MEDJEE
DIGITEXT | DEXTERITY | DEVELOPMENT

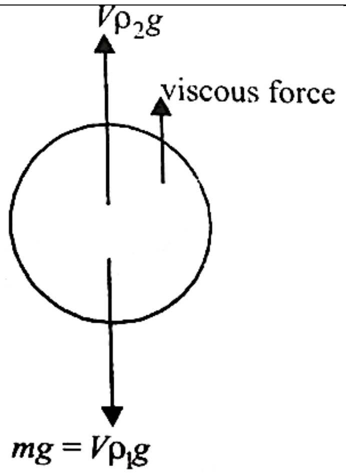
XI STD | WT - 16 | NEET - KEYS & HINTS

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

HINTS:

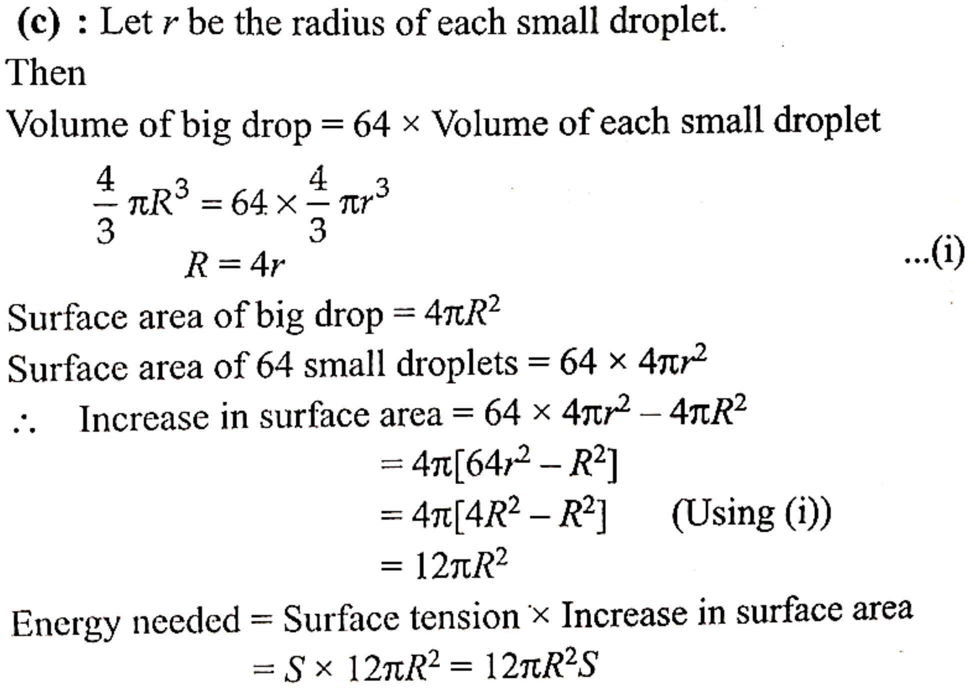
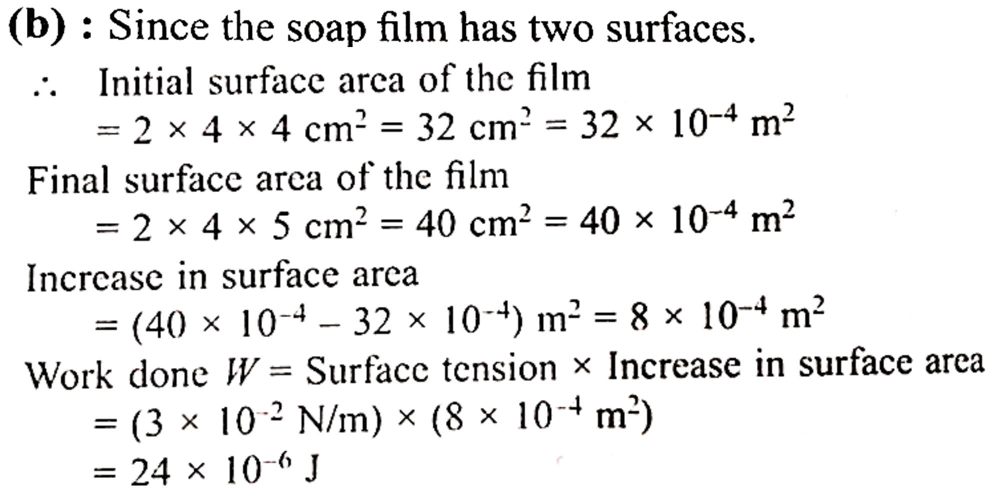
1	(c) : $h = \frac{2S\cos\theta}{r\rho g}$ i.e. $h \propto \frac{1}{r}$ $\therefore \frac{h'}{h} = \frac{r}{r/2} = 2$ or $h' = 2h$
2	(c) : Excess pressure inside the bubble, $P = 4S/r$. So smaller is the radius r, the larger is the excess pressure P. It means, the pressure of air is more in bubble A than in bubble B. So the air will go from bubble A to bubble B.
3	(b) : $h = \frac{2S\cos\theta}{r\rho g}$ $h = \frac{2\times 0.06\times\cos 0^\circ}{0.5\times10^{-3}\times10^{3}\times9.8} = 2.44\times10^{-2}\ \text{m} = 2.44\ \text{cm}$
4	(a) : $P = \frac{2S}{r} = \frac{4S}{D} = \frac{4\times0.072}{1.2\times10^{-3}} = 240\ \text{N m}^{-2}$
5	(a) : According to continuity equation $A_1v_1 = A_2v_2$ $v_2 = v_1\frac{A_1}{A_2} = v_1\left(\frac{D_1}{D_2}\right)^2 = 4\times\left(\frac{5}{4}\right)^2 = 6.25\ \text{ms}^{-1}$
6	(a) : Velocity of efflux, $v = \sqrt{2gh}$ Volume of liquid flowing out per second $= v\times A = \sqrt{2gh}\times A$ $= \sqrt{2\times10\times5}\times(10\times10^{-4}) = 10^{-2}\ \text{m}^3\ \text{s}^{-1}$
7	(b) : According to Stoke's law Viscous force $F = 6\pi\eta Rv$ $F = 6\pi\eta Rv \Rightarrow F \propto R$
8	(c) : According to equation of continuity, Av = constant It means, as area increases, velocity decreases. Thus, as blood flows from narrow arteries to wider one, velocity decreases. According to Bernoulli's theorem $P + \frac{1}{2}\rho v^2 = \text{constant}$ It means, as velocity decreases, pressure increases. Thus, when arteries become narrow, blood pressure increases.

	OR **Why:** When an artery narrows, its cross-sectional area decreases ⇒ the blood speed rises (continuity). Along a streamline, $P + \frac{1}{2}\rho v^2$ stays constant (Bernoulli), so higher speed in the constriction means lower static pressure there; to maintain flow the heart must raise the upstream pressure, giving a higher measured blood pressure.
9	**(a) :** When a sphere falling through a viscous medium it accelerates initially due to gravity. As a result of this its velocity increases, hence viscous force also increases. Finally when viscous force plus buoyant force becomes equal to force of gravity, the net force becomes zero and so does the acceleration. Then the sphere descends with a constant velocity. This constant velocity is called terminal velocity. At terminal velocity: • Net force = 0 • Downward force = Weight W • Upward forces = Buoyant force F_b + Viscous force F_v So, $W = F_b + F_v$
10	**(d) :** According to continuity equation, $A_1v_1 = A_2v_2$, *i.e.,* $v_2 = \frac{10}{5} \times 1 = 2$ m/s Now according to Bernoulli's equation, $P_1 + \frac{1}{2}\rho v_1^2 = P_2 + \frac{1}{2}\rho v_2^2$ $2000 + \frac{1}{2} \times 10^3 \times 1^2 = P_2 + \frac{1}{2} \times 10^3 \times 2^2$ On solving, we get P_2 = 500 Pa
11	**(a) :** $h_1 = \frac{2S\cos 0^\circ}{r_1\rho g}$ and $h_2 = \frac{2S\cos 0^\circ}{r_2\rho g}$ Given, $h = h_1 - h_2 = \frac{2S}{\rho g}\left[\frac{1}{r_1} - \frac{1}{r_2}\right] = \frac{2S(r_2 - r_1)}{r_1 r_2 \rho g}$ or $S = \frac{r_1 r_2 h \rho g}{2(r_2 - r_1)}$

12	**(b) :** The forces acting on the solid ball when it is falling through a liquid are mg downwards, upthrust upwards and the viscous force also acting upwards. The viscous force rapidly increases with velocity, attaining a maximum when the ball reaches the terminal velocity.  Then the acceleration is zero. $mg - V\rho_2 g - kv^2 = ma$ where V is volume, v is the terminal velocity. When the ball is moving with terminal velocity, $a = 0$ $\therefore \quad V\rho_1 g - V\rho_2 g - kv^2 = 0$ $v = \sqrt{\dfrac{Vg(\rho_1 - \rho_2)}{k}}$
13	**(d) :** $\because \quad F = -\eta A \dfrac{dv}{dx}$ $\therefore \quad F \propto \dfrac{dv}{dx}$ or $F \propto \dfrac{\Delta v}{\Delta x}$ $F \propto \dfrac{v}{x}$ (since, velocity of layer at bottom is zero) or $x \propto \dfrac{v}{F}$ But F is constant. $\therefore \quad x \propto v$ $\therefore \quad \dfrac{v_2}{v_1} = \dfrac{x_2}{x_1}$ or $\dfrac{v_2}{20} = \dfrac{40}{10}$ or $v_2 = 80$ cm/s OR Given: At $y = 10\ \text{cm}$, velocity = $20\ \text{cm/s}$. In river, velocity ∝ depth from bed (linear profile assumption). So at $y = 40\ \text{cm}$: $v = \dfrac{40}{10} \times 20 = 80\ \text{cm/s}$
14	The excess pressure inside a spherical soap bubble, compared to the outside pressure, is given by the formula $\Delta P = \dfrac{4T}{R}$, where T is the surface tension of the soap solution and R is the radius of the bubble.

	Let P_0 be the atmospheric pressure outside the larger bubble. The pressure inside the larger bubble, P_1, is $P_0 + \frac{4T}{R_2}$, where $R_2 = 3 \text{ cm}$ is the radius of the larger bubble. The pressure inside the smaller bubble, P_2, is $P_1 + \frac{4T}{R_1}$, where $R_1 = 1 \text{ cm}$ is the radius of the smaller bubble. Substituting P_1: $P_2 = P_0 + \frac{4T}{R_2} + \frac{4T}{R_1} = P_0 + 4T\left(\frac{1}{R_1} + \frac{1}{R_2}\right)$. The pressure difference between the inside of the smaller bubble and the outside of the larger bubble is $\Delta P_{total} = P_2 - P_0 = 4T\left(\frac{1}{R_1} + \frac{1}{R_2}\right)$. Let R be the radius of a single soap bubble that maintains the same pressure difference. Then $\Delta P_{total} = \frac{4T}{R}$. Equating the two expressions for ΔP_{total}: $\frac{4T}{R} = 4T\left(\frac{1}{R_1} + \frac{1}{R_2}\right)$ $\frac{1}{R} = \frac{1}{R_1} + \frac{1}{R_2}$ $\frac{1}{R} = \frac{1}{1 \text{ cm}} + \frac{1}{3 \text{ cm}}$ $\frac{1}{R} = \frac{3+1}{3 \text{ cm}} = \frac{4}{3 \text{ cm}}$ $R = \frac{3}{4} \text{ cm} = 0.75 \text{ cm}$
15	The angle of contact is determined by the *cohesive force* of the liquid molecules and the *adhesive force* between liquid and solid. Hence, it depends on **both the nature of the liquid and the solid.** **Answer: (c) both on solid and liquid only**
16	For **liquids**: viscosity **decreases** with rise in temperature (molecules move more freely). For **gases**: viscosity **increases** with rise in temperature (higher molecular collisions transfer momentum better). **Answer: (b) gases increases and liquids decreases**

17	(c) For parallel combination $\frac{1}{R_{eff}}=\frac{1}{R_1}+\frac{1}{R_2}$ $\Rightarrow \frac{\pi r^4}{8\eta l}=\frac{\pi r^4}{8\eta l_1}+\frac{\pi r^4}{8\eta l_2} \Rightarrow \frac{1}{l}=\frac{1}{l_1}+\frac{1}{l_2} \quad \therefore l=\frac{l_1 l_2}{l_1+l_2}$
18	**(a) :** Here, $r = 3.0\text{ mm} = 3\times10^{-3}\text{ m}$; $S = 4.65\times10^{-1}\text{ Nm}^{-1}$; Excess of pressure inside the drop of mercury is given by $P=\frac{2S}{r}=\frac{2\times4.65\times10^{-1}}{3\times10^{-3}}=310\text{ Pa}$
19	**(c) :** $h=\frac{2S\cos\theta}{r\rho g}$ $hr=\frac{2S\cos\theta}{\rho g}=\text{constant}$ or $h_1 r_1 = h_2 r_2$ or $h_2=\frac{h_1 r_1}{r_2}$ Substituting the values $h_2 = (2.0)(3) = 6.0$ cm
20	. **(a) :** The rate of flow of liquid (V) through capillary tube is $V=\frac{\pi P r^4}{8\eta l}=P\left(\frac{\pi r^4}{8\eta l}\right)=\frac{P}{R}=\frac{\text{Pressure difference}}{\text{Resistance}}$ where, $R=\frac{8\eta l}{\pi r^4}$ When two tubes are in series Total resistance $R = R_1 + R_2$ $\therefore$ Rate of flow of liquid, $V'=\frac{P}{R_1+R_2}$ $=\frac{P}{\frac{8\eta}{\pi}\left[\frac{l_1}{r_1^4}+\frac{l_2}{r_2^4}\right]}$ $=\frac{\pi P}{8\eta}\left[\frac{l_1}{r_1^4}+\frac{l_2}{r_2^4}\right]^{-1}$

21	 **(c) :** Let r be the radius of each small droplet. Then Volume of big drop = 64 × Volume of each small droplet $\frac{4}{3}\pi R^3 = 64 \times \frac{4}{3}\pi r^3$ $R = 4r$ ...(i) Surface area of big drop = $4\pi R^2$ Surface area of 64 small droplets = $64 \times 4\pi r^2$ $\therefore$ Increase in surface area = $64 \times 4\pi r^2 - 4\pi R^2$ $= 4\pi[64r^2 - R^2]$ $= 4\pi[4R^2 - R^2]$ (Using (i)) $= 12\pi R^2$ Energy needed = Surface tension × Increase in surface area $= S \times 12\pi R^2 = 12\pi R^2 S$
22	 **(b) :** Since the soap film has two surfaces. $\therefore$ Initial surface area of the film $= 2 \times 4 \times 4\ \text{cm}^2 = 32\ \text{cm}^2 = 32 \times 10^{-4}\ \text{m}^2$ Final surface area of the film $= 2 \times 4 \times 5\ \text{cm}^2 = 40\ \text{cm}^2 = 40 \times 10^{-4}\ \text{m}^2$ Increase in surface area $= (40 \times 10^{-4} - 32 \times 10^{-4})\ \text{m}^2 = 8 \times 10^{-4}\ \text{m}^2$ Work done W = Surface tension × Increase in surface area $= (3 \times 10^{-2}\ \text{N/m}) \times (8 \times 10^{-4}\ \text{m}^2)$ $= 24 \times 10^{-6}\ \text{J}$
23	c) Here, $r = 0.0015\, mm = 0.0015 \times 10^{-3} m$ $\eta = 2.0 \times 10^{-5} kg / ms$ $\rho = 1.0 \times 10^{3} kg / m^{3}$ $g = 10\ m / s^{2}$ Neglecting the density of air, the terminal velocity of the water drop is $v_T = \frac{2}{9}\frac{r^2 \rho g}{\eta}$ $= \frac{2 \times \left(0.0015 \times 10^{-3}\right)^2 \times 1.0 \times 10^3 \times 10}{9 \times 2.0 \times 10^{-5}} = 2.5 \times 10^{-4} m / s$

24 **(c) :** From Torricelli's theorem

$$v=\sqrt{(2gd)}$$

where v is horizontal velocity and d is the depth of water in barrel.

Time t to hit the ground is given by

$$h=\frac{1}{2}gt^2 \quad \text{or} \quad t=\sqrt{\frac{2h}{g}}$$

$$\therefore \quad R=vt=\sqrt{(2gd)}\sqrt{\frac{2h}{g}}=2\sqrt{dh}$$

$$\therefore \quad R^2=4dh \quad \text{or} \quad d=\frac{R^2}{4h}$$

25 **(d) :** Here, $R=\frac{2.8}{2}=1.4\text{ mm}=0.14\text{ cm}$;

$$\frac{4}{3}\pi R^3=125\times\frac{4}{3}\pi r^3 \quad \text{or} \quad r=\frac{R}{5}=\frac{0.14}{5}=0.028\text{ cm}$$

Change in energy = surface tension × increase in area

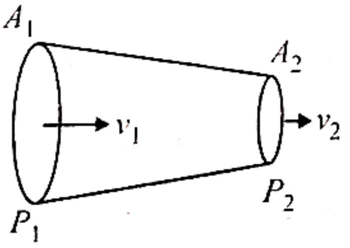
$$= 75\times[125\times 4\pi r^2-4\pi R^2]$$

$$= 75\times 4\pi\times[125\times(0.028)^2-(0.14)^2]$$

$$= 74\text{ erg}$$

26 **(b) :** According to continuity equation,

$$\frac{v_2}{v_1}=\frac{A_1}{A_2}=\frac{\pi\times(0.1)^2}{\pi\times(0.04)^2}=\frac{25}{4} \qquad \text{......(i)}$$



According to Bernoulli's equation for horizontal tube,

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

$$i.e., \quad v_2^2-v_1^2=\frac{2(P_1-P_2)}{\rho}$$

$$i.e., \quad v_2^2-v_1^2=\frac{(2\times 10)}{(1.25\times 10^3)}=16\times 10^{-3} \qquad \text{.....(ii)}$$

Substituting the value of v_2 from equation (i) in (ii)

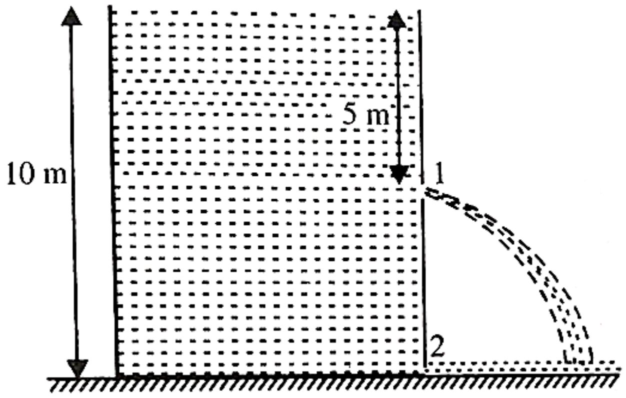
$(6.25v_1)^2-v_1^2=16\times 10^{-3}$, $\quad i.e., \; v_1=0.02\text{ m/s}$

So rate of flow through the tube

$$= A_1v_1\ (=A_2v_2)=\pi\times(0.1)^2\times 0.02$$

$$= 6.28\times 10^{-4}\text{ m}^3/\text{s}$$

27

(d) : 

Velocity with which water comes out at orifice 1,

$$v_1 = \sqrt{2g \times 5}$$

Velocity with which water comes out at orifice 2,

$$v_2 = \sqrt{2g \times 10}$$

$$\therefore \quad \frac{v_1}{v_2} = \sqrt{\frac{2g \times 5}{2g \times 10}} = \frac{1}{\sqrt{2}}$$

28

(a) : The required change in surface energy

$$= [4\pi(r + \Delta r)^2 - 4\pi r^2]S$$
$$= [4\pi(\Delta r)^2 + 8\pi r \Delta r]S$$

If we take Δr to be small, $(\Delta r)^2$ is still smaller and can be neglected.

Thus increase in surface energy $= 8\pi r \Delta r S$

29

(d) Reading of the spring balance

= Apparent weight of the block

= Actual weight – upthrust

$$= 12 - V_{in}\sigma g$$

$$= 12 - 500 \times 10^{-6} \times 10^3 \times 10 = 12 - 5 = 7N.$$

NB. Half-submerged volume $= 500\ \text{cm}^3 = 5 \times 10^{-4}\ \text{m}^3$.

30

(c) $P_1 = P_2 \Rightarrow \frac{F_1}{A_1} = \frac{F_2}{A_2} \Rightarrow \frac{10^7}{10^2} = \frac{2000 \times 10^3 \times 10^3}{A_2}$

$\therefore A_2 = 2 \times 10^4 cm^2 \qquad (g = 980 \approx 10^3 cm/s^2)$

OR

$$P = \frac{F_1}{A_1} = \frac{F_2}{A_2}.$$

	$F_1 = 10^7$ dyn $= 100\text{ N}, A_1 = 100\text{ cm}^2 = 0.01\text{ m}^2 \Rightarrow P = 10^4\text{ Pa}.$ $F_2 = 2000g \approx 1.96 \times 10^4\text{ N} \Rightarrow A_2 = \frac{F_2}{P} \approx 1.96\text{ m}^2 = 1.96 \times 10^4\text{ cm}^2.$ → (c) $2 \times 10^4\text{ cm}^2$
31	(d) Relative density of solid $= \frac{\text{weight in air}}{\text{weight in air} - \text{weight in water}}$ $\therefore$ Relative density of solid $= \frac{120}{120-80} = \frac{120}{40} = 3$ Relative density of liquid $= \frac{\text{weight in air} - \text{weight in liquid}}{\text{weight in air} - \text{weight in water}}$ $\therefore$ Relative density of liquid $= \frac{120-60}{120-80} = \frac{60}{40} = \frac{3}{2}.$
32	(a) Volume of log of wood $V = \frac{\text{mass}}{\text{density}} = \frac{120}{600} = 0.2\ m^3$ Let x weight that can be put on the log of wood. So weight of the body $= (120 + x) \times 10\ N$ Weight of displaced liquid $= V\sigma g = 0.2 \times 10^3 \times 10\ N$ The body will just sink in liquid if the weight of the body will be equal to the weight of displaced liquid. $\therefore\ (120 + x) \times 10 = 0.2 \times 10^3 \times 10$ $\Rightarrow 120 + x = 200\ \therefore\ x = 80\ kg.$
33	(c) Here, mass of block, $m = 1kg$ Volume of a block, $V = 3.6 \times 10^{-4} m^3$ Tension in the string, $T = mg = mg - V\rho_{water} g$ $\therefore$ Decrease in the tension of string $= T - T'$ $= mg - [mg - V\rho_{water} g] = V\rho_{water} g$ $= (3.6 \times 10^{-4} m^3) \times (10^3 kgm^{-3}) \times (10ms^{-2}) = 3.6\ N.$

34	**(c)** : Using Bernoulli's equation, $P_1 + \frac{1}{2}\rho v_1^2 = P_2 + \frac{1}{2}\rho v_2^2$ ...(i) where ρ is the density of liquid, v its velocity, P its pressure and subscripts 1 and 2 refer to two points. Also $A_1 v_1 = A_2 v_2$ by equation of continuity ...(ii) $P_1 - P_2 = \rho g \times 4.9$ ...(iii) From (i) and (iii), we get $v_2^2 - v_1^2 = \frac{2(P_1 - P_2)}{\rho} = \frac{2\rho g \times 4.9}{\rho} = (2g) \times 4.9$ $= 2 \times 980 \times 4.9$ $v_2^2 - v_1^2 = 98^2 \text{ cm}^2/\text{sec}^2$ ...(iv) Using (ii), $\frac{v_1}{v_2} = \frac{A_2}{A_1} = \frac{\pi \times 0.4^2}{\pi \times 1^2} = 0.16$ Substituting, $v_1^2 = 0.16^2 \times v_2^2$ in (iv), we get $v_2^2[1 - (0.16)^2] = 98^2$ $v_2 = \sqrt{\frac{98^2}{0.9744}}$ Quantity of water flowing $= A_1 v_1 = A_2 v_2 = \pi \times 0.4^2 \times \sqrt{\frac{98^2}{0.9744}} = 50$ c.c per sec
35	**(b)** : The terminal velocity of the body of radius r, density ρ falling through a medium of density σ is given by $v = \frac{2}{9}\frac{r^2(\rho - \sigma)g}{\eta}$ where η is the coefficient of viscosity of the medium $\therefore \quad v_{B_1} = \frac{2}{9}\frac{r_{B_1}^2}{\eta_{\text{water}}}(\rho_{B_1} - \sigma_{\text{water}})g$ ...(i) and $\quad v_{B_2} = \frac{2}{9}\frac{r_{B_2}^2}{\eta_{\text{liquid}}}(\rho_{B_2} - \sigma_{\text{liquid}})g$ ...(ii) where the subscripts B_1 and B_2 represent metal ball B_1 and metal ball B_2 respectively.

$\because \quad r_{B_1} = r_{B_2}$ and $v_{B_1} = v_{B_2}$ (Given)

Substituting these values in (i) and (ii), we get

$$\frac{\eta_{\text{water}}}{\eta_{\text{liquid}}} = \frac{(\rho_{B_1} - \sigma_{\text{water}})}{(\rho_{B_2} - \sigma_{\text{liquid}})}$$

Substituting the given values, we get

$$\frac{\eta_{\text{water}}}{\eta_{\text{liquid}}} = \frac{(3.2-1)}{(6.0-1.6)} \quad (\because \text{ Density of water} = 1 \text{ g cm}^{-3})$$

$$= \frac{2.2}{4.4} = 0.5$$

36

(a) : Let a and b be the radii of two soap bubbles before coalescing and c be the radius of bigger bubble.

$$\therefore \quad P_a = P_0 + \frac{4T}{a}, \quad V_a = \frac{4}{3}\pi a^3$$

$$P_b = P_0 + \frac{4T}{b}, \quad V_b = \frac{4}{3}\pi b^3$$

$$P_c = P_0 + \frac{4T}{c}, \quad V_c = \frac{4}{3}\pi c^3$$

where P_0 is the atmospheric pressure.

Now, as mass is conserved,

$$n_a + n_b = n_c$$

$$\frac{P_a V_a}{RT_a} + \frac{P_b V_b}{RT_b} = \frac{P_c V_c}{RT_c}$$

At constant temperature,

$$P_a V_a + P_b V_b = P_c V_c$$

$$\left(P_0 + \frac{4T}{a}\right)\left(\frac{4}{3}\pi a^3\right) + \left(P_0 + \frac{4T}{b}\right)\left(\frac{4}{3}\pi b^3\right) = \left(P_0 + \frac{4T}{c}\right)\left(\frac{4}{3}\pi c^3\right)$$

$$4T\left(a^2 + b^2 - c^2\right) = P_0\left(c^3 - a^3 - b^3\right)$$

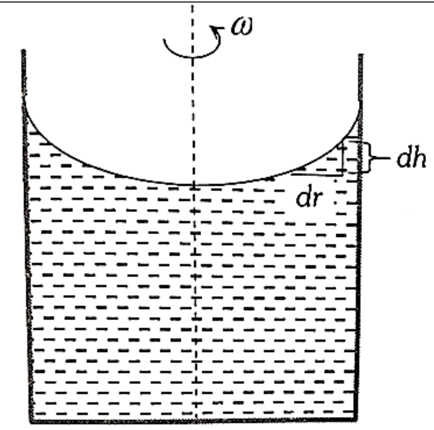
$$\frac{4}{3}T4\pi\left(a^2 + b^2 - c^2\right) = P_0\frac{4}{3}\pi\left(c^3 - a^3 - b^3\right)$$

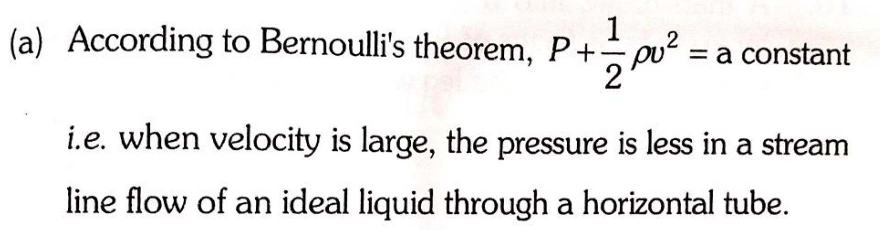
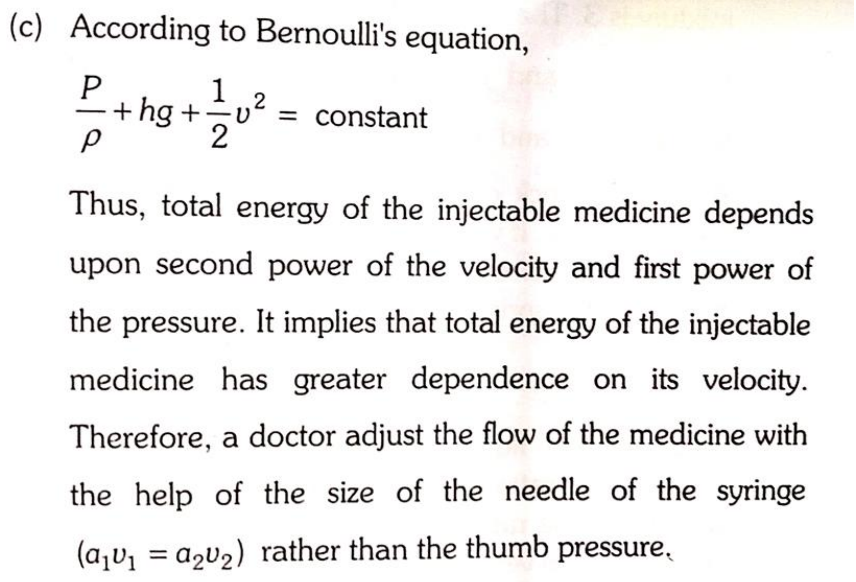
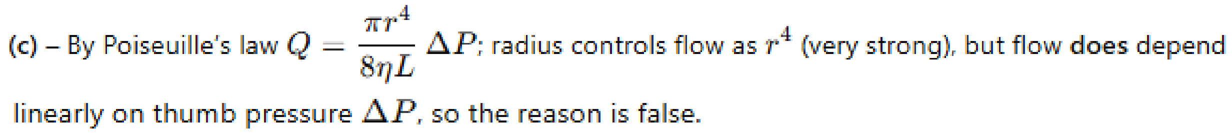
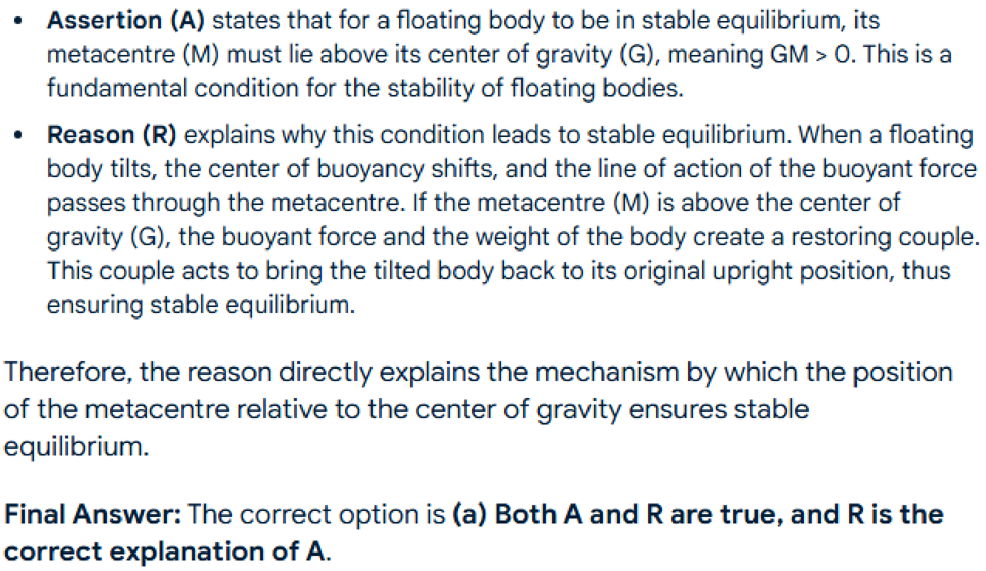
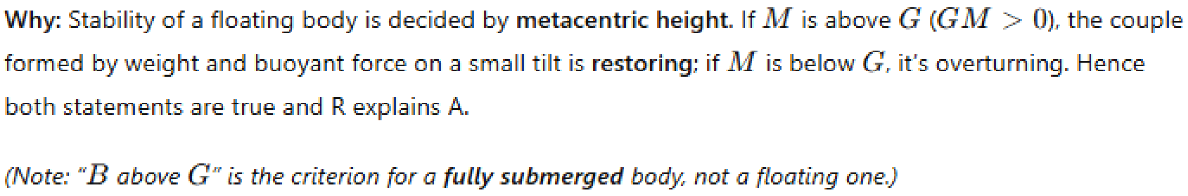
$$\frac{4T}{3}S = -P_0 V$$

$$4ST + 3P_0 V = 0$$

OR

	Let R_1 and R_2 are the radii of soap, bubbles before and after collapsing. Then given that $V = 2\left(\frac{4}{3}\pi R_1^3\right) - \frac{4}{3}\pi R_2^3$ ...(i) $S = 2(8\pi R_1^2) - 8\pi R_2^2$ ...(ii) $P_1V_1 = P_2V_2$ $\therefore \left(P_0 + \frac{4T}{R_1}\right)\left(2 \times \frac{4}{3}\pi R_1^3\right) = \left(p_0 + \frac{4T}{R_2}\right)\left(\frac{4}{3}\pi R_2^3\right)$ ...(iii) Solving these three equation we get the desired result.
37	Velocity of liquid through orifice, $\upsilon = \sqrt{2gy}$ and time taken by liquid to reach the ground $t = \sqrt{\frac{2(h+h-y)}{g}} = \sqrt{\frac{2(2h-y)}{g}}$ $\therefore$ Horizontal distance covered by liquid $x = \upsilon.t. = \sqrt{2gy} \times \sqrt{\frac{2(2h-y)}{g}} = \sqrt{4y(2h-y)}$ $\Rightarrow x^2 = 4y(2h-y)$ $\Rightarrow \frac{d(x)^2}{dy} = 8h - 8y$ for x to be maximum, $\frac{d}{dy}(x^2) = 0$ $\therefore 8h - 8y = 0$ or $h = y$ So $x_m = \sqrt{4h(2h-h)} = 2h$ **So, from the options:** (a) **True**; (b), (c), (d) **False.**

38	(c)  $\rho dr\,\omega^2 r = \rho g\,dh$ $\omega^2 \int_0^R r\,dr = g\int_0^h dh$ $\frac{\omega^2 R^2}{2} = gh$ $h = \frac{\omega^2 R^2}{2g} = \frac{25\,\omega^2}{2g}$.
39	(a) Since, the fluid move from higher pressure to lower pressure and in a fluid, the pressure increase with increase of depth. Hence, the pressure p_0 will be lesser at the top than that at the bottom $(p_0 + h\rho g)$ So, the air bubble moves from the bottom to the top and does not move sideways, since the pressure is same at the same level. Further in coming from bottom to top the pressure decreases. According to Boyle's law $pV =$ constant. Therefore, if pressure decreases the volume increases, it means radius increases. **Assertion is true:** A bubble does rise from the bottom of a lake to the top due to the pressure difference between the water at depth and the surface. **Reason is true:** As the bubble rises, the pressure on it decreases, causing its volume to increase, which in turn means its radius increases. **Relationship:** The reason directly explains the assertion because the pressure decrease is the key factor causing the bubble to rise and increase in size.

40	 (a) According to Bernoulli's theorem, $P+\frac{1}{2}\rho v^2$ = a constant *i.e.* when velocity is large, the pressure is less in a stream line flow of an ideal liquid through a horizontal tube.
41	 (c) According to Bernoulli's equation, $\frac{P}{\rho}+hg+\frac{1}{2}v^2$ = constant Thus, total energy of the injectable medicine depends upon second power of the velocity and first power of the pressure. It implies that total energy of the injectable medicine has greater dependence on its velocity. Therefore, a doctor adjust the flow of the medicine with the help of the size of the needle of the syringe $(a_1v_1 = a_2v_2)$ rather than the thumb pressure. OR  **(c)** – By Poiseuille's law $Q=\frac{\pi r^4}{8\eta L}\Delta P$; radius controls flow as r^4 (very strong), but flow **does** depend linearly on thumb pressure ΔP, so the reason is false.
42	 - **Assertion (A)** states that for a floating body to be in stable equilibrium, its metacentre (M) must lie above its center of gravity (G), meaning GM > 0. This is a fundamental condition for the stability of floating bodies. - **Reason (R)** explains why this condition leads to stable equilibrium. When a floating body tilts, the center of buoyancy shifts, and the line of action of the buoyant force passes through the metacentre. If the metacentre (M) is above the center of gravity (G), the buoyant force and the weight of the body create a restoring couple. This couple acts to bring the tilted body back to its original upright position, thus ensuring stable equilibrium. Therefore, the reason directly explains the mechanism by which the position of the metacentre relative to the center of gravity ensures stable equilibrium. **Final Answer:** The correct option is **(a) Both A and R are true, and R is the correct explanation of A**.  **Why:** Stability of a floating body is decided by **metacentric height**. If M is above G ($GM > 0$), the couple formed by weight and buoyant force on a small tilt is **restoring**; if M is below G, it's overturning. Hence both statements are true and R explains A. *(Note: "B above G" is the criterion for a* ***fully submerged*** *body, not a floating one.)*

43	**(c)** Kinetic energy is $\frac{1}{2}mv^2$ $\therefore \quad \frac{v^2}{2g} = \frac{\left(\frac{1}{2}mv^2\right)}{(mg)}$ is energy per unit weight. $\frac{\rho v^2}{2} = \frac{\left(\frac{1}{2}mv^2\right)}{(m/\rho)}$ is energy per unit volume and $\frac{v^2}{2} = \frac{\frac{1}{2}mv^2}{m}$ is energy per unit mass. **Answer: (c) i–q, ii–r, iii–p** • (i) $\frac{v^2}{2g} + \frac{p}{\rho g} + z = \text{const}$ → terms are "heads"; units are **length** → **total energy per unit weight (q)**. • (ii) $\frac{\rho v^2}{2} + p + \rho g z = \text{const}$ → units are **pressure (N m^{-2})** → **per unit volume (r)**. • (iii) $\frac{v^2}{2} + \frac{p}{\rho} + gz = \text{const}$ → units are **J kg^{-1}** → **per unit mass (p)**.
44	**(a)** Initial pressure at the bottom $= \rho g \times 2H + 2\rho \times g \times H$ $= 4\rho g H$ Base area of lower zone will be double of upper zone. Final density of the homogenous mixture: $= \frac{\rho_1 V_1 + \rho_2 V_2}{V_1 + V_2}$ $= \frac{\rho \times A \times 2H + 2\rho \times 2A \times H}{A \times 2H + 2A \times H} = \frac{3}{2}\rho$ Final pressure $= \frac{3}{2}\rho \times g \times 3H = \frac{9}{2}\rho g H$ pressure at $P = \frac{3}{2}\rho \times g \times 2H = 3\rho g H$
45	**Answer: (c) A→q, B→s, C→p, D→r** • A (Pascal's law) → **q:** pressure transmitted equally in a confined fluid. • B (Archimedes' principle) → **s:** upthrust equals weight of displaced fluid. • C (Capillarity) → **p:** rise/fall in narrow tubes due to adhesion–cohesion. • D (Turbulent flow) → **r:** irregular, eddy-filled motion beyond critical condition.
46	Moving down the group, stability of lower oxidation state increases, so the order will be Al < Ga < In < Tl. **Explanation:** The **+1 oxidation state** becomes more **stable** as we move **down** the group in Group 13 due to the

inert pair effect.

Inert Pair Effect:

- The reluctance of the **s-electrons** (in the outermost shell) to participate in bonding as atomic size increases.
- This effect becomes stronger down the group, making the **+1 oxidation state more stable** for **heavier elements** like **Tl**.

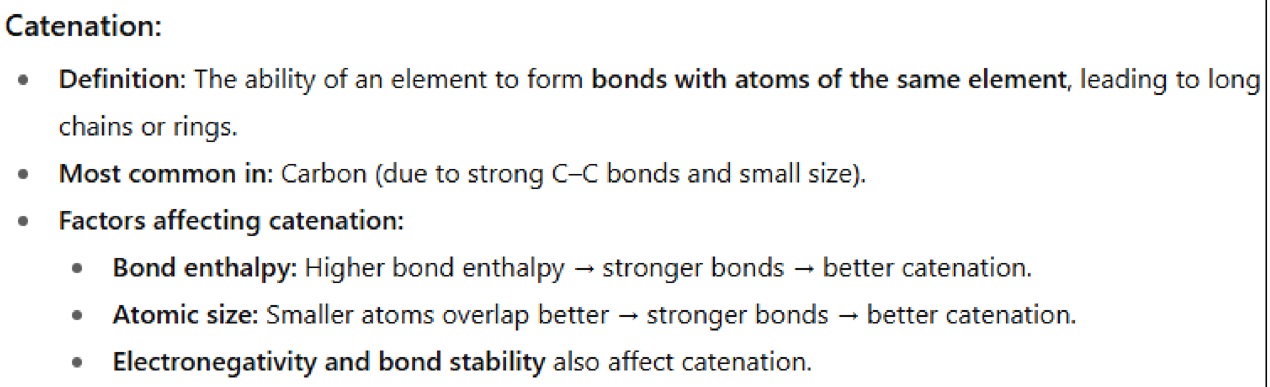
Stability trend in +1 oxidation state:

- **Al**: Least stable in +1 (prefers +3)
- **Ga**: Slightly more stable in +1 than Al
- **In**: Even more stable
- **Tl**: **Most stable** in +1

Final Answer: **a) Al < Ga < In < Tl**

47

The correct order of **bond enthalpy** (bond strength) for the given elements is:



Catenation:

- **Definition:** The ability of an element to form **bonds with atoms of the same element**, leading to long chains or rings.
- **Most common in:** Carbon (due to strong C–C bonds and small size).
- **Factors affecting catenation:**
  - **Bond enthalpy:** Higher bond enthalpy → stronger bonds → better catenation.
  - **Atomic size:** Smaller atoms overlap better → stronger bonds → better catenation.
  - **Electronegativity and bond stability** also affect catenation.

Explanation:

- Bond enthalpy generally **decreases down the group** due to increasing atomic size, which results in weaker overlap of atomic orbitals.
- Carbon (C) has the **strongest bond** because it is the smallest atom with the strongest orbital overlap.
- As we move down Group 14 (C → Si → Ge → Sn), bond enthalpy **decreases** in that order.

Correct answer: **a) C – C > Si – Si > Ge – Ge > Sn – Sn**

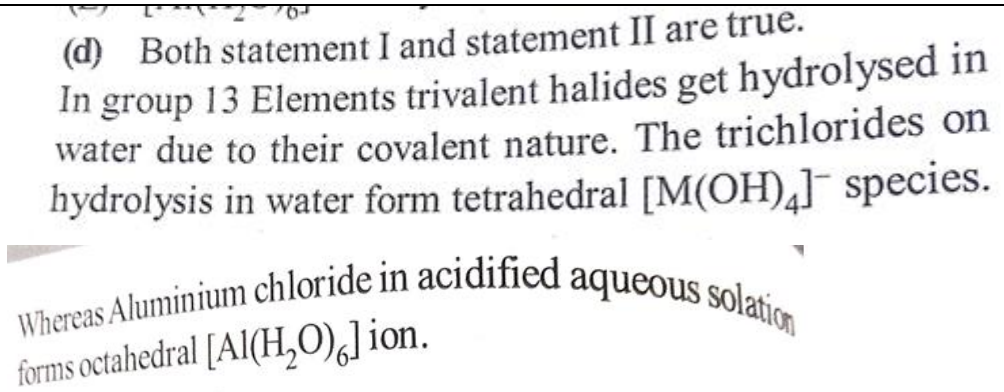
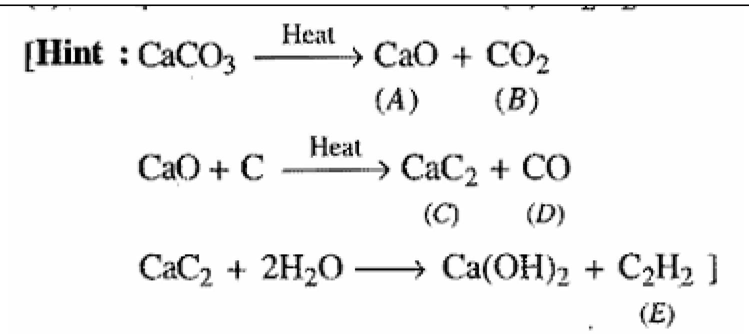
48

The correct answer is: **d) All of the above**

Explanation:

- Bucky ball, or buckminsterfullerene, is an allotrope of carbon.
- It is commonly referred to as C_{60} because it consists of 60 carbon atoms.

The carbon atoms in buckyballs are sp^2 hybridized, and the structure resembles a soccer ball, made up of hexagons and pentagons.

49	 **(d)** Both statement I and statement II are true. In group 13 Elements trivalent halides get hydrolysed in water due to their covalent nature. The trichlorides on hydrolysis in water form tetrahedral $[M(OH)_4]^-$ species. Whereas Aluminium chloride in acidified aqueous solation forms octahedral $[Al(H_2O)_6]$ ion.
50	 **[Hint :** $\underset{}{CaCO_3} \xrightarrow{\text{Heat}} \underset{(A)}{CaO} + \underset{(B)}{CO_2}$ $CaO + C \xrightarrow{\text{Heat}} \underset{(C)}{CaC_2} + \underset{(D)}{CO}$ $CaC_2 + 2H_2O \longrightarrow Ca(OH)_2 + \underset{(E)}{C_2H_2}$]
51	Due to the inert pair effect, stability of lower oxidation state, i.e +1 increases down the group. Group 13 elements: B, Al, Ga, In, Tl - The **monohalides** are in the **+1 oxidation state**. - The **trihalides** are in the **+3 oxidation state**. What happens down the group? - **Boron** monohalides are generally **unstable** because B prefers +3 oxidation state. - As we move **down the group**, the **stability of monohalides increases** due to the **inert pair effect**. - The inert pair effect makes the +1 oxidation state (monohalide) more stable in **heavier elements** like **In and Tl**. - So, **Tl(I) halides are more stable than Tl(III)**, and monohalides become more stable than trihalides for Tl. Hence: - The **stability of monohalides increases down the group**. Therefore, the correct answer is: **a) Increases down the group.** Summary: - Monohalides of B and Al are less stable. - Stability improves as we go from Ga → In → Tl due to inert pair effect. So monohalide stability **increases down the group**.
52	Explanation: - **$AlCl_3$** is known to be **covalent** in nature because aluminum chloride forms a **dimer** (Al_2Cl_6) in the solid and vapor phase, showing covalent bonding.

	- Aluminum has a small size and a relatively high charge density, leading to **polarization** of the chloride ions and formation of covalent bonds. Other options: - **a) $Al_2(SO_4)_3$**: Ionic compound (aluminum sulfate) – ionic bonds between Al^{3+} and SO_4^{2-} ions. - **b) Al_2O_3**: Mostly **ionic** with some covalent character, but predominantly ionic. - **d) AlF_3**: More ionic than covalent because F^- is highly electronegative and less polarizable. So: - **$AlCl_3$** is the best example of a **covalent compound** among the given choices. Final answer: **c) $AlCl_3$**
53	Explanation: - **Carbon** shows **tetravalency** because it forms **four sigma bonds**. - This happens due to **sp^3 hybridization**, where one 2s and three 2p orbitals mix to form **four equivalent sp^3 hybrid orbitals**. - Each sp^3 hybrid orbital forms a sigma bond, explaining carbon's tetravalency (as in methane, CH_4). Other options: - **sp^2 hybridization:** Carbon forms three sigma bonds and one pi bond (trivalent, e.g., ethene). - **dsp^2 hybridization:** Not applicable to carbon; used for some transition metals. - **All of these:** Not correct because tetravalency specifically arises from sp^3 hybridization. Final answer: **a) sp^3 hybridisation**
54	Explanation: - **Diamond:** Each carbon atom forms **4 sigma bonds** in a tetrahedral arrangement → **sp^3 hybridization**. - **Graphite:** Each carbon atom forms **3 sigma bonds** in a planar hexagonal lattice and has one unhybridized p orbital → **sp^2 hybridization**. Final answer: **b) sp^3, sp^2**
55	Explanation: - **A. Inorganic benzene** Inorganic benzene is **$B_3N_3H_6$ (borazine)**, so A → IV, - **B. Inorganic graphite** Inorganic graphite refers to **Boron Nitride (BN)** which is isoelectronic and structurally similar to graphite, so B → III. - **C. Jeweller's borax** Borax is sodium borate, formula $Na_2B_4O_7 \cdot 5H_2O$, so C → V. - **D. Alum** Alum acts as a mordant in dyeing, so D → II. - **E. Lubricating agent** Graphite is commonly used as a lubricant, so E → VI.

- **F. An abrasive**
  Diamond is widely used as an abrasive, so F → I.

Corresponding option: **d) A – IV, B – III, C – V, D – II, E – VI, F – I**

56 Graphite and BN (boron nitride) have layer structures.

Explanation:

- **Graphite** has a layered **hexagonal structure** with **sp^2 hybridized carbon atoms** arranged in sheets.
- **BN (Boron Nitride)** in its **hexagonal form (h-BN)** has a structure **very similar to graphite**:
  - It consists of **hexagonal layers**.
  - **Boron and nitrogen atoms** alternate in the lattice.
  - Just like graphite, the layers are held together by weak **van der Waals forces**.
  - BN is often referred to as **"inorganic graphite"** because of this resemblance.

Other options:

- **a) B_4C (Boron carbide)**:
  Has a hard, covalent crystal structure, **not similar to graphite**.
- **b) B_2H_6 (Diborane)**:
  Has a **bridge hydrogen structure**, **not similar to graphite**.
- **d) B (Boron)**:
  Has a **complex icosahedral** structure, **not layered like graphite**.

Final Answer: **c) BN**

57 Explanation:

In **orthoboric acid (H_3BO_3)**:

- The central **boron atom** is bonded to **three –OH groups**.
- Boron forms **three σ bonds** with oxygen atoms.
- There are **no lone pairs** on boron.
- This gives boron a **trigonal planar geometry**, which corresponds to **sp^2 hybridization**.

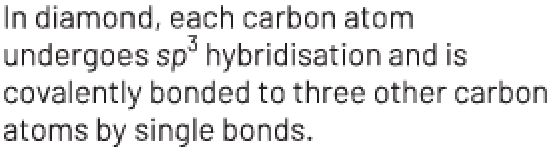
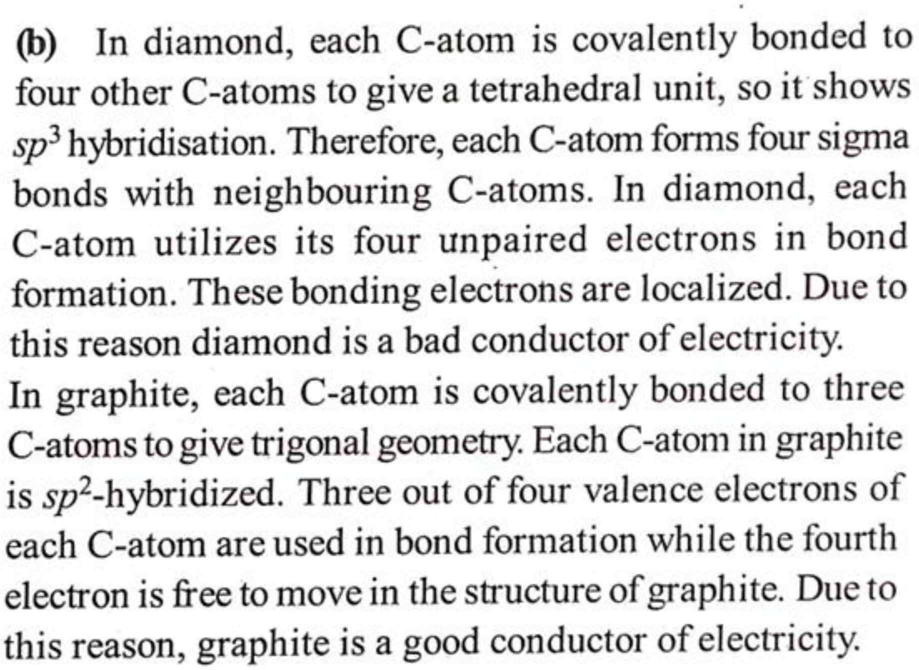
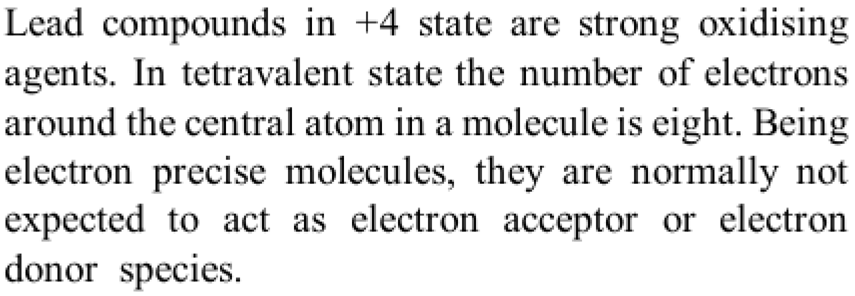
Final Answer: **b) sp^2**

58 Explanation:

- **C_{60} (Buckminsterfullerene or Buckyball)** is a molecule made entirely of **60 carbon atoms** arranged in a **spherical structure** composed of **20 hexagons and 12 pentagons**, like a soccer ball.
- Although C_{60} has **conjugated double bonds**, it is **not considered fully aromatic** because:
  - Not all double bonds are delocalized over the entire structure.
  - It **does not obey Hückel's rule** globally.
  - The delocalization is **localized to sections**, resembling **conjugated alkenes** rather than a fully aromatic system.

Why not the other options?

- **b) Graphite units** – Incorrect: C_{60} is not made of stacked graphite-like layers.
- **c) Several aromatic benzene molecules** – Incorrect: It is **not** composed of actual benzene rings.
- **d) Several tetrahedrons** – Incorrect: The geometry is spherical, not tetrahedral.

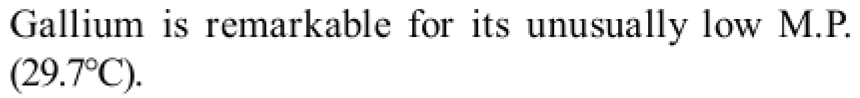
	Final Answer: **a) Several conjugated alkene units rather than an aromatic molecule**
59	 In diamond, each carbon atom undergoes sp^3 hybridisation and is covalently bonded to three other carbon atoms by single bonds.
60	Down the group (↓), M-M bond strength decreases and hence the tendency to undergo catenation also decreases. **Explanation:** **Catenation** is the ability of an element to form **bonds with itself**, creating long chains or structures. The tendency for catenation **decreases down Group 14** due to decreasing **M–M bond enthalpy** (weaker self-bonds) and increasing atomic size. **Catenation tendency order (Group 14):** **C > Si > Ge > Sn > Pb** • **Carbon (C)**: Highest catenation due to strong C–C bonds. **Tin (Sn)**: Has weak Sn–Sn bonds → **least tendency** to form chains.
61	 **(b)** In diamond, each C-atom is covalently bonded to four other C-atoms to give a tetrahedral unit, so it shows sp^3 hybridisation. Therefore, each C-atom forms four sigma bonds with neighbouring C-atoms. In diamond, each C-atom utilizes its four unpaired electrons in bond formation. These bonding electrons are localized. Due to this reason diamond is a bad conductor of electricity. In graphite, each C-atom is covalently bonded to three C-atoms to give trigonal geometry. Each C-atom in graphite is sp^2-hybridized. Three out of four valence electrons of each C-atom are used in bond formation while the fourth electron is free to move in the structure of graphite. Due to this reason, graphite is a good conductor of electricity.
62	 Lead compounds in +4 state are strong oxidising agents. In tetravalent state the number of electrons around the central atom in a molecule is eight. Being electron precise molecules, they are normally not expected to act as electron acceptor or electron donor species. Statement (i):**"The tendency to show +2 oxidation state increases in the sequence Ge < Sn < Pb." True**

	• This is due to the **inert pair effect** — the reluctance of the s-electrons (ns^2) to participate in bonding increases down the group (Group 14).
	• Hence, **Pb** shows +2 oxidation state more readily and stably than **Sn** and **Ge**.
	• So, **+2 state stability increases: Ge < Sn < Pb**
	
	Statement (ii):**"Tin in +2 state is a reducing agent." True**
	
	• **Sn^{2+}** can get **oxidized to Sn^{4+}**, so it **reduces** other species in the process.
	• That means it is a **reducing agent**.
	
	Statement (iii): **"Lead compounds in +2 state are strong oxidising agents." False**
	
	• **Pb^{2+}** is the **more stable oxidation state** of lead (again due to inert pair effect).
	• It **does not easily get oxidized to Pb^{4+}**, so it **cannot act as a strong oxidising agent**.
	• **Pb^{4+} compounds** are actually the **oxidising agents**, as they tend to get **reduced to Pb^{2+}**.
	
	Statement (iv):**"In tetravalent state, molecules of group 13 elements act as electron donor species." False**
	
	• **Group 13 elements** (like B, Al, Ga) typically form **trivalent compounds** (e.g., BF_3, $AlCl_3$), which are **electron-deficient** and act as **Lewis acids (electron acceptors)**.
	• Even in **+3 state**, they have **only 6 valence electrons**.
	• There is **no common +4 oxidation state** for group 13 elements.
	• So, this statement is **factually incorrect** on two counts:
	  ○ Group 13 elements don't commonly show +4 oxidation state.
	  ○ Even in high valence states, they **accept** electrons, not donate.
	
	Correct Option: **b) T T F F**

63	Explanation: **Why CO_2 is used in fire extinguishers:** • **Carbon dioxide is non-combustible**, meaning it **does not catch fire**. • It also **does not support combustion** — it **displaces oxygen**, which is essential for fire to continue. • When released, CO_2 forms a **blanket over the fire**, cutting off the **oxygen supply** and **suffocating the flames**. Why the other options are incorrect: • **a) High critical temperature** → Not related to extinguishing fire. • **b) Dry ice (solid CO_2)** → Useful in cooling, but not directly relevant to fire extinguishing. • **d) Colourless gas** → True, but not the reason it extinguishes fire. Final Answer: **c) It is neither combustible nor a supporter of combustion**
64	Explanation: When **aluminum (Al)** is added to **aqueous potassium hydroxide (KOH)**, a **redox reaction** occurs:

	$2Al + 2KOH + 6H_2O \rightarrow 2K[Al(OH)_4] + 3H_2 \uparrow$ • **Aluminum reacts with KOH and water** to form **potassium tetrahydroxoaluminate** $(K[Al(OH)_4])$ • And **hydrogen gas (H_2)** is evolved. Why the other options are incorrect: • **a) No action takes place** → Reaction **does occur** • **b) Oxygen gas is evolved** → No oxygen gas is formed, it's **hydrogen** • **c) Water is produced** → Water is **used**, not produced Final Answer: **d) Hydrogen gas is evolved**
65	Explanation: • When **carbon** is burned in **excess oxygen**, it forms **carbon dioxide (CO_2)**: $C + O_2 \rightarrow CO_2$ • When there is a **limited supply of oxygen (or air)**, **incomplete combustion** occurs, and **carbon monoxide (CO)** is formed: $2C + O_2 \rightarrow 2CO$ • In **absence of oxygen**, carbon does not burn. • **Moist air** doesn't specifically cause CO formation. Final Answer: **c) Limited supply of air or oxygen**
66	Due to maximum compatibility in size of orbitals involved in C – C bond (i.e 2p-2p overlap), it is maximum stable and hence maximum energy.
67	Let's analyze each: • **Carbon (A):** It is a **non-metal** → matches with **q** • **Lead (B):** It is a **metal** → matches with **p** • **Germanium (C):** It is a **metalloid** → matches with **r** **Answer: a) A – (q), B – (p), C – (r)**
68	The correct answer is: **a) It has carbon atoms arranged in large planes of rings of strongly bound carbon atoms with weak interplanar bonds** Explanation: Graphite consists of layers of carbon atoms arranged in hexagonal rings where each carbon is strongly bonded to three others in the same plane (sp^2 hybridization). These layers are held together by weak van der Waals forces, allowing them to slide over each other easily, which makes graphite a good solid lubricant. The strong in-plane bonds make it very stable and difficult to melt.
69	Answer is: **b) High refractive index** Explanation: While diamond is extremely hard (a), which makes it durable, its **sparkle and brilliance as a gem** mainly come from its **high refractive index** and strong dispersion of light. This causes the famous "fire" and sparkle that make diamonds so valuable as gemstones..

70	(i) Higher boranes are not flammable. • Higher boranes are flammable because they contain hydrogen and can burn. • So, statement (i) is incorrect. (ii) Boranes are hydrolyzed by water to give orthoboric acid. • Boranes generally hydrolyze to boric acid ($B(OH)_3$), which is sometimes called orthoboric acid. • So, statement (ii) is correct. (iii) Boranes undergo cleavage reactions with Lewis bases to give borane adducts. • Boranes react with Lewis bases to form adducts, but cleavage reactions refer to breaking of borane-borane bonds. • Typically, boranes form adducts with Lewis bases without necessarily undergoing cleavage. • So, statement (iii) is also incorrect if cleavage reaction is emphasized. But if it simply means borane reacts with Lewis bases to form adducts, then it's correct. Summary: • (i) Incorrect • (ii) Correct • (iii) Depending on interpretation, but mostly correct as borane forms adducts with Lewis bases. Answer: • Only statement (i) is incorrect. So, the correct choice is: a) (i) only
71	The correct answer is: **c) CCl4 (carbon tetrachloride)** Explanation: • The **Pyrene** fire extinguisher contains **carbon tetrachloride (CCl4)** as the extinguishing agent. • It was widely used historically because CCl4 effectively stops combustion by displacing oxygen. Other options like CS2 (carbon disulfide), CHCl3 (chloroform), and solid CO2 (dry ice) are not used in Pyrene extinguishers.
72	The correct answer is:**b) Diamond** Explanation: • **Diamond** is a chemically inactive allotrope of carbon because of its very strong covalent bonding and tightly packed tetrahedral structure. • It is extremely stable and does not react easily with most chemicals. Other forms like coal, charcoal, and animal charcoal are more reactive due to impurities and their amorphous structure.

73	Gallium is remarkable for its unusually low M.P. (29.7°C). Explanation: • **Gallium** is a metal that melts just above room temperature (~29.8°C or 85.6°F). • It can be liquid during a hot summer day. • Gallium is used in high-temperature thermometers and other specialized applications because of its low melting point and stability. The correct answer is: **c) Gallium**
74	The correct answer is: **b) Of inert pair effect** Explanation: • **Thallium (Tl)** shows +1 and +3 oxidation states. • The **inert pair effect** is responsible for the stability of the lower oxidation state (+1) in heavier p-block elements like thallium. This effect arises because the s-electrons (the “inert pair”) are less likely to participate in bonding as we move down the group.
75	The correct answer is: **a) 2** Explanation: • The ground state electronic configuration of carbon (atomic number 6) is: $1s^2 2s^2 2p^2$ In the 2p subshell, there are two electrons occupying two separate p orbitals (according to Hund’s rule), so there are **2 unpaired electrons**.

76	Borazole structure and bonding:
	• Borazole has a **planar hexagonal ring** with alternating boron (B) and nitrogen (N) atoms.
	• Each boron and nitrogen atom is bonded to one hydrogen atom.
	• The molecule exhibits aromaticity similar to benzene.
	Bond counting:
	• The ring has **6 B–N bonds**, which are sigma (σ) bonds.
	• Each B and N has a bond with hydrogen: 3 B–H bonds and 3 N–H bonds, all sigma (σ).
	• Total sigma bonds:
	  ○ 6 (B–N) + 3 (B–H) + 3 (N–H) = **12 σ bonds**
	• Pi bonds:
	  ○ The ring has a conjugated π system involving **3 π bonds** delocalized over the ring, analogous to benzene.
	Summary:
	• **12 sigma bonds:** 6 B–N + 3 B–H + 3 N–H
	• **3 pi bonds:** delocalized in the ring
	So, **option (b) 12σ, 3π** is correct.

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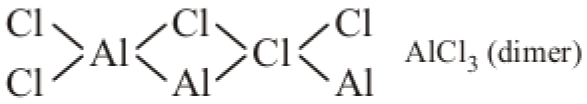
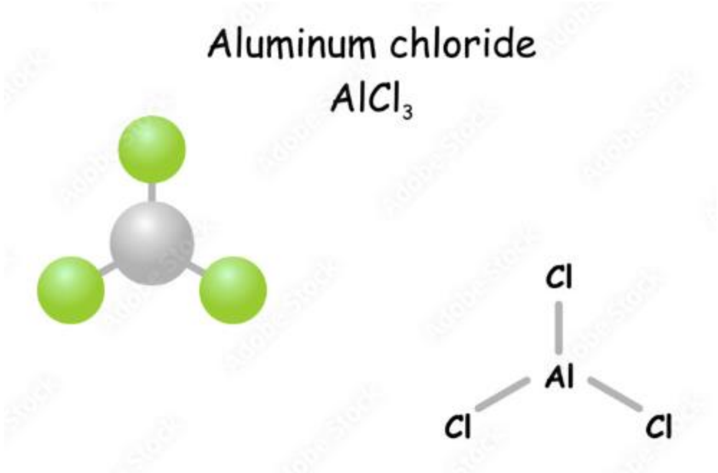




Feature	$AlCl_3$ (Monomer)	Al_2Cl_6 (Dimer)
Chemical formula	$AlCl_3$	Al_2Cl_6
Existence	Exists mostly in the **gas phase** and **high temperature**	Exists in **solid state** and **non-polar solvents**
Structure	**Trigonal planar** (sp^2 hybridisation)	**Dimer with bridged chlorines** (each Al is 4-coordinated)
Bonding	Simple covalent with 3 Al–Cl bonds	Two Al atoms linked by **two bridging Cl atoms**
Stability	Less stable alone at room temperature	More stable in solid and liquid forms
Reason for dimerization	To complete octet of Al atom (Al has only 6 electrons in $AlCl_3$)	Bridging Cl atoms donate lone pairs to satisfy Al's octet

78 **Assertion: Pb^{4+} compounds are stronger oxidizing agents than Sn^{4+} compounds. Correct**

- **Pb^{4+}** is less stable than **Sn^{4+}** due to the **inert pair effect**, so it tends to **get reduced to Pb^{2+}**, making it a **strong oxidizing agent**.
- In contrast, **Sn^{4+}** is relatively more stable and less readily reduced.

Reason: The higher oxidation states for the group 14 elements are more stable for the heavier members of the group due to inert pair effect Incorrect

- The **inert pair effect** causes the **lower oxidation states (like +2)** to become **more stable** as you go **down the group**, **not** the higher ones.
- So, **higher oxidation states (like +4)** are **less stable** for heavier elements like Pb.

Final Answer: **c) Assertion is correct, reason is incorrect.**

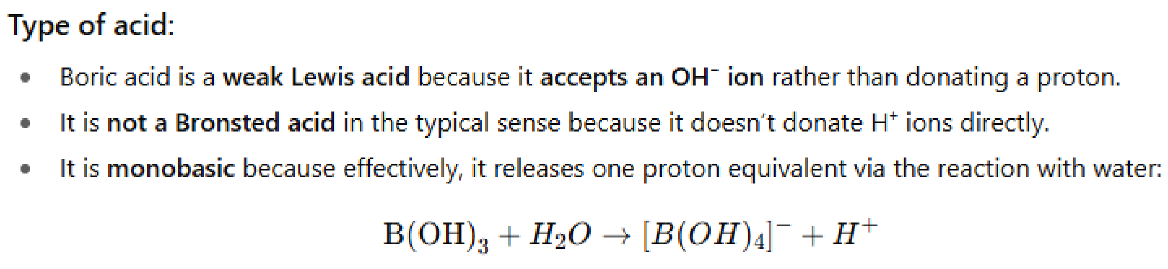
79 Explanation:

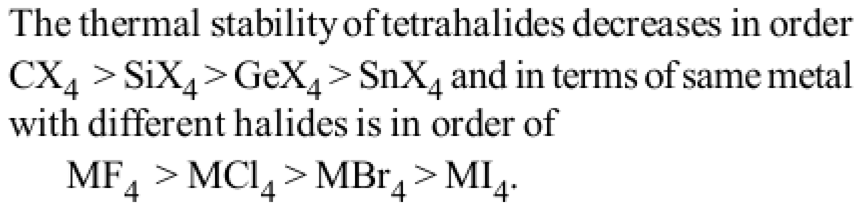
- **Dry ice** is the **solid form of carbon dioxide (CO_2)**.
- It **sublimes** (changes directly from solid to gas) at −78.5 °C under atmospheric pressure.
- Commonly used in refrigeration, fog effects, and preserving biological samples.

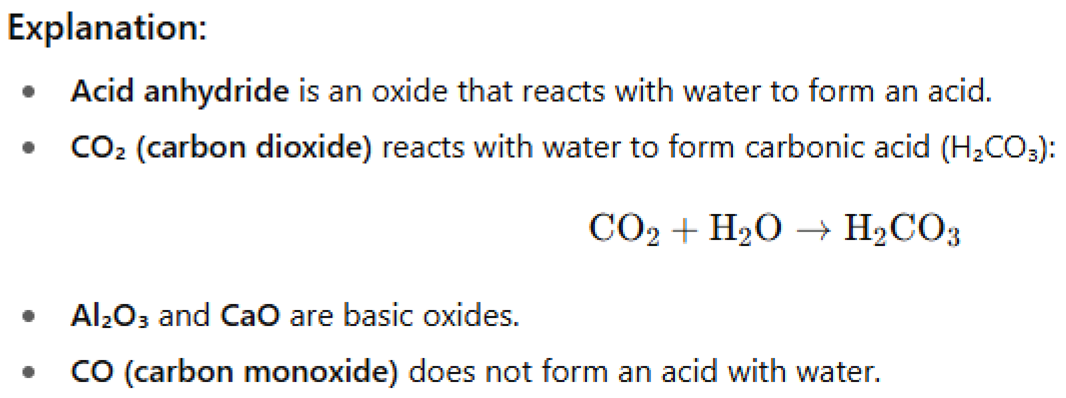
Why others are incorrect:

- **a) Solid BO_2** – Boron dioxide (not related to dry ice)
- **b) Solid BH_3** – Borane is not stable in solid form; it's a gas

	- **c) Solid PbO_2** – Lead dioxide, a completely different compound, used in batteries. Final answer: **d) Solid CO_2**

80	Nature of Boric Acid (H_3BO_3):
	- **Is it tribasic or monobasic?**
	  - Boric acid **does not donate protons (H^+) directly** like typical Bronsted acids.
	  - Instead, it acts as a **Lewis acid** by accepting a pair of electrons from OH^-.
	  - The formula **H_3BO_3** suggests 3 hydrogens, but these hydrogens are part of -OH groups and **not acidic protons** in the usual Bronsted sense.
	  - Therefore, **boric acid is considered monobasic**, meaning it releases only one proton indirectly (by interaction with water).
	
	Type of acid:
	- Boric acid is a **weak Lewis acid** because it **accepts an OH^- ion** rather than donating a proton.
	- It is **not a Bronsted acid** in the typical sense because it doesn't donate H^+ ions directly.
	- It is **monobasic** because effectively, it releases one proton equivalent via the reaction with water:
	$$\mathrm{B(OH)_3} + H_2O \rightarrow [B(OH)_4]^- + H^+$$
	Conclusion:
	- **Boric acid is a monobasic and weak Lewis acid.**
	Correct answer:
	a) Monobasic acid and weak Lewis acid

81	 The thermal stability of tetrahalides decreases in order $CX_4 > SiX_4 > GeX_4 > SnX_4$ and in terms of same metal with different halides is in order of $MF_4 > MCl_4 > MBr_4 > MI_4$. Compounds: - a) **$CCl_4$** (Carbon tetrachloride) - b) **$SiCl_4$** (Silicon tetrachloride) - c) **$GeCl_4$** (Germanium tetrachloride) - d) **$GeBr_4$** (Germanium tetrabromide) Thermal stability considerations: - Thermal stability of tetrahalides generally **increases down the group** because heavier elements form stronger bonds with halogens due to better orbital overlap and less electronegativity difference. - Among Group 14 tetrachlorides (CCl_4, $SiCl_4$, $GeCl_4$), thermal stability **increases** in the order: $$CCl_4 < SiCl_4 < GeCl_4$$ - Bromides are generally **less stable** than chlorides because the M–Br bond is weaker than M–Cl.

	So among these, **$GeBr_4$** is expected to be **least thermally stable** because: • Bromides have weaker bonds compared to chlorides. • Germanium bromide ($GeBr_4$) has weaker Ge–Br bonds compared to Ge–Cl bonds. **Answer: d) $GeBr_4$**
82	Matching: • **Metal borides (A):** Used **as control rods in nuclear industry** because of their neutron absorption properties. So, **A → s** • **Boron fibres (B):** Known for high strength and used in **bullet-proof vests** and aerospace materials. So, **B → q** • **Borax (C):** Commonly used as **flux for soldering metals**. So, **C → p** • **Boric acid (D):** Known for **mild antiseptic** properties. So, **D → r** Correct option: **d) A – (s), B – (q), C – (p), D – (r)**
83	Due to the presence of unpaired electron on each carbon atom in graphite, it behaves as a good conductor of electricity.
84	$H_2CO_3 \rightleftharpoons H_2O + CO_2$ Hence, CO_2 is a true acid anhydride.  **Explanation:** • **Acid anhydride** is an oxide that reacts with water to form an acid. • **CO_2 (carbon dioxide)** reacts with water to form carbonic acid (H_2CO_3): $CO_2 + H_2O \rightarrow H_2CO_3$ • **Al_2O_3** and **CaO** are basic oxides. • **CO (carbon monoxide)** does not form an acid with water. The correct answer is: **c) CO_2**
85	The correct answer is: **a) sp^2** Explanation: • In **fullerene (C_{60})**, each carbon atom is bonded to three other carbons forming a curved network of hexagons and pentagons. • Each carbon atom is **trigonal planar**, with **three sigma bonds** and one delocalized pi bond. This corresponds to **sp^2 hybridization**.

86

CONCEPT:

Properties of Group 13 Elements

- **Atomic Radii**
  - Atomic radii in Group 13 elements increase down the group. The correct order for the given elements is: Tℓ > In > Al > Ga > B.
- **Electronegativity**
  - Electronegativity generally decreases down the group. B > Al < Ga < In < Tℓ

Reactivity with Acids
  - Aluminium reacts with dilute HCl to produce hydrogen gas.
  - Concentrated HNO_3 forms a protective oxide layer on Al, making it passive.
- **Oxidation States**
  - Boron and Aluminium are more stable in the +3 oxidation state, while heavier elements might show stability in +1 oxidation state for specifics not as highly stable.
- **Hybridisation**
  - In $[Al(H_2O)_6]^{3+}$, Al is surrounded by six water molecules, indicating sp^3d^2 hybridisation (octahedral geometry).

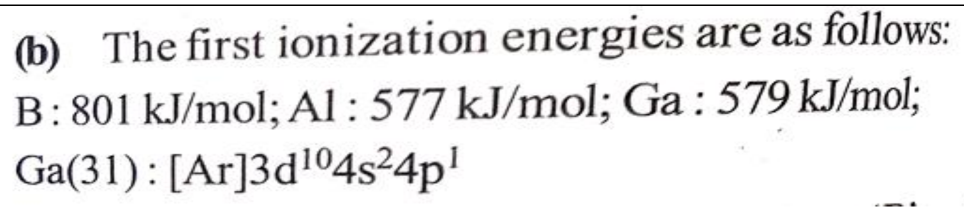
EXPLANATION:

- A. size order Tℓ > In > Al > Ga > B
- B. Electronegativity order B > Al < Ga < In < Tℓ
- D. B, Al are more stable in +3 oxidation state
- So, only C, E statements are correct.

- **E**: The hybridisation of Al in $[Al(H_2O)_6]^{3+}$ is sp^3d^2. **Correct**.

The correct answer is 1) (C) and (E) only.

87



(b) The first ionization energies are as follows:

B : 801 kJ/mol; Al : 577 kJ/mol; Ga : 579 kJ/mol;

Ga(31) : $[Ar]3d^{10}4s^24p^1$

Statement 1: **The decrease in first ionization enthalpy from B to Al is much larger than that from Al to Ga.**

- From **Boron (B) to Aluminum (Al)**, the ionization enthalpy decreases significantly because Al has an extra electron shell, increasing atomic size and decreasing nuclear attraction.
- From **Aluminum (Al) to Gallium (Ga)**, the decrease is smaller because Ga has **completely filled 3d orbitals** which cause poor shielding. This results in a smaller increase in atomic size and less drop in ionization enthalpy.
- So, the **decrease from B to Al is larger than from Al to Ga**.

Statement 1 is correct.

Statement 2: **The d orbitals in Ga are completely filled.**

- Gallium (Ga) has the electronic configuration:

$$[Ar]3d^{10}4s^24p^1$$

- The **3d orbitals are indeed completely filled**.

Statement 2 is correct.

Correct answer: **b) Both the statements 1 and 2 are correct**

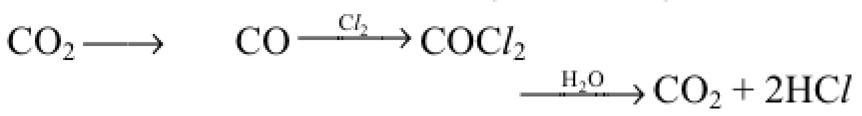
88

Explanation:

- In **graphite**, carbon atoms within each layer are **covalently bonded** forming strong hexagonal sheets.
- The **layers themselves** are held together by weak **van der Waals forces**, so the **interlayer distance** is much larger than the covalent radius.
- The typical **interlayer spacing** in graphite is about **3.35 Å**, which is roughly **4.5 times** the covalent radius of carbon (~0.77 Å).

The correct answer is:**c) Approximately 4½ times the covalent radius of Carbon.**

89



$$CO_2 \longrightarrow \quad CO \xrightarrow{Cl_2} COCl_2 \xrightarrow{H_2O} CO_2 + 2HCl$$

Let's analyze the reaction step-by-step:

1. Red hot coke → CO

Red hot coke (carbon) reacts with limited oxygen to give carbon monoxide (CO).

2. $CO + Cl_2 \rightarrow C + COCl_2$

This step involves the reaction of carbon monoxide with chlorine gas.

- Carbon monoxide (CO) reacts with chlorine to give phosgene ($COCl_2$) and carbon (C).

3. $C + H_2O \rightarrow HCl + A$

This step involves carbon reacting with water, producing HCl and compound A.

Now, let's identify the compounds:

- From the second step, the compound formed along with C is $COCl_2$ (phosgene).
- In the last step, carbon (C) reacts with water (steam), but typically carbon reacts with steam to give CO and H_2 (water gas). Here, HCl is produced, indicating the presence of chlorine.

So the compound A is likely CO_2 (carbon dioxide), as the reaction of carbon or carbon-containing species with water and chlorine leads to the formation of HCl and CO_2.

Hence, the correct answer is: a) CO_2, $COCl_2$

90

a) Graphite can act as electron donor or electron acceptor toward atoms and ions that penetrate

	between the layers. • This is true. Graphite's layered structure allows atoms and ions to intercalate (insert) between the layers, and graphite can either donate or accept electrons, forming intercalation compounds. b) The electrical conductivity of graphite is much similar to metals in the direction parallel to planes, but behaves like semiconductor in the direction perpendicular to planes. • This is true. Graphite exhibits high electrical conductivity along the graphene layers (parallel to planes) due to delocalized π-electrons, similar to metals. However, conductivity perpendicular to the layers is much lower, behaving more like a semiconductor or even an insulator because of weak van der Waals forces between layers. c) The oxidation products of graphite with alkaline permanganate support the hexagonal structure of graphite. • This is also true. Oxidation with alkaline permanganate produces graphite oxide or related compounds that still retain the layered hexagonal structure characteristic of graphite, though modified by oxygen functionalities. d) All of the above
91	When $H_2{}^{18}O$ is supplied, the evolved oxygen is $^{18}O_2$, proving O_2 is derived from water.
92	Mesophyll cells (especially palisade cells) in leaves are packed with chloroplasts. Under low light conditions, chloroplasts align parallel to the cell walls to maximize light capture.
93	Oxygen released in photosynthesis originates from water; thus, O_2 carries the ^{18}O label.
94	Light-driven reactions are the photochemical phase; the biosynthetic (“dark”) phase uses ATP and NADPH from light reactions.
95	Glucose (and intermediates) incorporate ^{14}C from CO_2; O_2 arises from water and is unlabeled.
96	(iii) wrong—chl a is blue-green, not red; (iv) wrong—photosynthesis is least in green; peaks are in blue & red.
97	Electrons originate at PS II, pass through ETS to PS I, which then reduces $NADP^+ \rightarrow NADPH$.
98	The action spectrum (rate of photosynthesis) corresponds closely to the absorption spectrum of chlorophyll a—exactly what the figure shows.
99	PS II → acceptor (uphill), through ETS (downhill), PS I excitation (uphill), to $NADP^+$ (downhill).
100	Red light excites P680 in PS II; electron transfer from the primary acceptor through cytochromes is an energy-releasing (downhill) flow.
101	In the Z-scheme, PSII → primary e^- acceptor → ETS → PSI → $NADP^+$ → NADPH; therefore A=PSII, B=e^- acceptor, C=ETS, D=PSI, E=NADPH.
102	PSI works in both cyclic & non-cyclic; PSII only in non-cyclic. Stroma lamellae have PSI only, grana have both. So only (iii) is correct.
103	In cyclic photophosphorylation, the excited e^- from P700 cycles back to P700 via carriers; no NADPH/O_2 formed.
104	Photosynthetic H^+ accumulate in the thylakoid lumen; in mitochondria they accumulate in the intermembrane space—both drive ATP synthase.
105	Answer is b
106	water is split inside, protons pile up in the lumen, and electrons flow through the membrane to power ATP production.
107	Answer is b
108	**PQ** is a lipid-soluble carrier in the thylakoid membrane that ferries e^- from PS II to cyt b_6f and carries H^+ from stroma into the lumen, building the proton gradient. PC carries e^- from cyt b_6f to PS I; Fd and $NADP^+$ act on the stroma side after PS I.
109	Answer is a
110	Dissipation of the proton gradient through ATP synthase releases energy that phosphorylates ADP to ATP.
111	Carboxylation is the crucial step; RuBisCO fixes CO_2 to RuBP yielding two 3-PGA.

112	CO_2 + RuBP (via RuBisCO) → 3-PGA; this is the carboxylation step of the Calvin cycle
113	Initial CO_2 fixation (PEPcase) in mesophyll; final CO_2 fixation (RuBisCO) in bundle sheath; mesophyll lacks RuBisCO
114	Per CO_2 fixed, Calvin cycle uses 3 ATP + 2 NADPH (→ 18 ATP + 12 NADPH per glucose)
115	A–CO_2 fixation; B–sugar formation; C–RuBP re-formation; D–photolysis → O_2
116	The bundle sheath walls are thick and impervious to gaseous exchange with no intercellular spaces.
117	Helianthus (sunflower) = C_3; Sorghum, Maize = C_4 (Kranz anatomy).
118	OAA (C_4) forms by PEP carboxylation in mesophyll (enzyme PEPcase).
119	C_4 ↔ Kranz anatomy; Chl b = accessory pigment; PSII drives water splitting/O_2.
120	If $^{14}CO_2$ first appears in OAA, the plant follows the C_4 pathway
121	Answer is c
122	Engelmann showed the action spectrum using bacteria; locating the "green substance in special bodies (chloroplasts)" was Sachs.
123	Light harvesting ↔ PS I & II; OEC ↔ P680 (PS II); Calvin ↔ C_3; Hatch–Slack ↔ C_4.
124	PEP is 3-carbon, not 2-carbon; PGA = 3C, malate = 4C, RuBP = 5C.
125	Both are true, but the reason (role of thylakoid membranes) doesn't explain why chloroplasts lie along mesophyll cell walls.
126	photophosphorylation makes ATP, not hexose; other pairs are correct.
127	Leaf colour is due to chlorophyll a, chlorophyll b, xanthophylls and carotenoids; the chief pigment is chlorophyll a, not b.
128	Green Sulphur bacteria perform anoxygenic photosynthesis (no O_2 release); *Nostoc, Cycas, Chara* are oxygenic.
129	Splitting of water is tied to PS II; the reason states the products (H^+, e^-, O_2) but doesn't explain the association with PS II.
130	Bundle sheath cells have many (often agranal) chloroplasts where the Calvin cycle operates at high CO_2, reducing photorespiration.
131	Stroma lamellae lack PS II (they have PS I and ATP synthase). Thylakoid membranes do contain pigments and the coupling factor (true).
132	Fixing 6 CO_2 → 1 glucose needs 18 ATP + 12 NADPH.
133	Both statements are true: protons return to stroma via CF_0 of ATP synthase; gradient breakdown releases energy for ATP formation. The reason doesn't specifically explain the CF_0 path, so (b).
134	PQ shuttles electrons from PS II to the Cyt b_6f complex.
135	Both true; they're called biosynthetic because they reduce CO_2 to sugars; the dependence on ATP/NADPH explains "light-independent," not the term "biosynthetic," hence (b).
136	The Calvin cycle occurs in the stroma (stromal matrix).
137	C_3 first product = 3-PGA (3C) → assertion false; C_4 first product = OAA (4C) → reason true.
138	At high irradiance, chlorophylls risk photo-oxidation; carotenoids/accessory pigments also protect by energy dissipation.
139	bundle sheath cells do form one or more layers around the vascular bundles in C_4 plants. This is the defining feature of Kranz anatomy.
140	PS II = P680 (absorbs maximally near 680 nm); PS I = P700.
141	In C4 plants, PEP (3-C) is the primary CO_2 acceptor and is fixed by PEP carboxylase; the reason is true but doesn't explain why PEP is the acceptor.
142	C_4 plants minimize photorespiration, show high photosynthesis at high T°, better water-use & N-use efficiency.
143	Assertion false—PEPcase is in mesophyll; Reason true—mesophyll lack RuBisCO (RuBisCO is in bundle sheath).

144	Light reaction yields ATP, NADPH, O_2; NADH is not formed.
145	C_4 plants concentrate CO_2 at RuBisCO in bundle sheath, effectively eliminating photorespiration; reason correctly explains.
146	Cyclic photophosphorylation uses PS I only; stroma lamellae have PS I only and lack NADP reductase; grana have PS I & PS II.
147	Photorespiration is wasteful—no sugar or ATP formed and ATP is actually consumed; reason explains.
148	The oxygen-evolving complex of PS II contains Mn (with Ca/Cl) essential for water photolysis.
149	Items listed (leaf number/size/age, mesophyll/chloroplasts, chlorophyll amount) are internal (plant) factors, not external; reason is true.
150	Calvin cycle requires CO_2, ATP, NADPH; light & chlorophyll aren't directly required for its reactions.
151	C3 plants show increased photosynthesis at higher CO_2; greenhouse crops (tomato, bell pepper) yield more when CO_2 is enriched—an example, not the mechanism.
152	Bundle-sheath cells have thick walls, no intercellular spaces, and numerous chloroplasts.
153	Tropical species have higher temperature optima; optimum depends on the plant's habitat.
154	RuBP binds with O_2 to form one molecule of phosphoglycerate and one molecule of phosphoglycolate
155	PEP is the primary CO_2 acceptor in mesophyll; RuBisCO is localized to bundle-sheath cells (mesophyll lacks it).
156	Protons accumulate in the thylakoid lumen; flow back to the stroma through ATP synthase to drive ATP formation.
157	Triose phosphate exits the chloroplast to make sucrose in cytosol; it also supports starch formation inside chloroplast.
158	Chemiosmosis involves a proton gradient, not an "electron gradient." $NADP^+$ reduction occurs on the stroma side.
159	Answer is d
160	Plant M drops at high light/temperature (photorespiration) → C3; L maintains higher rates and saturates later → C4 traits.
161	Variegated leaf → chlorophyll needed (II); Moll's →CO_2 essential (I); Ingenhousz →light essential (III); Engelmann →first action spectrum (IV).
162	Wheat (C_3) first stable product 3-PGA; sugarcane (C_4) first stable product oxaloacetate.
163	OEC→ photolysis of water (IV); proton gradient →ATP synthesis (III); pigments absorb specific wavelengths (I); photorespiration favored by high O_2 (II).
164	CO_2 fixes to RuBP giving PGA—the RuBP →PGA step (arrow P).
165	At M (light-saturated), CO_2 limits; at N (low light), light limits.
166	phosphoglycolate is the starting point of photorespiration. It is converted into glycolate, then processed through peroxisomes and mitochondria, eventually releasing CO_2 and forming glycine and serine—but those come later in the pathway.
167	X = photochemical (ATP, NADPH generation); Y = biosynthetic (CO_2 → carbohydrates).
168	Chl a → bright/blue-green (I); Chl b → yellow-green (III); xanthophylls → yellow (II); carotenoids → yellow to yellow-orange (IV).
169	It does not require light directly (can occur in day as long as ATP/NADPH are available).
170	Enzyme has F_0 (membrane channel for protons) and F_1 (stroma-side catalytic head); proton motive force drives conformational changes that synthesize ATP.
171	Assimilatory power" = ATP + NADPH formed in light reactions and used in the Calvin cycle.
172	Correct statements are III (cyclic makes ATP) and IV (O_2 from water).

173	PEPC is a hallmark of C_4/CAM, not required for primary CO_2 fixation in C_3 plants.
174	C_4 plants have Kranz anatomy, tolerate high T & light, lack photorespiration, and show higher productivity.
175	PEP is the primary CO_2 acceptor in C_4 plants; RuBP is the acceptor in C_3 plants.
176	Tropical plants show a higher temperature optimum for photosynthesis than plants adapted to temperate climates.
177	Light reaction yields ATP, NADPH (hydrogen donor) and O_2 (from water). No sugar is formed here.
178	A=F_0, B=thylakoid membrane, C=PSII, D=PSI. H^+ flow through F_0F_1-ATP synthase makes ATP.
179	Grana = stacks of thylakoids (II); Stroma = matrix (IV); Thylakoids = pigment membranes (I); Stroma lamellae = intergranal links (III).
180	Both statements are true: raising ambient CO_2 boosts C_3 photosynthesis; CO_2 compensation point is high in C_3 and low in C_4.