DAR-ES-SALAAM REGION

FORM VI MOCK EXAM

CHEMISTRY 3A

MARKING SCHEME.

Part I

Table of results.

Experiment	Pilot	1	2	3
Final volume (cm^3)	20.50	20.20	20.00	20.10
Initial volume (cm^3)	0.00	0.00	0.00	0.00
Volume used (cm^3)	20.50	20.20	20.00	20.10

Filling the table = 01 Mark
Decimal places = 01 Mark
Accurate volume = 01 Mark.
Total = (03) Marks

Average volume used $= \frac{T_1 + T_2 + T_3}{3}$

$= \frac{(20.20 + 20.00 + 20.10)\,cm^3}{3}$

$= 20.10\,cm^3$. (01 Mark)

Summary

20 cm^3 of a solution A_1 required 20.10 cm^3 of a solution A_2 for complete reaction. 01 Mark

Part II

Table of results.

Experiment	Pilot	1	2	3
Final volume (cm^3)	23.90	23.60	23.60	23.70
Initial volume (cm^3)	0.00	0.00	0.00	0.00
Volume used (cm^3).	23.90	23.60	23.60	23.70

Filling the table = (01)
Decimal places = (01)
Accurate volume = (01)
Total = (03)

Average volume used $= \frac{V_1 + V_2 + V_3}{3}$

$= \frac{(23.60 + 23.60 + 23.70)cm^3}{3}$

$= \frac{70.9}{3}$

$= 23.63\,cm^3$. 0/Mark

a) Calculate the;

i) Molarity of potassium permanganate.

Considering a balanced chemical equation.

5 | $C_2O_{4(aq)}^{2-} \longrightarrow 2CO_{2(g)} + 2e^-$

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

Overall reaction.

$5C_2O_4^{2-} + 2MnO_4^- + 16H^+ \longrightarrow 10CO_2 + 2Mn^{2+} + 8H_2O$ (01)

$n_o = 5$

$n_p = 2$.

Finding the molarity of sodium oxalate;

Conc. in $g/dm^3 = m/V = 3.35/0.5dm^3 = 6.7\,g/dm^3$ (00½)

Then; Molarity $= \frac{\text{Conc. in } g/dm^3}{\text{Molar mass}} = \frac{6.7g/dm^3}{134\,g/mol}$ (01)

$= 0.05M$.

From; $\frac{M_pV_p}{n_p} = \frac{M_oV_o}{n_o}$.

$M_p = \frac{M_oV_on_p}{V_pn_o}$ (00½)

$$M_p = \frac{0.05M \times 20cm^3 \times 2}{20.10 \times 5}$$

$$M_p = 0.02M \quad (01)$$

∴ The molarity of potassium permanganate is 0.02M.

ii) Concentration of potassium permanganate in g/dm^3.

From:

Conc. In g/dm^3 = Molarity x Molar mass.

$= 0.02M \times 158 g/mol.$

$= \underline{3.16 g/dm^3}.$ (01)

iii) Molarity of iron (ii) salt.

Considering a balanced equation,

$5 \mid Fe^{2+} \longrightarrow Fe^{3+} + e^-$

$1 \mid MnO_4^- + 8H^+ + 5e^- \longrightarrow Mn^{2+} + 4H_2O$

Overall equation,

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

$n_{Fe} = 5 \quad , n_p = 1.$

From; $\frac{M_{Fe}V_{Fe}}{n_{Fe}} = \frac{M_pV_p}{n_p}.$ (00½)

$$M_{Fe} = \frac{M_pV_pn_{Fe}}{V_{Fe}n_p}.$$

$$M_{Fe} = \frac{0.02M \times 20.10cm^3 \times 5}{23.63\ cm^3}$$

$M_{Fe} = 0.085M.$ (01)

∴ The molarity of iron(ii) salt is 0.085M.

iv) Concentration of anhydrous iron (ii) salt in g/dm^3.

From;

Concentration in g/dm^3 = Molarity x Molar mass.

= 0.085M x 284 g/mol.

= $\underline{24.14\ g/dm^3}$. (01)

b) Required the value of X.

Given;

Conc. in g/dm^3 = 33.3 g/dm^3.

Molarity = 0.085M.

From: Molar mass = $\frac{\text{Conc. in } g/dm^3}{\text{Molarity}}$

= $\frac{33.3\ g/dm^3}{0.085M}$.

= 391.76 g/mol. --- (01 Mark)

Then;

$Fe(SO_4)_2NH_4 \cdot XH_2O = 391.76$

$56 + (16+64)\times 2 + 14 + 4 + 18x = 391.76$ (00½)

$284 + 18x = 391.76$

$\frac{18x}{18} = \frac{107.76}{18}$

$x = 6$.

∴ The value of X is 6. (01)

2 (a) Part I.

Initial temperature (T_i) = 32°C.

Final temperature (T_f) = 52°C (01)

$\Delta T = T_f - T_i$

$\Delta T = 52°C - 32°C$

$\underline{\Delta T = 20°C.}$ (01)

Part II:

Initial temperature (T_i) = 32°C. (01)

Final temperature (T_f) = 34°C.

$\Delta T = T_f - T_i$

$\Delta T = 34°C - 32°C$ (01)

$\underline{\Delta T = 2°C.}$

(b) Required the heat evolved.

Part I:

$Mg_{(s)} + 2HCl_{(aq)} \longrightarrow MgCl_{2(aq)} + H_{2(g)}$ $\Delta H = ?$ (00½)

From: $\Delta H = -m \times c \times \Delta T.$

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

$\Delta H = -1 g/cm^3 \times 50 cm^3 \times 4.2 J g^{-1} K^{-1} \times 20°C$

$\Delta H = -4200 J$ or $-4.2 kJ.$ (01)

But; 0.2g of Mg $\equiv -4.2$ kJ

24g of Mg $\equiv$?

-504 kJ/mol. (01)

∴ The heat evolved during the reaction in part I is -504 kJ/mol.

Part II

$MgCO_{3(s)} + 2HCl_{(aq)} \longrightarrow MgCl_{2(aq)} + CO_{2(g)} + H_2O_{(l)}$ $\Delta H = ?$ (00½)

From; $\Delta H = -mc\Delta T$

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

$\Delta H = -1\,g/cm^3 \times 50\,cm^3 \times 2^\circ C \times 4.2\,J/gK$

$\Delta H = -420\,J$ or $-0.42\,kJ$. (01)

But;

$1\,g$ of $MgCO_3 \longrightarrow -0.42\,kJ$.

$84\,g\,(1\,mol)$ of $MgCO_3 \longrightarrow$?

$\Delta H = -35.28\,kJ/mol$. (01)

∴ The evolved during the reaction in part II is $-35.28\,kJ/mol$.

b) Required the enthalpy of $MgCO_3$.

Given equation;

i) $Mg_{(s)} + 2HCl \longrightarrow MgCl_{2(aq)} + H_2$, $\Delta H = -504\,kJmol^{-1}$.

ii) $MgCO_{3(s)} + 2HCl \longrightarrow MgCl_2 + CO_2 + H_2O$, $\Delta H = -35.28\,kJmol^{-1}$.

iii) $C + O_2 \longrightarrow CO_2$ $\Delta H = -394\,kJmol^{-1}$

iv) $H_2 + \frac{1}{2}O_2 \longrightarrow H_2O$ $\Delta H = -286\,kJmol^{-1}$.

Required equation,

$Mg + C + \frac{3}{2}O_2 \longrightarrow MgCO_3$ $\Delta H_f = ?$

00½@ = 02½ Marks.

Reversing equation (ii)

$MgCl_2 + CO_2 + H_2O \longrightarrow MgCO_3 + 2HCl$ $\quad \Delta H_1 = +35.28\ kjmol^{-1}$

$Mg + 2HCl \longrightarrow MgCl_2 + H_2$ $\quad \Delta H_2 = -504\ kjmol^{-1}$

$C + O_2 \longrightarrow CO_2$ $\quad \Delta H_3 = -394\ kjmol^{-1}$

$H_2 + \frac{1}{2}O_2 \longrightarrow H_2O$ $\quad \Delta H_4 = -286\ kjmol^{-1}$

02

$\Delta H_f = \Delta H_1 + \Delta H_2 + \Delta H_3 + \Delta H_4$ ——— 00 1/2

$\Delta H_f = +35.28 + -504 + -394 + -286\ kjmol^{-1}$

$\Delta H_f = -1148.72\ kjmol^{-1}$

01

∴ The heat of formation of $MgCO_3$ was $-1148.72\ kjmol^{-1}$.

S/N	Exp	Observation c1@	Inference. oo½@
(a)	01½	Green-yellow colour crystalline form	Fe^{2+}, Ni^{2+}, Cr^{3+}, Cu^{2+}, Fe^{3+} CrO_4^{2-} may be present. NO_3^-, SO_4^{2-}, Cl^-, $C_2O_4^{2-}$, CrO_4^{2-}, NO_2^-, CH_3COO^- $Cr_2O_7^{2-}$ may be present.
(b)	01½	Blue-green flame was observed Yellow sparks	Cu^{2+} may be present. Fe^{2+}, Fe^{3+} may be present.
(c)	01½	Black/Reddish brown residue was observed.	Cu^{2+}, Fe^{2+}, Fe^{3+} may be present.
(d)	01½	Colourless gas with irritating smell evolved, which turns moist litmus paper from blue to red and form dense white fumes with ammonia gas.	Cl^- may be present.
(e)	01½	Dirty green precipitate insoluble in excess turns brown on exposure to air.	Fe^{2+} may be present.
f	01½	i) Dark blue precipitate was formed.	Fe^{2+} confirmed.
	01½	ii) Blue precipitate soluble in excess ammonia forming a deep blue solution.	Cu^{2+} confirmed.
g	01½	White precipitate ~~soluble~~ was formed.	Cl^- confirmed.

Conclusion.

i) The cations in sample M are Fe^{2+} and Cu^{2+}. (01)

ii) The anion in sample M is Cl^- (01)

iii) The molecular formula M is $FeCl_2$ and $CuCl_2$. (01)

Total = 15 Marks