MOLE CONCEPT

MARKING SCHEME

1. a) Moles of Zinc used

$$Moles = \frac{Mass\ given}{Molar\ mass} = \frac{1.96g}{65.4} = 0.0299\ moles\ of\ Zn\ used\ \checkmark {}^1/_2$$

- Moles of Hydrochloric acid used.

1000cm^3 ⟶ 0.2 moles Hcl

∴ 100cm^3 ⟶ ?

$$\frac{100\ x\ 0.2}{1000cm^3} \checkmark ½ = 0.02\ moles\ of\ Hcl\ acid\ used. \checkmark ½$$

- Thus Zinc metal was in excess ✓ 1

b) If 65.4g of Zinc metal ✓ ½ ⟶ 22.4 litres at S.T.P

∴ 1.96g of Zinc metal ⟶ ?

$$= \frac{1.96g\ x\ 22.4 litres}{65.4g} \checkmark ½$$

$$0.6713\ litres\ of\ H_2\ gas\ \checkmark {}^1/_2$$

or

$$671.3cm^3\ of\ H_2 gas$$

2. <u>For Hydrogen</u>, H_2, molar mass= 2g

2g ⟶ 1mole ½

∴ 10g ⟶ ?

$$\frac{10g\ x\ 1mole}{2g} = 5\ moles\ of\ H_2\ gas \quad ½$$

For Nitrogen (IV) oxide gas, NO_2

Molar mass = 14 + 32 = 46g

1 mole of NO_2 ⟶ 46g ✓ ½

∴ 5 moles of NO_2 ⟶ ? ✓ ½

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

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

3. From the equation

$2NH_{3(g)} + CO_{2(g)} \longrightarrow (NH_2)_2CO_{(aq)} + H_2O_{(l)}$

Where;

2 moles of NH_3 → 1mole of urea

2(14 + 3) → (2 x 14) + (4 x 1) + (1 x 12) + (1 x 16)

2(17) → 28 + 4 + 12 + 16

34g ✓ $^1/_2$ → 60g

Hence; 34g of NH_3 → 1 mole of urea

∴ 340000g of NH_3 → ?

$$\frac{\overset{10000}{\cancel{340000}g} \; x 1 mole}{\cancel{34g}} \checkmark 1$$

= 10,000 moles of urea ✓$^1/_2$

4. RFM of NaOH = 40

Moles of NaOH = $^8/_{40}$ = 0.2m ✓ $^1/_2$mk

Moles of NaoH in $25cm^3$

$$\frac{25 x 0.2}{1000} = 0.005 \checkmark \, ^1/_2$$

Mole ratio 1: 2

Moles of acid = $\frac{0.005}{2}$ ✓ $^1/_2$

0.0025

$$1m = \frac{1 x 0.245}{0.0025} \checkmark 1$$

$= 98$ ✓ $^1/_2$

5.

$CH_{4(g)}$	:	$O_{2(g)}$	:	$CO_{2(g)}$		
12.0 cm^3	:	$24cm^3$	:	$36cm^3$		(1mk)
$1cm^3$	:	$2cm^3$	:	$3cm^3$		
1vol	:	2vol	:	3vol	which is a small (simple) whole number ratio	

according to Gay Lussac's law of combining volumes. (1mk)

6. $500cm^3 \geq 4.9$ g

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

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

$$0.1mols \quad = 9.8g$$

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

$$RMM \ of \ \ acid \ = \ 98 \qquad (\tfrac{1}{2}mk)$$

7.

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

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

8. Mass per litre of NaOH = 7.5 g x 1000 = 30gdm^3

Molarity of NaOH = 30/40 = 0.75 m (½)

Moles of NaOH reacted = 0.02 x 0.75 = 0.0015 moles

Moles of HCl used = 0.013 x 1 = 0.013 moles ½

Moles of NaOH that should have been used = 0.013 moles

Mass of NaOH reacted = 0.0015 x 40 = 0.06g (½)

Mass of NaOH required = 0.013 x 40 % = 0.52g (½)

% purity of NaOH = $\frac{0.56}{0.52}$ x 100 % = 11.54 %

9. a)

	N	**O**

Mass %	**30.4**	**69.6**
No of moles	$\frac{3.04}{14} = 2.17$	$\frac{69.6}{16} = 4.35$
Mole ration	$\frac{2.17}{2.17} = 1$	$\frac{4.35}{2.17} = 2$

½

E.F of compound is NO_2 ½

If 22.4dm³ of gas = 1 mole

Then 1 dm³ 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 x 4.11g = **92.064g**

OR

If 1 dm³ of gas = 4.11g

Then 22.4dm³ of gas = 22.4 x 4.11g
= 92.064g (½)

E.F.M of No_2 = 14 + 32 = 46

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

10. $$2HCl_{(aq)} + Na_2CO_{3(aq)} \longrightarrow 2NaCl_{(aq)} + H_2O_{(l)} + CO_{2(g)}$$ ✓ 1

Moles of Na_2CO_3 reacting = $\frac{1}{2} \times \frac{20 \times 0.5}{1000} = 0.005\ moles$ ✓ ½

Moles of Na_2CO_3 in 100cm³ = $\frac{0.005 \times 100}{25}$ ✓ ½ = 0.02 moles ✓ ½

Mass of Na_2CO_3 in the mixture = 0.02x 10.6
= 2.12g. ✓ ½

11. RFM of Na_2SO_3 is 126 ✓ ½

Number of moles of Na_2SO_3 = $\frac{25.2}{126}$ = 0.2✓ ½

Number of moles of HCl = 700 x 0.5 = 0.35✓ ½

1000

Reacting ratio is 1:2 ∴0.2 moles of Na_2SO_3 require 0.4 mole of HCl

∴Reagent in excess is Na_2SO_3

12. i) Concentration

$g/l = \frac{9.42}{600} \times 1000$

= 15.7 g/l✓1

Molarity

$\frac{21.5 \times 0.207}{25}$

= 0.17802M✓1

RFM

$\frac{15.7}{0.17802}$

= 88.192 ≈88✓1

ii) RCOOH = 88

R + 12 + 32 + 1 = 88

R = 88 – 45

R = 43✓1

13. a) Equation for the reaction

$2KOH_{(aq)} + H_2Y_{(aq)} \longrightarrow K_2Y_{(aq)} + 2H_2O_{(l0}$

Mole ratio 2 : 1

Moles of KOH = $\frac{25}{1000} \times 0.12$ ✓½

= 0.003 moles

∴ Moles of acid (H_2Y) = ½ x 0.003

= 0.0015 moles✓½

If $30cm^3$ contains 0.0015 moles

$100cm^3$ contains = $\frac{1000}{30} \times 0.0015$ ✓½

= 0.05 moles/l (0.05M)

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

If $500cm^3$ contains 3.15g

$1000cm^3$ contains $\frac{1000}{500} \times 3.15$✓½

= 6.30g/l

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

$\therefore$ R.F.M = $\frac{6.30}{0.05}$ ✓½

R.F.M = 126✓½

14.(a) (i) RMM ZnSO4 = 65+32+64 = 161 ✓ 1

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

(ii) Mass of water = 3.715 -2.08

= 1.635g ✓ 1

RMM H_2O = 2 + 16 = 18

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

(iii)	$ZnSO_4$	H_2O
mass:	$\frac{2.08}{161}$	0.09083 ✓ ½
	0.01291	
mole ratio :	$\frac{0.01291}{0.1291}$	$\frac{0.09083}{0.01291}$ ✓ ½
	1	7.035 ✓ ½
	1	7
		R = 7 ✓ ½

(b) (i) RMM $ZnSO_4.7H_2O$ = 161 + 7 x 18 = 287g ✓ ½

287g ZnSO4.7H2O = 65g

= 0.015g

$$\frac{287\ x\ 0.015}{65} = 0.06623g$$

(ii) $Moles\ \ of\ \ ZnSO_4.7H_2O\ =\ \frac{0.06623}{287}$

= 0.0002308 moles

5cm3 = 0.0002308moles

1000cm3 =?

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

$$=\ \ 0.04616\ \ M$$