

CHRISTIAN SOCIAL SERVICES COMMISSION (CSSC)  
NORTHERN ZONE JOINT EXAMINATIONS SYNDICATE (NZ-JES)



**FORM SIX PRE-NATIONAL EXAMINATIONS 2023**

132/3A

**CHEMISTRY 3A**

**MARKING SCHEME**

Question 1

**Results:**

The volume of the pipette used was 25cm<sup>3</sup>

The volume of the burette used was 50cm<sup>3</sup>

**Burette readings**

<b>Titration Number</b>	<b>Pilot</b>	<b>1</b>	<b>2</b>	<b>3</b>
Initial volume (cm <sup>3</sup> )	26.30	25.00	25.00	25.00
Final volume (cm <sup>3</sup> )	0.00	0.00	0.00	0.00
Volume used (cm <sup>3</sup> )	26.30	25.00	25.00	25.00

**(03 marks)**

The average titre value

$$\text{Titre value} = \frac{V_1 + V_2 + V_3}{3} \quad \text{(00}\frac{1}{2}\text{ marks)}$$

$$\text{Titre value} = \frac{25.00 + 25.00 + 25.00}{3} \quad \text{(00}\frac{1}{2}\text{ marks)}$$

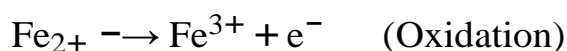
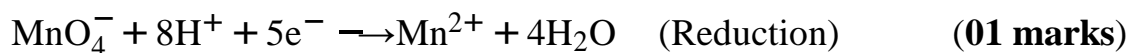
Titre value = 25.00cm<sup>3</sup> (00 $\frac{1}{2}$  marks)

**Summary:**

25.00cm<sup>3</sup> of Y required 25.00cm<sup>3</sup> of X for complete reaction. (01 marks)

**Questions:**

(a) (i) Half reaction involved.



(ii) The overall balanced ionic redox reaction.



(iii) An oxidant is KMnO<sub>4</sub> or MnO<sub>4</sub>. (00 $\frac{1}{2}$  marks)<sub>2</sub>

A reductant is FeSO<sub>4</sub> or Fe<sup>2+</sup> ions (00 $\frac{1}{2}$  marks)

(b) The indicator is not used, because KMnO<sub>4</sub> or MnO<sub>4</sub> ions is a self indicator due to its purple/pink colour which change in the process of reacting. (01 marks)

(c) In this experiment only H<sub>2</sub>SO<sub>4</sub> is used because HCl is oxidized to Cl<sub>2</sub> while HNO<sub>3</sub> is a strong oxidizing agent so instead of being used as medium for the reaction they interfere the reaction. (01 marks)

(d) Calculate:

(i) Concentration of FeSO<sub>4</sub>.XH<sub>2</sub>O in g/dm<sup>3</sup>

13.9g of FeSO<sub>4</sub>XH<sub>2</sub>O = 500cm<sup>3</sup> of distilled water

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

$$y = \frac{13.9 \times 1000}{500}$$

$$y = 27.80\text{g/dm}^3 \quad (00\frac{1}{2} \text{ marks})$$

The concentration of FeSO<sub>4</sub>.XH<sub>2</sub>O is 27.80g/dm<sup>3</sup> (00 $\frac{1}{2}$  marks)

(ii) Concentration of KMnO<sub>4</sub> in g/dm<sup>3</sup>

0.79g of KMnO<sub>4</sub> = 250cm<sup>3</sup> of distilled water

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

$$x = \frac{0.79 \times 1000}{250}$$

$$x = 3.16\text{g/dm}^3 \quad (00\frac{1}{2} \text{ marks})$$

The concentration of KMnO<sub>4</sub> is 3.16g/dm<sup>3</sup> (00 $\frac{1}{2}$  marks)

(iii) Molarity of  $\text{KMnO}_4$

$$\text{molarity} = \frac{\text{concentration}}{\text{molar mass}} \quad (00\frac{1}{2} \text{ marks})$$

$$\text{molarity} = \frac{3.16}{158} \quad (00\frac{1}{2} \text{ marks})$$

$$\text{molarity} = 0.02 \text{ mol/dm}^3$$

The molarity of  $\text{KMnO}_4$  is  $0.02 \text{ mol/dm}^3$  (00 $\frac{1}{2}$  marks)

(iv) Molarity of  $\text{FeSO}_4$

$$\text{MFe}^{2+} = \frac{n\text{Fe}^{2+} \times \text{MnO}_4^- \times V\text{MnO}_4^-}{1} \quad (00\frac{1}{2} \text{ marks})$$

$$\text{MFe}^{2+} = \frac{5 \times 0.02 \times 25.40}{1 \times 25.00} \quad (00\frac{1}{2} \text{ marks})$$

$$\text{MFe}^{2+} = 0.1 \text{ M}$$

The Molarity of  $\text{FeSO}_4$  or  $\text{Fe}^{2+}$  is  $0.1 \text{ M}$  (00 $\frac{1}{2}$  marks)

(v) Concentration of  $\text{FeSO}_4 \cdot \text{XH}_2\text{O}$

$$\text{Concentration} = \text{molarity} \times \text{molar mass} \quad (00\frac{1}{2} \text{ marks})$$

$$\text{Concentration} = 0.1 \times 152 \quad (00\frac{1}{2} \text{ marks})$$

$$\text{Concentration} = 15.29 \text{ g/dm}^3$$

The Concentration  $\text{FeSO}_4$  is  $15.29 \text{ g/dm}^3$  (00 $\frac{1}{2}$  marks)

(vi) Value of X in the formula  $\text{FeSO}_4 \cdot \text{XH}_2\text{O}$

$$\frac{\text{Mass of hydrated salt}}{\text{Mass of anhydrous}} = \frac{\text{molar mass of hydrated}}{\text{Molar mass of anhydrous}}$$

$$\frac{27.8}{15.2} = \frac{152 + 18X}{152}$$

$$X = 7$$

Alternative

$$\text{FeSO}_4 \cdot \text{XH}_2\text{O} = 278$$

$$56 + 32 + (16 \times 4) + 18x = 278$$

$$X = 126/18 = 7$$

Question 2

Table of results

a)

Salt	Volume of water V	Mass of salt (g)	Initial temperature of water T1(°C)	Final temperature of solution T2 (°C)	$\Delta T = T_2 - T_1$ (°C)	Molar mass of salt (Mr)
CuSO <sub>4</sub>	50	4	22	28	+6	160
CuSO <sub>4</sub> .5H <sub>2</sub> O	50	6	22	21	-1	250

(3 Marks)

b) Temperature change  $T = T_2 - T_1$  in each experiment

$$\text{CuSO}_4 = 28 - 22$$

$$\Delta T = +6^\circ\text{C}$$

(01 mark)

$$\text{For CuSO}_4 \cdot 5\text{H}_2\text{O} = 21 - 22$$

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

(01 mark)

Enthalpy of solution in each salt

For CuSO<sub>4</sub>

$$\Delta H = - (M \times C \times \Delta T)$$

$$= - (50 \times 1 \times 4.18 \times 6)$$

$$= -1254\text{J}$$

$$4\text{g} = -1254\text{J}$$

$$160\text{g/mol} = X$$

$$X = \frac{-1254 \times 160}{4}$$

4

Enthalpy of solution of CuSO<sub>4</sub> is -50160J/mol (-50.160Kj/mol)

For CuSO<sub>4</sub>.5H<sub>2</sub>O

$$\Delta H = -(M \times C \times \Delta T)$$

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

$$= 209\text{J}$$

$$\text{Then } 6\text{g} = 209\text{J}$$

$$250\text{g/mol} = X$$

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

6

Enthalpy of solution of CuSO<sub>4</sub>.5H<sub>2</sub>O is 8708.33J/mol (8.708kJ/mol<sup>-1</sup>)

c) The expected values are different from experimental value,

-CuSO<sub>4</sub>, the heat given out on dissolving the salt is lower (-50.160kJmol<sup>-1</sup>) than expected value (-66.10kJmol<sup>-1</sup>), because some of heat is absorbed by Cu<sup>2+</sup> ion during hydration of these ions.

Cu<sup>2+</sup><sub>(s)</sub> → Cu<sup>2+</sup><sub>(aq)</sub> during hydration of these ions the heat energy is absorbed and is termed as Enthalpy of hydration.

-CuSO<sub>4</sub>.5H<sub>2</sub>O, the heat absorbed by this salt is lower since there are five water molecules per mole that is already present in the salt, so the only small amount of energy is required to hydrate one mole of the salt, that is why the decrease in enthalpy of solution.

### Question 3

S/N	Experiment	Observation	Inferences
1.	(a) To 1cm <sup>3</sup> of first portion of filtrate solution NaOH solution was added till excess.	White precipitate soluble in excess NaOH was observed. (01 Mark)	Zn <sup>2+</sup> or Pb <sup>2+</sup> may be present. (01 Mark)
	(b) To 1cm <sup>3</sup> of second portion of filtrate solution NH <sub>4</sub> OH solution was added till excess.	White precipitate soluble in excess NH <sub>4</sub> OH was observed. (01 Mark)	Zn <sup>2+</sup> may be present. (01 Mark)
	(c) To 1cm <sup>3</sup> of third portion of filtrate solution HNO <sub>3</sub> solution was added followed by AgNO <sub>3</sub>	White precipitate insoluble in HNO <sub>3</sub> but soluble in	Cl <sup>-</sup> present, confirmed. (01 Mark)

	solution then $\text{NH}_3$ solution.	$\text{NH}_3$ solution. (01 Mark)	
2.	(a) To residue in a test-tube concentrated $\text{HCl}$ was added.	Effervescence observed and the gas evolved turn lime water to milky.(01 Mark)	$\text{CO}_3^{2-}$ or $\text{HCO}_3^-$ may be present.(01 Mark)
	(b)(i) To $1\text{cm}^3$ of first portion of residue solution $\text{MgSO}_4$ solution was added.	White precipitates observed.(01 Mark)	$\text{CO}_3^{2-}$ present, Confirmed (01 Mark).
	(ii) To $1\text{cm}^3$ of second portion of residue solution potassium iodide solution was added and heated.	Yellow ppt is formed which disappear on warming but re-appear on cooling.(01 Mark)	$\text{Pb}^{2+}$ present, confirmed (01 Mark).

### Conclusion

- (a) The cations in sample P are  $\text{Zn}^{2+}$  and  $\text{Pb}^{2+}$ . (00<sup>1</sup> marks)  
2
- (b) The anions in sample P are  $\text{Cl}^-$  and  $\text{CO}_3^{2-}$ . (00<sup>1</sup> marks)  
2
- (c) Sample P is a mixture of  $\text{ZnCl}_2$  and  $\text{PbCO}_3$  or  $\text{ZnCO}_3$  and  $\text{PbCl}_2$ .(02 marks)