All India Aakash Test Series for NEET - 2027

TEST - 3 (Code-I)

Click here for Code-J Sol.

Test Date : 18/01/2026

ANSWERS

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

HINTS & SOLUTIONS

[PHYSICS]

1. Answer (3)

Hint and Sol.: Work done due to a conservative force does not depend on the path taken, it depends on initial and final points i.e., displacement.

2. Answer (1)

Hint and Sol.: First block will have more kinetic energy due to absence of air drag.

3. Answer (4)

Hint: Instantaneous power, $P = \vec{F} \cdot \vec{v}$

Sol.: In first and second cases, force is constant and velocity is variable, hence power will be variable. In third case, force as well as velocity is constant, hence power delivered will be constant.

4. Answer (3)

Hint: Work done by variable force, $W = \int \vec{F} \cdot d\vec{x}$

Sol.: $W = \int_0^{\pi} 10 \sin x dx = 10(-\cos x)_0^{\pi}$

$W = -10(\cos\pi - \cos 0) = 20$ J

5. Answer (4)

Hint: Average power $= \dfrac{\text{Net work done}}{\text{Time}}$

Sol.: Net work done on the bullet

$= \Delta KE = 0 - \dfrac{1}{2} \times 10 \times 10^{-3} \times (500)^2$

$= -1250$ J

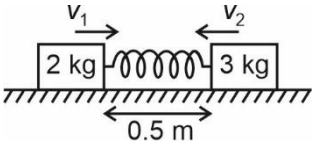
Magnitude of average power $= \dfrac{1250}{0.05} = 25$ kW

6. Answer (1)

Hint: When the spring comes to its natural length, then its potential energy will be converted to kinetic energy of the blocks.

Sol.: Initial potential energy $= \dfrac{1}{2} kx^2$

$U_i = \dfrac{1}{2} \times 200 \times (1.5 - 0.5)^2 = 100$ J



Since no external force is acting on the system, hence $\vec{P}_i = \vec{P}_f$

$0 = 2v_1 - 3v_2 \Rightarrow \dfrac{2}{3} v_1 = v_2$ ...(i)

$TME_i = TME_f$

$U_i + KE_i = U_f + KE_f$

$100 + 0 = 0 + \dfrac{1}{2} \times 2 \times v_1^2 + \dfrac{1}{2} \times 3 \times v_2^2$

$100 = v_1^2 + \dfrac{3}{2} \times \left(\dfrac{2}{3} v_1\right)^2$

$100 = \dfrac{5}{3} v_1^2 \Rightarrow v_1 = \sqrt{60}$ m/s

7. Answer (3)

Hint: Use work-energy theorem.

Sol.: $W_{net} = \Delta KE$

$W_{spring} + W_{friction} = KE_f - KE_i$

$-\dfrac{1}{2} \times 1000 \times \left(\dfrac{1}{4}\right)^2 + W_f = -\dfrac{1}{2} \times 10 \times 5^2$

$-\dfrac{125}{4} + W_f = -125 \Rightarrow W_f = -\dfrac{3}{4} \times 125$ J

Average power lost due to friction $= \dfrac{\frac{3}{4} \times 125}{3} = \dfrac{125}{4}$ W

8. Answer (2)

Hint: $W_{conservative} = -\Delta U$

Sol.: Work done by conservative force = – (change in potential energy)

$W_{A-B} + W_{B-C} + W_{C-D} = -U_f + U_i$

$-75 + 25 + 70 = -U_f + (-10)$

$U_f = -30$ J

9. Answer (3)

Hint and Sol.: For stable equilibrium, potential energy is minimum and $\dfrac{d^2U}{dr^2} > 0$

10. Answer (2)

Hint: Use relation $P = \sqrt{2mK}$

Sol.: $\frac{P_B}{P_A}=\frac{\sqrt{2m_Bk_B}}{\sqrt{2m_Ak_A}}=\sqrt{\frac{m_B}{m_A}}$

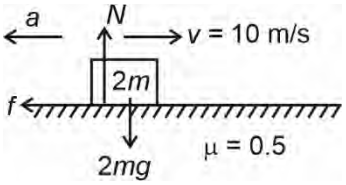
$\frac{P_B}{P_A}=\sqrt{\frac{9}{1}}=\frac{3}{1}$

11. Answer (4)

Hint: In perfectly inelastic collision both blocks will move together after collision.

Sol.: Speed of combined block system after collision = v

$m \times 20 = 2m \times v \Rightarrow v = 10$ m/s



$f = \mu \times N = \mu \times 2mg$

$f = m_T \times a \Rightarrow \mu \times 2mg = 2m \times a$

$a = \mu g = 0.5 \times 10 = 5$ m/s^2

$2as = v^2 - u^2 \Rightarrow 2 \times (-5) \times s = 0 - (-10)^2$

$\therefore$ Distance travelled = $s = 10$ m

12. Answer (2)

Hint and Sol.: In a rigid body, particles cannot move relative to each other, hence net work done by internal forces is zero.

In a system consisting of discrete masses, internal forces can do work.

13. Answer (1)

Hint and Sol.: A single external force will accelerate particle in its direction.

Work-energy theorem is valid for all types of forces.

14. Answer (1)

Hint: Use equations : $P = Fv$ and $a=\frac{vdv}{dx}$

Sol.: Instantaneous power, $P=\vec{F}\cdot\vec{v}$

Here P is constant.

$P = Fv = mva$

$P=m\times\frac{vdv}{dx}\times v \qquad \left\{a=\frac{vdv}{dx}\right\}$

$\int_0^x Pdx=\int_0^v mv^2dv$

$Px=\frac{mv^3}{3} \Rightarrow v=\left(\frac{3Px}{m}\right)^{\frac{1}{3}}$

$\frac{dx}{dt}=\left(\frac{3P}{m}\right)^{\frac{1}{3}}x^{\frac{1}{3}}$

$\int_0^x \frac{dx}{x^{\frac{1}{3}}}=\int_0^t\left(\frac{3P}{m}\right)^{\frac{1}{3}}dt$

$\frac{x^{\frac{-1}{3}+1}}{\frac{2}{3}}=\left(\frac{3P}{m}\right)^{\frac{1}{3}}t$

$\frac{3}{2}x^{\frac{2}{3}}=\left(\frac{3P}{m}\right)^{\frac{1}{3}}t \Rightarrow x\propto t^{\frac{3}{2}}$

15. Answer (4)

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

Sol.: $\Delta\vec{r}=\vec{r}_f-\vec{r}_i=\left(3\hat{i}+4\hat{j}+2\hat{k}\right)-\left(1\hat{i}+2\hat{j}+3\hat{k}\right)$

$\Delta\vec{r}=\left(2\hat{i}+2\hat{j}-\hat{k}\right)$ m

$W=\left(2\hat{i}+2\hat{j}+3\hat{k}\right)\cdot\left(2\hat{i}+2\hat{j}-\hat{k}\right)$

$= 4 + 4 - 3$

$W = 5$ J

16. Answer (2)

Hint: Work done by a force = Force × (Displacement of point of application in the direction of force)

Sol.: The given force is constant in magnitude as well as in direction.

Displacement in the direction of force equals R

$\therefore$ Work done by the force = FR

17. Answer (3)

Hint and Sol.: $\vec{\tau}_{ext}=\frac{\Delta\vec{L}}{\Delta t}$

$\therefore$ If $\vec{\tau}_{ext}=0 \Rightarrow \Delta\vec{L}=0$

18. Answer (4)

Hint and Sol.: The centre of mass of a system depends on the distribution and values of masses in the system. Position of COM is not necessarily at the geometric centre or inside the material.

19. Answer (3)

Hint and Sol.: Given ω = constant

$\therefore \quad \alpha=\frac{d\omega}{dt}=0$

$\Rightarrow$ Angular acceleration is zero

Tangential acceleration, $a_t = r\alpha$

$\therefore$ $a_t = 0$

Torque, $\tau = I\alpha$

$\therefore$ $\tau = 0$

20. Answer (3)

Hint: Use formula of COM

Sol.: $\vec{R}_{cm} = \frac{m_1\vec{r}_1 + m_2\vec{r}_2 + m_3\vec{r}_3}{m_1 + m_2 + m_3}$

$\vec{R}_{cm} = \frac{m(0\hat{i} + 0\hat{j}) + m(1\hat{i} + 1\hat{j}) + m(2\hat{i} + 2\hat{j})}{3m}$

$\vec{R}_{cm} = 1\hat{i} + 1\hat{j}$

21. Answer (3)

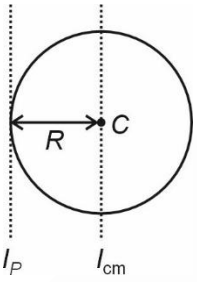
Hint: Use parallel axis theorem.

Sol.: Moment of inertia is I about the central axis.

Then MOI about a diametrical axis is $\frac{I}{2}$

$I_P = I_{cm} + Md^2$

$I_P = \frac{I}{2} + M \times R^2$ …(i)



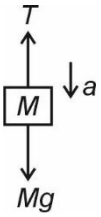
Also, $I = \frac{MR^2}{2}$

$\therefore \quad MR^2 = 2I$

Hence, $I_P = \frac{I}{2} + 2I = \frac{5I}{2}$

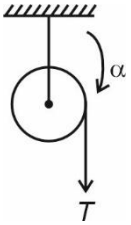
22. Answer (4)

Hint and Sol.: *FBD* of block:



$Mg - T = Ma$ …(i)

FBD of cylinder:



$\tau = I\alpha$

$TR = \frac{MR^2}{2}\alpha$ …(ii)

$a = R\alpha$ …(iii)

Solving equation (ii) and (iii), we get $T = \frac{Ma}{2}$

Put this in equation (i)

$Mg - \frac{Ma}{2} = Ma \Rightarrow a = \frac{2g}{3}$

23. Answer (3)

Hint and Sol.: Angular momentum,

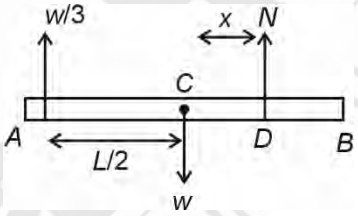
$\vec{L} = I\omega(-\hat{k}) + Mvd(-\hat{k})$

$\Rightarrow \quad \vec{L} = \left[\frac{MR^2\omega}{2} + Mvd\right](-\hat{k})$

24. Answer (4)

Hint: The bar is in rotational as well as translational equilibrium.

Sol.: Let the weight of the bar is w. Then



Translational equilibrium:

$N + \frac{w}{3} = w \Rightarrow N = \frac{2w}{3}$ …(i)

Rotational equilibrium:

Taking torque about centre C,

$\frac{w}{3} \times \frac{L}{2} = \frac{2w}{3} \times x \Rightarrow x = \frac{L}{4}$

$\therefore$ Total distance from end $A = \frac{L}{2} + \frac{L}{4} = \frac{3L}{4}$

25. Answer (1)

Hint: The ball will come to rest instantly as soon as the string becomes taut.

Sol.: The ball will drop by a distance of $2h$ before the string become taut

$P_i = mv = m\sqrt{2g(2h)} = 2m\sqrt{gh}$ …(i)

$P_f = 0$ …(ii)

$\therefore \quad I = |\Delta P| = 2m\sqrt{gh}$

26. Answer (1)

Hint: To get maximum compression in the spring, block m_2 should have maximum possible kinetic energy after collision.

Sol.: Let the speed of m_2 after collision is v', then

$$\frac{1}{2}m_2 \times v'^2 = \frac{1}{2}kx_0^2$$

For maximum x_0, v' should be maximum.

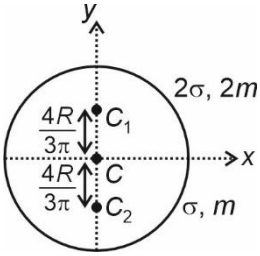
For $e = 1$ we get maximum v', when $m_1 = m_2$

$$\therefore \quad \frac{m_1}{m_2} = 1$$

27. Answer (4)

Hint: Centre of mass of half disc lies at distance $\frac{4R}{3\pi}$

Sol.:



$$Y_{cm} = \frac{m_1y_1 + m_2y_2}{m_1 + m_2}$$

$$Y_{cm} = \frac{2m \times \frac{4R}{3\pi} + m\left(-\frac{4R}{3\pi}\right)}{2m + m}$$

$$= \frac{\frac{4R}{3\pi} \times m}{3m} = \frac{4R}{9\pi}$$

28. Answer (4)

Hint and Sol.: Area under ω-t graph is equal to angular displacement (θ).

$$\theta = \frac{1}{2} \times 5 \times 10 = 25 \text{ rad}$$

29. Answer (3)

Hint and Sol.: Perpendicular as well as parallel axis theorem can be used to find moment of inertia of a laminar body.

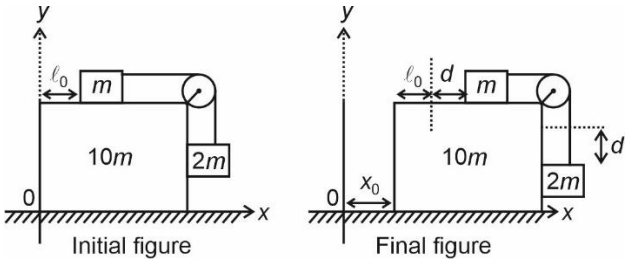
30. Answer (3)

Hint: There is no external force on the system in horizontal direction, hence COM of the system will remain at rest in horizontal direction.

Sol.:

$\because$ $F_{ext} = 0$ in horizontal direction.

$\therefore$ $\Delta X_{COM} = 0$



$$\Delta X_{COM} = \frac{m_1\Delta x_1 + m_2\Delta x_2 + m_3\Delta x_3}{m_1 + m_2 + m_3}$$

$$0 = \frac{m(x_0 + \ell_0 + d - \ell_0) + 2mx_0 + 10mx_0}{m + 2m + 10m}$$

$$0 = m(x_0 + d) + 2mx_0 + 10mx_0$$

$$-d = 13x_0 \Rightarrow x_0 = -\frac{d}{13}$$

31. Answer (1)

Hint and Sol.: Work = Force × Displacement

Torque = Arm length × force

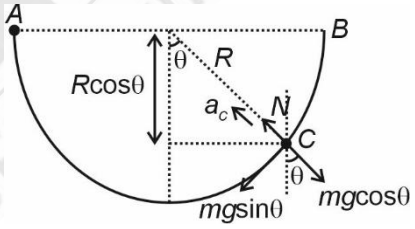
Hence, both have same dimension

32. Answer (1)

Hint: Use energy conservation principle.

Draw *FBD* of the block at a general location in terms of θ and then maximise horizontal component of force.

Sol.:



At point C:

$N - mg\cos\theta = ma_c$ …(i)

$$a_c = \frac{v^2}{r}$$ …(ii)

Apply energy conservation between points A and C

$$mgR\cos\theta = \frac{1}{2}mv^2$$

$$\frac{mv^2}{R} = 2mg\cos\theta$$ …(iii)

Put all the values in equation (i)

$N - mg\cos\theta = 2mg\cos\theta$

Horizontal component of normal reaction is

$N_x = N\cos(90° - \theta)$

$N_x = 3mg\cos\theta\sin\theta$

$N_x = \frac{3}{2}mg\sin 2\theta$

N_x will be maximum at $2\theta = 90°$

$\Rightarrow \theta = 45°$

Hence $(N_x)_{max} = \frac{3}{2}mg\sin 90° = \frac{3}{2}mg$

33. Answer (2)

Hint: Total angular momentum of the system remains conserved.

Apply work-energy theorem to find work done by friction.

Sol.: No external torque is acting on the system, hence angular momentum of the system remain conserved.

$L_i = L_f$

$I_0\omega_0 = 3I_0 \times \omega \Rightarrow \omega = \frac{\omega_0}{3}$

Apply work-energy theorem for disc 1:

$W_{net} = \Delta KE$

$W_{Friction} = \frac{1}{2}I_0 \times \left(\frac{\omega_0}{3}\right)^2 - \frac{1}{2}I_0\omega_0^2$

$= \frac{1}{2}I_0\omega_0^2\left(\frac{1}{9} - 1\right)$

$= -\frac{4}{9}I_0\omega_0^2$

Apply work-energy theorem for disc 2:

$W_{Friction} = \frac{1}{2}(2I_0) \times \left(\frac{\omega_0}{3}\right)^2 - 0$

$W_{Friction} = \left(\frac{I_0\omega_0^2}{9}\right)$

Total energy loss of the system = Total work done by the friction on the system.

$\therefore$ Energy loss $= \left|-\frac{4}{9}I_0\omega_0^2 + \frac{1}{9}I_0\omega_0^2\right|$

$= \frac{1}{3}I_0\omega_0^2$

34. Answer (4)

Hint and Sol.: When the stone reaches the ground

$mgh = \frac{1}{2}mv_f^2 - \frac{1}{2}mv^2$

$v_f = (2gh + v^2)^{\frac{1}{2}}$

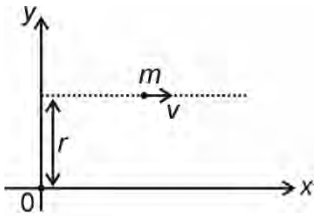
Final speed (v_f) is independent of direction of projection.

35. Answer (2)

Hint: Angular momentum of a particle,

$|\vec{L}| = mvr_\perp$

Sol.: According to the figure



$L = mvr \Rightarrow L$ remains constant

36. Answer (1)

Hint: Use equations: $\omega = \omega_0 + \alpha t$ and $\tau = I\alpha$

Sol.: $\omega = \omega_0 + \alpha t$

$0 = \frac{120 \times 2\pi}{60} + \alpha \times (2 \times 60)$

$\alpha = -\frac{4\pi}{2 \times 60} = -\frac{\pi}{30}$ rad/s^2

$\tau = I\alpha = 3 \times \left(-\frac{\pi}{30}\right) = -\frac{\pi}{10}$ N m

37. Answer (3)

Hint and Sol.: Motion of COM of a system only depends on net external force on the system, its motion does not get affected by internal forces.

38. Answer (3)

Hint and Sol.: In case of couple, net external force is zero but torque is non-zero.

39. Answer (2)

Hint: Area under force-displacement curve is equal to work done.

Sol.: According to work-energy theorem

$W_{net} = \Delta KE$

Area under F - x graph = ΔKE

$\frac{1}{2}(100 + 60) \times 10 = \Delta KE \Rightarrow \Delta KE = 800$ J

40. Answer (4)

Hint: Apply the formula of power

$P = \frac{dm}{dt}gh + \frac{1}{2}\frac{dm}{dt} \times v^2$

Sol.: Power required, $P = \frac{dm}{dt}gh + \frac{1}{2}\frac{dm}{dt} \times v^2$

$P = (2 \times 10 \times 20) + \left(\frac{1}{2} \times 2 \times 25\right)$

P = 425 J/s

$\eta = \frac{\text{Output power}}{\text{Input power}}$

Input power $= \frac{425}{\frac{60}{100}} = 708.3$ W

41. Answer (4)

Hint: Energy stored in spring, $U = \frac{1}{2}Kx^2$

Sol.: $U = \frac{1}{2}Kx^2, F = Kx$

$U = \frac{1}{2}K \times \frac{F^2}{K^2} \Rightarrow U \propto \frac{1}{K}$

$\therefore \frac{U_A}{U_B} = \frac{K_B}{K_A} \Rightarrow \frac{E}{U_B} = \frac{\frac{K}{2}}{K} \Rightarrow U_B = 2E$

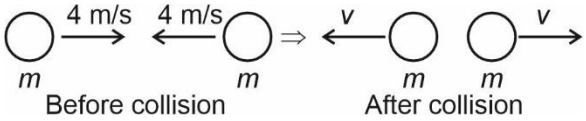
42. Answer (1)

Hint and Sol.: In critical condition, the speed of the particle can be zero when it is rotated in vertical circle with the help of a light rod.

43. Answer (2)

Hint: $e = \frac{\text{Relative velocity of separation}}{\text{Relative velocity of approach}}$

Sol.: Linear momentum of system will remain conserved, hence speeds after the collision will be same for both the balls.



$e = \frac{2v}{4+4} = \frac{3}{4}$

$2v = 6$

$\Rightarrow v = 3$ m/s

44. Answer (3)

Hint and Sol.: Flywheel has large moment of inertia. When input power is switched off, it continues to rotate for some time due its large moment of inertia.

45. Answer (4)

Hint: Power, $P = \vec{\tau} \cdot \vec{\omega}$

Sol.: $P = \left(a\hat{i} + b\hat{j} - 2\hat{k}\right) \cdot \left(2\hat{i} + 3\hat{j} - 4\hat{k}\right)$

$0 = 2a + 3b + 8$

Putting values of $a = -\frac{11}{2}$ and $b = 1$,

we get $P = 0$

$2 \times \left(-\frac{11}{2}\right) + (3 \times 1) + 8 = -11 + 11 = 0$

[CHEMISTRY]

46. Answer (2)

Hint: The process is adiabatic hence $q = 0$

Sol.: The process is irreversible hence

Work done (w) = $-P_{ex}\Delta V$

w = –1.20 (4.6 – 3.1)

w = –1.8 L atm = –1.8 × 101.3 = –182.3 J

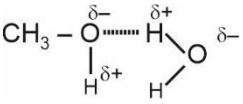
From first law of thermodynamics,

$\Delta U = q + w$

ΔU = –182.3 J

47. Answer (2)

Hint: Methanol forms intermolecular hydrogen bond with water.

Sol.: 

48. Answer (1)

Hint: The standard molar enthalpy of formation at 298 K for C(graphite) is zero

Sol.:

Substance	$\Delta_f H°$(kJ mol^{-1}
$Br_2(\ell)$	0
$H_2(g)$	0
HI(g)	+26.48
$Cl_2(g)$	0
C(diamond)	+1.89
S(rhombic)	0
Si(s)	0
HCl(g)	–92.31

49. Answer (4)

Hint: $\Delta S_{total} = \Delta S_{system} + \Delta S_{surrounding}$

Sol.: For spontaneous process, $\Delta S_{total} > 0$

50. Answer (3)

Hint: Entropy change will be positive if the randomness increases.

Sol.: In sublimation of camphor, melting of ice and evaporation of water, randomness of the molecules increases hence, in all these cases, $\Delta S > 0$

51. Answer (1)

Hint: $\Delta_r G° = -2.303\ RT \log K_p$

Sol.: $\Delta_r G° = -2.303 \times 8.314 \times 300 \log 1 \times 10^3$

$\Delta_r G° = -2.303 \times 8.314 \times 300 \times 3$

$\Delta_r G° = -17.23\ kJ\ mol^{-1}$

52. Answer (4)

Hint: 1 mole NaOH(aq) on reaction with 1 mol HCl (aq) will release 57.1 kJ of energy.

Sol.: $NaOH(aq) + HCl(aq) \rightarrow NaCl(aq) + H_2O(\ell)$

m mol of NaOH = 400 × 0.4 = 160 m mol

m mol of HCl = 500 × 0.3 = 150 m mol

HCl is limiting reagent

Heat released in the neutralisation process = $150 \times 10^{-3} \times 57.1 = 8.6$ kJ

53. Answer (4)

Hint: For $p\pi$-$d\pi$ bond formation, one of the atom should contain vacant d-orbital.

Sol.: Sulphur in SO_2, SO_4^{2-} and phosphorous in PO_4^{3-} contain vacant d-orbital. These species form $p\pi$-$d\pi$ bond with oxygen.

54. Answer (4)

Hint: Bond order $= \frac{1}{2}(N_b - N_a)$

Sol.:

- Bond order of $N_2 = \frac{1}{2}(10-4) = 3$

  Bond order of $N_2^+ = \frac{1}{2}(9-4) = 2.5$

- O_2^+ contains one unpaired electron in its π^* molecular orbital, hence, it is paramagnetic in nature.

55. Answer (4)

Hint: $N_2 = \sigma 1s^2\ \sigma^* 1s^2 \sigma 2s^2\ \sigma^* 2s^2\ \pi 2p_x^2 \equiv \pi 2p_y^2$

$\sigma 2p_z^2 \qquad \underbrace{\pi^* 2p_x \equiv \pi^* 2p_y}_{\text{Lowest unoccupied MO (LUMO)}}$

Sol.: $H_2^+ = \sigma 1s^1\ \underset{\text{(LUMO)}}{\sigma^* 1s}$

$He_2^+ = \sigma 1s^2 \sigma^* 1s^1\ \underset{\text{(LUMO)}}{\sigma 2s}$

$Be_2^+ = \sigma 1s^2 \sigma^* 1s^2 \sigma 2s^2 \sigma^* 2s^1\ \underset{\text{(LUMO)}}{\pi 2p_x \equiv \pi 2p_y}$

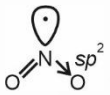
56. Answer (1)

Hint: C_2H_2 is a linear species in which both the carbon atoms are *sp* hybridised

Sol.:

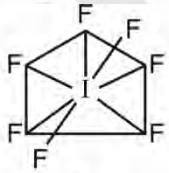
a. $H-\overset{sp}{C}\equiv\overset{sp}{C}-H$ b. $O=\overset{sp}{C}=O$

c. $F-\overset{sp}{Be}-F$ d. 

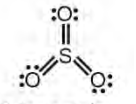
e. 

57. Answer (3)

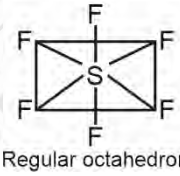
Hint: SO_3 is a trigonal planar molecule in which sulphur atom has no lone pair.

Sol.: 

IF_7



6 lone pairs

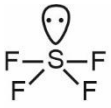


Regular octahedron

Trigonal planar

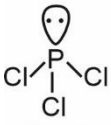
58. Answer (3)

Hint: Shape of the molecule depends on the arrangement of electron pairs (lone pairs and bond pairs) around central atom.

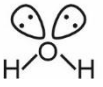
Sol.: 

See-saw

Bent T shape

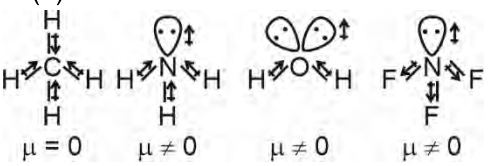


Trigonal pyramidal



Bent T shape

59. Answer (4)

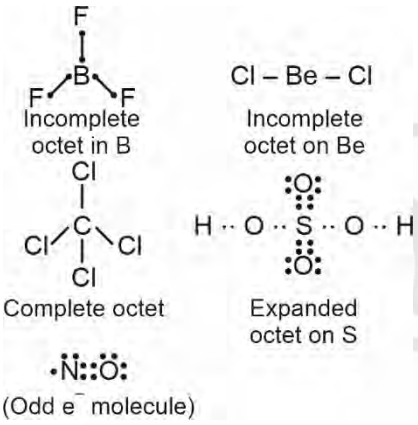
Hint: 

Sol.: N – H bond polarity is less than that of O – H bond polarity.

Molecule	Dipole moment (D)
H_2O	1.85
NH_3	1.47
NF_3	0.23
CH_4	0

60. Answer (3)

Hint: BF_3 and $BeCl_2$ are examples of incomplete octet.

Sol.: 

61. Answer (2)

Hint: $C_3H_8(g) + 5O_2(g) \rightarrow 3CO_2(g) + 4H_2O(\ell)$

Sol.:

$3C(\text{graphite}) + 4H_2(g) \rightarrow C_3H_8(g)$ …(i)

$\Delta H^\circ = -103.85\ kJ\ mol^{-1}$

$C(\text{graphite}) + O_2(g) \rightarrow CO_2(g)$ …(ii)

$\Delta H^\circ = -393.5\ kJ\ mol^{-1}$

$H_2(g) + \frac{1}{2}O_2(g) \rightarrow H_2O(\ell)$ …(iii)

$\Delta H^\circ = -285.8\ kJ\ mol^{-1}$

Applying; 3 × (ii) + 4 × (iii) – (i)

$3C(\text{graphite}) + 3O_2(g) \rightarrow 3CO_2(g)$

$\Delta H = -393.5 \times 3 = -1180.5\ kJ\ mol^{-1}$

$2H_2(g) + 2O_2(g) \rightarrow 4H_2O(\ell)$

$\Delta H = -285.8 \times 4 = -1143.2\ kJ\ mol^{-1}$

$3C(\text{graphite}) + 4H_2(g) \rightarrow C_3H_8(g)$

$\Delta H = +103.85\ kJ\ mol^{-1}$

$C_3H_8(g) + 5O_2(g) \rightarrow 3CO_2(g) + 4H_2O(\ell)$

$\Delta H = 103.85 - 1180.5 - 1143.2$

$= -2219.85$

62. Answer (3)

Hint and Sol.: Density is an intensive property as it does not depend on quantity or size of matter present.

63. Answer (1)

Hint: $W_{rev} = -2.303nRT\log\frac{P_i}{P_f}$

Sol.: $W_{rev} = -2.303 \times 2 \times 8.314 \times 300 \times \log\frac{4}{2}$

$= -2.303 \times 2 \times 8.314 \times 300 \times 0.3$

$= -3.4$ kJ

64. Answer (4)

Hint: During bond formation, energy is released

Sol.: Number of gaseous particles are decreasing in this process therefore, $\Delta_r S < 0$

65. Answer (2)

Hint: $\Delta H = \Delta U + \Delta n_g RT$ and $\Delta G = \Delta H - T\Delta S$

Sol.: $\Delta H = \Delta U + \Delta n_g RT$

$\Delta H = 4.5 + 3 \times 2 \times 300 \times 10^{-3}$

$\Delta H = 4.5 + 1.8$

$\Delta H = 6.3$ kcal

$\Delta G = \Delta H + T\Delta S$

$= 6.3 - 300 \times 60 \times 10^{-3}$

$= 6.3 - 18$

$= -11.7$ kcal

66. Answer (4)

Hint: State functions value depend only on the state of the system and not on how it is reached

Sol.: Heat (q) and work (w) are path dependent functions.

67. Answer (2)

Hint: For free expansion, $P_{ex} = 0$

Sol.: $w = -P_{ex}\Delta V = 0$

From first law of thermodynamics

$\Delta U = q + w$

$q = \Delta U - w = 0$ [$\because \Delta U = 0$ as temperature is constant]

68. Answer (1)

Hint: $\Delta_r H^\circ = \sum$ bond dissociation enthalpies of reactants $- \sum$ bond dissociation enthalpies of products.

Sol.: $\frac{1}{2}H_2(g) + \frac{1}{2}Br_2(g) \rightarrow HBr(g)$

$\Delta_r H^\circ = \frac{1}{2}(435.8 + 192) - 368$

$\Delta_r H^\circ = 313.9 - 368 = -54.1\ kJ\ mol^{-1}$

69. Answer (4)

Hint: Hess' law of constant heat summation is applied.

Sol.:

	ΔH (kJ mol^{-1})	
$A \rightarrow 2B$	+120	…(i)
$3B \rightarrow C + D$	–170	…(ii)
$E + 2A \rightarrow 3D$	+250	…(iii)
(iii) + (ii) – 2(i)		
$E + 2A \rightarrow 3D$	+250	
$3B \rightarrow C + D$	–170	
$-2A \rightarrow -4B$	–240	
$E + 7B \rightarrow C + 4D$	–160	

70. Answer (3)

Hint: $H_2O(\ell) \rightarrow H_2O(g)$

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

$\Delta n_g = 1$

Sol.: $\Delta U = \Delta H - \Delta n_g RT$

$\Delta H = x - 1 \times 8.314 \times 373 \times 10^{-3}$

$\Delta H = (x - 3.1)$ kJ mol^{-1}

71. Answer (1)

Hint: $T\Delta S_{sys}$ is the energy which is not available to do useful work. ΔG is the net energy available to do useful work.

Sol.: A reaction will be non-spontaneous at all temperature if $\Delta_r H° > 0$ and $\Delta_r S° < 0$

72. Answer (2)

Hint and Sol.: Promotion of electron is not an essential condition prior to hybridisation.

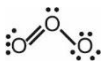
73. Answer (4)

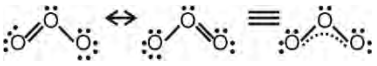
Hint: More the bond order, less will be the bond length

Sol.:

Species	C–O bond order
CO_2	2
CO_3^{2-}	1.33
CO	3

74. Answer (3)

Hint: 

Sol.: 

Total lone pairs in a canonical form of O_3 = 6

Formal charge on central oxygen atom = +1

75. Answer (2)

Hint and Sol.:

a. ZnO – Amphoteric

b. N_2O – Neutral

c. Cl_2O_7 – Acidic

d. MgO – Basic

76. Answer (1)

Hint: s and p block elements are called main group elements or representative elements.

Sol.:

Element	Block
Germanium	p block
Selenium	p block
Scandium	d block
Vanadium	d block

77. Answer (1)

Hint: Dubnium has atomic number 105 and has IUPAC symbol Db.

Sol.:

	IUPAC official name and IUPAC symbol	Atomic number	Name according to IUPAC nomenclature
a.	Dubnium (Db)	105	Unnilpentium
b.	Seaborgium (Sg)	106	Unnilhexium
c.	Bohrium (Bh)	107	Unnilseptium
d.	Hassium (Hs)	108	Unniloctium

78. Answer (3)

Hint: Element with atomic number more than that of uranium are called transuranium elements.

Sol.:

Neptunium – Transuranium element

Iodine – Halogen

Polonium – Chalcogen

Tellurium – Chalcogen

79. Answer (2)

Hint: For isoelectronic species, more is the positive charge on ion, smaller is the size of ion.

Sol.: Both F and Mg are second period elements and achieve Neon like configuration by making anion and cation respectively.

$Mg \xrightarrow{-2e^-} Mg^{2+}$

$F \xrightarrow{+e^-} F^-$

Both of these ions are isoelectronic and Mg^{2+} will have the smallest size due to higher effective nuclear charge.

80. Answer (2)

Hint: The correct order of ionisation enthalpy of second period elements is

Li < B < Be < C < O < N < F < Ne

Sol.: Argon is a noble gas in 3rd period and has highest first I.E. among all 3rd period elements.

$Na^+ = 1s^2, 2s^2\ 2p^6$

Stable inert gas configuration

$Mg^+ = 1s^2, 2s^2\ 2p^6\ 3s^1$

Removal of 2nd electron is easier from Mg^+ as compared to Na^+ hence, 2nd I.E. of Na is higher than that of Mg.

81. Answer (1)

Hint: Moving left to right along the 2nd period, electronegativity increases while moving down the group electronegativity decreases.

Sol.: Order of electronegativity

Si < C < N < O < F

82. Answer (1)

Hint and Sol.:

Element	**$\Delta_{eg}H$/(kJ mol^{-1})**
O	–141
S	–200
Se	–195
Te	–190

83. Answer (4)

Hint: Isoelectronic species have same number of electrons

Sol.:

Species		**Electrons**
P^{3-}	–	18
S^{2-}	–	18
Cr^+	–	23
Mn^{2+}	–	23
Fe	–	26
Ni^{2+}	–	26
Zn^{2+}	–	28
Cu^{2+}	–	27

84. Answer (1)

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

Sol.: $\mu_{calculated} = q \times d$

$= 1.6 \times 10^{-19} \times 1.5 \times 10^{-10}$ Cm

$$\% \text{ ionic character} = \frac{1.5 \times 3.33 \times 10^{-30}}{1.6 \times 10^{-19} \times 1.5 \times 10^{-10}} \times 100$$

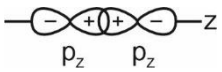
$$= \frac{3.33}{1.6} \times 100 = 20.8\%$$

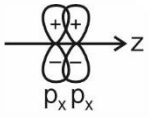
85. Answer (4)

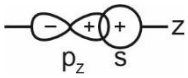
Hint: Negative overlap involves the overlap of lobes of opposite sign.

Sol.:

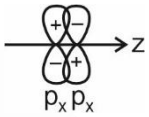
Positive overlap:







Negative overlap:



86. Answer (1)

Hint: At equilibrium, $\Delta G = 0$

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

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

$\Delta H = T\Delta S$, at equilibrium

Sol.: $\frac{1}{2}A_2 + B_2 \rightleftharpoons AB_2$

$$\Delta S = 40 - \left\{\frac{1}{2}(50) + 60\right\}$$

$\Delta S = 40 - (85) = -45$ JK^{-1} mol^{-1}

$$T = \frac{\Delta H}{\Delta S} = \frac{-19800}{-45} = 440\ K$$

87. Answer (3)

Hint: Hess's law of constant heat summation should be applied.

Sol.:

A(solid) $\rightarrow$ A(liquid) $\Delta H_1 = 6.1$ kJ mol^{-1} …(i)

A(liquid) $\rightarrow$ A(gas) $\Delta H_2 = 96.5$ kJ mol^{-1} …(ii)

Adding (i) and (ii)

A(solid) $\rightarrow$ A(gas)

$\Delta H = \Delta H_1 + \Delta H_2$

$= 6.1 + 96.5$

$= 102.6$ kJ mol^{-1}

88. Answer (2)

Hint: Heat capacity $(C) = \frac{q}{\Delta T}$

Sol.: For isothermal process, $\Delta T = 0$

Hence, heat capacity will be infinite.

89. Answer (4)

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

Sol.: Δn_g refers to the number of moles of gaseous products minus the number of moles of gaseous reactants.

			Δn_g
•	$PCl_5(g) \rightarrow PCl_3(g) + Cl_2(g)$	–	1
•	$N_2(g) + 3H_2(g) \rightarrow 2NH_3(g)$	–	–2
•	$H_2(g) + I_2(g) \rightarrow 2HI(g)$	–	Zero
•	$2NO(g) + O_2(g) \rightarrow 2NO_2(g)$	–	–1

90. Answer (3)

Hint: $\Delta H = nC_P\Delta T$

Sol.: For isothermal process, $\Delta T = 0$

$\therefore \Delta H = 0$

[BOTANY]

91. Answer (4)

Hint: Ovary is inferior in epigynous flowers.

Sol.: Guava, cucumber and bitter gourd have inferior ovary in which margin of the thalamus grows upward, enclosing the ovary completely and getting fused with it.

92. Answer (2)

Hint: In vexillary aestivation, the largest petal is called standard.

Sol.: Internodes of the shoot gets condensed and produce different kind of floral appendages laterally at successive nodes, instead of leaves. Bud is not present in the axil of leaflets of a compound leaf.

Based on the position of calyx, corolla and androecium in respect of the ovary on thalamus, flowers are described as hypogynous, perigynous and epigynous.

93. Answer (1)

Hint: Ground tissue system is also called as fundamental tissue system in plants.

Sol.: In leaf, mesophyll is the ground tissue. Hypodermis is absent in roots. Ground tissue system provides mechanical support.

94. Answer (4)

Hint: Cruciform corolla is the characteristic feature of the members of Brassicaceae family.

Sol.: Tap root system and bicarpellary syncarpous superior ovary is found in both Brassicaceae and Solanaceae family.

Bisexual flower with actinomorphic symmetry, sepals with valvate aestivation, endospermous seed are found in the members of Solanaceae family.

95. Answer (3)

Hint: Meristems are the specialised areas in plant body for active cell division.

Sol.: Sieve tube elements are long, tube-like living structures.

Lignin is deposited in the wall of tracheid, vessel and sclerenchyma only.

96. Answer (1)

Hint: Endodermis is characterised by the presence of a special 'thickened' band in their wall, called casparian strips.

Sol.: Pericycle gives rise to lateral roots and vascular cambium in dicotyledonous plants.

97. Answer (3)

Hint: In lotus, carpels are not fused.

Sol.: Canna shows the presence of asymmetric flowers. *Alstonia* shows whorled type of phyllotaxy.

98. Answer (1)

Hint: Radial type of vascular bundles are seen in roots.

Sol.: In a dicot stem, secondary growth is observed. Conjoint, closed type of vascular bundles are seen in monocot stems and dicot leaves.

99. Answer (3)

Hint: The apex of root is covered by a thimble-like structure, called root cap. It protects the tender apex of the root.

Sol.: Region of meristematic activity – The cells of this region are very small, thin walled with dense protoplasm.

Region of elongation – Cells of this region are responsible for the growth of root in length.

Region of maturation – Cells of this region differentiate and mature.

100. Answer (1)

Hint: In monocotyledonous plants, primary root is replaced by a number of fine fibrous roots.

Sol.: Mustard is a dicotyledonous plant in which primary root is long-lived, on the other hand, wheat is a monocotyledonous plant in which primary root is short-lived.

101. Answer (4)

Hint: All the tissues on the inner side of endodermis, constitute stele.

Sol.: Pericycle gives rise to the lateral roots. Vascular bundles help in transport of substances over long distance. Pith or medulla occupies the central part.

102. Answer (3)

Hint: In gulmohur, imbricate aestivation is seen.

Sol.: In imbricate aestivation, margin of petals or sepals overlaps each other but not in a particular direction.

103. Answer (1)

Hint: This layer is fibrous.

Sol.: Mesocarp of coconut is used in making coir.

104. Answer (1)

Hint: *Gloriosa*, *Asparagus* and *Colchicum* belong to the family Liliaceae.

Sol.: Axile placentation, bicarpellary syncarpous ovary, tap root, bisexual and actinomorphic flower, capsule or berry type of fruit and gamosepalous and gamopetalous flower are the characteristics of the members of solanaceae family.

105. Answer (1)

Hint: Epiphyllous condition is found in the members of Liliaceae.

Sol.: In tobacco, epipetalous condition is found.

In Sunhemp and Indigofera, epiphyllous condition is not found.

106. Answer (4)

Hint: The given figure represents free-central placentation.

Sol.: In free central placentation, ovules are borne on central axis and septa are absent in the ovary eg:- *Primrose*, *Dianthus*.

107. Answer (3)

Hint: In potato, axile placentation is seen.

Sol.: In potato, ovary is bilocular and epipetalous stamen is present.

108. Answer (4)

Hint: Stomata, trichomes and guard cells are the components of epidermal tissue system.

Sol.: Passage cells are present in endodermis which is the component of ground tissue system.

109. Answer (2)

Hint: The epidermal hairs found on stem are called trichomes.

Sol.: Trichomes in the shoot system, help in preventing water loss.

110. Answer (1)

Hint: Cohesion or adhesion of stamens is not seen in mustard.

Sol.: Mustard has six stamens, two small and four long.

111. Answer (1)

Hint: Coleoptile and coleorhiza are absent in dicot seeds.

Sol.: In dicot seeds, plumule and radicle are not covered in sheath like structures.

112. Answer (2)

Hint: In rose, perigynous flowers are present.

Sol.: In some leguminous plants, the leaf base swells and is called pulvinus.

113. Answer (4)

Hint: Banana is a monocotyledonous plant.

Sol.: In banana plant, closed vascular bundles are present.

114. Answer (3)

Hint: Floral formula does not represent placentation.

Sol.: In case of pea, condition of stamens is diadelphous, *i.e.*, 9 + 1 type.

115. Answer (2)

Hint: When a stamen is attached to the petal, then it is called epipetalous.

Sol.: Bilocular term is used for gynoecium.

116. Answer (3)

Hint: Persistent calyx is the feature of the members of Solanaceae family.

Sol.: Brinjal is the member of solanaceae family and has a persistent calyx.

117. Answer (3)

Hint: In gymnosperms, vessels are absent.

Sol.: Companion cell helps in maintaining the pressure gradient in the sieve tube.

Complex permanent tissues comprise of xylem and phloem.

118. Answer (4)

Hint: In alternate phyllotaxy, single leaf is present at each node in an alternate fashion.

Sol.: In cymose inflorescence, the flowers are borne in basipetal order.

Aggregate fruit is developed from polycarpellary apocarpous ovary.

119. Answer (1)

Hint: Stamens are united into more than two bundle in polyadelphous condition.

Sol.: In citrus, polyadelphous condition is observed.

120. Answer (1)

Hint: Innermost layer of cortex is called endodermis.

Sol.: Endodermis is the border between general cortex and stele.

121. Answer (3)

Hint: In dicotyledonous plant, bean shaped guard cells are present, in which outer walls are thin while the inner walls are highly thickened.

Sol.: Root hairs are unicellular and they increase the surface area for absorption.

Guard cells control the opening and closing of stomatal pore. When they are turgid the stomatal pore is open and when they are flaccid, the stomatal pore is closed.

122. Answer (3)

Hint: Cuticle is absent in roots.

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

123. Answer (2)

Hint: Endosperm is triploid in nature.

Sol.: Ploidy of endosperm is similar to aleurone layer.

124. Answer (2)

Hint: Aleurone layer is not found in dicot seeds.

Sol.: In bean, endosperm persists at maturity.

125. Answer (2)

Hint: If the pericarp is thick and fleshy, then it differentiates into three different layers namely epicarp, mesocarp and endocarp.

Sol.: In mango fruit, edible part is fleshy, juicy mesocarp.

126. Answer (3)

Hint: $G_{(n)}$ represents syncarpous ovary.

Sol.: Inferior ovary is represented in the floral formula as $\bar{G}_n$.

127. Answer (1)

Hint: K represents calyx.

Sol.:

% $\rightarrow$ Zygomorphic symmetry

φ $\rightarrow$ Bisexual flower

Br $\rightarrow$ Bracteate flower

128. Answer (3)

Hint: In Brinjal, there is no variation in the length of the filaments.

Sol.: Variation in the length of filaments within a flower is observed in *Salvia* and Mustard.

129. Answer (4)

Hint: Root hairs and trichomes are the part of epidermal tissue system.

Sol.: Ground tissue system is present between epidermal and vascular tissue system.

130. Answer (2)

Hint: When protoxylem is formed towards the centre, it is called endarch condition.

Sol.: In endarch condition, xylem grows from centre to periphery, called centrifugal growth.

131. Answer (4)

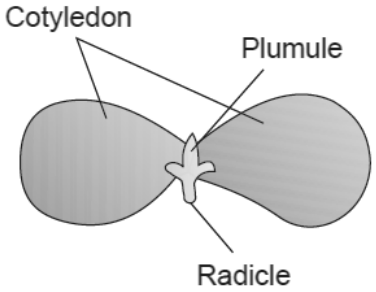
Hint: In conjoint type of vascular bundle, the xylem and phloem are jointly situated along the same radius of vascular bundle.

Sol.: The conjoint vascular bundles usually have the phloem located on the outer side of xylem.

132. Answer (2)

Hint: At the two ends of embryonal axis, are present the radicle and the plumule.

Sol.:



In dicotyledonous seeds, plumule and radicle are not enclosed in sheaths.

Future shoot of embryo is plumule.

133. Answer (1)

Hint: Ovary bears ovules on a cushion-like structure called placenta.

Sol.: The arrangement of ovules on placenta within the ovary is known as placentation.

134. Answer (4)

Hint: In basal placentation, single ovule is attached to the placenta.

Sol.: Mustard is the member of Brassicaceae family in which parietal placentation is seen.

135. Answer (3)

Hint: Medullary rays are found between vascular bundles in stems.

Sol.: These rays are found in stelar region.

[ZOOLOGY]

136. Answer (3)

Hint: Ammonia is the most toxic nitrogenous waste.

Sol.: The correct order of nitrogenous waste according to the decreasing toxicity is

Ammonia > Urea > Uric acid

- Many bony fishes, aquatic amphibians and aquatic insects are ammonotelic.
- Mammals are ureotelic.
- Land snails are uricotelic.

137. Answer (3)

Hint: Bones of pelvic girdle

Sol.:

- Based on location, three types of muscles are identified *i.e.*, skeletal, visceral and cardiac.
- Each middle ear contains three tiny bones – Malleus, incus, stapes
- Each coxal bone is formed by the fusion of three bones – Ilium, ischium, pubis
- Joints have been classified into three major structural forms – Fibrous, cartilaginous, synovial.

138. Answer (3)

Hint: Straight tube reabsorbing large amounts of water

Sol.: Bowman's capsule, PCT and DCT are present in the cortex region of kidneys.

Collecting duct extends from the cortex of kidney to the inner parts of medulla.

139. Answer (4)

Hint: Thin filaments slide over thick filaments

Sol.: In a resting state, the edges of thin filaments on either side of the thick filaments partially overlap the free ends of the thick filaments leaving the central part of the thick filaments. This central part of thick filament, not overlapped by thin filaments is called the 'H' zone.

140. Answer (2)

Hint: Troponin is a trimeric protein

Sol.: Each actin (thin) filament is made of two 'F' (filamentous) actins helically wound to each other. Each 'F' actin is a polymer of monomeric 'G' (globular) actins. Two filaments of another protein, tropomyosin also run close to 'F' actins throughout its length.

A complex protein troponin is distributed at regular intervals on the tropomyosin.

141. Answer (4)

Hint: A movement facilitated by cilia

Sol.: Flagellar movement helps in

a. Swimming of spermatozoa in human male
b. Maintenance of water current in canal system of sponges.
c. Locomotion of protists like *Euglena*.

Ciliary movement occurs in the female reproductive tract to facilitate passage of ova.

142. Answer (3)

Hint: Lesser than the width

Sol.: Each kidney of an adult human measures 10-12 cm in length 5-7 cm in width and 2-3 cm in thickness with an average weight of 120-170 g.

Human excretory system also consists of one pair of ureters, a urinary bladder and a urethra along with a pair of kidneys.

143. Answer (2)

Hint: Identify a flatworm

Sol.:

- Protonephridia or flame cells are excretory structures in platyhelminths (flatworms *e.g.* *Planaria*)
- Antennal glands/green glands are excretory structures in crustaceans.
- Malpighian tubules help in removal of nitrogenous wastes and osmoregulation in most of the insects including cockroaches.

144. Answer (3)

Hint: True for columnar cells

Sol.: PCT is lined by simple brush bordered cuboidal epithelium which increases the surface area for reabsorption. Nearly all of the essential nutrients and 70-80% of electrolytes and water are reabsorbed by PCT.

The nuclei of cuboidal cells (cube-like) are central in position.

The nuclei of columnar cells lie in the basal region.

145. Answer (2)

Hint: Angiotensin II increases blood pressure.

Sol.: Angiotensin II, being a powerful vasoconstrictor, increases the glomerular blood pressure and thereby GFR. Angiotensin II also activates adrenal cortex to release aldosterone. Aldosterone causes reabsorption of Na^+ and water from the distal parts of the tubule. This also leads to an increase in blood pressure and GFR. This complex mechanism is generally known as Renin-Angiotensin mechanism.

146. Answer (4)

Hint: Scapula is dorsally located.

Sol.: Each pectoral girdle is formed of two halves. Each half of pectoral girdle consists of a clavicle and a scapula.

Scapula is a large triangular flat bone situated in the dorsal part of thorax between the second and the seventh ribs. The dorsal, flat, triangular body of scapula has a slightly elevated ridge called the spine which projects as a flat expanded process called acromion. The clavicle articulates with it.

147. Answer (4)

Hint: 'A' is renal artery

Sol.:

'A' – Renal artery – Carries oxygenated blood

'B' – Renal vein – Carries deoxygenated blood

'C' – Dorsal aorta – Carries oxygenated blood

'D' – Inferior vena cava – Carries deoxygenated blood

148. Answer (3)

Hint: CNS sends voluntary signals for micturition.

Sol.: Urine is formed by nephrons of kidneys and not by liver. Urine is stored in urinary bladder till a voluntary signal is given by CNS. The signal for micturition is initiated by stretching of urinary bladder as it gets filled with urine. These stretch receptors send signals to the CNS. The CNS passes on motor messages to initiate contraction of smooth muscles of urinary bladder and simultaneous relaxation of urethral sphincter causing the release of urine. The process of release of urine is called micturition and the neural mechanism causing it is called the micturition reflex.

149. Answer (1)

Hint: Includes last thoracic vertebrae

Sol.: Human kidneys are reddish brown, bean-shaped structures situated between the levels of last thoracic and third lumbar vertebrae close to the dorsal inner wall of abdominal cavity.

150. Answer (1)

Hint: Causes concentration of fluid as it moves down

Sol.: The descending limb of loop of Henle is permeable to water but almost impermeable to electrolytes.

Ascending limb of loop of Henle is impermeable to water but allows transport of electrolytes actively or passively.

PCT is permeable to both water and electrolytes. DCT is also permeable to both water and electrolytes in the presence of certain hormones.

151. Answer (3)

Hint: Largest gland in our body eliminates cholesterol

Sol.:

Sweat glands	–	NaCl, small amounts of urea, lactic acid
Liver	–	Cholesterol, drugs and vitamins
Sebaceous glands	–	Sterols, hydrocarbon and waxes
Lungs	–	CO_2 and water

152. Answer (4)

Hint: Blood vessel that carries blood away from heart

Sol.: In uremic patients, urea can be removed by the process called haemodialysis. During the process of haemodialysis, the blood drained from a convenient artery is pumped into a dialysing unit, called artificial kidney after adding an anti-coagulant like heparin.

153. Answer (2)

Hint: Former affects neuro-muscular junction.

Sol.: Myasthenia gravis – Auto-immune disorder

Muscular dystrophy – Genetic disorder

Osteoporosis – Age-related disorder

Gout – Inflammatory disorder

154. Answer (3)

Hint: Useful in blood clotting

Sol.: Tetany is caused due to rapid spasms in muscle due to low levels of Ca^{2+} in blood. It is caused either due to low levels of parathormone or decreased levels of estrogen in old age women.

155. Answer (1)

Hint: White muscle fibres carry out anaerobic oxidation.

Sol.: Red muscle fibres carry out aerobic oxidation without accumulating much lactic acid. Thus, they can contract for a longer period without fatigue.

White muscle fibres carry out anaerobic oxidation for energy production and accumulate lactic acid in considerable amount during strenuous work and soon get fatigued.

156. Answer (2)

Hint: Skeletal and cardiac muscle fibres are striated.

Sol.: All voluntary muscle fibres (skeletal) are striated.

All branched muscle fibres (cardiac) are striated.

All fusiform muscle fibres (smooth) are involuntary.

157. Answer (2)

Hint: Globular head is an active ATPase enzyme.

Sol.: HMM = Globular head + short arm

LMM = Tail only

The globular head is an active ATPase enzyme and has binding sites for ATP and active sites for actin.

The HMM projects outwards at regular distance and angle from each other from the surface of a polymerised myosin filament.

158. Answer (2)

Hint: Hairpin shaped structure is located in medulla region.

Sol.: The Malpighian corpuscle (Bowman's capsule + glomerulus), PCT and DCT of the nephron are situated in the cortical region of the kidney whereas the loop of Henle dips into the medulla.

159. Answer (3)

Hint: False ribs do not have direct attachment on sternum.

Sol.:

- True ribs (1^{st} to 7^{th} pairs) are dorsally connected to the thoracic vertebrae and ventrally to sternum.
- False ribs (8^{th}, 9^{th} and 10^{th} pairs) join 7^{th} pair of ribs ventrally and thoracic vertebrae dorsally
- In floating ribs (11^{th} and 12^{th} pairs), one end of rib is attached to vertebral column and the other end is free.

160. Answer (4)

Hint: High myoglobin is responsible for red colour

Sol.:

	Red muscle fibres	–	**White muscle fibres**
(1)	Abundant myoglobin providing dark red colour	–	Very little quantity of myoglobin giving lighter colour
(2)	More mitochondria	–	Lesser mitochondria
(3)	Less sarcoplasmic reticulum	–	More sarcoplasmic reticulum
(4)	Have more blood capillaries	–	Have lesser blood capillaries

161. Answer (4)

Hint: Uric acid is the least toxic form of nitrogenous waste

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

$\therefore$ Decreasing toxicity order is

Ammonia > Urea > Uric acid

162. Answer (3)

Hint: Identify a skull bone.

Sol.:

- Ear ossicles are total 6 in number. Each middle ear contains 3 tiny bones – Malleus, incus and stapes
- Patella *i.e.*, knee caps are also 2 in number.
- Clavicle are 2 in number.
- Sphenoid is an unpaired cranial bone.

163. Answer (2)

Hint: A vasoconstrictor

Sol.:

- Angiotensin II activates adrenal cortex to release aldosterone.
- Aldosterone causes reabsorption of Na^+ and water from distal parts of the renal tubules.
- An increase in blood flow to the atria of heart can cause release of ANF.
- Excessive loss of fluid from body stimulates hypothalamus to release ADH or vasopressin.
- A fall in GFR can activate JG cells to release renin.

164. Answer (3)

Hint: Contractile proteins are parallely placed

Sol.: The reaction time of the muscle fibres can vary in different muscles.

Each organised skeletal muscle in our body is made of a number of muscle bundles or fascicles held together by a common collagenous connective tissue layer called fascia.

165. Answer (1)

Hint: Spinal cord passes through neural canal.

Sol.: Vertebral column extends from the base of skull and constitute main framework of the trunk. Each vertebra has a central hollow portion (neural canal) through which spinal cord passes. The vertebral column protects the spinal cord, supports the head and serves as the point of attachment for ribs and the musculature of back.

166. Answer (4)

Hint: Heart has little influence on kidney functions

Sol.: The functioning of kidneys is efficiently monitored and regulated by hormonal feedback mechanism involving hypothalamus, JGA and to certain extent, the heart.

The kidneys have built-in mechanisms for the regulation of glomerular filtration rate. One such efficient mechanism is carried out by juxta-glomerular apparatus.

167. Answer (2)

Hint: Counter current is more prominent in them.

Sol.: Desert animals for *e.g.* camels have more number of juxtamedullary nephrons as compared to cortical nephrons.

In former, loop of Henle is very long and runs deep into the medulla while loop of Henle is too short and extends only very little into the medulla in latter.

Juxtamedullary nephrons are responsible for production of concentrated urine.

168. Answer (4)

Hint: False ribs attach to the 7^{th} rib ventrally.

Sol.: There are 12 pairs of ribs. Each rib is a thin flat bone connected dorsally to the vertebral column and ventrally to the sternum.

First 7 pairs of ribs are called true ribs.

Next 3 pairs (8^{th}, 9^{th} and 10^{th}) are called false (vertebrochondral) ribs.

Last 2 pairs (11^{th} and 12^{th}) are called floating ribs.

169. Answer (2)

Hint: Total bones in one hindlimb is 30

Sol.: Each hindlimb constitutes

- 1 thigh bone
- 1 tibia and 1 fibula
- 7 tarsals
- 5 metatarsals
- 14 phalanges
- 1 patella

i.e., total 30 bones

So, both hindlimbs have 60 bones.

170. Answer (2)

Hint: An animal cell

Sol.: Animal cells are devoid of cell wall and a muscle cell is an animal cell.

In a muscle fibre, Ca^{2+} is stored in sarcoplasmic reticulum.

171. Answer (4)

Hint: Carpals have gliding joint.

Sol.: Ball and socket joint – Humerus and pectoral girdle and femur and pelvic girdle

Hinge joint – Knee joint

Pivot joint – Between atlas and axis

Gliding joint – Between the carpals

Saddle joint – Between carpal and metacarpal of thumb

172. Answer (1)

Hint: Both conditional reabsorption and selective secretion occurs in DCT.

Sol.: Conditional reabsorption of Na^+ and water takes place in DCT.

DCT is also capable of reabsorption of HCO_3^- and selective secretion of hydrogen and potassium ions and NH_3 to maintain the pH and sodium-potassium balance in blood.

173. Answer (3)

Hint: Joints are essential for all types of movements.

Sol.: Joints are essential for all types of movements involving the bony parts of the body. Locomotory movements are no exception to this.

Joints are points of contact between bones, or between bones and cartilages.

174. Answer (2)

Hint: Lungs remove 200 mL of CO_2 per minute.

Sol.: Our lungs remove large amounts of CO_2 (approximately 200 mL/minute) and also significant quantities of water everyday.

Thus, in 10 minutes = 200 mL × 10 = 2000 mL

$\therefore$ 2000 mL *i.e.*, 2 L of CO_2 will be removed by lungs in 10 minutes.

175. Answer (3)

Hint: 'X' is Bowman's capsule

Sol.: Each nephron has two parts, the glomerulus and the renal tubule.

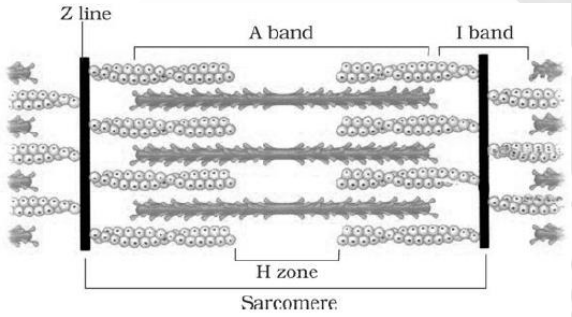
The renal tubule begins with a double walled cup-like structure called Bowman's capsule, which encloses the glomerulus.

Glomerulus is a tuft of capillaries formed by the afferent arteriole, a fine branch of renal artery. Blood from glomerulus is carried away by an efferent arteriole.

176. Answer (2)

Hint: Dark band is due to actin and myosin both

Sol.:



177. Answer (3)

Hint: Renin increases blood pressure.

Sol.: A fall in glomerular blood flow/glomerular blood pressure/GFR can activate the JG cells to release renin which converts angiotensinogen in blood to angiotensin I and further to angiotensin II. Angiotensin II, being a powerful vasoconstrictor, increases glomerular blood pressure and thereby GFR.

178. Answer (2)

Hint: 1 dark band and 2 halves of light bands

Sol.: The part of myofibril between two successive 'Z'-lines is called sarcomere. It is the structural and functional unit of myofibril. A sarcomere comprises of a single A band and half of each adjacent I-band.

179. Answer (2)

Hint: Oxalates in kidney

Sol.:

Glomerulonephritis – Inflammation of glomeruli of kidney

Renal calculi – Formation of stone or insoluble masses of crystallised salts within the kidneys

Uremia – Accumulation of urea in blood

Glycosuria – Glucose in urine

Ketonuria – Ketone bodies in urine

180. Answer (3)

Hint: A voluntary muscular movement.

Sol.: Visceral muscles are located in the inner walls of hollow visceral organs of the body like alimentary canal, reproductive tract, blood vessels *etc*. Anterior part of tongue has skeletal muscles.

❑ ❑ ❑

All India Aakash Test Series for NEET - 2027

TEST - 3 (Code-J)

Click here for Code-I Sol.

Test Date : 18/01/2026

ANSWERS

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

HINTS & SOLUTIONS

[PHYSICS]

1. Answer (3)

Hint and Sol.: Work done due to a conservative force does not depend on the path taken, it depends on initial and final points i.e., displacement.

2. Answer (1)

Hint and Sol.: First block will have more kinetic energy due to absence of air drag.

3. Answer (4)

Hint: Instantaneous power, $P = \vec{F} \cdot \vec{v}$

Sol.: In first and second cases, force is constant and velocity is variable, hence power will be variable. In third case, force as well as velocity is constant, hence power delivered will be constant.

4. Answer (3)

Hint: Work done by variable force, $W = \int \vec{F} \cdot d\vec{x}$

Sol.: $W = \int_0^{\pi} 10 \sin x dx = 10(-\cos x)_0^{\pi}$

$W = -10(\cos\pi - \cos 0) = 20$ J

5. Answer (4)

Hint: Average power $= \dfrac{\text{Net work done}}{\text{Time}}$

Sol.: Net work done on the bullet

$= \Delta\text{KE} = 0 - \dfrac{1}{2} \times 10 \times 10^{-3} \times (500)^2$

$= -1250$ J

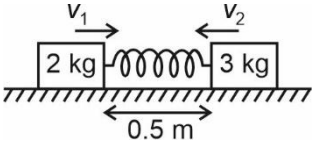
Magnitude of average power $= \dfrac{1250}{0.05} = 25$ kW

6. Answer (1)

Hint: When the spring comes to its natural length, then its potential energy will be converted to kinetic energy of the blocks.

Sol.: Initial potential energy $= \dfrac{1}{2}kx^2$

$U_i = \dfrac{1}{2} \times 200 \times (1.5 - 0.5)^2 = 100$ J



Since no external force is acting on the system, hence $\vec{P}_i = \vec{P}_f$

$0 = 2v_1 - 3v_2 \Rightarrow \dfrac{2}{3}v_1 = v_2$ …(i)

$TME_i = TME_f$

$U_i + \text{KE}_i = U_f + \text{KE}_f$

$100 + 0 = 0 + \dfrac{1}{2} \times 2 \times v_1^2 + \dfrac{1}{2} \times 3 \times v_2^2$

$100 = v_1^2 + \dfrac{3}{2} \times \left(\dfrac{2}{3}v_1\right)^2$

$100 = \dfrac{5}{3}v_1^2 \Rightarrow v_1 = \sqrt{60}$ m/s

7. Answer (3)

Hint: Use work-energy theorem.

Sol.: $W_{\text{net}} = \Delta\text{KE}$

$W_{\text{spring}} + W_{\text{friction}} = \text{KE}_f - \text{KE}_i$

$-\dfrac{1}{2} \times 1000 \times \left(\dfrac{1}{4}\right)^2 + W_f = -\dfrac{1}{2} \times 10 \times 5^2$

$-\dfrac{125}{4} + W_f = -125 \Rightarrow W_f = -\dfrac{3}{4} \times 125$ J

Average power lost due to friction $= \dfrac{\frac{3}{4} \times 125}{3} = \dfrac{125}{4}$ W

8. Answer (2)

Hint: $W_{\text{conservative}} = -\Delta U$

Sol.: Work done by conservative force = – (change in potential energy)

$W_{A-B} + W_{B-C} + W_{C-D} = -U_f + U_i$

$-75 + 25 + 70 = -U_f + (-10)$

$U_f = -30$ J

9. Answer (3)

Hint and Sol.: For stable equilibrium, potential energy is minimum and $\dfrac{d^2U}{dr^2} > 0$

10. Answer (2)

Hint: Use relation $P = \sqrt{2mK}$

Sol.: $\frac{P_B}{P_A}=\frac{\sqrt{2m_Bk_B}}{\sqrt{2m_Ak_A}}=\sqrt{\frac{m_B}{m_A}}$

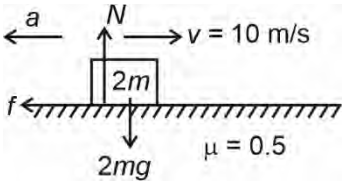
$\frac{P_B}{P_A}=\sqrt{\frac{9}{1}}=\frac{3}{1}$

11. Answer (4)

Hint: In perfectly inelastic collision both blocks will move together after collision.

Sol.: Speed of combined block system after collision = v

$m \times 20 = 2m \times v \Rightarrow v = 10$ m/s



$f = \mu \times N = \mu \times 2mg$

$f = m_T \times a \Rightarrow \mu \times 2mg = 2m \times a$

$a = \mu g = 0.5 \times 10 = 5$ m/s^2

$2as = v^2 - u^2 \Rightarrow 2 \times (-5) \times s = 0 - (-10)^2$

$\therefore$ Distance travelled = $s = 10$ m

12. Answer (2)

Hint and Sol.: In a rigid body, particles cannot move relative to each other, hence net work done by internal forces is zero.

In a system consisting of discrete masses, internal forces can do work.

13. Answer (1)

Hint and Sol.: A single external force will accelerate particle in its direction.

Work-energy theorem is valid for all types of forces.

14. Answer (1)

Hint: Use equations : $P = Fv$ and $a=\frac{vdv}{dx}$

Sol.: Instantaneous power, $P=\vec{F}\cdot\vec{v}$

Here P is constant.

$P = Fv = mva$

$P=m\times\frac{vdv}{dx}\times v \qquad \left\{a=\frac{vdv}{dx}\right\}$

$\int_0^x Pdx=\int_0^v mv^2dv$

$Px=\frac{mv^3}{3} \Rightarrow v=\left(\frac{3Px}{m}\right)^{\frac{1}{3}}$

$\frac{dx}{dt}=\left(\frac{3P}{m}\right)^{\frac{1}{3}}x^{\frac{1}{3}}$

$\int_0^x \frac{dx}{x^{\frac{1}{3}}}=\int_0^t\left(\frac{3P}{m}\right)^{\frac{1}{3}}dt$

$\frac{x^{\frac{-1}{3}+1}}{\frac{2}{3}}=\left(\frac{3P}{m}\right)^{\frac{1}{3}}t$

$\frac{3}{2}x^{\frac{2}{3}}=\left(\frac{3P}{m}\right)^{\frac{1}{3}}t \Rightarrow x\propto t^{\frac{3}{2}}$

15. Answer (4)

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

Sol.: $\Delta\vec{r}=\vec{r}_f-\vec{r}_i=\left(3\hat{i}+4\hat{j}+2\hat{k}\right)-\left(1\hat{i}+2\hat{j}+3\hat{k}\right)$

$\Delta\vec{r}=\left(2\hat{i}+2\hat{j}-\hat{k}\right)$ m

$W=\left(2\hat{i}+2\hat{j}+3\hat{k}\right)\cdot\left(2\hat{i}+2\hat{j}-\hat{k}\right)$

$= 4 + 4 - 3$

$W = 5$ J

16. Answer (2)

Hint: Work done by a force = Force × (Displacement of point of application in the direction of force)

Sol.: The given force is constant in magnitude as well as in direction.

Displacement in the direction of force equals R

$\therefore$ Work done by the force = FR

17. Answer (3)

Hint and Sol.: $\vec{\tau}_{ext}=\frac{\Delta\vec{L}}{\Delta t}$

$\therefore$ If $\vec{\tau}_{ext}=0 \Rightarrow \Delta\vec{L}=0$

18. Answer (4)

Hint and Sol.: The centre of mass of a system depends on the distribution and values of masses in the system. Position of COM is not necessarily at the geometric centre or inside the material.

19. Answer (3)

Hint and Sol.: Given ω = constant

$\therefore \quad \alpha=\frac{d\omega}{dt}=0$

$\Rightarrow$ Angular acceleration is zero

Tangential acceleration, $a_t = r\alpha$

$\therefore \quad a_t = 0$

Torque, $\tau = I\alpha$

$\therefore \quad \tau = 0$

20. Answer (3)

Hint: Use formula of COM

Sol.: $\vec{R}_{cm} = \dfrac{m_1\vec{r}_1 + m_2\vec{r}_2 + m_3\vec{r}_3}{m_1 + m_2 + m_3}$

$\vec{R}_{cm} = \dfrac{m(0\hat{i} + 0\hat{j}) + m(1\hat{i} + 1\hat{j}) + m(2\hat{i} + 2\hat{j})}{3m}$

$\vec{R}_{cm} = 1\hat{i} + 1\hat{j}$

21. Answer (4)

Hint: Power, $P = \vec{\tau} \cdot \vec{\omega}$

Sol.: $P = \left(a\hat{i} + b\hat{j} - 2\hat{k}\right) \cdot \left(2\hat{i} + 3\hat{j} - 4\hat{k}\right)$

$0 = 2a + 3b + 8$

Putting values of $a = -\dfrac{11}{2}$ and $b = 1$,

we get $P = 0$

$2 \times \left(-\dfrac{11}{2}\right) + (3 \times 1) + 8 = -11 + 11 = 0$

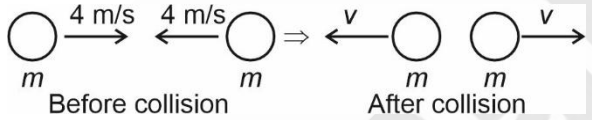
22. Answer (3)

Hint and Sol.: Flywheel has large moment of inertia. When input power is switched off, it continues to rotate for some time due its large moment of inertia.

23. Answer (2)

Hint: $e = \dfrac{\text{Relative velocity of separation}}{\text{Relative velocity of approach}}$

Sol.: Linear momentum of system will remain conserved, hence speeds after the collision will be same for both the balls.



$e = \dfrac{2v}{4+4} = \dfrac{3}{4}$

$2v = 6$

$\Rightarrow v = 3$ m/s

24. Answer (1)

Hint and Sol.: In critical condition, the speed of the particle can be zero when it is rotated in vertical circle with the help of a light rod.

25. Answer (4)

Hint: Energy stored in spring, $U = \dfrac{1}{2}Kx^2$

Sol.: $U = \dfrac{1}{2}Kx^2, F = Kx$

$U = \dfrac{1}{2}K \times \dfrac{F^2}{K^2} \Rightarrow U \propto \dfrac{1}{K}$

$\therefore \dfrac{U_A}{U_B} = \dfrac{K_B}{K_A} \Rightarrow \dfrac{E}{U_B} = \dfrac{\frac{K}{2}}{K} \Rightarrow U_B = 2E$

26. Answer (4)

Hint: Apply the formula of power

$P = \dfrac{dm}{dt}gh + \dfrac{1}{2}\dfrac{dm}{dt} \times v^2$

Sol.: Power required, $P = \dfrac{dm}{dt}gh + \dfrac{1}{2}\dfrac{dm}{dt} \times v^2$

$P = (2 \times 10 \times 20) + \left(\dfrac{1}{2} \times 2 \times 25\right)$

P = 425 J/s

$\eta = \dfrac{\text{Output power}}{\text{Input power}}$

Input power $= \dfrac{425}{\frac{60}{100}} = 708.3$ W

27. Answer (2)

Hint: Area under force-displacement curve is equal to work done.

Sol.: According to work-energy theorem

$W_{net} = \Delta KE$

Area under F - x graph = ΔKE

$\dfrac{1}{2}(100 + 60) \times 10 = \Delta KE \Rightarrow \Delta KE = 800$ J

28. Answer (3)

Hint and Sol.: In case of couple, net external force is zero but torque is non-zero.

29. Answer (3)

Hint and Sol.: Motion of COM of a system only depends on net external force on the system, its motion does not get affected by internal forces.

30. Answer (1)

Hint: Use equations: $\omega = \omega_0 + \alpha t$ and $\tau = I\alpha$

Sol.: $\omega = \omega_0 + \alpha t$

$0 = \dfrac{120 \times 2\pi}{60} + \alpha \times (2 \times 60)$

$\alpha = -\dfrac{4\pi}{2 \times 60} = -\dfrac{\pi}{30}$ rad/s^2

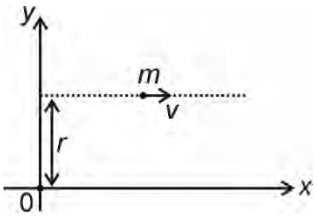
$\tau = I\alpha = 3 \times \left(-\dfrac{\pi}{30}\right) = -\dfrac{\pi}{10}$ N m

31. Answer (2)

Hint: Angular momentum of a particle,

$|\vec{L}| = mvr_{\perp}$

Sol.: According to the figure



$L = mvr \Rightarrow L$ remains constant

32. Answer (4)

Hint and Sol.: When the stone reaches the ground

$$mgh = \frac{1}{2}mv_f^2 - \frac{1}{2}mv^2$$

$$v_f = (2gh + v^2)^{\frac{1}{2}}$$

Final speed (v_f) is independent of direction of projection.

33. Answer (2)

Hint: Total angular momentum of the system remains conserved.

Apply work-energy theorem to find work done by friction.

Sol.: No external torque is acting on the system, hence angular momentum of the system remain conserved.

$L_i = L_f$

$$I_0\omega_0 = 3I_0 \times \omega \Rightarrow \omega = \frac{\omega_0}{3}$$

Apply work-energy theorem for disc 1:

$W_{net} = \Delta KE$

$$W_{Friction} = \frac{1}{2}I_0 \times \left(\frac{\omega_0}{3}\right)^2 - \frac{1}{2}I_0\omega_0^2$$

$$= \frac{1}{2}I_0\omega_0^2\left(\frac{1}{9} - 1\right)$$

$$= -\frac{4}{9}I_0\omega_0^2$$

Apply work-energy theorem for disc 2:

$$W_{Friction} = \frac{1}{2}(2I_0) \times \left(\frac{\omega_0}{3}\right)^2 - 0$$

$$W_{Friction} = \left(\frac{I_0\omega_0^2}{9}\right)$$

Total energy loss of the system = Total work done by the friction on the system.

$$\therefore \text{ Energy loss } = \left|-\frac{4}{9}I_0\omega_0^2 + \frac{1}{9}I_0\omega_0^2\right|$$

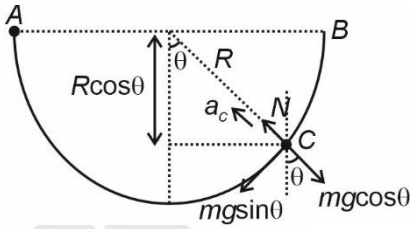
$$= \frac{1}{3}I_0\omega_0^2$$

34. Answer (1)

Hint: Use energy conservation principle.

Draw *FBD* of the block at a general location in terms of θ and then maximise horizontal component of force.

Sol.:



At point *C*:

$N - mg\cos\theta = ma_c$ …(i)

$$a_c = \frac{v^2}{r}$$ …(ii)

Apply energy conservation between points *A* and *C*

$$mgR\cos\theta = \frac{1}{2}mv^2$$

$$\frac{mv^2}{R} = 2mg\cos\theta$$ …(iii)

Put all the values in equation (i)

$N - mg\cos\theta = 2mg\cos\theta$

Horizontal component of normal reaction is

$N_x = N\cos(90° - \theta)$

$N_x = 3mg\cos\theta\sin\theta$

$$N_x = \frac{3}{2}mg\sin 2\theta$$

N_x will be maximum at $2\theta = 90°$

$\Rightarrow \theta = 45°$

Hence $(N_x)_{max} = \frac{3}{2}mg\sin 90° = \frac{3}{2}mg$

35. Answer (1)

Hint and Sol.: Work = Force × Displacement

Torque = Arm length × force

Hence, both have same dimension

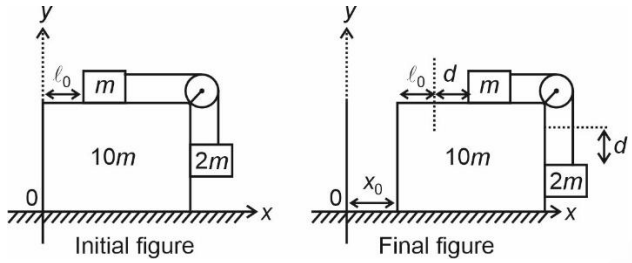
36. Answer (3)

Hint: There is no external force on the system in horizontal direction, hence COM of the system will remain at rest in horizontal direction.

Sol.:

$\because$ $F_{ext} = 0$ in horizontal direction.

$\therefore$ $\Delta X_{COM} = 0$



$$\Delta X_{COM} = \frac{m_1\Delta x_1 + m_2\Delta x_2 + m_3\Delta x_3}{m_1 + m_2 + m_3}$$

$$0 = \frac{m(x_0 + \ell_0 + d - \ell_0) + 2mx_0 + 10mx_0}{m + 2m + 10m}$$

$0 = m(x_0 + d) + 2mx_0 + 10mx_0$

$$-d = 13x_0 \Rightarrow x_0 = -\frac{d}{13}$$

37. Answer (3)

Hint and Sol.: Perpendicular as well as parallel axis theorem can be used to find moment of inertia of a laminar body.

38. Answer (4)

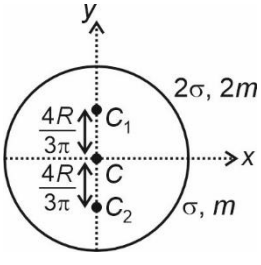
Hint and Sol.: Area under ω-t graph is equal to angular displacement (θ).

$$\theta = \frac{1}{2} \times 5 \times 10 = 25 \text{ rad}$$

39. Answer (4)

Hint: Centre of mass of half disc lies at distance $\frac{4R}{3\pi}$

Sol.:



$$Y_{cm} = \frac{m_1y_1 + m_2y_2}{m_1 + m_2}$$

$$Y_{cm} = \frac{2m \times \frac{4R}{3\pi} + m\left(-\frac{4R}{3\pi}\right)}{2m + m}$$

$$= \frac{\frac{4R}{3\pi} \times m}{3m} = \frac{4R}{9\pi}$$

40. Answer (1)

Hint: To get maximum compression in the spring, block m_2 should have maximum possible kinetic energy after collision.

Sol.: Let the speed of m_2 after collision is v', then

$$\frac{1}{2}m_2 \times v'^2 = \frac{1}{2}kx_0^2$$

For maximum x_0, v' should be maximum.

For $e = 1$ we get maximum v', when $m_1 = m_2$

$\therefore$ $\frac{m_1}{m_2} = 1$

41. Answer (1)

Hint: The ball will come to rest instantly as soon as the string becomes taut.

Sol.: The ball will drop by a distance of $2h$ before the string become taut

$P_i = mv = m\sqrt{2g(2h)} = 2m\sqrt{gh}$ …(i)

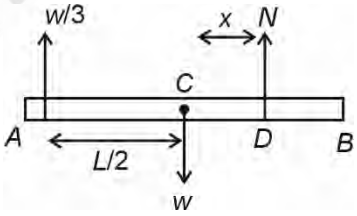
$P_f = 0$ …(ii)

$\therefore$ $I = |\Delta P| = 2m\sqrt{gh}$

42. Answer (4)

Hint: The bar is in rotational as well as translational equilibrium.

Sol.: Let the weight of the bar is w. Then



Translational equilibrium:

$$N + \frac{w}{3} = w \Rightarrow N = \frac{2w}{3} \quad \text{…(i)}$$

Rotational equilibrium:

Taking torque about centre C,

$$\frac{w}{3} \times \frac{L}{2} = \frac{2w}{3} \times x \Rightarrow x = \frac{L}{4}$$

$\therefore$ Total distance from end $A = \frac{L}{2} + \frac{L}{4} = \frac{3L}{4}$

43. Answer (3)

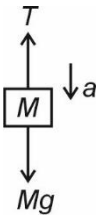
Hint and Sol.: Angular momentum,

$\vec{L} = I\omega(-\hat{k}) + Mvd(-\hat{k})$

$\Rightarrow \vec{L} = \left[\frac{MR^2\omega}{2} + Mvd\right](-\hat{k})$

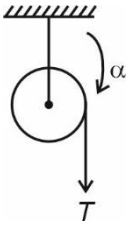
44. Answer (4)

Hint and Sol.: *FBD* of block:



$Mg - T = Ma$ …(i)

FBD of cylinder:



$\tau = I\alpha$

$TR = \frac{MR^2}{2}\alpha$ …(ii)

$a = R\alpha$ …(iii)

Solving equation (ii) and (iii), we get $T = \frac{Ma}{2}$

Put this in equation (i)

$Mg - \frac{Ma}{2} = Ma \Rightarrow a = \frac{2g}{3}$

45. Answer (3)

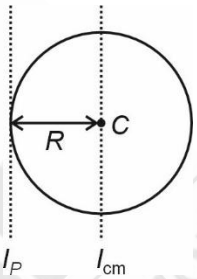
Hint: Use parallel axis theorem.

Sol.: Moment of inertia is *I* about the central axis.

Then MOI about a diametrical axis is $\frac{I}{2}$

$I_P = I_{cm} + Md^2$

$I_P = \frac{I}{2} + M \times R^2$ …(i)



Also, $I = \frac{MR^2}{2}$

$\therefore MR^2 = 2I$

Hence, $I_P = \frac{I}{2} + 2I = \frac{5I}{2}$

[CHEMISTRY]

46. Answer (3)

Hint: $\Delta H = nC_P\Delta T$

Sol.: For isothermal process, $\Delta T = 0$

$\therefore \Delta H = 0$

47. Answer (4)

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

Sol.: Δn_g refers to the number of moles of gaseous products minus the number of moles of gaseous reactants.

			Δn_g
•	$PCl_5(g) \rightarrow PCl_3(g) + Cl_2(g)$	–	1
•	$N_2(g) + 3H_2(g) \rightarrow 2NH_3(g)$	–	–2
•	$H_2(g) + I_2(g) \rightarrow 2HI(g)$	–	Zero
•	$2NO(g) + O_2(g) \rightarrow 2NO_2(g)$	–	–1

48. Answer (2)

Hint: Heat capacity $(C) = \frac{q}{\Delta T}$

Sol.: For isothermal process, $\Delta T = 0$

Hence, heat capacity will be infinite.

49. Answer (3)

Hint: Hess's law of constant heat summation should be applied.

Sol.:

$A(solid) \rightarrow A(liquid)$ $\Delta H_1 = 6.1$ kJ mol^{-1} …(i)

$A(liquid) \rightarrow A(gas)$ $\Delta H_2 = 96.5$ kJ mol^{-1} …(ii)

Adding (i) and (ii)

$A(solid) \rightarrow A(gas)$

$\Delta H = \Delta H_1 + \Delta H_2$

$= 6.1 + 96.5$

$= 102.6$ kJ mol^{-1}

50. Answer (1)

Hint: At equilibrium, $\Delta G = 0$

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

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

$\Delta H = T\Delta S$, at equilibrium

Sol.: $\frac{1}{2}A_2 + B_2 \rightleftharpoons AB_2$

$$\Delta S = 40 - \left\{\frac{1}{2}(50) + 60\right\}$$

$\Delta S = 40 - (85) = -45\ JK^{-1}\ mol^{-1}$

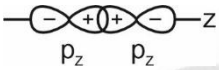
$$T = \frac{\Delta H}{\Delta S} = \frac{-19800}{-45} = 440\ K$$

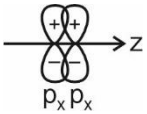
51. Answer (4)

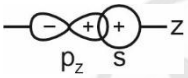
Hint: Negative overlap involves the overlap of lobes of opposite sign.

Sol.:

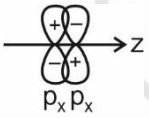
Positive overlap:







Negative overlap:



52. Answer (1)

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

Sol.: $\mu_{calculated} = q \times d$

$= 1.6 \times 10^{-19} \times 1.5 \times 10^{-10}$ Cm

$$\text{\% ionic character} = \frac{1.5 \times 3.33 \times 10^{-30}}{1.6 \times 10^{-19} \times 1.5 \times 10^{-10}} \times 100$$

$$= \frac{3.33}{1.6} \times 100 = 20.8\%$$

53. Answer (4)

Hint: Isoelectronic species have same number of electrons

Sol.:

Species		Electrons
P^{3-}	–	18
S^{2-}	–	18
Cr^{+}	–	23
Mn^{2+}	–	23
Fe	–	26
Ni^{2+}	–	26
Zn^{2+}	–	28
Cu^{2+}	–	27

54. Answer (1)

Hint and Sol.:

Element	$\Delta_{eg}H/(kJ\ mol^{-1})$
O	–141
S	–200
Se	–195
Te	–190

55. Answer (1)

Hint: Moving left to right along the 2nd period, electronegativity increases while moving down the group electronegativity decreases.

Sol.: Order of electronegativity

Si < C < N < O < F

56. Answer (2)

Hint: The correct order of ionisation enthalpy of second period elements is

Li < B < Be < C < O < N < F < Ne

Sol.: Argon is a noble gas in 3rd period and has highest first I.E. among all 3rd period elements.

$Na^+ = 1s^2, 2s^2\ 2p^6$

Stable inert gas configuration

$Mg^+ = 1s^2, 2s^2\ 2p^6\ 3s^1$

Removal of 2nd electron is easier from Mg^+ as compared to Na^+ hence, 2nd I.E. of Na is higher than that of Mg.

57. Answer (2)

Hint: For isoelectronic species, more is the positive charge on ion, smaller is the size of ion.

Sol.: Both F and Mg are second period elements and achieve Neon like configuration by making anion and cation respectively.

$$Mg \xrightarrow{-2e^-} Mg^{2+}$$

$$F \xrightarrow{+e^-} F^-$$

Both of these ions are isoelectronic and Mg^{2+} will have the smallest size due to higher effective nuclear charge.

58. Answer (3)

Hint: Element with atomic number more than that of uranium are called transuranium elements.

Sol.:

Neptunium	–	Transuranium element
Iodine	–	Halogen
Polonium	–	Chalcogen
Tellurium	–	Chalcogen

59. Answer (1)

Hint: Dubnium has atomic number 105 and has IUPAC symbol Db.

Sol.:

	IUPAC official name and IUPAC symbol	Atomic number	Name according to IUPAC nomenclature
a.	Dubnium (Db)	105	Unnilpentium
b.	Seaborgium (Sg)	106	Unnilhexium
c.	Bohrium (Bh)	107	Unnilseptium
d.	Hassium (Hs)	108	Unniloctium

60. Answer (1)

Hint: s and p block elements are called main group elements or representative elements.

Sol.:

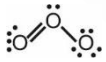
Element	Block
Germanium	p block
Selenium	p block
Scandium	d block
Vanadium	d block

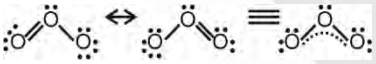
61. Answer (2)

Hint and Sol.:

a. ZnO – Amphoteric
b. N_2O – Neutral
c. Cl_2O_7 – Acidic
d. MgO – Basic

62. Answer (3)

Hint: 

Sol.: 

Total lone pairs in a canonical form of O_3 = 6

Formal charge on central oxygen atom = +1

63. Answer (4)

Hint: More the bond order, less will be the bond length

Sol.:

Species	C–O bond order
CO_2	2
CO_3^{2-}	1.33
CO	3

64. Answer (2)

Hint and Sol.: Promotion of electron is not an essential condition prior to hybridisation.

65. Answer (1)

Hint: $T\Delta S_{sys}$ is the energy which is not available to do useful work. ΔG is the net energy available to do useful work.

Sol.: A reaction will be non-spontaneous at all temperature if $\Delta_rH° > 0$ and $\Delta_rS° < 0$

66. Answer (3)

Hint: $H_2O(\ell) \rightarrow H_2O(g)$

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

$\Delta n_g = 1$

Sol.: $\Delta U = \Delta H - \Delta n_gRT$

$\Delta H = x - 1 \times 8.314 \times 373 \times 10^{-3}$

$\Delta H = (x - 3.1)$ kJ mol^{-1}

67. Answer (4)

Hint: Hess' law of constant heat summation is applied.

Sol.:

	ΔH (kJ mol^{-1})	
$A \rightarrow 2B$	+120	…(i)
$3B \rightarrow C + D$	–170	…(ii)
$E + 2A \rightarrow 3D$	+250	…(iii)
(iii) + (ii) – 2(i)		
$E + 2A \rightarrow 3D$	+250	
$3B \rightarrow C + D$	–170	
$-2A \rightarrow -4B$	–240	
$E + 7B \rightarrow C + 4D$	–160	

68. Answer (1)

Hint: $\Delta_rH° = \sum$ bond dissociation enthalpies of reactants $-\sum$ bond dissociation enthalpies of products.

Sol.: $\frac{1}{2}H_2(g) + \frac{1}{2}Br_2(g) \rightarrow HBr(g)$

$\Delta_rH° = \frac{1}{2}(435.8 + 192) - 368$

$\Delta_rH°$ = 313.9 – 368 = – 54.1 kJ mol^{-1}

69. Answer (2)

Hint: For free expansion, $P_{ex} = 0$

Sol.: $w = -P_{ex}\Delta V = 0$

From first law of thermodynamics

$\Delta U = q + w$

$q = \Delta U - w = 0$ [$\because \Delta U = 0$ as temperature is constant]

70. Answer (4)

Hint: State functions value depend only on the state of the system and not on how it is reached

Sol.: Heat (q) and work (w) are path dependent functions.

71. Answer (2)

Hint: $\Delta H = \Delta U + \Delta n_g RT$ and $\Delta G = \Delta H - T\Delta S$

Sol.: $\Delta H = \Delta U + \Delta n_g RT$

$\Delta H = 4.5 + 3 \times 2 \times 300 \times 10^{-3}$

$\Delta H = 4.5 + 1.8$

$\Delta H = 6.3$ kcal

$\Delta G = \Delta H + T\Delta S$

$= 6.3 - 300 \times 60 \times 10^{-3}$

$= 6.3 - 18$

$= -11.7$ kcal

72. Answer (4)

Hint: During bond formation, energy is released

Sol.: Number of gaseous particles are decreasing in this process therefore, $\Delta_r S < 0$

73. Answer (1)

Hint: $W_{rev} = -2.303nRT\log\frac{P_i}{P_f}$

Sol.: $W_{rev} = -2.303 \times 2 \times 8.314 \times 300 \times \log\frac{4}{2}$

$= -2.303 \times 2 \times 8.314 \times 300 \times 0.3$

$= -3.4$ kJ

74. Answer (3)

Hint and Sol.: Density is an intensive property as it does not depend on quantity or size of matter present.

75. Answer (2)

Hint: $C_3H_8(g) + 5O_2(g) \rightarrow 3CO_2(g) + 4H_2O(\ell)$

Sol.:

$3C(\text{graphite}) + 4H_2(g) \rightarrow C_3H_8(g)$ ...(i)

$\Delta H° = -103.85$ kJ mol^{-1}

$C(\text{graphite}) + O_2(g) \rightarrow CO_2(g)$ ...(ii)

$\Delta H° = -393.5$ kJ mol^{-1}

$H_2(g) + \frac{1}{2}O_2(g) \rightarrow H_2O(\ell)$ ...(iii)

$\Delta H° = -285.8$ kJ mol^{-1}

Applying; 3 × (ii) + 4 × (iii) – (i)

$3C(\text{graphite}) + 3O_2(g) \rightarrow 3CO_2(g)$

$\Delta H = -393.5 \times 3 = -1180.5$ kJ mol^{-1}

$2H_2(g) + 2O_2(g) \rightarrow 4H_2O(\ell)$

$\Delta H = -285.8 \times 4 = -1143.2$ kJ mol^{-1}

$3C(\text{graphite}) + 4H_2(g) \rightarrow C_3H_8(g)$

$\Delta H = +103.85$ kJ mol^{-1}

$C_3H_8(g) + 5O_2(g) \rightarrow 3CO_2(g) + 4H_2O(\ell)$

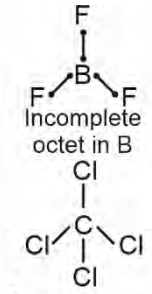
$\Delta H = 103.85 - 1180.5 - 1143.2$

$= -2219.85$

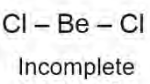
76. Answer (3)

Hint: BF_3 and $BeCl_2$ are examples of incomplete octet.

Sol.:

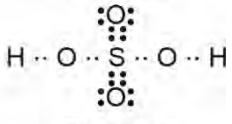


Incomplete octet in B



Incomplete octet on Be

Complete octet

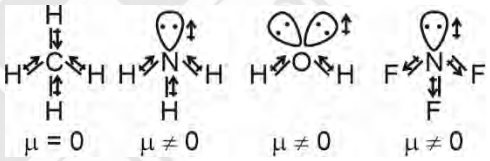


Expanded octet on S

(Odd e$^-$ molecule)

77. Answer (4)

Hint:



$\mu = 0$ $\mu \neq 0$ $\mu \neq 0$ $\mu \neq 0$

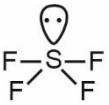
Sol.: N – H bond polarity is less than that of O – H bond polarity.

Molecule	**Dipole moment (D)**
H_2O	1.85
NH_3	1.47
NF_3	0.23
CH_4	0

78. Answer (3)

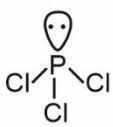
Hint: Shape of the molecule depends on the arrangement of electron pairs (lone pairs and bond pairs) around central atom.

Sol.:

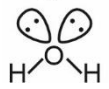


See-saw

Bent T shape



Trigonal pyramidal

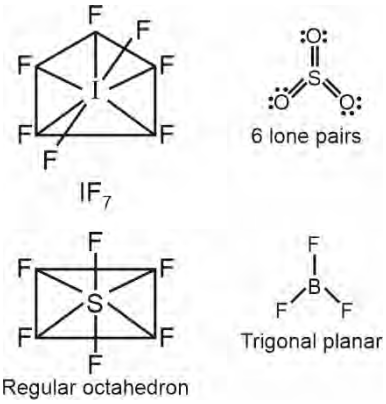


Bent T shape

79. Answer (3)

Hint: SO_3 is a trigonal planar molecule in which sulphur atom has no lone pair.

Sol.:



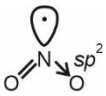
80. Answer (1)

Hint: C_2H_2 is a linear species in which both the carbon atoms are *sp* hybridised

Sol.:

a. $H-\overset{sp}{C}\equiv\overset{sp}{C}-H$ b. $O=\overset{sp}{C}=O$

c. $F-\overset{sp}{Be}-F$ d. 

e. 

81. Answer (4)

Hint: $N_2 = \sigma1s^2\,\sigma^*1s^2\sigma2s^2\,\sigma^*2s^2\,\pi2p_x^2 \equiv \pi2p_y^2$

$\sigma2p_z^2$ $\underbrace{\pi^*2p_x \equiv \pi^*2p_y}_{\text{Lowest unoccupied MO (LUMO)}}$

Sol.: $H_2^+ = \sigma1s^1\,\underset{(LUMO)}{\sigma^*1s}$

$He_2^+ = \sigma1s^2\sigma^*1s^1\,\underset{(LUMO)}{\sigma2s}$

$Be_2^+ = \sigma1s^2\sigma^*1s^2\sigma2s^2\sigma^*2s^1\,\underset{(LUMO)}{\pi2p_x \equiv \pi2p_y}$

82. Answer (4)

Hint: Bond order $= \frac{1}{2}(N_b - N_a)$

Sol.:

- Bond order of $N_2 = \frac{1}{2}(10-4) = 3$

  Bond order of $N_2^+ = \frac{1}{2}(9-4) = 2.5$

- O_2^+ contains one unpaired electron in its π^* molecular orbital, hence, it is paramagnetic in nature.

83. Answer (4)

Hint: For $p\pi$-$d\pi$ bond formation, one of the atom should contain vacant d-orbital.

Sol.: Sulphur in SO_2, SO_4^{2-} and phosphorous in PO_4^{3-} contain vacant d-orbital. These species form $p\pi$-$d\pi$ bond with oxygen.

84. Answer (4)

Hint: 1 mole NaOH(aq) on reaction with 1 mol HCl (aq) will release 57.1 kJ of energy.

Sol.: $NaOH(aq) + HCl(aq) \rightarrow NaCl(aq) + H_2O(\ell)$

m mol of NaOH = 400 × 0.4 = 160 m mol

m mol of HCl = 500 × 0.3 = 150 m mol

HCl is limiting reagent

Heat released in the neutralisation process = $150 \times 10^{-3} \times 57.1 = 8.6$ kJ

85. Answer (1)

Hint: $\Delta_rG° = -2.303\,RT\,\log K_p$

Sol.: $\Delta_rG° = -2.303 \times 8.314 \times 300 \log 1 \times 10^3$

$\Delta_rG° = -2.303 \times 8.314 \times 300 \times 3$

$\Delta_rG° = -17.23$ kJ mol^{-1}

86. Answer (3)

Hint: Entropy change will be positive if the randomness increases.

Sol.: In sublimation of camphor, melting of ice and evaporation of water, randomness of the molecules increases hence, in all these cases, $\Delta S > 0$

87. Answer (4)

Hint: $\Delta S_{total} = \Delta S_{system} + \Delta S_{surrounding}$

Sol.: For spontaneous process, $\Delta S_{total} > 0$

88. Answer (1)

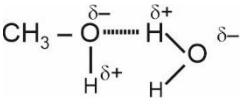
Hint: The standard molar enthalpy of formation at 298 K for C(graphite) is zero

Sol.:

Substance	$\Delta_fH°$(kJ mol^{-1}
$Br_2(\ell)$	0
$H_2(g)$	0
HI(g)	+26.48
$Cl_2(g)$	0
C(diamond)	+1.89
S(rhombic)	0
Si(s)	0
HCl(g)	–92.31

89. Answer (2)

Hint: Methanol forms intermolecular hydrogen bond with water.

Sol.: 

90. Answer (2)

Hint: The process is adiabatic hence $q = 0$

Sol.: The process is irreversible hence

Work done (w) = $-P_{ex}\Delta V$

$w = -1.20\ (4.6 - 3.1)$

$w = -1.8$ L atm $= -1.8 \times 101.3 = -182.3$ J

From first law of thermodynamics,

$\Delta U = q + w$

$\Delta U = -182.3$ J

[BOTANY]

91. Answer (3)

Hint: Medullary rays are found between vascular bundles in stems.

Sol.: These rays are found in stelar region.

92. Answer (4)

Hint: In basal placentation, single ovule is attached to the placenta.

Sol.: Mustard is the member of Brassicaceae family in which parietal placentation is seen.

93. Answer (1)

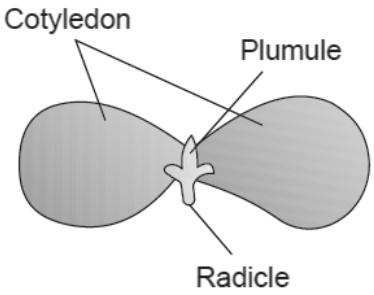
Hint: Ovary bears ovules on a cushion-like structure called placenta.

Sol.: The arrangement of ovules on placenta within the ovary is known as placentation.

94. Answer (2)

Hint: At the two ends of embryonal axis, are present the radicle and the plumule.

Sol.:



In dicotyledonous seeds, plumule and radicle are not enclosed in sheaths.

Future shoot of embryo is plumule.

95. Answer (4)

Hint: In conjoint type of vascular bundle, the xylem and phloem are jointly situated along the same radius of vascular bundle.

Sol.: The conjoint vascular bundles usually have the phloem located on the outer side of xylem.

96. Answer (2)

Hint: When protoxylem is formed towards the centre, it is called endarch condition.

Sol.: In endarch condition, xylem grows from centre to periphery, called centrifugal growth.

97. Answer (4)

Hint: Root hairs and trichomes are the part of epidermal tissue system.

Sol.: Ground tissue system is present between epidermal and vascular tissue system.

98. Answer (3)

Hint: In Brinjal, there is no variation in the length of the filaments.

Sol.: Variation in the length of filaments within a flower is observed in *Salvia* and Mustard.

99. Answer (1)

Hint: K represents calyx.

Sol.:

% $\rightarrow$ Zygomorphic symmetry

$\varnothing$ $\rightarrow$ Bisexual flower

Br $\rightarrow$ Bracteate flower

100. Answer (3)

Hint: $G_{(n)}$ represents syncarpous ovary.

Sol.: Inferior ovary is represented in the floral formula as $\bar{G}_n$.

101. Answer (2)

Hint: If the pericarp is thick and fleshy, then it differentiates into three different layers namely epicarp, mesocarp and endocarp.

Sol.: In mango fruit, edible part is fleshy, juicy mesocarp.

102. Answer (2)

Hint: Aleurone layer is not found in dicot seeds.

Sol.: In bean, endosperm persists at maturity.

103. Answer (2)

Hint: Endosperm is triploid in nature.

Sol.: Ploidy of endosperm is similar to aleurone layer.

104. Answer (3)

Hint: Cuticle is absent in roots.

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

105. Answer (3)

Hint: In dicotyledonous plant, bean shaped guard cells are present, in which outer walls are thin while the inner walls are highly thickened.

Sol.: Root hairs are unicellular and they increase the surface area for absorption.

Guard cells control the opening and closing of stomatal pore. When they are turgid the stomatal pore is open and when they are flaccid, the stomatal pore is closed.

106. Answer (1)

Hint: Innermost layer of cortex is called endodermis.

Sol.: Endodermis is the border between general cortex and stele.

107. Answer (1)

Hint: Stamens are united into more than two bundle in polyadelphous condition.

Sol.: In citrus, polyadelphous condition is observed.

108. Answer (4)

Hint: In alternate phyllotaxy, single leaf is present at each node in an alternate fashion.

Sol.: In cymose inflorescence, the flowers are borne in basipetal order.

Aggregate fruit is developed from polycarpellary apocarpous ovary.

109. Answer (3)

Hint: In gymnosperms, vessels are absent.

Sol.: Companion cell helps in maintaining the pressure gradient in the sieve tube.

Complex permanent tissues comprise of xylem and phloem.

110. Answer (3)

Hint: Persistent calyx is the feature of the members of Solanaceae family.

Sol.: Brinjal is the member of solanaceae family and has a persistent calyx.

111. Answer (2)

Hint: When a stamen is attached to the petal, then it is called epipetalous.

Sol.: Bilocular term is used for gynoecium.

112. Answer (3)

Hint: Floral formula does not represent placentation.

Sol.: In case of pea, condition of stamens is diadelphous, *i.e.*, 9 + 1 type.

113. Answer (4)

Hint: Banana is a monocotyledonous plant.

Sol.: In banana plant, closed vascular bundles are present.

114. Answer (2)

Hint: In rose, perigynous flowers are present.

Sol.: In some leguminous plants, the leaf base swells and is called pulvinus.

115. Answer (1)

Hint: Coleoptile and coleorhiza are absent in dicot seeds.

Sol.: In dicot seeds, plumule and radicle are not covered in sheath like structures.

116. Answer (1)

Hint: Cohesion or adhesion of stamens is not seen in mustard.

Sol.: Mustard has six stamens, two small and four long.

117. Answer (2)

Hint: The epidermal hairs found on stem are called trichomes.

Sol.: Trichomes in the shoot system, help in preventing water loss.

118. Answer (4)

Hint: Stomata, trichomes and guard cells are the components of epidermal tissue system.

Sol.: Passage cells are present in endodermis which is the component of ground tissue system.

119. Answer (3)

Hint: In potato, axile placentation is seen.

Sol.: In potato, ovary is bilocular and epipetalous stamen is present.

120. Answer (4)

Hint: The given figure represents free-central placentation.

Sol.: In free central placentation, ovules are borne on central axis and septa are absent in the ovary eg:- *Primrose*, *Dianthus*.

121. Answer (1)

Hint: Epiphyllous condition is found in the members of Liliaceae.

Sol.: In tobacco, epipetalous condition is found.

In Sunhemp and Indigofera, epiphyllous condition is not found.

122. Answer (1)

Hint: *Gloriosa*, *Asparagus* and *Colchicum* belong to the family Liliaceae.

Sol.: Axile placentation, bicarpellary syncarpous ovary, tap root, bisexual and actinomorphic flower, capsule or berry type of fruit and gamosepalous and gamopetalous flower are the characteristics of the members of solanaceae family.

123. Answer (1)

Hint: This layer is fibrous.

Sol.: Mesocarp of coconut is used in making coir.

124. Answer (3)

Hint: In gulmohur, imbricate aestivation is seen.

Sol.: In imbricate aestivation, margin of petals or sepals overlaps each other but not in a particular direction.

125. Answer (4)

Hint: All the tissues on the inner side of endodermis, constitute stele.

Sol.: Pericycle gives rise to the lateral roots. Vascular bundles help in transport of substances over long distance. Pith or medulla occupies the central part.

126. Answer (1)

Hint: In monocotyledonous plants, primary root is replaced by a number of fine fibrous roots.

Sol.: Mustard is a dicotyledonous plant in which primary root is long-lived, on the other hand, wheat is a monocotyledonous plant in which primary root is short-lived.

127. Answer (3)

Hint: The apex of root is covered by a thimble-like structure, called root cap. It protects the tender apex of the root.

Sol.: Region of meristematic activity – The cells of this region are very small, thin walled with dense protoplasm.

Region of elongation – Cells of this region are responsible for the growth of root in length.

Region of maturation – Cells of this region differentiate and mature.

128. Answer (1)

Hint: Radial type of vascular bundles are seen in roots.

Sol.: In a dicot stem, secondary growth is observed. Conjoint, closed type of vascular bundles are seen in monocot stems and dicot leaves.

129. Answer (3)

Hint: In lotus, carpels are not fused.

Sol.: Canna shows the presence of asymmetric flowers. *Alstonia* shows whorled type of phyllotaxy.

130. Answer (1)

Hint: Endodermis is characterised by the presence of a special 'thickened' band in their wall, called casparian strips.

Sol.: Pericycle gives rise to lateral roots and vascular cambium in dicotyledonous plants.

131. Answer (3)

Hint: Meristems are the specialised areas in plant body for active cell division.

Sol.: Sieve tube elements are long, tube-like living structures.

Lignin is deposited in the wall of tracheid, vessel and sclerenchyma only.

132. Answer (4)

Hint: Cruciform corolla is the characteristic feature of the members of Brassicaceae family.

Sol.: Tap root system and bicarpellary syncarpous superior ovary is found in both Brassicaceae and Solanaceae family.

Bisexual flower with actinomorphic symmetry, sepals with valvate aestivation, endospermous seed are found in the members of Solanaceae family.

133. Answer (1)

Hint: Ground tissue system is also called as fundamental tissue system in plants.

Sol.: In leaf, mesophyll is the ground tissue. Hypodermis is absent in roots. Ground tissue system provides mechanical support.

134. Answer (2)

Hint: In vexillary aestivation, the largest petal is called standard.

Sol.: Internodes of the shoot gets condensed and produce different kind of floral appendages laterally at successive nodes, instead of leaves. Bud is not present in the axil of leaflets of a compound leaf.

Based on the position of calyx, corolla and androecium in respect of the ovary on thalamus, flowers are described as hypogynous, perigynous and epigynous.

135. Answer (4)

Hint: Ovary is inferior in epigynous flowers.

Sol.: Guava, cucumber and bitter gourd have inferior ovary in which margin of the thalamus grows upward, enclosing the ovary completely and getting fused with it.

[ZOOLOGY]

136. Answer (3)

Hint: A voluntary muscular movement.

Sol.: Visceral muscles are located in the inner walls of hollow visceral organs of the body like alimentary canal, reproductive tract, blood vessels *etc*. Anterior part of tongue has skeletal muscles.

137. Answer (2)

Hint: Oxalates in kidney

Sol.:

Glomerulonephritis – Inflammation of glomeruli of kidney

Renal calculi – Formation of stone or insoluble masses of crystallised salts within the kidneys

Uremia – Accumulation of urea in blood

Glycosuria – Glucose in urine

Ketonuria – Ketone bodies in urine

138. Answer (2)

Hint: 1 dark band and 2 halves of light bands

Sol.: The part of myofibril between two successive 'Z'-lines is called sarcomere. It is the structural and functional unit of myofibril. A sarcomere comprises of a single A band and half of each adjacent I-band.

139. Answer (3)

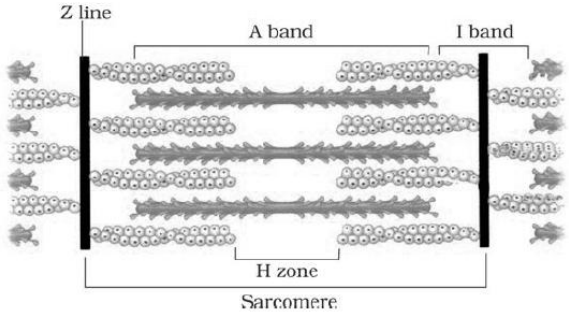
Hint: Renin increases blood pressure.

Sol.: A fall in glomerular blood flow/glomerular blood pressure/GFR can activate the JG cells to release renin which converts angiotensinogen in blood to angiotensin I and further to angiotensin II. Angiotensin II, being a powerful vasoconstrictor, increases glomerular blood pressure and thereby GFR.

140. Answer (2)

Hint: Dark band is due to actin and myosin both

Sol.:



141. Answer (3)

Hint: 'X' is Bowman's capsule

Sol.: Each nephron has two parts, the glomerulus and the renal tubule.

The renal tubule begins with a double walled cup-like structure called Bowman's capsule, which encloses the glomerulus.

Glomerulus is a tuft of capillaries formed by the afferent arteriole, a fine branch of renal artery. Blood from glomerulus is carried away by an efferent arteriole.

142. Answer (2)

Hint: Lungs remove 200 mL of CO_2 per minute.

Sol.: Our lungs remove large amounts of CO_2 (approximately 200 mL/minute) and also significant quantities of water everyday.

Thus, in 10 minutes = 200 mL × 10 = 2000 mL

$\therefore$ 2000 mL *i.e.*, 2 L of CO_2 will be removed by lungs in 10 minutes.

143. Answer (3)

Hint: Joints are essential for all types of movements.

Sol.: Joints are essential for all types of movements involving the bony parts of the body. Locomotory movements are no exception to this.

Joints are points of contact between bones, or between bones and cartilages.

144. Answer (1)

Hint: Both conditional reabsorption and selective secretion occurs in DCT.

Sol.: Conditional reabsorption of Na^+ and water takes place in DCT.

DCT is also capable of reabsorption of HCO_3^- and selective secretion of hydrogen and potassium ions and NH_3 to maintain the pH and sodium-potassium balance in blood.

145. Answer (4)

Hint: Carpals have gliding joint.

Sol.: Ball and socket joint – Humerus and pectoral girdle and femur and pelvic girdle

Hinge joint – Knee joint

Pivot joint – Between atlas and axis

Gliding joint – Between the carpals

Saddle joint – Between carpal and metacarpal of thumb

146. Answer (2)

Hint: An animal cell

Sol.: Animal cells are devoid of cell wall and a muscle cell is an animal cell.

In a muscle fibre, Ca^{2+} is stored in sarcoplasmic reticulum.

147. Answer (2)

Hint: Total bones in one hindlimb is 30

Sol.: Each hindlimb constitutes

- 1 thigh bone
- 1 tibia and 1 fibula
- 7 tarsals
- 5 metatarsals
- 14 phalanges
- 1 patella

i.e., total 30 bones

So, both hindlimbs have 60 bones.

148. Answer (4)

Hint: False ribs attach to the 7^{th} rib ventrally.

Sol.: There are 12 pairs of ribs. Each rib is a thin flat bone connected dorsally to the vertebral column and ventrally to the sternum.

First 7 pairs of ribs are called true ribs.

Next 3 pairs (8^{th}, 9^{th} and 10^{th}) are called false (vertebrochondral) ribs.

Last 2 pairs (11^{th} and 12^{th}) are called floating ribs.

149. Answer (2)

Hint: Counter current is more prominent in them.

Sol.: Desert animals for *e.g.* camels have more number of juxtamedullary nephrons as compared to cortical nephrons.

In former, loop of Henle is very long and runs deep into the medulla while loop of Henle is too short and extends only very little into the medulla in latter.

Juxtamedullary nephrons are responsible for production of concentrated urine.

150. Answer (4)

Hint: Heart has little influence on kidney functions

Sol.: The functioning of kidneys is efficiently monitored and regulated by hormonal feedback mechanism involving hypothalamus, JGA and to certain extent, the heart.

The kidneys have built-in mechanisms for the regulation of glomerular filtration rate. One such efficient mechanism is carried out by juxta-glomerular apparatus.

151. Answer (1)

Hint: Spinal cord passes through neural canal.

Sol.: Vertebral column extends from the base of skull and constitute main framework of the trunk. Each vertebra has a central hollow portion (neural canal) through which spinal cord passes. The vertebral column protects the spinal cord, supports the head and serves as the point of attachment for ribs and the musculature of back.

152. Answer (3)

Hint: Contractile proteins are parallely placed

Sol.: The reaction time of the muscle fibres can vary in different muscles.

Each organised skeletal muscle in our body is made of a number of muscle bundles or fascicles held together by a common collagenous connective tissue layer called fascia.

153. Answer (2)

Hint: A vasoconstrictor

Sol.:

- Angiotensin II activates adrenal cortex to release aldosterone.
- Aldosterone causes reabsorption of Na^+ and water from distal parts of the renal tubules.
- An increase in blood flow to the atria of heart can cause release of ANF.
- Excessive loss of fluid from body stimulates hypothalamus to release ADH or vasopressin.
- A fall in GFR can activate JG cells to release renin.

154. Answer (3)

Hint: Identify a skull bone.

Sol.:

- Ear ossicles are total 6 in number. Each middle ear contains 3 tiny bones – Malleus, incus and stapes
- Patella *i.e.*, knee caps are also 2 in number.
- Clavicle are 2 in number.
- Sphenoid is an unpaired cranial bone.

155. Answer (4)

Hint: Uric acid is the least toxic form of nitrogenous waste

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

$\therefore$ Decreasing toxicity order is

Ammonia > Urea > Uric acid

156. Answer (4)

Hint: High myoglobin is responsible for red colour

Sol.:

	Red muscle fibres	–	White muscle fibres
(1)	Abundant myoglobin providing dark red colour	–	Very little quantity of myoglobin giving lighter colour
(2)	More mitochondria	–	Lesser mitochondria
(3)	Less sarcoplasmic reticulum	–	More sarcoplasmic reticulum
(4)	Have more blood capillaries	–	Have lesser blood capillaries

157. Answer (3)

Hint: False ribs do not have direct attachment on sternum.

Sol.:

- True ribs (1^{st} to 7^{th} pairs) are dorsally connected to the thoracic vertebrae and ventrally to sternum.
- False ribs (8^{th}, 9^{th} and 10^{th} pairs) join 7^{th} pair of ribs ventrally and thoracic vertebrae dorsally
- In floating ribs (11^{th} and 12^{th} pairs), one end of rib is attached to vertebral column and the other end is free.

158. Answer (2)

Hint: Hairpin shaped structure is located in medulla region.

Sol.: The Malpighian corpuscle (Bowman's capsule + glomerulus), PCT and DCT of the nephron are situated in the cortical region of the kidney whereas the loop of Henle dips into the medulla.

159. Answer (2)

Hint: Globular head is an active ATPase enzyme.

Sol.: HMM = Globular head + short arm

LMM = Tail only

The globular head is an active ATPase enzyme and has binding sites for ATP and active sites for actin.

The HMM projects outwards at regular distance and angle from each other from the surface of a polymerised myosin filament.

160. Answer (2)

Hint: Skeletal and cardiac muscle fibres are striated.

Sol.: All voluntary muscle fibres (skeletal) are striated.

All branched muscle fibres (cardiac) are striated.

All fusiform muscle fibres (smooth) are involuntary.

161. Answer (1)

Hint: White muscle fibres carry out anaerobic oxidation.

Sol.: Red muscle fibres carry out aerobic oxidation without accumulating much lactic acid. Thus, they can contract for a longer period without fatigue.

White muscle fibres carry out anaerobic oxidation for energy production and accumulate lactic acid in considerable amount during strenuous work and soon get fatigued.

162. Answer (3)

Hint: Useful in blood clotting

Sol.: Tetany is caused due to rapid spasms in muscle due to low levels of Ca^{2+} in blood. It is caused either due to low levels of parathormone or decreased levels of estrogen in old age women.

163. Answer (2)

Hint: Former affects neuro-muscular junction.

Sol.: Myasthenia gravis – Auto-immune disorder

Muscular dystrophy – Genetic disorder

Osteoporosis – Age-related disorder

Gout – Inflammatory disorder

164. Answer (4)

Hint: Blood vessel that carries blood away from heart

Sol.: In uremic patients, urea can be removed by the process called haemodialysis. During the process of haemodialysis, the blood drained from a convenient artery is pumped into a dialysing unit, called artificial kidney after adding an anti-coagulant like heparin.

165. Answer (3)

Hint: Largest gland in our body eliminates cholesterol

Sol.:

Sweat glands	–	NaCl, small amounts of urea, lactic acid
Liver	–	Cholesterol, drugs and vitamins
Sebaceous glands	–	Sterols, hydrocarbon and waxes
Lungs	–	CO_2 and water

166. Answer (1)

Hint: Causes concentration of fluid as it moves down

Sol.: The descending limb of loop of Henle is permeable to water but almost impermeable to electrolytes.

Ascending limb of loop of Henle is impermeable to water but allows transport of electrolytes actively or passively.

PCT is permeable to both water and electrolytes. DCT is also permeable to both water and electrolytes in the presence of certain hormones.

167. Answer (1)

Hint: Includes last thoracic vertebrae

Sol.: Human kidneys are reddish brown, bean-shaped structures situated between the levels of last thoracic and third lumbar vertebrae close to the dorsal inner wall of abdominal cavity.

168. Answer (3)

Hint: CNS sends voluntary signals for micturition.

Sol.: Urine is formed by nephrons of kidneys and not by liver. Urine is stored in urinary bladder till a voluntary signal is given by CNS. The signal for micturition is initiated by stretching of urinary bladder as it gets filled with urine. These stretch receptors send signals to the CNS. The CNS passes on motor messages to initiate contraction of smooth muscles of urinary bladder and simultaneous relaxation of urethral sphincter causing the release of urine. The process of release of urine is called micturition and the neural mechanism causing it is called the micturition reflex.

169. Answer (4)

Hint: 'A' is renal artery

Sol.:

'A'	– Renal artery	– Carries oxygenated blood
'B'	– Renal vein	– Carries deoxygenated blood
'C'	– Dorsal aorta	– Carries oxygenated blood
'D'	– Inferior vena cava	– Carries deoxygenated blood

170. Answer (4)

Hint: Scapula is dorsally located.

Sol.: Each pectoral girdle is formed of two halves. Each half of pectoral girdle consists of a clavicle and a scapula.

Scapula is a large triangular flat bone situated in the dorsal part of thorax between the second and the seventh ribs. The dorsal, flat, triangular body of scapula has a slightly elevated ridge called the spine which projects as a flat expanded process called acromion. The clavicle articulates with it.

171. Answer (2)

Hint: Angiotensin II increases blood pressure.

Sol.: Angiotensin II, being a powerful vasoconstrictor, increases the glomerular blood pressure and thereby GFR. Angiotensin II also activates adrenal cortex to release aldosterone. Aldosterone causes reabsorption of Na^+ and water from the distal parts of the tubule. This also leads to an increase in blood pressure and GFR. This complex mechanism is generally known as Renin-Angiotensin mechanism.

172. Answer (3)

Hint: True for columnar cells

Sol.: PCT is lined by simple brush bordered cuboidal epithelium which increases the surface area for reabsorption. Nearly all of the essential nutrients and 70-80% of electrolytes and water are reabsorbed by PCT.

The nuclei of cuboidal cells (cube-like) are central in position.

The nuclei of columnar cells lie in the basal region.

173. Answer (2)

Hint: Identify a flatworm

Sol.:

- Protonephridia or flame cells are excretory structures in platyhelminths (flatworms *e.g.* *Planaria*)
- Antennal glands/green glands are excretory structures in crustaceans.
- Malpighian tubules help in removal of nitrogenous wastes and osmoregulation in most of the insects including cockroaches.

174. Answer (3)

Hint: Lesser than the width

Sol.: Each kidney of an adult human measures 10-12 cm in length 5-7 cm in width and 2-3 cm in thickness with an average weight of 120-170 g.

Human excretory system also consists of one pair of ureters, a urinary bladder and a urethra along with a pair of kidneys.

175. Answer (4)

Hint: A movement facilitated by cilia

Sol.: Flagellar movement helps in

a. Swimming of spermatozoa in human male

b. Maintenance of water current in canal system of sponges.

c. Locomotion of protists like *Euglena*.

Ciliary movement occurs in the female reproductive tract to facilitate passage of ova.

176. Answer (2)

Hint: Troponin is a trimeric protein

Sol.: Each actin (thin) filament is made of two 'F' (filamentous) actins helically wound to each other. Each 'F' actin is a polymer of monomeric 'G' (globular) actins. Two filaments of another protein, tropomyosin also run close to 'F' actins throughout its length.

A complex protein troponin is distributed at regular intervals on the tropomyosin.

177. Answer (4)

Hint: Thin filaments slide over thick filaments

Sol.: In a resting state, the edges of thin filaments on either side of the thick filaments partially overlap the free ends of the thick filaments leaving the central part of the thick filaments. This central part of thick filament, not overlapped by thin filaments is called the 'H' zone.

178. Answer (3)

Hint: Straight tube reabsorbing large amounts of water

Sol.: Bowman's capsule, PCT and DCT are present in the cortex region of kidneys.

Collecting duct extends from the cortex of kidney to the inner parts of medulla.

179. Answer (3)

Hint: Bones of pelvic girdle

Sol.:

- Based on location, three types of muscles are identified *i.e.*, skeletal, visceral and cardiac.
- Each middle ear contains three tiny bones – Malleus, incus, stapes
- Each coxal bone is formed by the fusion of three bones – Ilium, ischium, pubis
- Joints have been classified into three major structural forms – Fibrous, cartilaginous, synovial.

180. Answer (3)

Hint: Ammonia is the most toxic nitrogenous waste.

Sol.: The correct order of nitrogenous waste according to the decreasing toxicity is

Ammonia > Urea > Uric acid

- Many bony fishes, aquatic amphibians and aquatic insects are ammonotelic.
- Mammals are ureotelic.
- Land snails are uricotelic.

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