

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 = $\frac{\text{Energy}}{q(\text{charge})}$

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

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

Divalent anion = M^{2-}

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

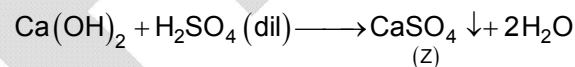
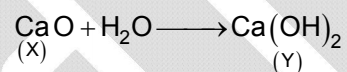
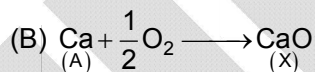
$$n = 1.25(x+2)$$

$$p = x$$

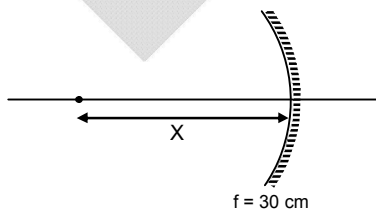
$$n + p = 79$$

On solving value of $x = 34$

$\therefore \text{Se}^{-2}$



32.



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

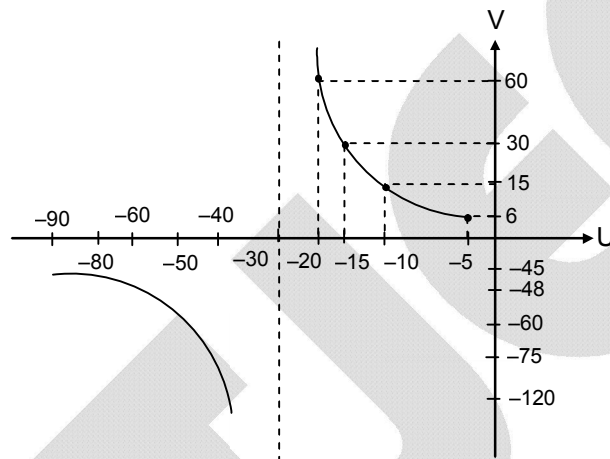
$$\Rightarrow \frac{1}{V} + \frac{1}{-X} = \frac{1}{-30}$$

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

$$U = -X$$

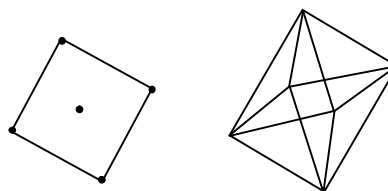
	U	V
1.	-5 cm	6 cm

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 $\frac{1}{9} \times \frac{25}{100} = \frac{1}{36}$ 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 $= r\sqrt{2}$



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

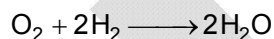
$$(iii) F = \frac{(9 \times 10^9)(1.6 \times 10^{-19})^2}{(2.7 \times 10^{-15})^2} \left(\sqrt{2} + \frac{1}{4} \right) = 5.26 \times 10 = 52.6 \text{ N}$$

$$(iv) F_{\text{attr.}} = \frac{Gm^2}{r^2} \left(\sqrt{2} + \frac{1}{4} \right) = \frac{(6.67 \times 10^{-11})(1.67 \times 10^{-27})^2}{(2.7 \times 10^{-15})^2} \left(\sqrt{2} + \frac{1}{4} \right) = 4.25 \times 10^{-35} \text{ N}$$

$$(v) \frac{F_{\text{rep.}}}{F_{\text{att}}} = \frac{52.6}{4.25 \times 10^{-35}} = 1.24 \times 10^{36}$$

- (vi) Radially outward.

35. (A) = 31.7g Mg



$$122.5 \text{ gm KClO}_3 = \frac{3}{2} \times 32 \text{ g of O}_2$$

$$90 \text{ gm of 60\% purity} = 90 \times \frac{3}{2} \times \frac{32 \times 60}{122.5 \times 100} = 0.235 \times 90 = 21.15$$

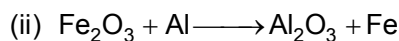
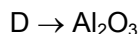
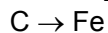
$$32 \text{ g of O}_2 = 2 \times 2 \text{ g m of H}_2$$

$$21.15 = \frac{21.15 \times 4}{32} = 2.64 \text{ gm H}_2$$

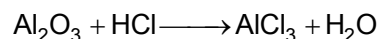
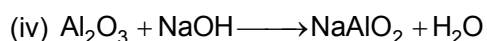
$$24 \text{ gm of Mg} = 2 \text{ gm H}_2$$

$$(31.7 \text{ gm of Mg}) = 2.64$$

- (B) (i) A \rightarrow Al

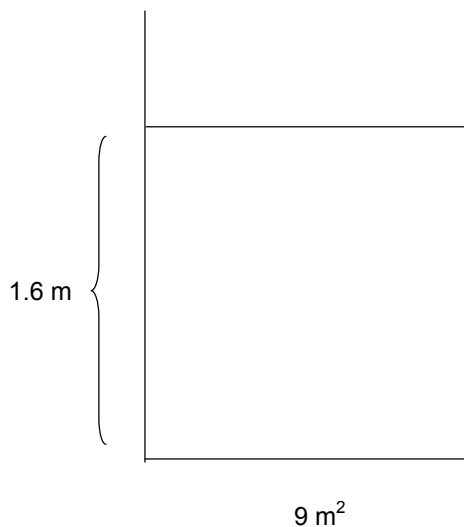


(iii) Amphoteric

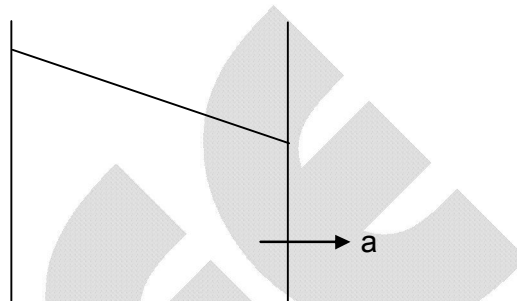


36. (I) (i) a, b (ii) a, b
 (II) d
 (III) (i) 0 (ii) 2

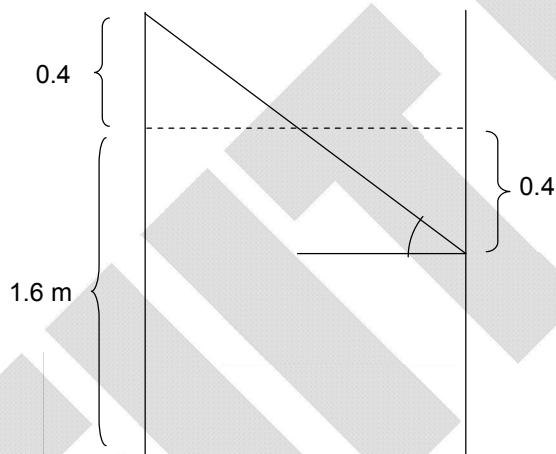
37.



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



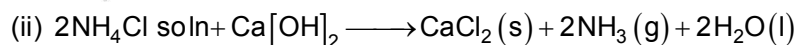
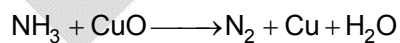
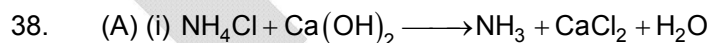
(iii) For maximum acceleration



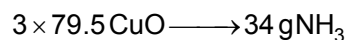
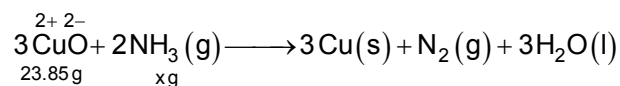
$$\tan \theta = \frac{a}{g}$$

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

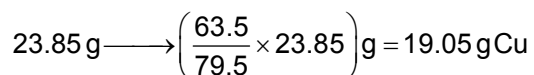
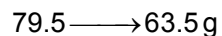
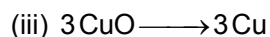
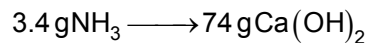
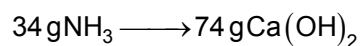
(iv) D
 In a direction perpendicular to the free surface of water.



100 mL
10.7%



$23.85 \text{ g} \longrightarrow \frac{34}{3 \times 79.5} \times 23.85 \text{ g} = 3.4 \text{ g NH}_3$



(B) (i) Oq_3/Oq_5 [$O \rightarrow \text{As}$, $q \rightarrow \text{Br}$]

(ii) $g[\text{Mn}]$

(iii) $a[\text{K}]$

(iv) $K[\text{Cu}]$

(v) n, o [As , Ge]

(vi) l [Zn]

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

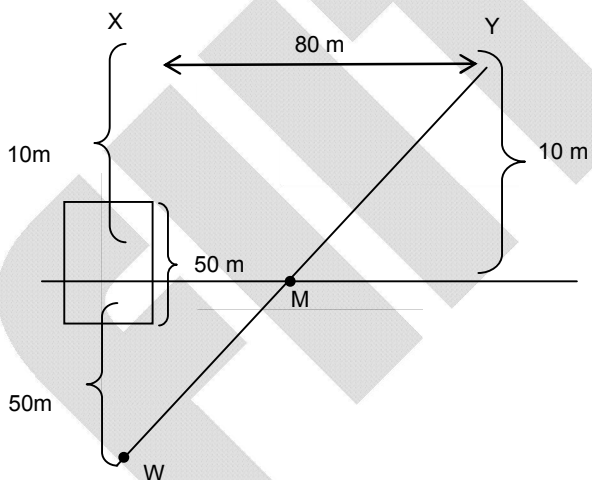
40.

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

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

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

(B)



$$\text{(i) } 900(A)(50) \text{ g} = (1000)(A)(50 - x) \text{ g}$$

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

$$\Rightarrow x = 50 - 45 = 5 \text{ m}$$

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

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

$$t_y - t_x = 0.07$$

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

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

$$\Rightarrow V_i = 3214 \text{ m/s}$$

- (iii) $t = 0.103 \text{ s}$
 (iv) $t = 0.033 \text{ s}$
 (v) $V_i = 3214 \text{ m/s}$

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

5 ml

$\text{HCl} = 3 \text{ g/ml}$

100 drop $\text{NaOH}^{(1M)} = 6 \text{ ml}$

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

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

Eq HCl = Eq. NaOH

↓

5 ml $\times M = 0.12 \times 1$

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

= $0.024 \times 36.5 \text{ g/L}$

= 0.876 g/L

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

(B) (i) $\text{NaOH} + \text{H}_2\text{O} \longrightarrow (\text{NaOH solution}) \xrightarrow{\text{Dilution}} 250 \text{ ml}$

1 g (given mass)

$\text{NaOH} + \text{Diabasic acid} \longrightarrow \text{Pr oduct}$
at end point

(1 - x)g (reacted mass)

At end point

$11.3 \times M = 10 \times 0.05 \times 2$

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

= 0.088 M

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

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

Spill amount = $1 - 0.88 = 0.12 \text{ g}$

(ii) As one millimoles 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 (10% law)

(iii) B \rightarrow E

B (i) a (ii) b

C (b)