

THE UNITED REPUBLIC OF TANZANIA  
PRESIDENT'S OFFICE - REGIONAL ADMINISTRATION  
AND LOCAL GOVERNMENT

NJOMBE REGION AND MBARAU DISTRICT

FORM SIX PRE-NATIONAL EXAMINATION MARCH 2024

132/3B CHEMISTRY 3B

MARKING SCHEME GUIDE

Pg. 1.

SOLUTION.

- 1) The volume of the pipette used was 25 cm<sup>3</sup> 00/2  
 The volume of the burette used was 50 cm<sup>3</sup> 00/2

Burette readings:

Titration number	Pilot	1	2	3
Final volume (cm <sup>3</sup> )	25.00	25.00	26.30	25.00
Initial volume (cm <sup>3</sup> )	0.00	0.10	1.40	0.20
Volume used (cm <sup>3</sup> )	25.00	24.90	24.90	24.80

(04 marks)

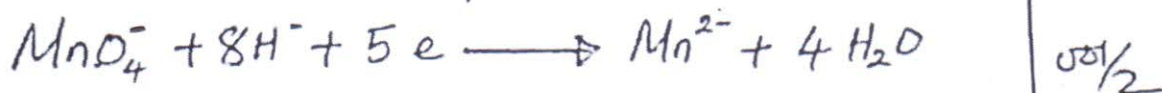
The average titre value

$$\frac{24.90 + 24.90 + 24.80}{3} = 24.90 \text{ cm}^3 \quad (00/2)$$

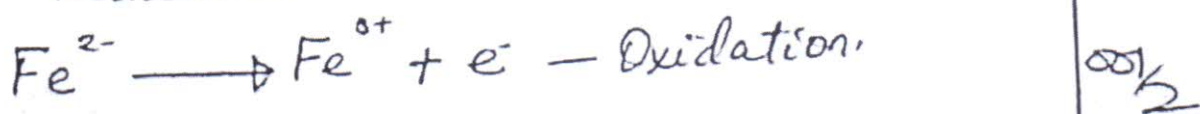
Summary:

25.00 cm<sup>3</sup> of B, required 24.00 cm<sup>3</sup> of A, for complete reaction. (00/2)

@ (i) Half reaction equations involved.



Reduction



(ii) Overall ionic equation for the reaction



(iii) An oxidant is KMnO<sub>4</sub> or MnO<sub>4</sub><sup>-</sup> 00/2

- A reductant is FeSO<sub>4</sub> or Fe<sup>2+</sup> ions. 00/2

a) The indicator is not used, because  $\text{KMnO}_4$  or  $\text{MnO}_4^-$  ions is a self-indicator due to its purple/pink colour which changes in the process of reacting.

01

b) In this experiment only  $\text{H}_2\text{SO}_4$  is used because,  $\text{HCl}$  is oxidized to  $\text{Cl}_2$  and  $\text{HNO}_3$  is a strong oxidizing agent, so instead of being used as medium for the reaction they interfere the reaction.

01

c) (i) Concentration of  $\text{FeSO}_4 \cdot \text{H}_2\text{O}$  in  $\text{gdm}^3$   
13.90g of  $\text{FeSO}_4 \cdot \text{H}_2\text{O} \equiv 500 \text{ cm}^3$  of distilled water

$1 \text{ dm}^3 \equiv 1000 \text{ cm}^3$  of distilled water

$$y = \frac{13.90 \times 1000}{500} = 27.80$$

$\therefore$  The concentration of  $\text{FeSO}_4 \cdot \text{H}_2\text{O}$  is  $27.80 \text{ gdm}^3$

01

(ii) Concentration of  $\text{KMnO}_4$  in  $\text{gdm}^3$   
0.79 of  $\text{KMnO}_4 \equiv 250 \text{ cm}^3$  of distilled water

$1 \text{ dm}^3 \equiv 1000 \text{ cm}^3$  of distilled water.

$$q = \frac{0.79 \times 1000}{250} = 3.16$$

$\therefore$  The concentration of  $\text{KMnO}_4$  is  $3.16 \text{ gdm}^3$

02

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

$$\text{Molarity} = \frac{\text{concentration}}{\text{Molar Mass}}$$

$$= \frac{3.16}{158} = 0.02\text{M}$$

$\therefore$  The molarity of  $\text{KMnO}_4$  is  $0.02 \text{ mol dm}^{-3}$

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

From the overall balanced redox reaction equation above.

$$M_{\text{Fe}^{2+}} = \frac{n_{\text{Fe}^{2+}} \times M_{\text{MnO}_4^-} \times V_{\text{MnO}_4^-}}{n_{\text{MnO}_4^-} \times V_{\text{Fe}^{2+}}}$$

$$= \frac{5 \times 0.02 \times 24.90}{1 \times 25.00}$$

$$= 0.10\text{M}$$

$\therefore$  The molarity of  $\text{FeSO}_4$  or  $\text{Fe}^{2+}$  is  $0.10 \text{ mol dm}^{-3}$

(v) Concentration of  $\text{FeSO}_4$  in  $\text{g dm}^{-3}$

$$\text{Concentration} = \text{Molarity} \times \text{Molar mass}$$

$$= 0.10 \times 152 = 15.20$$

$\therefore$  The concentration of  $\text{FeSO}_4$  is  $15.20 \text{ g dm}^{-3}$

(v) Value of  $x$ , in the formula  $FeSO_4 \cdot xH_2O$   
From

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

$$\frac{27.80}{15.20} = \frac{152 + 18x}{152}$$

$$15.20(152 + 18x) = 27.80 \times 152$$

$$2310.40 + 273.60x = 4225.60$$

$$x = \frac{4225.60 - 2310.40}{273.60} = 7$$

∴ The value of  $x$ , is 7 and the formula now is  $FeSO_4 \cdot 7H_2O$

02

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Total  
20  
marks

## Experimental results

Experimental	Initial temperature (°C)	Final temperature (°C)	Temperature change (°C)
S	24.00	20.00	-4
T	24.00	26.00	+2

FT = 03  
marks

(a) The heat change in each experiment  
From for salt D

The formula

$$\Delta H = -(c\rho V \Delta T)$$

$$\text{But } c = 4.2 \text{ J g}^{-1} \text{ K}^{-1}$$

$$\rho = 1.0 \text{ g cm}^{-3}$$

$$V = 50 \text{ cm}^3$$

$$\Delta T = -4.00 \text{ K}$$

$$\Delta H = -4.2 \times 1 \times 50 \times -4 \quad \text{02 marks}$$

The heat change is 840 J

For salt T

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

$$\Delta H = -(50 \times 4.2 \times 2)$$

$$\Delta H = -420 \text{ J}$$

B.6

∴ The heat change is  $-420\text{J}$  02 marks

(b) The molar heat change of solution in each experiment

$$\text{The molar heat change} = \frac{\text{Heat}}{\text{Number of moles}}$$

For salt S

$$\text{The heat change} = 840\text{J} (0.84\text{kJ})$$

$$\text{number of moles} = \frac{\text{mass given}}{\text{molar mass}}$$

$$\text{Mass given} = 5.60\text{g}$$

$$\text{molar mass of S} = 286\text{g/mol}$$

$$= \frac{5.60\text{g}}{286\text{g/mol}}$$

$$= 0.0196 \text{ moles} \quad 01 \text{ mark}$$

Then

$$\text{Molar heat change} = \frac{\text{Heat change}}{\text{Number of moles}}$$

$$= \frac{840\text{J}}{0.0196}$$

$$= 42857.14\text{J/mol} \text{ or } 42.86\text{kJ/mol} \quad 02 \text{ marks}$$

∴ The molar heat change of solution for salt S is  $42.86\text{kJ/mol}$

For salt T

$$\text{The heat change} = -420\text{J} (-0.42\text{kJ})$$

$$n = \frac{\text{mass}}{\text{molar mass}}$$

But Mass given = 2.12g

molar mass = 106g/mol

$$\text{number of moles} = \frac{2.12\text{g}}{106\text{g/mol}}$$

= 0.02 moles of mark

Then molar heat change =  $\frac{\text{Heat change}}{\text{Number of moles}}$

$$= \frac{-420\text{J}}{0.02\text{ moles}}$$

$$= -21000\text{J/mol} = -21\text{kJ/mol}$$

02 marks

∴ The molar heat change of solution for salt T is  
-21 kJ/mol

(c) The molar heat of hydration of anhydrous carbonate to decahydrate sodium carbonate

$\Delta H$  of solution (Hydration energy) =  $\Delta H$  for hydrated +  $\Delta H$  for anhydrous

$$\Delta H = +42.86\text{ kJ/mol} - 21.00\text{ kJ/mol}$$

$$\Delta H = 21.86\text{ kJ/mol}$$

02 marks

(d) The molar heat change for salt (S) (hydrated one) the heat was absorbed by the salt and only small amount of energy were required to dissolve one moles of salt thus the heat change was endothermic while the molar heat change for salt T (anhydrous one) the heat was given out on dissolving the lattice must be destroyed and hence negative lattice. thus it is exothermic process.

02 marks

### QUESTION 3

Experiment	Observation	Inference
(a)	Green crystals	$Fe^{2+}$ , $Ni^{2+}$ , $Cr^{3+}$ and $Cu^{2+}$ may be present
(b)	Colourless gas evolves and forms white dense fumes with ammonia gas	$Cl^-$ may be present
(c)	Soluble in cold water	$NO_3^-$ , $Cl^-$ , $SO_4^{2-}$ , $HCO_3^-$ , $Na^+$ , $K^+$ , $Mg^{2+}$ may be present
(d)	Dirty green ppt turns brown on exposure to air and insoluble in excess solution	$Fe^{2+}$ may be present
(e)	Colourless gas with irritating smell evolves and forms white dense fumes with ammonia gas	$Cl^-$ may be present
(f) Confirmatory test		

Confirmatory test for  $Fe^{2+}$   
 - To the solution of Sample E few drops of Potassium hexacyanoferrate (III) was added

Dark blue precipitate is formed.

$Fe^{2+}$  confirmed

Confirmatory test for  $Cl^-$

- To the sample solution E, dilute  $HNO_3$  was added followed by  $AgNO_3$  solution

White ppt soluble in dilute  $NH_3$  solution was formed.

$Cl^-$  confirmed.

Confirmatory test for  $SO_4^{2-}$

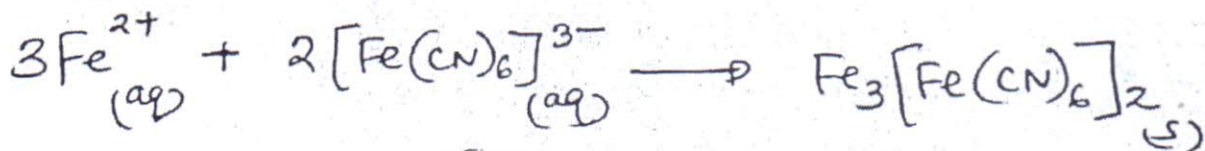
- To a sample solution E,  $BaCl_2$  solution was added followed by dil.  $HCl$  solution.

White precipitate was formed

$SO_4^{2-}$  confirmed.

$(\frac{0.01}{2} \times 0.04 \text{ mol/L}) \times \frac{0.01}{2} = 0.04 \text{ mol/L}$

v) Chemical equations for experiments (F)

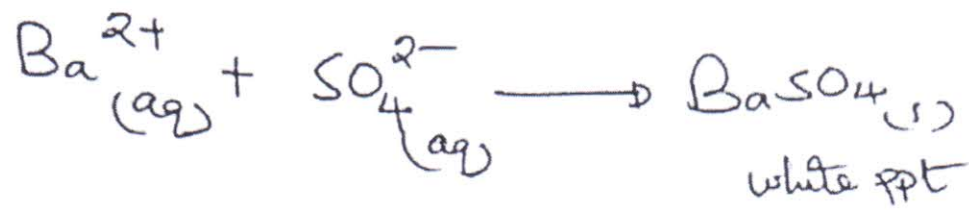


(2 marks)

Dark blue

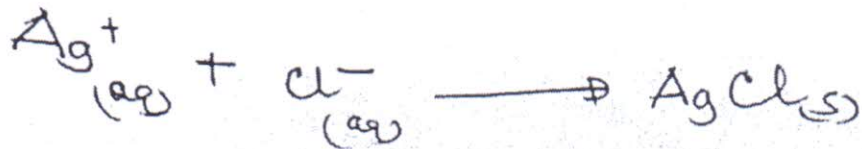
For  $Fe^{2+}$ .

For  $\text{SO}_4^{2-}$



(0/1 marks)

For  $\text{Cl}^-$



white ppt -

(0/1 marks)

(iii) Cation is  $\frac{\text{Fe}^{2+}}{(0/1 \text{ mark})}$  and Anion is  $\frac{\text{Cl}^-}{(0/1 \text{ marks})}$  and  $\frac{\text{SO}_4^{2-}}{(0/1 \text{ mark})}$