TANZANIA HEADS OF ISLAMIC SCHOOL COUNCIL (TAHISCO)

INTER ISLAMIC MOCK EXAMIMNATION

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)	1st titre value (ii) – (i) using POP	21.60	21.50	21.50	21.50
(v)	2nd 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 (cm3)	22.30	22.20	22.20	22.20
(iv)	1st titre value (ii) – (i) using POP	17.30	17.20	17.20	17.20
(v)	2nd titre value (iii) – (ii) using MO	5.00	5.00	5.00	5.00

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

Accurate data – (02 marks)

Two decimal place (01mark)

The average titre values:

When POP was used = $\frac{21.50+21.50+21.50}{3}$

= 21.50cm^3 **(00 ½ mark)**

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

$= 6.30cm^3$ **(00 ½ mark)**

Summary:

$25.00cm^3$ of solution X required $21.50cm^3$ of solution Y when POP was the indicator and $6.30cm^3$ 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

$NaOH_{(aq)} + HCl_{(aq)} \longrightarrow NaCl_{(aq)} + H_2O_{(l)}$ **(00 ½ mark)**

$Na_2CO_{3(aq)} + HCl_{(aq)} \longrightarrow NaHCO_{3(aq)} + NaCl_{(aq)}$ **(00 ½ mark)**

(ii) M.O

$NaHCO_{3(aq)} + HCl_{(aq)} \longrightarrow NaCl_{(aq)} + H_2O_{(l)} + CO_{2(g)}$ **(00 ½ mark)**

(c) The concentration in Mol/dm^3 and g/dm^3

(i) For sodium Hydroxide (NaOH)

Consider the reaction equation

$NaOH(aq) + HCl(aq) \longrightarrow NaCl(aq) + H_2O_{(l)}$

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

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

$= \frac{9.125g}{0.25dm^3}$ **(00 ½ mark)**

$= 36.5g/dm^3$

Then molarity of acid (HCl) = $\frac{36.59/dm^3}{36.5g/mol}$

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

Then

Molarity of acid (Ma) = 1.0M

Molarity of base (NaOH) (Mb) = ?

Volume of base (Vb) = $25.00cm^3$

Number of moles of acid (na) = 1

Number of moles of base (nb) = 1

The volume of acid for n patriotization of NaOH

Va = 21.50 – 6.30 = 15.20 cm^3

From titration formula

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

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

Mb = $\frac{1.0\times15.2\times1}{25\times1}$ **(00 ½ mark)**

= 0.608mol/dm^3(M) **(00 ½ mark)**

∴ Molarity (concentration) of NaOH in mol/dm^3 is 0.608 mol/dm^3.

Then in g/dm^3

Mass concentrates = Molarity x molar mass

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

Molarity = 0.608mol/dm^3.

Then

Mass concentration = 0.608mol/dm^3 x 40g/mol **(00 ½ mark)**

= 24.32g/dm^3

∴ The concentration of NaOH in g/dm^3 is 24.32g/dm^3. **(00 ½ mark)**

(ii) For sodium carbonate

$Na_2CO_{3(aq)} + HCl(aq) \longrightarrow NaHCO_{3(aq)} + NaCl_{(aq)}$

Molarity of acid (Ma) = 1M

Molarity of base (Mb) = ?

Volume of acid (Va) = 6.30cm^3

Volume of base (Vb) = 25cm^3

Number of moles of acid (na) = 1

Number of moles of base (nb) = 1

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

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

= $\frac{1\times6.30\times1}{25\times1}$ **(01 mark)**

= 0.252M

∴ The molar concentration of Na_2CO_3 is 0.252mol/dm^3. **(01 mark)**

Then mass concentration of Na2CO3

Molar mass of Na_3CO_3 = (23x2) + 12 + (16 x 3) = 106g/mol

Molar concentration = 0.252mol/dm^3

From the formula

Mass concentration = molarity x molar mass

= 0.252 x 106 **(00 ½ mark)**

= 26.712g/dm3

∴ The mass concentration Na_2CO_3 is 26.712g/dm^3 **(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)g/dm3

= 51.032g/dm3

The total mass of the mixture is 51.032g

% of sodium hydroxide = $\frac{Mass\ of\ NaOH}{Total\ mass} \times 100\%$ **(00 ½ mark)**

= $\frac{\mathbf{24.32}}{\mathbf{51.02}} \times \mathbf{100}\%$

= **47.66%** **(00 ½ mark)**

% of sodium carbonate = Mass of Na2CO3 x 100%

Total mass

= $\frac{2.712}{51.032} x100\%$ **(00 ½ mark)**

= 52.34% **(00 ½ mark)**

OR

% of sodium carbonate = 100% - % of sodium hydroxide

= 100% - 47.66%

= 52.34%

∴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, $\Delta T = T_2-T_1$	Molecular mass of salt
CuSO4	50	4.0	29	36	+7	160
$CuSO_45H_2O$	50	6.0	29	28	-1	250

FT (2marks) Accuracy (03 marks)

Questions

(a) Temperature change, $\Delta T=(T_2-T_1)^oC$ in each experiment for

$CuSO_4$: $T_2 - T_1 = 36 - 29 = +7^oC$. **(00 ½ mark)**

$CuSO_4.5H_2O$: $T_2 - T_1 = 28 - 29 = {}^-1^oC$. **(00 ½ mark)**

(b) Enthalpy of solution of each salt.

For $CuSO_4$ $\Delta H = -(mxC \times \Delta T)$ **(00 ½ mark)**

Where m = mass of water = 50g. From γ x V of water **(00 ½ mark)**

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

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

$= - 1463$ J **(00 ½ mark)**

So 4g ≡ -1463J **(00 ½ mark)**

160g ≡ ?

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

$= {}^-58520J/mol$

$= {}^-58.52kJmol^{-1}$ **(00 ½ mark)**

∴ The enthalpy of solution of $CuSO_4$ is $-58.52kJmol^{-1}$ **(00 ½ mark)**

For $CuSO_4.5H_2O$, $\Delta H= -(mxC x\Delta T)$ **(00 ½ mark)**

Where

m = 50g **(00 ½ mark)**

$\Delta T = -1^oC$

$C = 4.18Jg^{-10}C^{-1}$

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

$\Delta H = {}^+209J$ **(00 ½ mark)**

Then

$6.0g \equiv {}^+209J$ **(00 ½ mark)**

$250.0g \equiv ?$

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

$= {}^+8708.33J/mol$

$= {}^+8.70833kJmol^{-1}$ **(00 ½ mark)**

∴ The enthalpy of solution of $CuSO_4.5H_2O$ is $+8.70833kJmol^{-1}$ **(00 ½ mark)**

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

(i) $CuSO_4$; The heat given out on dissolving the salt Δ tower (-58.52kJmol) than expected value, (-66.10kJmol) 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) $CuSO_4.5H_2O$; The heat absorbed by this salt is lower, ($^{+}8.70833kJmol^{-1}$) 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	Non-transition metals may be present
		Crystalline form	$No_3^-, SO_4^{2-}, Cl^-, C_2O_4^{2-}$ present
		Powder form	CO_3^{2-} and HCO_3^- may be present except CO_3^{2-} of NH_4^+, K^+ and N_a^+
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	Insolate in hot or cold water **(01mark)**	SO_4^{2-} of B_a^{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 utility 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 in soluble 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 gexacyario ferrator (H) was added	Bluish-white precipitate was formed	Zn2+ 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