

TANZANIA HEADS OF ISLAMIC SCHOOL COUNCIL (TAHISCO)

INTER ISLAMIC MOCK EXAMINATION

CHEMISTRY 3A

MARKING SCHEME

2026

1. Solution

The volume of pipette used was 25.0cm^3 or 20cm^3 **(00 ½ mark)**

The volume of burette used was 50.00cm^3 . **(00 ½ mark)**

Table of result for 25.0cm^3 pipette

BURETTE		TITRATION			
		Pilot	1	2	3
(i)	Initial readings (cm^3)	0.00	0.00	0.00	0.00
(ii)	Final readings using POP (cm^3)	21.60	21.50	21.50	21.50
(iii)	Final readings using MO (cm^3)	27.90	27.80	27.80	27.80
(iv)	1 st titre value (ii) – (i) using POP	21.60	21.50	21.50	21.50
(v)	2 nd titre value (iii) – (ii) using MO	6.30	6.30	6.30	6.30

Table of Result for 20.0cm^3 pipette

BURETTE READINGS		TITRATION			
		Pilot	1	2	3
(i)	Initial readings (cm^3)	0.00	0.00	0.00	0.00
(ii)	Final reading using POP (cm^3)	17.30	17.20	17.20	17.20
(iii)	Final reading using MO (cm^3)	22.30	22.20	22.20	22.20
(iv)	1 st titre value (ii) – (i) using POP	17.30	17.20	17.20	17.20
(v)	2 nd titre value (iii) – (ii) using MO	5.00	5.00	5.00	5.00

Either of the table: Fitting table – (01mark)

Accurate data – (02 marks)

Two decimal place (01mark)

The average titre values:

$$\begin{aligned}\text{When POP was used} &= \frac{21.50+21.50+21.50}{3} \\ &= 21.50\text{cm}^3 \quad \textbf{(00 ½ mark)}\end{aligned}$$

$$\text{When M.O used} = \frac{6.30+6.30+6.30}{3}$$

$$= 6.30\text{cm}^3 \quad (\text{00 } \frac{1}{2} \text{ mark})$$

Summary:

25.00cm³ of solution X required 21.50cm³ of solution Y when POP was the indicator and 6.30cm³ when MO was the indicator. **(01 ½ marks)**

Questions:

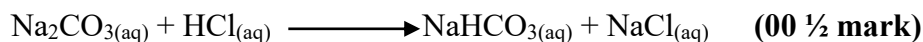
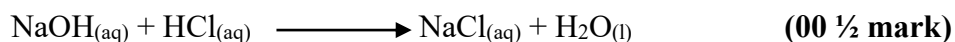
(a) The colour changes during titrations were:-

(i) When POP was used: From pink to colourless **(01mark)**

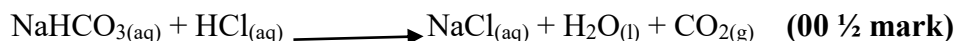
(ii) When MO was used: From yellow to pink **(01mark)**

(b) The appropriate chemical equations when using

(i) P.O.P



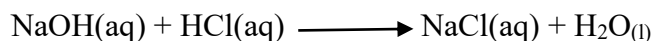
(ii) M.O



(c) The concentration in Mol/dm³ and g/dm³

(i) For sodium Hydroxide (NaOH)

Consider the reaction equation



$$\text{The molarity of acid (HCl)} = \frac{\text{Mass concentration}}{\text{Molar mass}}$$

$$\text{But Mass concentration} = \frac{\text{Mass given (g)}}{\text{Volume given (dm}^3\text{)}}$$

$$= \frac{9.125\text{g}}{0.25\text{dm}^3} \quad (\text{00 } \frac{1}{2} \text{ mark})$$

$$= 36.5\text{g/dm}^3$$

$$\text{Then molarity of acid (HCl)} = \frac{36.5\text{g/dm}^3}{36.5\text{g/mol}}$$

$$\text{The molarity of acid (HCl)} = 1\text{mol/dm}^3 \text{ (M)}$$

Then

$$\text{Molarity of acid (Ma)} = 1.0\text{M}$$

$$\text{Molarity of base (NaOH) (Mb)} = ?$$

$$\text{Volume of base (Vb)} = 25.00\text{cm}^3$$

$$\text{Number of moles of acid (na)} = 1$$

$$\text{Number of moles of base (nb)} = 1$$

The volume of acid for n patriotization of NaOH

$$V_a = 21.50 - 6.30 = 15.20 \text{ cm}^3$$

From titration formula

$$\frac{MaVa}{na} = \frac{MbVg}{ng} \quad \text{(00 ½ mark)}$$

$$Mb = \frac{MaVan}{naVg}$$

$$Mb = \frac{1.0 \times 15.2 \times 1}{25 \times 1} \quad \text{(00 ½ mark)}$$

$$= 0.608 \text{ mol/dm}^3 \text{ (M)} \quad \text{(00 ½ mark)}$$

∴ Molarity (concentration) of NaOH in mol/dm³ is 0.608 mol/dm³.

Then in g/dm³

Mass concentration = Molarity x molar mass

Molar mass of NaOH = 23+16+1 = 40g/mol

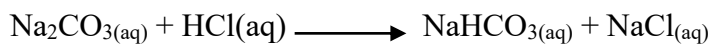
Molarity = 0.608mol/dm³.

Then

$$\begin{aligned} \text{Mass concentration} &= 0.608 \text{ mol/dm}^3 \times 40 \text{ g/mol} \quad \text{(00 ½ mark)} \\ &= 24.32 \text{ g/dm}^3 \end{aligned}$$

∴ The concentration of NaOH in g/dm³ is 24.32g/dm³. (00 ½ mark)

(ii) For sodium carbonate



Molarity of acid (Ma) = 1M

Molarity of base (Mb) = ?

Volume of acid (Va) = 6.30cm³

Volume of base (Vb) = 25cm³

Number of moles of acid (na) = 1

Number of moles of base (nb) = 1

$$\frac{MaVa}{na} = \frac{MbVb}{nb}$$

$$Mb = \frac{MaVanb}{naVb}$$

$$= \frac{1 \times 6.30 \times 1}{25 \times 1} \quad \text{(01 mark)}$$

$$= 0.252 \text{ M}$$

∴ The molar concentration of Na₂CO₃ is 0.252mol/dm³. (01 mark)

Then mass concentration of Na₂CO₃

Molar mass of Na₂CO₃ = (23x2) + 12 + (16 x 3) = 106g/mol

$$\text{Molar concentration} = 0.252 \text{ mol/dm}^3$$

From the formula

$$\begin{aligned} \text{Mass concentration} &= \text{molarity} \times \text{molar mass} \\ &= 0.252 \times 106 && \text{(00 ½ mark)} \\ &= 26.712 \text{ g/dm}^3 \end{aligned}$$

$$\therefore \text{The mass concentration Na}_2\text{CO}_3 \text{ is } 26.712 \text{ g/dm}^3 \quad \text{(00 ½ mark)}$$

(d) The percentage composition of mass of both Na_2CO_3 and NaHCO_3

First, let obtain the total mass of the two components of solution

$$= (26.712 + 24320) \text{ g/dm}^3$$

$$= 51.032 \text{ g/dm}^3$$

The total mass of the mixture is 51.032g

$$\begin{aligned} \% \text{ of sodium hydroxide} &= \frac{\text{Mass of NaOH}}{\text{Total mass}} \times 100\% && \text{(00 ½ mark)} \\ &= \frac{24.32}{51.02} \times 100\% \\ &= 47.66\% && \text{(00 ½ mark)} \end{aligned}$$

$$\begin{aligned} \% \text{ of sodium carbonate} &= \frac{\text{Mass of Na}_2\text{CO}_3}{\text{Total mass}} \times 100\% \\ &= \frac{2.712}{51.032} \times 100\% && \text{(00 ½ mark)} \\ &= 52.34\% && \text{(00 ½ mark)} \end{aligned}$$

OR

$$\begin{aligned} \% \text{ of sodium carbonate} &= 100\% - \% \text{ of sodium hydroxide} \\ &= 100\% - 47.66\% \\ &= 52.34\% \end{aligned}$$

$\therefore$ The percentage composition by mass of sodium hydroxide and sodium carbonate is 47.66% and 52.34% respectively. (01mark)

2. Table 1:

Salt	Volume of water (cm ³)	Mass of salt (g)	Initial temperature T ₃ (°C)	Final temperature T ₂ (°C)	Temperature change, ΔT = T ₂ -T ₁	Molecular mass of salt
CuSO ₄	50	4.0	29	36	+7	160
CuSO ₄ ·5H ₂ O	50	6.0	29	28	-1	250

FT (2marks) Accuracy (03 marks)

Questions

(a) Temperature change, $\Delta T = (T_2 - T_1)^\circ\text{C}$ in each experiment for

$$\text{CuSO}_4: T_2 - T_1 = 36 - 29 = +7^\circ\text{C}. \quad (00 \frac{1}{2} \text{ mark})$$

$$\text{CuSO}_4 \cdot 5\text{H}_2\text{O}: T_2 - T_1 = 28 - 29 = -1^\circ\text{C}. \quad (00 \frac{1}{2} \text{ mark})$$

(b) Enthalpy of solution of each salt.

$$\text{For CuSO}_4 \Delta H = -(m \times C \times \Delta T) \quad (00 \frac{1}{2} \text{ mark})$$

$$\text{Where } m = \text{mass of water} = 50\text{g. From } \gamma \times V \text{ of water} \quad (00 \frac{1}{2} \text{ mark})$$

$$C = \text{specific heat capacity} = 4.18\text{Jg}^{-1}\text{C}^{-1}$$

$$\Delta H = - (50 \times 4.18 \times 7)$$

$$= -1463 \text{ J} \quad (00 \frac{1}{2} \text{ mark})$$

$$\text{So } 4\text{g} \equiv -1463\text{J} \quad (00 \frac{1}{2} \text{ mark})$$

$$160\text{g} \equiv ?$$

$$X = \frac{160 \times -1463}{4}$$

$$= -58520\text{J/mol}$$

$$= -58.52\text{kJmol}^{-1} \quad (00 \frac{1}{2} \text{ mark})$$

$$\therefore \text{The enthalpy of solution of CuSO}_4 \text{ is } -58.52\text{kJmol}^{-1} \quad (00 \frac{1}{2} \text{ mark})$$

$$\text{For CuSO}_4 \cdot 5\text{H}_2\text{O}, \Delta H = -(m \times C \times \Delta T) \quad (00 \frac{1}{2} \text{ mark})$$

Where

$$m = 50\text{g} \quad (00 \frac{1}{2} \text{ mark})$$

$$\Delta T = -1^\circ\text{C}$$

$$C = 4.18\text{Jg}^{-1}\text{C}^{-1}$$

$$\Delta H = -(50 \times 4.18 \times -1)$$

$$\Delta H = +209\text{J} \quad (00 \frac{1}{2} \text{ mark})$$

Then

$$6.0\text{g} \equiv +209\text{J} \quad (00 \frac{1}{2} \text{ mark})$$

$$250.0\text{g} \equiv ?$$

$$x = \frac{209 \times 250}{6}$$

$$= +8708.33\text{J/mol}$$

$$= +8.70833\text{kJmol}^{-1} \quad (00 \frac{1}{2} \text{ mark})$$

$$\therefore \text{The enthalpy of solution of CuSO}_4 \cdot 5\text{H}_2\text{O} \text{ is } +8.70833\text{kJmol}^{-1} \quad (00 \frac{1}{2} \text{ mark})$$

(c) The expected values of enthalpy of solution are different from the experimental values as follows:

- (i) CuSO_4 ; The heat given out on dissolving the salt Δ tower (-58.52kJmol^{-1}) than expected value, (-66.10kJmol^{-1}) because; some of heat is absorbing by Cu^{2+} ions, during hydration of these ions, and this heat is known as the enthalpy of hydration. **(01 ½ marks)**
- (ii) $\text{CuSO}_4 \cdot 5\text{H}_2\text{O}$; The heat absorbed by this salt is lower, ($+8.70833\text{kJmol}^{-1}$) since; there are five (5) water molecules per mole of salt that is already present in the salt, so the only small amount is required to dissolve mole of salt. **(01 ½ marks)**

3.

S/N	EXPERIMENT	OBSERVATION	INFERENCE
1.	The sample Z was observed (01mark)	White Crystalline form Powder form	Non-transition metals may be present NO_3^- , SO_4^{2-} , Cl^- , $\text{C}_2\text{O}_4^{2-}$ present CO_3^{2-} and HCO_3^- may be present except CO_3^{2-} of NH_4^+ , K^+ and Na^+
2	Flame test was performed on sample Z	Brick red flame was observed	Ca^{2+} may be present (01mark)
3.	Dil. HCl was added to the test tube containing solid sample Z	Effervescence of a colourless gas which turns moist litmus paper from blue to red was observed	CO_3^{2+} , HCO_3^- may be present. (01mark)
4.	A spatula full of sample Z was added in a test tube followed by 8cm^3 of distilled water. This mixture was warmed for one minute	Insoluble in hot or cold water (01mark)	SO_4^{2-} of Ba^{2+} , Sr^{2+} , Ca^{2+} , Pb^{2+} may be present CO_3^{2-} may be present except of Na^+ , K^+ , NH_4^+
	The solution was divided into four portions: (i) To the first portion, ammonia solution was added drop-wise until excess	White precipitates which were soluble in excess observed	Zn^{2+} may be present (01mark)
	(ii) To the second portion, lead acetate solution was added followed by dil. HCl	White precipitates formed which was insoluble in dilute HCl	SO_4^{2-} confirmed (01 mark)
	(iii) To the third portion ammonium oxalate	White precipitate was formed	Ca^{2+} confirmed (01mark)

	solution was added followed by excess ammonia solution		
(iv)	To the fourth portion, few drops of CaCl_2 was added	White precipitate was formed	CO_3^{2-} confirmed (01mark)
(v)	To the fifth portion, potassium hexacyano ferrate (H) was added	Bluish-white precipitate was formed	Zn^{2+} confirmed (01mark)

Conclusion

(a) The cations present are Zn^{2+} and Ca^{2+}

01mark 01mark

(b) The anions present in sample Z are CO_3^{2-} and SO_4^{2-}

1mark 1mark

(c) Sample Z contain salt ZnSO_4 and CaCO_3

1mark 1mark