '-' sign use for detrimental and 0 for neutral interaction.
 - In commensalism, one species is benefitted (+) and other is neither benefitted nor harmed (0).
 - In both parasitism and predation, only one species benefitted (+) and the interaction is detrimental (-) to other species.
 - Both the species are benefitted in mutualism.
- 176. (b)** The correct sequence for the transport of sperms is as follows
Seminiferous tubules → Rete testis → Vasa efferentia → Epididymis → Vas deferens → Ejaculatory duct → Urethra
- 177. (b)** The adhering junctions perform the function of cementing to keep neighboring cell together.
- 178. (b)** A is true, but R is false. R can be corrected as
The primary oocyte gives rise to two unequal sized cells by first meiotic division. One of the daughter cells of the secondary oocytes, is large and receives most of the cytoplasm, while the other is small called polar body.
Both these cells are not equally functional. The secondary oocyte divides by second meiotic division and form ovum or egg cell, which plays an important role in fertilisation. The role of polar body is unidentified, but do not play any role in fertilisation.
- 179. (b)** Statement in option (b) is incorrect and can be corrected as
The triangular structure called sinus venosus joins the right atrium in frog's heart. It receives blood through the major veins called vena cava.
- 180. (b)** Statement I is true, but statement II is false and can be corrected as
Due to genetic and other unknown reasons in arthritis the body attacks self-cells, which results in damage to the body.
- 181. (b)** Both A and R are true and R is the correct explanation of A.
Type II restriction enzymes are used in *in vitro* to recognise and cleave DNA at specific sites. Thus, they are used as an important tool in recombinant DNA technology.
- 182. (b)** Statement I is true, but statement II is false and it can be corrected as
Muscular dystrophy is the progressive degeneration of skeletal muscle mostly due to genetic disorder.



- 183.** (b) The boy is suffering from exophthalmic goitre or Grave's disease. The signs of this disease include hyperthyroidism, exophthalmos, i.e. protrusion of eyeball due to the deposition of fat behind the eyes.
- 184.** (b) The antibodies produced in response to allergens like dust, pollens, animal dander, etc., is IgE type.
- 185.** (c) Friedrich Meischer in 1869 identified DNA as an acidic substance present in the nucleus. He named it as nuclein.
- 186.** (c) About 97% of oxygen is carried in combination with haemoglobin of erythrocytes. Thus, the maximum transportation of O_2 in blood occurs as oxyhaemoglobin.
- 187.** (c) Statement I is correct, but statement II is incorrect and can be corrected as
The role of oxygen in the regulation of respiratory rhythm is quite insignificant.
Instead, the chemosensitive area situated adjacent to the rhythm centre are highly sensitive to CO_2 and hydrogen ions. Increase in these substances can activate this centre, which in turn can signal the rhythm centre to make necessary adjustments in the respiratory process by which these substances can be eliminated.
- 188.** (a) The correct matches are A-2, B-1, C-4, D-5.
 - *Ascaris* also known as roundworms which causes ascariasis.
 - *Wuchereria* also known as filarial worm and causes elephantiasis or filariasis.
 - *Trichopyton* are responsible for ringworms.
 - *Entamoeba histolytica* is a protozoan parasite responsible for causing amoebiasis in humans.
- 189.** (a) Diuretic drugs like acetazolamide, mannitol, etc, are frequently used in the treatment of high blood pressure as they increase the removal of excess fluid from the body.
- 190.** (a) The correct matches are A-4, B-2, C-1, D-3.
 - β -cells are cells that make insulin which controls the level of glucose in the blood.
 - α -cells release glucagon, which elevates blood glucose.
 - S-cells produce somatostatin which is a strong inhibitor of somatotropin, insulin and glucagon.
 - F-cells secrete pancreatic polypeptide (PP) which is an endogenous peptide hormone.
- 191.** (c) AIDS is caused by the human immunodeficiency Virus (HIV), a member of a group of virus called retro virus which have an envelope enclosing the RNA genome.
- 192.** (b) A is true, but R is false. R can be corrected as
The axonal membrane is more permeable to potassium ions and it moves from higher concentration to lower concentration. Since, the axonal loses its positive ions, it becomes more negatively charged and outside the axonal membrane becomes positively charged. This state of the axonal membrane is called the polarised state.
- 193.** (b) The maximum volume of air a person can breathe in after a forced expiration or the maximum volume of air a person can breathe out after a forced inspiration is called vital capacity. This includes Tidal Volume, Inspiratory Reserve Volume and Expiratory Reserve volume (TV+ IRV+ ERV).
- 194.** (c) For person with blood group 'B' the antigens on RBCs would be B type, while the antibodies in the plasma would be anti-A type.
- 195.** (d) Each artery and vein consists of three layers. The inner lining is made up of squamous endothelium, the tunica intima a middle layer of smooth muscles and elastic fibres and an external layer called tunica externa.
- 196.** (c) Statements I and IV are incorrect and these can be corrected as
 - Synaptic cleft of neurons secrete chemicals called neurotransmitters, which are involved in the transmission of impulses.
 - Spinal cord and cranial nerves are made of myelinated nerve fibres.
- 197.** (d) Statement in option (d) is incorrect about phenylketonuria. It can be corrected as
It is an inborn error of metabolism that results in decreased metabolism of the amino acid phenylalanine.
- 198.** (a) Statement in option (a) is correct. Other statements are incorrect and can be corrected as
 - In somatic hybridisation, the isolated protoplasts from two different varieties of plants (each having a desired character) are fused to get hybrid protoplasts.
 - The milk obtained from transgenic cow contained human alpha lactalbumin which was nutritionally more enhanced.
 - Golden rice is a genetically modified rice variety with enhanced production of vitamin-A.
- 199.** (b) A is true, but R is false. R can be corrected as
The left auricle receives oxygenated blood from the lungs.
- 200.** (c) The correct matches are A-2, B-1, C-3, D-4.
 - PCT (Proximal Convolute Tubule) is responsible for reabsorption of significant substances like glucose, amino acids, water, ions, etc.
 - The vasa recta and Henle's loop plays a significant role in production of concentrated urine.
 - The initial step of urine formation starts at glomerulus. This filtration is called ultrafiltration.
 - Selective secretion of hydrogen and potassium ions takes place in DCT (Distal Convolute Tubule).

