

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.

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1. You are provided with the following solutions:

E: 0.02 M potassium permanganate

F: 3.15 g hydrated oxalic acid in 500 cm³ solution

G: 1 M sulphuric acid

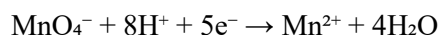
Summary:

Volume of pipette used = 25 cm³

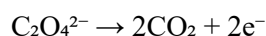
25 cm³ of F required 23.60 cm³ of E for complete reaction

Questions

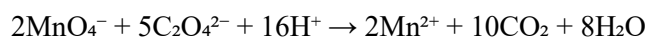
(a) Write a half reaction equation for the reduction of MnO₄⁻ ions to Mn²⁺ in acidic solution



(b) Write a half reaction equation for the oxidation of C₂O₄²⁻ to CO₂



(c) Write an overall ionic equation



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

$$\text{Molar mass of C}_2\text{H}_2\text{O}_4 \cdot x\text{H}_2\text{O} = 90 + 18x$$

$$\text{Moles of F} = \text{mol of MnO}_4^- \times 5/2$$

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

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

$$\text{Molar mass} = 0.1575 \div 0.00118 = 133.47$$

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

Therefore $x = 2$

(e) Molecular formula of hydrated oxalic acid = $\text{C}_2\text{H}_2\text{O}_4 \cdot 2\text{H}_2\text{O}$

2. You are provided with:

I: 0.4 g magnesium

J: 0.6 g magnesium carbonate

K: 60 cm³ of 1 M HCl

Case I: $\text{Mg} + 2\text{HCl} \rightarrow \text{MgCl}_2 + \text{H}_2$

$T_1 = 25.0^\circ\text{C}$, $T_2 = 36.5^\circ\text{C} \rightarrow \Delta T = 11.5^\circ\text{C}$

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

Case II: $\text{MgCO}_3 + 2\text{HCl} \rightarrow \text{MgCl}_2 + \text{CO}_2 + \text{H}_2\text{O}$

$T_3 = 25.0^\circ\text{C}$, $T_4 = 32.0^\circ\text{C} \rightarrow \Delta T = 7.0^\circ\text{C}$

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

(b) Calculate enthalpy of formation of MgCO_3

$\text{Mg} + \text{CO}_2 + \text{H}_2\text{O} \rightarrow \text{MgCO}_3$

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

$\Delta H_{\text{formation of CO}_2} = -394 \text{ kJ/mol}$

$\Delta H_{\text{formation of H}_2\text{O}} = -286 \text{ kJ/mol}$

$\Delta H_{\text{formation of MgCO}_3} = \Delta H_{\text{CO}_2} + \Delta H_{\text{H}_2\text{O}} - \Delta H_{\text{reaction}}$

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

Enthalpy of formation of $\text{MgCO}_3 = -678.24 \text{ kJ/mol}$

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 \rightarrow 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):

