All India Aakash Test Series for NEET-2025

TEST - 2 (Code-C)

Test Date : 29/10/2023

ANSWERS

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

HINTS & SOLUTIONS

[PHYSICS]

SECTION - A

1. Answer (2)

Hint & Sol.: A vector quantity has magnitude as well as direction.

2. Answer (3)

Hint: $\vec{A} = n\vec{B}$ if $\vec{A} \| \vec{B}$, then n should be positive for parallel vectors.

Sol.: $\frac{a_1}{a_2} = \frac{b_1}{b_2} = \frac{c_1}{c_2}$

$\frac{4}{2} = \frac{3}{\alpha} = \frac{2}{1}$

$3 = 2\alpha$

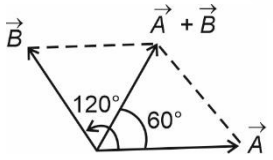
$\alpha = \frac{3}{2}$

3. Answer (1)

Hint: $R = \sqrt{A^2 + B^2 + 2AB\cos\theta}$

Sol.: $|\vec{A}| = |\vec{B}| = |\vec{R}|$

$\therefore R^2 = \sqrt{R^2 + R^2 + 2R^2\cos\theta} \Rightarrow \theta = 120°$



Resultant of two vectors of equal magnitude is always at the angle bisector of the angle between the vectors.

4. Answer (2)

Hint: Time taken by the projectile to reach maximum height is $\frac{u\sin\theta}{g}$.

Sol.: $t = \frac{u\sin\theta}{g}$

Given $t_1 = t_2$

$\therefore \frac{u_1\sin\theta_1}{g} = \frac{u_2\sin\theta_2}{g}$

$\frac{u_1}{u_2} = \frac{\sin\theta_2}{\sin\theta_1}$

5. Answer (3)

Hint: Maximum horizontal range is achieved by a ball when it is thrown at 45° from horizontal.

Sol.: $R = \frac{u^2\sin 2\theta}{g}$

for R_{max}, $\theta = 45°$

$\therefore R_{max} = \frac{u^2}{g} = 200\text{ m}$ ...(i)

Maximum height can be achieved when a ball is thrown vertically upward.

$H_{max} = \frac{u^2}{2g}$

$\therefore H_{max} = \frac{200}{2} = 100\text{ m}$

6. Answer (4)

Hint: Distance travelled on a circle is given by, $l = R\theta$

Sol.: For quarter circle, angle covered is $\frac{\pi}{2}$

$\therefore$ distance = $R\theta \Rightarrow \ell = \frac{\pi R}{2}$ ...(i)

Time = $\frac{\text{distance}}{\text{speed}} = \frac{\pi R/2}{v}$

$t = \frac{22\times 14}{7\times 2\times 2} = 11\text{ s}$

7. Answer (4)

Hint: Use $\vec{v} = \frac{d\vec{r}}{dt}$

Sol.: $\vec{v} = \frac{d\vec{r}}{dt} = 2\hat{i} + 6t\,\hat{j}$

$\vec{v}|_{t=2} = \left(2\hat{i} + 12\hat{j}\right)\text{ m/s}$

8. Answer (4)

Hint: $y = ax^2 + bx + c$ is the equation of parabola

Sol.: $x = 2t \Rightarrow t = \frac{x}{2}$

$y = t^2 + 2t + 2$

$$y=\left(\frac{x}{2}\right)^2+2\left(\frac{x}{2}\right)+2$$

$$y=\frac{x^2}{4}+x+2$$

This is the equation of parabola.

9. Answer (4)

Hint: $\vec{V}_{br}=\vec{V}_b-\vec{V}_r$

$\Rightarrow \vec{V}_b=\vec{V}_{br}+\vec{V}_r$

Sol.: $\vec{V}_b=\vec{V}_{br}+\vec{V}_r$

$=\left(2\hat{i}+6\hat{j}\right)+\left(3\hat{i}+2\hat{j}\right)$

$=\left(5\hat{i}+8\hat{j}\right)$ m/s

10. Answer (3)

Hint: Acceleration of A w.r.t. B is $\vec{a}_{AB}=\vec{a}_A-\vec{a}_B$

$$\vec{a}_A=\frac{d^2\vec{r}_A}{dt^2},\qquad \vec{a}_B=\frac{d^2\vec{r}_B}{dt^2}$$

Sol.: $\vec{r}_A=3t^2\hat{i}+2t\,\hat{j},\ \vec{r}_B=t\,\hat{i}+2t^2\,\hat{j}+3\hat{k}$

$$\vec{v}_A=\frac{d\vec{r}_A}{dt}=6t\,\hat{i}+2\hat{j},\qquad \vec{v}_B=\frac{d\vec{r}_B}{dt}=\hat{i}+4t\,\hat{j}$$

$$\vec{a}_A=\frac{d\vec{v}_A}{dt}=6\hat{i},\quad \vec{a}_B=4\hat{j}$$

$$\vec{a}_{AB}=\vec{a}_A-\vec{a}_B=6\hat{i}-4\hat{j}$$

$$\left|\vec{a}_{AB}\right|=\sqrt{6^2+4^2}=\sqrt{36+16}=\sqrt{52}$$

11. Answer (2)

Hint: $y=x\tan\theta\left(1-\frac{x}{R}\right),\qquad \frac{H}{R}=\frac{\tan\theta}{4}$

Sol.: $y=\sqrt{3}\,x-x^2$

$$y=\sqrt{3}\,x\left(1-\frac{x}{\sqrt{3}}\right)$$

$R=\sqrt{3}$ m, $\qquad \tan\theta=\sqrt{3}$

$$H=R\frac{\tan\theta}{4}=\sqrt{3}x\frac{\sqrt{3}}{4}=\frac{3}{4}\text{ m}$$

12. Answer (1)

Hint: $H_{max}=\frac{u^2\sin^2\theta}{2g}$

$H_{max}\propto\sin^2\theta$

Sol.: $\frac{H_A}{H_B}=\frac{\sin^2\theta_1}{\sin^2\theta_2}$

$$\frac{H_A}{H_B}=\frac{\left(\frac{3}{5}\right)^2}{\left(\frac{4}{5}\right)^2}=\frac{9}{16}$$

13. Answer (4)

Hint: Time of flight of projectile motion is given by

$$T=\frac{2u\sin\theta}{g}$$

Sol.: $T_A=\frac{2u\sin\theta}{g},T_B=\frac{2u\sin(90-\theta)}{g}=\frac{2u\cos\theta}{g}$

$$T_A+T_B=\frac{2u}{g}[\sin\theta+\cos\theta]$$

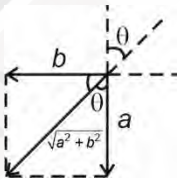
$$=\frac{2u}{g}\sqrt{2}\left[\frac{1}{\sqrt{2}}\sin\theta+\frac{1}{\sqrt{2}}\cos\theta\right]$$

$$=\frac{2\sqrt{2}u}{g}\sin\left(\frac{\pi}{4}+\theta\right)=\frac{\sqrt{8}u}{g}\sin\left(\frac{\pi}{4}+\theta\right)$$

14. Answer (4)

Hint: $\vec{V}_{\text{rain/cyclist}}=\vec{V}_{\text{rain}}-\vec{V}_{\text{cyclist}}$

Sol.:



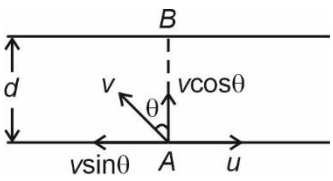
$$\sin\theta=\frac{b}{\sqrt{a^2+b^2}}\quad\Rightarrow\quad\theta=\sin^{-1}\left(\frac{b}{\sqrt{a^2+b^2}}\right)$$ and

$$\theta=\tan^{-1}\left(\frac{b}{a}\right)$$

15. Answer (2)

Hint: Shortest path is along the perpendicular direction of river flow

Sol.:



Shortest path is 'AB'

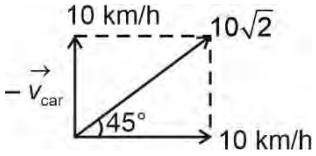
$$t=\frac{d}{v\cos\theta}\Rightarrow\frac{30}{60}=\frac{1}{2\times2\cos\theta}\Rightarrow2\cos\theta=1$$

$\Rightarrow\theta=60^\circ$ therefore, $u=v\sin\theta=2\times\frac{\sqrt{3}}{2}=\sqrt{3}$ km/h

16. Answer (3)

Hint: $\vec{V}_{\text{bird/car}} = \vec{V}_b - \vec{V}_c$

Sol.:



$\therefore$ Velocity of bird w.r.t. car is $10\sqrt{2}$, NE

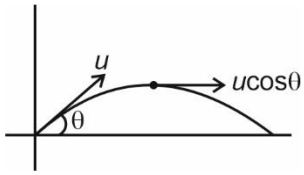
17. Answer (2)

Hint: Unit vector $\hat{P} = \dfrac{\vec{P}}{|\vec{P}|}$

Sol.: $\hat{P} = \dfrac{\hat{i}+\hat{j}+\hat{k}}{\sqrt{3}}$

18. Answer (3)

Hint & Sol.: At maximum height only horizontal component of velocity is present.



19. Answer (3)

Hint: $R = \sqrt{a^2 + b^2 + 2ab\cos\theta}$

Sol.: $R = \sqrt{(4a)^2 + b^2 + 2(4a)b\cos\left(\dfrac{\pi}{2}\right)}$

$R = \sqrt{8^2 + 8^2}$

$R = 8\sqrt{2}$ unit

20. Answer (3)

Hint & Sol.: In uniform circular motion speed is constant but acceleration is variable.

21. Answer (1)

Hint & Sol.: Equation of trajectory of a projectile is given by $y = x\tan\theta\left(1-\dfrac{x}{R}\right)$. By comparison, we get R = 100 m

22. Answer (2)

Hint: $T = \sqrt{\dfrac{2h}{g}}$

T = time of flight

Sol.: $T = \sqrt{\dfrac{2\times 1960}{9.8}}$

$T = \sqrt{400}$

T = 20 s

23. Answer (3)

Hint: $\underset{\left(\text{Velocity of rain w.r.t. boy}\right)}{\vec{V}_{R/B}} = \underset{\left(\text{Velocity of rain w.r.t. ground}\right)}{\vec{V}_{R/g}} - \underset{\left(\text{Velocity of boy w.r.t. ground}\right)}{\vec{V}_{B/g}}$

Sol.: Using relative velocity concept, we can write

$\vec{V}_{R/B} = \vec{V}_{R/g} - \vec{V}_{B/g}$

$-12\hat{j} = \vec{V}_{R/g} - 5\hat{i}$

$\vec{V}_{R/g} = 5\hat{i} - 12\hat{j}$

$|\vec{V}_{R/g}| = \sqrt{5^2 + 12^2} = 13$ m/s

24. Answer (3)

Hint: In uniform circular motion

$v = \omega r$

Sol.: $v = r\omega$

$4 = 2.\omega$

ω = 2 rad/s

25. Answer (1)

Hint and Sol.:

$a_{rel} = g - g = 0$

$x_{rel} = u_{rel} \times t$

Hence path of one projectile from another projectile will be a straight line path

26. Answer (2)

Hint: Centripetal acceleration, $a_c = \dfrac{v^2}{R}$

Sol.: Given, $\vec{v} = \hat{i} - \hat{j}$

$|\vec{v}| = \sqrt{1^2 + 1^2} = \sqrt{2}$ m/s

Centripetal acceleration:

$a_c = \dfrac{v^2}{R} = \dfrac{\left(\sqrt{2}\right)^2}{6} = \dfrac{1}{3}$ m/s^2

27. Answer (2)

Hint: $\vec{v}$ and $\vec{a}$ are non-parallel

Sol.: If $\vec{v}$ and $\vec{a}$ are non-parallel and $|\vec{a}|$ is constant then path is always parabola.

28. Answer (1)

Hint: Time period $T = \dfrac{2\pi r}{v}$

Sol.: $\frac{T_A}{T_B}=\frac{r_A}{v_A}\frac{v_B}{r_B}$

$\frac{T_A}{T_B}=\frac{(R)(2v)}{v(2R)}=1$

29. Answer (3)

Hint: Use $\vec{v}=\vec{u}+at$

Sol.: $\vec{v}=4\hat{i}+6\hat{j}$

$\vec{u}=2\hat{i}+2\hat{j}$

$\Rightarrow \quad \vec{v}=\vec{u}+\vec{a}t$

$4\hat{i}+6\hat{j}=(2\hat{i}+2\hat{j})+\vec{a}\times 2$

$\Rightarrow \quad 2\vec{a}=2\hat{i}+4\hat{j}$

$\vec{a}=\hat{i}+2\hat{j}$

$|\vec{a}|=\sqrt{1+2^2}=\sqrt{5}$ m/s^2

30. Answer (2)

Hint & Sol.: According to triangle law of vector addition, for the given arrangement of vectors, the correct relation is $\vec{C}+\vec{A}=\vec{B}\Rightarrow\vec{C}=\vec{B}-\vec{A}$.

31. Answer (2)

Hint: $R=\frac{u^2\sin 2\theta}{g}$

Sol.: $R_{max}=\frac{u^2}{g}$ at $\theta=\frac{\pi}{4}$ radian

32. Answer (4)

Hint: Minute hand of a clock covers one rotation in 1 hour or 60 minutes.

Sol.: Angular speed = $\frac{\text{Angular displacement}}{\text{time}}$

$\omega=\frac{2\pi}{60\times 60}=\frac{\pi}{1800}$ rad/s

33. Answer (1)

Hint: $\left|\vec{A}\right|=1=\sqrt{A_x^2+A_y^2+A_z^2}$

Sol.: $1=(0.2)^2+(0.6)^2+c^2$

$c=\sqrt{\frac{3}{5}}$

34. Answer (2)

Hint: $\tan\theta=\frac{V_y}{V_x}$

Sol.: $\tan\theta=\frac{4t^3}{3t^2}=\frac{4t}{3}$

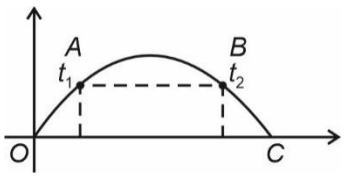
at $t=1$

$\tan\theta=\frac{4}{3}$

$\theta=53°$

35. Answer (3)

Hint & Sol.:



$y=u_yt-\frac{1}{2}gt^2$

$\Rightarrow \quad gt^2-2u_yt+2y=0$

$t_1+t_2=\frac{2u_y}{g}=T$

SECTION - B

36. Answer (1)

Hint: $\frac{(a_r)_A}{(a_r)_B}=\frac{r_A\omega_A^2}{r_B\omega_B^2}$

Sol.: $\frac{(a_r)_A}{(a_r)_B}=\frac{R}{2R}\cdot\frac{\omega^2}{4\omega^2}=\frac{1}{8}$

37. Answer (1)

Hint: $y=x\tan\theta\left(1-\frac{x}{R}\right)$

Sol.: $\tan\theta=\frac{1}{\sqrt{3}}$, $R=\frac{2u_xu_y}{g}$

$R=\frac{2\times\sqrt{3}\times 1}{10}=\frac{\sqrt{3}}{5}$

$y=\frac{x}{\sqrt{3}}\left(1-\frac{5x}{\sqrt{3}}\right)$

$Y=\frac{x}{\sqrt{3}}-\frac{5x^2}{3}$

38. Answer (2)

Hint: Use equation $s=ut+\frac{1}{2}at^2$

Sol.: $u_y=20\sin 30°=10$ m/s

Applying $s=ut+\frac{1}{2}at^2$ in vertical direction

$$y = u_y t + \frac{1}{2}a_y t^2$$

$$-400 = 10t + \frac{1}{2}(-10)\times t^2$$

$5t^2 - 10t - 400 = 0 \Rightarrow t^2 - 2t - 80 = 0$

$t^2 - 10t + 8t - 80 = 0$

$t(t-10) + 8(t-10) = 0 \Rightarrow (t-10)(t+8) = 0$

$\therefore t = -8$ s, 10 s

Hence, the ball will strike the ground after 10 s.

39. Answer (2)

Hint: Horizontal range $= \frac{u^2 \sin 2\theta}{g}$; Maximum height $= \frac{u^2 \sin^2\theta}{2g}$

Sol.: $R = \frac{u^2 \sin^2\theta}{g} = \frac{2u^2 \sin\theta\cos\theta}{g}$

$$H = \frac{u^2 \sin^2\theta}{2g} \quad ...(i)$$

$$\frac{R^2}{H} = \frac{8u^2\cos^2\theta}{2g} ...(ii)$$

Using equations (i) and (ii) and putting values in equation $\sin^2\theta + \cos^2\theta = 1$, we get

$$u = \sqrt{2gH + \frac{gR^2}{8H}}$$

$$\therefore u = \sqrt{2\times 10\times 30 + \frac{10\times\left(60\sqrt{2}\right)^2}{8\times 30}}$$

$$u = \sqrt{6\times 100 + \frac{60^2\times 2}{24}}$$

$u = 30$ m/s

40. Answer (3)

Hint & Sol.: Use $\cos^2\alpha + \cos^2\beta + \cos^2\gamma = 1$

41. Answer (1)

Hint: Due to the horizontal motion of plank, ball will have horizontal velocity equal to 10 m/s.

Sol.: $u_x = 10$ m/s, $a_x = 0$

$u_y = 20$ m/s, $a_y = -10$ m/s^2

$\therefore v_y = u_y + a_y \times t \Rightarrow v_y = 20 - 10\times 1 = 10$ m/s

At $t = 1$ s, the speed of the ball will be

$$v = \sqrt{v_x^2 + v_y^2} = \sqrt{10^2 + 10^2} = 10\sqrt{2} \text{ m/s}$$

42. Answer (3)

Hint: Use equation of trajectory

$$y = x\tan\theta - \frac{gx^2}{2u^2\cos^2\theta}$$

Sol.: Putting $x = 30$ m in equation of trajectory, we get

$$y = 30\tan 30^\circ - \frac{10\times 30\times 30}{2\times 25\times 25\times\cos^2 30^\circ}$$

$$y = 30\times\frac{1}{\sqrt{3}} - \frac{5\times 6\times 6\times 4}{5\times 5\times 3}$$

$$y = \left(10\sqrt{3} - \frac{48}{5}\right)\text{m}$$

43. Answer (1)

Hint: Concept of centripetal acceleration

Sol.: Centripetal acceleration is towards the centre of the circle.

44. Answer (4)

Hint: Average acceleration, $\langle\vec{a}\rangle = \frac{\vec{v}_f - \vec{v}_i}{\Delta t}$

Sol.: $\vec{v}_i = v\cos 45^\circ\hat{i} + v\sin 45^\circ\hat{j} = \frac{v}{\sqrt{2}}\hat{i} + \frac{v}{\sqrt{2}}\hat{j}$

$\vec{v}_f = 0\hat{i} + v\hat{j}$

$$\langle\vec{a}\rangle = \frac{\vec{v}_f - \vec{v}_i}{\Delta t} = \frac{v\hat{j} - \left(\frac{v}{\sqrt{2}}\hat{i} + \frac{v}{\sqrt{2}}\hat{j}\right)}{1}$$

$$\langle\vec{a}\rangle = \left[-\frac{v}{\sqrt{2}}\hat{i} + \left(v - \frac{v}{\sqrt{2}}\right)\hat{j}\right] \text{m/s}^2$$

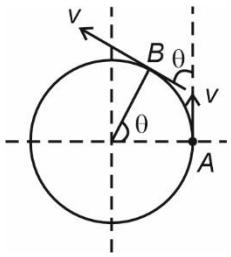
45. Answer (3)

Hint: $|\vec{C}|_{max} = |\vec{A}| + |\vec{B}|$ and $|\vec{C}|_{min} = |\vec{A}| - |\vec{B}|$

Sol.: Set of values 4, 8, 2 not possible.

46. Answer (2)

Hint: $|\overrightarrow{\Delta v}| = |\vec{v}_B - \vec{v}_A|$



Sol.: $\Delta v = \sqrt{v^2 + v^2 - 2v^2\cos\theta}$

$\Delta v = \sqrt{2v^2(1-\cos\theta)}$

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

$\Delta v = 2v\sin\left(\frac{\theta}{2}\right)$

47. Answer (3)

Hint: $T = \sqrt{\frac{2h}{g}}$

Sol.: Time to reach the ground does not depend on horizontal speed.

48. Answer (1)

Hint: Maximum height attained by a projectile is given by $H = \frac{u^2\sin^2\theta}{2g}$

Sol.: $H \propto u^2$

$\frac{\Delta H}{H} = \frac{2\Delta u}{u}$

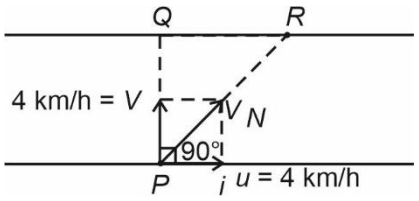
similarly $\frac{\Delta T}{T} = \frac{\Delta u}{u}$

i.e. $\left(\frac{\Delta T}{T}\right)\times 100 = \frac{1}{2}\left(\frac{\Delta H}{H}\right)\times 100$

$= \frac{1}{2}\times 2 = 1\%$

49. Answer (2)

Hint & Sol.:



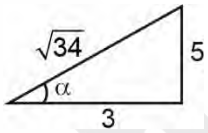
$\theta = 90°$

50. Answer (4)

Hint: Direction cosines $\cos\alpha = \frac{a_x}{\sqrt{a_x^2 + a_y^2 + a_z^2}}$

Sol.: $\vec{P} + \vec{Q} = 3\hat{i} - 3\hat{j} + 4\hat{k}$

Angle with x-axis:



$\cos\alpha = \frac{3}{\sqrt{9+9+16}} = \frac{3}{\sqrt{34}}$

$\tan\alpha = \frac{5}{3}$

$\alpha = \tan^{-1}\left(\frac{5}{3}\right)$

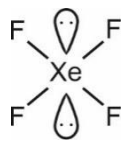
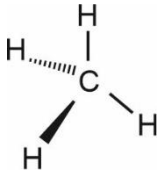
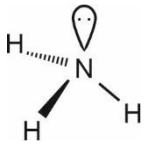
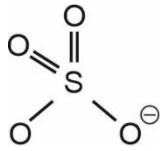
[CHEMISTRY]

SECTION - A

51. Answer (1)

Hint: The species in which central atom is sp^3d^2 hybridised may have square planar shape

Sol.:

Species	Hybridisation of central atom	Shape
XeF_4	sp^3d^2	 (Square planar)
CH_4	sp^3	 (Tetrahedral)
NH_3	sp^3	 (Pyramidal)
SO_4^{2-}	sp^3	 (Tetrahedral)

52. Answer (3)

Hint: The species which contains paired electrons in molecular orbitals will be diamagnetic in nature.

Sol.: Li_2 and C_2 contain paired electrons in their molecular orbitals

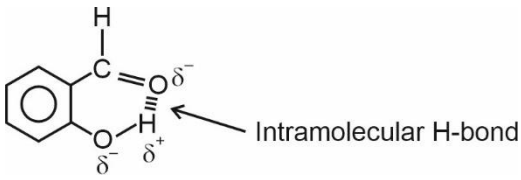
Li_2 : $(\sigma 1s)^2\ (\sigma^* 1s)^2\ (\sigma 2s)^2$

C_2 : $(\sigma 1s)^2\ (\sigma^* 1s)^2\ (\sigma 2s)^2\ (\sigma^* 2s)^2\ \left(\pi 2p_x^2 = \pi 2p_y^2\right)$

53. Answer (3)

Hint: Intramolecular hydrogen bond is formed when hydrogen atom is in between the two highly electronegative (F, O, N) atoms, present in the same molecule.

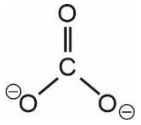
Sol.:



54. Answer (3)

Hint: Bond order $= \dfrac{\text{Total number of bonds}}{\text{Total number of } \sigma - \text{bonds}}$

Sol.:

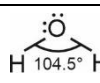
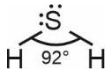


Bond order $= \dfrac{4}{3} = 1.33$

55. Answer (4)

Hint: Net dipole moment is determined by bond dipole and shape of the molecule.

Sol.:

Molecule	Shape	Dipole moment μ(D)
H_2O		1.85
H_2S		0.95
CO_2	O=C=O	0

56. Answer (1)

Hint: IUPAC official name of element having atomic number 101 is Mendelevium

Sol.:

Atomic number	IUPAC official name
101	Mendelevium
102	Nobelium
104	Rutherfordium
106	Seaborgium

57. Answer (2)

Hint: The elements which belong to *s* or *p* block are called representative elements.

Sol.: Rubidium (Rb) belongs to *s* block. Indium (In) and Tellurium (Te) belong to p-block hence these are representative elements. Fe belongs to '*d*' block

58. Answer (3)

Hint: Oxides of non-metals in their higher oxidation states are acidic in nature.

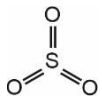
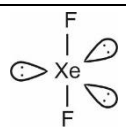
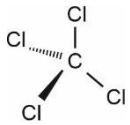
Sol.:

Oxides	Chemical nature
N_2O	Neutral
CO	Neutral
Na_2O	Basic
CaO	Basic
Cl_2O_7	Acidic
NO_2	Acidic
Al_2O_3	Amphoteric
As_2O_3	Amphoteric

59. Answer (2)

Hint: Species with sp^3d hybridisation has one of the bond angles equal to 180°.

Sol.:

Species	Shape	Hybridisation	Bond angle
SO_3		sp^2	120°
XeF_2		sp^3d	180°
CCl_4		sp^3	109° 28′

60. Answer (1)

Hint: Electronic configuration of O_2:

$(\sigma 1s)^2\ (\sigma^* 1s)^2\ (\sigma 2s)^2\ (\sigma^* 2s)^2\ (\sigma 2p_z)^2$

$\left(\pi 2p_x^2 = \pi 2p_y^2\right)\left(\pi^* 2p_x^1 = \pi^* 2p_y^1\right)$

Sol.: Electronic configuration of

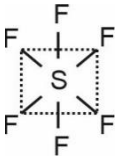
O_2^+ : $(\sigma 1s)^2$ $(\sigma^*1s)^2$ $(\sigma 2s)^2$ $(\sigma^*2s)^2$ $(\sigma 2p_z)^2$ $\left(\pi 2p_x^2 = \pi 2p_y^2\right)\left(\pi^* 2p_x^1\right)$

B_2 : $(\sigma 1s)^2$ $(\sigma^*1s)^2$ $(\sigma 2s)^2$ $(\sigma^*2s)^2$ $\left(\pi 2p_x^1 = \pi 2p_y^1\right)$

61. Answer (3)

Hint: Central atom in SF_6 is sp^3d^2 hybridised

Sol.:



Maximum number of atoms in a plane will be 5 in SF_6

62. Answer (2)

Hint: Bond order $(BO) : \frac{N_b - N_a}{2}$

Sol.: BO of $O_2^+ = \frac{10-5}{2} = 2.5$

BO of $C_2^+ = \frac{7-4}{2} = 1.5$

BO of $O_2 = \frac{10-6}{2} = 2$

BO of $N_2^+ = \frac{9-4}{2} = 2.5$

63. Answer (4)

Hint: Central atom in $XeOF_4$ is sp^3d^2 hybridised.

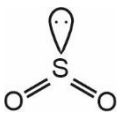
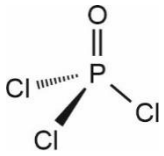
Sol.:

Central atom is sp^3d^2 hybridised and shape of the molecule is square pyramidal.

64. Answer (3)

Hint: The species which does not contain multiple bond will not possess π bond

Sol.:

Molecule	Structure	No. of π bonds
C_2H_2	H—C≡C—H	2
SO_2		2
C_2H_6	CH_3—CH_3	0
$POCl_3$		1

65. Answer (4)

Hint: Halogens easily accept electrons to attain inert gas configuration.

Sol.: Generally down the group, tendency to accept electron by the atoms decreases hence negative electron gain enthalpy decreases.

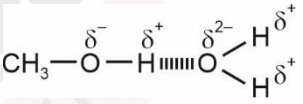
- Correct order of negative electron gain enthalpy : Cl > Br > S > Se

Element	$\Delta_{eg}H$ (kJ mol^{-1})
Cl	–349
Br	–325
S	–200
Se	–195

66. Answer (4)

Hint: Ethyl alcohol contains –OH group.

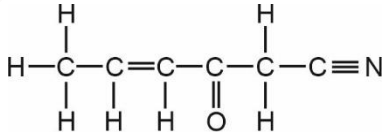
Sol.: Ethyl alcohol associates with water by intermolecular hydrogen bonding hence it is easily soluble in water



67. Answer (2)

Hint: CN contains two π-bonds

Sol.:



Number of σ-bonds = 14

Number of π-bonds = 4

68. Answer (1)

Hint: More is the bond order, smaller is the bond length.

Sol.:

Molecule/Ion	Bond order
N_2	3
N_2^-	2.5
N_2^+	2.5
N_2^{2-}	2

69. Answer (1)

Hint: The elements which show characteristics of both metals and non-metals are called semi-metals.

Sol.: Group 16 elements are called chalcogens.

70. Answer (1)

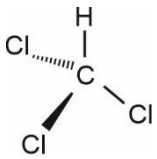
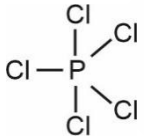
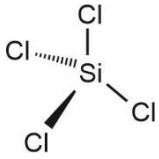
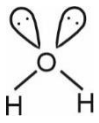
Hint: If bond order is zero the species does not exist.

Sol.: Bond order of Be_2 is zero. Hence it does not exist.

71. Answer (1)

Hint: In tetrahedral structure, if the atoms attached with carbon are different the species will be polar

Sol.:

Molecule	Shape	Dipole moment (μ)
$CHCl_3$		μ = 1.04 D
PCl_5		μ = 0
$SiCl_4$		μ = 0
H_2O		μ = 1.85 D

72. Answer (3)

Hint: The molecular species [number of electrons ≥ 8] in which $\sigma 2p_z$ is vacant will have only π bonds

Sol.: C_2 : $(\sigma 1s)^2$ $(\sigma^* 1s)^2$ $(\sigma 2s)^2$ $(\sigma^* 2s)^2$ $\left(\pi 2p_x^2 = \pi 2p_y^2\right)$

C_2 consists of both pi bonds because of the presence of four electrons in two pi molecular orbitals.

73. Answer (3)

Hint: After sharing electrons if each atom has 8 electrons in valance shell, then it is said that octet rule has been followed.

Sol.:

Molecule	Electronic distribution
SF_6	12 electrons around S atom
SCl_2	8 electrons around S atom
PF_5	10 electrons around P atom
H_2SO_4	12 electrons around S atom

74. Answer (4)

Hint: Larger is the size of atom, longer is the bond length.

Sol.: Correct order of size of atom : C > N > O > H

Correct order of bond length

C—C > C—O > N—O > C—H

75. Answer (3)

Hint: For isoelectronic species, more is the value of Z, smaller is the size of ion.

Sol.: Order of Z value : F > O > N

Size of ion : $N^{3-} > O^{2-} > F^-$

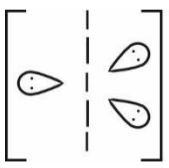
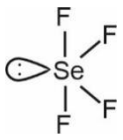
76. Answer (3)

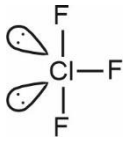
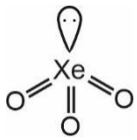
Hint & Sol.: σ s-orbital does not contain nodal plane.

77. Answer (1)

Hint: For sp^3d hybridized species, lesser is the number of bond pairs more is the number of lone pairs on central atom

Sol.:

Species	Shape	No. of lone pairs on central atom
I_3^-		3
SeF_4		1

ClF_3		2
XeO_3		1

78. Answer (3)

Hint: Sulphur posses vacant *d* orbital hence variable hybridization of sulphur is possible in different species.

Sol.:

Molecule/ion	Hybridization of central atom
$SOCl_2$	sp^3
SO_2	sp^2
SF_4	sp^3d

79. Answer (4)

Hint: If the number of bond pairs and lone pairs are equal then the species will be isostructural.

Sol.: ClO_3^- and BrO_3^- are pyramidal in shape but are not isoelectronic. Total number of electrons in ClO_3^- is 42 and in BrO_3^- is 60.

80. Answer (4)

Hint: Some of the elements of second and third period which are diagonally related with each other, show similar chemical properties.

Sol.: Be and Al are diagonally related with each other.

81. Answer (2)

Hint: Electronic configuration of calcium is

Ca (Z = 20) : $1s^2 2s^2 2p^6 3s^2 3p^6 4s^2$

Sol.: $1s^2 2s^2 2p^5$ is electronic configuration of F.

- Calcium will lose two electrons and two fluorine atoms will gain one electron each to attain inert gas configuration. Therefore the formula of the compound will be CaX_2.

82. Answer (1)

Hint & Sol.: Octet theory does not explain the relative stability of molecules.

83. Answer (4)

Hint: E (Z = 43) : [Kr] $4d^5 5s^2$

Sol.:

- One of the valence electrons goes to 5*s* orbital hence the period will be 5th
- Sum of the electrons in valence shell determines group. Group number 5 + 2 = 7.

84. Answer (2)

Hint: Electronic configuration of O_2

$(\sigma 1s)^2 \quad (\sigma^* 1s)^2 \quad (\sigma 2s)^2 \quad (\sigma^* 2s)^2 \quad (\sigma 2p_z)^2$

$\left(\pi 2p_x^2 = \pi 2p_y^2\right)\left(\pi^* 2p_x^1 = \pi^* 2p_y^1\right)$

Sol.: Electronic configuration of O_2^+

$(\sigma 1s)^2 \quad (\sigma^* 1s)^2 \quad (\sigma 2s)^2 \quad (\sigma^* 2s)^2 \quad (\sigma 2p_z)^2$

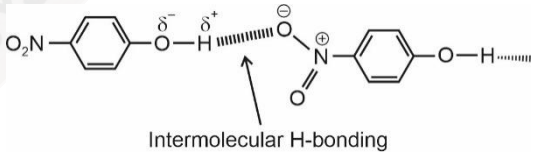
$\left(\pi 2p_x^2 = \pi 2p_y^2\right)\left(\pi^* 2p_x^1\right)$

Highest energy occupied orbital in O_2^+ is $\pi^* 2p_x$

85. Answer (2)

Hint: HF is associated with each other by intermolecular H-bonding.

Sol.:

- Magnitude of H-bonding depends on the physical state of the compound. It is maximum in solid state and minimum in gaseous state.
- Because of intermolecular hydrogen bonding, boiling point of HF is more than HCl.
- 

SECTION - B

86. Answer (3)

Hint: % ionic character = $\frac{\mu_{observed}}{\mu_{calculated}} \times 100$

Sol.: $\mu_{calculated} = q \times d$ [$q = 1.6 \times 10^{-19}$ C]

$= 1.6 \times 10^{-19} \times 100 \times 10^{-12}$ C m

$= 1.6 \times 10^{-29}$ C m

$\mu_{observed} = 1.2$ D

$= 1.2 \times 3.33 \times 10^{-30}$ Cm (1 D = 3.33×10^{-30} C m)

$= 4 \times 10^{-30}$ C m

% ionic character = $\frac{4 \times 10^{-30}}{1.6 \times 10^{-29}} \times 100$

$= 2.5 \times 10 = 25\%$

87. Answer (2)

Hint: Percentage s-character

$$= \frac{\text{No. of s – orbitals involved in hybridisation}}{\text{Total no. of orbitals involved in hybridisation}} \times 100$$

Sol.: Percentage s character in sp^3d orbital $= \frac{1\times100}{5} = 20\%$

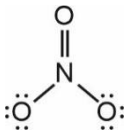
Percentage p character in sp^3d^2 orbitals $= \frac{3\times100}{6} = 50\%$

88. Answer (4)

Hint:

$$\text{Formal charge} = \begin{bmatrix}\text{Total no. of valance}\\ \text{electrons in free atom}\end{bmatrix} - \begin{bmatrix}\text{Total no. of}\\ \text{non – bonding}\\ \text{(lone pair)}\\ \text{electrons}\end{bmatrix} - \frac{1}{2}\begin{bmatrix}\text{Total no. of}\\ \text{bonding}\\ \text{electrons}\end{bmatrix}$$

Sol.:

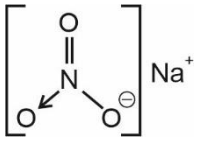


Formal charge on nitrogen = $5 - 0 - \frac{1}{2}\times8 = +1$

89. Answer (2)

Hint: In co-ordinate bond, one atom donates its electron pair to another atom to attain octet

Sol.:



$NaNO_3$ contains, electrovalent, covalent as well as ionic bonds.

90. Answer (3)

Hint: The covalent radius is half of the distance between two similar atoms joined by a covalent bond in the same molecule.

Sol.:

- The covalent radius is measured approximately as the radius of an atom's core which is in contact with the core of an adjacent atom in bonded situation.
- The van der Waals radius represents the overall size of the atom which includes its valence shell in a non-bonded situation.

91. Answer (3)

Hint: Chlorine belongs to halogen family.

Sol.: Palladium → Transition metal

Chlorine → Halogen

Thorium → Actinoid

Samarium → Lanthanoid

92. Answer (3)

Hint & Sol.: IUPAC name of an element with atomic number 109 is Unnilennium.

93. Answer (2)

Hint: Energy is generally released when an element accepts electron

Sol.: $F \longrightarrow F^{\ominus}$ and $Na \longrightarrow Na^{\ominus}$ are exothermic processes while ionisation of sodium ($Na \rightarrow Na^+$) is endothermic process.

94. Answer (4)

Hint: With increasing atomic number, the ionisation enthalpy of an atom in a period usually increases.

Sol.:

Electronic configuration	Element	Ionisation enthalpy (kJ mol^{-1})
$1s^2 2s^2 2p^4$	O	1314
$1s^2 2s^2 2p^5$	F	1681
$1s^2 2s^2 2p^3$	N	1402
$1s^2 2s^2$	Be	899

95. Answer (2)

Hint: In a period the electronegativity generally increases from left to right.

Sol.: In a group electronegativity generally decreases

Correct order of electronegativity

O > N > S > P

96. Answer (2)

Hint: In PCl_5, three bonds are equatorial bonds while two bonds are axial bonds.

Sol.: As the axial bond pairs suffer more repulsive interaction from the equatorial bond pairs, therefore axial bonds have been found to be slightly longer and hence slightly weaker than the equatorial bonds.

97. Answer (1)

Hint: For isoelectronic species, more is the charge on cation, more is polarising power.

Sol.: More is the polarising power of cation, more is the covalent character of the compound.

98. Answer (3)

Hint: If the central atom is *sp* hybridized or sp^3d hybridized the shapes of the molecule may be linear.

Sol.:

Molecules	Hybridization of central atom	Shape
CO_2, $BeCl_2$, CS_2	*sp*	Linear
C_2H_2	Each carbon is *sp* hybridised	Linear
H_2O	sp^3	V-shape
SO_2	sp^2	Bent

99. Answer (4)

Hint: Along a period, the atomic size decreases as effective nuclear charge increases.

Sol.:

- If an atom loses its electron it becomes a cation. The hold of electrons by the nucleus increases and the size decreases.
- If an atom gains one electron, it becomes an anion. The hold of electrons by the nucleus decreases and the size of anion increases.

100. Answer (4)

Hint & Sol.: A π bonding MO has symmetrical electron density above and below the inter-nuclear axis. The π^* antibonding MO has a node between the nuclei.

[BOTANY]

SECTION - A

101. Answer (3)

Hint: In this kingdom both autotrophic and heterotrophic modes of nutrition are present.

Sol.: The three domain system proposed by Carl Woese divides the kingdom Monera into two domains.

102. Answer (2)

Hint: *Nostoc* grows in nutrient enriched water bodies.

Sol.: *Nostoc* often blooms in polluted water bodies.

103. Answer (4)

Hint: Viroids are found to be free RNA.

Sol.: Viroids are smaller than viruses and cause potato spindle tuber disease.

Prions cause infectious neurological disease.

104. Answer (3)

Hint: Methanogens are found in one of the most harsh habitats.

Sol.: Methanogens are a type of archaebacteria.

105. Answer (3)

Hint: Creutzfeldt-Jacob disease in humans is caused by prions.

Sol.: Prions consist of abnormally folded protein and was similar in size to viruses.

106. Answer (2)

Hint: Mycoplasma are placed in a kingdom Monera.

Sol.: Mycoplasma are prokaryotic organisms and they are devoid of nuclear membrane. Many mycoplasma are pathogenic in animals and plants.

107. Answer (2)

Hint: Slime moulds are saprophytic protists.

Sol.: Under suitable condition, they form an aggregation called plasmodium. Later during unfavourable condition plasmodium differentiate and form fruiting bodies. The spores possess true walls and they can survive for many years under adverse condition.

108. Answer (4)

Hint: Diatoms are chief producers in the oceans.

Sol.: Diatoms are members of Protista group. It is an eukaryotic organism and has membrane bound organelles as well as well defined nucleus.

109. Answer (1)

Hint: Dikaryophase is observed in members of Ascomycetes and Basidiomycetes.

Sol.: All of the given characteristics are found in Basidiomycetes. *Ustilago* is a member of Basidiomycetes.

110. Answer (4)

Hint: Hyphae are continuous tubes filled with multinucleated cytoplasm called coenocytic hyphae and are found in members of Phycomycetes.

Sol.: *Albugo* is a member of Phycomycetes with aseptate and coenocytic mycelium.

111. Answer (3)

Hint: *Trypanosoma* cause sleeping sickness.

Sol.:

- The parasitic form of flagellated protozoan causes disease like sleeping sickness.
- Amoeboid protozoan produce false feet to capture prey.
- Ciliated protozoan have cavity that opens to the outside of cell surface.
- Sporozoan includes diverse organism that have infectious spore like stage in their life cycle.

112. Answer (3)

Hint: Yeast is unicellular.

Sol.: Mostly fungi have multicellular body organisation but *Saccharomyces* is unicellular fungus.

113. Answer (4)

Hint: Conidia are the asexual spores.

Sol.: In fungi, the sexual reproduction takes place by oospores, ascospores and basidiospores.

114. Answer (3)

Hint: Dinoflagellates appear yellow, green, brown, blue or red depending on the main pigments present in their cells.

Sol.: Dinoflagellates are mostly marine and photosynthetic. Most of them have two flagella one lies longitudinally and other transversely.

115. Answer (1)

Hint: Bacteria as a group show the most extensive metabolic diversity.

Sol.: Bacteria are the sole members of kingdom Monera.

Bacterial structure are very simple, they are very complex in behaviour.

116. Answer (3)

Hint: The biological name of Mango is *Mangifera indica*.

Sol.: The first word denoting the genus starts with a capital letter while the specific epithet starts with a small letter.

117. Answer (4)

Hint: Label on herbarium sheet provides information about local name, botanical name and family of specimen.

Sol.: Label of the herbarium sheet does not mention size of the plant.

118. Answer (2)

Hint: Sapindale is an order.

Sol.: Insecta is a class.

119. Answer (3)

Hint: Human being is only living organism who is aware of himself.

Sol.: *Solanum melongena* belongs to Solanaceae family.

120. Answer (4)

Hint: For plants, scientific names are based on agreed principle and criteria provided in ICBN.

Sol.: ICBN stands for International Code for Botanical Nomenclature.

121. Answer (2)

Hint: T.O. Diener discovered new infectious agent called viroids that was smaller than viruses.

Sol.: M.W. Beijerinck demonstrated that the extract of the infected plants of tobacco could cause infection in healthy plants.

D.J. Ivanowsky recognised certain microbes as causal organisms of mosaic disease of tobacco.

W.M. Stanley showed that virus could be crystallised.

122. Answer (4)

Hint: In Ascomycetes, sexual spores called ascospores are produced endogenously.

Sol.: In members of Basidiomycetes, sexual spores are produced exogenously after karyogamy followed by meiosis.

123. Answer (3)

Hint: He classified plants into trees, shrubs and herbs.

Sol.: Aristotle divided animals into two groups, those which had red blood and those that did not.

124. Answer (3)

Hint: Most fungi absorb soluble organic matter from dead substrates.

Sol.: Fungi constitute a unique kingdom of heterotrophic organisms.

Members of Plantae show autotrophic mode of nutrition.

125. Answer (2)

Hint: In deuteromycetes, perfect stage (sexual stage) is absent.

Sol.: Conidia are asexual spores generally found in ascomycetes and deuteromycetes.

126. Answer (2)

Hint: *Penicillium* is the source of antibiotic.

Sol.: *Aspergillus* is known as the weed of laboratory.

127. Answer (4)

Hint: The viruses that infect animal have either ss or dsRNA or dsDNA.

Sol.: The viruses that infect plant generally have single stranded RNA and viruses that infect bacteria usually have dsDNA, as genetic material.

128. Answer (3)

Hint: Influenza is caused by virus.

Sol.: Typhoid and citrus canker are caused by bacteria.

Herpes, AIDS, mumps and influenza are caused by viruses.

129. Answer (3)

Hint: Sporangiospores are produced by zygomycetes.

Conidia are produced by ascomycetes and deuteromycetes.

Sol.: Conidia are asexual spores produced by *Aspergillus*, *Penicillium* and *Trichoderma.*

Sporangiospores are non motile asexual spores produced by *Mucor* and *Rhizopus.*

130. Answer (4)

Hint: R. H. Whittaker gave five kingdom classification.

Sol.: A heterotrophic bacterium is helpful in making curd. Chemosynthetic autotrophic bacteria play great role in recycling nutrients.

131. Answer (4)

Hint: Members of Animalia are eukaryotes.

Sol.: Bladderwort and Venus fly trap are insectivorous plants and *Cuscuta* is a parasite.

Members of kingdom Animalia do not have cell wall.

132. Answer (2)

Hint: Ascospores are produced endogenously in sac like asci.

Sol.: *Albugo* belongs to Phycomycetes.

Trichoderma have only asexual stage in their life cycle.

Neurospora belongs to Ascomycetes.

Claviceps belongs to Ascomycetes in which ascospores are produced endogenously.

133. Answer (4)

Hint: Late blight of potato is caused by a member of Oomycetes.

Sol.: *Phytophthora infestans* causes late blight of potato.

134. Answer (3)

Hint: The given diagram is of bacteriophage a bacterial virus.

Sol.: In the protein coat of bacteriophage, head encloses DNA. Collar represents the region between head and sheath. In the figure, it is labelled as A. Label B represents tail fibres.

135. Answer (1)

Hint: The members of chrysophyta group have cell wall embedded with silica.

Sol.: In diatoms, the cell walls form two thin overlapping shells which fit together as in soap box.

SECTION - B

136. Answer (2)

Hint: Catalogue includes the alphabetical arrangement of species of a particular place describing their features.

Sol.: Museum have collections of preserved plants and animals which are used for study and reference. Flora gives the actual account of habitat and distribution of various plants of a given area. Herbarium serves as quick source of reference in taxonomical studies.

137. Answer (3)

Hint: Biological nomenclature of plants follows the rules assigned in ICBN.

Sol.: The correctly printed name of wheat is *Triticum aestivum.*

138. Answer (1)

Hint: Lower the taxa, more are the characteristics that the members within the taxon share.

Sol.: As we go higher from species to kingdom, the number of common characteristics goes on decreasing.

139. Answer (4)

Hint: *Chlamydomonas* and *Paramoecium* both are single celled eukaryotes.

Sol.: According to R.H. Whittaker, kingdom Protista has brought together *Chlamydomonas*, *Chlorella* with *Paramoecium* and *Amoeba*.

140. Answer (3)

Hint: Comma-shaped bacteria are called vibrio.

Sol.: Rod-shaped bacteria are called Bacilli.

141. Answer (2)

Hint: All single celled eukaryotes are placed under Protista.

Sol.: Eukaryotic organisms have both 70S and 80S types of ribosomes.

142. Answer (4)

Hint: Euglenoids have a protein rich layer called pellicle which makes their body flexible.

Sol.: Euglenoids do not have cell wall.

143. Answer (2)

Hint: *Pinus* shows mycorrhizal association.

Sol.: Mycorrhiza is the association of fungi with roots of higher plants.

144. Answer (2)

Hint: Viruses are non-cellular organisms and they are inert outside their specific host.

Sol.: Viruses are small obligate parasites that cannot grow outside the living cells. It takes over the machinery of the host's cell to replicate themselves.

145. Answer (2)

Hint: Members of Deuteromycetes have only asexual or vegetative phase of fungi.

Sol.: *Alternaria*, *Trichoderma* and *Colletotrichum* are members of Deuteromycetes.

146. Answer (1)

Hint: Fusion of protoplasm between two motile or non-motile gametes is called plasmogamy.

Sol.: The sexual cycle involves the following three steps :

Plasmogamy $\rightarrow$ Karyogamy $\rightarrow$ Meiosis

147. Answer (2)

Hint: Morels and truffles belong to Ascomycetes class.

Sol.: In ascomycetes, mycelium is branched and septate. The asexual spores are produced exogenously. Sexual spores are called ascospores which are produced endogenously.

148. Answer (4)

Hint: These are photosynthetic autotrophic eubacteria.

Sol.: *Nostoc* and *Anabaena* can fix atmospheric nitrogen in specialised cell that are called heterocyst.

149. Answer (2)

Hint: TMV are riboviruses.

Sol.: TMV are viruses which have ssRNA.

150. Answer (2)

Hint: The algal component of lichens is known as phycobiont, which is autotrophic and it prepares food for fungi.

Sol.: In lichens fungi provide shelter and absorb mineral nutrients.

Lichens were not introduced in the five kingdom classification proposed by R.H. Whittaker.

[ZOOLOGY]

SECTION - A

151. Answer (3)

Hint: This is the volume of air that will remain in the lungs after a normal expiration.

Sol.: Expiratory Capacity (EC): Total volume of air a person can expire after a normal inspiration. This includes tidal volume and expiratory reserve volume.

Functional Residual Capacity (FRC): Volume of air that will remain in the lungs after a normal expiration. This includes ERV+RV.

Vital Capacity (VC): The maximum volume of air a person can breathe in after a forced expiration. This includes ERV, TV and IRV or the maximum volume of air a person can breathe out after a forced inspiration.

Expiratory Reserve Volume (ERV): Additional volume of air, a person can expire by a forcible expiration. This averages 1000 mL to 1100 mL.

152. Answer (3)

Hint: Lower invertebrate

Sol.: Flatworms respire through body surface by simple diffusion in free living forms. Amphibians like frogs can respire through their moist skin (cutaneous respiration) also. Among vertebrates, fishes use gills whereas amphibians, reptiles, birds and mammals respire through lungs.

153. Answer (2)

Hint: These vertebrae lie below the neck

Sol.: Trachea divides at the level of 5^{th} thoracic vertebra in humans.

154. Answer (1)

Hint: pO_2 of 40 mmHg

Sol.:

Respiratory Gas	Atmospheric Air	Alveoli	Blood (Deoxygenated)	Blood (Oxygenated)	Tissues
O_2	159	104	40	95	40
CO_2	0.3	40	45	40	45

155. Answer (4)

Hint: Gives rise to a number of very thin, irregular-walled and vascularised bag-like structures.

Sol.: Incomplete rings of hyaline cartilage prevent collapse of primary, secondary, tertiary bronchi and initial bronchioles. Each terminal bronchiole gives rise to a number of very thin, irregular-walled and vascularised bag-like structures called alveoli. The branching network of bronchi, bronchioles and alveoli comprise the lungs.

156. Answer (3)

Hint: Minute volume

Sol.: Volume of air a healthy man can inhale or exhale effortlessly in each breath is tidal volume.

Minute volume = Tidal volume × Respiratory rate
= (500 mL × 12) to (500 mL × 16)

= 6000 mL to 8000 mL

157. Answer (3)

Hint: Exclude disease related to chronic smokers

Sol.: In certain industries, especially those involving grinding or stone-breaking, so much dust is produced that the defense mechanism of the body cannot fully cope with the situation. Long exposure can give rise to inflammation leading to fibrosis of lungs (proliferation of fibrous tissues) and thus causing serious lung damage. Workers in such industries should wear protective masks.

Typhoid and pneumonia are bacterial diseases.

158. Answer (3)

Hint: Function performed by alveoli

Sol.: The part starting with the external nostrils up to the terminal bronchioles constitute the conducting part whereas the alveoli and their ducts form the respiratory or exchange part of the respiratory system.

The conducting part transports the atmospheric air to the alveoli, clears it from foreign particles, humidifies and also brings the air to body temperature. Exchange part is the site of actual diffusion of O_2 and CO_2 between blood and atmospheric air.

159. Answer (1)

Hint: Nasal chamber opens into this region of respiratory tract.

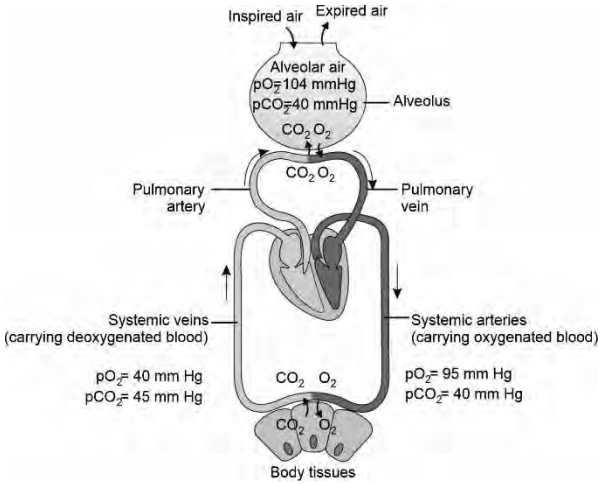
Sol.: Pharynx opens through the larynx region into the trachea. Epiglottis is thin, elastic flap guarding the windpipe. We have two lungs which are covered by a double layered pleura, with pleural fluid between them. It reduces friction on the lung-surface.

The outer pleural membrane is in close contact with the thoracic lining whereas the inner pleural membrane is in contact with the lung surface.

160. Answer (3)

Hint: It carries oxygenated blood.

Sol.:



161. Answer (4)

Hint: Forms at tissue level

Sol.: Myoglobin is a red coloured oxygen storing pigment present in muscles.

Carboxyhaemoglobin is formed by binding of haemoglobin with carbon monoxide.

Methemoglobin is a form of haemoglobin in which iron in the haem group is in Fe^{3+} state, rather than the normal Fe^{2+} state.

162. Answer (2)

Hint: 1 mL of deoxygenated blood delivers approximately 0.04 mL of CO_2 to the alveoli.

Sol.: Every 100 mL of deoxygenated blood delivers approximately 4 mL of CO_2 to the alveoli. Therefore, every 800 mL of deoxygenated blood will deliver approximately 32 mL of CO_2 to the alveoli in an adult man under normal physiological conditions.

163. Answer (2)

Hint: Exchange of gases occurs here

Sol.: Each terminal bronchiole gives rise to a number of very thin, irregular walled and vascularised bag-like structures called alveoli where exchange of gases takes place between blood and alveolar air. Alveoli is lined by simple squamous epithelium.

164. Answer (4)

Hint: This occurs during inspiration.

Sol.: During inspiration, diaphragm and external inter-costal muscles contract.

Intrapleural pressure becomes more negative. Volume of thoracic cavity increases.

165. Answer (1)

Hint: Maximum O_2 is transported as oxyhaemoglobin.

Sol.: Blood is the medium of transport for O_2 and CO_2. About 97 percent of O_2 is transported by RBCs in the blood. The remaining 3 percent of O_2 is carried in a dissolved state through the plasma. Nearly 20-25 percent of CO_2 is transported by RBCs whereas 70 percent of it is carried as bicarbonate. About 7 percent of CO_2 is carried in a dissolved state through plasma.

166. Answer (3)

Hint: Exclude the region that possess chemosensitive area

Sol: Human beings have a significant ability to maintain and moderate the respiratory rhythm to suit the demands of the body tissues. This is done by the neural system. A specialised centre present in the medulla region of the brain called respiratory rhythm centre is primarily responsible for this regulation. Another centre present in the pons region of the brain called pneumotaxic centre can moderate the functions of the respiratory rhythm centre. Neural signal from this centre can reduce the duration of inspiration and thereby alter the respiratory rate.

167. Answer (1)

Hint: Leads to left shift of O_2-dissociation curve

Sol.: In the alveoli, where there is high pO_2, low pCO_2, lesser H^+ concentration and lower temperature, the factors are all favourable for the formation of oxyhaemoglobin, whereas in the tissues, where low pO_2, high pCO_2, high H^+ concentration and higher temperature exist,the conditions are favourable for dissociation of oxygen from the oxyhaemoglobin.

168. Answer (3)

Hint: Less than 20/min

Sol.: Rate of breathing under normal physiological conditions in a healthy man is 12-16/min.

169. Answer (2)

Hint: Nasal and oral cavity opens into pharynx followed by larynx.

Sol.: Flow chart showing structures involved in respiratory passage is

Nostrils $\rightarrow$ Nasal chamber $\rightarrow$ Pharynx $\rightarrow$ Larynx $\rightarrow$ Trachea $\rightarrow$ Primary bronchi $\rightarrow$ Secondary bronchi $\rightarrow$ Tertiary bronchi $\rightarrow$ Bronchioles $\rightarrow$ Alveolar ducts $\rightarrow$ Atria $\rightarrow$ Alveolar sac $\rightarrow$ Alveoli

170. Answer (1)

Hint: Animal respires through moist skin.

Sol.: Among vertebrates, fishes use gills whereas amphibians, reptiles, birds and mammals respire through lungs. Amphibians like frogs can respire through their moist skin (cutaneous respiration) also. Earthworm use their moist cuticle and insects have a network of tube to transport atmospheric air within the body.

171. Answer (1)

Hint: Utilisation of O_2 by tissue occurs in the last.

Sol.: Respiration involves the following steps:

(i) Breathing or pulmonary ventilation by which atmospheric air is drawn in and CO_2 rich alveolar air is released out.

(ii) Diffusion of gases (O_2 and CO_2) across alveolar membrane.

(iii) Transport of gases by the blood.

(iv) Diffusion of O_2 and CO_2 between blood and tissues.

(v) Utilisation of O_2 by the cells for catabolic reactions and resultant release of CO_2.

172. Answer (3)

Hint: Contraction of external inter-costal muscles lifts up the ribs and sternum.

Sol.: Inspiration is initiated by contraction of diaphragm which increases the volume of thoracic chamber in the antero-posterior axis. The contraction of external inter-costal muscles lift up the ribs and the sternum causing an increase in the volume of the thoracic chamber in the dorso-ventral axis. Relaxation of diaphragm and external inter- costal muscles leads to expiration.

173. Answer (4)

Hint: Average volume is 1100 mL to 1200 mL.

Sol.: Residual volume: The volume of air which remains in the lungs even after the forceful expiration. This averages to 1100–1200 mL.

174. Answer (2)

Hint: 20 mL of O_2 is carried by 100 mL of oxygenated blood during normal physiological conditions.

Sol.: Every 100 mL of oxygenated blood can deliver around 5 mL of O_2 to the tissues under normal physiological conditions in humans. Every 100 mL of deoxygenated blood delivers approximately 4 mL of CO_2 to the alveoli.

175. Answer (2)

Hint: High H^+ concentration is favourable for dissociation of O_2 from oxyhaemoglobin.

Sol.: Binding of oxygen with haemoglobin is primarily related to partial pressure of O_2. Partial pressure of CO_2, hydrogen ion concentration and temperature are other factors that can affect with the binding of oxygen with Hb.

176. Answer (3)

Hint: 97% of O_2 is transported by RBCs in the blood.

Sol.: Blood is the medium of transport for O_2 and CO_2. About 97% of O_2 is transported by RBCs in the blood. The remaining 3 percent of O_2 is carried in a dissolved state through the plasma.

177. Answer (3)

Hint: Pulmonary artery carries deoxygenated blood.

Sol.:

Respiratory Gas	Atmospheric Air	Alveoli	Blood (Deoxygenated)	Blood (Oxygenated)	Tissue
O_2	159	104	40	95	40
CO_2	0.3	40	45	40	45

178. Answer (1)

Hint: It increases breathing rate.

Sol.: Centre present in the pons region of the brain called pneumotaxic centre can moderate the functions of the respiratory rhythm centre. Neural signals from this centre can reduce the duration of inspiration and thereby alter the respiratory rate.

179. Answer (2)

Hint: Percentage of CO_2 carried by RBCs

Sol.: As the solubility of CO_2 is 20-25 times higher than that of O_2, the amount of CO_2 that can diffuse through the diffusion membrane per unit difference in partial pressure is much higher as compared to that of O_2.

180. Answer (1)

Hint: Area sensitive to CO_2 and H^+ ions is present in hindbrain

Sol.: A specialised centre present in the medulla region of the brain called respiratory rhythm centre is primarily responsible to regulate respiratory rhythm. A chemosensitive area is located adjacent to the rhythm centre which is highly sensitive to CO_2 and H^+ ions.

181. Answer (3)

Hint: pO_2 is high at alveolar site.

Sol.: At the tissue site where pCO_2 is high due to catabolism, CO_2 diffuses into blood (RBCs and plasma) and forms HCO_3^- and H^+. At the alveolar site where pCO_2 is low, the reaction proceeds in opposite direction leading to formation of CO_2 and H_2O. Thus, CO_2 trapped as bicarbonate at the tissue level, is transported to the alveoli and is released out as CO_2.

182. Answer (4)

Hint: Additional muscles of expiration.

Sol.: An increase in pulmonary volume decreases the intra-pulmonary pressure to less than the

atmospheric pressure which forces the air from outside to move in the lungs, *i.e.*, inspiration. An increase in intra-pulmonary pressure to slightly above the atmospheric pressure causes the expulsion of air from the lungs, *i.e.*, expiration.

183. Answer (2)

Hint: Respiratory surface is decreased

Sol.: Asthma – Occurs due to an allergic reaction to foreign substances that affect the respiratory tract.

Emphysema – One of the major causes of this is cigarette smoking.

Pneumoconiosis – Occurs due to inhalation of mineral dust, characterised by inflammation, coughing and fibrosis.

Asphyxia – This condition is caused by increase in CO_2 concentration in tissues.

184. Answer (4)

Hint: It includes vital capacity and residual volume

Sol.: Inspiratory capacity (IC) = TV + IRV

Expiratory capacity (EC) = TV + ERV

Functional residual Capacity (FRC) = ERV + RV

Vital Capacity (VC) = ERV + TV + IRV

Total Lung Capacity (TLC) = TV + IRV +ERV + RV

185. Answer (4)

Hint: Helps is lung movement

Sol.: Pleural fluid reduces the friction on the lung surface. Negative intrapleural pressure prevents collapsing of lungs.

SECTION - B

186. Answer (1)

Hint: This part is not supported by cartilaginous rings.

Sol.: The part starting with the external nostrils upto the terminal bronchioles constitute the conducting part whereas the alveoli and their ducts form the respiratory or exchange part of respiratory system.

187. Answer (4)

Hint: Vital capacity

Sol.: Vital Capacity (VC): The maximum volume of air a person can breathe in after a forced expiration. This includes ERV, TV and IRV or the maximum volume of air a person can breathe out after a forced inspiration.

Functional Residual Capacity (FRC): Volume of air that will remain in the lungs after a normal expiration. This includes ERV+RV.

188. Answer (2)

Hint: pO_2 decreases

Sol.: Emphysema is a chronic disorder in which alveolar walls are damaged due to which respiratory surface is decreased. One of the major causes of this is cigarette smoking. Asthma is a difficulty in breathing causing wheezing due to inflammation of bronchi and bronchioles.

189. Answer (3)

Hint: Assists in transport of gases

Sol.: RBCs contain a very high concentration of the enzyme, carbonic anhydrase and minute quantities of the same is present in the plasma too. This enzyme facilitates the following reaction in both directions.

$$CO_2 + H_2O \underset{}{\overset{\text{Carbonic anhydrase}}{\rightleftharpoons}} H_2CO_3 \overset{\text{Carbonic anhydrase}}{\rightleftharpoons} HCO_3^- + H^+$$

190. Answer (4)

Hint: A vertebrate

Sol.: Mechanisms of breathing vary among different groups of animals depending mainly on their habitats and levels of organisation. Lower invertebrates like sponges, coelenterates, flatworms, *etc.*, exchange O_2 with CO_2 by simple diffusion over their entire body surface.

191. Answer (4)

Hint: Located adjacent to respiratory rhythm centre

Sol.: A chemosensitive area is situated adjacent to the rhythm centre which is highly sensitive to CO_2 and hydrogen ions. Increase in these substances can activate this centre, which in turn can signal the rhythm centre to make necessary adjustments in the respiratory process by which these substances can be eliminated. Receptors associated with aortic arch and carotid artery can also recognise changes in CO_2 and H^+ concentration and send necessary signals to the rhythm centre for remedial actions. The role of oxygen in the regulation of respiratory rhythm is quite insignificant.

192. Answer (1)

Hint: Exclude occupational respiratory disorders

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

Emphysema is a chronic disorder in which alveolar walls are damaged due to which respiratory surface is decreased. One of the major causes of this is cigarette smoking.

193. Answer (1)

Hint: Less than 0.001 m

Sol.: The diffusion membrane is made up of three major layers namely, the thin squamous epithelium of alveoli, the endothelium of alveolar capillaries and the basement substance (composed of a thin basement membrane supporting the squamous epithelium and the basement membrane surrounding the single layer endothelial cells of capillaries) in between them. However, its total thickness is much less than a millimetre.

194. Answer (3)

Hint: Volume of air that will remain in the lungs after forceful expiration

Sol.: Residual volume cannot be measured by spirometer. So, FRC and TLC can also not be measured with this instrument.

195. Answer (1)

Hint: Inspiratory capacity + Functional residual capacity = TLC

Sol.:

S/N	Respiratory Capacities	Formulae and volume
1.	Inspiratory Capacity (IC)	TV + IRV = 3000 – 3500 mL
2.	Expiratory Capacity (EC)	TV + ERV = 1500 – 1600 mL
3.	Functional Residual Capacity (FRC)	ERV + RV = 2100 – 2300 mL
4.	Vital Capacity (VC)	ERV + TV + IRV = 4000 – 4600 mL
5.	Total Lung Capacity (TLC)	RV + ERV + TV + IRV = 5100 – 5800 mL

196. Answer (1)

Hint: Zn^{2+} is the co-factor of this enzyme.

Sol.: $CO_2 + H_2O \underset{}{\overset{\text{Carbonic anhydrase}}{\rightleftharpoons}}$

$$H_2CO_3 \overset{\text{Carbonic anhydrase}}{\rightleftharpoons} HCO_3^- + H^+$$

197. Answer (3)

Hint: It leads to decrease in the blood pressure.

Sol.: Receptors associated with aortic arch and carotid artery can recognise changes in CO_2 and H^+ concentration and send necessary signals to the respiratory rhythm centre for remedial actions. The role of oxygen in the regulation of respiratory rhythm is quite insignificant.

198. Answer (3)

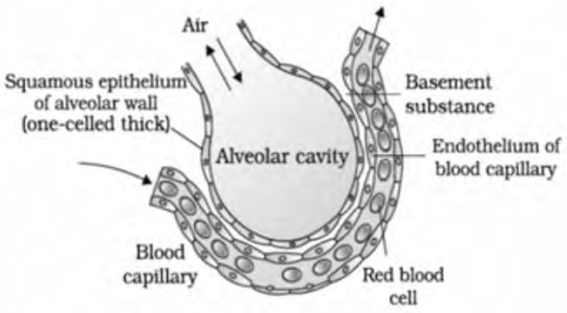
Hint: High pCO_2 and low pO_2 is at tissue level.

Sol.: Oxygen dissociation curve is highly useful in studying the effects of factors like pCO_2, H^+ concentration, *etc.*, on binding of O_2 with haemoglobin. In the alveoli, where there is high pO_2, low pCO_2, less H^+ concentration and lower temperature, the factors are all favourable for the formation of oxyhaemoglobin, whereas in the tissues, where low pO_2, high pCO_2, high H^+ concentration and higher temperature exist, the conditions are favourable for dissociation of oxygen from the oxyhaemoglobin.

199. Answer (2)

Hint: Diffusion membrane contains an acellular membrane.

Sol.:



200. Answer (3)

Hint: Sternum is mid-ventral bone of thorax.

Sol.: The thoracic chamber is formed dorsally by the vertebral column, ventrally by the sternum, laterally by ribs and on the lower side by the dome-shaped diaphragm.

❑ ❑ ❑

All India Aakash Test Series for NEET-2025

TEST - 2 (Code-D)

Test Date : 29/10/2023

ANSWERS

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

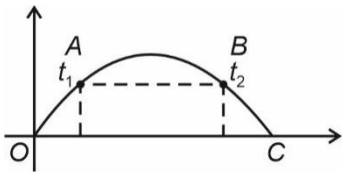
HINTS & SOLUTIONS

[PHYSICS]

SECTION - A

1. Answer (3)

Hint & Sol.:



$$y = u_y t - \frac{1}{2}gt^2$$

$$\Rightarrow \quad gt^2 - 2u_y t + 2y = 0$$

$$t_1 + t_2 = \frac{2u_y}{g} = T$$

2. Answer (2)

Hint: $\tan\theta = \frac{V_y}{V_x}$

Sol.: $\tan\theta = \frac{4t^3}{3t^2} = \frac{4t}{3}$

at $t = 1$

$$\tan\theta = \frac{4}{3}$$

$\theta = 53°$

3. Answer (1)

Hint: $\left|\vec{A}\right| = 1 = \sqrt{A_x^2 + A_y^2 + A_z^2}$

Sol.: $1 = (0.2)^2 + (0.6)^2 + c^2$

$$c = \sqrt{\frac{3}{5}}$$

4. Answer (4)

Hint: Minute hand of a clock covers one rotation in 1 hour or 60 minutes.

Sol.: Angular speed = $\frac{\text{Angular displacement}}{\text{time}}$

$$\omega = \frac{2\pi}{60 \times 60} = \frac{\pi}{1800} \text{ rad/s}$$

5. Answer (2)

Hint: $R = \frac{u^2 \sin 2\theta}{g}$

Sol.: $R_{max} = \frac{u^2}{g}$ at $\theta = \frac{\pi}{4}$ radian

6. Answer (2)

Hint & Sol.: According to triangle law of vector addition, for the given arrangement of vectors, the correct relation is $\vec{C} + \vec{A} = \vec{B} \Rightarrow \vec{C} = \vec{B} - \vec{A}$.

7. Answer (3)

Hint: Use $\vec{v} = \vec{u} + at$

Sol.: $\vec{v} = 4\hat{i} + 6\hat{j}$

$$\vec{u} = 2\hat{i} + 2\hat{j}$$

$$\Rightarrow \quad \vec{v} = \vec{u} + \vec{a}t$$

$$4\hat{i} + 6\hat{j} = (2\hat{i} + 2\hat{j}) + \vec{a} \times 2$$

$$\Rightarrow \quad 2\vec{a} = 2\hat{i} + 4\hat{j}$$

$$\vec{a} = \hat{i} + 2\hat{j}$$

$$|\vec{a}| = \sqrt{1 + 2^2} = \sqrt{5} \text{ m/s}^2$$

8. Answer (1)

Hint: Time period $T = \frac{2\pi r}{v}$

Sol.: $\frac{T_A}{T_B} = \frac{r_A}{v_A}\frac{v_B}{r_B}$

$$\frac{T_A}{T_B} = \frac{(R)(2v)}{v(2R)} = 1$$

9. Answer (2)

Hint: $\vec{v}$ and $\vec{a}$ are non-parallel

Sol.: If $\vec{v}$ and $\vec{a}$ are non-parallel and $|\vec{a}|$ is constant then path is always parabola.

10. Answer (2)

Hint: Centripetal acceleration, $a_c = \frac{v^2}{R}$

Sol.: Given, $\vec{v} = \hat{i} - \hat{j}$

$$|\vec{v}| = \sqrt{1^2 + 1^2} = \sqrt{2} \text{ m/s}$$

Centripetal acceleration:

$$a_c = \frac{v^2}{R} = \frac{\left(\sqrt{2}\right)^2}{6} = \frac{1}{3} \text{ m/s}^2$$

11. Answer (1)

Hint and Sol.:

$a_{rel} = g - g = 0$

$x_{rel} = u_{rel} \times t$

Hence path of one projectile from another projectile will be a straight line path

12. Answer (3)

Hint: In uniform circular motion

$v = \omega r$

Sol.: $v = r\omega$

$4 = 2.\omega$

$\omega = 2$ rad/s

13. Answer (3)

Hint: $\underset{\left(\text{Velocity of rain w.r.t. boy}\right)}{\vec{v}_{R/B}} = \underset{\left(\text{Velocity of rain w.r.t. ground}\right)}{\vec{v}_{R/g}} - \underset{\left(\text{Velocity of boy w.r.t. ground}\right)}{\vec{v}_{B/g}}$

Sol.: Using relative velocity concept, we can write

$\vec{v}_{R/B} = \vec{v}_{R/g} - \vec{v}_{B/g}$

$-12\hat{j} = \vec{v}_{R/g} - 5\hat{i}$

$\vec{v}_{R/g} = 5\hat{i} - 12\hat{j}$

$\left|\vec{v}_{R/g}\right| = \sqrt{5^2 + 12^2} = 13$ m/s

14. Answer (2)

Hint: $T = \sqrt{\frac{2h}{g}}$

T = time of flight

Sol.: $T = \sqrt{\frac{2 \times 1960}{9.8}}$

$T = \sqrt{400}$

$T = 20$ s

15. Answer (1)

Hint & Sol.: Equation of trajectory of a projectile is given by $y = x\tan\theta\left(1 - \frac{x}{R}\right)$. By comparison, we get $R = 100$ m

16. Answer (3)

Hint & Sol.: In uniform circular motion speed is constant but acceleration is variable.

17. Answer (3)

Hint: $R = \sqrt{a^2 + b^2 + 2ab\cos\theta}$

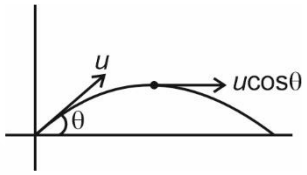
Sol.: $R = \sqrt{(4a)^2 + b^2 + 2(4a)b\cos\left(\frac{\pi}{2}\right)}$

$R = \sqrt{8^2 + 8^2}$

$R = 8\sqrt{2}$ unit

18. Answer (3)

Hint & Sol.: At maximum height only horizontal component of velocity is present.



19. Answer (2)

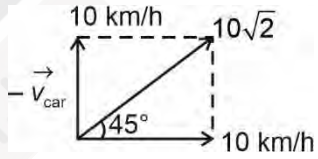
Hint: Unit vector $\hat{P} = \frac{\vec{P}}{|\vec{P}|}$

Sol.: $\hat{P} = \frac{\hat{i} + \hat{j} + \hat{k}}{\sqrt{3}}$

20. Answer (3)

Hint: $\vec{V}_{\text{bird/car}} = \vec{V}_b - \vec{V}_c$

Sol.:

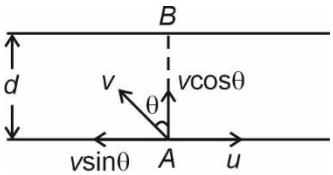


$\therefore$ Velocity of bird w.r.t. car is $10\sqrt{2}$, NE

21. Answer (2)

Hint: Shortest path is along the perpendicular direction of river flow

Sol.:



Shortest path is '*AB*'

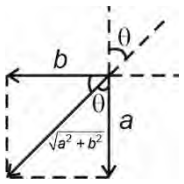
$t = \frac{d}{v\cos\theta} \Rightarrow \frac{30}{60} = \frac{1}{2 \times 2\cos\theta} \Rightarrow 2\cos\theta = 1$

$\Rightarrow \theta = 60^\circ$ therefore, $u = v\sin\theta = 2 \times \frac{\sqrt{3}}{2} = \sqrt{3}$ km/h

22. Answer (4)

Hint: $\vec{V}_{\text{rain/cyclist}} = \vec{V}_{\text{rain}} - \vec{V}_{\text{cyclist}}$

Sol.:



$$\sin\theta = \frac{b}{\sqrt{a^2+b^2}} \quad \Rightarrow \quad \theta = \sin^{-1}\left(\frac{b}{\sqrt{a^2+b^2}}\right) \quad \text{and}$$

$$\theta = \tan^{-1}\left(\frac{b}{a}\right)$$

23. Answer (4)

Hint: Time of flight of projectile motion is given by

$$T = \frac{2u\sin\theta}{g}$$

Sol.: $T_A = \frac{2u\sin\theta}{g}, T_B = \frac{2u\sin(90-\theta)}{g} = \frac{2u\cos\theta}{g}$

$$T_A + T_B = \frac{2u}{g}[\sin\theta + \cos\theta]$$

$$= \frac{2u}{g}\sqrt{2}\left[\frac{1}{\sqrt{2}}\sin\theta + \frac{1}{\sqrt{2}}\cos\theta\right]$$

$$= \frac{2\sqrt{2}u}{g}\sin\left(\frac{\pi}{4}+\theta\right) = \frac{\sqrt{8}u}{g}\sin\left(\frac{\pi}{4}+\theta\right)$$

24. Answer (1)

Hint: $H_{max} = \frac{u^2\sin^2\theta}{2g}$

$$H_{max} \propto \sin^2\theta$$

Sol.: $\frac{H_A}{H_B} = \frac{\sin^2\theta_1}{\sin^2\theta_2}$

$$\frac{H_A}{H_B} = \frac{\left(\frac{3}{5}\right)^2}{\left(\frac{4}{5}\right)^2} = \frac{9}{16}$$

25. Answer (2)

Hint: $y = x\tan\theta\left(1-\frac{x}{R}\right), \qquad \frac{H}{R} = \frac{\tan\theta}{4}$

Sol.: $y = \sqrt{3}\,x - x^2$

$$y = \sqrt{3}\,x\left(1-\frac{x}{\sqrt{3}}\right)$$

$R = \sqrt{3}$ m, $\qquad \tan\theta = \sqrt{3}$

$$H = R\frac{\tan\theta}{4} = \sqrt{3}x\frac{\sqrt{3}}{4} = \frac{3}{4}\text{ m}$$

26. Answer (3)

Hint: Acceleration of *A* w.r.t. *B* is $\vec{a}_{AB} = \vec{a}_A - \vec{a}_B$

$$\vec{a}_A = \frac{d^2\vec{r}_A}{dt^2}, \qquad \vec{a}_B = \frac{d^2\vec{r}_B}{dt^2}$$

Sol.: $\vec{r}_A = 3t^2\hat{i} + 2t\,\hat{j}, \ \vec{r}_B = t\,\hat{i} + 2t^2\,\hat{j} + 3\hat{k}$

$$\vec{v}_A = \frac{d\vec{r}_A}{dt} = 6t\,\hat{i} + 2\hat{j}, \qquad \vec{v}_B = \frac{d\vec{r}_B}{dt} = \hat{i} + 4t\,\hat{j}$$

$$\vec{a}_A = \frac{d\vec{v}_A}{dt} = 6\hat{i}, \ \ \vec{a}_B = 4\hat{j}$$

$$\vec{a}_{AB} = \vec{a}_A - \vec{a}_B = 6\hat{i} - 4\hat{j}$$

$$|\vec{a}_{AB}| = \sqrt{6^2+4^2} = \sqrt{36+16} = \sqrt{52}$$

27. Answer (4)

Hint: $\vec{V}_{br} = \vec{V}_b - \vec{V}_r$

$$\Rightarrow \vec{V}_b = \vec{V}_{br} + \vec{V}_r$$

Sol.: $\vec{V}_b = \vec{V}_{br} + \vec{V}_r$

$$= \left(2\hat{i} + 6\hat{j}\right) + \left(3\hat{i} + 2\hat{j}\right)$$

$$= \left(5\hat{i} + 8\hat{j}\right)\text{ m/s}$$

28. Answer (4)

Hint: $y = ax^2 + bx + c$ is the equation of parabola

Sol.: $x = 2t \Rightarrow t = \frac{x}{2}$

$y = t^2 + 2t + 2$

$$y = \left(\frac{x}{2}\right)^2 + 2\left(\frac{x}{2}\right) + 2$$

$$y = \frac{x^2}{4} + x + 2$$

This is the equation of parabola.

29. Answer (4)

Hint: Use $\vec{v} = \frac{d\vec{r}}{dt}$

Sol.: $\vec{v} = \frac{d\vec{r}}{dt} = 2\hat{i} + 6t\,\hat{j}$

$$\vec{v}|_{t=2} = \left(2\hat{i} + 12\hat{j}\right)\text{ m/s}$$

30. Answer (4)

Hint: Distance travelled on a circle is given by, $l = R\theta$

Sol.: For quarter circle, angle covered is $\frac{\pi}{2}$

$\therefore$ distance = $R\theta \Rightarrow \ell = \frac{\pi R}{2}$ ...(i)

$\text{Time} = \frac{\text{distance}}{\text{speed}} = \frac{\pi R/2}{v}$

$t = \frac{22 \times 14}{7 \times 2 \times 2} = 11\,\text{s}$

31. Answer (3)

Hint: Maximum horizontal range is achieved by a ball when it is thrown at 45° from horizontal.

Sol.: $R = \frac{u^2 \sin 2\theta}{g}$

for R_{max}, $\theta = 45°$

$\therefore R_{max} = \frac{u^2}{g} = 200\,\text{m}$ ...(i)

Maximum height can be achieved when a ball is thrown vertically upward.

$H_{max} = \frac{u^2}{2g}$

$\therefore H_{max} = \frac{200}{2} = 100\,\text{m}$

32. Answer (2)

Hint: Time taken by the projectile to reach maximum height is $\frac{u\sin\theta}{g}$.

Sol.: $t = \frac{u\sin\theta}{g}$

Given $t_1 = t_2$

$\therefore \frac{u_1 \sin\theta_1}{g} = \frac{u_2 \sin\theta_2}{g}$

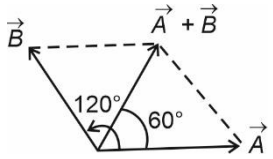
$\frac{u_1}{u_2} = \frac{\sin\theta_2}{\sin\theta_1}$

33. Answer (1)

Hint: $R = \sqrt{A^2 + B^2 + 2AB\cos\theta}$

Sol.: $|\vec{A}| = |\vec{B}| = |\vec{R}|$

$\therefore R^2 = \sqrt{R^2 + R^2 + 2R^2\cos\theta} \Rightarrow \theta = 120°$



Resultant of two vectors of equal magnitude is always at the angle bisector of the angle between the vectors.

34. Answer (3)

Hint: $\vec{A} = n\vec{B}$ if $\vec{A} \| \vec{B}$, then n should be positive for parallel vectors.

Sol.: $\frac{a_1}{a_2} = \frac{b_1}{b_2} = \frac{c_1}{c_2}$

$\frac{4}{2} = \frac{3}{\alpha} = \frac{2}{1}$

$3 = 2\alpha$

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

35. Answer (2)

Hint & Sol.: A vector quantity has magnitude as well as direction.

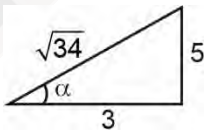
SECTION - B

36. Answer (4)

Hint: Direction cosines $\cos\alpha = \frac{a_x}{\sqrt{a_x^2 + a_y^2 + a_z^2}}$

Sol.: $\vec{P} + \vec{Q} = 3\hat{i} - 3\hat{j} + 4\hat{k}$

Angle with x-axis:



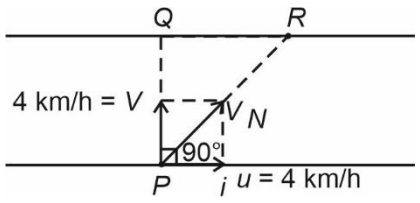
$\cos\alpha = \frac{3}{\sqrt{9+9+16}} = \frac{3}{\sqrt{34}}$

$\tan\alpha = \frac{5}{3}$

$\alpha = \tan^{-1}\left(\frac{5}{3}\right)$

37. Answer (2)

Hint & Sol.:



$\theta = 90°$

38. Answer (1)

Hint: Maximum height attained by a projectile is given by $H = \frac{u^2 \sin^2\theta}{2g}$

Sol.: $H \propto u^2$

$\frac{\Delta H}{H} = \frac{2\Delta u}{u}$

similarly $\frac{\Delta T}{T} = \frac{\Delta u}{u}$

i.e. $\left(\frac{\Delta T}{T}\right)\times 100 = \frac{1}{2}\left(\frac{\Delta H}{H}\right)\times 100$

$= \frac{1}{2}\times 2 = 1\%$

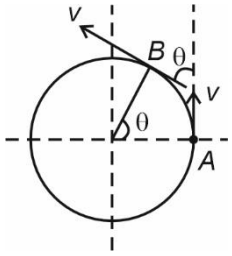
39. Answer (3)

Hint: $T = \sqrt{\frac{2h}{g}}$

Sol.: Time to reach the ground does not depend on horizontal speed.

40. Answer (2)

Hint: $\left|\overrightarrow{\Delta v}\right| = \left|\vec{v}_B - \vec{v}_A\right|$



Sol.: $\Delta v = \sqrt{v^2 + v^2 - 2v^2\cos\theta}$

$\Delta v = \sqrt{2v^2(1-\cos\theta)}$

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

$\Delta v = 2v\sin\left(\frac{\theta}{2}\right)$

41. Answer (3)

Hint: $\left|\vec{C}\right|_{max} = \left|\vec{A}\right| + \left|\vec{B}\right|$ and $\left|\vec{C}\right|_{min} = \left|\vec{A}\right| - \left|\vec{B}\right|$

Sol.: Set of values 4, 8, 2 not possible.

42. Answer (4)

Hint: Average acceleration, $\langle\vec{a}\rangle = \frac{\vec{v}_f - \vec{v}_i}{\Delta t}$

Sol.: $\vec{v}_i = v\cos 45°\hat{i} + v\sin 45°\hat{j} = \frac{v}{\sqrt{2}}\hat{i} + \frac{v}{\sqrt{2}}\hat{j}$

$\vec{v}_f = 0\hat{i} + v\hat{j}$

$\langle\vec{a}\rangle = \frac{\vec{v}_f - \vec{v}_i}{\Delta t} = \frac{v\hat{j} - \left(\frac{v}{\sqrt{2}}\hat{i} + \frac{v}{\sqrt{2}}\hat{j}\right)}{1}$

$\langle\vec{a}\rangle = \left[-\frac{v}{\sqrt{2}}\hat{i} + \left(v - \frac{v}{\sqrt{2}}\right)\hat{j}\right]$ m/s^2

43. Answer (1)

Hint: Concept of centripetal acceleration

Sol.: Centripetal acceleration is towards the centre of the circle.

44. Answer (3)

Hint: Use equation of trajectory

$y = x\tan\theta - \frac{gx^2}{2u^2\cos^2\theta}$

Sol.: Putting x = 30 m in equation of trajectory, we get

$y = 30\tan 30° - \frac{10\times 30\times 30}{2\times 25\times 25\times\cos^2 30°}$

$y = 30\times\frac{1}{\sqrt{3}} - \frac{5\times 6\times 6\times 4}{5\times 5\times 3}$

$y = \left(10\sqrt{3} - \frac{48}{5}\right)$m

45. Answer (1)

Hint: Due to the horizontal motion of plank, ball will have horizontal velocity equal to 10 m/s.

Sol.: u_x = 10 m/s, a_x = 0

u_y = 20 m/s, a_y = – 10 m/s^2

$\therefore v_y = u_y + a_y \times t \Rightarrow v_y = 20 - 10\times 1 = 10$ m/s

At t = 1 s, the speed of the ball will be

$v = \sqrt{v_x^2 + v_y^2} = \sqrt{10^2 + 10^2} = 10\sqrt{2}$ m/s

46. Answer (3)

Hint & Sol.: Use $\cos^2\alpha + \cos^2\beta + \cos^2\gamma = 1$

47. Answer (2)

Hint: Horizontal range $= \frac{u^2\sin 2\theta}{g}$; Maximum height $= \frac{u^2\sin^2\theta}{2g}$

Sol.: $R = \frac{u^2 \sin^2\theta}{g} = \frac{2u^2 \sin\theta\cos\theta}{g}$

$H = \frac{u^2 \sin^2\theta}{2g}$ ...(i)

$\frac{R^2}{H} = \frac{8u^2\cos^2\theta}{2g}$...(ii)

Using equations (i) and (ii) and putting values in equation $\sin^2\theta + \cos^2\theta = 1$, we get

$u = \sqrt{2gH + \frac{gR^2}{8H}}$

$\therefore\ u = \sqrt{2\times10\times30 + \frac{10\times\left(60\sqrt{2}\right)^2}{8\times30}}$

$u = \sqrt{6\times100 + \frac{60^2\times2}{24}}$

u = 30 m/s

48. Answer (2)

Hint: Use equation $s = ut + \frac{1}{2}at^2$

Sol.: $u_y = 20\sin30° = 10$ m/s

Applying $s = ut + \frac{1}{2}at^2$ in vertical direction

$y = u_y t + \frac{1}{2}a_y t^2$

$-400 = 10t + \frac{1}{2}(-10)\times t^2$

$5t^2 - 10t - 400 = 0 \Rightarrow t^2 - 2t - 80 = 0$

$t^2 - 10t + 8t - 80 = 0$

$t(t-10) + 8(t-10) = 0 \Rightarrow (t-10)(t+8) = 0$

$\therefore\ t = -8$ s, 10 s

Hence, the ball will strike the ground after 10 s.

49. Answer (1)

Hint: $y = x\tan\theta\left(1 - \frac{x}{R}\right)$

Sol.: $\tan\theta = \frac{1}{\sqrt{3}}$, $R = \frac{2u_x u_y}{g}$

$R = \frac{2\times\sqrt{3}\times1}{10} = \frac{\sqrt{3}}{5}$

$y = \frac{x}{\sqrt{3}}\left(1 - \frac{5x}{\sqrt{3}}\right)$

$Y = \frac{x}{\sqrt{3}} - \frac{5x^2}{3}$

50. Answer (1)

Hint: $\frac{(a_r)_A}{(a_r)_B} = \frac{r_A\omega_A^2}{r_B\omega_B^2}$

Sol.: $\frac{(a_r)_A}{(a_r)_B} = \frac{R}{2R}\cdot\frac{\omega^2}{4\omega^2} = \frac{1}{8}$

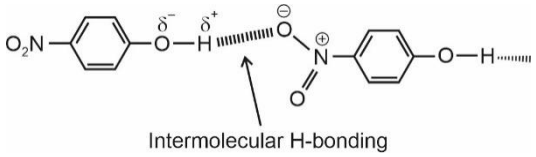
[CHEMISTRY]

SECTION - A

51. Answer (2)

Hint: HF is associated with each other by intermolecular H-bonding.

Sol.:

- Magnitude of H-bonding depends on the physical state of the compound. It is maximum in solid state and minimum in gaseous state.
- Because of intermolecular hydrogen bonding, boiling point of HF is more than HCl.
- 

52. Answer (2)

Hint: Electronic configuration of O_2

$(\sigma1s)^2$ $(\sigma^*1s)^2$ $(\sigma2s)^2$ $(\sigma^*2s)^2$ $(\sigma2p_z)^2$ $\left(\pi2p_x^2 = \pi2p_y^2\right)\left(\pi^*2p_x^1 = \pi^*2p_y^1\right)$

Sol.: Electronic configuration of O_2^+

$(\sigma1s)^2$ $(\sigma^*1s)^2$ $(\sigma2s)^2$ $(\sigma^*2s)^2$ $(\sigma2p_z)^2$ $\left(\pi2p_x^2 = \pi2p_y^2\right)\left(\pi^*2p_x^1\right)$

Highest energy occupied orbital in O_2^+ is π^*2p_x

53. Answer (4)

Hint: E (Z = 43) : [Kr] $4d^5 5s^2$

Sol.:

- One of the valence electrons goes to 5*s* orbital hence the period will be 5th
- Sum of the electrons in valence shell determines group. Group number 5 + 2 = 7.

54. Answer (1)

Hint & Sol.: Octet theory does not explain the relative stability of molecules.

55. Answer (2)

Hint: Electronic configuration of calcium is

Ca (Z = 20) : $1s^2 2s^2 2p^6 3s^2 3p^6 4s^2$

Sol.: $1s^2 2s^2 2p^5$ is electronic configuration of F.

- Calcium will lose two electrons and two fluorine atoms will gain one electron each to attain inert gas configuration. Therefore the formula of the compound will be CaX_2.

56. Answer (4)

Hint: Some of the elements of second and third period which are diagonally related with each other, show similar chemical properties.

Sol.: Be and Al are diagonally related with each other.

57. Answer (4)

Hint: If the number of bond pairs and lone pairs are equal then the species will be isostructural.

Sol.: ClO_3^- and BrO_3^- are pyramidal in shape but are not isoelectronic. Total number of electrons in ClO_3^- is 42 and in BrO_3^- is 60.

58. Answer (3)

Hint: Sulphur posses vacant *d* orbital hence variable hybridization of sulphur is possible in different species.

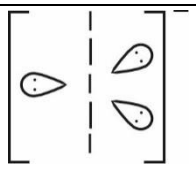
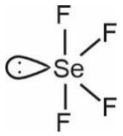
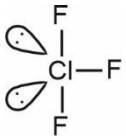
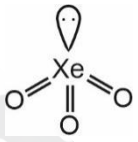
Sol.:

Molecule/ion	Hybridization of central atom
$SOCl_2$	sp^3
SO_2	sp^2
SF_4	sp^3d

59. Answer (1)

Hint: For sp^3d hybridized species, lesser is the number of bond pairs more is the number of lone pairs on central atom

Sol.:

Species	Shape	No. of lone pairs on central atom
I_3^-		3
SeF_4		1
ClF_3		2
XeO_3		1

60. Answer (3)

Hint & Sol.: σ s-orbital does not contain nodal plane.

61. Answer (3)

Hint: For isoelectronic species, more is the value of Z, smaller is the size of ion.

Sol.: Order of Z value : F > O > N

Size of ion : $N^{3-} > O^{2-} > F^-$

62. Answer (4)

Hint: Larger is the size of atom, longer is the bond length.

Sol.: Correct order of size of atom : C > N > O > H

Correct order of bond length

C—C > C—O > N—O > C—H

63. Answer (3)

Hint: After sharing electrons if each atom has 8 electrons in valance shell, then it is said that octet rule has been followed.

Sol.:

Molecule	Electronic distribution
SF_6	12 electrons around S atom
SCl_2	8 electrons around S atom
PF_5	10 electrons around P atom
H_2SO_4	12 electrons around S atom

64. Answer (3)

Hint: The molecular species [number of electrons ≥ 8] in which $\sigma 2p_z$ is vacant will have only π bonds

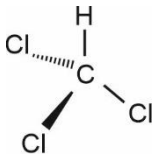
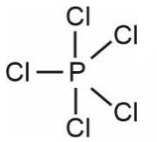
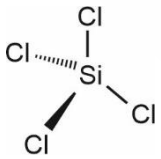
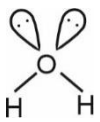
Sol.: C_2 : $(\sigma 1s)^2$ $(\sigma^* 1s)^2$ $(\sigma 2s)^2$ $(\sigma^* 2s)^2$ $\left(\pi 2p_x^2 = \pi 2p_y^2\right)$

C_2 consists of both pi bonds because of the presence of four electrons in two pi molecular orbitals.

65. Answer (1)

Hint: In tetrahedral structure, if the atoms attached with carbon are different the species will be polar

Sol.:

Molecule	Shape	Dipole moment (μ)
$CHCl_3$		μ = 1.04 D
PCl_5		μ = 0
$SiCl_4$		μ = 0
H_2O		μ = 1.85 D

66. Answer (1)

Hint: If bond order is zero the species does not exist.

Sol.: Bond order of Be_2 is zero. Hence it does not exist.

67. Answer (1)

Hint: The elements which show characteristics of both metals and non-metals are called semi-metals.

Sol.: Group 16 elements are called chalcogens.

68. Answer (1)

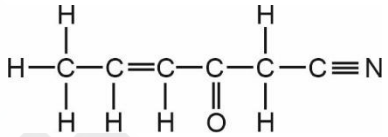
Hint: More is the bond order, smaller is the bond length.

Sol.:

Molecule/Ion	Bond order
N_2	3
N_2^-	2.5
N_2^+	2.5
N_2^{2-}	2

69. Answer (2)

Hint: CN contains two π-bonds

Sol.: 

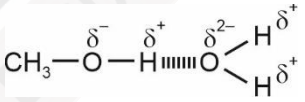
Number of σ-bonds = 14

Number of π-bonds = 4

70. Answer (4)

Hint: Ethyl alcohol contains –OH group.

Sol.: Ethyl alcohol associates with water by intermolecular hydrogen bonding hence it is easily soluble in water



71. Answer (4)

Hint: Halogens easily accept electrons to attain inert gas configuration.

Sol.: Generally down the group, tendency to accept electron by the atoms decreases hence negative electron gain enthalpy decreases.

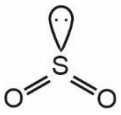
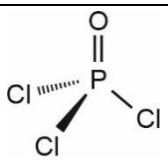
- Correct order of negative electron gain enthalpy : Cl > Br > S > Se

Element	$\Delta_{eg}H$ (kJ mol^{-1})
Cl	–349
Br	–325
S	–200
Se	–195

72. Answer (3)

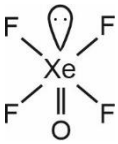
Hint: The species which does not contain multiple bond will not possess π bond

Sol.:

Molecule	Structure	No. of π bonds
C_2H_2	H—C≡C—H	2
SO_2		2
C_2H_6	CH_3—CH_3	0
$POCl_3$		1

73. Answer (4)

Hint: Central atom in $XeOF_4$ is sp^3d^2 hybridised.

Sol.: 

Central atom is sp^3d^2 hybridised and shape of the molecule is square pyramidal.

74. Answer (2)

Hint: Bond order $(BO): \frac{N_b - N_a}{2}$

Sol.: BO of $O_2^+ = \frac{10-5}{2} = 2.5$

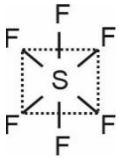
BO of $C_2^+ = \frac{7-4}{2} = 1.5$

BO of $O_2 = \frac{10-6}{2} = 2$

BO of $N_2^+ = \frac{9-4}{2} = 2.5$

75. Answer (3)

Hint: Central atom in SF_6 is sp^3d^2 hybridised

Sol.: 

Maximum number of atoms in a plane will be 5 in SF_6

76. Answer (1)

Hint: Electronic configuration of O_2:

$(\sigma 1s)^2 \quad (\sigma^*1s)^2 \quad (\sigma 2s)^2 \quad (\sigma^*2s)^2 \quad (\sigma 2p_z)^2 \left(\pi 2p_x^2 = \pi 2p_y^2\right)\left(\pi^* 2p_x^1 = \pi^* 2p_y^1\right)$

Sol.: Electronic configuration of

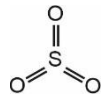
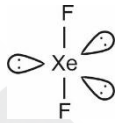
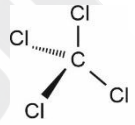
$O_2^+ : (\sigma 1s)^2 \quad (\sigma^*1s)^2 \quad (\sigma 2s)^2 \quad (\sigma^*2s)^2 \quad (\sigma 2p_z)^2 \left(\pi 2p_x^2 = \pi 2p_y^2\right)\left(\pi^* 2p_x^1\right)$

$B_2 : (\sigma 1s)^2 \ (\sigma^*1s)^2 \ (\sigma 2s)^2 \ (\sigma^*2s)^2 \ \left(\pi 2p_x^1 = \pi 2p_y^1\right)$

77. Answer (2)

Hint: Species with sp^3d hybridisation has one of the bond angles equal to 180°.

Sol.:

Species	Shape	Hybridisation	Bond angle
SO_3		sp^2	120°
XeF_2		sp^3d	180°
CCl_4		sp^3	109° 28′

78. Answer (3)

Hint: Oxides of non-metals in their higher oxidation states are acidic in nature.

Sol.:

Oxides	Chemical nature
N_2O	Neutral
CO	Neutral
Na_2O	Basic
CaO	Basic
Cl_2O_7	Acidic
NO_2	Acidic
Al_2O_3	Amphoteric
As_2O_3	Amphoteric

79. Answer (2)

Hint: The elements which belong to *s* or *p* block are called representative elements.

Sol.: Rubidium (Rb) belongs to *s* block. Indium (In) and Tellurium (Te) belong to p-block hence these are representative elements. Fe belongs to '*d*' block

80. Answer (1)

Hint: IUPAC official name of element having atomic number 101 is Mendelevium

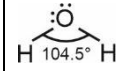
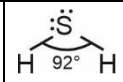
Sol.:

Atomic number	IUPAC official name
101	Mendelevium
102	Nobelium
104	Rutherfordium
106	Seaborgium

81. Answer (4)

Hint: Net dipole moment is determined by bond dipole and shape of the molecule.

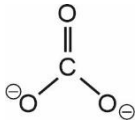
Sol.:

Molecule	Shape	Dipole moment μ(D)
H_2O		1.85
H_2S		0.95
CO_2	O=C=O	0

82. Answer (3)

Hint: $\text{Bond order} = \dfrac{\text{Total number of bonds}}{\text{Total number of } \sigma - \text{bonds}}$

Sol.:

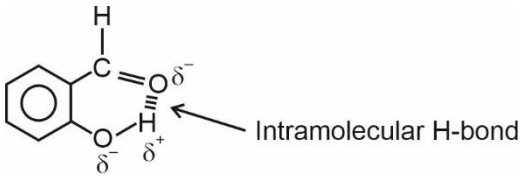


$$\text{Bond order} = \frac{4}{3} = 1.33$$

83. Answer (3)

Hint: Intramolecular hydrogen bond is formed when hydrogen atom is in between the two highly electronegative (F, O, N) atoms, present in the same molecule.

Sol.:



84. Answer (3)

Hint: The species which contains paired electrons in molecular orbitals will be diamagnetic in nature.

Sol.: Li_2 and C_2 contain paired electrons in their molecular orbitals

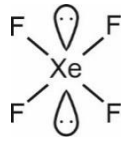
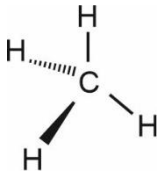
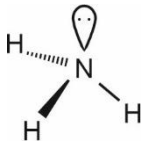
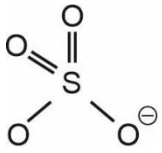
$Li_2 : (\sigma 1s)^2 (\sigma^* 1s)^2 (\sigma 2s)^2$

$C_2 : (\sigma 1s)^2 (\sigma^* 1s)^2 (\sigma 2s)^2 (\sigma^* 2s)^2 \left(\pi 2p_x^2 = \pi 2p_y^2\right)$

85. Answer (1)

Hint: The species in which central atom is sp^3d^2 hybridised may have square planar shape

Sol.:

Species	Hybridisation of central atom	Shape
XeF_4	sp^3d^2	 (Square planar)
CH_4	sp^3	 (Tetrahedral)
NH_3	sp^3	 (Pyramidal)
SO_4^{2-}	sp^3	 (Tetrahedral)

SECTION - B

86. Answer (4)

Hint & Sol.: A π bonding MO has symmetrical electron density above and below the inter-nuclear axis. The π* antibonding MO has a node between the nuclei.

87. Answer (4)

Hint: Along a period, the atomic size decreases as effective nuclear charge increases.

Sol.:

- If an atom loses its electron it becomes a cation. The hold of electrons by the nucleus increases and the size decreases.
- If an atom gains one electron, it becomes an anion. The hold of electrons by the nucleus decreases and the size of anion increases.

88. Answer (3)

Hint: If the central atom is *sp* hybridized or sp^3d hybridized the shapes of the molecule may be linear.

Sol.:

Molecules	Hybridization of central atom	Shape
CO_2, $BeCl_2$, CS_2	*sp*	Linear
C_2H_2	Each carbon is *sp* hybridised	Linear
H_2O	sp^3	V-shape
SO_2	sp^2	Bent

89. Answer (1)

Hint: For isoelectronic species, more is the charge on cation, more is polarising power.

Sol.: More is the polarising power of cation, more is the covalent character of the compound.

90. Answer (2)

Hint: In PCl_5, three bonds are equatorial bonds while two bonds are axial bonds.

Sol.: As the axial bond pairs suffer more repulsive interaction from the equatorial bond pairs, therefore axial bonds have been found to be slightly longer and hence slightly weaker than the equatorial bonds.

91. Answer (2)

Hint: In a period the electronegativity generally increases from left to right.

Sol.: In a group electronegativity generally decreases

Correct order of electronegativity

O > N > S > P

92. Answer (4)

Hint: With increasing atomic number, the ionisation enthalpy of an atom in a period usually increases.

Sol.:

Electronic configuration	Element	Ionisation enthalpy ($kJ\ mol^{-1}$)
$1s^2 2s^2 2p^4$	O	1314
$1s^2 2s^2 2p^5$	F	1681
$1s^2 2s^2 2p^3$	N	1402
$1s^2 2s^2$	Be	899

93. Answer (2)

Hint: Energy is generally released when an element accepts electron

Sol.: $F \longrightarrow F^{\ominus}$ and $Na \longrightarrow Na^{\ominus}$ are exothermic processes while ionisation of sodium ($Na \rightarrow Na^+$) is endothermic process.

94. Answer (3)

Hint & Sol.: IUPAC name of an element with atomic number 109 is Unnilennium.

95. Answer (3)

Hint: Chlorine belongs to halogen family.

Sol.: Palladium → Transition metal

Chlorine → Halogen

Thorium → Actinoid

Samarium → Lanthanoid

96. Answer (3)

Hint: The covalent radius is half of the distance between two similar atoms joined by a covalent bond in the same molecule.

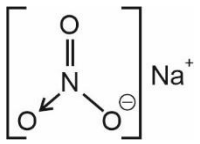
Sol.:

- The covalent radius is measured approximately as the radius of an atom's core which is in contact with the core of an adjacent atom in bonded situation.
- The van der Waals radius represents the overall size of the atom which includes its valence shell in a non-bonded situation.

97. Answer (2)

Hint: In co-ordinate bond, one atom donates its electron pair to another atom to attain octet

Sol.:



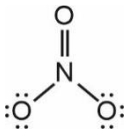
$NaNO_3$ contains, electrovalent, covalent as well as ionic bonds.

98. Answer (4)

Hint:

$$\text{Formal charge} = \left[\begin{matrix}\text{Total no. of valance}\\ \text{electrons in free atom}\end{matrix}\right] - \left[\begin{matrix}\text{Total no. of}\\ \text{non – bonding}\\ \text{(lone pair)}\\ \text{electrons}\end{matrix}\right] - \frac{1}{2}\left[\begin{matrix}\text{Total no. of}\\ \text{bonding}\\ \text{electrons}\end{matrix}\right]$$

Sol.:



Formal charge on nitrogen = $5 - 0 - \frac{1}{2} \times 8 = +1$

99. Answer (2)

Hint: Percentage s-character

$$= \frac{\begin{matrix}\text{No. of s – orbitals involved}\\ \text{in hybridisation}\end{matrix}}{\begin{matrix}\text{Total no. of orbitals involved}\\ \text{in hybridisation}\end{matrix}} \times 100$$

Sol.: Percentage s character in sp^3d orbital = $\frac{1 \times 100}{5} = 20\%$

Percentage p character in sp^3d^2 orbitals = $\frac{3 \times 100}{6} = 50\%$

100. Answer (3)

Hint: % ionic character = $\frac{\mu_{observed}}{\mu_{calculated}} \times 100$

Sol.: $\mu_{calculated}$ = q × d [q = 1.6 × 10^{-19} C]

= 1.6 × 10^{-19} × 100 × 10^{-12} C m

= 1.6 × 10^{-29} C m

$\mu_{observed}$ = 1.2 D

= 1.2 × 3.33 × 10^{-30} Cm (1 D = 3.33 × 10^{-30} C m)

= 4 × 10^{-30} C m

% ionic character = $\frac{4 \times 10^{-30}}{1.6 \times 10^{-29}} \times 100$

= 2.5 × 10 = 25%

[BOTANY]

SECTION - A

101. Answer (1)

Hint: The members of chrysophyta group have cell wall embedded with silica.

Sol.: In diatoms, the cell walls form two thin overlapping shells which fit together as in soap box.

102. Answer (3)

Hint: The given diagram is of bacteriophage a bacterial virus.

Sol.: In the protein coat of bacteriophage, head encloses DNA. Collar represents the region between head and sheath. In the figure, it is labelled as A. Label B represents tail fibres.

103. Answer (4)

Hint: Late blight of potato is caused by a member of Oomycetes.

Sol.: *Phytophthora infestans* causes late blight of potato.

104. Answer (2)

Hint: Ascospores are produced endogenously in sac like asci.

Sol.: *Albugo* belongs to Phycomycetes.

Trichoderma have only asexual stage in their life cycle.

Neurospora belongs to Ascomycetes.

Claviceps belongs to Ascomycetes in which ascospores are produced endogenously.

105. Answer (4)

Hint: Members of Animalia are eukaryotes.

Sol.: Bladderwort and Venus fly trap are insectivorous plants and *Cuscuta* is a parasite.

Members of kingdom Animalia do not have cell wall.

106. Answer (4)

Hint: R. H. Whittaker gave five kingdom classification.

Sol.: A heterotrophic bacterium is helpful in making curd. Chemosynthetic autotrophic bacteria play great role in recycling nutrients.

107. Answer (3)

Hint: Sporangiospores are produced by zygomycetes.

Conidia are produced by ascomycetes and deuteromycetes.

Sol.: Conidia are asexual spores produced by *Aspergillus*, *Penicillium* and *Trichoderma.*

Sporangiospores are non motile asexual spores produced by *Mucor* and *Rhizopus.*

108. Answer (3)

Hint: Influenza is caused by virus.

Sol.: Typhoid and citrus canker are caused by bacteria.

Herpes, AIDS, mumps and influenza are caused by viruses.

109. Answer (4)

Hint: The viruses that infect animal have either ss or dsRNA or dsDNA.

Sol.: The viruses that infect plant generally have single stranded RNA and viruses that infect bacteria usually have dsDNA, as genetic material.

110. Answer (2)

Hint: *Penicillium* is the source of antibiotic.

Sol.: *Aspergillus* is known as the weed of laboratory.

111. Answer (2)

Hint: In deuteromycetes, perfect stage (sexual stage) is absent.

Sol.: Conidia are asexual spores generally found in ascomycetes and deuteromycetes.

112. Answer (3)

Hint: Most fungi absorb soluble organic matter from dead substrates.

Sol.: Fungi constitute a unique kingdom of heterotrophic organisms.

Members of Plantae show autotrophic mode of nutrition.

113. Answer (3)

Hint: He classified plants into trees, shrubs and herbs.

Sol.: Aristotle divided animals into two groups, those which had red blood and those that did not.

114. Answer (4)

Hint: In Ascomycetes, sexual spores called ascospores are produced endogenously.

Sol.: In members of Basidiomycetes, sexual spores are produced exogenously after karyogamy followed by meiosis.

115. Answer (2)

Hint: T.O. Diener discovered new infectious agent called viroids that was smaller than viruses.

Sol.: M.W. Beijerinck demonstrated that the extract of the infected plants of tobacco could cause infection in healthy plants.

D.J. Ivanowsky recognised certain microbes as causal organisms of mosaic disease of tobacco.

W.M. Stanley showed that virus could be crystallised.

116. Answer (4)

Hint: For plants, scientific names are based on agreed principle and criteria provided in ICBN.

Sol.: ICBN stands for International Code for Botanical Nomenclature.

117. Answer (3)

Hint: Human being is only living organism who is aware of himself.

Sol.: *Solanum melongena* belongs to Solanaceae family.

118. Answer (2)

Hint: Sapindale is an order.

Sol.: Insecta is a class.

119. Answer (4)

Hint: Label on herbarium sheet provides information about local name, botanical name and family of specimen.

Sol.: Label of the herbarium sheet does not mention size of the plant.

120. Answer (3)

Hint: The biological name of Mango is *Mangifera indica*.

Sol.: The first word denoting the genus starts with a capital letter while the specific epithet starts with a small letter.

121. Answer (1)

Hint: Bacteria as a group show the most extensive metabolic diversity.

Sol.: Bacteria are the sole members of kingdom Monera.

Bacterial structure are very simple, they are very complex in behaviour.

122. Answer (3)

Hint: Dinoflagellates appear yellow, green, brown, blue or red depending on the main pigments present in their cells.

Sol.: Dinoflagellates are mostly marine and photosynthetic. Most of them have two flagella one lies longitudinally and other transversely.

123. Answer (4)

Hint: Conidia are the asexual spores.

Sol.: In fungi, the sexual reproduction takes place by oospores, ascospores and basidiospores.

124. Answer (3)

Hint: Yeast is unicellular.

Sol.: Mostly fungi have multicellular body organisation but *Saccharomyces* is unicellular fungus.

125. Answer (3)

Hint: *Trypanosoma* cause sleeping sickness.

Sol.:

- The parasitic form of flagellated protozoan causes disease like sleeping sickness.
- Amoeboid protozoan produce false feet to capture prey.
- Ciliated protozoan have cavity that opens to the outside of cell surface.

Sporozoan includes diverse organism that have infectious spore like stage in their life cycle.

126. Answer (4)

Hint: Hyphae are continuous tubes filled with multinucleated cytoplasm called coenocytic hyphae and are found in members of Phycomycetes.

Sol.: *Albugo* is a member of Phycomycetes with aseptate and coenocytic mycelium.

127. Answer (1)

Hint: Dikaryophase is observed in members of Ascomycetes and Basidiomycetes.

Sol.: All of the given characteristics are found in Basidiomycetes. *Ustilago* is a member of Basidiomycetes.

128. Answer (4)

Hint: Diatoms are chief producers in the oceans.

Sol.: Diatoms are members of Protista group. It is an eukaryotic organism and has membrane bound organelles as well as well defined nucleus.

129. Answer (2)

Hint: Slime moulds are saprophytic protists.

Sol.: Under suitable condition, they form an aggregation called plasmodium. Later during unfavourable condition plasmodium differentiate and form fruiting bodies. The spores possess true walls and they can survive for many years under adverse condition.

130. Answer (2)

Hint: Mycoplasma are placed in a kingdom Monera.

Sol.: Mycoplasma are prokaryotic organisms and they are devoid of nuclear membrane. Many mycoplasma are pathogenic in animals and plants.

131. Answer (3)

Hint: Creutzfeldt-Jacob disease in humans is caused by prions.

Sol.: Prions consist of abnormally folded protein and was similar in size to viruses.

132. Answer (3)

Hint: Methanogens are found in one of the most harsh habitats.

Sol.: Methanogens are a type of archaebacteria.

133. Answer (4)

Hint: Viroids are found to be free RNA.

Sol.: Viroids are smaller than viruses and cause potato spindle tuber disease.

Prions cause infectious neurological disease.

134. Answer (2)

Hint: *Nostoc* grows in nutrient enriched water bodies.

Sol.: *Nostoc* often blooms in polluted water bodies.

135. Answer (3)

Hint: In this kingdom both autotrophic and heterotrophic modes of nutrition are present.

Sol.: The three domain system proposed by Carl Woese divides the kingdom Monera into two domains.

SECTION - B

136. Answer (2)

Hint: The algal component of lichens is known as phycobiont, which is autotrophic and it prepares food for fungi.

Sol.: In lichens fungi provide shelter and absorb mineral nutrients.

Lichens were not introduced in the five kingdom classification proposed by R.H. Whittaker.

137. Answer (2)

Hint: TMV are riboviruses.

Sol.: TMV are viruses which have ssRNA.

138. Answer (4)

Hint: These are photosynthetic autotrophic eubacteria.

Sol.: *Nostoc* and *Anabaena* can fix atmospheric nitrogen in specialised cell that are called heterocyst.

139. Answer (2)

Hint: Morels and truffles belong to Ascomycetes class.

Sol.: In ascomycetes, mycelium is branched and septate. The asexual spores are produced exogenously. Sexual spores are called ascospores which are produced endogenously.

140. Answer (1)

Hint: Fusion of protoplasm between two motile or non-motile gametes is called plasmogamy.

Sol.: The sexual cycle involves the following three steps :

Plasmogamy $\rightarrow$ Karyogamy $\rightarrow$ Meiosis

141. Answer (2)

Hint: Members of Deuteromycetes have only asexual or vegetative phase of fungi.

Sol.: *Alternaria*, *Trichoderma* and *Colletotrichum* are members of Deuteromycetes.

142. Answer (2)

Hint: Viruses are non-cellular organisms and they are inert outside their specific host.

Sol.: Viruses are small obligate parasites that cannot grow outside the living cells. It takes over the machinery of the host's cell to replicate themselves.

143. Answer (2)

Hint: *Pinus* shows mycorrhizal association.

Sol.: Mycorrhiza is the association of fungi with roots of higher plants.

144. Answer (4)

Hint: Euglenoids have a protein rich layer called pellicle which makes their body flexible.

Sol.: Euglenoids do not have cell wall.

145. Answer (2)

Hint: All single celled eukaryotes are placed under Protista.

Sol.: Eukaryotic organisms have both 70S and 80S types of ribosomes.

146. Answer (3)

Hint: Comma-shaped bacteria are called vibrio.

Sol.: Rod-shaped bacteria are called Bacilli.

147. Answer (4)

Hint: *Chlamydomonas* and *Paramoecium* both are single celled eukaryotes.

Sol.: According to R.H. Whittaker, kingdom Protista has brought together *Chlamydomonas*, *Chlorella* with *Paramoecium* and *Amoeba*.

148. Answer (1)

Hint: Lower the taxa, more are the characteristics that the members within the taxon share.

Sol.: As we go higher from species to kingdom, the number of common characteristics goes on decreasing.

149. Answer (3)

Hint: Biological nomenclature of plants follows the rules assigned in ICBN.

Sol.: The correctly printed name of wheat is *Triticum aestivum.*

150. Answer (2)

Hint: Catalogue includes the alphabetical arrangement of species of a particular place describing their features.

Sol.: Museum have collections of preserved plants and animals which are used for study and reference. Flora gives the actual account of habitat and distribution of various plants of a given area. Herbarium serves as quick source of reference in taxonomical studies.

[ZOOLOGY]

SECTION - A

151. Answer (4)

Hint: Helps is lung movement

Sol.: Pleural fluid reduces the friction on the lung surface. Negative intrapleural pressure prevents collapsing of lungs.

152. Answer (4)

Hint: It includes vital capacity and residual volume

Sol.: Inspiratory capacity (IC) = TV + IRV

Expiratory capacity (EC) = TV + ERV

Functional residual Capacity (FRC) = ERV + RV

Vital Capacity (VC) = ERV + TV + IRV

Total Lung Capacity (TLC) = TV + IRV +ERV + RV

153. Answer (2)

Hint: Respiratory surface is decreased

Sol.: Asthma – Occurs due to an allergic reaction to foreign substances that affect the respiratory tract.

Emphysema – One of the major causes of this is cigarette smoking.

Pneumoconiosis – Occurs due to inhalation of mineral dust, characterised by inflammation, coughing and fibrosis.

Asphyxia – This condition is caused by increase in CO_2 concentration in tissues.

154. Answer (4)

Hint: Additional muscles of expiration.

Sol.: An increase in pulmonary volume decreases the intra-pulmonary pressure to less than the atmospheric pressure which forces the air from outside to move in the lungs, *i.e.*, inspiration. An increase in intra-pulmonary pressure to slightly above the atmospheric pressure causes the expulsion of air from the lungs, *i.e.*, expiration.

155. Answer (3)

Hint: pO_2 is high at alveolar site.

Sol.: At the tissue site where pCO_2 is high due to catabolism, CO_2 diffuses into blood (RBCs and plasma) and forms HCO_3^- and H^+. At the alveolar site where pCO_2 is low, the reaction proceeds in opposite direction leading to formation of CO_2 and H_2O. Thus, CO_2 trapped as bicarbonate at the tissue level, is transported to the alveoli and is released out as CO_2.

156. Answer (1)

Hint: Area sensitive to CO_2 and H^+ ions is present in hindbrain

Sol.: A specialised centre present in the medulla region of the brain called respiratory rhythm centre is primarily responsible to regulate respiratory rhythm. A chemosensitive area is located adjacent to the rhythm centre which is highly sensitive to CO_2 and H^+ ions.

157. Answer (2)

Hint: Percentage of CO_2 carried by RBCs

Sol.: As the solubility of CO_2 is 20-25 times higher than that of O_2, the amount of CO_2 that can diffuse through the diffusion membrane per unit difference in partial pressure is much higher as compared to that of O_2.

158. Answer (1)

Hint: It increases breathing rate.

Sol.: Centre present in the pons region of the brain called pneumotaxic centre can moderate the functions of the respiratory rhythm centre. Neural signals from this centre can reduce the duration of inspiration and thereby alter the respiratory rate.

159. Answer (3)

Hint: Pulmonary artery carries deoxygenated blood.

Sol.:

Respiratory Gas	Atmospheric Air	Alveoli	Blood (Deoxygenated)	Blood (Oxygenated)	Tissue
O_2	159	104	40	95	40
CO_2	0.3	40	45	40	45

160. Answer (3)

Hint: 97% of O_2 is transported by RBCs in the blood.

Sol.: Blood is the medium of transport for O_2 and CO_2. About 97% of O_2 is transported by RBCs in the blood. The remaining 3 percent of O_2 is carried in a dissolved state through the plasma.

161. Answer (2)

Hint: High H^+ concentration is favourable for dissociation of O_2 from oxyhaemoglobin.

Sol.: Binding of oxygen with haemoglobin is primarily related to partial pressure of O_2. Partial

pressure of CO_2, hydrogen ion concentration and temperature are other factors that can affect with the binding of oxygen with Hb.

162. Answer (2)

Hint: 20 mL of O_2 is carried by 100 mL of oxygenated blood during normal physiological conditions.

Sol.: Every 100 mL of oxygenated blood can deliver around 5 mL of O_2 to the tissues under normal physiological conditions in humans. Every 100 mL of deoxygenated blood delivers approximately 4 mL of CO_2 to the alveoli.

163. Answer (4)

Hint: Average volume is 1100 mL to 1200 mL.

Sol.: Residual volume: The volume of air which remains in the lungs even after the forceful expiration. This averages to 1100–1200 mL.

164. Answer (3)

Hint: Contraction of external inter-costal muscles lifts up the ribs and sternum.

Sol.: Inspiration is initiated by contraction of diaphragm which increases the volume of thoracic chamber in the antero-posterior axis. The contraction of external inter-costal muscles lift up the ribs and the sternum causing an increase in the volume of the thoracic chamber in the dorso-ventral axis. Relaxation of diaphragm and external inter- costal muscles leads to expiration.

165. Answer (1)

Hint: Utilisation of O_2 by tissue occurs in the last.

Sol.: Respiration involves the following steps:

(i) Breathing or pulmonary ventilation by which atmospheric air is drawn in and CO_2 rich alveolar air is released out.

(ii) Diffusion of gases (O_2 and CO_2) across alveolar membrane.

(iii) Transport of gases by the blood.

(iv) Diffusion of O_2 and CO_2 between blood and tissues.

(v) Utilisation of O_2 by the cells for catabolic reactions and resultant release of CO_2.

166. Answer (1)

Hint: Animal respires through moist skin.

Sol.: Among vertebrates, fishes use gills whereas amphibians, reptiles, birds and mammals respire through lungs. Amphibians like frogs can respire through their moist skin (cutaneous respiration) also. Earthworm use their moist cuticle and insects have a network of tube to transport atmospheric air within the body.

167. Answer (2)

Hint: Nasal and oral cavity opens into pharynx followed by larynx.

Sol.: Flow chart showing structures involved in respiratory passage is

Nostrils $\rightarrow$ Nasal chamber $\rightarrow$ Pharynx $\rightarrow$ Larynx $\rightarrow$ Trachea $\rightarrow$ Primary bronchi $\rightarrow$ Secondary bronchi $\rightarrow$ Tertiary bronchi $\rightarrow$ Bronchioles $\rightarrow$ Alveolar ducts $\rightarrow$ Atria $\rightarrow$ Alveolar sac $\rightarrow$ Alveoli

168. Answer (3)

Hint: Less than 20/min

Sol.: Rate of breathing under normal physiological conditions in a healthy man is 12-16/min.

169. Answer (1)

Hint: Leads to left shift of O_2-dissociation curve

Sol.: In the alveoli, where there is high pO_2, low pCO_2, lesser H^+ concentration and lower temperature, the factors are all favourable for the formation of oxyhaemoglobin, whereas in the tissues, where low pO_2, high pCO_2, high H^+ concentration and higher temperature exist,the conditions are favourable for dissociation of oxygen from the oxyhaemoglobin.

170. Answer (3)

Hint: Exclude the region that possess chemosensitive area

Sol: Human beings have a significant ability to maintain and moderate the respiratory rhythm to suit the demands of the body tissues. This is done by the neural system. A specialised centre present in the medulla region of the brain called respiratory rhythm centre is primarily responsible for this regulation. Another centre present in the pons region of the brain called pneumotaxic centre can moderate the functions of the respiratory rhythm centre. Neural signal from this centre can reduce the duration of inspiration and thereby alter the respiratory rate.

171. Answer (1)

Hint: Maximum O_2 is transported as oxyhaemoglobin.

Sol.: Blood is the medium of transport for O_2 and CO_2. About 97 percent of O_2 is transported by RBCs in the blood. The remaining 3 percent of O_2 is carried in a dissolved state through the plasma. Nearly 20-25 percent of CO_2 is transported by RBCs whereas 70 percent of it is carried as bicarbonate. About 7 percent of CO_2 is carried in a dissolved state through plasma.

172. Answer (4)

Hint: This occurs during inspiration.

Sol.: During inspiration, diaphragm and external inter-costal muscles contract.

Intrapleural pressure becomes more negative. Volume of thoracic cavity increases.

173. Answer (2)

Hint: Exchange of gases occurs here

Sol.: Each terminal bronchiole gives rise to a number of very thin, irregular walled and vascularised bag-like structures called alveoli where exchange of gases takes place between blood and alveolar air. Alveoli is lined by simple squamous epithelium.

174. Answer (2)

Hint: 1 mL of deoxygenated blood delivers approximately 0.04 mL of CO_2 to the alveoli.

Sol.: Every 100 mL of deoxygenated blood delivers approximately 4 mL of CO_2 to the alveoli. Therefore, every 800 mL of deoxygenated blood will deliver approximately 32 mL of CO_2 to the alveoli in an adult man under normal physiological conditions.

175. Answer (4)

Hint: Forms at tissue level

Sol.: Myoglobin is a red coloured oxygen storing pigment present in muscles.

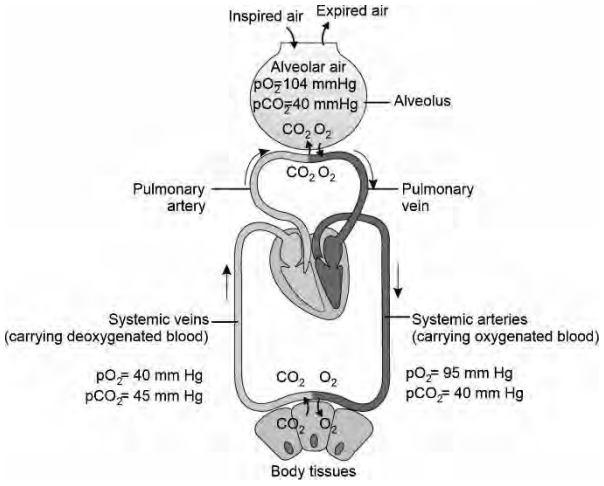
Carboxyhaemoglobin is formed by binding of haemoglobin with carbon monoxide.

Methemoglobin is a form of haemoglobin in which iron in the haem group is in Fe^{3+} state, rather than the normal Fe^{2+} state.

176. Answer (3)

Hint: It carries oxygenated blood.

Sol.:



177. Answer (1)

Hint: Nasal chamber opens into this region of respiratory tract.

Sol.: Pharynx opens through the larynx region into the trachea. Epiglottis is thin, elastic flap guarding the windpipe. We have two lungs which are covered by a double layered pleura, with pleural fluid between them. It reduces friction on the lung-surface.

The outer pleural membrane is in close contact with the thoracic lining whereas the inner pleural membrane is in contact with the lung surface.

178. Answer (3)

Hint: Function performed by alveoli

Sol.: The part starting with the external nostrils up to the terminal bronchioles constitute the conducting part whereas the alveoli and their ducts form the respiratory or exchange part of the respiratory system.

The conducting part transports the atmospheric air to the alveoli, clears it from foreign particles, humidifies and also brings the air to body temperature. Exchange part is the site of actual diffusion of O_2 and CO_2 between blood and atmospheric air.

179. Answer (3)

Hint: Exclude disease related to chronic smokers

Sol.: In certain industries, especially those involving grinding or stone-breaking, so much dust is produced that the defense mechanism of the body cannot fully cope with the situation. Long exposure can give rise to inflammation leading to fibrosis of lungs (proliferation of fibrous tissues) and thus causing serious lung damage. Workers in such industries should wear protective masks.

Typhoid and pneumonia are bacterial diseases.

180. Answer (3)

Hint: Minute volume

Sol.: Volume of air a healthy man can inhale or exhale effortlessly in each breath is tidal volume.

Minute volume = Tidal volume × Respiratory rate

= (500 mL × 12) to (500 mL × 16)

= 6000 mL to 8000 mL

181. Answer (4)

Hint: Gives rise to a number of very thin, irregular-walled and vascularised bag-like structures.

Sol.: Incomplete rings of hyaline cartilage prevent collapse of primary, secondary, tertiary bronchi and initial bronchioles. Each terminal bronchiole gives

rise to a number of very thin, irregular-walled and vascularised bag-like structures called alveoli. The branching network of bronchi, bronchioles and alveoli comprise the lungs.

182. Answer (1)

Hint: pO_2 of 40 mmHg

Sol.:

Respiratory Gas	Atmospheric Air	Alveoli	Blood (Deoxygenated)	Blood (Oxygenated)	Tissues
O_2	159	104	40	95	40
CO_2	0.3	40	45	40	45

183. Answer (2)

Hint: These vertebrae lie below the neck

Sol.: Trachea divides at the level of 5th thoracic vertebra in humans.

184. Answer (3)

Hint: Lower invertebrate

Sol.: Flatworms respire through body surface by simple diffusion in free living forms. Amphibians like frogs can respire through their moist skin (cutaneous respiration) also. Among vertebrates, fishes use gills whereas amphibians, reptiles, birds and mammals respire through lungs.

185. Answer (3)

Hint: This is the volume of air that will remain in the lungs after a normal expiration

Sol.: **Expiratory Capacity (EC):** Total volume of air a person can expire after a normal inspiration. This includes tidal volume and expiratory reserve volume.

Functional Residual Capacity (FRC): Volume of air that will remain in the lungs after a normal expiration. This includes ERV+RV.

Vital Capacity (VC): The maximum volume of air a person can breathe in after a forced expiration. This includes ERV, TV and IRV or the maximum volume of air a person can breathe out after a forced inspiration.

Expiratory Reserve Volume (ERV): Additional volume of air, a person can expire by a forcible expiration. This averages 1000 mL to 1100 mL.

SECTION - B

186. Answer (3)

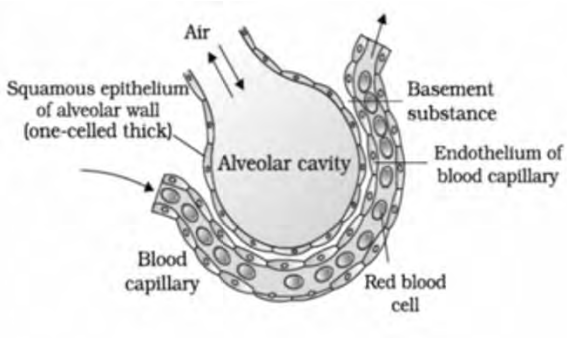
Hint: Sternum is mid-ventral bone of thorax.

Sol.: The thoracic chamber is formed dorsally by the vertebral column, ventrally by the sternum, laterally by ribs and on the lower side by the dome-shaped diaphragm.

187. Answer (2)

Hint: Diffusion membrane contains an acellular membrane.

Sol.:



188. Answer (3)

Hint: High pCO_2 and low pO_2 is at tissue level.

Sol.: Oxygen dissociation curve is highly useful in studying the effects of factors like pCO_2, H^+ concentration, *etc.*, on binding of O_2 with haemoglobin. In the alveoli, where there is high pO_2, low pCO_2, less H^+ concentration and lower temperature, the factors are all favourable for the formation of oxyhaemoglobin, whereas in the tissues, where low pO_2, high pCO_2, high H^+ concentration and higher temperature exist, the conditions are favourable for dissociation of oxygen from the oxyhaemoglobin.

189. Answer (3)

Hint: It leads to decrease in the blood pressure.

Sol.: Receptors associated with aortic arch and carotid artery can recognise changes in CO_2 and H^+ concentration and send necessary signals to the respiratory rhythm centre for remedial actions. The role of oxygen in the regulation of respiratory rhythm is quite insignificant.

190. Answer (1)

Hint: Zn^{2+} is the co-factor of this enzyme.

Sol.: $CO_2 + H_2O \xrightleftharpoons{\text{Carbonic anhydrase}}$

$$H_2CO_3 \xrightleftharpoons{\text{Carbonic anhydrase}} HCO_3^- + H^+$$

191. Answer (1)

Hint: Inspiratory capacity + Functional residual capacity = TLC

Sol.:

S/N	Respiratory Capacities	Formulae and volume
1.	Inspiratory Capacity (IC)	TV + IRV = 3000 – 3500 mL
2.	Expiratory Capacity (EC)	TV + ERV = 1500 – 1600 mL
3.	Functional Residual Capacity (FRC)	ERV + RV = 2100 – 2300 mL
4.	Vital Capacity (VC)	ERV + TV + IRV = 4000 – 4600 mL
5.	Total Lung Capacity (TLC)	RV + ERV + TV + IRV = 5100 – 5800 mL

192. Answer (3)

Hint: Volume of air that will remain in the lungs after forceful expiration

Sol.: Residual volume cannot be measured by spirometer. So, FRC and TLC can also not be measured with this instrument.

193. Answer (1)

Hint: Less than 0.001 m

Sol.: The diffusion membrane is made up of three major layers namely, the thin squamous epithelium of alveoli, the endothelium of alveolar capillaries and the basement substance (composed of a thin basement membrane supporting the squamous epithelium and the basement membrane surrounding the single layer endothelial cells of capillaries) in between them. However, its total thickness is much less than a millimetre.

194. Answer (1)

Hint: Exclude occupational respiratory disorders

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

Emphysema is a chronic disorder in which alveolar walls are damaged due to which respiratory surface is decreased. One of the major causes of this is cigarette smoking.

195. Answer (4)

Hint: Located adjacent to respiratory rhythm centre

Sol.: A chemosensitive area is situated adjacent to the rhythm centre which is highly sensitive to CO_2 and hydrogen ions. Increase in these substances can activate this centre, which in turn can signal the rhythm centre to make necessary adjustments in the respiratory process by which these substances can be eliminated. Receptors associated with aortic arch and carotid artery can also recognise changes in CO_2 and H^+ concentration and send necessary signals to the rhythm centre for remedial actions. The role of oxygen in the regulation of respiratory rhythm is quite insignificant.

196. Answer (4)

Hint: A vertebrate

Sol.: Mechanisms of breathing vary among different groups of animals depending mainly on their habitats and levels of organisation. Lower invertebrates like sponges, coelenterates, flatworms, *etc*., exchange O_2 with CO_2 by simple diffusion over their entire body surface.

197. Answer (3)

Hint: Assists in transport of gases

Sol.: RBCs contain a very high concentration of the enzyme, carbonic anhydrase and minute quantities of the same is present in the plasma too. This enzyme facilitates the following reaction in both directions.

$$CO_2 + H_2O \underset{}{\overset{\text{Carbonic anhydrase}}{\rightleftharpoons}} H_2CO_3 \overset{\text{Carbonic anhydrase}}{\rightleftharpoons} HCO_3^- + H^+$$

198. Answer (2)

Hint: pO_2 decreases

Sol.: Emphysema is a chronic disorder in which alveolar walls are damaged due to which respiratory surface is decreased. One of the major causes of this is cigarette smoking. Asthma is a difficulty in breathing causing wheezing due to inflammation of bronchi and bronchioles.

199. Answer (4)

Hint: Vital capacity

Sol.: Vital Capacity (VC): The maximum volume of air a person can breathe in after a forced expiration. This includes ERV, TV and IRV or the maximum volume of air a person can breathe out after a forced inspiration.

Functional Residual Capacity (FRC): Volume of air that will remain in the lungs after a normal expiration. This includes ERV+RV.

200. Answer (1)

Hint: This part is not supported by cartilaginous rings.

Sol.: The part starting with the external nostrils upto the terminal bronchioles constitute the conducting part whereas the alveoli and their ducts form the respiratory or exchange part of respiratory system.

❑ ❑ ❑