THE UNITED REPUBLIC OF TANZANIA

PRESIDENT'S OFFICE

REGIONAL ADMINISTRATION AND LOCAL GOVERNMENT

FORM SIX SPECIAL SCHOOLS EXAMINATIONS

132/3B **CHEMISTRY 3B**

MARKING SCHEME

Question One

Volume of pipette used = 20.00cm^3 **(0.5 mark)**

Table of results

	Pilot	I	II	III
Initial burette reading (cm^3)	0.000	0.00	0.00	0.00
Final burette reading (cm^3) Under POP	10.30	10.20	10.10	10.20
Final burette reading (cm^3) Under (MO)	25.70	25.40	25.50	25.40
Titer volume (cm^3) Under (POP)	10.30	10.20	10.10	10.20
Titer volume (cm^3) Under (MO)	15.70	15.40	15.50	15.40

Average titre volume under POP = $\frac{V1+V2+V3}{3} = \frac{10.20+10.10+10.20}{3}$ = 10.17 cm^3 **(00 ½ Mark)**

Average titre volume (Under MO) = $\frac{V1+V2+V3}{3} = \frac{15.40+15.50+15.40}{3}$ = 15.43cm^3 **(00 ½ Mark)**

Distribution of marks on the table of result should be as follows;

- Well completed table (C.T) **01 mark**
- Decimal place (DP) **01 Mark**
- Accurace (AC) **01 marks**

Summary

<u>20.00cm^3</u>of solution B_1 required 10.17 cm^3 of solution B_2 under POP and **15.430cm^3** of B_2 under MO. **(01 mark)**

(a) Molarity of solution B_2.
Given concentration of HCl 14.6 g/dm^3
Molar mass of HCl = (1+ 35.5) g/mol = 36.5g/mol
Molarity (14.6/36.5) mol/dm^3 = 0.4M **(01 mark)**

From a dilution law

$M_1V_1 = M_2V_2$ **00½ marks**
M_1 = 0.4M.
V_1 = 100cm^3
M_2=? **00½ marks**
V_2 = 200cm^3.

$M_2 = \frac{M_1V_1}{V_2}$
$M_2 = \frac{0.4M\ x\ 100cm3}{200cm3}$ **00½ marks**
M_2 = 0.2M.

Molarity f solution B_2 = 0.2M **00½ marks**

(b) volume required to neutralize

i. Na_2CO_3 only.

Volume under POP × 2

10.17 cm^3× 2

= 20.34 cm^3 **(00½ Mark)**

ii. $NaHCO_3$ only

= 15.43 cm^3

But Original $NaHCO_3$ which is pure is Volume of B_2 under MO –Volume of B_2 under POP

= (15.43 -10.17) cm^3

=5.26 cm^3 **(00½ mark)**

(c) Molarity of (i) $NaHCO_3$

Consider the chemical equation below

$NaHCO_3(aq) + HCl(aq) \longrightarrow NaCl\ (aq) + H_2O(aq) + CO_{2\ (g)}$.....,..(ii)

(00½ mark)

Given:

Volume of acid (V_{B2}) to neutralize pure $NaHCO_3$ = 5.26 cm^3

Molarity of B_2 (M_{B2}) = 0.2M

Volume of Base (VB_1) = 20cm^3

. $\frac{M_a V_a}{M_b V_b} = \frac{na}{nb}$ **(00½ Mark)**

$\frac{0.2\ x\ 5.26}{M_b\ x\ 20} = \frac{1}{1}$ **(00½ Mark)**

Mb = 0.05M **(00 ½ Marks)**

Concentration in mass per liter solution = Molarity X molar mass

Molar mass of $NaHCO_3$ = 23+1+12+16 x 3 = 84g/mol. **(00½ mark)**

0.05mol/dm^3 x 84g/mol **(00 ½ Marks)**

4.2 grams per litre solution (4.2g/dm^3) **(00 ½ Mark)**

ii) Molarity of Na_2CO_3

Consider the Chemical equation below

$Na_2CO_3(aq) + 2HCl(aq) \longrightarrow 2NaCl\ (aq) + H_2O(aq) + CO_{2\ (g)}$.....,..(ii)

Given:

Volume of acid (V_{B2}) to neutralize pure Na_2CO_3 = 20.34 cm^3 **(00½ Mark)**

Molarity of B_2 (M_{B2}) = 0.2M

Volume of Base (V_{B1}) = 20cm^3

. $\frac{M_a V_a}{M_b V_b} = \frac{na}{nb}$ **(01 Mark)**

$\frac{0.2x20.34}{M_b x20} = \frac{2}{1}$

Mb = 0.10M **(00 ½ Mark)**

Concentration in mass per liter solution = Molarity X molar mass

Molar mass of Na_2CO_3 = 23 x 2 + 12 + 16 x 3 = 106g/mol. **(00 ½ Mark)**

0.10mol/dm^3 x 106g/mol **(00 ½ Mark)**

10.60 grams per litre solution (10.6g/dm^3)

Total mass of pure NaHCO3 and Na_2CO_3 = (4.2 + 10.6) grams **(00½ Marks)**

= 14.8 grams **(00 ½ Mark)**

(ii) $Na_2CO_3.X\ H_2O$.

Value of X

Total mass of Pure Na_2CO_3 and $NaHCO_3$ = 14.6 grams

But mass of sample mixture was 16.4g ~~50~~0cm^3

? 1000cm^3

$= \frac{16.4g\ x\ 1000cm3}{500cm3}$

= 32.8g/dm^3 **(01 mark)**

Since Total mass of pure NaHCO3 and Na_2CO_3 = 14.8g and Total mass of sample mixture is 32.8g, their difference in mass is impurity due to the water of crystallization.

32.8 -14.8 = 18grams. **(01 Mark)**

	Na_2CO_3	H_2O
Mass	10.6	18
÷ molar mass	10.6/106 =0.1	18/18 =1

÷ by smallest	0.1/0.1 = 1	1/0.1 = 10

(01 Marks)

The ratio of Na_2CO_3 to H_2O is 1: 10 **(00 ½ Marks)**

Therefore the water of Crystallization = 10.

It is $Na_2CO_3.10\ H_2O$ (X = 10) **00½ marks**

2. (a) Table of results

Salt	**Volume of water (cm^3)**	**Mass of salt (g)**	**Initial temperature of water T_1 (^oC)**	**Final temperature of solution T_2 (^oC)**	**Temperature change (ΔT)**	**Molar weight of the sample (M_r)**
$CuSO_4$	50	2	22	28	+6	160
$CuSO_4.5H_2O$	50	4	22	21	-1	250

NB: Complete filled table **(**03 ***marks*****)**
Accuracy **(**02 ***marks*****)**

(b) To find enthalpy of solution in each salt:

For $CuSO_4$

$\Delta H = -(C_w \rho_w V_w \Delta T)$ ***(***00$\frac{1}{2}$ ***mark)***

= - density of solution x volume of solution x specific heat capacity x temperature change

$\Delta H = -50\ cm^3 \times 1.0\ g/cm^3 \times 4.18\ J\ g^{-1}K^{-1} \times 6\ ^\circ C = -1254J$ **(**02 **marks)**

Molar heat evolved = Heat evolved **(**00$\frac{1}{2}$**mark)**

Number of moles of $CuSO_4$

= - 1254J = -10,032 J/mol

(2/160) mol

Thus, molar heat evolved by $CuSO_4$ was 10.032 kJ/mol **(**02 **marks)**

For $CuSO_4.5H_2O$

$\Delta H = -(C_w \rho_w V_w \Delta T)$ ***(***00$\frac{1}{2}$ ***mark)***

= - density of solution x volume of solution x specific heat capacity x temperature change

$\Delta H = -50\ cm^3 \times 1.0\ g/cm^3 \times 4.18\ J\ g^{-1}K^{-1} \times -1\ ^\circ C = 209J$ **(**02 **marks)**

Molar heat evolved = Heat evolved **(00$\frac{1}{2}$mark)**

Number of moles of $CuSO_4.5H_2O$

= 209 J = 13,062.5 J/mol

(4/250) mol

Thus, molar heat absorbed by $CuSO_4.5H_2O$ was 13.06 kJ/mol **(02 marks)**

Question Three

s/n	Experiment	Observations	Inferences
1	The appearance of sample K	White crystalline sample x with no characteristic smell. **(00½ Marks)**	Transition element absent <u>or</u> non – transition element may be present **(00½ Mark)**
			CO_3^{2-}, HCO_3^- may be absent or so, NO_3^- , SO_4^{2-} or Cl^-may be present.
2	Addition of Con H_2SO_4 followed by warming.	Residue white when cold yellow when hot and white when cold **(00½Mark)**	Zn^{2+} may be present **00½ Mark)**
		Colourless gas which turn wet blue litmus paper red and form white dense fumes with ammonia **(00½Mark)**	Cl^- present **(00½Mark)**
3	Small amount of sample K were heated in dry test tube	Colour less gas which turns wet blue litmus paper red and given dense white fumes with ammonia **(00½ Mark)**	Cl^- may be present **(00½ Mark)**
4	Sample solution was made and dissolved to four portion	Soluble in cold water to form a clear colourless solution **(00½ Mark)**	Soluble salt of or Cl^- may be present **(00½ Mark)**
	(i) Addition aqueous ammonia solution to first portion till excess	White gelatinous ppt soluble in excess ammonia solution were observed **(00½Mark)**	Zn^{2+} may be present **(00½ Mark)**
	(ii) Addition silver nitrate ($AgNO_3$) solution to second portion till excess	White ppt were observed **(00½Marks)**	Cl^- present and confirmed **(01Mark)**
	(iii) To third portion, barium chloride	White ppt were observed **(00½Marks)**	SO_4^{2-} Present and confirmed **(01 Mark)**

		($BaCl_2$) solution was added		
	(iv)	To a small portion of a sample solution K, potassium hexacyabnoferrate (II) solution was added	White ppt were observed **(00½Marks)**	Zn^{2+} present and confirmed **(00½ Mark)**
	(v)	OR. To a small portion of sample solution K, dilNaOH solution was added till excess.	White ppt solution in excess NaOH. **(00 ½ Mark)** (Any one confirmatory test)	Zn^{2+} present and confirmed. **(00½Mark)**

Conclusion:

(a) $Ag^{+}_{(aq)} + Cl^{-}_{(aq)} \rightarrow Agcl(s)$ ……. (**01Mark**)
$Ba^{2+}_{(aq)}) + SO_4^{2-}{}_{(aq)} \rightarrow BaSO_{4(s)}$ …… **(01Mark)**

(b) Zn^{2+} can be confirmed by using either:
Potassium hexacyanoferrate (II) any one …….. **(00½ Mark)**
Or Sodium Hydroxide (NaOH) solution

(c) The cation is Zn^{2+} and anions are Cl^{-} and SO_4^{2-} ……**(01 ½ Mark)**