THE UNITED REPUBLIC OF TANZANIA

NATIONAL EXAMINATIONS COUNCIL

ADVANCED CERTIFICATE OF SECONDARY EDUCATION EXAMINATION

132/3A **CHEMISTRY 3A**

(For Both School and Private Candidates)

Time: 3 Hours **ANSWERS** **Year: 2018**

Instructions

1. This paper consists of THREE questions.

2. Answer all questions.

1. You are provided with the following solutions:

E: 0.02 M potassium permanganate

F: 3.15 g hydrated oxalic acid in 500 cm^3 solution

G: 1 M sulphuric acid

Summary:

Volume of pipette used = 25 cm^3

25 cm^3 of F required 23.60 cm^3 of E for complete reaction

Questions

(a) Write a half reaction equation for the reduction of MnO_4^- ions to Mn^{2+} in acidic solution

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

(b) Write a half reaction equation for the oxidation of $C_2O_4^{2-}$ to CO_2

$C_2O_4^{2-} \rightarrow 2CO_2 + 2e^-$

(c) Write an overall ionic equation

$2MnO_4^- + 5C_2O_4^{2-} + 16H^+ \rightarrow 2Mn^{2+} + 10CO_2 + 8H_2O$

(d) Deduce the value of water of crystallization in hydrated oxalic acid

Molar mass of $C_2H_2O_4 \cdot xH_2O = 90 + 18x$

Moles of F = mol of $MnO_4^- \times 5/2$

$= (0.02 \times 23.60 \div 1000) \times 5/2 = 0.00118$ mol

Mass = 3.15 g in 500 $cm^3 \rightarrow$ in 25 $cm^3 = 3.15 \times 25 \div 500 = 0.1575$ g

Molar mass = $0.1575 \div 0.00118 = 133.47$

$133.47 = 90 + 18x \rightarrow x = (133.47 - 90) \div 18 = 2.4 \approx 2$

Therefore x = 2

(e) Molecular formula of hydrated oxalic acid = $C_2H_2O_4 \cdot 2H_2O$

2. You are provided with:

I: 0.4 g magnesium

J: 0.6 g magnesium carbonate

K: 60 cm^3 of 1 M HCl

Case I: $Mg + 2HCl \rightarrow MgCl_2 + H_2$

$T_1 = 25.0°C$, $T_2 = 36.5°C \rightarrow \Delta T = 11.5°C$

$Q = mc\Delta T = 60 \times 4.2 \times 11.5 = 2898\ J = 2.898\ kJ$

Case II: $MgCO_3 + 2HCl \rightarrow MgCl_2 + CO_2 + H_2O$

$T_3 = 25.0°C$, $T_4 = 32.0°C \rightarrow \Delta T = 7.0°C$

$Q = 60 \times 4.2 \times 7.0 = 1764\ J = 1.764\ kJ$

(b) Calculate enthalpy of formation of $MgCO_3$

$Mg + CO_2 + H_2O \rightarrow MgCO_3$

$\Delta H_{reaction} = -1.764\ kJ$

$\Delta H_{formation\ of\ CO_2} = -394\ kJ/mol$

$\Delta H_{formation\ of\ H_2O} = -286\ kJ/mol$

$\Delta H_{formation\ of\ MgCO_3} = \Delta HCO_2 + \Delta HH_2O - \Delta H_{reaction}$

$= -394 + (-286) - (-1.764) = -680 + 1.764 = -678.24\ kJ/mol$

Enthalpy of formation of $MgCO_3 = -678.24\ kJ/mol$

3. You are provided with sample N containing one cation and one anion. Carry out the experiments described in Table 3. Record carefully your observations, make appropriate inferences and finally identify the anion and cation present in sample N.

Table 3: Table of results

S/n	Experiment	Observations	Inference
(a)	Observe the appearance of sample N	White crystalline solid	Ionic salt likely present
(b)	Heat a little sample N in a dry test tube	Brown gas evolved (NO_2), pungent smell	Presence of nitrate ion (NO_3^-)
(c)(i)	Add NaOH and warm	Ammonia gas evolved, confirmed by smell	Presence of NH_4^+ ion
(c)(ii)	Add freshly prepared $FeSO_4$ followed by conc. H_2SO_4	No brown ring observed	Absence of NO_2^+ or other oxidizing species
(c)(iii)	Add lead ethanoate and boil	No visible precipitate	No sulphate, chloride or halides present
(e)	Perform confirmatory tests for cation and anion	NH_4^+ confirmed by moist red litmus → blue; NO_3^- confirmed by ring test	Confirms NH_4^+ and NO_3^-

Conclusion:

(i) The cation in sample N is NH_4^+

(ii) The anion in sample N is NO_3^-

(iii) The molecular formula for sample N is NH_4NO_3

(iv) Balanced chemical equation for experiment (b):

$NH_4NO_3(s) \rightarrow NO_2(g) + H_2O(g) + N_2(g)$ (on heating)