HINTS & SOLUTIONS

ANSWERS

1.	(2)	41.	(3)	81.	(4)	121.	(2)	161.	(3)
2.	(4)	42.	(4)	82.	(3)	122.	(4)	162.	(1)
3.	(2)	43.	(1)	83.	(1)	123.	(4)	163.	(4)
4.	(2)	44.	(1)	84.	(1)	124.	(3)	164.	(2)
5.	(4)	45.	(1)	85.	(2)	125.	(4)	165.	(3)
6.	(3)	46.	(2)	86.	(2)	126.	(4)	166.	(4)
7.	(1)	47.	(4)	87.	(3)	127.	(4)	167.	(4)
8.	(4)	48.	(1)	88.	(4)	128.	(2)	168.	(1)
9.	(3)	49.	(2)	89.	(1)	129.	(4)	169.	(4)
10.	(1)	50.	(2)	90.	(3)	130.	(4)	170.	(3)
11.	(4)	51.	(4)	91.	(1)	131.	(2)	171.	(3)
12.	(3)	52.	(4)	92.	(4)	132.	(4)	172.	(4)
13.	(2)	53.	(1)	93.	(1)	133.	(3)	173.	(1)
14.	(2)	54.	(3)	94.	(2)	134.	(1)	174.	(1)
15.	(3)	55.	(4)	95.	(3)	135.	(1)	175.	(4)
16.	(4)	56.	(2)	96.	(3)	136.	(2)	176.	(4)
17.	(3)	57.	(2)	97.	(3)	137.	(2)	177.	(3)
18.	(3)	58.	(1)	98.	(4)	138.	(2)	178.	(2)
19.	(3)	59.	(2)	99.	(4)	139.	(2)	179.	(4)
20.	(2)	60.	(2)	100.	(2)	140.	(1)	180.	(2)
21.	(4)	61.	(3)	101.	(2)	141.	(1)	181.	(4)
22.	(4)	62.	(3)	102.	(3)	142.	(2)	182.	(4)
23.	(3)	63.	(3)	103.	(1)	143.	(4)	183.	(3)
24.	(2)	64.	(4)	104.	(2)	144.	(3)	184.	(2)
25.	(1)	65.	(2)	105.	(4)	145.	(3)	185.	(3)
26.	(2)	66.	(1)	106.	(2)	146.	(3)	186.	(3)
27.	(1)	67.	(1)	107.	(2)	147.	(2)	187.	(2)
28.	(3)	68.	(2)	108.	(3)	148.	(1)	188.	(4)
29.	(2)	69.	(3)	109.	(1)	149.	(3)	189.	(3)
30.	(2)	70.	(2)	110.	(3)	150.	(4)	190.	(1)
31.	(4)	71.	(3)	111.	(3)	151.	(4)	191.	(3)
32.	(4)	72.	(3)	112.	(4)	152.	(1)	192.	(2)
33.	(2)	73.	(4)	113.	(4)	153.	(4)	193.	(4)
34.	(1)	74.	(1)	114.	(3)	154.	(3)	194.	(3)
35.	(1)	75.	(4)	115.	(4)	155.	(2)	195.	(3)
36.	(3)	76.	(2)	116.	(4)	156.	(3)	196.	(1)
37.	(1)	77.	(1)	117.	(3)	157.	(3)	197.	(2)
38.	(1)	78.	(3)	118.	(3)	158.	(4)	198.	(1)
39.	(2)	79.	(2)	119.	(1)	159.	(3)	199.	(4)
40.	(1)	80.	(2)	120.	(2)	160.	(1)	200.	(3)

HINTS & SOLUTIONS

[PHYSICS]

SECTION-A

1. Answer (2)

Hint: $P_{out} = \eta P_{in}$ and $P_{in} = \frac{mgh}{t}$

Sol.: Since, $P_{out} = \eta\frac{mgh}{t}$

$\Rightarrow P_{out} = 0.8 \times 10 \times 10 \times 60 = 4.8$ kW

2. Answer (4)

Hint: $\vec{\tau} = \vec{r} \times \vec{F}$ and $W = \vec{F}.\vec{S}$

Sol.: The moment of inertia of uniform ring about an axis passing through its centre and normal to the plane is MR^2 and moment of inertia of uniform solid sphere about its diameter is $\frac{2}{5}MR^2$.

3. Answer (2)

Hint: $\vec{F} = q\vec{E}$

Sol.: From the figure, electric field is radially outward, i.e., source charge is positive hence net force on dipole will be leftwards and dipole will move towards left.

4. Answer (2)

Hint and Sol.: Zener diode, in reverse bias after breakdown, act as a constant voltage source hence it can be used as a voltage regulator.

At thermal equilibrium, if p-n junction is not biased, then $I_{drift} = I_{Diffusion}$

5. Answer (4)

Hint: Use mechanical energy conservation.

Sol.: Given $\frac{1}{2}mv^2 = 2mgy$

$\Rightarrow mgy = \frac{1}{4}mv^2$ …(1)

Now from conservation of mechanical energy

$0 + mgh = \frac{1}{2}mv^2 + mgy$ …(2)

From equation (1) and (2)

$mgh = \frac{1}{2}mv^2 + \frac{1}{4}mv^2$

$v^2 = \frac{4gh}{3}$

$\Rightarrow v = \sqrt{\frac{4gh}{3}}$

6. Answer (3)

Hint: Use de Morgan's law, $\overline{A \cdot B} = \overline{A} + \overline{B}$

Sol.: $y = \overline{A \cdot B} + \overline{B \cdot C}$

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

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

$= \overline{A . B . C}$

7. Answer (1)

Hint & Sol.:

4.645 → Uncertain digit

Preceding digit (even)

Hence, 4.645 in three significant figures is 4.64.

8. Answer (4)

Hint & **Sol.:** [Strain] = $[M^0L^0T^0]$

[Stress] = $[ML^{-1}T^{-2}]$

[Force] = $[MLT^{-2}]$

[Surface Tension] = $[ML^0T^{-2}]$

9. Answer (3)

Hint: Area under the *a-t* graph gives change in velocity.

Sol.: Δv = area under the *a-t* curve

$= \frac{20 \times (6-0)}{2} + \frac{-20 \times (8-6)}{2}$

$= 60 - 20$

$= 40$ m/s

10. Answer (1)

Hint: $V = \frac{kQ}{r}$

Sol.: $\frac{4}{3}\pi R^3 = 8 \cdot \frac{4}{3}\pi r^3$

$\Rightarrow R = 2r$

Now, $\frac{V_{bigger}}{V_{smaller}} = \frac{\frac{k(8Q)}{R}}{\frac{kQ}{r}} = \frac{8r}{R} = 4$

11. Answer (4)

Hint: Use current divider rule $i_2 = \left(\frac{R_1}{R_1 + R_2}\right) i$

Sol.: $i_2 = \frac{R_1}{R_1 + R_2} i$

$i_3 = i_1 + i_2$ and $i_4 = 0$ (Since, R_3 and R_4 are short circuited)

$\therefore \quad \frac{i_4}{i_2} = 0$

12. Answer (3)

Hint: $F = \left|\frac{\Delta \vec{p}}{\Delta t}\right|$

Sol.: $\left|\Delta \vec{p}\right| = \left|-mv\cos 30° - mv\cos 30°\right|$

$= 2mv\cos 30°$

$= 2 \times 5 \times 20 \times \frac{\sqrt{3}}{2} = 100\sqrt{3}$ kg m/s

$F = \left|\frac{\Delta \vec{p}}{\Delta t}\right| = \frac{100\sqrt{3}}{0.01} = 10\sqrt{3}$ kN

13. Answer (2)

Hint: $\vec{F} = \frac{d\vec{p}}{dt}$

Sol.: As F is the slope of p-t graph. Hence, force is maximum at point Q because slope is maximum at this point.

14. Answer (2)

Hint: $I = I_{cm} + Md^2$

Sol.: $2\pi R = L \Rightarrow R = \frac{L}{2\pi}$

$I_{YY'} = \frac{MR^2}{2} + MR^2 = \frac{3}{2}MR^2$

$= \frac{3}{2}(\lambda L)\frac{L^2}{(2\pi)^2} = \frac{3\lambda L^3}{8\pi^2}$

15. Answer (3)

Hint: $v_e = \sqrt{\frac{2GM}{R}}$

Sol.: $\frac{v_e}{v_e'} = \sqrt{\frac{M_e}{R_e} \times \frac{R_P}{M_P}}$

$= \sqrt{\frac{1}{2} \times \frac{3}{1}} = \sqrt{\frac{3}{2}}$

$\Rightarrow v_e' = \left(\sqrt{\frac{2}{3}}\right) v_e$

16. Answer (4)

Hint: Pressure, $P = \frac{F}{A} = \frac{\text{Weight}}{A}$

Sol.: By placing the sleepers below the rails cross-sectional area is increased. This in turn reduces the pressure due to weight of train on the rails.

17. Answer (3)

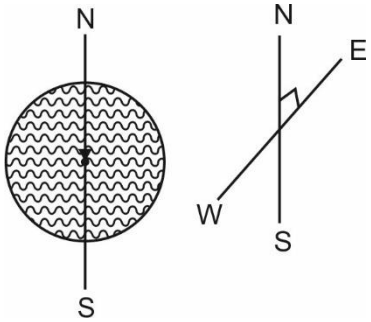
Hint: Use Bernoulli's Principle

Sol.: For upward force, net pressure should be in upward direction. From Bernoulli's principle, speed on the upper surface should be greater than on the lower surface i.e., upper surface should be of larger length.

18. Answer (3)

Hint: $\vec{F} = ILB\sin\theta\hat{n}$

Sol.:



$L_{eff} = 2R = 2 \times 0.1 = 0.2$ m

$F = 5(0.2) \times 1.5 \times \sin 90°$

$= 1.5$ N (downwards)

19. Answer (3)

Hint & Sol.: Iron is ferromagnetic while calcium and aluminium are paramagnetic substance. These have positive susceptibility. Bismuth is diamagnetic which has negative susceptibility.

20. Answer (2)

Hint: Induced emf, $e = L\left|\frac{di}{dt}\right|$

Sol.: $L = \frac{e}{\left|\frac{di}{dt}\right|}$

$= \frac{200}{\frac{(5-1)}{0.1}} = 5$ H

21. Answer (4)

Hint: $I_d = I_c = \frac{dq}{dt}$

Sol.: From Gauss's law

$q = \varepsilon_0\phi_E = \varepsilon_0 AE$

Now, $I_d = \frac{dq}{dt} = \frac{d}{dt}(\varepsilon_0\phi_E) = \varepsilon_0\frac{d\phi_E}{dt} = \varepsilon_0 A\left(\frac{dE}{dt}\right)$

Also, $q = CV \Rightarrow I_d = \frac{dq}{dt} = \frac{d}{dt}(CV) = C\frac{dV}{dt}$

22. Answer (4)

Hint: $\omega \approx \omega_0 \pm \frac{R}{2L}$ and $\omega_0 = \frac{1}{\sqrt{LC}}$

Sol.: $\omega_0 = \frac{1}{\sqrt{LC}} = \frac{1}{\sqrt{4\times10^{-4}}} = 50$ rad/s

$\omega = 50 \pm \frac{40}{(2\times4)} = (50\pm5)$ rad/s

= 45 rad/s and 55 rad/s

23. Answer (3)

Hint & Sol.: Young's modulus, $Y = \frac{FL}{A\Delta L}$,

Bulk modulus $B = -\frac{\Delta P}{\left(\frac{\Delta V}{V}\right)}$

Compressibility $K = \frac{1}{B} = -\frac{\Delta V}{V\Delta P}$

Poisson's ratio $\upsilon = -\left(\frac{\Delta R/R}{\Delta L/L}\right)$

24. Answer (2)

Hint: In forward bias, *p-n* junction diode is shorted and in reverse bias it is opened.

Sol.: $I_{2\Omega} = \frac{V}{R} = \frac{10}{2} = 5$ A

25. Answer (1)

Hint: $\lambda = \frac{h}{p} = \frac{h}{\sqrt{2meV}}$

Sol.: $\lambda = \frac{h}{\sqrt{2meV}}$

For electron, putting all the values

$\lambda = \frac{1.227}{\sqrt{54}}$ nm

= 0.167 nm

26. Answer (2)

Hint: $\vec{E} = -\frac{\partial V}{\partial x}\hat{i} - \frac{\partial V}{\partial y}\hat{j} - \frac{\partial V}{\partial z}\hat{k}$

Sol.:

$\vec{E} = \frac{-\partial}{\partial x}(x+y+z)\hat{i} - \frac{\partial}{\partial y}(x+y+z)\hat{j} - \frac{\partial}{\partial z}(x+y+z)\hat{k}$

$= (-\hat{i}-\hat{j}-\hat{k})$ V/m $= -(\hat{i}+\hat{j}+\hat{k})$ V/m

27. Answer (1)

Hint: Use law of conservation of linear momentum

Sol.: Given $K_1 + K_2 = 11$ MeV …(1)

Since $P_i = P_f$

$0 = \sqrt{2K_1M_1} - \sqrt{2K_2M_2}$

$\sqrt{2K_1(216m)} = \sqrt{2K_2(4m)}$

$K_1 = K_2\left(\frac{4}{216}\right) = \frac{K_2}{54}$ …(2)

From equation (1) & (2)

$K_1 = 0.2$ MeV and $K_2 = 10.8$ MeV

28. Answer (3)

Hint & **Sol.:** $E_n = \frac{-13.6z^2}{n^2}$ eV

$\Rightarrow E_n \propto n^{-2}$

29. Answer (2)

Hint: At near point, $m = 1 + \frac{D}{f}$, for simple microscope.

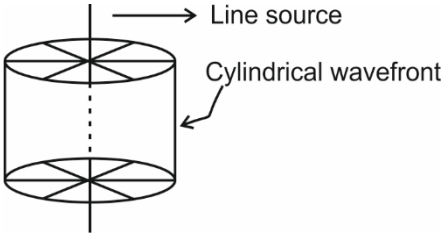
Sol.: $m = 1 + \frac{D}{f}$

$= 1 + \frac{25}{2}$

$= 13.5$

30. Answer (2)

Hint & Sol.:



31. Answer (4)

Hint: $PV = nRT$

Sol.: At constant pressure

$P\Delta V = nR\Delta T$

Now, $\frac{P\Delta V}{PV} = \frac{nR\Delta T}{nRT}$

$\Rightarrow \frac{\Delta V}{V} = \frac{\Delta T}{T}$

$\Rightarrow \Delta V = \frac{V}{T}\Delta T$

Now comparing with $\Delta V = \gamma V \Delta T$, we get

$\gamma = \frac{1}{T}$

32. Answer (4)

Hint & Sol.: O_2 is not a greenhouse gas while CO_2, CH_4, and N_2O absorbs the heat radiations and are called greenhouse gases.

33. Answer (2)

Hint: $\Delta Q = \Delta U + W$

Sol.: Since, $\Delta Q = \Delta U + W$

Hence, $\frac{\Delta Q}{\Delta t} = \frac{\Delta U}{\Delta t} + \frac{W}{\Delta t}$

$\Rightarrow 100 = \frac{\Delta U}{\Delta t} + 80$

$\Rightarrow \frac{\Delta U}{\Delta t} = 20$ J/s

34. Answer (1)

Hint: $f_{KE} = 2f_x$

Sol.: Given $x = (5m)\cos\left[2\pi t(s) + \frac{\pi}{4}\right]$

$\Rightarrow \omega = 2\pi$

$\Rightarrow f_x = 1\ s^{-1}$

Hence, $f_{KE} = 2f_x = 2\ s^{-1}$

$f_{KE} = 2$ Hz

35. Answer (1)

Hint: $\Delta\phi = \frac{2\pi}{\lambda}.\Delta x$

Sol.: Given path difference = $\frac{\lambda}{2}$

Now, phase difference, $\Delta\phi = \frac{2\pi}{\lambda}\left(\frac{\lambda}{2}\right) = \pi$

SECTION-B

36. Answer (3)

Hint: $I_{rms} = \sqrt{\frac{\int i^2 dt}{\int dt}}$

Sol.: $I_{rms} = \sqrt{\frac{\int_0^{T/2} (-I_0 \sin\omega t)^2 dt + \int_{T/2}^{T} 0\, dt}{T}}$

$= I_0\sqrt{\frac{\int_0^{T/2} (\sin\omega t)^2 dt}{\int_0^{T} dt}}$

$= I_0\sqrt{\left[\frac{1}{4}\right]} = \frac{I_0}{2}$

37. Answer (1)

Hint: $KE_{max} = \frac{hc}{\lambda} - W_0$

Sol.: $\frac{1}{2}m_e v_{max}^2 = \frac{hc}{\lambda} - W_0$

$v_{max}^2 = \frac{2(hc - \lambda W_0)}{\lambda m_e}$

$v_{max} = \sqrt{\frac{2(hc - \lambda W_0)}{\lambda m_e}}$

38. Answer (1)

Hint: Use $h = ut + \frac{1}{2}gt^2$

Sol.: For upward velocity, $h = -ut_1 + \frac{1}{2}gt_1^2$ ...(1)

For downward velocity $h = ut_2 + \frac{1}{2}gt_2^2$ …(2)

$h(t_1 + t_2) = \frac{1}{2}gt_1t_2\,(t_1 + t_2)$

$h = \frac{1}{2}gt_1t_2$ …(3)

For free fall, $h = \frac{1}{2}gt^2$ …(4)

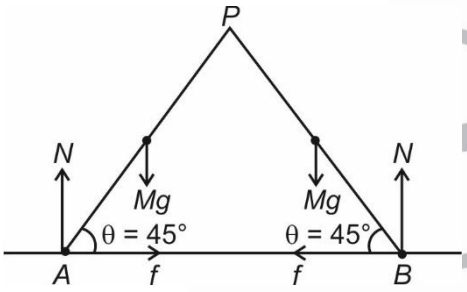
From equation (3) and (4)

$t^2 = t_1t_2$

$\Rightarrow \quad t = \sqrt{t_1t_2}$

39. Answer (2)

Hint: At equilibrium $\sum\vec{F} = 0$ and $\sum\vec{\tau} = 0$



Sol.:

Since, $\sum\vec{F} = 0$

$\Rightarrow \quad N + N = 2Mg$

$N = Mg$ …(1)

Now torque about point P is zero i.e.,

$\tau_P = 0$

$\tau_P = N(L\cos\theta) - f\,(L\sin\theta) - Mg.\frac{L}{2}(\cos\theta)$

$f\sin\theta = \frac{Mg}{2}\cos\theta$

$f = \frac{Mg}{2}$

40. Answer (1)

Hint: $W = \vec{F}\cdot\Delta\vec{r}$

Sol.: Given $\vec{F} = (\hat{i} + 2\hat{j} + 3\hat{k})$ N and

$\Delta\vec{r} = \vec{r_2} - \vec{r_1}$

$= (-\hat{i})$ m

Now, $W = \vec{F}\cdot\vec{r} = (\hat{i} + 2\hat{j} + 3\hat{k}).(-\hat{i}) = -1$ J

41. Answer (3)

Hint: $\vec{\tau} = \vec{r}\times\vec{F} = rF_\perp$

Sol.:

$\tau = (10\sin 30°\times 0.3 + 50\sqrt{3}\sin 60°\times 0.5)$ clockwise

= (1.5 + 37.5) clockwise

= 39 N m, clockwise

42. Answer (4)

Hint: $f = \frac{1}{2\pi}\sqrt{\frac{K}{m}}$ and $K_{eff} = K_1 + K_2$ for parallel combination.

Sol.: $f = \frac{1}{2\pi}\sqrt{\frac{2K}{m}}$ (When both springs are present)

$f' = \frac{1}{2\pi}\sqrt{\frac{K}{m}}$ (When one spring is removed)

Now,

$\frac{f'}{f} = \frac{1}{\sqrt{2}}$

$\Rightarrow f' = \frac{f}{\sqrt{2}}$

43. Answer (1)

Hint: Use $U = \frac{-Gm_1m_2}{r}$ and law of conservation of linear momentum and law of conservation of mechanical energy.

Sol.: By linear momentum conservation

$0 = mv_1 - mv_2 \Rightarrow v_1 = v_2$ …(1)

By energy conservation

$0 + 0 = \frac{1}{2}mv_1^2 + \frac{1}{2}mv_2^2 - \frac{Gm^2}{a}$

$v = \sqrt{\frac{Gm}{a}}$

Relative speed of approach = $v + v = 2\sqrt{\frac{Gm}{a}}$

44. Answer (1)

Hint: $\Delta E = 4\pi R^2T\,(n^{1/3} - 1)$

Sol.: $\frac{4}{3}\pi R^3 = 27\times\frac{4}{3}\pi r^3$

$\Rightarrow \quad r = \frac{R}{3}$

Gain in surface energy, $\Delta E = (27 \times 4\pi r^2 - 4\pi R^2)T$

$= (12\pi R^2 - 4\pi R^2)T = 8\pi R^2 T$

45. Answer (1)

Hint: Efficiency of Carnot engine is $\eta = 1 - \frac{T_2}{T_1}$

Sol.: $\eta = \left(1 - \frac{300}{600}\right) = \frac{1}{2}$

$\frac{W}{Q_1} = \frac{1}{2}$

$Q_1 = 2W$ = 1200 J per cycle

46. Answer (2)

Hint: $f = f_0\left[\frac{v}{v - v_s}\right]$

Sol.: $\frac{f_1}{f_2} = \frac{v - v_2}{v - v_1} = \frac{320 - 16}{320 - 32}$

$= \frac{304}{288} = \frac{19}{18}$

47. Answer (4)

Hint: $\vec{F} = i\,(\vec{l} \times \vec{B})$

Sol.: $\vec{F}_{AB} = i\,(\vec{L}_{AB} \times \vec{B})$

$\because$ L_{AB} = 3a (effective length)

$\therefore \quad \vec{F} = I\,(3a\hat{i}) \times (B_0\hat{k})$

$= (-3IaB_0\hat{j})$

48. Answer (1)

Hint: $\frac{I_c}{I_E} = \alpha$ and $\alpha = \frac{\beta}{1+\beta}$

Sol.: $I_c = \left(\frac{\beta}{\beta + 1}\right) I_E = \frac{50}{51} \times 10.2$

= 10 mA

49. Answer (2)

Hint: For minimum deviation, $i = e$ and $i + e = \delta_m + A$

Sol.: $i + e = \delta_m + A$

$\delta_m = 106° - 60° = 46°$

50. Answer (2)

Hint: $V = IR$

Sol.: Since both resistors of 3 Ω are shorted i.e. No current will flow through these resistors

$I_{AB} = \frac{10}{5} = 2$ A

[CHEMISTRY]

SECTION-A

51. Answer (4)

Hint: Bond order = $\frac{N_b - N_a}{2}$

Sol.: $O_2(16e^-)$: $(\sigma 1s)^2$, $(\sigma^* 1s)^2$, $(\sigma 2s)^2$, $(\sigma^* 2s)^2$, $(\sigma 2p_z)^2$, $(\pi 2p_x)^2 = (\pi 2p_y)^2$, $(\pi^* 2p_x)^1 = (\pi^* 2p_y)^1$

Species	Bond order
O_2	BO = $\frac{10-6}{2}$ = 2
O_2^+	BO = $\frac{10-5}{2}$ = 2.5
O_2^-	BO = $\frac{10-7}{2}$ = 1.5
O_2^{2+}	BO = $\frac{10-4}{2}$ = 3

52. Answer (4)

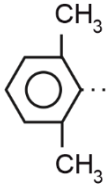
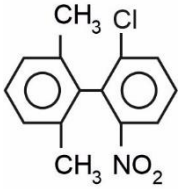
Hint: For 'l' subshell, value of m_l lies between –l to +l.

Sol.: For l = 1, m = –1, 0, +1

So for l = 1, m = –2 is not possible

53. Answer (1)

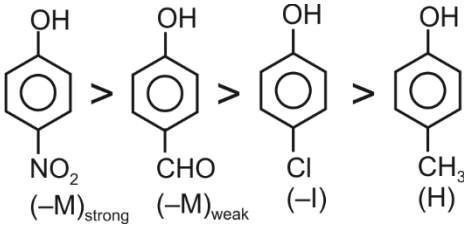
Hint: Molecules having plane of symmetry are optically inactive.

Sol.: Due to symmetrically substituted ring,  ring, the compound  contains a plane of symmetry so it is optically inactive

54. Answer (3)

Hint: Electron withdrawing groups present on phenol increases acidic nature of phenol.

Sol.: Acidic Nature:

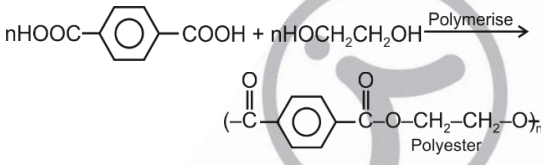


55. Answer (4)

Hint: Monomers of terylene are ethylene glycol and terephthalic acid.

Sol.:

- Terylene is a condensation polymer as H_2O molecules are removed during its formation.



- Bakelite is a thermosetting plastic

56. Answer (2)

Hint: C_3O_2: O = C = C = C = O

Sol.: $\overset{-2}{O}=\overset{+2}{C}=\overset{0}{C}=\overset{+2}{C}=\overset{-2}{O}$: C_3O_2

57. Answer (2)

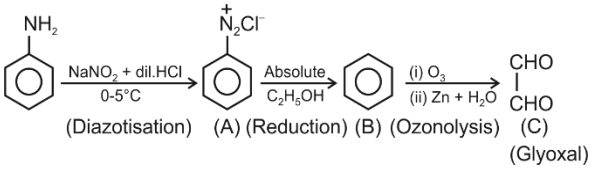
Hint: Gold sol is a negatively charged sol.

Sol.: A negatively charged sol is most easily coagulated by a cation having maximum charge. So, among the given options negatively charged gold sol is most easily coagulated by Al^{3+} ion.

58. Answer (1)

Hint: Absolute C_2H_5OH reduces benzenediazonium chloride into benzene.

Sol.:



59. Answer (2)

Hint & Sol.: The maximum limit of nitrate in drinking water is 50 ppm. Excess nitrate in drinking water can cause disease such as methemoglobinemia.

60. Answer (2)

Hint: Discharge potential (DP) of H_2O is less than discharge potential of SO_4^{2-}

Sol.: $Na_2SO_4 \rightarrow 2Na^+ + SO_4^{2-}$

Species having lesser discharge potentials will be oxidized or reduced at anode or cathode.

At anode: $2H_2O \rightarrow 4H^+ + O_2 + 4e^-$

61. Answer (3)

Hint: On moving down the group, the solubility of 2^{nd} group sulphates decreases.

Sol.: Due to large size of sulphate ions, the lattice energy of 2^{nd} group sulphate do not change much. So as the size of 2^{nd} group metal increases their hydration energy decreases as a result their solubility also decreases.

Order of solubility: $BeSO_4 > MgSO_4 > CaSO_4 > BaSO_4$

62. Answer (3)

Hint: Salts of weak base and strong acid on hydrolysis form acidic solution.

Sol.:

- Na_2SO_4 : Salt of strong base and strong acid so pH = 7
- CH_3COOK : Salt of strong base and weak acid so pH > 7
- NH_4Cl : Salt of weak base and strong acid so pH < 7
- CH_3COONH_4 : Salt of weak base and weak weak acid so pH ≈ 7

63. Answer (3)

Hint: Endothermic reactions are favoured at high temperature.

Sol.: $A(g) + B(g) \rightleftharpoons C(g) + 2D(g)$, $\Delta_r H = + xkJ$

- Since $(n_p)_g > (n_r)_g$, so on increasing pressure reaction will shift to backward direction hence formation of products is favoured at low pressure.
- Since reaction is endothermic so on increasing temperature reaction will shift to forward direction and more product will form.

64. Answer (4)

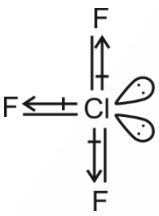
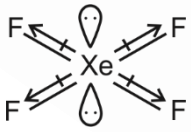
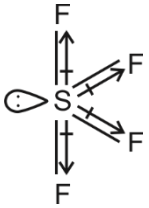
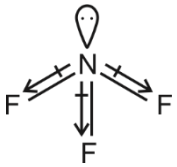
Hint: & Sol.:

Name	IUPAC Official Name
Unnilunium	Mendelevium
Unnilpentium	Dubnium
Unnilennium	Meitnerium
Unnilhexium	Seaborgium
Unnilseptium	Bohrium
Unnilbium	Nobelium
Unniltrium	Lawrencium

65. Answer (2)

Hint: ClF_3: sp^3d, XeF_4 : sp^3d^2, SF_4 : sp^3d, NF_3 : sp^3

Sol.:

- ClF_3 :  $\mu \neq 0$
- XeF_4 :  $\mu = 0$
- SF_4 :  $\mu \neq 0$
- NF_3 :  $\mu \neq 0$

66. Answer (1)

Hint: For fcc unit cell : $\sqrt{2}a = 4r$

Sol.: $4r = \sqrt{2}a$

$\therefore$ Atomic radius (r) $= \frac{\sqrt{2}a}{4} = \frac{\sqrt{2}}{4} \times 200\ \text{pm}$

$= \frac{100}{\sqrt{2}}\ \text{pm}$

67. Answer (1)

Hint: When the intermolecular attractive forces between A-A and B-B are weaker than those between A-B, negative deviation is observed.

Sol.: H-bonding between phenol and aniline is stronger than the respective intermolecular H-bonding between similar molecules so phenol and aniline mixture shows negative deviation from Raoult's law.

68. Answer (2)

Hint: $\Delta T_f = iK_f m$

Sol.: Lesser the value of ΔT_f, more will be the freezing point of solution.

Solution	ΔT_f
0.1m NaCl	$\Delta T_f = 2 \times K_f \times 0.1 = 0.2K_f$
0.1m Urea	$\Delta T_f = 1 \times K_f \times 0.1 = 0.1K_f$
0.1m K_2SO_4	$\Delta T_f = 3 \times K_f \times 0.1 = 0.3K_f$
0.1m $MgCl_2$	$\Delta T_f = 3 \times K_f \times 0.1 = 0.3K_f$

69. Answer (3)

Hint: Spin only magnetic moment $(\mu) = \sqrt{n(n+2)}$ BM

where, n = number of unpaired electron.

Sol.:

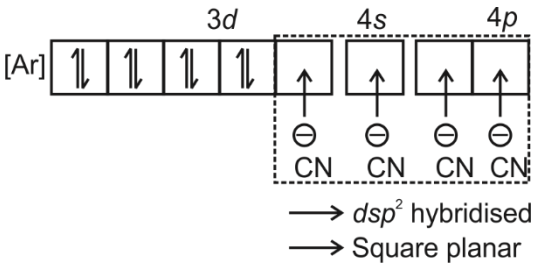
Ion	Unpaired $e^{\ominus}$(n)	$\mu = \sqrt{n(n+2)}$ BM
Mn^{2+}	n = 5	$\mu = \sqrt{5(5+2)} = \sqrt{35}$ BM
Fe^{2+}	n = 4	$\mu = \sqrt{4(4+2)} = \sqrt{24}$ BM
Ti^{2+}	n = 2	$\mu = \sqrt{2(2+2)} = \sqrt{8}$ BM
Cu^{2+}	n = 1	$\mu = \sqrt{1(1+2)} = \sqrt{3}$ BM

70. Answer (2)

Hint: CN^- is a strong field ligand.

Sol.: Ni^{2+}: $[Ar]3d^8\ 4s^0\ 4p^0\ 4d^0$

Ni^{2+} in $[Ni(CN)_4]^{2-}$:



Since no unpaired electron is present so $[Ni(CN)_4]^{2-}$ is diamagnetic in nature.

71. Answer (3)

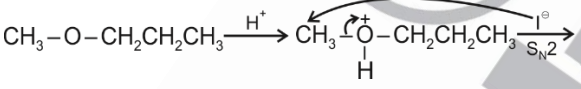
Hint & Sol.: Series of ligands in increasing order of field strength is known as spectrochemical series and given as

$I^- < Br^- < SCN^- < Cl^- < S^{2-} < F^-$

72. Answer (3)

Hint: Ethers with 1°-alkyl group follow S_N2 path with HI.

Sol.:

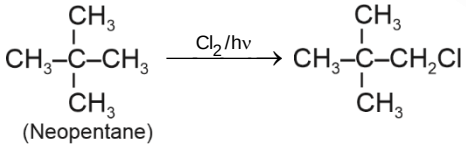
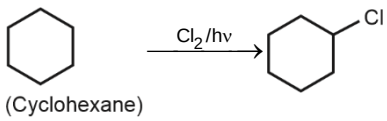


$$CH_3-I + CH_3CH_2CH_2OH \xrightarrow{HI} CH_3CH_2CH_2I$$

73. Answer (4)

Hint: Hydrocarbon having more than one type of H-atoms will give more than one mono-chloro products on chlorination.

Sol.:

- $CH_3-CH_3 \xrightarrow{Cl_2/h\nu} CH_3CH_2Cl$
  (Ethane)
- 
  (Neopentane)
- 
  (Cyclohexane)
- $\begin{matrix}CH_3\\CH_3\end{matrix}\!\!>CH-CH_3 \xrightarrow{Cl_2/h\nu}$
  (Isobutane)

$$\begin{matrix}CH_3\\CH_3\end{matrix}\!\!>C(Cl)-CH_3 + \begin{matrix}CH_3\\CH_3\end{matrix}\!\!>CH-CH_2Cl$$

74. Answer (1)

Hint: Dipole-induced dipole forces operate between the polar molecules having permanent dipole and non-polar molecules lacking permanent dipole.

Sol.:

- HCl is polar molecule while Ne is non-polar so permanent dipole of $\overset{\delta+}{H}\overset{\delta-}{Cl}$ will induce dipole on the electrically neutral Ne.
- London forces are associated with non-polar molecules.

75. Answer (4)

Hint: For a spontaneous process,

$\Delta G° = \Delta H° - T\Delta S° < 0$

Sol.:

$\Delta_rH°$	$\Delta_rS°$	$\Delta_rG°$	Description
–	–	–(at low T)	Reaction spontaneous at low temperature
–	+	–(at all T)	Reaction spontaneous at all temperature
+	+	+(at low T)	Reaction non-spontaneous at low temperature
+	–	+(at all T)	Reaction non-spontaneous at all temperature

76. Answer (2)

Hint: Haber's process: $N_2(g) + 3H_2(g) \rightarrow 2NH_3(g)$

Sol.: $N_2(g) + 3H_2(g) \rightarrow 2NH_3(g)$

From stoichiometry,

$$\frac{(n_{N_2})_{reacted}}{1} = \frac{(n_{H_2})_{reacted}}{3} = \frac{(n_{NH_3})_{formed}}{2}$$

$$\therefore \quad (n_{NH_3})_{formed} = 2\times(n_{N_2})_{reacted} = 2\times10 = 20$$

77. Answer (1)

Hint: Cu at 573 K is a dehydrogenating agent.

Sol.: $\underset{(1°\text{–alcohol})}{R-CH_2-OH} \xrightarrow[573\,K]{Cu} \underset{\text{Aldehyde}}{R-CHO+H_2}$

78. Answer (3)

Hint: Iodoform test is shown by compounds containing $CH_3-\overset{\overset{O}{\|}}{C}-$ group or $CH_3-\underset{\underset{OH}{|}}{CH}-$ group.

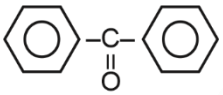
Sol.:

- $CH_3-\underset{\underset{OH}{|}}{CH}-H \xrightarrow{I_2+NaOH} CHI_3+HCOONa$

  Ethanol

- $CH_3-\overset{\overset{O}{\|}}{C}-CH_3 \xrightarrow{I_2+NaOH} CHI_3+CH_3COONa$

  Propanone

-  $\xrightarrow{I_2+NaOH}$ No reaction

  Benzophenone

- $CH_3-\underset{\underset{OH}{|}}{CH}-CH_2-CH_3 \xrightarrow{I_2+NaOH} CHI_3+CH_3CH_2COONa$

  Butan-2-ol

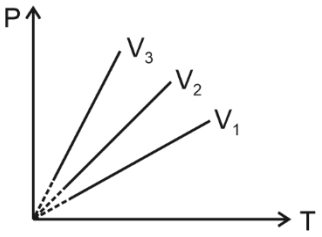
79. Answer (2)

Hint: Gay Lussac's law : at constant volume, $\frac{P}{T}$ = constant.

Sol.: Gay Lussac's Law at constant volume(V),

$P \propto T$

$\therefore$ $P = kT$ (k = constant)



So curve between P and T will be straight line passing through origin and as the slope of straight line increases, V decreases hence

$V_3 < V_2 < V_1$

80. Answer (2)

Hint: $w_{rev} = -\int_{V_i}^{V_f} P_{ex} dV$

Sol.:

$$w_{rev} = -\int_{V_i}^{V_f} P_{ex} dV = -\int_{V_i}^{V_f} (P_{in} \pm dp) dV \; \square \; -\int_{V_i}^{V_f} P_{in} dV$$

$$= -\int_{V_i}^{V_f} \frac{nRT}{V} dV = -nRT \ln \frac{V_f}{V_i}$$

$\therefore$ $w = -2.303nRT \log \frac{V_f}{V_i}$

81. Answer (4)

Hint: Be^{2+} ion has very small size.

Sol.: Due to very small size of Be^{2+}, Be shows high covalent character in its halides (non-polar nature) so beryllium halides are soluble in organic solvents.

82. Answer (3)

Hint & Sol.: Permanent hardness of water is due to the presence of soluble salts of Mg and Ca in the form of chlorides and sulphates.

83. Answer (1)

Hint: $k = \frac{0.693}{t_{1/2}}$ (for 1st order reaction)

Sol.: For 1st order reaction,

$$t_{1/2} = \frac{0.693}{k} = \frac{0.693}{1.386 \times 10^{-2}} = 50 \text{ s}$$

84. Answer (1)

Hint: Norethindrone is an example of synthetic progesterone derivative.

Sol.:

- Meprobamate is a mild tranquilizer suitable for relieving tension.
- Codeine is narcotic analgesic used for the relief of cardiac pain.
- Prontosil is an effective antibacterial, which resembles in structure to the compound, Salvarsan.
- Norethindrone is an example of synthetic progesterone derivative most widely used as antifertility drug.

85. Answer (2)

Hint: Aldehydes gives nucleophilic addition reaction with Grignard reagent.

Sol.: $\underset{\text{(Propionaldehyde)}}{CH_3CH_2-CH=O} \xrightarrow[\text{dry ether}]{\overset{\delta-}{C_2H_5}\overset{\delta+}{MgBr}} CH_3CH_2-CH(OMgBr)(C_2H_5) \xrightarrow{H_2O/H^+} \underset{\text{Pentan-3-ol}}{CH_3\overset{1}{C}H_2\overset{2}{C}H\overset{3}{C}H\overset{4}{C}H_2\overset{5}{C}H_3}$ (OH at C-3)

SECTION-B

86. Answer (2)

Hint: Those amino acids which cannot be synthesised in the body and must be obtained through diet, are known as essential amino acids.

Sol.:

- Threonine (CH_3–$\underset{OH}{CH}$–$\underset{NH_2}{CH}$–COOH) is an essential amino acid.
- Alanine, glutamic acid and serine are non-essential amino acids.

87. Answer (3)

Hint: More the electronegativity of halogen atom of hypohalous acid, more will be the acidic strength of acid.

Sol.:

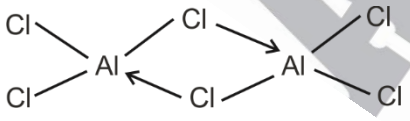
- Acidic strength : H_2O < H_2S < H_2Se
  (Ka) 1.8×10^{-16} 1.3×10^{-7} 1.3×10^{-4}
- Boiling point : HBr < HI < HF
  (in K) 206 238 293
- Acidic strength: HOI < HOBr < HOCl
- Basic character: $\underbrace{As_2O_3 < Sb_2O_3}_{\text{amphoteric}} < \underbrace{Bi_2O_3}_{\text{Predominantly basic}}$

88. Answer (4)

Hint: Boron does not has *d*-orbital.

Sol.: $AlCl_3$ is dimerised through halogen bridging and exist as Al_2Cl_6.

Al_2Cl_6 :



- Maximum covalency of boron is four as its outer shell (2nd shell) has only four orbitals i.e 2*s* $2p_x$ $2p_y$ and $2p_z$.

89. Answer (1)

Hint: $\Lambda_m = \frac{\kappa\times1000}{M}$

and $\Lambda^o_{CH_3COOH} = \lambda^o_{CH_3COO^-} + \lambda^o_{H^+}$

Sol.: $\Lambda_m = \frac{\kappa\times1000}{M}$

$= \frac{9\times10^{-5}\times1000}{0.002} = 45\ S\ cm^2\ mol^{-1}$

$\Lambda^o_{CH_3COOH} = \lambda^o_{CH_3COO^-} + \lambda^o_{H^+}$

$= 41 + 349 = 390\ S\ cm^2\ mol^{-1}$

$\alpha = \frac{\Lambda_m}{\Lambda^o_m} = \frac{45}{390} = 0.115 \approx 0.12$

90. Answer (3)

Hint: Fe_2O_3 is reduced to FeO in lower temperature range in blast furnace.

Sol.: Lower temperature range in blast furnace (500-800 K):

- $3Fe_2O_3 + CO \rightarrow 2Fe_3O_4 + CO_2$
- $Fe_3O_4 + 4CO \rightarrow 3Fe + 4CO_2$
- $Fe_2O_3 + CO \rightarrow 2FeO + CO_2$

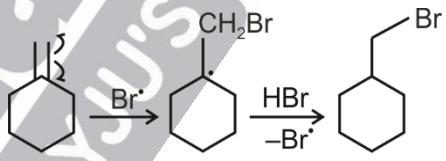
91. Answer (1)

Hint: Addition of HBr to alkene in presence of peroxide follows Antimarkovnikov rule.

Sol.:

C_6H_5CO–O–O–$COC_6H_5 \longrightarrow 2C_6H_5COO^{\bullet} \longrightarrow 2C_6H_5^{\bullet} + CO_2$

$C_6H_5^{\bullet} \xrightarrow{HBr} C_6H_6 + Br^{\bullet}$



(Stable 3° free radical)

92. Answer (4)

Hint: Zn is low boiling point metal.

Sol.:

- Zone refining method is very useful for producing semiconductor and other metals of high purity e.g. Silicon, germanium.
- Mond process used for refining Nickel:

$$\underset{\text{(Impure)}}{Ni} + 4CO \xrightarrow{330\text{-}350\ K} \underset{\text{(Volatile)}}{Ni(CO)_4}$$

$$Ni(CO)_4 \xrightarrow{450\text{-}470\ K} \underset{\text{(Pure)}}{Ni} + 4CO$$

- van Arkel method for refining Zirconium.

$$\underset{\text{(Impure)}}{Zr} + 2I_2 \xrightarrow{\Delta} \underset{\text{(Volatile)}}{ZrI_4}$$

$$ZrI_4 \xrightarrow{1800\ K} \underset{\text{(Pure)}}{Zr} + 2I_2$$

- Distillation method is very useful for low boiling metals like zinc.

93. Answer (1)

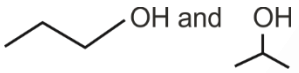
Hint: The free rotation about C–C single bond results into different spatial arrangements of atoms in space, which are known as conformers.

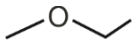
Sol.: In all the conformations of alkanes, the bond angles and the bond length remain the same.

94. Answer (2)

Hint: General formula of both alcohol and ethers is $C_nH_{2n+2}O$

Sol.: C_3H_8O:

Alcohols : 

Ethers : 

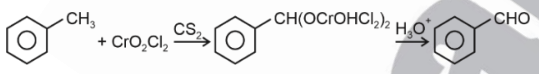
95. Answer (3)

Hint: Cyanides can be reduced to aldehydes by means of Stephen's reduction.

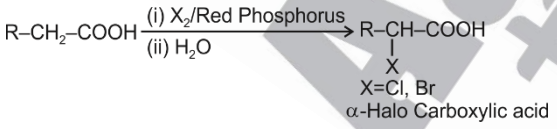
Sol.:

- Gatterman-Koch reaction :

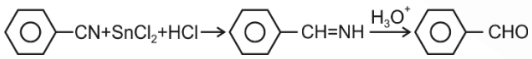
- Etard Reaction :



- Hell-Volhard-Zelinsky reaction:



- Stephen reaction :



96. Answer (3)

Hint: In FCC lattice if N atoms are present then number of octahedral and tetrahedral voids will be respectively N and 2N.

Sol.: For fcc unit cell :

$$\frac{\text{Octahedral voids}}{\text{Total voids}} = \frac{OV}{OV+TV} = \frac{N}{N+2N} = \frac{1}{3}$$

97. Answer (3)

Hint: Among lanthanoids, as the atomic number of Ln increases, size of Ln^{3+} ion decreases.

Sol.:

Ion :	**Ce^{3+}**	**Eu^{3+}**	**Dy^{3+}**	**Tm^{3+}**
Z:	58	63	66	69
Ionic : radii (pm)	103	95	91	87

98. Answer (4)

Hint: No. of atoms = Mole × N_A × atomicity.

Sol.:

- NH_3 : No. of atoms = $\frac{3.4}{17}\times N_A \times 4 = 0.8N_A$
- H_2O : No. of atoms = $\frac{3.6}{18}\times N_A \times 3 = 0.6N_A$
- CH_4 : No. of atoms = $\frac{0.16}{16}\times N_A \times 5 = 0.05N_A$
- CO_2 : No. of atoms = $\frac{13.2}{44}\times N_A \times 3 = 0.9N_A$

99. Answer (4)

Hint: $E_{total} = \frac{nhc}{\lambda}$

Sol.: Energy of one photon

$$= E = \frac{hc}{\lambda} = \frac{6.626\times10^{-34}\times3\times10^{8}}{6626\times10^{-12}}\text{ J}$$

$= 3 \times 10^{-17}$ J

Let n photons provide 1J energy.

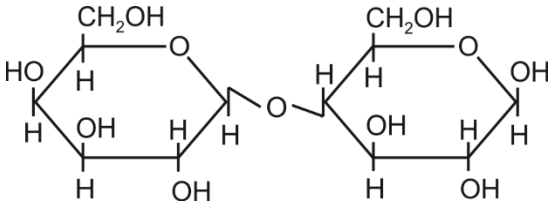
So, $E_{total} = nE$

$1 = n \times 3 \times 10^{-17}$

$$n = \frac{1}{3\times10^{-17}} = 3.33\times10^{16}$$

100. Answer (2)

Hint: Lactose:



Sol.: Lactose is a disaccharide containing glycosidic linkage between C1 of galactose and C4 of glucose which on hydrolysis gives β-D-galactose and β-D-glucose.

[BOTANY]

SECTION-A

101. Answer (2)

Hint: Museum contains preserved specimens.

Sol.: Museum has collection of preserved dead plant and animal specimens.

102. Answer (3)

Hint: R.H. Whittaker used cell type as one of the criteria.

Sol.: Ribosome structure was not taken into consideration by R.H. Whittaker.

103. Answer (1)

Hint: Slime moulds are not photosynthetic.

Sol.: Diatoms are photosynthetic and good indicator of water pollution.

104. Answer (2)

Hint: Brown and red algae produce hydrocolloids.

Sol.: Red algae *Gelidium* produce agar.

105. Answer (4)

Hint: Prothallus is the gametophytic structure.

Sol.: Prothallus is photosynthetic multicellular structure.

106. Answer (2)

Hint: Thorns are protective structures.

Sol.: Thorns are seen in *Bougainvillea*.

Spines are seen in *Opuntia*

Pumpkin, Cucumber } Stem Tendril

107. Answer (2)

Hint: Mustard has distinct calyx and corolla.

Sol.: Epitepalous condition is seen in members of Lily family.

108. Answer (3)

Hint: In endarch condition protoxylem lies towards pith.

Sol.: Endarch condition is seen in stem and exarch condition is seen in roots.

109. Answer (1)

Hint: Roots have casparian strips on endodermis.

Sol.: Casparian strips are found on both endodermis of monocot and dicot roots. It is absent in stems.

110. Answer (3)

Hint: Inclusion bodies are membraneless.

Sol.: Inclusion bodies store reserve food in prokaryotes.

111. Answer (3)

Hint: Lysosome contains hydrolytic enzymes.

Sol.: Hydrolytic enzymes are active at acidic pH.

112. Answer (4)

Hint: APC promotes cell from metaphase to anaphase.

Sol.: APC ensures attachment of spindle fibres to kinetochores and separation of chromatids.

113. Answer (4)

Hint: Chromatid separation takes place in anaphase II.

Sol.: Homologous chromosomes separate in anaphase I.

114. Answer (3)

Hint: First two phases of prophase-I are short lived.

Sol.: Zygotene and leptotene stages are shorter than pachytene.

115. Answer (4)

Hint: ψ_w is chemical potential of water.

Sol.: Higher the concentration of water more its ψ_w.

116. Answer (4)

Hint: Facilitated diffusion is movement of molecules along the concentration gradient.

Sol.: Uphill transport is active transport which requires energy. Facilitated diffusion is passive transport.

117. Answer (3)

Sol.: Nitrogen fixation is formation of NH_3 from N_2.

Conversion of NH_3 into NO_2^- / NO_3^- is nitrification.

118. Answer (3)

Hint: A micronutrient is a component of nitrogenase and nitrate reductase.

Sol.: Molybdenum is required for both nitrogenase and nitrate reductase.

119. Answer (1)

Hint: PEP is primary CO_2 acceptor in C_4 plants.

Sol.: Phosphoenolpyruvate is a 3C compound.

120. Answer (2)

Hint: PS II is related to oxygen evolution.

Sol.: In cyclic photophosphorylation, there is only PS I involved and only ATP is synthesized.

121. Answer (2)

Hint: Substrate level phosphorylation is direct ATP synthesis.

Sol.: During conversion of Succinyl CoA to Succinic acid, there is synthesis of GTP.

122. Answer (4)

Sol.: Cytochrome c oxidase complex is also called complex IV in ETS.

123. Answer (4)

Hint: Secondary meristem forms redifferentiated tissue.

Sol.: Secondary cortex is a redifferentiated tissue.

124. Answer (3)

Hint: Cytokinin helps in cell division.

Sol.: Cytokinin delays senescence and reduces aging.

125. Answer (4)

Hint: Heterogametes means male and female gametes are different from each other.

Sol.: *Spirogyra* produces isogametes.

126. Answer (4)

Hint: Dioecious plants have male and female sex organs on different plants.

Sol.: Papaya and date palm are dioecious.

127. Answer (4)

Hint: Gametophytes are haploid structures.

Sol.: Female gametophyte or embryo sac is haploid (n).

128. Answer (2)

Hint: Autogamy, cleistogamy and geitonogamy can bring genetically same type of pollen grains to stigma.

Sol.: Xenogamy transfers genetically different pollen grains to stigma.

129. Answer (4)

Hint: False fruits include thalamus also.

Sol.: Banana is parthenocarpic fruit. It is seedless.

130. Answer (4)

Hint: Grasshopper has XX – XO type of sex determination.

Sol.: Males and females do not have same number of chromosomes. Males have one chromosome less than the female grasshopper.

131. Answer (2)

Hint: Gene for phenylketonuria is present on autosomal chromosome.

Sol.: Phenylketonuria is autosomal recessive disorder.

132. Answer (4)

Hint: Glycosidic bond joins sugar to base.

Sol.: Phosphoester bond joins phosphate to sugar and phosphodiester bond joins two nucleotides.

133. Answer (3)

Hint: Template strand with polarity 3′ to 5′ has continuous replication.

Sol.: On strand with polarity 5′ to 3′, lagging daughter strand is formed and it is discontinuous.

134. Answer (1)

Hint: Regulator gene is a constitutive gene.

Sol.: Regulator gene synthesizes repressor protein. If it gets mutated, no repressor will be synthesized.

135. Answer (1)

Sol.: The ability to generate a whole plant from any cell/explant is called totipotency.

SECTION-B

136. Answer (2)

Hint: Resistance in plants can be created by conventional or mutation breeding.

Sol.: In mung bean, resistance to yellow mosaic virus is created by mutation breeding.

137. Answer (2)

Sol.: *Trichoderma polysporum* produces cyclosporin A, an immunosuppressive agent.

138. Answer (2)

Hint: Curd is more nutritious than milk.

Sol.: Curd contains vitamin B_{12} that makes it more nutritious.

139. Answer (2)

Hint: It is +, 0 relationship.

Sol.: Barnacles growing on the back of whale is an example of commensalism.

140. Answer (1)

Hint: Regulators maintain homeostasis.

Sol.: Conformers cannot maintain constant body temperature.

141. Answer (1)

Hint: NPP = GPP – R.

Sol.: Gross primary productivity is rate of production of organic matter by producers.

142. Answer (2)

Sol.: Habitat loss and fragmentation is the most important cause driving animals and plants to extinction.

143. Answer (4)

Hint: Primary consumers are herbivores.

Sol.: Rabbit is primary consumer or herbivore.

144. Answer (3)

Hint: '*Ex-situ*' conservation is 'off-site' conservation.

Sol.: Biodiversity hot spots are '*in-situ*' conservation strategies.

145. Answer (3)

Hint: Montreal protocol was signed to protect ozone.

Sol.: Montreal protocol was signed to control the emission of ozone depleting substances.

146. Answer (3)

Sol.: Slash and burn agriculture is commonly known as Jhum cultivation.

147. Answer (2)

Hint: Parenchymatous cells have protoplasm.

Sol.: Xylem parenchyma is living. All other components of xylem are dead.

148. Answer (1)

Hint: A bivalent is a pair of homologous chromosomes.

Sol.: Bivalents align themselves on equatorial plate in metaphase I.

149. Answer (3)

Hint: Succinate dehydrogenase also acts as complex II of ETS.

Sol.: Succinate dehydrogenase found attached to inner membrane of mitochondria.

150. Answer (4)

Hint: All viruses have capsid and genetic material.

Sol.: Envelope is not seen in all viruses. It is found in some viruses only, like HIV.

[ZOOLOGY]

SECTION-A

151. Answer (4)

Hint: Sperm fertilises the ovum in ampullary region of oviduct.

Sol.: Internal fertilisation : Syngamy occurs inside the body of a female organism.

External fertilisation : Syngamy occurs outside the body of a female organism.

Arrhenotoky : Unfertilized egg develops into male organism.

152. Answer (1)

Hint: Trichomoniasis is caused by a protozoan.

Sol.: HIV (Human Immunodeficiency Virus) is a causative agent of AIDS.

Herpes Simplex Virus is a causative agent of genital herpes.

Human Papilloma Virus is a causative agent of genital warts.

Trichomonas vaginalis (a protozoan) is a causative agent of trichomoniasis.

Treponema pallidum (a bacterium) is a causative agent of syphilis.

Neisseria gonorrhoeae (a bacterium) is a causative microbe of gonorrhoea.

153. Answer (4)

Hint: Contains combination of estrogen and progestogen.

Sol.:

Non-medicated IUD	Lippes loop
Copper-releasing IUDs	CuT, Cu7 and Multiload 375
Hormone-releasing IUDs	LNG-20 and progestasert
Combined oral contraceptive pill	Contains the combination of estrogen and progestogens

154. Answer (3)

Hint: Hyaluronidase

Sol.: The middle piece of the sperm possesses numerous mitochondria. For normal fertility, at least 60% sperms must have normal shape, size and at least 40% of them must show vigorous motility.

The sperm head contains an elongated haploid nucleus.

155. Answer (2)

Hint: Helps in lubrication

Sol.: Seminal vesicles secrete seminal fluid.

Prostate gland is present in male reproductive system.

Bulbourethral/Cowper's glands are present in male reproductive system which helps in the lubrication of the penis.

Bartholin's glands are a pair of small reddish yellow glands on each side of vaginal orifice and secrete alkaline secretion for lubrication and neutralising acidity of urine.

156. Answer (3)

Hint: They are also called as "Amphibians of the plant kingdom".

Sol.: *Psilophyton* is a genus of extinct vascular land plants of Devonian period and is thought to gave rise to sphenopsids, conifers and ferns.

Chlorophyte ancestors gave rise to bryophytes.

157. Answer (3)

Hint: The first human like being was the hominid.

Sol.: *Homo habilis* had brain capacity between 650-800 cc. They probably did not eat meat. Other given options are correct.

158. Answer (4)

Hint: Reproduces through multiple fission

Sol.: *Plasmodium* enters the human as sporozoites through the bite of infected female *Anopheles* mosquito. The parasites initially multiply asexually within hepatocytes and then attack RBCs, resulting in their rupture.

159. Answer (3)

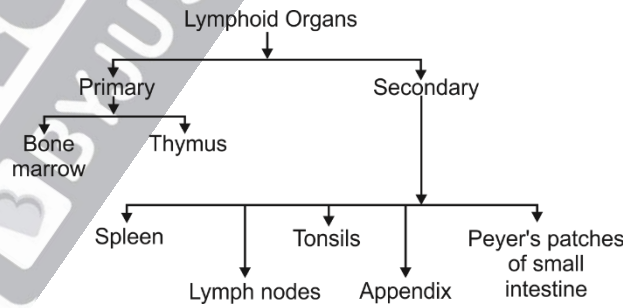
Hint: Caused by *Ascaris*

Sol.: *Wuchereria malayi* and *Wuchereria bancrofti,* the filarial worms cause a slowly developing chronic inflammation of the organs in which they live for many years, usually the lymphatic vessels of the lower limbs and the disease is called elephantiasis/filariasis.

160. Answer (1)

Hint: The gland undergoes atrophy

Sol.: The thymus is a lobular organ located near the heart and beneath the breastbone. The thymus is quite large at the time of birth but keeps reducing in size from puberty onwards.



161. Answer (3)

Hint: Tumors which do not show metastasis.

Sol.: Transformation of normal cells into cancerous neoplastic cells may be induced by carcinogens.

Malignant tumors are mass of proliferating cells called neoplastic or tumor cells and possess the property of metastasis.

162. Answer (1)

Hint: Morphine is its example

Sol.: Opioids are the drugs, which bind to specific opioid receptors present in human CNS and GI tract. Heroin, commonly called smack is chemically diacetylmorphine which is obtained by acetylation of morphine, extracted from the latex of poppy plant *i.e*., *Papaver somniferum.*

163. Answer (4)

Hint: FSH induces superovulation

Sol.: In MOET, a cow is administered hormones, with FSH–like activity to induce follicular maturation and superovulation. Instead of one egg, which they normally yield per cycle, they produce 6-8 eggs.

164. Answer (2)

Hint: Lobsters belong to the same category

Sol.: **Freshwater fishes:** *Catla, Rohu* and common carp.

Marine fishes: *Hilsa,* Sardines, Mackerel and Pomfret.

Shellfish includes some crustaceans and molluscs.

165. Answer (3)

Hint: *Hisardale* is a resultant of this type of breeding.

Sol.:

Inbreeding: Mating of more closely related individuals within the same breed for 4-6 generations.

Out-crossing: Practice of mating of animals within the same breed, but having no common ancestors on either side of their pedigree upto 4-6 generations. It helps in overcoming inbreeding depression.

Interspecific hybridization : Practice of mating male and female animals of two different related species.

166. Answer (4)

Hint: Chimeric DNA containing host cells will proliferate in a culture medium containing ampicillin and tetracycline.

Sol.: *Cla*I site is neither present in amp^R gene nor in tet^R gene of pBR322. So, if the foreign gene is inserted at *Cla*I site, the resultant colonies (recombinants and non-recombinants) will be amp^R as well as tet^R.

167. Answer (4)

Hint: Acts on chitin present in fungi

Sol.: Chitinase degrades fungal cell wall which is made up of chitin (a homopolysaccharide).

168. Answer (1)

Hint: Bioreactor has controlled growing conditions.

Sol.: A bioreactor provides the optimal conditions for achieving the desired product by providing optimum growth conditions (temperature, substrate, pH, salts, vitamins, oxygen).

169. Answer (4)

Hint: Milk produced by Rosie contains α-lactalbumin.

Sol.:

	Column-I		**Column-II**
(a)	Probe	(ii)	ssDNA/RNA tagged with radioactive molecule
(b)	ELISA	(i)	Antigen-antibody interaction
(c)	α-1-antitrypsin	(iv)	Used to treat emphysema
(d)	First transgenic cow, Rosie	(iii)	Produced human protein-enriched milk

170. Answer (3)

Hint: pH value above 7 activates Bt toxin protein.

Sol.: A nematode, *Meloidogyne incognita* infects the roots of tobacco plants and causes a great reduction in yield.

RNAi involves silencing of a specific mRNA due to a complementary dsRNA molecule that binds to and prevents translation of the mRNA (silencing).

Proteins encoded by the genes *cryIAc* and *cryIIAb* control the cotton bollworms, that of *cryIAb* controls corn borer.

171. Answer (3)

Hint: Belongs to phylum Coelenterata

Sol.: *Obelia* belongs to phylum Coelenterata. In *Obelia*, polyps produce medusae asexually and medusae form the polyps sexually.

172. Answer (4)

Hint: A structure similar to notochord.

Sol.: Hemichordates have a rudimentary structure in the collar region called stomochord, a structure similar to notochord. Proboscis gland in hemichordates act as an excretory structure.

173. Answer (1)

Hint: Equal to the number of optic lobes in a human

Sol.: *Clarias* (Magur) belongs to phylum Chordata (class-Osteichthyes). Bony fishes have 4 pairs of gills which are covered by an operculum on each side. Their skin is covered with cycloid/ctenoid scales.

174. Answer (1)

Hint: Cube-like cells are found in PCT of nephron.

Sol.: Cuboidal epithelium is composed of a single layer of cube-like cells. Columnar epithelium is composed of a single layer of tall and slender cells.

Compound epithelium is made up of more than one layer of cells and thus has a limited role in secretion and absorption.

175. Answer (4)

Hint: Excretes the form of nitrogenous waste which is least toxic.

Sol.: At the junction of midgut and hindgut is present a ring of 100-150 yellow coloured thin filamentous Malpighian tubules which help in the removal of excretory products from haemolymph in the form of uric acid.

176. Answer (4)

Hint: Present in 10^{th} segment of both sexes

Sol.: In females, the 7^{th} sternum is boat shaped and together with the 8^{th} and 9^{th} sterna forms a brood or genital pouch whose anterior part contains female gonopore, spermathecal pore and collaterial glands. In both sexes, the 10^{th} segment bears a pair of jointed filamentous structures called anal cerci.

177. Answer (3)

Hint: K_m remains same but V_{max} decreases.

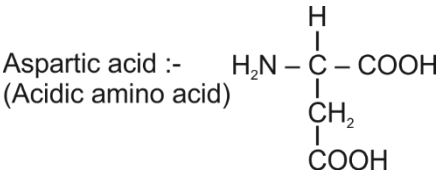
Sol.: Inhibition of alcohol dehydrogenase by ethanol, inhibition of succinic dehydrogenase by malonate and oxaloacetate; all are examples of competitive inhibition.

Inhibition of cytochrome oxidase by cyanide is an example of non-competitive inhibition.

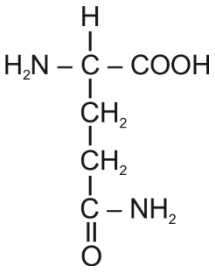
178. Answer (2)

Hint: Amino acid which participates in synthesis of melatonin.

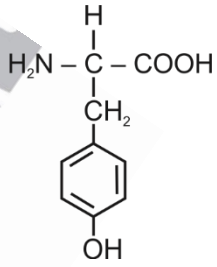
Sol.: Aspartic acid :- (Acidic amino acid)



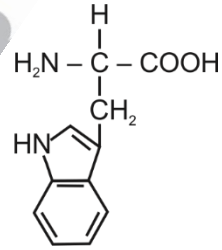
Glutamine :- (Polar amino acid)



Tyrosine :- (Aromatic amino acid)



Tryptophan :- (Aromatic amino acid)



179. Answer (4)

Hint: Prosthetic group-nucleic acid

Sol.: Lipoprotein – (prosthetic group - lipids). Glycoprotein – (prosthetic group - carbohydrates).

Phosphoprotein – (prosthetic group - phosphoric acid).

Chromoprotein – (prosthetic group - pigment)

↓

E.g.: Cytochromes.

Nucleoprotein (prosthetic group - nucleic acid)

↓

E.g.: Protamine.

180. Answer (2)

Hint: Cane sugar

Sol.: Sucrose is a non-reducing sugar, hence gives negative test with Benedict's reagent. Lactose and maltose are reducing disaccharides. Cellulose is a polysaccharide.

181. Answer (4)

Hint: Gastro term is used for stomach.

Sol.: The opening of oesophagus into stomach is regulated by gastro-oesophageal sphincter.

The opening of ductus choledochus (common bile duct) into duct of Wirsung is regulated by sphincter of Boyden.

The opening of hepato-pancreatic duct into duodenum is regulated by sphincter of Oddi.

182. Answer (4)

Hint: Helps in the completion of digestion of proteins

Sol.: In small intestine:

$$\text{DNA} \xrightarrow{\text{DNase}} \text{2-deoxyribonucleotides}$$

In mouth:

$$\underset{(30\%)}{\text{Starch}} \xrightarrow[\text{pH 6.8}]{\text{Ptyalin}} \text{Maltose}$$

In small intestine:

$$\text{Diglycerides and monoglycerides} \xrightarrow{\text{Lipases}} \text{Fatty acids + glycerol}$$

183. Answer (3)

Hint: Maximum volume of air a person can breathe out after a forced inspiration

Sol.: EC = TV + ERV

FRC = ERV + RV

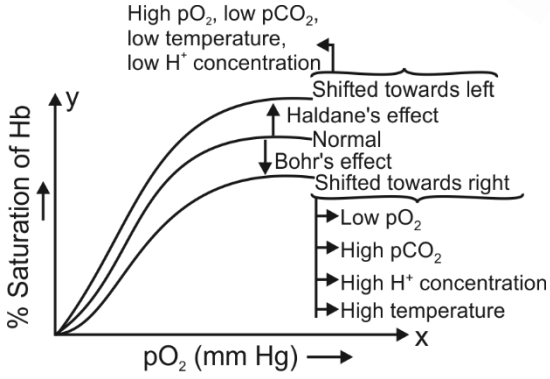
TLC = RV + TV + ERV + IRV

VC = ERV + TV + IRV or ERV + IC or EC + IRV

184. Answer (2)

Hint: It shifts the oxygen-haemoglobin dissociation curve to the left

Sol.:



Oxygen-haemoglobin dissociation curve

185. Answer (3)

Hint: SV = EDV – ESV

Sol.: CO = SV × HR

Cardiac output = (EDV – ESV) × HR

= (100 – 40) × 100

= (60 × 100) mL

= 6000 mL

= 6 L

SECTION-B

186. Answer (3)

Hint: SA node is called "pacemaker of heart".

Sol.: The correct route through which impulse travels in human heart is:

SA node → AV node → Bundle of His → Purkinje fibres → Heart muscles.

187. Answer (2)

Hint: Renal corpuscle

Sol.:

Glomerulonephritis: Inflammation of glomeruli.

Pyelonephritis: Inflammation of the renal pelvis.

188. Answer (4)

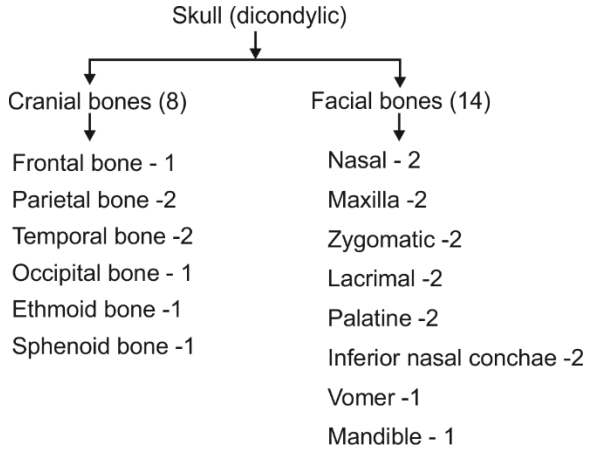
Hint: Opposite effect of aldosterone

Sol.: ADH, RAAS and ANF provide an elaborate system of checks and balance that regulate the kidney functioning, to control body fluid osmolarity, salt concentrations, blood pressure and blood volume.

189. Answer (3)

Hint: Cranial bones are eight in number

Sol.:



190. Answer (1)

Hint: Z-lines come close to each other

Sol.: Effects of muscle contraction:

(a) Length of A-band remains same

(b) Length of I-band decreases

(c) Length of sarcomere decreases

(d) Z-lines come close to each other

(e) M-line almost disappears

(f) H-zone almost disappears

191. Answer (3)

Hint: Situated in the dermis of skin.

Sol.:

- Meissner's corpuscles and Pacinian corpuscles are tangoreceptors, respond to gentle touch and pressure respectively.
- Cristae and macula are part of vestibular apparatus of internal ear that is responsible for maintaining dynamic and static balance.

192. Answer (2)

Hint: Function of cones: Daylight vision

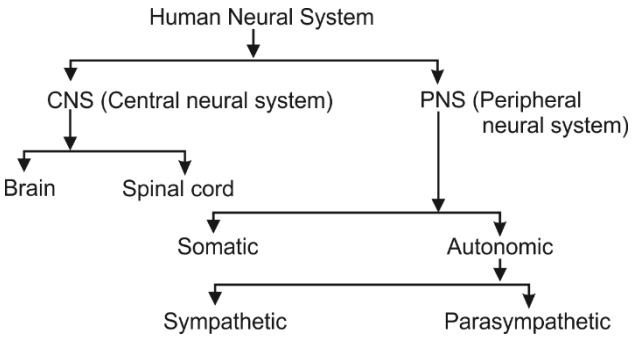
Sol.:

	Rods	**Cones**
Visual pigment	Rhodopsin	Iodopsin
Function	Scotopic vision	Photopic vision
Sensation of colour	Absent	Present
Location	Absent in fovea	Present in fovea

193. Answer (4)

Hint: Part of PNS

Sol.:



Visceral neural system comprises the whole complex of nerves, fibres, ganglia, and plexus by which impulses travel from the CNS to the viscera and from the viscera to the CNS.

194. Answer (3)

Hint: Neurohypophysis releases milk-ejecting hormone

Sol.: Oxytocin and ADH are actually synthesised by hypothalamus and are transported axonally to neurohypophysis (Posterior lobe of pituitary gland).

195. Answer (3)

Hint: Hormone of fight/flight

Sol.: Epinephrine and norepinephrine are produced by adrenal medulla. Both of these hormones help in elevating heart rate and rate of respiration.

196. Answer (1)

Hint: Animals with radial symmetry

Sol.: *Echinus* and *Asterias* belong to phylum Echinodermata. Water vascular system is the most distinctive feature of echinoderms.

Examples of animals belonging to phylum Arthropoda are as follows:

Economically important insects – *Apis* (Honey bee), *Bombyx* (Silkworm), *Laccifer* (Lac insect)

Vectors – *Anopheles*, *Culex* and *Aedes* (Mosquitoes)

Gregarious pest – *Locusta* (Locust)

Living fossil – *Limulus* (King crab)

197. Answer (2)

Hint: Exhibits notochord

Sol.: *Pteropus* (Flying fox) is a mammal. It exhibits segmentation and a complete digestive system. Circulatory and respiratory systems are also present in it.

198. Answer (1)

Hint: Cellulose is a polymeric substance.

Sol.:

Alkaloids	Morphine, Codeine, etc.
Terpenoids	Monoterpenes, Diterpenes, etc.
Polymeric substances	Rubber, Gums, Cellulose

199. Answer (4)

Hint: A double bond is formed at the place of removal of groups.

Sol.:

- Glucohexokinase belongs to class II, *i.e*., transferases that catalyse the transfer of specific groups other than hydrogen from one substrate to another.
- Sucrase belongs to class III *i.e*., hydrolases that catalyse the larger molecules into smaller molecules with addition of water.
- PEP carboxylase belongs to class VI *i.e*., ligases that catalyse covalent bonding of two substrates to form a large molecule.
- Aldolase belongs to class IV *i.e*., lyases that catalyse the cleavage of substrate into two parts, without the use of water leaving double bond.

200. Answer (3)

Hint: Proliferation of fibrous tissues cause serious lung damage.

Sol.: Asthma is a difficulty in breathing causing wheezing due to inflammation of bronchi and bronchioles.

Emphysema is a chronic disorder in which alveolar walls are damaged due to which respiratory surface is decreased.

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