All India Aakash Test Series for NEET-2023

TEST - 3 (Code-E)

Test Date : 29/01/2023

ANSWERS

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

HINTS & SOLUTIONS

[PHYSICS]

SECTION-A

1. Answer (4)

Hint: $\hat{u} = \dfrac{\vec{A}\times\vec{B}}{|\vec{A}\times\vec{B}|}$

Sol.: $\vec{A}\times\vec{B} = \begin{vmatrix} \hat{i} & \hat{j} & \hat{k} \\ 1 & 1 & 2 \\ 1 & -2 & 0 \end{vmatrix}$

$= \hat{i}(1\times 0-(-2)\times 2)-\hat{j}(1\times 0-1\times 2)$

$+\hat{k}(1\times(-2)-(1)\times(1))$

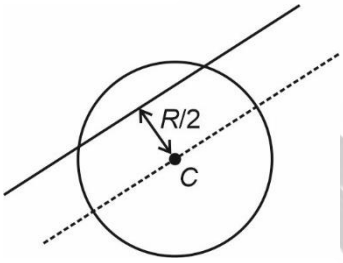
$= 4\hat{i}+2\hat{j}-3\hat{k}$

$\hat{u} = \dfrac{4\hat{i}+2\hat{j}-3\hat{k}}{\sqrt{4^2+2^2+3^2}} = \dfrac{4\hat{i}+2\hat{j}-3\hat{k}}{\sqrt{29}}$

2. Answer (2)

Hint: $I = mk^2$

Sol.: Using parallel axis theorem



$I = I_C + m\left(\dfrac{R}{2}\right)^2$

$= \dfrac{2}{5}mR^2 + \dfrac{mR^2}{4}$

$mk^2 = \dfrac{13mR^2}{20}$

$\Rightarrow \quad k = \sqrt{\dfrac{13}{20}}R$

3. Answer (3)

Hint: Apply conservation of angular momentum.

Sol.: $I\omega$ = constant

$\rho\times\dfrac{4}{3}\pi R^3 = (8\rho)\times\dfrac{4}{3}\pi R'^3$

$\Rightarrow \quad \dfrac{R}{2} = R'$

$I_1\omega_1 = I_2\omega_2$

$\dfrac{2}{5}mR^2\left(\dfrac{2\pi}{24}\right) = \dfrac{2}{5}m\left(\dfrac{R}{2}\right)^2\times\dfrac{2\pi}{T}$

$T = \dfrac{24}{4} = 6\text{ h}$

4. Answer (3)

Hint: $f_e = \dfrac{q_1q_2}{4\pi\varepsilon_0 r^2}$ and $f_G = \dfrac{Gm_1m_2}{r^2}$

Sol.: At equilibrium

$f_e = f_G \Rightarrow \dfrac{q_1q_2}{4\pi\varepsilon_0 r^2} = \dfrac{Gm_1m_2}{r^2}$

$\Rightarrow \quad \dfrac{n^2e^2}{4\pi\varepsilon_0 r^2} = \dfrac{Gm^2}{r^2}$

$n = \sqrt{\dfrac{4\pi\varepsilon_0 Gm^2}{e^2}}$

5. Answer (3)

Hint: $1+r+r^2+\ldots.. = \dfrac{1}{1-r}$ (if $r<1$)

$|I_g| = \dfrac{Gm}{r^2}$

Sol.: $I_g = \dfrac{Gm}{r^2}+\dfrac{G(m/2)}{(2r)^2}+\dfrac{G(m/4)}{(4r)^2}+\ldots$

$I_g = \dfrac{Gm}{r^2}\left(1+\dfrac{1}{8}+\dfrac{1}{8^2}+\ldots.\infty\right)$

$= \dfrac{Gm}{r^2}\left(\dfrac{1}{1-\frac{1}{8}}\right) = \dfrac{8Gm}{7r^2}$

6. Answer (2)

Hint: Time period of geostationary satellite is 24 hours.

Sol.: $\left(\dfrac{T}{6}\right)^{3/2} = \left(\dfrac{24}{6}\right)^{3/2}$

$= (4)^{3/2} = 8$

7. Answer (1)

Hint: Energy density = $\frac{1}{2}Y\times(\text{strain})^2$

Sol.: Energy density $=\frac{1}{2}\times 2\times 10^{10}\times\left(\frac{0.1}{100}\right)^2$

$= 10^4$ J/m^3

8. Answer (2)

Hint : Modulus of elasticity = Slope of stress-strain curve.

Sol. : $\frac{y_A}{y_B}=\frac{\tan 60^\circ}{\tan 30^\circ}=3$

9. Answer (4)

Hint: $\Delta P = \rho gh$

Sol.: For same volume, level of liquid is maximum for *D*.

10. Answer (3)

Hint and Sol.: $v=\sqrt{2gh}$

$v\propto\sqrt{h}$ and $V\propto\rho^0$

11. Answer (2)

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

Sol.: $V = -(2x + y + 3z)$

$\vec{I}_g=2\hat{i}+\hat{j}+3\hat{k}$

12. Answer (4)

Hint: $\tau = I\alpha$

Sol.:

$\Rightarrow\quad mg\frac{L}{2}+2mgL=\left(\frac{mL^2}{3}+(2m)L^2\right)\alpha$

$\Rightarrow\quad \frac{5mgL}{2}=\left(\frac{7mL^2}{3}\right)\alpha$

$\Rightarrow\quad \alpha=\frac{15}{14}\frac{g}{L}$

13. Answer (2)

Hint: Conservation of angular momentum

Sol.: $I_1\omega_1 = I_2\omega_2$

$mR^2\cdot\omega = \{mR^2 + (mR^2 + mR^2)\}\omega'$

$= 3mR^2\omega$

$\Rightarrow\quad \omega' = \omega/3$

14. Answer (1)

Hint: $Y_{COM}=\frac{m_1y_1+m_2y_2}{m_1+m_2}$

Sol.: $y_{COM}=\frac{m\left(\frac{2R}{\pi}\right)-m_1\left(\frac{4R}{3\pi}\right)}{m+m_1}=0$

$\Rightarrow\quad m_1=\frac{m\left(\frac{2}{\pi}\right)}{\left(\frac{4}{3}\pi\right)}\Rightarrow m_1=\frac{3m}{2}$

15. Answer (3)

Hint: $\vec{v}_{com}=\frac{m_1\vec{v}_1+m_2\vec{v}_2+m_3\vec{v}_3}{m_1+m_2+m_3}$

Sol.: $\vec{v}_{com}=\frac{m\vec{v}_1+m\vec{v}_2+m\vec{v}_3}{m+m+m}$

$=\frac{\vec{v}_1+\vec{v}_2+\vec{v}_3}{3}=0$ (using triangle law of vector addition)

16. Answer (3)

Hint: $\omega=\frac{(V_\perp)_{\text{Relative}}}{R}$

Sol.: $\omega=\frac{v_A-(-v_B)}{L}$

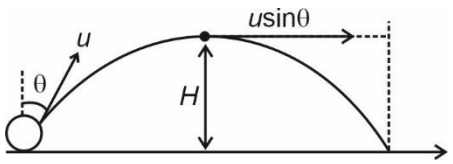
$=\frac{2v+v}{L}$

$=\frac{3v}{L}$

17. Answer (1)

Hint: $\vec{L}=\vec{r}\times\vec{p}$

Sol.:



$|\vec{L}| = r_\perp p$

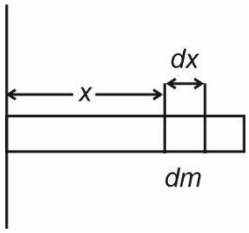
$L=mu\sin\theta\times\frac{u^2\cos^2\theta}{2g}$

$=\frac{mu^3\sin\theta\cdot\cos^2\theta}{2g}$

18. Answer (2)

Hint: $I = \int dmx^2$

Sol.:



$dm = kxdx$

$$I = \int_0^L dmx^2 = \int_0^L kx^3 dx$$

$$= k\left[\frac{x^4}{4}\right]_0^L = \frac{kL^4}{4}$$

19. Answer (4)

Hint and Sol.:

- Moment of inertia of a body about an axis depends on the mass distribution of body about that axis.
- Moment of inertia of a body is rotational analogue of inertia of body

20. Answer (1)

Hint: Conservation of mechanical energy.

Sol.: Applying conservation of mechanical energy

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

$$\frac{mv^2}{2} + \frac{mv^2}{5} = mgh$$

$$h = \frac{7v^2}{10g} \quad \left(v = \frac{3v_0}{2}\right)$$

$$h = \frac{63v_0^2}{40g}$$

21. Answer (3)

Hint: Conservation of mechanical energy and $\vec{v} = \vec{\omega} \times \vec{R}$.

Sol.: Shift in center of mass = $2R$

$$\Rightarrow \quad 2mgR = \frac{1}{2}I\omega^2$$

$$\Rightarrow \quad 2mgR = \frac{1}{2}\left(\frac{5}{4}mR^2\right)\omega^2$$

$$\Rightarrow \quad \omega = \sqrt{\frac{16g}{5R}}$$

$$v = \omega(2R) = \sqrt{\frac{64\,Rg}{5}}$$

22. Answer (1)

Hint: $\vec{L} = \vec{r} \times \vec{p} + I_C\vec{\omega}$

Sol.: $|\vec{L}| = (2R)mv\sin 90^\circ - \frac{mR^2}{2}\omega$

$$= 2Rm(2\omega R) - \frac{m\omega R^2}{2}$$

$$= 4m\omega R^2 - \frac{m\omega R^2}{2}$$

$= 3.5\ m\omega R^2$

23. Answer (4)

Hint: Conservation of mechanical energy

Sol.: Applying conservation of mechanical energy.

$PE_i + KE_i = PE_f + KE_F$

$$-\frac{GMm}{R} + \frac{1}{2}m\left(\frac{V_e}{3}\right)^2 = PE_f + 0$$

$$PE_f = -\frac{GMm}{R} + \frac{m}{2} \times \frac{2GM}{9R}$$

$$= -\frac{8}{9}\frac{GMm}{R}$$

24. Answer (1)

Hint: $\frac{dA}{dt} = \frac{|\vec{L}|}{2m} = \text{constant}$

Sol.: $\frac{|\vec{L}|}{2m} = \frac{3A}{T}$

$$\Rightarrow \quad |\vec{L}| = \frac{6mA}{T}$$

25. Answer (3)

Hint: $T = 2\pi\sqrt{\frac{L}{g}}$ and $g = \frac{GM}{r^2}$

Sol.: $T_1 = 2\pi\sqrt{\frac{L}{g}}$

$$T_2 = 2\pi\sqrt{\frac{L}{g'}} \quad \left(g' = \frac{GM}{(3R)^2} = \frac{g}{9}\right)$$

$$T_2 = 2\pi\sqrt{\frac{9L}{g}} = 3T_1$$

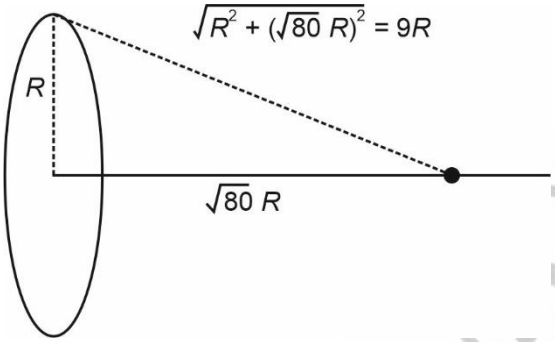
$$\frac{T_2}{T_1} = 3$$

26. Answer (1)

Hint: $W = \Delta U$

Sol.: $W = \Delta U = U_f - U_i$

$$U_i = -\frac{GMm}{R}$$



$$U_f = -\frac{GMm}{9R}$$

$W = U_f - U_i$

$$= -\frac{GMm}{9R} - \left(-\frac{GMm}{R}\right)$$

$$= \frac{8}{9}\frac{GMm}{R}$$

27. Answer (4)

Hint: $g = \frac{4}{3}G\pi\rho R$

Sol.: $\frac{g_1}{g_2} = \frac{\rho_1 R_1}{\rho_2 R_2} = \frac{1}{2} \times \frac{4}{1} = 2$

28. Answer (2)

Hint: $T^2 \propto R^3$

Sol.: $\frac{T_2}{T_1} = \frac{\left(\frac{R}{4}\right)^{3/2}}{R^{3/2}} = \frac{1}{8}$

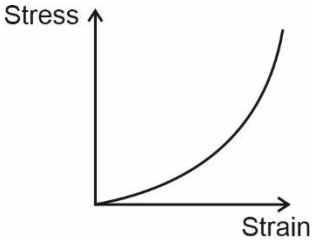
$$T_2 = \frac{365.25}{8} \approx 45.66 \text{ days}$$

29. Answer (1)

Hint and Sol.: $Y = 200 \times 10^9$ N/m^2

30. Answer (1)

Hint and Sol.: Stress-strain curve for elastic tissue of aorta is



31. Answer (3)

Hint and Sol.: Tangential strain is a dimensionless quantity.

32. Answer (4)

Hint: $\Delta P = \frac{4T}{R}$ and $A = 4\pi R^2$

Sol.: $\frac{\Delta P_1}{\Delta P_2} = \frac{\frac{4T}{R_1}}{\frac{4T}{R_2}} = \frac{R_2}{R_1} = \frac{0.02}{0.03} = \frac{2}{3}$

$$\frac{A_1}{A_2} = \left(\frac{R_1}{R_2}\right)^2 = \left(\frac{3}{2}\right)^2 = \frac{9}{4}$$

33. Answer (3)

Hint: Specific gravity = $\frac{\text{Weight in air}}{\text{Buoyant force in water}}$

Sol.: Specific gravity $= \frac{120}{40} = 3$

34. Answer (2)

Hint: Height of liquid inside capillary tube

$$h = \frac{2T\cos\theta}{\rho g r}$$

Sol.: $h = \frac{2T\cos\theta}{\rho g r}$

$h = 0 \Rightarrow \theta$ can be 90°

35. Answer (3)

Hint: Height of liquid inside capillary tube

$$h = \frac{2T\cos\theta}{\rho g r}$$

Sol.: Let $M = \rho\pi r^2 h$

$$h \propto \frac{1}{r} \Rightarrow h' = 2h$$

$$M' = \rho\pi\left(\frac{r}{2}\right)^2 h'$$

$$= \frac{\rho\pi r^2 h}{2} = \frac{M}{2}$$

SECTION-B

36. Answer (4)

Hint: $\tan\theta = \frac{a}{g}$

Sol.: $\tan\theta = \frac{2g}{3g} = \frac{2}{3} = \frac{h}{L}$

$$\Rightarrow \quad h = \frac{2L}{3}$$

37. Answer (2)

Hint: $r = \frac{r_1 r_2}{r_1 - r_2}$

Sol.: $r = \frac{3r \times r}{3r - r} = \frac{3r}{2}$

38. Answer (3)

Hint: Equation of continuity and Bernoulli's theorem.

Sol.: $v = \sqrt{2gh}$

$Av_1 = av$

$$v_1 = \frac{a}{A}\sqrt{2g}\sqrt{h} \Rightarrow -\frac{dh}{dt} = \frac{a}{A}\sqrt{2g}\sqrt{h}$$

$$\Rightarrow \quad -\int_h^0 \frac{dh}{\sqrt{h}} = \frac{a}{A}\sqrt{2g}\int_0^t dt$$

$$[2\sqrt{h}]_0^h = \frac{a}{A}\sqrt{2g}[t]_0^t$$

$$2(\sqrt{h}) = \frac{a}{A}\sqrt{2g}\ t$$

$$\Rightarrow \quad t = \frac{\sqrt{2}A}{a\sqrt{g}}(\sqrt{h}) = \frac{A}{a}\sqrt{\frac{2H}{g}}$$

39. Answer (2)

Hint: $K = \frac{YA}{L}$ and for parallel combination

$K = K_1 + K_2$

Sol.: $K = K_1 + K_2$

$$\frac{2Y'A}{L} = \frac{YA}{L} + \frac{2YA}{L}$$

$$Y' = \frac{Y + 2Y}{2} = \frac{3Y}{2}$$

40. Answer (3)

Hint and Sol.: $E_i = -E_0 = -\frac{GMm}{2r}$

$$E_f = -\frac{GMm}{2(3r)} = -\frac{GMm}{6r}$$

$$W = E_f - E_i = -\frac{GMm}{6r} - \left(-\frac{GMm}{2r}\right)$$

$$= \frac{GMm}{3r} = \frac{2}{3}E_0$$

$$x = \frac{2}{3}$$

41. Answer (2)

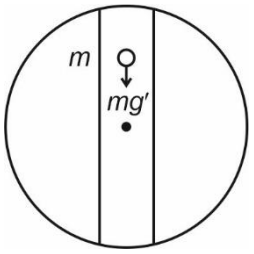
Hint : Use parallel axes theorem

Sol.: $I = 2(I_c + md^2) = 2\left[\frac{MR^2}{4} + MR^2\right]$

$$= 2 \times \frac{5}{4}mR^2 = \frac{10}{4}mR^2$$

42. Answer (1)

Hint and Sol.: $f_{net} = -mg' = -\frac{GMmx}{R^3} = ma$



$a = -\omega^2 x$

$$-\frac{GMmx}{R^3} = m(-\omega^2 x)$$

$$\Rightarrow \quad T = 2\pi\sqrt{\frac{R}{g}}$$

43. Answer (1)

Hint: $g' = g - \omega^2 R\cos^2\lambda$

Sol.: $\frac{g}{2} = g - \omega^2 R$

$\Rightarrow \quad \omega^2 R = \frac{g}{2}$

$\Rightarrow \quad \omega = \sqrt{\frac{g}{2R}}$

44. Answer (4)

Hint: $\alpha = \frac{a}{R}$

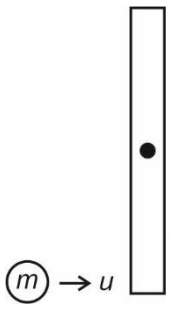
Sol.: $\frac{a_1}{4} = \frac{a_2}{1}$

$\Rightarrow \quad a_2 = \frac{5}{4}\,\text{m/s}^2$

45. Answer (4)

Hint: Conservation of angular momentum.

Sol.: $L_i = L_f$



$mu\frac{L}{2} = I\omega$

$\frac{muL}{2} = \left(\frac{mL^2}{12} + m\left(\frac{L}{2}\right)^2\right)\omega$

$\Rightarrow \quad \frac{muL}{2} = \frac{mL^2}{3}\omega$

$\Rightarrow \quad \omega = \frac{3u}{2L}$

46. Answer (3)

Hint and Sol.: $\frac{\text{Rotational KE}}{\text{TotaL KE}} = \frac{\frac{1}{2}I\omega^2}{\frac{1}{2}mv^2 + \frac{1}{2}I\omega^2}$

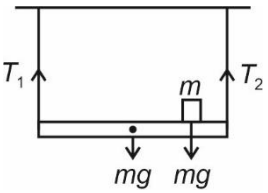
$= \frac{\frac{1}{2}\times\frac{2}{3}mR^2\times\frac{v^2}{R^2}}{\frac{1}{2}mv^2 + \frac{1}{2}\times\frac{2}{3}mR^2\times\frac{v^2}{R^2}}$

$= \frac{2}{5}$

47. Answer (3)

Hint: At equilibrium $f_{net} = 0$ and $\tau_{net} = 0$

Sol.:



$\tau_{net} = 0$

$\Rightarrow \quad T_1\left(\frac{L}{2}\right) + mg\,(0) + mg\left(\frac{L}{3}\right) - T_2\left(\frac{L}{2}\right) = 0$

$\Rightarrow \quad T_2 - T_1 = \frac{2mg}{3} \qquad \ldots(i)$

$T_1 + T_2 = 2mg \qquad \ldots(ii)$

$T_2 = \frac{4mg}{3} \quad T_1 = \frac{2mg}{3}$

$\Rightarrow \quad \frac{T_1}{T_2} = \frac{\frac{2mg}{3}}{\frac{4\,mg}{3}} = \frac{1}{2}$

48. Answer (2)

Hint: $V = \omega R$

Sol.: $V_A = 2\omega R$

$V_B = \sqrt{2}\,\omega R$

$\therefore \quad \frac{V_A}{V_B} = \sqrt{2}$

49. Answer (2)

Hint: Apply angular impulse and angular momentum equation about point of contact.

Sol.: $Jr = L_f$

$\Rightarrow \quad Jr = mv'r + I\omega$

$Jr = mv'r + (mr^2)\frac{v'}{r}$

$v' = \frac{J}{2m}$

50. Answer (1)

Hint: Moment of inertia about an axis passing from COM is minimum.

Sol.: $I = 3x^2 - 12x + 7$

$\frac{dI}{dx} = 6x - 12 = 0$

$x = 2$

[CHEMISTRY]

SECTION-A

51. Answer (3)

Hint: Change in state function depends on initial and final states of system, not the path followed

Sol.: $\Delta U = q + w$

ΔH and (q + w) are state functions. But 'q' and 'w' separately are path functions.

52. Answer (2)

Hint: $w = -P_{ext}(\Delta V)$

$\Delta U = q + w$

Sol.: In vacuum, $P_{ext} = 0$

So, w = 0

At constant volume, $\Delta V = 0$

So, w = 0

$\Delta U = q + w$

$\Delta U = q_v$

53. Answer (2)

Hint: First law of thermodynamics.

$\Delta U = q + w$

Sol.: q = – 10 J

w = – 20 J

ΔU = [– 10 – 20] J

ΔU = –30 J

54. Answer (1)

Hint: An extensive property is a property whose value depends on the quantity of matter present in the system.

Sol.: Mass, enthalpy and heat capacity are extensive properties.

55. Answer (4)

Hint: $\Delta H = \Delta U + \Delta n_g RT$

Sol.: If Δn_g = + ve, then $\Delta H > \Delta U$.

For reaction, $PCl_5(g) \rightarrow PCl_3(g) + Cl_2(g)$

$\Delta n_g = (2 - 1) = +1$

56. Answer (3)

Hint: $\Delta_r H°$ = (Sum of enthalpies of product) – (Sum of enthalpies of reactants)

Sol.: $ZnO(s) + CO(g) \rightarrow Zn(s) + CO_2(g)$

$\Delta_r H° = \left[\Delta_f H°(Zn,s) + \Delta_f H°(CO_2,g)\right] - \left[\Delta_f H°(ZnO,s) + \Delta_f H°(CO,g)\right]$

= [0 + (– 393.51)] – [(–348.28) + (–110.53)]

= [–393.51 + 348.28 +110.53] kJ mol^{-1}

= 65.3 kJ mol^{-1}

57. Answer (3)

Hint: The equilibrium constant helps in predicting the direction in which a given reaction will proceed at any stage. For this purpose, we calculate the reaction quotient (Q).

Sol.: If $Q > K_c \rightarrow$ Reaction will proceed reverse.

If $Q < K_c \rightarrow$ Reaction will proceed forward.

If $Q = K_c \rightarrow$ Reaction is already at equilibrium.

58. Answer (3)

Hint: $K_p = (atm)^{\Delta n_g}$

Sol.: $\Delta n_g = 1 - 4 = -3$

$K_p = (atm)^{-3}$

59. Answer (4)

Hint: Bronsted acid is a species that is capable of donating a hydrogen ion (H^+) and base are species that accept H^+.

Sol.:

$$\underset{\text{Acid}}{H_2SO_4} \rightleftharpoons \underset{\text{Conjugate base}}{HSO_4^-} + H^+$$

$$\underset{\text{Acid}}{H_3PO_4} \rightleftharpoons \underset{\text{Conjugate base}}{H_2PO_4^-} + H^+$$

60. Answer (2)

Hint: $\Delta_r G° = -nFE°_{cell}$

Sol.: $E^{\circ}_{cell} = xV$

$2Fe^{3+}(aq) + 2I^{-}(aq) \rightarrow 2Fe^{2+}(aq) + I_2(s)$

$n = 2 \times 1 = 2$

$\Delta_r G^{\circ} = -2xF$

61. Answer (2)

Hint: The products of electrolysis depend on the different oxidising and reducing species present in the electrolytic cell and their standard electrode potential.

Sol.: The reaction with higher value of E° is preferred.

$2H_2O + 2e^{-} \rightarrow H_2 + 2OH^{-}$ [cathode]

62. Answer (3)

Hint: In a disproportionation reaction, an element in one oxidation state is simultaneously oxidised and reduced.

Sol.: $\overset{+1\ -1}{2H_2O_2}(aq) \rightarrow \overset{+1\ -2}{2H_2O}(\ell) + \overset{0}{O_2}(g)$

$P_4^0(s) + 3OH^{-}(aq) + 3H_2O(\ell) \rightarrow \overset{-3}{PH_3}(g) + 3H_2\overset{+1}{PO_2^{-}}$

$\overset{0}{Cl_2}(g) + 2OH^{-}(aq) \rightarrow \overset{+1}{ClO^{-}}(aq) + \overset{-1}{Cl^{-}}(aq) + H_2O(\ell)$

In the below given reaction, fluorine does not show a disproportionation reaction.

$\overset{0}{2F_2}(g) + 2OH^{-}(aq) \rightarrow \overset{-1}{2F^{-}}(aq) + \overset{+2-1}{OF_2}(g) + H_2O(\ell)$

63. Answer (3)

Hint and Sol.:

$PH_3 \Rightarrow x + 3 = 0$

$x = -3.$

$H_3PO_3 \Rightarrow 3 + x + 3(-2) = 0$

$x = 6 - 3$

$x = 3$

$H_4P_2O_7 \Rightarrow 4 + 2x + 7(-2) = 0$

$2x = 10$

$x = 5$

$H_4P_2O_6 \Rightarrow 4 + 2x + 6(-2) = 0$

$2x = 8$

$x = 4$

64. Answer (4)

Hint: All decomposition reactions are not redox reactions.

Sol.: $\overset{+5-2}{2KClO_3}(s) \xrightarrow{\Delta} \overset{+1\ -1}{2KCl}(s) + \overset{0}{3O_2}(g)$

It is a redox reaction,

$\overset{+2\ +4\ -2}{CaCO_3}(s) \xrightarrow{\Delta} \overset{+2-2}{CaO}(s) + \overset{+4-2}{CO_2}(g)$

It is not a redox reaction.

65. Answer (3)

Hint: If oxidation number of an element is intermediate, it can act as oxidising as well as reducing agent.

Sol.: In SO_2, oxidation state of sulphur is +4 while sulphur can show minimum –2 and maximum +6 oxidation state.

66. Answer (3)

Hint: In acidic medium

$6e^{-} + \overset{+6}{Cr_2}O_7^{2-} \longrightarrow 2Cr^{3+}$

Sol.: $Cr_2O_7^{2-} + H_2S \longrightarrow S + 2Cr^{3+}$

Equivalent of $Cr_2O_7^{2-}$ = Equivalent of H_2S

$(n \times nf)_{Cr_2O_7^{2-}} = (n \times nf)_{H_2S}$

$n \times 6 = 1 \times 2$

$n = \frac{2}{6}$

$\boxed{n = \frac{1}{3}}$

67. Answer (4)

Hint: The elements having positive value of the standard reduction potential undergo reduction more easily than H^{+} ion.

Sol.: $Cu^{2+} + 2e^{-} \longrightarrow Cu(s) \quad E^{\circ} = 0.34\,V$

$2H^{+} + 2e^{-} \longrightarrow H_2(g) \quad E^{\circ} = 0.00V$

Hence, Cu^{2+} gets reduced more easily than H^{+} ions. So, we can say that $H_2(g)$ will not be liberated when dilute H_2SO_4 is treated with Cu.

68. Answer (2)

Hint: $\frac{w}{E} = \frac{Q}{F}$

Sol.: $\frac{20 \times 2}{40} = \frac{1.93 \times t}{96500}$

$t = 5 \times 10^4$ s

69. Answer (3)

Hint: The equilibrium constant for an endothermic reaction increases as the temperature increases.

Sol.: $A(g) + 2B(g) \rightleftharpoons 3C(g) + D(g)$

$\Delta_r H = +10\,kJ$

$\Delta n_g = 4 - 3 = -1.$

- If Δn_g is negative then low pressure favours the reaction to proceed towards forward direction.
- For an endothermic reaction as temperature increases, reaction moves in forward direction.

70. Answer (2)

Hint and Sol.: Equilibrium constant is temperature dependent only.

71. Answer (2)

Hint: $\alpha = \frac{\Lambda_m}{\Lambda_m^\circ}$

Sol.: $\Lambda_m^\circ(CH_3COOH) = \lambda_m^\circ(CH_3COO^-) + \lambda_m^\circ(H^+)$

= 40.9 + 349.1

= 390 S cm^2 mol^{-1}

$\alpha = \frac{\Lambda_m}{\Lambda_m^\circ} = \frac{16.48}{390}$

$\alpha \approx 0.04$

72. Answer (3)

Hint: On dilution, the ionic interaction decreases.

Sol.: As the ionic interaction decreases on dilution, the mobility of ions increases. Hence, molar conductance of a strong electrolyte also increases.

73. Answer (2)

Hint: For pure H_2O, $[H^+] = [OH^-]$

Sol.: $K_w = [H^+]\,[OH^-]$

$K_w = [H^+]^2$

$10^{-12} = [H^+]^2$

$[H^+] = 10^{-6}$ M

pH = – log $[H^+]$ = 6

74. Answer (3)

Hint: Acidic Buffer: Mixture of weak acid and its salt formed with a strong base.

Sol.: $pH = pK_a + \log \frac{[salt]}{[acid]}$

$pK_a = pH - \log \frac{[salt]}{[acid]}$

$= 3.76 - \log \frac{(0.01)}{(0.1)} = 3.76 + 1 = 4.76$

75. Answer (2)

Hint: The thermal efficiency (η) of a fuel conversion device is the amount of useful energy produced relative to the change in enthalpy.

Sol.: $\eta = \frac{\text{Useful energy}}{\Delta H}$

$\eta = \frac{\Delta G}{\Delta H}$

76. Answer (1)

Hint: For conjugate acid-base pair

$K_w = K_a \times K_b$

Sol.: –log K_w = – log (K_aK_b)

$pK_w = pK_a + pK_b$

$pK_a = pK_w - pK_b$

= 14 – 4.19

= 9.81

77. Answer (3)

Hint: The mixture of weak acid and salt of its conjugate base considered as an acidic buffer.

Sol.:

$CH_3COOH + NaOH \rightarrow CH_3COONa + H_2O$

(100 × 0.1)meq (5 × 0.1)meq

10 meq 5 meq

5 meq —

5 meq

$CH_3COOH + CH_3COONa \rightarrow$ Acidic Buffer

78. Answer (3)

Hint:

$Zn \longrightarrow Zn^{2+} + 2e^-; E^\circ_{Zn^{2+}/Zn} = -0.76V$

$Cu^{2+} + 2e^- \longrightarrow Cu; E^\circ_{Cu^{2+}/Cu} = 0.34\ V$

Sol.: $E^\circ_{cell} = E^\circ_R - E^\circ_L$

$= (0.34) - (-0.76)$

$= 1.1\ V$

79. Answer (4)

Hint: As standard reduction potential increases reducing power of the elements decreases.

Sol.:

Metals	E°(V)	Order of reducing power
A	– 0.76	C > A > B
B	+ 0.52	
C	– 1.66	

80. Answer (2)

Hint: $\Delta H^\circ = \Delta U^\circ + \Delta n_g RT$

Sol.: $CH_4(g) + 2O_2(g) \rightarrow CO_2(g) + 2H_2O(\ell)$

$\Delta n_g = 1 - 3 = -2$

$\Delta H^\circ = \Delta U^\circ + \Delta n_g RT$

$\Delta U^\circ = \Delta H^\circ - \Delta n_g RT$

$\Delta U^\circ = -X + 2 \times R \times 298$

81. Answer (4)

Hint:

$BaF_2(s) \rightleftharpoons Ba^{2+}(aq) + 2F^-(aq)$

s 2s

$K_{sp} = (s)\ (2s)^2$

$K_{sp} = 4s^3$

Sol.: $s = \left(\frac{K_{sp}}{4}\right)^{1/3}$

$s = \left(\frac{10^{-6}}{4}\right)^{1/3} = \frac{10^{-2}}{(4)^{1/3}} M$

82. Answer (3)

Hint & Sol.: Mercury cell consists of zinc-mercury amalgam as anode and a paste of HgO and carbon as the cathode. Electrolyte used is paste of KOH and ZnO.

83. Answer (3)

Hint: Equilibrium constant for the reverse reaction is the inverse of the equilibrium constant for the reaction in the forward direction.

Sol.: $SO_2(g) + \frac{1}{2}O_2(g) \rightleftharpoons SO_3(g) \rightarrow K$

$2SO_3(g) \rightleftharpoons 2SO_2(g) + O_2(g) \rightarrow \left(\frac{1}{K}\right)^2$

84. Answer (2)

Hint: $K_p = K_C(RT)^{\Delta n_g}$

Sol.: If $\Delta n_g = 0$, Then, $K_p = K_c$

$2HI(g) \rightleftharpoons H_2(g) + I_2(g)$

$\because \Delta n_g = 2 - 2 = 0 \ \therefore K_p = K_C$

85. Answer (3)

Hint and Sol.: If $K_c > 10^3$, products predominate over reactants. If K_c is very large, the reaction proceeds nearly to completion.

SECTION-B

86. Answer (4)

Hint: For any cell reaction

$E^\circ_{cell} = E^\circ_{cathode} - E^\circ_{anode}$

Sol.: In reaction

$A + 2A^{3+} \rightarrow 2A^{2+}$

Anode : $A \rightarrow A^{2+} + 2e^-$

Cathode : $A^{3+} + e^- \rightarrow A^{2+}$

$E^\circ_{cell} = y - (-x)$

$= x + y$

87. Answer (3)

Hint: $\lambda_m = \frac{k \times 1000}{M}$

Sol.: $k = \frac{\lambda_m \times M}{1000}$

$= \frac{110 \times 0.25}{1000}$

$= 2.75 \times 10^{-2}\ Scm^{-1}$

88. Answer (1)

Hint: In pressure vs volume graph, the area under the curve during expansion is work done by the gas.

Sol.:

- Maximum area under the curve is for curve A followed by B then C.
- Zero work done in curve D because

  volume is constant [dV = 0]

  $w = -\int_{v_i}^{v_f} pdv$

  w = 0

89. Answer (1)

Hint: The standard enthalpy change for the formation of one mole of a compound from its elements in their most stable states of aggregation is called Standard Molar Enthalpy of formation $\Delta_f H^o$.

Sol.: $H_2(g) + Br_2(\ell) \rightarrow 2HBr$

Two moles of a compound is formed, so it is not consider as $\Delta_f H^\circ(HBr, g)$.

90. Answer (2)

Hint:

$$\Delta_r H^\circ = \sum_{[reactants]} \text{Bond Enthalpies} - \sum_{[products]} \text{Bond Enthalpies}$$

Sol.: $\Delta rH^o = [(\Delta_{bond}H^\circ(C=C) + 4\Delta_{bond}H^o(C-H) + \Delta_{bond}H^o(H-H))] - [(6\Delta_{bond}H^o(C-H) + \Delta_{bond}H^o(C-C))]$

$\Delta_r H^\circ = (b + 4d + a) - [c + 6d]$

$\Delta_r H^\circ = b + 4d + a - c - 6d = a + b - c - 2d$

91. Answer (2)

Hint: $\Delta G = \Delta H - T\Delta S$

Sol.:

ΔH	ΔS	Description
–	+	Reaction is spontaneous at all temperatures
+	–	Reaction is nonspontaneous at all temperatures
+	+	Reaction is nonspontaneous at low temperature
–	–	Reaction is nonspontaneous at high temperature

92. Answer (3)

Hint: Lewis acids are those species which accept electron pair.

Sol.: BF_3, $AlCl_3$ & Co^{3+} are Lewis acids.

93. Answer (4)

Hint: pH = –log[H^+]

Sol.: KOH = 0.01M = 10^{-2}M

pOH = log (10^{-2})

pOH = 2

pK_w = pH + pOH

14 = pH +2

pH = 12

94. Answer (1)

Hint: Conjugate base of weak acid undergoes salt hydrolysis in water and increases the pH of solution.

Sol.: $K_2CO_3 \longrightarrow 2K^+ + CO_3^{2-}$

(CO_3^{2-}: Conjugate base of weak acid)

$CO_3^{2-} + H_2O \rightleftharpoons HCO_3^- + OH^-$

- Due to formation of OH^-, pH of solution increases.
- Cl^-, SO_4^{2-} and ClO_4^- anions of strong acid simply get hydrated, not hydrolysed.

95. Answer (4)

Hint: $\frac{w}{E}=\frac{Q}{F}$

Sol.: $4OH^- \longrightarrow O_2 + 4e^- + 2H_2O$.

$n_f = 4$

Number of Faraday = mole × n_f

= 2 × 4 = 8F.

96. Answer (3)

Hint: Carbon suboxide = C_3O_2

Sol.:

O = C = C = C = O

–2 +2 0 +2 0

Sum of oxidation number of all 'C' atoms

= 2 + 0 + 2

97. Answer (4)

Hint:

$MnO_4^- \longrightarrow Mn^{2+}, n_f = 5$

$Br^- \longrightarrow Br_2, \ n_f = 1$

Sol.:

$2MnO_4^- + 10Br^- + 16H^+ \rightarrow 2Mn^{2+} + 5Br_2 + 8H_2O$

Coefficients of reactants are as follow :

MnO_4^-	Br^-	H^+
2	10	16

98. Answer (3)

Hint: $\Delta G = \Delta G^\circ + RT \ln K$

Sol.: At equilibrium

$\Delta G = 0$

$\Delta G^\circ = -RT \ln K$

$\Delta G^\circ = -8.314 \text{ Jmol}^{-1}\text{K}^{-1} \times 298 \text{ K} \times \ln (3.8 \times 10^{-3})$

99. Answer (1)

Hint: $\frac{w}{E}=\frac{Q}{F}$

Sol.: Moles of electrons = $\frac{Q}{F}$

$= \frac{1 \times 96.5}{96500} = 10^{-3}$

Number of electrons $= 10^{-3} \times 6.02 \times 10^{23}$

$= 6.02 \times 10^{20}$

100. Answer (3)

Hint: For a heterogenous equilibrium, pure solids or liquids concentrations do not appear in the expression of the equilibrium constant.

Sol.:

$Ag_2O(s) + 2HNO_3(aq) \rightleftharpoons 2AgNO_3(aq) + H_2O(\ell)$

$K_c = \frac{[AgNO_3]^2}{[HNO_3]^2}$

[BOTANY]

SECTION-A

101. Answer (2)

Hint: Vegetative characters are habit, colour, number, shape of leaves *etc*.

Sol.: Artificial system of classification was based mainly on vegetative characters or on androecium structure (system given by Linnaeus).

102. Answer (3)

Hint: Natural affinities include not only external features but also internal features.

Sol.: Natural system of classification was based on natural affinities among the organisms. It was given by Bentham and Hooker for flowering plants.

103. Answer (4)

Hint: Natural system was based on external features (morphology) as well as internal features.

Sol.: Internal features on which natural system was based are ultrastructure, anatomy, embryology and phytochemistry.

104. Answer (3)

Hint: DNA sequences, amino acid sequences, aromatic compounds *etc*. are chemical constituents of the plant.

Sol.: Chemotaxonomy is based on chemical constituents of plants.

- Cytotaxonomy/karyotaxonomy is based on cytological information.
- Numerical taxonomy is based on all observable characters and are carried out using computers.

105. Answer (1)

Hint: Cytotaxonomy is based on cytological information.

Sol.: Chemotaxonomy uses the chemical constituents and DNA sequence of chromosomes.

106. Answer (3)

Hint: *Volvox* and *Eudorina* are colonial algae.

Sol.: *Ulothrix* and *Spirogyra* are filamentous algae.

107. Answer (1)

Hint: Primary meristems are group of actively dividing cells that appear early in life of plants and contribute to the formation of the primary plant body *e.g.*, apical meristem, intercalary meristem *etc*.

Sol.: Secondary meristems appear later in life of plants and contribute to the lateral or secondary growth *e.g.,* cork cambium *etc*. Primary meristem such as intrafascicular cambium also contributes in secondary growth.

108. Answer (3)

Hint: Meristems that occur in the mature regions of roots and shoots of many plant produce woody axis and help in secondary growth.

Sol.: Lateral meristems help in lateral growth that occurs later in the life of the plant *i.e.*, secondary growth.

109. Answer (1)

Hint: Parenchyma forms the major component within organs.

Sol.: The cells of parenchyma are generally isodiametric. Their walls are thin and made up of cellulose. They may either be closely packed or have small intercellular spaces.

They perform functions like photosynthesis, storage, secretion *etc*.

110. Answer (2)

Hint: Collenchyma is absent in monocots.

Sol.: Cells of collenchyma are closely packed with no intercellular spaces and they are living cells.

111. Answer (1)

Hint: Elongated portions of pith between two adjacent vascular bundles in dicot stem are pith rays or medullary rays.

Sol.: Cells of medullary rays de-differentiate at the time of secondary growth and form interfascicular cambium which joins with already existing intravascular cambium (primary meristem) to form vascular cambium ring and help in secondary growth.

112. Answer (2)

Hint: Floridean starch is reserve food material of Rhodophyceae.

Sol.:
- Chlorophyll 'a' and pyrenoids are associated with green algae.
- Agar is found in red algae.
- Two unequal lateral flagella are found in brown algae.

113. Answer (1)

Hint: *Chlorella* is a unicellular green alga used as food for space travellers as it is source of single cell protein (SCP).

Sol.:
- Rhodophyceae exhibits complex post-fertilisation development.
- Agar is used in preparation of ice-creams.
- *Ectocarpus* has filamentous body.

114. Answer (3)

Hint: Bryophytes are first terrestrial plants but dependent on water for their fertilisation thus, known as "amphibians of plant kingdom".

Sol.: The pteridophytes are found in cool, damp, shady places. They also require water for fertilisation thus, are known as vascular amphibians.

115. Answer (3)

Hint: Gemmae are asexual, multicellular, nonvascular, green, haploid buds present on upper surface of gametophytic thallus.

Sol.: Gemmae are asexual buds of liverworts, found in *Marchantia*.

116. Answer (4)

Hint: Main plant body in *Sphagnum* (a moss) is haploid *i.e.*, gametophyte.

Sol.: Gametophyte, protonema and rhizoids are haploid structures. Capsule is a part of sporophyte and hence, diploid structure.

117. Answer (1)

Hint: Floridean starch is the reserve food material of red algae and it is structurally similar to amylopectin and glycogen.

Sol.: Mosses are more elaborate than liverworts.

Bryophytes are economically less important but ecologically more important.

118. Answer (3)

Hint: Phloem parenchyma is seen in dicotyledonous plants.

Sol.: Phloem parenchyma is absent in most of the monocotyledons.

The cell wall of phloem parenchyma is composed of cellulose and has pits through which plasmodesmatal connections exist between the cells.

The phloem parenchyma stores food material and other substances like resins, latex and mucilage.

119. Answer (1)

Hint: Brown algae vary in colour from olive green to various shades of brown.

Sol.: Various shades of brown in phaeophyceae depend upon the amount of the xanthophyll pigment, fucoxanthin.

120. Answer (4)

Hint: Phaeophyceae have motile asexual spores, pear shaped (pyriform) zoospores with two unequal laterally inserted flagella.

Sol.: Pyrenoids are storage structures in Chlorophyceae having proteinaceous centre with starchy sheath.

121. Answer (2)

Hint: Pollen is reduced male gametophyte.

Sol.: *Sequoia*, also known as giant red wood tree is one of the tallest gymnosperms.

122. Answer (4)

Hint: Lateral roots are endogenous in origin.

Sol.: In dicots, lateral roots arise from the pericycle.

123. Answer (4)

Hint: Roots have radial vascular bundles.

Sol.: Conjoint, collateral, closed vascular bundles are found in monocot stem where xylem and phloem are present on same radius and cambium is not present.

124. Answer (1)

Hint: Late wood or autumn wood is dark in colour and has a higher density.

Sol.: Heartwood is modified secondary xylem, present towards pith. It is dark in colour due to depositions.

125. Answer (1)

Hint: De-differentiated tissues are secondary meristems.

Sol.: Apical meristem is a primary meristem that appears early in the life of plants.

126. Answer (3)

Hint: Stems have conjoint, collateral vascular bundles with endarch xylem.

Sol.: Vascular cambium is present in dicot stems

In monocot stems, cambium is absent *i.e.*, closed vascular bundles are present.

Hypodermis in dicot stems is collenchymatous whereas in monocot stems hypodermis is sclerenchymatous.

127. Answer (2)

Hint: Phellem is cork and phelloderm is secondary cortex.

Sol.: Secondary xylem is produced inner to the vascular cambium ring *i.e.*, towards pith, and bark includes cells outside vascular cambium ring, like phellem, phelloderm, phloem *etc.*

128. Answer (3)

Hint: Cuticle is a coating of cutin (waxy substance) to prevent transpirational loss of water.

Sol.: Cuticle is required in aerial plant parts like stem and leaf. Thus, it is absent in underground part *i.e.*, roots.

129. Answer (3)

Hint: Scattered vascular bundles are found in monocot stems.

Sol.: Gram, China rose and mustard are dicots which have ring-like arrangements of vascular bundles.

130. Answer (3)

Hint: In dicot roots, cambium is developed at the time of secondary growth.

Sol.: Vascular cambium ring in dicot roots is completely secondary and wavy in nature.

It has no differential activity and is made up of dedifferentiated pericycle cells above xylem and conjunctive tissue below phloem.

131. Answer (3)

Hint: Casparian strips are barrier or check points formed due to deposition of suberin.

Sol.: The tangential as well as radial walls of endodermal cells have a deposition of water impermeable, waxy material suberin in the form of casparian strips in roots (both dicots and monocots) acting as barrier or check points for transport.

132. Answer (2)

Hint: In dicot leaves, mesophyll cells are differentiated into two layers, palisade parenchyma and spongy parenchyma.

Sol.: Bulliform cells are specialised modified, large, empty, colourless epidermal cells of isobilateral leaves of monocots which help in curling of leaves to minimise surface area and reduce transpirational loss of water.

133. Answer (2)

Hint: Casparian strips act as barrier or check point and control the quantity of solutes that reach the xylem.

Sol.: Casparian strips are present in endodermis.

Pericycle gives rise to lateral roots as well as form vascular cambium in dicot roots during secondary growth.

134. Answer (4)

Hint: Annual rings are formed due to variations in external environment and tropical areas have constant hot and humid condition.

Sol.: Annual rings are more distinct in plants growing in temperate areas.

Late wood or autumn wood is dark in colour and has higher density.

135. Answer (2)

Hint: Periderm is a product of secondary growth.

Sol.: Secondary growth is found in dicot stem and dicot root.

Phellem (Cork cell)
Phellogen (Cork cambium)] Periderm
Phelloderm (secondary cortex)

SECTION-B

136. Answer (3)

Hint: Numerical taxonomy is carried out using computers based on all observable characters.

Sol.: Hundreds of characters are considered at the same time. Number and codes are assigned to all the characters.

Each character is of equal importance.

137. Answer (1)

Hint: Zoospores are motile asexual spores.

Sol.: Most common asexual spores of algae are motile zoospores.

- Conidia and sporangiospores are asexual spores of fungi.
- Aplanospores are non-motile asexual spores.

138. Answer (2)

Hint: *Eudorina* and *Volvox* have dissimilar gametes (anisogametes).

Sol.: *Ulothrix* has isogametes which are flagellated.

Non-flagellated (non-motile) isogametes or homogametes are present in *Spirogyra*.

139. Answer (1)

Hint: Fusion between one large, non-motile (static) female gamete and a smaller, motile male gamete is oogamous reproduction.

Sol.: *Ulothrix* and *Spirogyra* show isogamous reproduction.

Eudorina shows anisogamous reproduction.

Fucus shows oogamous reproduction.

140. Answer (4)

Hint: Many species of *Porphyra*, *Laminaria* and *Sargassum* are among 70 species of marine algae used as food.

Sol.: *Volvox* is colonial fresh water green algae.

141. Answer (2)

Hint: *Pteris*, *Dryopteris* and *Adiantum* belong to Pteropsida.

Sol.: *Selaginella* and *Lycopodium* belong to Lycopsida.

142. Answer (1)

Hint: Thallophytes are plants which are not well differentiated into true roots, stems and leaves *e.g.,* Algae.

Sol.:
- Spermatophytes are seed-producing plants like angiosperms.
- Gymnosperms are seed-producing archegoniates.
- Bryophytes are first embryophytes.

143. Answer (4)

Hint: Lateral meristems are secondary meristems which are involved in lateral growth.

Sol.: Fascicular vascular cambium, interfascicular cambium and cork cambium, all are secondary or lateral meristems, which appear later in life of plants and are responsible for cylindrical growth, thus, also known as cylindrical meristem.

144. Answer (1)

Hint: The roots of *Pinus* are in fungal association forming mycorrhiza.

Sol.: The roots of *Cycas* have symbiotic association with nitrogen - fixing blue-green algae *i.e.*, *Anabaena*.

145. Answer (1)

Hint: Bryophytes are called amphibians of the plant kingdom but they lack a vascular system.

Sol.: The main plant body of the bryophytes is haploid. It produces gametes, hence called a gametophyte.

146. Answer (3)

Hint: Phaeophyceae are found primarily in marine habitat and they show great variation in size and form.

Sol.: *Wolffia* is the smallest angiosperm.

147. Answer (3)

Hint: Exarch xylem is a feature of roots.

Sol.: Water-containing cavities are present in vascular bundles of monocot stems.

Ring-like arrangement of vascular bundles is present in dicot stem.

148. Answer (3)

Hint: Primary meristem appears early in life of plants and responsible for primary growth of plants.

Sol.:
- Cork is redifferentiated or secondary permanent tissue.
- Phellogen or cork cambium is de-differentiated or secondary meristematic tissue.
- Vascular cambium is a secondary meristem.

149. Answer (4)

Hint: Sclereids are dead sclerenchymatous cells.

Sol.: Liquid endosperm of coconut represents free nuclear condition or multinucleate condition.

150. Answer (3)

Hint: Stomata regulate the process of transpiration and gaseous exchange.

Sol.: A few epidermal cells, in the vicinity of the guard cells become specialised in their shape and size and are known as subsidiary cells.

Each stoma is composed of two bean-shaped cells known as guard cells which enclose stomatal pore.

[ZOOLOGY]

SECTION-A

151. Answer (2)

Hint: Excreted with minimum loss of water

Sol.: Reptiles are the first true land vertebrates. Insects belong to the largest class of phylum Arthropoda. Reptiles, birds, land snails and insects excrete nitrogenous wastes as uric acid in the form of pellet or paste with a minimum loss of water and are called uricotelic animals.

Many bony fishes, aquatic amphibians and aquatic insects are ammonotelic in nature.

Mammals, many terrestrial amphibians and marine fishes mainly excrete urea and are called ureotelic animals.

152. Answer (3)

Hint: Least toxic nitrogenous waste is very important for land vertebrates laying shelled eggs

Sol.: Ammonia, urea and uric acid are the major forms of nitrogenous wastes excreted by the animals. Ammonia is the most toxic form and requires large amount of water for its elimination, whereas uric acid, being the least toxic, can be removed with a minimum loss of water.

153. Answer (1)

Hint: Also known as 'Friends of farmers'

Sol.: Nephridia are the tubular excretory structures of earthworms and other annelids. Nephridia help to remove nitrogenous wastes and maintain a fluid and ionic balance.

- Malpighian tubules are the excretory structures of most of the insects including cockroaches (*Periplaneta*).
- Antennal glands or green glands perform the excretory function in crustaceans like prawns.
- Protonephridia or flame cells are the excretory structures in platyhelminthes (Flatworms, *e.g.*, *Planaria*).

154. Answer (2)

Hint: Belongs to the phylum which includes pore bearer animals

Sol.: Flagellar movements help in the swimming of spermatozoa, maintenance of water current in the canal system of sponges and in the locomotion of protozoans like *Euglena*.

Hydra uses its tentacles for capturing its prey and locomotion.

In *Paramecium*, cilia help in the movement of food through cytopharynx and in locomotion as well.

155. Answer (3)

Hint: Visceral muscles

Sol.: Visceral muscles are located in the inner walls of hollow visceral organs of the body like the alimentary canal, reproductive tract, *etc*. They do not exhibit any striations and are smooth in appearance. Hence, they are called smooth muscles (non-striated). Their activities are not under the voluntary control of the nervous system and are therefore known as involuntary muscles.

156. Answer (4)

Hint: Ability to respond to a stimulus

Sol.: Muscles have the special properties like excitability, contractility, extensibility and elasticity.

- The property of shortening and then returning to relaxed state of the muscle fibre is called elasticity. A stimulus such as nerve impulse, hormones, mechanical, thermal or chemical stimulus are required for excitation of the muscles which then causes muscles to contract.

157. Answer (4)

Hint: Lies along the peripheries of the body

Sol.: The Central Nervous System (CNS) includes the brain and the spinal cord and is the site of information processing and control.

- The peripheral Nervous System (PNS) lies along the peripheries of the body. It comprises all the nerves of the body associated with the CNS.

158. Answer (2)

Hint: Possess centre which controls respiration

Sol.: The medulla oblongata contains centres which control respiration, cardiovascular reflexes and gastric secretions.

- The hypothalamus contains a number of centres which control body temperature, urge for eating and drinking.
- Cerebellum does not initiate the movements of the body but modulates or reorganises the motor commands.

159. Answer (2)

Hint: The nerve fibre which lacks Nissl's granules.

Sol.: The dendrites branch repeatedly to further give rise to smaller fibres. The dendrites of one neuron receive electrical impulses from different sources, *i.e.*, other neurons and then transmit these impulses towards the cell body of the neuron to which they belong.

- Axon lacks Nissl's granules and they carry impulses away from the cyton to a synapse or to a neuromuscular junction.

160. Answer (4)

Hint: Inner parts of cerebral hemisphere

Sol.: The inner parts of cerebral hemispheres and a group of deep structures like amygdala, hippocampus, *etc.*, form a complex structure called the limbic lobe or limbic system. Along with the hypothalamus, it is involved in the regulation of sexual behaviour, expression of emotional reactions (*e.g.*, excitement, pleasure, rage and fear), and motivation.

161. Answer (1)

Hint: Retroperitoneal arrangement

Sol.: As the kidneys are fused with the body wall on the dorsal side, peritoneal cover is present only on the ventral side. This arrangement is called retroperitoneal arrangement.

- Each kidney of an adult human measures 10-12 cm in length, 5-7 cm in width, 2-3 cm in thickness with an average weight of 120-170 g.
- Some amount of urea may be retained in the kidney matrix of some ureotelic animals to maintain a desired osmolarity.

162. Answer (4)

Hint: Perform active absorption and secretion

Sol.: There are two types of nephrons *i.e.*, cortical nephrons and juxta medullary nephrons.

- In majority of nephrons, the loop of Henle is too short and extends only very little into the medulla. Such nephrons are called cortical nephrons.
- In some of the nephrons, the loop of Henle is very long and runs deep into the medulla. These nephrons are called Juxtamedullary nephrons.

163. Answer (4)

Hint: Presence of microvilli increases the surface area for reabsorption in PCT

Sol.: PCT is lined by simple cuboidal brush border epithelium which increases the surface area for reabsorption. Nearly all of the essential nutrients, and 70-80 per cent of electrolytes and water are reabsorbed by this segment. PCT also helps to maintain the pH and ionic balance of the body fluids by selective secretion of hydrogen ions, ammonia and potassium ions into the filtrate and by absorption of HCO_3^- from it.

164. Answer (2)

Hint: Epithelial cells of Bowman's capsule is called podocytes

Sol.: The epithelial cells of Bowman's capsule called podocytes are arranged in an intricate manner so as to leave some minute spaces called filtration slits or slit pores.

- Juxtaglomerular Apparatus (JGA) is a special sensitive region formed by cellular modifications in DCT and the afferent arteriole at the location of their contact.
- The Malpighian corpuscle, PCT and DCT of the nephron are situated in the cortical region of the kidney.

165. Answer (2)

Hint: Nitrogenous waste

Sol.: Substances like glucose, amino acids, Na^+ *etc*., in the filtrate are reabsorbed actively whereas the nitrogenous wastes are absorbed by passive transport. Reabsorption of water also occurs passively in the initial segments of the nephron.

166. Answer (1)

Hint: Movement and locomotion cannot be studied separately

Sol.: Muscle bundles or fascicles are held together by a common collagenous connective tissue layer called fascia.

Locomotion requires a perfect coordinated activity of muscular, skeletal and neural systems.

Methods of locomotion performed by animals vary with their habitats and the demand of the situation.

167. Answer (4)

Hint: Assist in forming the shoulder joint

Sol.: Pelvic girdle consists of two coxal bones. Each coxal bone is formed by the fusion of three bones–ilium, ischium and pubis. At the point of fusion of the above bones is a cavity called acetabulum to which the thigh bone articulates.

Below the acromion is a depression called the glenoid cavity which articulates with the head of the humerus to form the shoulder joint.

168. Answer (1)

Hint: Total number of phalanges in both forearm is 28

Sol.: The total number of facial bones in an adult man is 14 while that of cranial bones is 8 and wrist bones in one forearm is 8.

169. Answer (4)

Hint: Skeletal system in an adult man comprises 206 bones.

Sol.: Mechanism of muscle contraction is best explained by the sliding filament theory which states that contraction of a muscle fibre takes place by the sliding of the thin filaments over the thick filaments.

- Stimulation of a muscle fibre by a motor neuron occurs at the neuromuscular junction.
- Osteoporosis is an age-related disorder characterised by decreased bone mass and increased chances of fractures. Decreased levels of estrogen is a common cause.

170. Answer (3)

Hint: Number of cervical vertebrae in manatees

Sol.: Almost all mammals including human beings have seven cervical vertebrae. Other characteristic features of mammals are:

- Presence of mammary glands
- Presence of pinna, hair on body, sweat glands and a four-chambered heart.
- Sloths and manatees are the mammals that do not have seven cervical vertebrae.

171. Answer (2)

Hint: Helps in restoring the resting potential after hyperpolarisation

Sol.: When a neuron is not conducting any impulse, *i.e.*, resting, the axonal membrane is comparatively more permeable to potassium ions and nearly impermeable to sodium ions. Similarly, the membrane is impermeable to negatively charged proteins present in the axoplasm.

- The outer surface of the axonal membrane possesses a positive charge while its inner surface has negative charge. At rest, sodium-potassium pump transports 3 Na^+ outwards for $2K^+$ into the cell.

172. Answer (1)

Hint: Commonly found in autonomous neural system

Sol.: There are two types of axons, namely myelinated and unmyelinated. In PNS, the myelinated nerve fibres are enveloped with Schwann cells, which form a myelin sheath around the axon. Unmyelinated nerve fibre is enclosed by a Schwann cell that does not form a myelin sheath around the axon, and is commonly found in the somatic and autonomous neural systems.

173. Answer (2)

Hint: Middle cavity of cochlea.

Sol.: The membranous labyrinth is filled with a fluid called endolymph. The coiled portion of the labyrinth is called cochlea. The membranes constituting cochlea, the Reissner's and basilar, divide the surrounding perilymph filled bony labyrinth into an upper scala vestibuli and a lower scala tympani. The space within cochlea called scala media is filled with endolymph.

174. Answer (4)

Hint: Function performed by a part of hindbrain

Sol.: Hypothalamus lies at the base of the thalamus. It contains a number of centres which control body temperature, urge for eating and drinking. It also contains several groups of neurosecretory cells, which secrete hormones called hypothalamic hormones.

The medulla oblongata contains centres which control respiration, cardiovascular reflexes and gastric secretions.

175. Answer (1)

Hint: Humans are ureotelic

Sol.: Ammonia produced by metabolism is converted into urea in the liver of ureotelic animals and released into the blood which is filtered and excreted out by the kidneys.

- Our lungs remove large amounts of CO_2 (approximately 200 mL/minute) and also significant quantities of water everyday.
- Sweat produced by the sweat glands is a watery fluid constituting NaCl, small amounts of urea, lactic acids, *etc*., though, the primary function of sweat is to facilitate a cooling effect on the body surface.

176. Answer (1)

Hint: Caused by the hyposecretion of insulin

Sol.: Presence of glucose (glycosuria) and ketone bodies (ketonuria) in urine are indicative of diabetes mellitus.

- In glomerulonephritis, there is inflammation of glomeruli.
- In renal calculi, stone or insoluble mass of crystallised salts (oxalates, *etc*.) are formed within the kidney.

177. Answer (2)

Hint: It passes through the centre of H-zone

Sol.: The H-zone in the skeletal muscle fibre is due to the central gap between actin filaments extending through myosin filaments in the A-band.

- 'M' line is a thin fibrous membrane.
- Sarcomere is the functional unit of contraction, that has a central 'A' band made of thick myosin filaments, and two half 'I' bands made of thin actin filaments on either side of 'Z' lines.

178. Answer (2)

Hint: Rapid spasms is seen in this disorder

Sol.:
- **Myasthenia gravis** – Auto-immune disorder affecting neuromuscular junction leading to fatigue, weakening and paralysis of skeletal muscle.
- **Muscular dystrophy** – Progressive degeneration of skeletal muscle mostly due to genetic disorder.
- **Gout** – Inflammation of joints due to accumulation of uric acid crystals.

179. Answer (4)

Hint: White of the eye

Sol.: The wall of the eyeball is composed of three layers. The external layer is composed of a dense connective tissue and is called sclera (A). It is milky white in colour except in the front.

- The middle layer, choroid (D), contains many blood vessels and looks bluish in colour. The choroid layer is thin over the posterior two-thirds of the eyeball, but it becomes thick in the anterior part to form ciliary body.
- Photoreceptor cells are not present in the blind spot (C). The fovea (B) is a thinned-out portion of the retina where only the cones are densely packed.

180. Answer (2)

Hint: Photosensitive compound is made up of opsin and retinal

Sol.: The purplish red protein, rhodopsin, contained in the rods type of photoreceptor cells of the human eye contains a derivative of vitamin A.

- Photoreceptors in the human eye are depolarised during darkness and become hyperpolarized in response to the light stimulus.
- The neurons of the olfactory epithelium extend from the outside environment directly into a pair of broad bean-sized organs, called olfactory bulb, which are extensions of the brain's limbic system.

181. Answer (4)

Hint: Lymphs induce ripple in this membrane

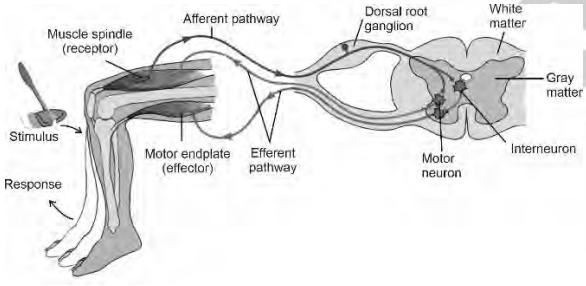
Sol.:

- The organ of Corti is a structure located on the basilar membrane which contains hair cells that act as auditory receptors.
- The tympanic membrane is also called the ear drum or tympanum.

182. Answer (2)

Hint: Motor end plate is an effector organ

Sol.:



Knee jerk reflex is a monosynaptic reflex that lacks interneuron.

183. Answer (4)

Hint: Formation of concentrated urine

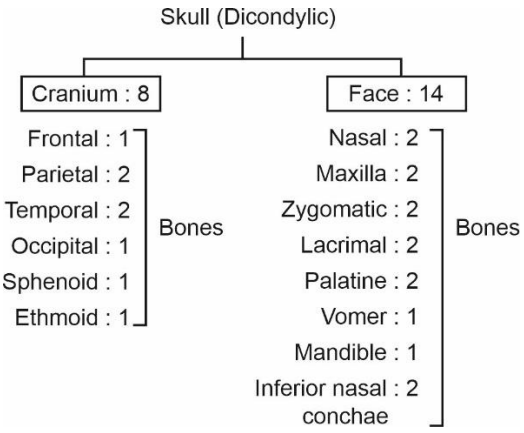
Sol.: Tea, coffee and alcohol are natural diuretics. Diuretics are medications or compounds designed to increase the amount of water expelled from the body as urine.

- Renin is component of RAAS that leads to reabsorption of NaCl and water.
- ANF checks RAAS.

184. Answer (4)

Hint: Largest and strongest facial bone

Sol.:



185. Answer (1)

Hint: Vital for the control of rapid muscular activities

Sol.: Three major regions make up the brain stem; mid brain, pons and medulla oblongata. Brain stem forms the connections between the brain and spinal cord. Cerebrum and hypothalamus are parts of the forebrain.

SECTION-B

186. Answer (4)

Hint: Leads to minimal loss of water

Sol.: Sweat produced by sweat glands is a watery fluid containing NaCl, small amounts of urea, amino acids, lactic acid and glucose *etc*. Though, the primary function of sweat is to facilitate a cooling effect on the body surface, it also helps in the removal of some of the wastes mentioned above.

187. Answer (3)

Hint: Storehouse of calcium ions

Sol.: Myoglobin content is high in some of the muscles which give a reddish appearance. Such muscles are called the red muscle fibres. These muscles also contain plenty of mitochondria which can utilize the large amount of oxygen stored in them for ATP production. These muscles, therefore, can also be called aerobic muscles.

- On the other hand, some of the muscles possess very less quantity of myoglobin and therefore, appear pale or whitish. These are the white fibres. Number of mitochondria are also few in them, but the amount of sarcoplasmic reticulum is high. They depend on anaerobic process for energy.

188. Answer (2)

Hint: Hyaline cartilage

Sol.: Hyaline cartilage occurs at the nasal septum.

- Bones and cartilage are specialised connective tissues. The former has very hard matrix due to calcium salts in it and the latter has slightly pliable matrix due to chondroitin salts.

189. Answer (4)

Hint: Function attributed to association area

Sol.: The cerebral cortex contains motor area, sensory areas and large regions that are neither clearly sensory nor motor in function. These regions called the association area are responsible for complex functions like intersensory associations, memory and communication.

- Medulla oblongata contains centres which control respiration, gastric secretions and cardiovascular reflexes.
- Pneumotaxic centre is present in pons, which can moderate the functions of the respiratory rhythm centre located in the medulla oblongata.

190. Answer (2)

Hint: Contractile tissue

Sol.: Proprioceptors are present in skeletal muscle in the region of spindle. Eyes are photoreceptors. Hypothalamus contains osmoreceptors and adrenal gland is an endocrine gland.

- Nociceptors respond to painful stimuli and baroreceptors respond to pressure.

191. Answer (3)

Hint: Straight tube

Sol.: DCT is a highly coiled part of nephron and lies close to the Malpighian body. Conditional reabsorption of Na^+ and water takes place in this segment. DCT is also capable of reabsorption of HCO_3^- and selective secretion of H^+ and K^+ ions to maintain the pH and sodium potassium balance in blood.

- Collecting duct allows passage of small amounts of urea into the medullary interstitium to keep up the osmolarity. It is not a part of nephron.

192. Answer (3)

Hint: Ultrafiltration

Sol.: The first step in urine formation is the filtration of blood, which is carried out by the glomerulus and is called glomerular filtration. On an average, 1100-1200 mL of blood is filtered by the kidneys per minute which constitute roughly $1/5^{th}$ of the blood pumped out by each ventricle of the heart in a minute.

- Blood is filtered so finely through filtration membranes, that almost all the constituents of the plasma except the proteins pass into the lumen of the Bowman's capsule. Therefore, it is considered as a process of ultrafiltration.

193. Answer (2)

Hint: Hip joint

Sol.: Ball and socket joint is the most free joint of all joints. It is present in shoulder joint and hip joint.

- Hinge joint is present between tibia and femur (knee joint). Pivot joint is present between atlas and axis, radius and ulna.
- Saddle joint is present between carpal and metacarpal of human thumb.

194. Answer (3)

Hint: Does not allow any movement

Sol.: Fibrous joint is shown by the flat skull bones which fuse end-to-end with the help of dense fibrous connective tissues in the form of sutures, to form the cranium.

- The contractile protein of skeletal muscle involving ATPase activity is myosin.
- Troponin and tropomyosin are regulatory proteins in the muscle contraction.

195. Answer (2)

Hint: Present between internodes

Sol.: In myelinated nerve fibres of PNS (cranial nerves and spinal nerves), nodes of Ranvier are present in between internodes. Nodes of Ranvier have axolemma and neurilemma but they lack myelin sheath.

196. Answer (2)

Hint: Connects middle ear with pharynx.

Sol.:

- Eustachian tube equalises pressures on both sides of the ear drum.
- Vestibular apparatus helps in maintaining balance of the body and posture.
- Auditory meatus is a part of the external ear.

197. Answer (2)

Hint: Juxtaglomerular cells of kidney produce erythropoietin

Sol.: Juxtaglomerular cells of kidney produce a hormone called erythropoietin which stimulates erythropoiesis (formation of RBCs). Kidneys also secrete calcitriol, which promotes absorption of Ca^{2+} and phosphorous in small intestine and accelerates bone formation.

- The urine formed is slightly acidic (pH – 6.0).
- In haemodialysis, the cleared blood is pumped back to the body through a vein after addition of anti-heparin to it.

198. Answer (2)

Hint: Vertebrochondral ribs are also known as false ribs.

Sol.: The first cervical vertebrae is Atlas and the second is called Axis. On the upper surface of atlas, there is presence of kidney-shaped facets for articulation with the condyles of the occipital bone.

- Sternum is a flat bone present on the ventral midline of the thorax. It is present just under the skin in the middle of the chest.

199. Answer (2)

Hint: In *Hydra*, neurons are not organised to form an organ.

Sol.: The neural organisation is very simple in lower invertebrates. For example, in *Hydra*, it is composed of a network of neurons. The neurons system is better organised in insects, where a brain is present along with a number of ganglia and neural tissues. The vertebrates have a more developed neural system.

200. Answer (3)

Hint: Sympathetic and parasympathetic neural systems have antagonistic effects on the organs.

Sol.: During fight, fright and flight response, catecholamines are secreted from adrenal medulla.

- In sympathetic neural system, the neurotransmitter is adrenaline/noradrenaline.

❑ ❑ ❑

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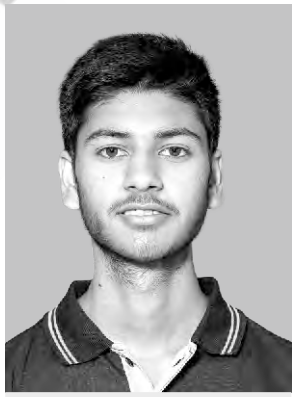

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ANSWERS

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

HINTS & SOLUTIONS

[PHYSICS]

SECTION-A

1. Answer (3)

Hint: Height of liquid inside capillary tube

$$h = \frac{2T\cos\theta}{\rho g r}$$

Sol.: Let $M = \rho\pi r^2 h$

$$h \propto \frac{1}{r} \Rightarrow h' = 2h$$

$$M' = \rho\pi\left(\frac{r}{2}\right)^2 h'$$

$$= \frac{\rho\pi r^2 h}{2} = \frac{M}{2}$$

2. Answer (2)

Hint: Height of liquid inside capillary tube

$$h = \frac{2T\cos\theta}{\rho g r}$$

Sol.: $h = \frac{2T\cos\theta}{\rho g r}$

$h = 0 \Rightarrow \theta$ can be 90°

3. Answer (3)

Hint: Specific gravity = $\frac{\text{Weight in air}}{\text{Buoyant force in water}}$

Sol.: Specific gravity $= \frac{120}{40} = 3$

4. Answer (4)

Hint: $\Delta P = \frac{4T}{R}$ and $A = 4\pi R^2$

Sol.: $\frac{\Delta P_1}{\Delta P_2} = \frac{\frac{4T}{R_1}}{\frac{4T}{R_2}} = \frac{R_2}{R_1} = \frac{0.02}{0.03} = \frac{2}{3}$

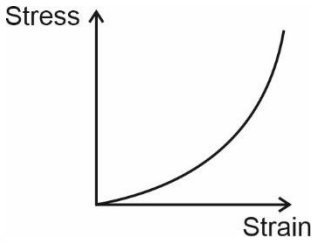
$$\frac{A_1}{A_2} = \left(\frac{R_1}{R_2}\right)^2 = \left(\frac{3}{2}\right)^2 = \frac{9}{4}$$

5. Answer (3)

Hint and Sol.: Tangential strain is a dimensionless quantity.

6. Answer (1)

Hint and Sol.: Stress-strain curve for elastic tissue of aorta is



7. Answer (1)

Hint and Sol.: Y = 200 × 10^9 N/m^2

8. Answer (2)

Hint: $T^2 \propto R^3$

Sol.: $\frac{T_2}{T_1} = \frac{\left(\frac{R}{4}\right)^{3/2}}{R^{3/2}} = \frac{1}{8}$

$T_2 = \frac{365.25}{8} \approx 45.66$ days

9. Answer (4)

Hint: $g = \frac{4}{3}G\pi\rho R$

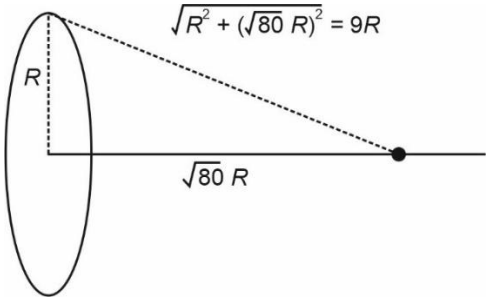
Sol.: $\frac{g_1}{g_2} = \frac{\rho_1 R_1}{\rho_2 R_2} = \frac{1}{2} \times \frac{4}{1} = 2$

10. Answer (1)

Hint: $W = \Delta U$

Sol.: $W = \Delta U = U_f - U_i$

$$U_i = -\frac{GMm}{R}$$



$$U_f = -\frac{GMm}{9R}$$

$W = U_f - U_i$

$$= -\frac{GMm}{9R} - \left(-\frac{GMm}{R}\right)$$

$$= \frac{8}{9}\frac{GMm}{R}$$

11. Answer (3)

Hint: $T = 2\pi\sqrt{\frac{L}{g}}$ and $g = \frac{GM}{r^2}$

Sol.: $T_1 = 2\pi\sqrt{\frac{L}{g}}$

$$T_2 = 2\pi\sqrt{\frac{L}{g'}} \quad \left(g' = \frac{GM}{(3R)^2} = \frac{g}{9}\right)$$

$$T_2 = 2\pi\sqrt{\frac{9L}{g}} = 3T_1$$

$$\frac{T_2}{T_1} = 3$$

12. Answer (1)

Hint: $\frac{dA}{dt} = \frac{|\vec{L}|}{2m} = \text{constant}$

Sol.: $\frac{|\vec{L}|}{2m} = \frac{3A}{T}$

$$\Rightarrow \quad |\vec{L}| = \frac{6mA}{T}$$

13. Answer (4)

Hint: Conservation of mechanical energy

Sol.: Applying conservation of mechanical energy.

$PE_i + KE_i = PE_f + KE_F$

$$-\frac{GMm}{R} + \frac{1}{2}m\left(\frac{V_e}{3}\right)^2 = PE_f + 0$$

$$PE_f = -\frac{GMm}{R} + \frac{m}{2} \times \frac{2GM}{9R}$$

$$= -\frac{8}{9}\frac{GMm}{R}$$

14. Answer (1)

Hint: $\vec{L} = \vec{r} \times \vec{p} + I_C\vec{\omega}$

Sol.: $|\vec{L}| = (2R)mv\sin 90^\circ - \frac{mR^2}{2}\omega$

$$= 2Rm(2\omega R) - \frac{m\omega R^2}{2}$$

$$= 4m\omega R^2 - \frac{m\omega R^2}{2}$$

$= 3.5\ m\omega R^2$

15. Answer (3)

Hint: Conservation of mechanical energy and $\vec{v} = \vec{\omega} \times \vec{R}$.

Sol.: Shift in center of mass = $2R$

$$\Rightarrow \quad 2mgR = \frac{1}{2}I\omega^2$$

$$\Rightarrow \quad 2mgR = \frac{1}{2}\left(\frac{5}{4}mR^2\right)\omega^2$$

$$\Rightarrow \quad \omega = \sqrt{\frac{16g}{5R}}$$

$$v = \omega(2R) = \sqrt{\frac{64\,Rg}{5}}$$

16. Answer (1)

Hint: Conservation of mechanical energy.

Sol.: Applying conservation of mechanical energy

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

$$\frac{mv^2}{2} + \frac{mv^2}{5} = mgh$$

$$h = \frac{7v^2}{10g} \quad \left(v = \frac{3v_0}{2}\right)$$

$$h = \frac{63v_0^2}{40g}$$

17. Answer (4)

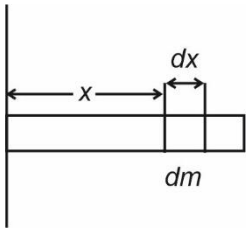
Hint and Sol.:

- Moment of inertia of a body about an axis depends on the mass distribution of body about that axis.
- Moment of inertia of a body is rotational analogue of inertia of body

18. Answer (2)

Hint: $I = \int dmx^2$

Sol.:



$dm = kxdx$

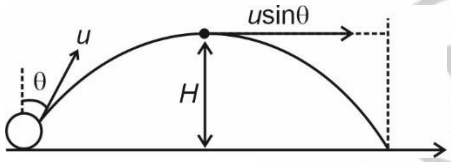
$$I = \int_0^L dmx^2 = \int_0^L kx^3 dx$$

$$= k\left[\frac{x^4}{4}\right]_0^L = \frac{kL^4}{4}$$

19. Answer (1)

Hint: $\vec{L} = \vec{r} \times \vec{p}$

Sol.:



$$|\vec{L}| = r_\perp p$$

$$L = mu\sin\theta \times \frac{u^2\cos^2\theta}{2g}$$

$$= \frac{mu^3 \sin\theta \cdot \cos^2\theta}{2g}$$

20. Answer (3)

Hint: $\omega = \frac{(V_\perp)_{\text{Relative}}}{R}$

Sol.: $\omega = \frac{v_A - (-v_B)}{L}$

$$= \frac{2v + v}{L}$$

$$= \frac{3v}{L}$$

21. Answer (3)

Hint: $\vec{v}_{com} = \frac{m_1\vec{v}_1 + m_2\vec{v}_2 + m_3\vec{v}_3}{m_1 + m_2 + m_3}$

Sol.: $\vec{v}_{com} = \frac{m\vec{v}_1 + m\vec{v}_2 + m\vec{v}_3}{m + m + m}$

$= \frac{\vec{v}_1 + \vec{v}_2 + \vec{v}_3}{3} = 0$ (using triangle law of vector addition)

22. Answer (1)

Hint: $Y_{COM} = \frac{m_1 y_1 + m_2 y_2}{m_1 + m_2}$

Sol.: $y_{COM} = \frac{m\left(\frac{2R}{\pi}\right) - m_1\left(\frac{4R}{3\pi}\right)}{m + m_1} = 0$

$$\Rightarrow \quad m_1 = \frac{m\left(\frac{2}{\pi}\right)}{\left(\frac{4}{3}\pi\right)} \Rightarrow m_1 = \frac{3m}{2}$$

23. Answer (2)

Hint: Conservation of angular momentum

Sol.: $I_1\omega_1 = I_2\omega_2$

$mR^2 \cdot \omega = \{mR^2 + (mR^2 + mR^2)\}\omega'$

$= 3mR^2\omega$

$\Rightarrow \quad \omega' = \omega/3$

24. Answer (4)

Hint: $\tau = I\alpha$

Sol.:

$$\Rightarrow \quad mg\frac{L}{2} + 2mgL = \left(\frac{mL^2}{3} + (2m)L^2\right)\alpha$$

$$\Rightarrow \quad \frac{5mgL}{2} = \left(\frac{7mL^2}{3}\right)\alpha$$

$$\Rightarrow \quad \alpha = \frac{15}{14}\frac{g}{L}$$

25. Answer (2)

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

Sol.: $V = -(2x + y + 3z)$

$\vec{I}_g = 2\hat{i} + \hat{j} + 3\hat{k}$

26. Answer (3)

Hint and Sol.: $v = \sqrt{2gh}$

$v \propto \sqrt{h}$ and $V \propto \rho^0$

27. Answer (4)

Hint: $\Delta P = \rho gh$

Sol.: For same volume, level of liquid is maximum for *D*.

28. Answer (2)

Hint : Modulus of elasticity = Slope of stress-strain curve.

Sol. : $\frac{y_A}{y_B} = \frac{\tan 60^\circ}{\tan 30^\circ} = 3$

29. Answer (1)

Hint: Energy density = $\frac{1}{2} Y \times (\text{strain})^2$

Sol.: Energy density $= \frac{1}{2} \times 2 \times 10^{10} \times \left(\frac{0.1}{100}\right)^2$

$= 10^4$ J/m^3

30. Answer (2)

Hint: Time period of geostationary satellite is 24 hours.

Sol.: $\left(\frac{T}{6}\right)^{3/2} = \left(\frac{24}{6}\right)^{3/2}$

$= (4)^{3/2} = 8$

31. Answer (3)

Hint: $1 + r + r^2 + ... = \frac{1}{1-r}$ (if $r < 1$)

$|I_g| = \frac{Gm}{r^2}$

Sol.: $I_g = \frac{Gm}{r^2} + \frac{G(m/2)}{(2r)^2} + \frac{G(m/4)}{(4r)^2} + ...$

$I_g = \frac{Gm}{r^2}\left(1 + \frac{1}{8} + \frac{1}{8^2} + ...\infty\right)$

$= \frac{Gm}{r^2}\left(\frac{1}{1-\frac{1}{8}}\right) = \frac{8Gm}{7r^2}$

32. Answer (3)

Hint: $f_e = \frac{q_1 q_2}{4\pi\varepsilon_0 r^2}$ and $f_G = \frac{Gm_1 m_2}{r^2}$

Sol.: At equilibrium

$f_e = f_G \Rightarrow \frac{q_1 q_2}{4\pi\varepsilon_0 r^2} = \frac{Gm_1 m_2}{r^2}$

$\Rightarrow \quad \frac{n^2 e^2}{4\pi\varepsilon_0 r^2} = \frac{Gm^2}{r^2}$

$n = \sqrt{\frac{4\pi\varepsilon_0 Gm^2}{e^2}}$

33. Answer (3)

Hint: Apply conservation of angular momentum.

Sol.: $I\omega$ = constant

$\rho \times \frac{4}{3}\pi R^3 = (8\rho) \times \frac{4}{3}\pi R'^3$

$\Rightarrow \quad \frac{R}{2} = R'$

$I_1\omega_1 = I_2\omega_2$

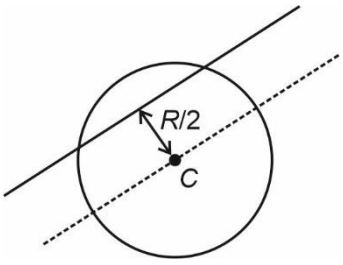
$\frac{2}{5}mR^2\left(\frac{2\pi}{24}\right) = \frac{2}{5}m\left(\frac{R}{2}\right)^2 \times \frac{2\pi}{T}$

$T = \frac{24}{4} = 6$ h

34. Answer (2)

Hint: $I = mk^2$

Sol.: Using parallel axis theorem



$I = I_C + m\left(\frac{R}{2}\right)^2$

$= \frac{2}{5}mR^2 + \frac{mR^2}{4}$

$mk^2 = \frac{13mR^2}{20}$

$\Rightarrow \quad k = \sqrt{\frac{13}{20}}R$

35. Answer (4)

Hint: $\hat{u} = \dfrac{\vec{A}\times\vec{B}}{|\vec{A}\times\vec{B}|}$

Sol.: $\vec{A}\times\vec{B} = \begin{vmatrix} \hat{i} & \hat{j} & \hat{k} \\ 1 & 1 & 2 \\ 1 & -2 & 0 \end{vmatrix}$

$= \hat{i}(1\times 0-(-2)\times 2)-\hat{j}(1\times 0-1\times 2)$

$+\hat{k}(1\times(-2)-(1)\times(1))$

$= 4\hat{i}+2\hat{j}-3\hat{k}$

$\hat{u} = \dfrac{4\hat{i}+2\hat{j}-3\hat{k}}{\sqrt{4^2+2^2+3^2}} = \dfrac{4\hat{i}+2\hat{j}-3\hat{k}}{\sqrt{29}}$

SECTION-B

36. Answer (1)

Hint: Moment of inertia about an axis passing from COM is minimum.

Sol.: $I = 3x^2 - 12x + 7$

$\dfrac{dI}{dx} = 6x - 12 = 0$

$x = 2$

37. Answer (2)

Hint: Apply angular impulse and angular momentum equation about point of contact.

Sol.: $Jr = L_f$

$\Rightarrow \quad Jr = mv'r + I\omega$

$Jr = mv'r + (mr^2)\dfrac{v'}{r}$

$v' = \dfrac{J}{2m}$

38. Answer (2)

Hint: $V = \omega R$

Sol.: $V_A = 2\omega R$

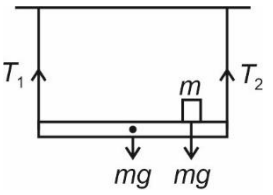
$V_B = \sqrt{2}\,\omega R$

$\therefore \quad \dfrac{V_A}{V_B} = \sqrt{2}$

39. Answer (3)

Hint: At equilibrium $f_{net} = 0$ and $\tau_{net} = 0$

Sol.:



$\tau_{net} = 0$

$\Rightarrow \quad T_1\left(\dfrac{L}{2}\right) + mg\,(0) + mg\left(\dfrac{L}{3}\right) - T_2\left(\dfrac{L}{2}\right) = 0$

$\Rightarrow \quad T_2 - T_1 = \dfrac{2mg}{3} \qquad \ldots(i)$

$T_1 + T_2 = 2mg \qquad \ldots(ii)$

$T_2 = \dfrac{4mg}{3} \qquad T_1 = \dfrac{2mg}{3}$

$\Rightarrow \quad \dfrac{T_1}{T_2} = \dfrac{\frac{2mg}{3}}{\frac{4\,mg}{3}} = \dfrac{1}{2}$

40. Answer (3)

Hint and Sol.: $\dfrac{\text{Rotational KE}}{\text{TotaL KE}} = \dfrac{\frac{1}{2}I\omega^2}{\frac{1}{2}mv^2+\frac{1}{2}I\omega^2}$

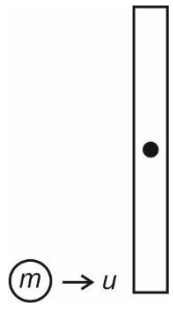
$= \dfrac{\frac{1}{2}\times\frac{2}{3}mR^2\times\frac{v^2}{R^2}}{\frac{1}{2}mv^2+\frac{1}{2}\times\frac{2}{3}mR^2\times\frac{v^2}{R^2}}$

$= \dfrac{2}{5}$

41. Answer (4)

Hint: Conservation of angular momentum.

Sol.: $L_i = L_f$



$mu\dfrac{L}{2} = I\omega$

$$\frac{muL}{2}=\left(\frac{mL^2}{12}+m\left(\frac{L}{2}\right)^2\right)\omega$$

$$\Rightarrow \quad \frac{muL}{2}=\frac{mL^2}{3}\omega$$

$$\Rightarrow \quad \omega=\frac{3u}{2L}$$

42. Answer (4)

Hint: $\alpha=\frac{a}{R}$

Sol.: $\frac{a_1}{4}=\frac{a_2}{1}$

$$\Rightarrow \quad a_2=\frac{5}{4}\text{ m/s}^2$$

43. Answer (1)

Hint: $g' = g - \omega^2 R\cos^2\lambda$

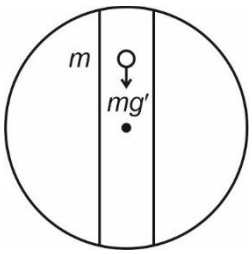
Sol.: $\frac{g}{2}=g-\omega^2R$

$$\Rightarrow \quad \omega^2R=\frac{g}{2}$$

$$\Rightarrow \quad \omega=\sqrt{\frac{g}{2R}}$$

44. Answer (1)

Hint and Sol.: $f_{\text{net}}=-mg'=-\frac{GMmx}{R^3}=ma$



$a = -\omega^2 x$

$$-\frac{GMmx}{R^3}=m(-\omega^2x)$$

$$\Rightarrow \quad T=2\pi\sqrt{\frac{R}{g}}$$

45. Answer (2)

Hint : Use parallel axes theorem

Sol.: $I=2(I_c+md^2)=2\left[\frac{MR^2}{4}+MR^2\right]$

$$=2\times\frac{5}{4}mR^2=\frac{10}{4}mR^2$$

46. Answer (3)

Hint and Sol.: $E_i=-E_0=-\frac{GMm}{2r}$

$$E_f=-\frac{GMm}{2(3r)}=-\frac{GMm}{6r}$$

$$W=E_f-E_i=-\frac{GMm}{6r}-\left(-\frac{GMm}{2r}\right)$$

$$=\frac{GMm}{3r}=\frac{2}{3}E_0$$

$$x=\frac{2}{3}$$

47. Answer (2)

Hint: $K=\frac{YA}{L}$ and for parallel combination

$K = K_1 + K_2$

Sol.: $K = K_1 + K_2$

$$\frac{2Y'A}{L}=\frac{YA}{L}+\frac{2YA}{L}$$

$$Y'=\frac{Y+2Y}{2}=\frac{3Y}{2}$$

48. Answer (3)

Hint: Equation of continuity and Bernoulli's theorem.

Sol.: $v=\sqrt{2gh}$

$Av_1 = av$

$$v_1=\frac{a}{A}\sqrt{2g}\sqrt{h}\Rightarrow -\frac{dh}{dt}=\frac{a}{A}\sqrt{2g}\sqrt{h}$$

$$\Rightarrow \quad -\int_h^0\frac{dh}{\sqrt{h}}=\frac{a}{A}\sqrt{2g}\int_0^t dt$$

$$[2\sqrt{h}]_0^h=\frac{a}{A}\sqrt{2g}[t]_0^t$$

$$2\left(\sqrt{h}\right)=\frac{a}{A}\sqrt{2g}\ t$$

$$\Rightarrow \quad t = \frac{\sqrt{2}A}{a\sqrt{g}}\left(\sqrt{h}\right) = \frac{A}{a}\sqrt{\frac{2H}{g}}$$

49. Answer (2)

Hint: $r = \frac{r_1 r_2}{r_1 - r_2}$

Sol.: $r = \frac{3r \times r}{3r - r} = \frac{3r}{2}$

50. Answer (4)

Hint: $\tan\theta = \frac{a}{g}$

Sol.: $\tan\theta = \frac{2g}{3g} = \frac{2}{3} = \frac{h}{L}$

$$\Rightarrow \quad h = \frac{2L}{3}$$

[CHEMISTRY]

SECTION-A

51. Answer (3)

Hint and Sol.: If $K_c > 10^3$, products predominate over reactants. If K_c is very large, the reaction proceeds nearly to completion.

52. Answer (2)

Hint: $K_p = K_C(RT)^{\Delta n_g}$

Sol.: If $\Delta n_g = 0$, Then, $K_p = K_c$

$$2HI(g) \rightleftharpoons H_2(g) + I_2(g)$$

$\because \Delta n_g = 2 - 2 = 0 \ \therefore K_p = K_C$

53. Answer (3)

Hint: Equilibrium constant for the reverse reaction is the inverse of the equilibrium constant for the reaction in the forward direction.

Sol.: $SO_2(g) + \frac{1}{2}O_2(g) \rightleftharpoons SO_3(g) \rightarrow K$

$$2SO_3(g) \rightleftharpoons 2SO_2(g) + O_2(g) \rightarrow \left(\frac{1}{K}\right)^2$$

54. Answer (3)

Hint & Sol.: Mercury cell consists of zinc-mercury amalgam as anode and a paste of HgO and carbon as the cathode. Electrolyte used is paste of KOH and ZnO.

55. Answer (4)

Hint: $BaF_2(s) \rightleftharpoons \underset{s}{Ba^{2+}}(aq) + \underset{2s}{2F^-}(aq)$

$K_{sp} = (s)\,(2s)^2$

$K_{sp} = 4s^3$

Sol.: $s = \left(\frac{K_{sp}}{4}\right)^{1/3}$

$$s = \left(\frac{10^{-6}}{4}\right)^{1/3} = \frac{10^{-2}}{(4)^{1/3}}\,M$$

56. Answer (2)

Hint: $\Delta H° = \Delta U° + \Delta n_g RT$

Sol.: $CH_4(g) + 2O_2(g) \rightarrow CO_2(g) + 2H_2O(\ell)$

$\Delta n_g = 1 - 3 = -2$

$\Delta H° = \Delta U° + \Delta n_g RT$

$\Delta U° = \Delta H° - \Delta n_g RT$

$\Delta U° = -X + 2 \times R \times 298$

57. Answer (4)

Hint: As standard reduction potential increases reducing power of the elements decreases.

Sol.:

Metals	E°(V)	Order of reducing power
A	– 0.76	C > A > B
B	+ 0.52	
C	– 1.66	

58. Answer (3)

Hint:

$$Zn \longrightarrow Zn^{2+} + 2e^-;\ E°_{Zn^{2+}/Zn} = -0.76V$$

$$Cu^{2+} + 2e^- \longrightarrow Cu\ ;\ E°_{Cu^{2+}/Cu} = 0.34\ V$$

Sol.: $E°_{cell} = E°_R - E°_L$

$= (0.34) - (-0.76)$

$= 1.1\ V$

59. Answer (3)

Hint: The mixture of weak acid and salt of its conjugate base considered as an acidic buffer.

Sol.:

$$\underset{(100\times0.1)\text{meq}}{CH_3COOH} + \underset{(5\times0.1)\text{meq}}{NaOH} \rightarrow CH_3COONa + H_2O$$

10 meq 5 meq

5 meq —

5 meq

$CH_3COOH + CH_3COONa \rightarrow$ Acidic Buffer

60. Answer (1)

Hint: For conjugate acid-base pair

$K_w = K_a \times K_b$

Sol.: $-\log K_w = -\log (K_aK_b)$

$pK_w = pK_a + pK_b$

$pK_a = pK_w - pK_b$

$= 14 - 4.19$

$= 9.81$

61. Answer (2)

Hint: The thermal efficiency (η) of a fuel conversion device is the amount of useful energy produced relative to the change in enthalpy.

Sol.: $\eta = \dfrac{\text{Useful energy}}{\Delta H}$

$\eta = \dfrac{\Delta G}{\Delta H}$

62. Answer (3)

Hint: Acidic Buffer: Mixture of weak acid and its salt formed with a strong base.

Sol.: $pH = pK_a + \log \dfrac{[\text{salt}]}{[\text{acid}]}$

$pK_a = pH - \log \dfrac{[\text{salt}]}{[\text{acid}]}$

$= 3.76 - \log \dfrac{(0.01)}{(0.1)} = 3.76 + 1 = 4.76$

63. Answer (2)

Hint: For pure H_2O, $[H^+] = [OH^-]$

Sol.: $K_w = [H^+]\,[OH^-]$

$K_w = [H^+]^2$

$10^{-12} = [H^+]^2$

$[H^+] = 10^{-6}$ M

$pH = -\log [H^+] = 6$

64. Answer (3)

Hint: On dilution, the ionic interaction decreases.

Sol.: As the ionic interaction decreases on dilution, the mobility of ions increases. Hence, molar conductance of a strong electrolyte also increases.

65. Answer (2)

Hint: $\alpha = \dfrac{\Lambda_m}{\overset{\circ}{\Lambda}_m}$

Sol.: $\overset{\circ}{\Lambda}_m(CH_3COOH) = \overset{\circ}{\lambda}_m(CH_3COO^-) + \overset{\circ}{\lambda}_m(H^+)$

$= 40.9 + 349.1$

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

$\alpha = \dfrac{\Lambda_m}{\overset{\circ}{\Lambda}_m} = \dfrac{16.48}{390}$

$\alpha \approx 0.04$

66. Answer (2)

Hint and Sol.: Equilibrium constant is temperature dependent only.

67. Answer (3)

Hint: The equilibrium constant for an endothermic reaction increases as the temperature increases.

Sol.: $A(g) + 2B(g) \rightleftharpoons 3C(g) + D(g)$

$\Delta_r H = +10\,kJ$

$\Delta n_g = 4 - 3 = -1.$

- If Δn_g is negative then low pressure favours the reaction to proceed towards forward direction.
- For an endothermic reaction as temperature increases, reaction moves in forward direction.

68. Answer (2)

Hint: $\dfrac{w}{E} = \dfrac{Q}{F}$

Sol.: $\dfrac{20\times2}{40} = \dfrac{1.93\times t}{96500}$

$t = 5 \times 10^4$ s

69. Answer (4)

Hint: The elements having positive value of the standard reduction potential undergo reduction more easily than H^+ ion.

Sol.: $Cu^{2+} + 2e^- \longrightarrow Cu(s) \quad E^\circ = 0.34\,V$

$2H^+ + 2e^- \longrightarrow H_2(g) \quad E^\circ = 0.00V$

Hence, Cu^{2+} gets reduced more easily than H^+ ions. So, we can say that $H_2(g)$ will not be liberated when dilute H_2SO_4 is treated with Cu.

70. Answer (3)

Hint: In acidic medium

$6e^- + \overset{+6}{Cr_2}O_7^{2-} \longrightarrow 2Cr^{3+}$

Sol.: $Cr_2O_7^{2-} + H_2S \longrightarrow S + 2Cr^{3+}$

Equivalent of $Cr_2O_7^{2-}$ = Equivalent of H_2S

$(n \times nf)_{Cr_2O_7^{2-}} = (n \times nf)_{H_2S}$

$n \times 6 = 1 \times 2$

$n = \frac{2}{6}$

$\boxed{n = \frac{1}{3}}$

71. Answer (3)

Hint: If oxidation number of an element is intermediate, it can act as oxidising as well as reducing agent.

Sol.: In SO_2, oxidation state of sulphur is +4 while sulphur can show minimum –2 and maximum +6 oxidation state.

72. Answer (4)

Hint: All decomposition reactions are not redox reactions.

Sol.: $2\overset{+5-2}{KClO_3}(s) \xrightarrow{\Delta} 2\overset{+1\ -1}{KCl}(s) + 3\overset{0}{O_2}(g)$

It is a redox reaction,

$\overset{+2\ +4\ -2}{CaCO_3}(s) \xrightarrow{\Delta} \overset{+2-2}{CaO}(s) + \overset{+4-2}{CO_2}(g)$

It is not a redox reaction.

73. Answer (3)

Hint and Sol.:

$PH_3 \Rightarrow x + 3 = 0$

$x = -3.$

$H_3PO_3 \Rightarrow 3 + x + 3(-2) = 0$

$x = 6 - 3$

$x = 3$

$H_4P_2O_7 \Rightarrow 4 + 2x + 7(-2) = 0$

$2x = 10$

$x = 5$

$H_4P_2O_6 \Rightarrow 4 + 2x + 6(-2) = 0$

$2x = 8$

$x = 4$

74. Answer (3)

Hint: In a disproportionation reaction, an element in one oxidation state is simultaneously oxidised and reduced.

Sol.: $2\overset{+1\ -1}{H_2O_2}(aq) \rightarrow 2\overset{+1-2}{H_2O}(\ell) + \overset{0}{O_2}(g)$

$P_4^0(s) + 3OH^-(aq) + 3H_2O(\ell) \rightarrow$

$\overset{-3}{PH_3}(g) + 3H_2\overset{+1}{PO_2^-}$

$\overset{0}{Cl_2}(g) + 2OH^-(aq) \rightarrow \overset{+1}{ClO^-}(aq) + \overset{-1}{Cl^-}(aq) + H_2O(\ell)$

In the below given reaction, fluorine does not show a disproportionation reaction.

$\overset{0}{2F_2}(g) + 2OH^-(aq) \rightarrow \overset{-1}{2F^-}(aq) + \overset{+2-1}{OF_2}(g) + H_2O(\ell)$

75. Answer (2)

Hint: The products of electrolysis depend on the different oxidising and reducing species present in the electrolytic cell and their standard electrode potential.

Sol.: The reaction with higher value of E° is preferred.

$2H_2O + 2e^- \rightarrow H_2 + 2OH^-$ [cathode]

76. Answer (2)

Hint: $\Delta_r G^\circ = -nFE^\circ_{cell}$

Sol.: $E^\circ_{cell} = xV$

$2Fe^{3+}(aq) + 2I^-(aq) \rightarrow 2Fe^{2+}(aq) + I_2(s)$

$n = 2 \times 1 = 2$

$\Delta_rG^\circ = -2xF$

77. Answer (4)

Hint: Bronsted acid is a species that is capable of donating a hydrogen ion (H^+) and base are species that accept H^+.

Sol.:

$H_2SO_4 \rightleftharpoons HSO_4^- + H^+$
Acid — Conjugate base

$H_3PO_4 \rightleftharpoons H_2PO_4^- + H^+$
Acid — Conjugate base

78. Answer (3)

Hint: $K_p = (atm)^{\Delta n_g}$

Sol.: $\Delta n_g = 1 - 4 = -3$

$K_p = (atm)^{-3}$

79. Answer (3)

Hint: The equilibrium constant helps in predicting the direction in which a given reaction will proceed at any stage. For this purpose, we calculate the reaction quotient (Q).

Sol.: If $Q > K_c \rightarrow$ Reaction will proceed reverse.

If $Q < K_c \rightarrow$ Reaction will proceed forward.

If $Q = K_c \rightarrow$ Reaction is already at equilibrium.

80. Answer (3)

Hint: Δ_rH° = (Sum of enthalpies of product) – (Sum of enthalpies of reactants)

Sol.: $ZnO(s) + CO(g) \rightarrow Zn(s) + CO_2(g)$

$\Delta_rH^\circ = [\Delta_fH^\circ(Zn,s) + \Delta_fH^\circ(CO_2, g)] - [\Delta_fH^\circ(ZnO, s) + \Delta_fH^\circ(CO, g)]$

$= [0 + (-393.51)] - [(-348.28) + (-110.53)]$

$= [-393.51 + 348.28 + 110.53]$ kJ mol^{-1}

$= 65.3$ kJ mol^{-1}

81. Answer (4)

Hint: $\Delta H = \Delta U + \Delta n_gRT$

Sol.: If Δn_g = + ve, then $\Delta H > \Delta U$.

For reaction, $PCl_5(g) \rightarrow PCl_3(g) + Cl_2(g)$

$\Delta n_g = (2 - 1) = +1$

82. Answer (1)

Hint: An extensive property is a property whose value depends on the quantity of matter present in the system.

Sol.: Mass, enthalpy and heat capacity are extensive properties.

83. Answer (2)

Hint: First law of thermodynamics.

$\Delta U = q + w$

Sol.: $q = -10$ J

$w = -20$ J

$\Delta U = [-10 - 20]$ J

$\Delta U = -30$ J

84. Answer (2)

Hint: $w = -P_{ext}(\Delta V)$

$\Delta U = q + w$

Sol.: In vacuum, $P_{ext} = 0$

So, $w = 0$

At constant volume, $\Delta V = 0$

So, $w = 0$

$\Delta U = q + w$

$\Delta U = q_v$

85. Answer (3)

Hint: Change in state function depends on initial and final states of system, not the path followed

Sol.: $\Delta U = q + w$

ΔH and $(q + w)$ are state functions. But 'q' and 'w' separately are path functions.

SECTION-B

86. Answer (3)

Hint: For a heterogenous equilibrium, pure solids or liquids concentrations do not appear in the expression of the equilibrium constant.

Sol.:

$Ag_2O(s) + 2HNO_3(aq) \rightleftharpoons 2AgNO_3(aq) + H_2O(\ell)$

$K_c = \dfrac{[AgNO_3]^2}{[HNO_3]^2}$

87. Answer (1)

Hint: $\frac{w}{E}=\frac{Q}{F}$

Sol.: Moles of electrons = $\frac{Q}{F}$

$=\frac{1\times 96.5}{96500}=10^{-3}$

Number of electrons = $10^{-3}\times 6.02\times 10^{23}$

$=6.02\times 10^{20}$

88. Answer (3)

Hint: $\Delta G=\Delta G^{\circ}+RT\ln K$

Sol.: At equilibrium

$\Delta G = 0$

$\Delta G^{\circ} = -RT\ln K$

$\Delta G^{\circ} = -8.314\ Jmol^{-1}K^{-1}\times 298\ K\times \ln(3.8\times 10^{-3})$

89. Answer (4)

Hint:

$MnO_4^- \longrightarrow Mn^{2+}, n_f = 5$

$Br^- \longrightarrow Br_2,\ n_f = 1$

Sol.:

$2MnO_4^- + 10Br^- + 16H^+ \rightarrow 2Mn^{2+} + 5Br_2 + 8H_2O$

Coefficients of reactants are as follow :

MnO_4^-	Br^-	H^+
2	10	16

90. Answer (3)

Hint: Carbon suboxide = C_3O_2

Sol.:

O = C = C = C = O

–2 +2 0 +2 0

Sum of oxidation number of all 'C' atoms

= 2 + 0 + 2

91. Answer (4)

Hint: $\frac{w}{E}=\frac{Q}{F}$

Sol.: $4OH^- \longrightarrow O_2 + 4e^- + 2H_2O$.

$n_f = 4$

Number of Faraday = mole × n_f

= 2 × 4 = 8F.

92. Answer (1)

Hint: Conjugate base of weak acid undergoes salt hydrolysis in water and increases the pH of solution.

Sol.: $K_2CO_3 \longrightarrow 2K^+ + CO_3^{2-}$

(CO_3^{2-}: Conjugate base of weak acid)

$CO_3^{2-} + H_2O \rightleftharpoons HCO_3^- + OH^-$

- Due to formation of OH^-, pH of solution increases.
- Cl^-, SO_4^{2-} and ClO_4^- anions of strong acid simply get hydrated, not hydrolysed.

93. Answer (4)

Hint: pH = –log[H^+]

Sol.: KOH = 0.01M = 10^{-2}M

pOH = log (10^{-2})

pOH = 2

pK_w = pH + pOH

14 = pH +2

pH = 12

94. Answer (3)

Hint: Lewis acids are those species which accept electron pair.

Sol.: BF_3, $AlCl_3$ & Co^{3+} are Lewis acids.

95. Answer (2)

Hint: $\Delta G=\Delta H-T\Delta S$

Sol.:

ΔH	ΔS	Description
–	+	Reaction is spontaneous at all temperatures
+	–	Reaction is nonspontaneous at all temperatures
+	+	Reaction is nonspontaneous at low temperature
–	–	Reaction is nonspontaneous at high temperature

96. Answer (2)

Hint:

$$\Delta_r H^\circ = \sum_{[\text{reactants}]} \text{Bond Enthalpies} - \sum_{[\text{products}]} \text{Bond Enthalpies}$$

Sol.: $\Delta rH^o = [(\Delta_{bond}H^\circ(C=C) + 4\Delta_{bond}H^o(C-H) + \Delta_{bond}H^o(H-H))] - [(6\Delta_{bond}H^o(C-H) + \Delta_{bond}H^o(C-C))]$

$\Delta_r H^\circ = (b + 4d + a) - [c + 6d]$

$\Delta_r H^\circ = b + 4d + a - c - 6d = a + b - c - 2d$

97. Answer (1)

Hint: The standard enthalpy change for the formation of one mole of a compound from its elements in their most stable states of aggregation is called Standard Molar Enthalpy of formation $\Delta_f H^o$.

Sol.: $H_2(g) + Br_2(\ell) \rightarrow 2HBr$

Two moles of a compound is formed, so it is not consider as $\Delta_f H^\circ(HBr, g)$.

98. Answer (1)

Hint: In pressure vs volume graph, the area under the curve during expansion is work done by the gas.

Sol.:

- Maximum area under the curve is for curve A followed by B then C.
- Zero work done in curve D because volume is constant [dV = 0]

$$w = -\int_{V_i}^{V_f} pdv$$

$w = 0$

99. Answer (3)

Hint: $\lambda_m = \frac{k \times 1000}{M}$

Sol.: $k = \frac{\lambda_m \times M}{1000}$

$= \frac{110 \times 0.25}{1000}$

$= 2.75 \times 10^{-2}$ Scm^{-1}

100. Answer (4)

Hint: For any cell reaction

$E^\circ_{cell} = E^\circ_{cathode} - E^\circ_{anode}$

Sol.: In reaction

$A + 2A^{3+} \rightarrow 2A^{2+}$

Anode : $A \rightarrow A^{2+} + 2e^-$

Cathode : $A^{3+} + e^- \rightarrow A^{2+}$

$E^\circ_{cell} = y - (-x)$

$= x + y$

[BOTANY]

SECTION-A

101. Answer (2)

Hint: Periderm is a product of secondary growth.

Sol.: Secondary growth is found in dicot stem and dicot root.

Phellem (Cork cell)
Phellogen (Cork cambium)] Periderm
Phelloderm (secondary cortex)

102. Answer (4)

Hint: Annual rings are formed due to variations in external environment and tropical areas have constant hot and humid condition.

Sol.: Annual rings are more distinct in plants growing in temperate areas.

Late wood or autumn wood is dark in colour and has higher density.

103. Answer (2)

Hint: Casparian strips act as barrier or check point and control the quantity of solutes that reach the xylem.

Sol.: Casparian strips are present in endodermis.

Pericycle gives rise to lateral roots as well as form vascular cambium in dicot roots during secondary growth.

104. Answer (2)

Hint: In dicot leaves, mesophyll cells are differentiated into two layers, palisade parenchyma and spongy parenchyma.

Sol.: Bulliform cells are specialised modified, large, empty, colourless epidermal cells of isobilateral leaves of monocots which help in curling of leaves to minimise surface area and reduce transpirational loss of water.

105. Answer (3)

Hint: Casparian strips are barrier or check points formed due to deposition of suberin.

Sol.: The tangential as well as radial walls of endodermal cells have a deposition of water impermeable, waxy material suberin in the form of casparian strips in roots (both dicots and monocots) acting as barrier or check points for transport.

106. Answer (3)

Hint: In dicot roots, cambium is developed at the time of secondary growth.

Sol.: Vascular cambium ring in dicot roots is completely secondary and wavy in nature.

It has no differential activity and is made up of dedifferentiated pericycle cells above xylem and conjunctive tissue below phloem.

107. Answer (3)

Hint: Scattered vascular bundles are found in monocot stems.

Sol.: Gram, China rose and mustard are dicots which have ring-like arrangements of vascular bundles.

108. Answer (3)

Hint: Cuticle is a coating of cutin (waxy substance) to prevent transpirational loss of water.

Sol.: Cuticle is required in aerial plant parts like stem and leaf. Thus, it is absent in underground part *i.e.*, roots.

109. Answer (2)

Hint: Phellem is cork and phelloderm is secondary cortex.

Sol.: Secondary xylem is produced inner to the vascular cambium ring *i.e.*, towards pith, and bark includes cells outside vascular cambium ring, like phellem, phelloderm, phloem *etc*.

110. Answer (3)

Hint: Stems have conjoint, collateral vascular bundles with endarch xylem.

Sol.: Vascular cambium is present in dicot stems

In monocot stems, cambium is absent *i.e.*, closed vascular bundles are present.

Hypodermis in dicot stems is collenchymatous whereas in monocot stems hypodermis is sclerenchymatous.

111. Answer (1)

Hint: De-differentiated tissues are secondary meristems.

Sol.: Apical meristem is a primary meristem that appears early in the life of plants.

112. Answer (1)

Hint: Late wood or autumn wood is dark in colour and has a higher density.

Sol.: Heartwood is modified secondary xylem, present towards pith. It is dark in colour due to depositions.

113. Answer (4)

Hint: Roots have radial vascular bundles.

Sol.: Conjoint, collateral, closed vascular bundles are found in monocot stem where xylem and phloem are present on same radius and cambium is not present.

114. Answer (4)

Hint: Lateral roots are endogenous in origin.

Sol.: In dicots, lateral roots arise from the pericycle.

115. Answer (2)

Hint: Pollen is reduced male gametophyte.

Sol.: *Sequoia*, also known as giant red wood tree is one of the tallest gymnosperms.

116. Answer (4)

Hint: Phaeophyceae have motile asexual spores, pear shaped (pyriform) zoospores with two unequal laterally inserted flagella.

Sol.: Pyrenoids are storage structures in Chlorophyceae having proteinaceous centre with starchy sheath.

117. Answer (1)

Hint: Brown algae vary in colour from olive green to various shades of brown.

Sol.: Various shades of brown in phaeophyceae depend upon the amount of the xanthophyll pigment, fucoxanthin.

118. Answer (3)

Hint: Phloem parenchyma is seen in dicotyledonous plants.

Sol.: Phloem parenchyma is absent in most of the monocotyledons.

The cell wall of phloem parenchyma is composed of cellulose and has pits through which plasmodesmatal connections exist between the cells.

The phloem parenchyma stores food material and other substances like resins, latex and mucilage.

119. Answer (1)

Hint: Floridean starch is the reserve food material of red algae and it is structurally similar to amylopectin and glycogen.

Sol.: Mosses are more elaborate than liverworts.

Bryophytes are economically less important but ecologically more important.

120. Answer (4)

Hint: Main plant body in *Sphagnum* (a moss) is haploid *i.e.*, gametophyte.

Sol.: Gametophyte, protonema and rhizoids are haploid structures. Capsule is a part of sporophyte and hence, diploid structure.

121. Answer (3)

Hint: Gemmae are asexual, multicellular, nonvascular, green, haploid buds present on upper surface of gametophytic thallus.

Sol.: Gemmae are asexual buds of liverworts, found in *Marchantia*.

122. Answer (3)

Hint: Bryophytes are first terrestrial plants but dependent on water for their fertilisation thus, known as “amphibians of plant kingdom”.

Sol.: The pteridophytes are found in cool, damp, shady places. They also require water for fertilisation thus, are known as vascular amphibians.

123. Answer (1)

Hint: *Chlorella* is a unicellular green alga used as food for space travellers as it is source of single cell protein (SCP).

Sol.:
- Rhodophyceae exhibits complex post-fertilisation development.
- Agar is used in preparation of ice-creams.
- *Ectocarpus* has filamentous body.

124. Answer (2)

Hint: Floridean starch is reserve food material of Rhodophyceae.

Sol.:
- Chlorophyll ‘a’ and pyrenoids are associated with green algae.
- Agar is found in red algae.
- Two unequal lateral flagella are found in brown algae.

125. Answer (1)

Hint: Elongated portions of pith between two adjacent vascular bundles in dicot stem are pith rays or medullary rays.

Sol.: Cells of medullary rays de-differentiate at the time of secondary growth and form interfascicular cambium which joins with already existing intravascular cambium (primary meristem) to form vascular cambium ring and help in secondary growth.

126. Answer (2)

Hint: Collenchyma is absent in monocots.

Sol.: Cells of collenchyma are closely packed with no intercellular spaces and they are living cells.

127. Answer (1)

Hint: Parenchyma forms the major component within organs.

Sol.: The cells of parenchyma are generally isodiametric. Their walls are thin and made up of cellulose. They may either be closely packed or have small intercellular spaces.

They perform functions like photosynthesis, storage, secretion *etc*.

128. Answer (3)

Hint: Meristems that occur in the mature regions of roots and shoots of many plant produce woody axis and help in secondary growth.

Sol.: Lateral meristems help in lateral growth that occurs later in the life of the plant *i.e.*, secondary growth.

129. Answer (1)

Hint: Primary meristems are group of actively dividing cells that appear early in life of plants and contribute to the formation of the primary plant body *e.g.*, apical meristem, intercalary meristem *etc*.

Sol.: Secondary meristems appear later in life of plants and contribute to the lateral or secondary growth *e.g.,* cork cambium *etc*. Primary meristem such as intrafascicular cambium also contributes in secondary growth.

130. Answer (3)

Hint: *Volvox* and *Eudorina* are colonial algae.

Sol.: *Ulothrix* and *Spirogyra* are filamentous algae.

131. Answer (1)

Hint: Cytotaxonomy is based on cytological information.

Sol.: Chemotaxonomy uses the chemical constituents and DNA sequence of chromosomes.

132. Answer (3)

Hint: DNA sequences, amino acid sequences, aromatic compounds *etc*. are chemical constituents of the plant.

Sol.: Chemotaxonomy is based on chemical constituents of plants.

- Cytotaxonomy/karyotaxonomy is based on cytological information.
- Numerical taxonomy is based on all observable characters and are carried out using computers.

133. Answer (4)

Hint: Natural system was based on external features (morphology) as well as internal features.

Sol.: Internal features on which natural system was based are ultrastructure, anatomy, embryology and phytochemistry.

134. Answer (3)

Hint: Natural affinities include not only external features but also internal features.

Sol.: Natural system of classification was based on natural affinities among the organisms. It was given by Bentham and Hooker for flowering plants.

135. Answer (2)

Hint: Vegetative characters are habit, colour, number, shape of leaves *etc*.

Sol.: Artificial system of classification was based mainly on vegetative characters or on androecium structure (system given by Linnaeus).

SECTION-B

136. Answer (3)

Hint: Stomata regulate the process of transpiration and gaseous exchange.

Sol.: A few epidermal cells, in the vicinity of the guard cells become specialised in their shape and size and are known as subsidiary cells.

Each stoma is composed of two bean-shaped cells known as guard cells which enclose stomatal pore.

137. Answer (4)

Hint: Sclereids are dead sclerenchymatous cells.

Sol.: Liquid endosperm of coconut represents free nuclear condition or multinucleate condition.

138. Answer (3)

Hint: Primary meristem appears early in life of plants and responsible for primary growth of plants.

Sol.:
- Cork is redifferentiated or secondary permanent tissue.
- Phellogen or cork cambium is de-differentiated or secondary meristematic tissue.
- Vascular cambium is a secondary meristem.

139. Answer (3)

Hint: Exarch xylem is a feature of roots.

Sol.: Water-containing cavities are present in vascular bundles of monocot stems.

Ring-like arrangement of vascular bundles is present in dicot stem.

140. Answer (3)

Hint: Phaeophyceae are found primarily in marine habitat and they show great variation in size and form.

Sol.: *Wolffia* is the smallest angiosperm.

141. Answer (1)

Hint: Bryophytes are called amphibians of the plant kingdom but they lack a vascular system.

Sol.: The main plant body of the bryophytes is haploid. It produces gametes, hence called a gametophyte.

142. Answer (1)

Hint: The roots of *Pinus* are in fungal association forming mycorrhiza.

Sol.: The roots of *Cycas* have symbiotic association with nitrogen - fixing blue-green algae *i.e.*, *Anabaena*.

143. Answer (4)

Hint: Lateral meristems are secondary meristems which are involved in lateral growth.

Sol.: Fascicular vascular cambium, interfascicular cambium and cork cambium, all are secondary or lateral meristems, which appear later in life of plants and are responsible for cylindrical growth, thus, also known as cylindrical meristem.

144. Answer (1)

Hint: Thallophytes are plants which are not well differentiated into true roots, stems and leaves *e.g.,* Algae.

Sol.:
- Spermatophytes are seed-producing plants like angiosperms.
- Gymnosperms are seed-producing archegoniates.
- Bryophytes are first embryophytes.

145. Answer (2)

Hint: *Pteris*, *Dryopteris* and *Adiantum* belong to Pteropsida.

Sol.: *Selaginella* and *Lycopodium* belong to Lycopsida.

146. Answer (4)

Hint: Many species of *Porphyra*, *Laminaria* and *Sargassum* are among 70 species of marine algae used as food.

Sol.: *Volvox* is colonial fresh water green algae.

147. Answer (1)

Hint: Fusion between one large, non-motile (static) female gamete and a smaller, motile male gamete is oogamous reproduction.

Sol.: *Ulothrix* and *Spirogyra* show isogamous reproduction.

Eudorina shows anisogamous reproduction.

Fucus shows oogamous reproduction.

148. Answer (2)

Hint: *Eudorina* and *Volvox* have dissimilar gametes (anisogametes).

Sol.: *Ulothrix* has isogametes which are flagellated.

Non-flagellated (non-motile) isogametes or homogametes are present in *Spirogyra*.

149. Answer (1)

Hint: Zoospores are motile asexual spores.

Sol.: Most common asexual spores of algae are motile zoospores.
- Conidia and sporangiospores are asexual spores of fungi.
- Aplanospores are non-motile asexual spores.

150. Answer (3)

Hint: Numerical taxonomy is carried out using computers based on all observable characters.

Sol.: Hundreds of characters are considered at the same time. Number and codes are assigned to all the characters.

Each character is of equal importance.

[ZOOLOGY]

SECTION-A

151. Answer (1)

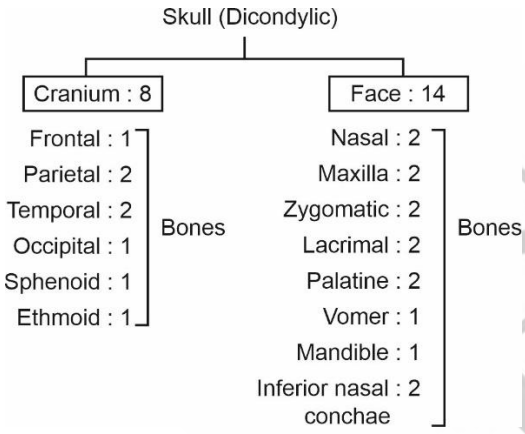
Hint: Vital for the control of rapid muscular activities

Sol.: Three major regions make up the brain stem; mid brain, pons and medulla oblongata. Brain stem forms the connections between the brain and spinal cord. Cerebrum and hypothalamus are parts of the forebrain.

152. Answer (4)

Hint: Largest and strongest facial bone

Sol.:



153. Answer (4)

Hint: Formation of concentrated urine

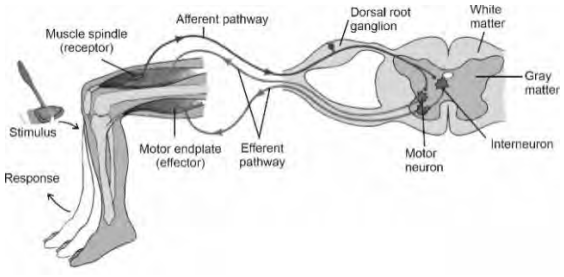
Sol.: Tea, coffee and alcohol are natural diuretics. Diuretics are medications or compounds designed to increase the amount of water expelled from the body as urine.

- Renin is component of RAAS that leads to reabsorption of NaCl and water.
- ANF checks RAAS.

154. Answer (2)

Hint: Motor end plate is an effector organ

Sol.:



Knee jerk reflex is a monosynaptic reflex that lacks interneuron.

155. Answer (4)

Hint: Lymphs induce ripple in this membrane

Sol.:

- The organ of Corti is a structure located on the basilar membrane which contains hair cells that act as auditory receptors.
- The tympanic membrane is also called the ear drum or tympanum.

156. Answer (2)

Hint: Photosensitive compound is made up of opsin and retinal

Sol.: The purplish red protein, rhodopsin, contained in the rods type of photoreceptor cells of the human eye contains a derivative of vitamin A.

- Photoreceptors in the human eye are depolarised during darkness and become hyperpolarized in response to the light stimulus.
- The neurons of the olfactory epithelium extend from the outside environment directly into a pair of broad bean-sized organs, called olfactory bulb, which are extensions of the brain's limbic system.

157. Answer (4)

Hint: White of the eye

Sol.: The wall of the eyeball is composed of three layers. The external layer is composed of a dense connective tissue and is called sclera (A). It is milky white in colour except in the front.

- The middle layer, choroid (D), contains many blood vessels and looks bluish in colour. The choroid layer is thin over the posterior two-thirds of the eyeball, but it becomes thick in the anterior part to form ciliary body.
- Photoreceptor cells are not present in the blind spot (C). The fovea (B) is a thinned-out portion of the retina where only the cones are densely packed.

158. Answer (2)

Hint: Rapid spasms is seen in this disorder

Sol.:
- **Myasthenia gravis** – Auto-immune disorder affecting neuromuscular junction leading to fatigue, weakening and paralysis of skeletal muscle.
- **Muscular dystrophy** – Progressive degeneration of skeletal muscle mostly due to genetic disorder.
- **Gout** – Inflammation of joints due to accumulation of uric acid crystals.

159. Answer (2)

Hint: It passes through the centre of H-zone

Sol.: The H-zone in the skeletal muscle fibre is due to the central gap between actin filaments extending through myosin filaments in the A-band.

- 'M' line is a thin fibrous membrane.
- Sarcomere is the functional unit of contraction, that has a central 'A' band made of thick myosin filaments, and two half 'I' bands made of thin actin filaments on either side of 'Z' lines.

160. Answer (1)

Hint: Caused by the hyposecretion of insulin

Sol.: Presence of glucose (glycosuria) and ketone bodies (ketonuria) in urine are indicative of diabetes mellitus.

- In glomerulonephritis, there is inflammation of glomeruli.
- In renal calculi, stone or insoluble mass of crystallised salts (oxalates, *etc*.) are formed within the kidney.

161. Answer (1)

Hint: Humans are ureotelic

Sol.: Ammonia produced by metabolism is converted into urea in the liver of ureotelic animals and released into the blood which is filtered and excreted out by the kidneys.

- Our lungs remove large amounts of CO_2 (approximately 200 mL/minute) and also significant quantities of water everyday.
- Sweat produced by the sweat glands is a watery fluid constituting NaCl, small amounts of urea, lactic acids, *etc*., though, the primary function of sweat is to facilitate a cooling effect on the body surface.

162. Answer (4)

Hint: Function performed by a part of hindbrain

Sol.: Hypothalamus lies at the base of the thalamus. It contains a number of centres which control body temperature, urge for eating and drinking. It also contains several groups of neurosecretory cells, which secrete hormones called hypothalamic hormones.

The medulla oblongata contains centres which control respiration, cardiovascular reflexes and gastric secretions.

163. Answer (2)

Hint: Middle cavity of cochlea.

Sol.: The membranous labyrinth is filled with a fluid called endolymph. The coiled portion of the labyrinth is called cochlea. The membranes constituting cochlea, the Reissner's and basilar, divide the surrounding perilymph filled bony labyrinth into an upper scala vestibuli and a lower scala tympani. The space within cochlea called scala media is filled with endolymph.

164. Answer (1)

Hint: Commonly found in autonomous neural system

Sol.: There are two types of axons, namely myelinated and unmyelinated. In PNS, the myelinated nerve fibres are enveloped with Schwann cells, which form a myelin sheath around the axon. Unmyelinated nerve fibre is enclosed by a Schwann cell that does not form a myelin sheath around the axon, and is commonly found in the somatic and autonomous neural systems.

165. Answer (2)

Hint: Helps in restoring the resting potential after hyperpolarisation

Sol.: When a neuron is not conducting any impulse, *i.e.*, resting, the axonal membrane is comparatively more permeable to potassium ions and nearly impermeable to sodium ions. Similarly, the membrane is impermeable to negatively charged proteins present in the axoplasm.

- The outer surface of the axonal membrane possesses a positive charge while its inner surface has negative charge. At rest, sodium-potassium pump transports 3 Na^+ outwards for $2K^+$ into the cell.

166. Answer (3)

Hint: Number of cervical vertebrae in manatees

Sol.: Almost all mammals including human beings have seven cervical vertebrae. Other characteristic features of mammals are:

- Presence of mammary glands
- Presence of pinna, hair on body, sweat glands and a four-chambered heart.
- Sloths and manatees are the mammals that do not have seven cervical vertebrae.

167. Answer (4)

Hint: Skeletal system in an adult man comprises 206 bones.

Sol.: Mechanism of muscle contraction is best explained by the sliding filament theory which states that contraction of a muscle fibre takes place by the sliding of the thin filaments over the thick filaments.

- Stimulation of a muscle fibre by a motor neuron occurs at the neuromuscular junction.
- Osteoporosis is an age-related disorder characterised by decreased bone mass and increased chances of fractures. Decreased levels of estrogen is a common cause.

168. Answer (1)

Hint: Total number of phalanges in both forearm is 28

Sol.: The total number of facial bones in an adult man is 14 while that of cranial bones is 8 and wrist bones in one forearm is 8.

169. Answer (4)

Hint: Assist in forming the shoulder joint

Sol.: Pelvic girdle consists of two coxal bones. Each coxal bone is formed by the fusion of three bones–ilium, ischium and pubis. At the point of fusion of the above bones is a cavity called acetabulum to which the thigh bone articulates. Below the acromion is a depression called the glenoid cavity which articulates with the head of the humerus to form the shoulder joint.

170. Answer (1)

Hint: Movement and locomotion cannot be studied separately

Sol.: Muscle bundles or fascicles are held together by a common collagenous connective tissue layer called fascia.

Locomotion requires a perfect coordinated activity of muscular, skeletal and neural systems.

Methods of locomotion performed by animals vary with their habitats and the demand of the situation.

171. Answer (2)

Hint: Nitrogenous waste

Sol.: Substances like glucose, amino acids, Na^+ *etc.*, in the filtrate are reabsorbed actively whereas the nitrogenous wastes are absorbed by passive transport. Reabsorption of water also occurs passively in the initial segments of the nephron.

172. Answer (2)

Hint: Epithelial cells of Bowman's capsule is called podocytes

Sol.: The epithelial cells of Bowman's capsule called podocytes are arranged in an intricate manner so as to leave some minute spaces called filtration slits or slit pores.

- Juxtaglomerular Apparatus (JGA) is a special sensitive region formed by cellular modifications in DCT and the afferent arteriole at the location of their contact.
- The Malpighian corpuscle, PCT and DCT of the nephron are situated in the cortical region of the kidney.

173. Answer (4)

Hint: Presence of microvilli increases the surface area for reabsorption in PCT

Sol.: PCT is lined by simple cuboidal brush border epithelium which increases the surface area for reabsorption. Nearly all of the essential nutrients, and 70-80 per cent of electrolytes and water are reabsorbed by this segment. PCT also helps to maintain the pH and ionic balance of the body fluids by selective secretion of hydrogen ions, ammonia and potassium ions into the filtrate and by absorption of HCO_3^- from it.

174. Answer (4)

Hint: Perform active absorption and secretion

Sol.: There are two types of nephrons *i.e.*, cortical nephrons and juxta medullary nephrons.

- In majority of nephrons, the loop of Henle is too short and extends only very little into the medulla. Such nephrons are called cortical nephrons.
- In some of the nephrons, the loop of Henle is very long and runs deep into the medulla. These nephrons are called Juxtamedullary nephrons.

175. Answer (1)

Hint: Retroperitoneal arrangement

Sol.: As the kidneys are fused with the body wall on the dorsal side, peritoneal cover is present only on the ventral side. This arrangement is called retroperitoneal arrangement.

- Each kidney of an adult human measures 10-12 cm in length, 5-7 cm in width, 2-3 cm in thickness with an average weight of 120-170 g.
- Some amount of urea may be retained in the kidney matrix of some ureotelic animals to maintain a desired osmolarity.

176. Answer (4)

Hint: Inner parts of cerebral hemisphere

Sol.: The inner parts of cerebral hemispheres and a group of deep structures like amygdala, hippocampus, *etc.*, form a complex structure called the limbic lobe or limbic system. Along with the hypothalamus, it is involved in the regulation of sexual behaviour, expression of emotional reactions (*e.g.*, excitement, pleasure, rage and fear), and motivation.

177. Answer (2)

Hint: The nerve fibre which lacks Nissl's granules.

Sol.: The dendrites branch repeatedly to further give rise to smaller fibres. The dendrites of one neuron receive electrical impulses from different sources, *i.e.*, other neurons and then transmit these impulses towards the cell body of the neuron to which they belong.

- Axon lacks Nissl's granules and they carry impulses away from the cyton to a synapse or to a neuromuscular junction.

178. Answer (2)

Hint: Possess centre which controls respiration

Sol.: The medulla oblongata contains centres which control respiration, cardiovascular reflexes and gastric secretions.

- The hypothalamus contains a number of centres which control body temperature, urge for eating and drinking.
- Cerebellum does not initiate the movements of the body but modulates or reorganises the motor commands.

179. Answer (4)

Hint: Lies along the peripheries of the body

Sol.: The Central Nervous System (CNS) includes the brain and the spinal cord and is the site of information processing and control.

- The peripheral Nervous System (PNS) lies along the peripheries of the body. It comprises all the nerves of the body associated with the CNS.

180. Answer (4)

Hint: Ability to respond to a stimulus

Sol.: Muscles have the special properties like excitability, contractility, extensibility and elasticity.

- The property of shortening and then returning to relaxed state of the muscle fibre is called elasticity. A stimulus such as nerve impulse, hormones, mechanical, thermal or chemical stimulus are required for excitation of the muscles which then causes muscles to contract.

181. Answer (3)

Hint: Visceral muscles

Sol.: Visceral muscles are located in the inner walls of hollow visceral organs of the body like the alimentary canal, reproductive tract, *etc.* They do not exhibit any striations and are smooth in appearance. Hence, they are called smooth muscles (non-striated). Their activities are not under the voluntary control of the nervous system and are therefore known as involuntary muscles.

182. Answer (2)

Hint: Belongs to the phylum which includes pore bearer animals

Sol.: Flagellar movements help in the swimming of spermatozoa, maintenance of water current in the canal system of sponges and in the locomotion of protozoans like *Euglena*.

Hydra uses its tentacles for capturing its prey and locomotion.

In *Paramecium*, cilia help in the movement of food through cytopharynx and in locomotion as well.

183. Answer (1)

Hint: Also known as 'Friends of farmers'

Sol.: Nephridia are the tubular excretory structures of earthworms and other annelids. Nephridia help to remove nitrogenous wastes and maintain a fluid and ionic balance.

- Malpighian tubules are the excretory structures of most of the insects including cockroaches (*Periplaneta*).
- Antennal glands or green glands perform the excretory function in crustaceans like prawns.
- Protonephridia or flame cells are the excretory structures in platyhelminthes (Flatworms, *e.g.*, *Planaria*).

184. Answer (3)

Hint: Least toxic nitrogenous waste is very important for land vertebrates laying shelled eggs

Sol.: Ammonia, urea and uric acid are the major forms of nitrogenous wastes excreted by the animals. Ammonia is the most toxic form and requires large amount of water for its elimination, whereas uric acid, being the least toxic, can be removed with a minimum loss of water.

185. Answer (2)

Hint: Excreted with minimum loss of water

Sol.: Reptiles are the first true land vertebrates. Insects belong to the largest class of phylum Arthropoda. Reptiles, birds, land snails and insects excrete nitrogenous wastes as uric acid in the form of pellet or paste with a minimum loss of water and are called uricotelic animals.

Many bony fishes, aquatic amphibians and aquatic insects are ammonotelic in nature.

Mammals, many terrestrial amphibians and marine fishes mainly excrete urea and are called ureotelic animals.

SECTION-B

186. Answer (3)

Hint: Sympathetic and parasympathetic neural systems have antagonistic effects on the organs.

Sol.: During fight, fright and flight response, catecholamines are secreted from adrenal medulla.

- In sympathetic neural system, the neurotransmitter is adrenaline/noradrenaline.

187. Answer (2)

Hint: In *Hydra*, neurons are not organised to form an organ.

Sol.: The neural organisation is very simple in lower invertebrates. For example, in *Hydra*, it is composed of a network of neurons. The neurons system is better organised in insects, where a brain is present along with a number of ganglia and neural tissues. The vertebrates have a more developed neural system.

188. Answer (2)

Hint: Vertebrochondral ribs are also known as false ribs.

Sol.: The first cervical vertebrae is Atlas and the second is called Axis. On the upper surface of atlas, there is presence of kidney-shaped facets for articulation with the condyles of the occipital bone.

- Sternum is a flat bone present on the ventral midline of the thorax. It is present just under the skin in the middle of the chest.

189. Answer (2)

Hint: Juxtaglomerular cells of kidney produce erythropoietin

Sol.: Juxtaglomerular cells of kidney produce a hormone called erythropoietin which stimulates erythropoiesis (formation of RBCs). Kidneys also secrete calcitriol, which promotes absorption of Ca^{2+} and phosphorous in small intestine and accelerates bone formation.

- The urine formed is slightly acidic (pH – 6.0).
- In haemodialysis, the cleared blood is pumped back to the body through a vein after addition of anti-heparin to it.

190. Answer (2)

Hint: Connects middle ear with pharynx.

Sol.:

- Eustachian tube equalises pressures on both sides of the ear drum.
- Vestibular apparatus helps in maintaining balance of the body and posture.
- Auditory meatus is a part of the external ear.

191. Answer (2)

Hint: Present between internodes

Sol.: In myelinated nerve fibres of PNS (cranial nerves and spinal nerves), nodes of Ranvier are present in between internodes. Nodes of Ranvier have axolemma and neurilemma but they lack myelin sheath.

192. Answer (3)

Hint: Does not allow any movement

Sol.: Fibrous joint is shown by the flat skull bones which fuse end-to-end with the help of dense fibrous connective tissues in the form of sutures, to form the cranium.

- The contractile protein of skeletal muscle involving ATPase activity is myosin.
- Troponin and tropomyosin are regulatory proteins in the muscle contraction.

193. Answer (2)

Hint: Hip joint

Sol.: Ball and socket joint is the most free joint of all joints. It is present in shoulder joint and hip joint.

- Hinge joint is present between tibia and femur (knee joint). Pivot joint is present between atlas and axis, radius and ulna.
- Saddle joint is present between carpal and metacarpal of human thumb.

194. Answer (3)

Hint: Ultrafiltration

Sol.: The first step in urine formation is the filtration of blood, which is carried out by the glomerulus and is called glomerular filtration. On an average, 1100-1200 mL of blood is filtered by the kidneys per minute which constitute roughly $1/5^{th}$ of the blood pumped out by each ventricle of the heart in a minute.

- Blood is filtered so finely through filtration membranes, that almost all the constituents of the plasma except the proteins pass into the lumen of the Bowman's capsule. Therefore, it is considered as a process of ultrafiltration.

195. Answer (3)

Hint: Straight tube

Sol.: DCT is a highly coiled part of nephron and lies close to the Malpighian body. Conditional reabsorption of Na^+ and water takes place in this segment. DCT is also capable of reabsorption of HCO_3^- and selective secretion of H^+ and K^+ ions to maintain the pH and sodium potassium balance in blood.

- Collecting duct allows passage of small amounts of urea into the medullary interstitium to keep up the osmolarity. It is not a part of nephron.

196. Answer (2)

Hint: Contractile tissue

Sol.: Proprioceptors are present in skeletal muscle in the region of spindle. Eyes are photoreceptors. Hypothalamus contains osmoreceptors and adrenal gland is an endocrine gland.

- Nociceptors respond to painful stimuli and baroreceptors respond to pressure.

197. Answer (4)

Hint: Function attributed to association area

Sol.: The cerebral cortex contains motor area, sensory areas and large regions that are neither clearly sensory nor motor in function. These regions called the association area are responsible for complex functions like intersensory associations, memory and communication.

- Medulla oblongata contains centres which control respiration, gastric secretions and cardiovascular reflexes.
- Pneumotaxic centre is present in pons, which can moderate the functions of the respiratory rhythm centre located in the medulla oblongata.

198. Answer (2)

Hint: Hyaline cartilage

Sol.: Hyaline cartilage occurs at the nasal septum.

- Bones and cartilage are specialised connective tissues. The former has very hard matrix due to calcium salts in it and the latter has slightly pliable matrix due to chondroitin salts.

199. Answer (3)

Hint: Storehouse of calcium ions

Sol.: Myoglobin content is high in some of the muscles which give a reddish appearance. Such muscles are called the red muscle fibres. These muscles also contain plenty of mitochondria which can utilize the large amount of oxygen stored in them for ATP production. These muscles, therefore, can also be called aerobic muscles.

- On the other hand, some of the muscles possess very less quantity of myoglobin and therefore, appear pale or whitish. These are the white fibres. Number of mitochondria are also few in them, but the amount of sarcoplasmic reticulum is high. They depend on anaerobic process for energy.

200. Answer (4)

Hint: Leads to minimal loss of water

Sol.: Sweat produced by sweat glands is a watery fluid containing NaCl, small amounts of urea, amino acids, lactic acid and glucose *etc*. Though, the primary function of sweat is to facilitate a cooling effect on the body surface, it also helps in the removal of some of the wastes mentioned above.

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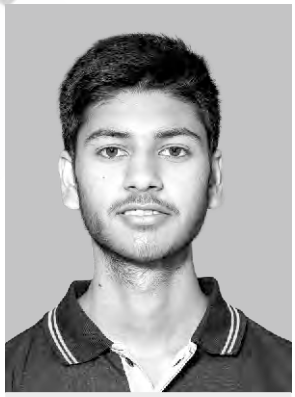

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