

# MOLE CONCEPT

## MARKING SCHEME

1. a) Moles of Zinc used

$$\text{Moles} = \frac{\text{Mass given}}{\text{Molar mass}} = \frac{1.96\text{g}}{65.4} = 0.0299 \text{ moles of Zn used } \checkmark^{1/2}$$

- Moles of Hydrochloric acid used.

$$1000\text{cm}^3 \longrightarrow 0.2 \text{ moles Hcl}$$

$$\therefore 100\text{cm}^3 \longrightarrow ?$$

$$\frac{100 \times 0.2 \checkmark^{1/2}}{1000\text{cm}^3} = 0.02 \text{ moles of Hcl acid used. } \checkmark^{1/2}$$

- Thus Zinc metal was in excess  $\checkmark 1$

b) If 65.4g of Zinc metal  $\checkmark^{1/2}$   $\longrightarrow$  22.4 litres at S.T.P

$\therefore$  1.96g of Zinc metal  $\longrightarrow$  ?

$$= \frac{1.96\text{g} \times 22.4\text{litres} \checkmark^{1/2}}{65.4\text{g}}$$

$$0.6713\text{litres of } H_2 \text{ gas } \checkmark^{1/2}$$

or

$$671.3\text{cm}^3 \text{ of } H_2 \text{ gas}$$

2. For Hydrogen,  $H_2$ , molar mass = 2g

$$2\text{g} \longrightarrow 1\text{mole } \checkmark^{1/2}$$

$$\therefore 10\text{g} \longrightarrow ?$$

$$\frac{10\text{g} \times 1\text{mole}}{2\text{g}} = 5\text{moles of } H_2 \text{ gas } \checkmark^{1/2}$$

For Nitrogen (IV) oxide gas,  $NO_2$

$$\text{Molar mass} = 14 + 32 = 46\text{g}$$

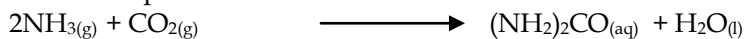
$$1 \text{ mole of } NO_2 \longrightarrow 46\text{g } \checkmark^{1/2}$$

$$\therefore 5 \text{ moles of } NO_2 \longrightarrow ? \checkmark^{1/2}$$

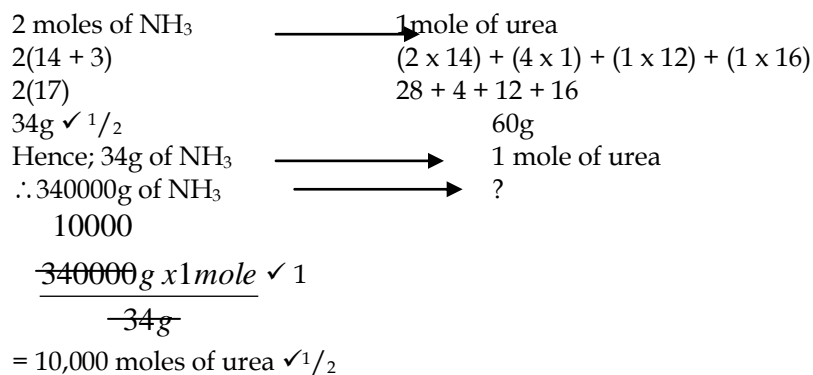
$$= \frac{5\text{moles} \times 46\text{g}}{1\text{mole}}$$

= 230g of  $NO_2$  gas will occupy the same volume of 10g of  $H_2$  gas

3. From the equation



Where;



4. RFM of NaOH = 40  
 Moles of NaOH =  $\frac{8}{40} = 0.2\text{m} \checkmark^{1/2}\text{mk}$   
 Moles of NaOH in  $25\text{cm}^3$

$$\frac{25 \times 0.2}{1000} = 0.005 \checkmark^{1/2}$$

Mole ratio 1: 2

$$\begin{array}{l}
 \text{Moles of acid} = \frac{0.005}{2} \checkmark^{1/2} \\
 0.0025
 \end{array}$$

$$\begin{array}{l}
 1\text{m} \quad \quad \quad = \frac{1 \times 0.245}{0.0025} \quad \checkmark 1 \\
 \quad \quad \quad = 98 \quad \quad \quad \checkmark^{1/2}
 \end{array}$$

5.  $\text{CH}_4(\text{g}) \quad : \quad \text{O}_2(\text{g}) \quad : \quad \text{CO}_2(\text{g})$   
 $12.0 \text{ cm}^3 \quad : \quad 24\text{cm}^3 \quad : \quad 36\text{cm}^3 \quad \quad \quad (1\text{mk})$   
 $1\text{cm}^3 \quad : \quad 2\text{cm}^3 \quad : \quad 3\text{cm}^3$   
 $1\text{vol} \quad : \quad 2\text{vol} \quad : \quad 3\text{vol} \quad \quad \quad \text{which is a small (simple) whole number ratio}$   
 according to Gay Lussac's law of combining volumes. (1mk)

6.  $500\text{cm}^3 \geq 4.9 \text{ g}$

$$1000\text{cm}^3 \geq \frac{1000}{500} \times 4.9\text{g} = 9.8\text{g} \quad (1\text{mk})$$

if 0.3 molar w.r.t  $H^+_{(aq)}$  then  $\frac{0.3}{3}$  molar w.r.t acid since it is a tribasic acid

$$0.1 \text{ mols} = 9.8 \text{ g}$$

$$1 \text{ mol} \equiv \frac{1}{0.1} \times 9.8 = 98 \text{ g} \quad (1 \text{mk})$$

$$\text{RMM of acid} = 98 \quad (\frac{1}{2} \text{mk})$$

7.

$$24 \text{ dm}^3 = \frac{24}{1} \times 2.667 \text{ g} = 64.008 \text{ g} \quad (1 \text{mark})$$

$$\text{Rmm of gas } x = 64.008 \text{ (no units)} \quad (1 \text{mark})$$

8. Mass per litre of NaOH =  $7.5 \text{ g} \times 1000 = 30 \text{ g dm}^3$   
Molarity of NaOH =  $30/40 = 0.75 \text{ m} (\frac{1}{2})$

Moles of NaOH reacted =  $0.02 \times 0.75 = 0.0015 \text{ moles}$

Moles of HCl used =  $0.013 \times 1 = 0.013 \text{ moles } \frac{1}{2}$

Moles of NaOH that should have been used =  $0.013 \text{ moles}$

Mass of NaOH reacted =  $0.0015 \times 40 = 0.06 \text{ g} (\frac{1}{2})$

Mass of NaOH required =  $0.013 \times 40 = 0.52 \text{ g} (\frac{1}{2})$

% purity of NaOH =  $\frac{0.06}{0.52} \times 100 \% = 11.54 \%$

9. a)

	N	O
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<b>Mass %</b>	<b>30.4</b>	<b>69.6</b>
<b>No of moles</b>	$\frac{3.04}{14} = 2.17$	$\frac{69.6}{16} = 4.35$
<b>Mole ration</b>	$\frac{2.17}{2.17} = 1$	$\frac{4.35}{2.17} = 2$

$\frac{1}{2}$

E.F of compound is  $\text{NO}_2$   $\frac{1}{2}$

If  $22.4\text{dm}^3$  of gas = 1 mole

Then  $1\text{ dm}^3$  of gas =  $1/22.4 = 0.044$  moles

If 0.044 moles of the gas = 4.11g

Then 1 mol of the gas =  $1/0.044 \times 4.11\text{g} = \underline{92.064\text{g}}$

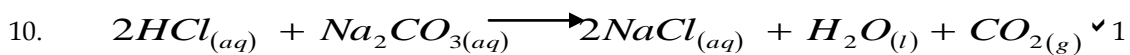
**OR**

If  $1\text{ dm}^3$  of gas = 4.11g

Then  $22.4\text{dm}^3$  of gas =  $22.4 \times 4.11\text{g}$   
 $= 92.064\text{g}$  ( $\frac{1}{2}$ )

E.F.M of  $\text{NO}_2 = 14 + 32 = 46$

$$n = \frac{\text{M.F.}}{M} = \frac{92}{46} = 2$$



$$\text{Moles of Na}_2\text{CO}_3 \text{ reacting} = \frac{1}{2} \times \frac{20 \times 0.5}{1000} = 0.005 \text{ moles} \quad \checkmark \frac{1}{2}$$

$$\text{Moles of Na}_2\text{CO}_3 \text{ in } 100\text{cm}^3 = \frac{0.005 \times 100}{25} \checkmark \frac{1}{2} = 0.02 \text{ moles} \quad \checkmark \frac{1}{2}$$

$$\text{Mass of Na}_2\text{CO}_3 \text{ in the mixture} = 0.02 \times 106 = 2.12\text{g} \quad \checkmark \frac{1}{2}$$

11. RFM of  $\text{Na}_2\text{SO}_3$  is 126 ✓  $\frac{1}{2}$

$$\text{Number of moles of Na}_2\text{SO}_3 = \frac{25.2}{126} = 0.2 \quad \checkmark \frac{1}{2}$$

$$\text{Number of moles of HCl} = \frac{700 \times 0.5}{1000} = 0.35 \quad \checkmark \frac{1}{2}$$

4

1000

Reacting ratio is 1:2  $\therefore$  0.2 moles of  $\text{Na}_2\text{SO}_3$  require 0.4 mole of HCl  
 $\therefore$  Reagent in excess is  $\text{Na}_2\text{SO}_3$

<p>12. i) Concentration</p> $\text{g/l} = \frac{9.42}{600} \times 1000$ $= 15.7 \text{ g/l} \checkmark 1$	<p style="text-align: center;">Molarity</p> $\frac{21.5 \times 0.207}{25}$ $= 0.17802\text{M} \checkmark 1$	<p style="text-align: center;">RFM</p> $\frac{15.7}{0.17802}$ $= 88.192 \quad \approx 88 \checkmark 1$
<p>ii) <math>\text{RCOOH} = 88</math>  <math>\text{R} + 12 + 32 + 1 = 88</math>  <math>\text{R} = 88 - 45</math>  <math>\text{R} = 43 \checkmark 1</math></p>		

13. a) Equation for the reaction

$$2\text{KOH}_{(\text{aq})} + \text{H}_2\text{Y}_{(\text{aq})} \longrightarrow \text{K}_2\text{Y}_{(\text{aq})} + 2\text{H}_2\text{O}_{(\text{l})}$$

Mole ratio      2 : 1

Moles of KOH =  $\frac{25}{1000} \times 0.12 \checkmark 1/2$

= 0.003 moles

$\therefore$  Moles of acid ( $\text{H}_2\text{Y}$ ) =  $1/2 \times 0.003$

= 0.0015 moles  $\checkmark 1/2$

If  $30\text{cm}^3$  contains 0.0015 moles

$100\text{cm}^3$  contains =  $\frac{1000}{30} \times 0.0015 \checkmark 1/2$

= 0.05 moles/l (0.05M)

b) Molarity =  $\frac{\text{mass/l}}{\text{R.F.M}}$

If  $500\text{cm}^3$  contains 3.15g

$1000\text{cm}^3$  contains  $\frac{1000}{500} \times 3.15 \checkmark 1/2$

= 6.30g/l

$0.05 = \frac{6.30}{\text{R.F.M}}$

$$\therefore \text{R.F.M} = \frac{6.30}{0.05} \checkmark \frac{1}{2}$$

$$\text{R.F.M} = 126 \checkmark \frac{1}{2}$$

14.(a) (i)  $\text{RMM ZnSO}_4 = 65+32+64 = 161 \checkmark 1$

$$\text{moles of Zn} = \frac{65}{165} = 0.4037 \text{ moles} \checkmark 1$$

(ii) Mass of water = 3.715 - 2.08

$$= 1.635\text{g} \checkmark 1$$

$$\text{RMM H}_2\text{O} = 2 + 16 = 18$$

$$\text{Moles of water} = \frac{1.635}{18} = 0.09083 \text{ moles.}$$

(iii)	$\begin{array}{l} \text{ZnSO}_4 \\ \text{mass: } \frac{2.08}{161} \\ 0.01291 \\ \text{mole ratio : } \frac{0.01291}{0.1291} \\ 1 \\ 1 \end{array}$	$\begin{array}{l} \text{H}_2\text{O} \\ 0.09083 \checkmark \frac{1}{2} \\ \\ \frac{0.09083}{0.01291} \checkmark \frac{1}{2} \\ 7.035 \checkmark \frac{1}{2} \\ 7 \\ \text{R} = 7 \checkmark \frac{1}{2} \end{array}$
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(b) (i)  $\text{RMM ZnSO}_4 \cdot 7\text{H}_2\text{O} = 161 + 7 \times 18 = 287\text{g} \checkmark \frac{1}{2}$

$$287\text{g ZnSO}_4 \cdot 7\text{H}_2\text{O} = 65\text{g}$$

$$= 0.015\text{g}$$

$$\frac{287 \times 0.015}{65} = 0.06623\text{g}$$

(ii)  $\text{Moles of ZnSO}_4 \cdot 7\text{H}_2\text{O} = \frac{0.06623}{287}$

$$= 0.0002308 \text{ moles}$$

$$5\text{cm}^3 = 0.0002308 \text{ moles}$$

$$1000\text{cm}^3 = ?$$

$$\frac{1000\text{cm}^3 \times 0.0002308 \text{ moles}}{5\text{cm}^3}$$

$$= 0.04616 \text{ M}$$