THE UNITED REPUBLIC OF TANZANIA

PRESIDENT'S OFFICE – REGIONAL ADMINISTRATION AND LOCAL GOVERNMENT

NJOMBE REGION AND MBARALI DISTRICT

FORM SIX PRE-NATIONAL EXAMINATION MARCH 2024

132/3B CHEMISTRY 3B

# MARKING SCHEME GUIDE

SOLUTION.

1) The volume of the pipette used was $25cm^3$ 00½
The volume of the burette used was $50cm^3$ 00½

Burette Readings:

| Titration number | Pilot | 1 | 2 | 3 |
|---|---|---|---|---|
| Final volume ($cm^3$) | 25.00 | 25.00 | 26.30 | 25.00 |
| Initial volume ($cm^3$) | 0.00 | 0.10 | 1.40 | 0.20 |
| Volume used ($cm^3$) | 25.00 | 24.90 | 24.90 | 24.80 |

(04 marks)

The average titre value

$$\frac{24.90 + 24.90 + 24.80}{3} = 24.90cm^3$$ (00½)

Summary:

$25.00\ cm^3$ of B, required $24.00\ cm^3$ of A, for complete reaction. (00½)

@ (i) Half reaction equations involved.

$MnO_4^- + 8H^- + 5e \longrightarrow Mn^{2-} + 4H_2O$ 00½

Reduction

$Fe^{2-} \longrightarrow Fe^{0+} + e^-$ — Oxidation. 00½

(ii) Overall ionic equation for the reaction

$MnO_4 + 5Fe^{2-} + 8H^- \longrightarrow Mn^{2-} + 5Fe^{3+} + 4H_2O$ 01

(iii) An oxidant is $KMnO_4$ or $MnO_4^-$ 00½

- A reductant is $FeSO_4$ or $Fe^{2+}$ ions. 00½

@ The indicator is not used, because $KMnO_4$ or $MnO_4$ ions is a self-indicator due to its purple/pink colour which changes in the process of reacting. 01

(b) In this experiment only $H_2SO_4$ is used because, HCl is oxidized to $Cl_2$ and $HNO_3$ is a strong oxidizing agent, so instead of being used as medium for the reaction they interfere the reaction. 01

(c) (i) Concentration of $FeSO_4 X H_2O$ in $gdm^3$

$13.90g$ of $FeSO_4 X H_2O \equiv 500\ cm^3$ of distilled water

$Y \equiv 1000\ cm^3$ of distilled water

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

∴ The concentration of $FeSO_4 X H_2O$ is $27.80 gdm^3$ 01

(ii) Concentration of $KMnO_4$ in $gdm^3$

$0.79$ of $KMnO_4 \equiv 250\ cm^3$ of distilled water

$q \equiv 1000\ cm^3$ of distilled water.

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

∴ The concentration of $KMnO_4$ is 02

$3.16\ gdm^3$

(iii) Molarity of $KMnO_4$

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

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

∴ The molarity of $KMnO_4$ is $0.02\ moldm^{-3}$ 0

(iv) Molarity of $FeSO_4$

From the overall balanced redox reaction equation above.

$$M_{Fe^{2+}} = \frac{n_{Fe^{2-}} \times M_{MnO_4^-} \times V_{MnO_4^-}}{n_{MnO_4^-} \times V_{Fe^{2+}}}$$

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

$$= 0.10M$$

∴ The molarity of $FeSO_4$ or $Fe^{2-}$ is $0.10\ moldm^{-3}$ 02

(v) Concentration of $FeSO_4$ in $gdm^{-3}$

Concentration = Molarity x Molar mass

$$= 0.10 \times 152 = 15.20$$

∴ The concentration of $FeSO_4$ is $15.20\ gdm^{-3}$ 0

(vi) Value of X, in the formula $FeSO_4 X H_2O$

· From

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

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

$$15.20(152 \div 18X) = 27.80 \times 152$$

$$2310.40 + 273.6X = 4225.60$$

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

∴ The value of X, is 7 and the formula now is $FeSO_4 7H_2O$ 02

Total 20 marks

QUESTION 2

Solution

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 mks

(a) The heat change in each experiment

From for salt D

The formula

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

But $C = 4.2 J g^{-1} K^{-1}$

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

$V = 50 cm^3$

$\Delta T = -4.00 K$

$\Delta H = -4.2 \times 1 \times 50 \times -4$ 02 marks

The heat change is 840J

For salt T

$\Delta H = -(MC\Delta T)$

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

$\Delta H = -420 J$

∴ The heat change is −420J 02 marks

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

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

For salt S

The heat change = 840J (0.84KJ)

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

Mass given = 5.60g

molar mass of S = 286g/mol

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

= 0.0196 moles 01 mark

Then

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

$= \frac{840J}{0.0196}$ 02 marks

= 42857.14J/mol or 42.86 KJ/mol

∴ The molar heat change of solution for salt S is 42.86 KJ/mol

For salt T

The heat change = −420J (−0.42KJ)

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

But Mass given = 2.12g

Molar mass = 106g/mol

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

= 0.02 moles 01 mark

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

= $\frac{-420J}{0.02 \text{ moles}}$ 02 marks

= −21000J/mol = −21KJ/mol

∴ The molar heat change of solution for salt T is −21 KJ/mol

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

ΔH of solution (Hydration energy) = ΔH for hydrated + ΔH for Unhydrate

ΔH = +42.86 KJ/mol − 21.00 KJ/mol

ΔH = 21.86KJ/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 mole of salt thus the heat change was endothermic while the molar heat change for salt T (Unhydrous one) the heat was given out on dissolving the lattice must be destroyed and hence negative lattice. Thus it is exothermic process. 02 marks

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## QUESTION 3

(i)

| Experiment | Observation | Inference |
|---|---|---|
| (a) | Green crystals | $Fe^{2+}$, $Ni^{2+}$, $Cr^{3+}$ and $Cu^{2+}$ may be present |
| (b) | Colourless gas evolved and forms white dense fumes with ammonia gas | $Cl^-$ may be present |
| (c) | Soluble in cold water | $NO_3^-$, $Cl^-$, $SO_4^{2-}$, $HCO_3^-$, $Na^+$, $K^+$, $NH_4^+$ 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 evolved and forms white dense fumes with ammonia gas | $Cl^-$ may be present |
| (f) Confirmatory test | | |

| | | |
|---|---|---|
| Confirmatory test for $Fe^{2+}$<br>– To the solution of Sample E few drops of Potassium hexacyano-ferrate (II) was added | Dark blue Precipitate is formed. | $Fe^{2+}$ confirmed |
| Confirmatory test for $Cl^-$<br>– 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 $SO_4^{2-}$<br>– To a sample solution E, $BaCl_2$ solution was added followed by dil. HCl solution. | White precipitate was formed | $SO_4^{2-}$ confirmed. |

(01½ @ = 04 marks) 01½ @ = 04 Marks

i) Chemical equations for experiments (f)

$$3Fe^{2+}_{(aq)} + 2[Fe(CN)_6]^{3-}_{(aq)} \longrightarrow Fe_3[Fe(CN)_6]_{2(s)}$$

(2 Marks) Dark blue

For $Fe^{2+}$.

for $SO_4^{2-}$

$$Ba^{2+}_{(aq)} + SO_4^{2-}{}_{(aq)} \longrightarrow BaSO_{4(s)}$$

white ppt

(0 / marks)

For $Cl^-$

$$Ag^+_{(aq)} + Cl^-_{(aq)} \longrightarrow AgCl_{(s)}$$

white ppt.

(0 / marks)

(iii) Cation is $Fe^{2+}$ (0 / mark) and Anion is $Cl^-$ (0 / marks) and $SO_4^{2-}$ (0 / mark)