INDIAN NATIONAL JUNIOR SCIENCE OLYMPIAD – 2018
Held on – January 27, 2018

HINTS AND SOLUTIONS

1.	**C**	2.	**D**	3.	**A**	4.	**C**
5.	**D**	6.	**A**	7.	**C**	8.	**B**
9.	**C**	10.	**B**	11.	**C**	12.	**C**
13.	**D**	14.	**C**	15.	**C**	16.	**D**
17.	**B**	18.	**B**	19.	**B**	20.	**A**
21.	**A**	22.	**C**	23.	**B**	24.	**D**
25.	**B**	26.	**A**	27.	**A**	28.	**D**
29.	**C**	30.	**A**				

31. (A) Potential difference $= \dfrac{\text{Energy}}{q(\text{charge})}$

$$q = \frac{E}{Pd} = \frac{2\times 1.6\times 10^{-19}}{1} C$$

$q = 2 \times 1.6 \times 10^{-19}$ C

Divalent anion = M^{2-}

$$n = \left[(x+2) + \frac{(x+2)\times 25}{100}\right]$$

$n = 1.25\ (x+2)$

$p = x$

$n + p = 79$

On solving value of $x = 34$

$\therefore Se^{-2}$

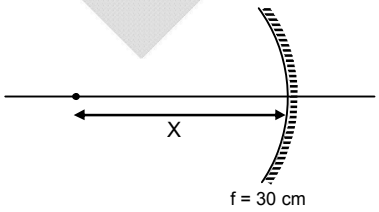
(B) $\underset{(A)}{Ca} + \frac{1}{2}O_2 \longrightarrow \underset{(X)}{CaO}$

$\underset{(X)}{CaO} + H_2O \longrightarrow \underset{(Y)}{Ca(OH)_2}$

$\underset{(Y)}{Ca(OH)_2} + Cl_2 \longrightarrow \underset{(B)}{CaOCl_2} + H_2O$

$\underset{(Z)}{Ca(OH)_2} + H_2SO_4\,(dil) \longrightarrow CaSO_4 \downarrow + 2H_2O$

32.



$$\frac{1}{V} + \frac{1}{U} = \frac{1}{f}$$

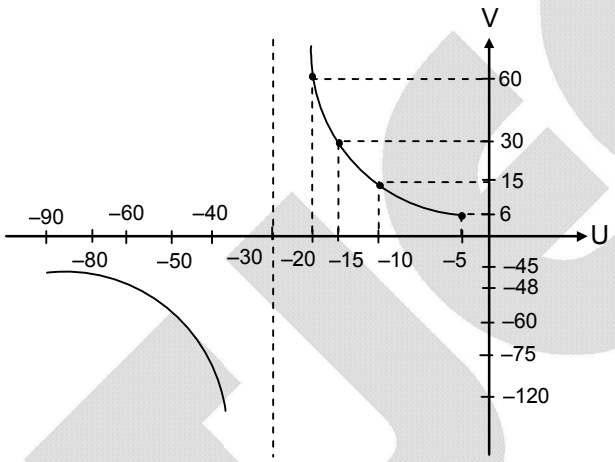
$$\Rightarrow \quad \frac{1}{V} + \frac{1}{-X} = \frac{1}{-30}$$

$$\Rightarrow \quad V = \frac{30X}{30 - X}$$

$U = -X$

	U	V
1.	–5 cm	6 cm

2.	–10 cm	15 cm
3.	–15 cm	30 cm
4.	–20 cm	60 cm
5.	–30 cm	$\pm\infty$
6.	–40 cm	–120 cm
7.	–50 cm	–75 cm
8.	–60 cm	–60 cm
9.	–80 cm	–48 cm
10.	–90 cm	–45 cm



33. (i) As 100 mL glucose solution contain = 5 g glucose

200 mL glucose solution contain = $\frac{5}{100}\times 200 = 10\,g$ i.e. $\frac{10}{180} = \frac{1}{18}$

(ii) $C_6H_{12}O_6 + O_2 \longrightarrow 2CH_3COCOOH + 2H_2O$

$\frac{1}{18}$ moles of glucose gives $\frac{2}{18}$ = $\frac{1}{9}$ moles Pyruvic acid

(iii) $CH_3COCOOH \longrightarrow$ lactic acid [$CH_3CHOHCOOH$]

(1 mole) (1 mole)

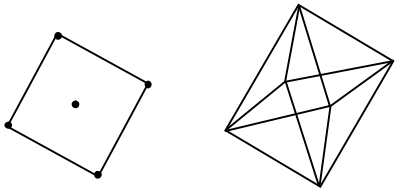
$\frac{1}{9}$ mole $\frac{1}{9}$ mole lactic acid

(iv) $CH_3COCOOH + \frac{5}{2}O_2 \longrightarrow 3CO_2 + 2H_2O$

$\frac{1}{9}$ mole pyruvic acid gives $\frac{3}{9}$ moles CO_2 = $\frac{1}{3}$ moles CO_2

(v) (i) Cytoplasm (ii) Cytoplasm (iii) Mitochondria

34. (i) 4 protons will be on a square of side a and rest 2 protons will be at perpendicular drawn from the centre of square with its distance equal from all four protons equal to the side of square = $r\sqrt{2}$



(ii) $F = \frac{kq^2}{(r\sqrt{2})^2}\frac{1}{\sqrt{2}}(4) + \frac{kq^2}{(2r)^2} = \frac{kq^2}{r^2}\left(\sqrt{2} + \frac{1}{4}\right)$

(iii) $F = \frac{(9\times10^9)(1.6\times10^{-19})^2}{(2.7\times10^{-15})^2}\left(\sqrt{2} + \frac{1}{4}\right)$

= 5.26 × 10 = 52.6 N

(iv) $F_{attr.} = \frac{Gm^2}{r^2}\left(\sqrt{2} + \frac{1}{4}\right) = \frac{\left(6.67\times10^{-11}\right)\left(1.67\times10^{-27}\right)^2}{\left(2.7\times10^{-15}\right)^2}\left(\sqrt{2} + \frac{1}{4}\right)$

$= 4.25\times10^{-35}\text{N}$

(v) $\frac{F_{rep.}}{F_{att}} = \frac{52.6}{4.25\times10^{-35}} = 1.24\times10^{36}$

(vi) Radially outward.

35. (A) = 31.7g Mg

$KClO_3 \longrightarrow KCl + \frac{3}{2}O_2$

$O_2 + 2H_2 \longrightarrow 2H_2O$

$Mg + H_2O \longrightarrow MgO + H_2$

122.5 gm $KClO_3$ = $\frac{3}{2}\times 32\,\text{g of}\,O_2$

90 gm of 60% purity = $90\times\frac{3}{2}\times\frac{32\times60}{122.5\times100} = 0.235\times90 = 21.15$

32 g of O_2 = 2 × 2 g m of H_2

21.15 = $\frac{21.15\times4}{32} = 2.64\,\text{gm}\,H_2$

24 gm of Mg = 2 gm H_2

(31.7. gm of Mg) = 2.64

(B) (i) $A \rightarrow Al$

$B \rightarrow Fe_2O_3$

$C \rightarrow Fe$

$D \rightarrow Al_2O_3$

(ii) $Fe_2O_3 + Al \longrightarrow Al_2O_3 + Fe$

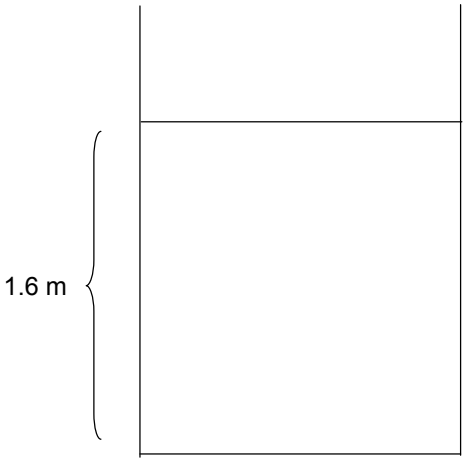
(iii) Amphoteric

(iv) $Al_2O_3 + NaOH \longrightarrow NaAlO_2 + H_2O$

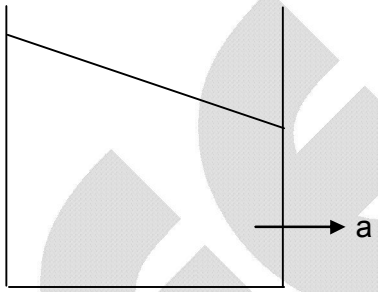
$Al_2O_3 + HCl \longrightarrow AlCl_3 + H_2O$

36. (I) (i) a, b (ii) a, b
(II) d 2/3
(III) (i) 0 (ii) 1

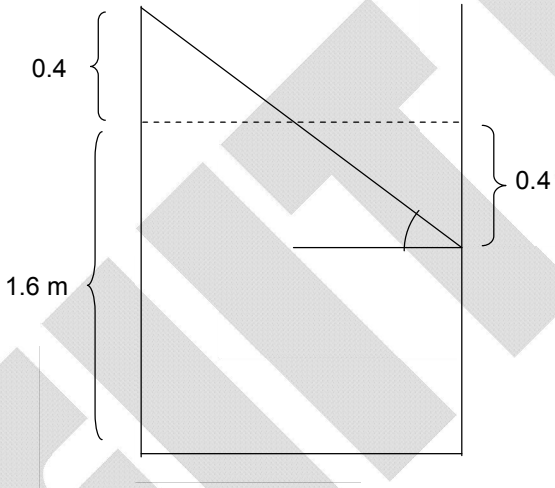
37.



(i) Yes, it will be horizontal
(ii) No, it will NOT be horizontal



(iii) For maximum acceleration



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

$$\Rightarrow \frac{0.8}{3} = \frac{a_{max}}{10} \Rightarrow a_{max} = \frac{8}{3} m/s^2$$

(iv) D
In a direction perpendicular to the free surface of water.

38. (A) (i) $NH_4Cl + Ca(OH)_2 \longrightarrow NH_3 + CaCl_2 + H_2O$

$NH_3 + CuO \longrightarrow N_2 + Cu + H_2O$

(ii) $2NH_4Cl\ soln + Ca[OH]_2 \longrightarrow CaCl_2(s) + 2NH_3(g) + 2H_2O(l)$

($\downarrow$ 100 mL, 10.7%)

$3\underset{23.85\,g}{CuO} + \underset{x\,g}{2NH_3(g)} \longrightarrow 3Cu(s) + N_2(g) + 3H_2O(l)$

$3 \times 79.5\,CuO \longrightarrow 34\,g\,NH_3$

$23.85\,g \longrightarrow \frac{34}{3 \times 79.5} \times 23.85\,g = 3.4\ g\ NH_3$

$34\,g NH_3 \longrightarrow 74\,g Ca(OH)_2$

$3.4\,g NH_3 \longrightarrow 74\,g Ca(OH)_2$

(iii) $3\,CuO \longrightarrow 3\,Cu$

$79.5 \longrightarrow 63.5\,g$

$23.85\,g \longrightarrow \left(\frac{63.5}{79.5} \times 23.85\right) g = 19.05\,g\,Cu$

(B) (i) Oq_3/Oq_5 [O → As, q → Br]
(ii) g[Mn]
(iii) a[K]
(iv) K[Cu]
(v) n, o [As, Ge]
(vi) ℓ [Zn]

39. 1. B 2. C 3. C 4. B 5. C 6. B

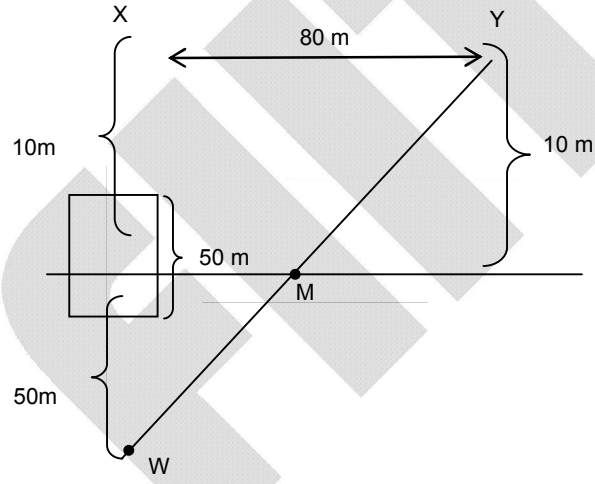
40.

(A) $q\Delta V = \frac{1}{2} m V_e^{\,2} - \frac{1}{2} m V_4^{\,2}$

$q(10) = \frac{1}{2}(0.02)[40]^2 - \frac{1}{2}(0.02)(20)^2$

$\Rightarrow q = \frac{0.01(60)(20)}{10} = 1.2C$

(B)



(i) $900(A)(50)g = (1000)(A)(50-x)g$

$\Rightarrow 9(50) = 10(50-x)$

$\Rightarrow x = 50 - 45 = 5\,m$

(ii) $YM = \sqrt{10^2 + \left(\frac{40}{3}\right)^2} = \frac{50}{3} m.$

$YW = \sqrt{80^2 + 60^2} = 100\,m.$

$t_y - t_x = 0.07$

$\Rightarrow \left[\frac{\frac{250}{3}}{V_w} + \frac{\frac{50}{3}}{V_a}\right] - \left[\frac{5}{V_w} + \frac{50}{V_i} + \frac{5}{V_a}\right] = 0.07$ $\Rightarrow$ [V_w = 1500 m/s, V_a = 350 m/s]

$\Rightarrow \frac{235}{3V_w} + \frac{35}{3V_a} - \frac{50}{V_i} = 0.07$

$\Rightarrow V_i$ = 3214 m/s

(iii) t = 0.103 s
(iv) t = 0.033 s
(v) V_i = 3214 m/s

41. (A) $HCl + Hph \xrightarrow{NaOH\,(1M\ 2\ drop)} Pink$

5 ml
HCl = 3 g/ml
100 drop $\overset{(1M)}{NaOH}$ = 6 ml

2 drop 1 M = $\frac{6}{100} \times 2$

= $\frac{12}{100}$ = 0.12 ml of NaOH

Eq HCl = Eq.NaOH
↓
5 ml × M = 0.12 × 1

$M = \frac{0.12}{5} = 0.024$ mol/L

= 0.024 × 36.5 g/L
= 0.876 g/L

= $\frac{0.876}{1000} \times 5$ g / 5ml = 0.00438 g

(B) (i) $NaOH + H_2O \longrightarrow (NaOH\ solution) \xrightarrow{Dilution} 250$ ml

1 g (given mass)

$NaOH + Diabasic\ acid \longrightarrow \underset{at\ end\ point}{Product}$

(1 – x)g (reacted mass)

At end point

11.3 × M = 10 × 0.05 × 2

$M = \frac{10 \times 0.05 \times 2}{11.3}$

= 0.088 M

$M = \frac{y \times 1000}{40 \times 250}$

$0.088 = \frac{y}{10}$ g = y = 0.88 g

Spill amount = 1 –0.88 = 0.12 g

(ii) As one milimoles of NaOH = 6×10^{20} molecules
As half millimoles of Diabasic acid = 3×10^{20} molecules

42. A (i) 5
(ii) A = 400 J B = 400 J C = 400 J D = 20 J E = 20 J F = 20 J
(iii) B, E

B (i) a (ii) b
C (b)