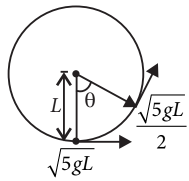
VERY SIMILAR PRACTICE TEST 3

Hints and Explanations

1. (d) : According to conservation of energy,



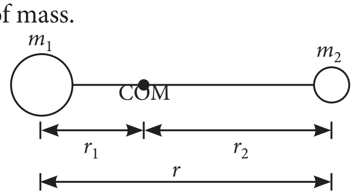
$$\frac{1}{2}Mv^2 = \frac{1}{2}M\left(\frac{v}{2}\right)^2 + Mgh$$

$$\frac{1}{2}M5gL = \frac{1}{2}M\frac{5gL}{4} + MgL(1-\cos\theta)$$

or $\cos\theta = -\frac{7}{8}$ or $\theta = \cos^{-1}\left(\frac{-7}{8}\right) = 151°$

$\therefore \frac{3\pi}{4} < \theta < \pi$

2. (c) : A diatomic molecule consists of two atoms of masses m_1 and m_2 at a distance r apart. Let r_1 and r_2 be the distances of the atoms from the centre of mass.



The moment of inertia of this molecule about an axis passing through its centre of mass and perpendicular to a line joining the atoms is

$I = m_1r_1^2 + m_2r_2^2$

As $m_1r_1 = m_2r_2$ or $r_1 = \frac{m_2}{m_1}r_2$

$\therefore r_1 = \frac{m_2}{m_1}(r - r_1)$; $r_1 = \frac{m_2r}{m_1 + m_2}$

Similarly, $r_2 = \frac{m_1r}{m_1 + m_2}$

Therefore, the moment of inertia can be written as

$$I = m_1\left(\frac{m_2r}{m_1+m_2}\right)^2 + m_2\left(\frac{m_1r}{m_1+m_2}\right)^2$$

$$= \frac{m_1m_2}{m_1+m_2}r^2 \quad \text{...(i)}$$

According to Bohr's quantisation condition

$$L = \frac{nh}{2\pi} \quad \text{or} \quad L^2 = \frac{n^2h^2}{4\pi^2} \quad \text{...(ii)}$$

Rotational energy, $E = \frac{L^2}{2I}$

$$E = \frac{n^2h^2}{8\pi^2 I} = \frac{n^2\hbar^2(m_1+m_2)}{2m_1m_2r^2} \quad \text{(Using (i) and (ii))}$$

3. (a) : In pure semiconductor electron-hole pair = $7 \times 10^{15}\ m^{-3}$

Initially total charge carrier $n_{initial} = n_h + n_e$
$= 14 \times 10^{15}$

After doping donor impurity

$N_D = \frac{5\times10^{28}}{10^7} = 5\times10^{21}$ and $n_e = \frac{N_D}{2} = 2.5 \times 10^{21}$

So, $n_{final} = n_h + n_e \Rightarrow n_{final} \approx n_e \approx 2.5 \times 10^{21}$

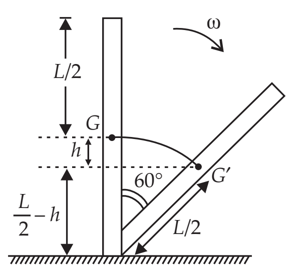
$(\because\ n_e >> n_h)$

$$\text{Factor} = \frac{n_{final} - n_{initial}}{n_{initial}} = \frac{2.5\times10^{21} - 14\times10^{15}}{14\times10^{15}}$$

$$\approx \frac{2.5\times10^{21}}{14\times10^{15}} = 1.8 \times 10^5$$

4. (d) : The fall of centre of gravity h is given by

$$\frac{\left(\frac{L}{2} - h\right)}{\left(\frac{L}{2}\right)} = \cos 60° \quad \text{or} \quad h = \frac{L}{2}(1 - \cos 60°)$$



$\therefore$ Decrease in potential energy

$$= Mgh = Mg\frac{L}{2}(1 - \cos 60°)$$

Kinetic energy of rotation $= \frac{1}{2}I\omega^2 = \frac{1}{2} \times \frac{ML^2}{3}\omega^2$

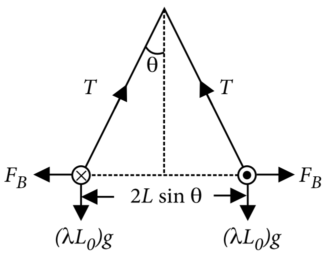
[$I = \frac{ML^2}{3}$ (because rod is rotating about an axis passing through its one end)]

According to law of conservation of energy,

$$Mg\frac{L}{2}(1-\cos 60^\circ) = \frac{ML^2}{6}\omega^2$$

$$\therefore \quad \omega = \sqrt{\frac{6g}{L}\sin 30^\circ} = \sqrt{\frac{6g}{L}\left(\frac{1}{2}\right)} = \sqrt{\frac{3g}{2L}}$$

5. (a) : The force per unit length between current carrying parallel wires is



$$\frac{dF}{dL} = \frac{\mu_0 I\, I}{\pi d}$$

If two wires carry current in opposite directions the magnetic force is repulsive, due to which the parallel wires have moved out so that equilibrium is reached. Figure shows free body diagram of each wire. In equilibrium,

$\Sigma F_y = 0,\ 2T\cos\theta = (\lambda L_0)\,g$ ...(i) $\Sigma F_z = 0,\ 2T\sin\theta$ ...(ii)

Now dividing eqn. (ii) by eqn. (i) we get

$$\tan\theta = \frac{F_B}{L_0 \lambda g}$$

where, the magnetic force,

$$F_B = \left(\frac{dF}{dL}\right)\times L_0 = \frac{\mu_0 I^2}{4\pi\sin\theta}\frac{L_0}{L}$$

For small θ, $\tan\theta \simeq \sin\theta \simeq \theta$

$$\therefore\ \theta = I\sqrt{\frac{\mu_0}{4\pi\lambda g L}}$$

6. (b) : The maximum value of the induced current,

$$I_{max} = \frac{\varepsilon_{max}}{R} = \frac{ABN\omega}{R}.$$

Given, $A = \pi r^2 = 3.14(8\times10^{-2}\text{ m})^2$, $B = 3\times10^{-2}$ T, $N = 20$, $\omega = 50$ rad s^{-1} and $R = 10\ \Omega$.

$$\therefore\ I_{max} = \frac{3.14(8\times10^{-2}\text{ m})^2(3\times10^{-2}\text{ T})\times20(50\text{ rad s}^{-1})}{10\ \Omega}$$

$= 0.0603$ A

The average power loss in the form of heat,

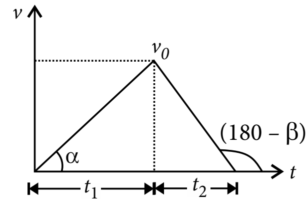
$$P_{av} = \frac{1}{2}I_{max}^2 R = \frac{1}{2}(0.0603\text{ A})^2(10\Omega)$$

$= 0.018$ W $= 18$ mW.

7. (a) : Slope of $v - t$ graph = Acceleration.

$$\alpha = \frac{v_0}{t_1},\ \beta = \frac{v_0}{t_2}$$

$$\therefore\ \frac{\beta}{\alpha} = \frac{t_1}{t_2}$$



Displacement = Area under $v - t$ graph

$\therefore\ x = \frac{1}{2}t_1\times v_0$ and $y = \frac{1}{2}t_2\times v_0$

Hence, $\frac{x}{y} = \frac{t_1}{t_2} = \frac{\beta}{\alpha}$

8. (d) : Bulk modulus, $B = \frac{\text{Normal stress}}{\text{Volumetric strain}}$

$$P = \frac{N}{A} = \frac{N}{(2\pi a)b}$$

$$\text{Volumetric strain} = \frac{2\pi a\,\Delta a\times b}{\pi a^2\times b} = \frac{2\Delta a}{a}$$

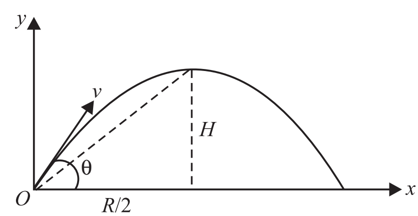
$$\therefore\ B = \frac{N}{2\pi ab}\times\frac{a}{2\Delta a}$$

$N = 4\pi b\,\Delta a\times B$

$\therefore$ Required force = Frictional force

$= \mu N = (4\pi\mu Bb)\Delta a$

9. (c) : From figure,



$$\text{Average velocity, } v_{av} = \frac{\sqrt{H^2 + (R^2/4)}}{T/2} \qquad ...(i)$$

Here, $H = \frac{v^2\sin^2\theta}{2g}$;

$R = \frac{v^2\sin 2\theta}{g}$ and $T = \frac{2v\sin\theta}{g}$

Putting these values in equation (i), we get,

$$v_{av} = \frac{v}{2}\sqrt{1+3\cos^2\theta}$$

10. (a) : The current in the circuit at any instant is, $I = a + b\sin\omega t$.

Hence, the effective value, I_{eff}, of the current in the circuit will be given by

$$I_{\text{eff}}^2 = \left[\frac{\int_0^T I^2 dt}{\int_0^T dt}\right] = \frac{1}{T}\int_0^T I^2 dt = \frac{1}{T}\int_0^T [a + b\sin\omega t]^2 dt$$

$$\Rightarrow \quad I_{\text{eff}}^2 = \frac{1}{T}\int_0^T [a^2 + 2ab\sin\omega t + b^2\sin^2\omega t]dt. \quad \text{...(i)}$$

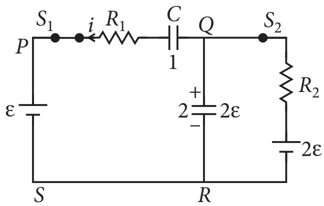
Now, we have

$$\frac{1}{T}\int_0^T \sin\omega t\, dt = 0 \text{ and } \frac{1}{T}\int_0^T \sin^2\omega t\, dt = \frac{1}{2}$$

Substituting these values in equation (i), we get

$$I_{\text{eff}} = \sqrt{\left[a^2 + \frac{b^2}{2}\right]}$$

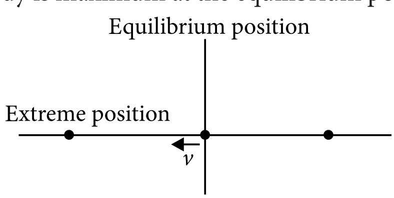
11. (b) : Just before S_1 is closed the potential across capacitor 2 is 2ε.



Just after S_1 is closed the potential difference across capacitors 1 and 2 are 0 and 2ε respectively.

So current $I = \frac{2\varepsilon - \varepsilon}{R_1} = \frac{\varepsilon}{R_1}$ will flow from Q to P.

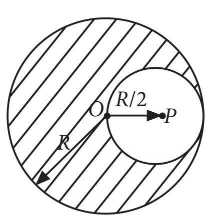
12. (d) : In a simple harmonic motion, velocity of the body is maximum at the equilibrium position.



Now, time taken by a particle executing simple harmonic motion to reach extreme position (where velocity of the body is zero) from equilibrium position is $T/4$.

Hence, option (d) is correct.

13. (d) : Potential at point P (centre of cavity) before removing the spherical portion,



$$V_1 = \frac{-GM}{2R^3}\left(3R^2 - \left(\frac{R}{2}\right)^2\right)$$

$$= \frac{-GM}{2R^3}\left(3R^2 - \frac{R^2}{4}\right) = \frac{-11GM}{8R}$$

Mass of spherical portion to be removed,

$$M' = \frac{MV'}{V} = \frac{M\frac{4\pi}{3}\left(\frac{R}{2}\right)^3}{\frac{4\pi}{3}R^3} = \frac{M}{8}$$

Potential at point P due to spherical portion to be removed

$$V_2 = \frac{-3GM'}{2R'} = \frac{-3G(M/8)}{2(R/2)} = \frac{-3GM}{8R}$$

$\therefore$ Potential at the centre of cavity formed

$$V_P = V_1 - V_2 = \frac{-11GM}{8R} - \left(\frac{-3GM}{8R}\right) = \frac{-GM}{R}$$

14. (b) : $\vec{E} \times \vec{B}$ gives direction of wave propagation.

$$\Rightarrow \quad \hat{k} \times \vec{B} \,||\, \frac{\hat{i} + \hat{j}}{\sqrt{2}}$$

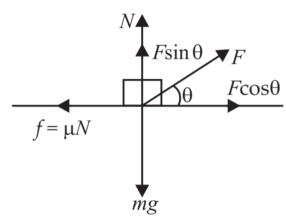
Now, $\hat{k} \times \left(\frac{\hat{i} - \hat{j}}{\sqrt{2}}\right) = \frac{\hat{j} - (-\hat{i})}{\sqrt{2}} = \frac{\hat{i} + \hat{j}}{\sqrt{2}}$

Wave propagation vector should be along $\frac{\hat{i} + \hat{j}}{\sqrt{2}}$

and direction of magnetic field is along $\frac{\hat{i} - \hat{j}}{\sqrt{2}}$.

15. (a) : $N + F\sin\theta = mg$

$N = mg - F\sin\theta$ ...(i)



Force of friction,

$f = \mu N = \mu(mg - F\sin\theta)$

The block will move, when

$F\cos\theta \geq f$

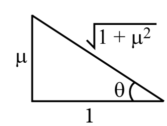
$F\cos\theta \geq \mu(mg - F\sin\theta)$

$$F \geq \frac{\mu mg}{\cos\theta + \mu\sin\theta} \quad \text{...(ii)}$$

F will be minimum, when

$\cos\theta + \mu\sin\theta$ = maximum, for which

$$\frac{d}{d\theta}(\cos\theta + \mu\sin\theta) = 0$$



or $-\sin\theta + \mu\cos\theta = 0$

or $\mu\cos\theta = \sin\theta$

or $\tan\theta = \mu$ or $\theta = \tan^{-1}(\mu)$

$$\therefore \quad \sin\theta = \frac{\mu}{\sqrt{1+\mu^2}} \text{ and } \cos\theta = \frac{1}{\sqrt{1+\mu^2}}$$

From (ii), $F \geq \dfrac{\mu mg}{\dfrac{1}{\sqrt{1+\mu^2}} + \dfrac{\mu^2}{\sqrt{1+\mu^2}}}$

$$F \geq \frac{\mu mg}{\sqrt{1+\mu^2}} \quad \therefore \quad F_{\min} = \frac{\mu mg}{\sqrt{1+\mu^2}}$$

16. (d) : Maximum amplitude, $A_{\max} = A_c + A_m$ ...(i)

Minimum amplitude, $A_{\min} = A_c - A_m$ ...(ii)

Solving (i) and (ii), we get

$$A_c = \frac{A_{\max} + A_{\min}}{2}, \quad A_m = \frac{A_{\max} - A_{\min}}{2}$$

Modulation index, $\mu = \dfrac{A_m}{A_c} = \dfrac{A_{\max} - A_{\min}}{A_{\max} + A_{\min}}$

$$\mu = \frac{25\text{ V} - 5\text{ V}}{25\text{ V} + 5\text{ V}} = \frac{20}{30} = \frac{2}{3}$$

17. (a) : Here, $\vec{E} = -E_0 \hat{i}$; initial velocity $\vec{v} = v_0 \hat{i}$

Force acting on electron due to electric field

$$\vec{F} = (-e)(-E_0 \hat{i}) = eE_0 \hat{i}$$

Acceleration produced in the electron,

$$\vec{a} = \frac{\vec{F}}{m} = \frac{eE_0}{m} \hat{i}$$

Now, velocity of electron after time t,

$$\vec{v}_t = \vec{v} + \vec{a}\,t = \left(v_0 + \frac{eE_0 t}{m}\right)\hat{i}$$

or $|\vec{v}_t| = v_0 + \dfrac{eE_0 t}{m}$

Now, $\lambda_t = \dfrac{h}{mv_t} = \dfrac{h}{m\left(v_0 + \dfrac{eE_0 t}{m}\right)} = \dfrac{h}{mv_0\left(1 + \dfrac{eE_0 t}{mv_0}\right)}$

$$= \frac{\lambda_0}{\left(1 + \dfrac{eE_0 t}{mv_0}\right)} \qquad \left(\because \lambda_0 = \frac{h}{mv_0}\right)$$

18. (a) : Average time of collision between molecules,

$$\tau = \frac{\text{Mean free path}(\lambda)}{\text{Mean speed }(\bar{v})} = \frac{1}{\left(\sqrt{2}\pi d^2 \dfrac{N}{V}\right)\left(\sqrt{\dfrac{8k_BT}{m\pi}}\right)}$$

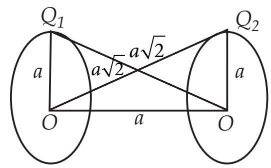
$$\therefore \quad \tau \propto \frac{V}{\sqrt{T}} \quad \text{or} \quad T \propto \frac{V^2}{\tau^2}$$

For adiabatic expansion, $TV^{\gamma-1}$ = constant

or $\dfrac{V^2}{\tau^2} V^{\gamma-1}$ = constant or $\tau \propto V^{\frac{(\gamma+1)}{2}}$

Comparing it with $\tau \propto V^q$, we get $q = \dfrac{\gamma+1}{2}$

19. (c) : The electrostatic potential at the centre of the first ring (*i.e.*, at O) with charge Q_1 is due to charge Q_1 itself as well as due to charge Q_2 on the second ring which is given by



$$V_1 = \frac{1}{4\pi\varepsilon_0}\frac{Q_1}{a} + \frac{1}{4\pi\varepsilon_0}\frac{Q_2}{a\sqrt{2}}$$

Similarly, the electrostatic potential at the centre of the second ring (*i.e.*, at O') is given by

$$V_2 = \frac{1}{4\pi\varepsilon_0}\frac{Q_1}{a\sqrt{2}} + \frac{1}{4\pi\varepsilon_0}\frac{Q_2}{a}$$

Required work done , $W = q(V_1 - V_2)$

$$= q\left[\frac{1}{4\pi\varepsilon_0}\frac{Q_1}{a} + \frac{1}{4\pi\varepsilon_0}\frac{Q_2}{a\sqrt{2}} - \frac{1}{4\pi\varepsilon_0}\frac{Q_1}{a\sqrt{2}} - \frac{1}{4\pi\varepsilon_0}\frac{Q_2}{a}\right]$$

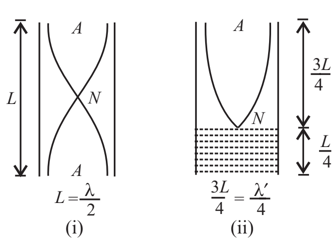
$$= \frac{q}{4\pi\varepsilon_0 a}\left[Q_1 + \frac{Q_2}{\sqrt{2}} - \frac{Q_1}{\sqrt{2}} - Q_2\right]$$

$$= \frac{q}{4\pi\varepsilon_0 a}\left[\frac{\sqrt{2}Q_1 + Q_2 - Q_1 - \sqrt{2}Q_2}{\sqrt{2}}\right]$$

$$= \frac{q}{4\pi\varepsilon_0 a\sqrt{2}}\left[\sqrt{2}(Q_1 - Q_2) - 1(Q_1 - Q_2)\right]$$

$$= \frac{q(\sqrt{2}-1)}{4\pi\varepsilon_0 a\sqrt{2}}(Q_1 - Q_2)$$

20. (a) :



A cylindrical tube open at both the ends, its fundamental frequency is

$$\upsilon = \frac{v}{\lambda} = \frac{v}{2L} = 390 \text{ Hz} \quad \text{... (i)}$$

where v is the velocity of sound in air.

If a $(1/4)^{th}$ of cylindrical tube is immersed in a water, it will become a closed pipe of length three-fourth that of an open pipe as shown in figure (ii). Therefore, its fundamental frequency is

$$\upsilon' = \frac{v}{\lambda'} = \frac{v}{3L}$$

$$\upsilon' = \frac{v}{3L} = \frac{2}{3}\left(\frac{v}{2L}\right) = \frac{2}{3} \times 390 \text{ Hz} \quad \text{(using(i))}$$

$= 260$ Hz.

21. (12.0) : Using mirror formula,

$$v = \frac{uf}{u-f} = \frac{(-15)\times(-10)}{-15+10} = -30 \text{ cm},$$

$$m = -\frac{v}{u} = -2 \quad \therefore A'B' = C'D' = 2 \times AB = 2 \times 1 = 2 \text{ mm}$$

Now for longitudinal magnification,

$$\frac{B'C'}{BC} = \frac{A'D'}{AD} = \frac{v^2}{u^2} = 4 \Rightarrow B'C' = A'D' = 4 \text{ mm}$$

$\therefore$ Perimeter length = 2 + 2 + 4 + 4 = 12 mm

22. (3.0): Flux through an area with half angle θ as shown is

$$\phi_E = \frac{Q}{2\varepsilon_0}(1-\cos\theta)$$

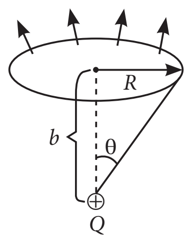
Here, $\cos\theta = \frac{1}{\sec\theta} = \frac{1}{\sqrt{1+\tan^2\theta}}$

$$= \frac{1}{\sqrt{1+R^2/b^2}} = \frac{1}{\sqrt{\left(1+\frac{3b^2}{b^2}\right)}} = \frac{1}{2}$$

$\therefore$ Flux through disc, $\phi_1 = \frac{Q}{4\varepsilon_0}$

So, flux which is not passing through the disc

$$\phi_2 = \frac{Q}{\varepsilon_0} - \frac{Q}{4\varepsilon_0} = \frac{3}{4}\frac{Q}{\varepsilon_0}$$



Hence, ratio is $\frac{\phi_2}{\phi_1} = \frac{\frac{3}{4}\frac{Q}{\varepsilon_0}}{\frac{1}{4}\frac{Q}{\varepsilon_0}} = 3$

23. (0.312) : Here,

Distance between the slits, $d = 2$ mm $= 2 \times 10^{-3}$ m

Distance of the screen from the slits, $D = 1.2$ m

Wavelengths,

$\lambda_1 = 6500$ Å $= 6500 \times 10^{-10} = 6.5 \times 10^{-7}$ m

and $\lambda_2 = 5200$ Å $= 5200 \times 10^{-10} = 5.2 \times 10^{-7}$ m

Distance of n^{th} bright fringe from the centre bright fringe is

$$x_n = \frac{n\lambda D}{d} \quad \text{...(i)}$$

If x_4 and x'_4 be the distances of the fourth bright fringes of wavelengths λ_1 and λ_2 respectively, then from eqn. (i)

$$x_4 = \frac{4\lambda_1 D}{d} \text{ and } x'_4 = \frac{4\lambda_2 D}{d}$$

Thus, the separation between them is

$$\Delta x = x_4 - x'_4 = \frac{4\lambda_1 D}{d} - \frac{4\lambda_2 D}{d} = \frac{4D(\lambda_1 - \lambda_2)}{d}$$

$$= \frac{4(1.2 \text{ m})(6.5\times10^{-7}\text{ m} - 5.2\times10^{-7}\text{ m})}{(2\times10^{-3}\text{ m})}$$

$= 3.12 \times 10^{-4}$ m $= 0.312 \times 10^{-3}$ m $= 0.312$ mm

24. (8.0): Here,

radius of the sphere, $r = 10$ cm $= 10 \times 10^{-2}$ m

work function, $\phi_0 = 2.4$ eV

energy of a photon, $E = h\upsilon = 4.2$ eV

According to Einstein's photoelectric equation

$h\upsilon = \phi_0 + eV_s$

4.2 eV = 2.4 eV + eV_s

$eV_s = 4.2$ eV $- 2.4$ eV $= 1.8$ eV

$\therefore$ $V_s = 1.8$ V

The sphere will stop emitting photoelectrons, when the potential on its surface becomes 1.8 V. Let N be the number of photoelectrons emitted from the sphere. Then,

charge on the sphere, $Q = Ne$

$$V_s = \frac{1}{4\pi\varepsilon_0}\frac{Q}{r} = \frac{1}{4\pi\varepsilon_0}\frac{Ne}{r}$$

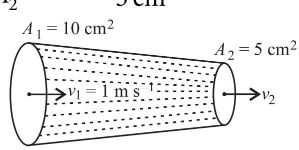
$$N = \frac{V_s \times r}{\frac{1}{4\pi\varepsilon_0}\times e} = \frac{1.8 \times r}{\frac{1}{4\pi\varepsilon_0}\times e} = \frac{1.8\times10\times10^{-2}}{9\times10^9\times1.6\times10^{-19}}$$

$$= \frac{18}{16}\times\frac{1}{9}\times10^9 = 1.25\times10^8$$

25. (500) : According to equation of continuity,

$A_1 v_1 = A_2 v_2$

$$\therefore v_2 = \frac{A_1 v_1}{A_2} = \frac{10 \text{ cm}^2 \times 1 \text{ m s}^{-1}}{5 \text{ cm}^2} = 2 \text{ m s}^{-1}$$



For a horizontal pipe, according to Bernoulli's theorem

$$P_1 + \frac{1}{2}\rho v_1^2 = P_2 + \frac{1}{2}\rho v_2^2$$

or $$P_2 = P_1 + \frac{1}{2}\rho(v_1^2 - v_2^2)$$

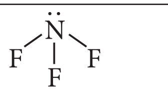
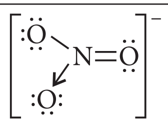
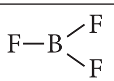
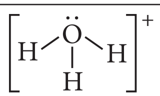
$$= 2000 + \frac{1}{2}\times 10^3 \times (1^2 - 2^2)$$

($\because$ Density of water, $\rho = 10^3$ kg m^{-3})

$$= 2000 - \frac{1}{2}\times 10^3 \times 3 = 2000 - 1500 = 500 \text{ Pa}$$

26. (c) : This leads to stronger coulombic forces of attractions in NaF.

27. (c) : Isostructural pairs have similar structures.

NF_3		Triangular pyramidal
NO_3^-		Triangular planar
BF_3		Triangular planar
H_3O^+		Triangular pyramidal
HN_3	H∖N̈=N=N̈	Linear

Thus, isostructural pairs are [NF_3, H_3O^+] and [NO_3^-, BF_3].

28. (c) : Iron coated with zinc does not get rusted even if cracks appear on the surface because Zn will take part in redox reaction not Fe, as Zn is more reactive than Fe. If iron is coated with tin and cracks appear on the surface, Fe will take part in redox reaction because Sn is less reactive than Fe.

29. (d) : $\frac{r_1}{r_2} = \left[\frac{2.4\times10^{-2}}{1.2\times10^{-2}}\right]^x$

$8 = (2)^x \Rightarrow (2)^3 = (2)^x \quad \therefore \quad x = 3$

Hence, the order of reaction is 3.

30. (b) : $V_2 = \left(V_1 + \frac{V_1 \times 10}{100}\right) = 1.1\, V_1$

Now, $\frac{V_1}{(t_1+273)} = \frac{1.1\, V_1}{(t_2+273)}$

or $t_2 = (1.1t_1 + 27.3)$

Increase in temperature $= 1.1t_1 + 27.3 - t_1$

$= (0.1t_1 + 27.3)$

Percent increase $= \frac{(0.1t_1 + 27.3)\times 100}{t_1}$

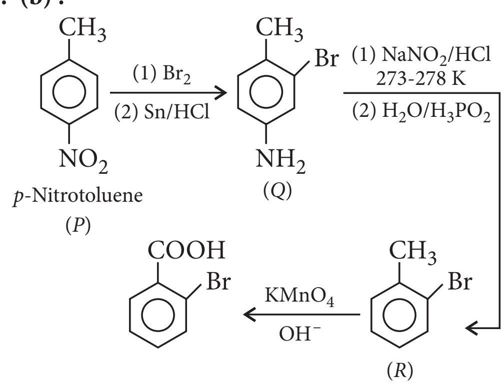
$= \left(10 + \frac{2730}{t_1}\right)\%$

31. (d) : $CH_3CH_2OH \xrightarrow{PCl_5} \underset{X}{CH_3CH_2Cl} \xrightarrow{\text{alc. KOH}} \underset{Y}{CH_2{=}CH_2} \xrightarrow[H_2O,\,\Delta]{H_2SO_4,\text{ room temp.}}$ ⌒OH or $\underset{Z}{CH_3CH_2OH}$

32. (a) : Oxidising roasting is a very common type of roasting in metallurgy and is carried out to remove sulphur and arsenic in the form of their volatile oxides. CS_2 is more volatile than CO_2. So, option (a) is of no significance for roasting sulphide ores to their oxides. The reduction process is on the thermodynamic stability of the products and not on their volatility.

33. (c) : NO (B.O. = 2.5, Paramagnetic) $\longrightarrow$ NO^+ (B.O. = 3, Diamagnetic)

34. (b) :



35. (d) : The stability of the carbanion decreases as the electronegativity of the carbon carrying –ve charge decreases or the hybridisation of carbon carrying –ve charge changes from *sp* to sp^2 to sp^3. Thus, $RC\equiv C^-$ is the most stable while $R_3C-CH_2^-$ is the least stable carbanion. Out of $C_6H_5^-$ and $R_2C=CH^-$; $R_2C=CH^-$ is less stable due to +*I*-effect of the two *R* groups. Thus, the overall stability decreases in the order :

$RC\equiv C^- > C_6H_5^- > R_2C=CH^- > R_3C-CH_2^-$

36. (c) : The higher the charge on the metal ion, smaller is the ionic size and more is the complex

forming ability. Thus, the degree of complex formation decreases in the order
$M^{4+} > MO_2^{2+} > M^{3+} > MO_2^{+}$
The higher tendency of complex formation of MO_2^{2+} as compared to M^{3+} is due to high concentration of charge on metal atom M in MO_2^{2+}.

37. (b) **38.** (a)

39. (d) : Extent of adsorption, $\frac{x}{m} = kp^{1/n}$
(Freundlich adsorption isotherm)
The amount of gas adsorbed does not increase as rapidly as the pressure.
Extent of adsorption, $\frac{x}{m} = \frac{ap}{(1+bp)}$
(Langmuir adsorption isotherm)
where k, a, b are constants and p is a pressure.

40. (b) : The process $O \rightarrow D$, occurs at constant volume, thus, $\Delta V = 0$
$\therefore \quad w = P\Delta V = 0$, then
$\Delta U = q + w \Rightarrow \Delta U = q + 0 = q$

41. (a) : $\underset{(A)}{MnO_2} + 4HCl \longrightarrow \underset{(B)}{Cl_2} + MnCl_2 + 2H_2O$

$$\underset{\text{(Excess)}}{3Cl_2} + NH_3 \longrightarrow \underset{\text{(C)}}{NCl_3} + 3HCl$$

42. (a) : Empirical formula weight $= 12 + 2 \times 1 = 14$
22.4 L of $N_2 \equiv 28$ g
$\Rightarrow \quad 1$ L of $N_2 = \frac{28}{22.4}$ g
Now, 1 L of organic gas $= \frac{28}{22.4}$ g
$\Rightarrow \quad 22.4$ L of organic gas = 28 g
$\therefore \quad$ Molecular weight of gas = 28 g
$(\text{Empirical weight})_n$ = Molecular weight
$n = \frac{28}{14} = 2$
Molecular formula = $(\text{Empirical formula})_n$
$= (CH_2)_2 = C_2H_4$

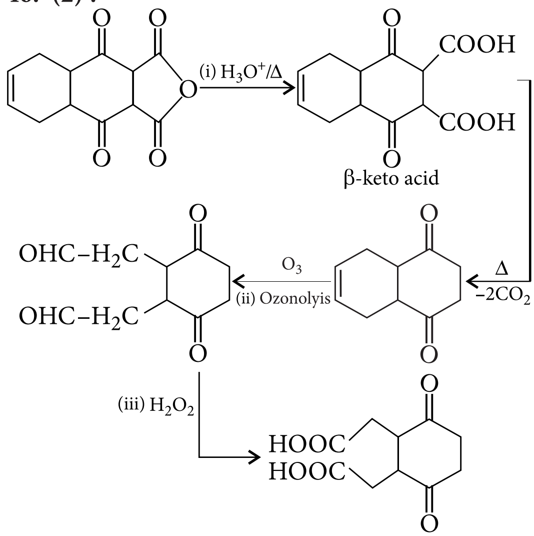
43. (d) : H_2O_2 oxidises Na_2SO_3 to Na_2SO_4, KI to I_2, PbS to $PbSO_4$ and reduces O_3 to O_2.

$$H_2O_2 + O_3 \longrightarrow H_2O + 2O_2$$

44. (c) : At the given pH (6.0) of the solution, alanine (pI = 6.0), exists as a dipolar ion while arginine (pI = 10.2) exists as a cation. Hence, on passing an electric current, alanine will not migrate to any electrode while arginine will migrate to cathode.

45. (b) : Prostaglandin is not a steroidal hormone. It is a derivative of fatty acid.

46. (2) :



47. (2.74) : pH of 0.01 M HCl solution,
$HCl + H_2O \longrightarrow H_3O^+ + Cl^-$

$$[H^+] = \frac{0.01}{1\text{ L}} = 10^{-2}\text{ M} \quad \therefore \text{ pH} = 2.0$$

CH_3COONa contains CH_3COO^- ions which react with H_3O^+ ion from HCl. Assume complete reaction of H_3O^+ with CH_3COO^- ion.

	CH_3COO^- +	H_3O^+ $\longrightarrow$	CH_3COOH +	H_2O
Initial conc.	0.02 M	0.01 M	—	—
Final conc.	0.01 M (excess)	0	0.01 M	0.01 M

$CH_3COOH + H_2O \rightleftharpoons CH_3COO^- + H_3O^+$

$$K_a = \frac{[CH_3COO^-][H_3O^+]}{[CH_3COOH]} = \frac{[0.01][H_3O^+]}{0.01} = 1.8 \times 10^{-5}$$

$\therefore \quad [H_3O^+] = 1.8 \times 10^{-5}$, so pH = 4.74
Change in pH = 4.74 – 2.00 = 2.74

48. (3) : $3Cl_2 + 6KOH \rightarrow KClO_3 + 5KCl + 3H_2O$
$KClO_3$ is used in fire works and safety matches and Cl_2 is greenish yellow gas.

49. (8) : Kinetic energy of emitted photoelectron is
$K.E. = h\nu - h\nu_0 = h(\nu - \nu_0)$
For the light of frequency 3.2×10^{16} sec^{-1}
$K.E._1 = h(3.2 \times 10^{16} - \nu_0)$
For the light of frequency 2×10^{16} sec^{-1}
$K.E._2 = h(2.0 \times 10^{16} - \nu_0)$
It is given that $K.E._1 = 2K.E._2$
$\therefore \quad h(3.2 \times 10^{16} - \nu_0) = 2h(2.0 \times 10^{16} - \nu_0)$
$3.2 \times 10^{16} - \nu_0 = 2(2.0 \times 10^{16} - \nu_0)$
$3.2 \times 10^{16} - \nu_0 = 4.0 \times 10^{16} - 2\nu_0$