

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: 2019

Instructions

1. This paper consists of THREE questions.
2. Answer all questions.

maktaba.tetea.org



1. You are provided with the following solutions:

UU: 0.5 M KMnO_4 solution diluted from 20 cm^3 to 500 cm^3

VV: H_2O_2 solution made by diluting 13.9 cm^3 of commercial hydrogen peroxide to 500 cm^3

ZZ: 2.0 M H_2SO_4

Summary:

Volume of pipette = 25 cm^3

25 cm^3 of acidified VV required 22.40 cm^3 of UU for complete oxidation

Questions

(a) Write half reaction equations

Oxidation (H_2O_2): $\text{H}_2\text{O}_2 \rightarrow \text{O}_2 + 2\text{H}^+ + 2\text{e}^-$

Reduction (MnO_4^-): $\text{MnO}_4^- + 8\text{H}^+ + 5\text{e}^- \rightarrow \text{Mn}^{2+} + 4\text{H}_2\text{O}$

(b) Calculate the molarity of solution:

(i) UU

Original: 20 cm^3 of 0.5 M $\rightarrow$ diluted to 500 cm^3

Moles = $0.5 \times 20 \div 1000 = 0.01 \text{ mol}$

Molarity = $0.01 \div 0.5 = 0.02 \text{ mol/dm}^3$

(ii) VV

From the redox equation:

$2\text{MnO}_4^- + 5\text{H}_2\text{O}_2 + 6\text{H}^+ \rightarrow 2\text{Mn}^{2+} + 5\text{O}_2 + 8\text{H}_2\text{O}$

So: 2 mol MnO_4^- reacts with 5 mol H_2O_2

Moles of $\text{KMnO}_4 = 0.02 \times 22.40 \div 1000 = 0.000448 \text{ mol}$

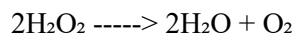
Moles of $\text{H}_2\text{O}_2 = 5/2 \times 0.000448 = 0.00112 \text{ mol}$

Volume of VV = $25 \text{ cm}^3 = 0.025 \text{ dm}^3$

Molarity of VV = $0.00112 \div 0.025 = 0.0448 \text{ mol/dm}^3$

(c) Volume strength of commercial H_2O_2

From decomposition:



2 mol (68 g) H_2O_2 gives $22.4 \text{ dm}^3 \text{ O}_2$

Moles in $1 \text{ dm}^3 = 0.0448 \text{ mol}$

O_2 evolved = $(22.4 \times 0.0448 \times 2) = 2.007 \text{ dm}^3$

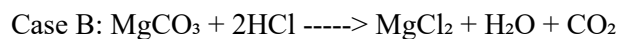
Volume strength = 2.007

2. You are provided with:

B₁: 1 M HCl

B₂: 0.2 g magnesium

B₃: 1 g magnesium carbonate



Given:

$c = 4.2 \text{ Jg}^{-1}\text{K}^{-1}$, $\rho = 1 \text{ g/cm}^3$, $V = 50 \text{ cm}^3 \rightarrow \text{mass} = 50 \text{ g}$

(a) Heat evolved = $mc\Delta T$

Case A:

$T_1 = 25.0^\circ\text{C}$, $T_2 = 35.5^\circ\text{C} \rightarrow \Delta T = 10.5^\circ\text{C}$

$$Q = 50 \times 4.2 \times 10.5 = 2205 \text{ J} = 2.205 \text{ kJ}$$

Case B:

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

$$Q = 50 \times 4.2 \times 7.0 = 1470 \text{ J} = 1.470 \text{ kJ}$$

(b) Calculate enthalpy of formation of MgCO_3

Given:

$$\Delta H_1 (\text{CO}_2) = -394 \text{ kJ/mol}$$

$$\Delta H_2 (\text{H}_2\text{O}) = -286 \text{ kJ/mol}$$

$$\Delta H (\text{reaction from part b}) = -1.470 \text{ kJ}$$

Using Hess's Law:

$$\Delta H_f(\text{MgCO}_3) = \Delta H(\text{CO}_2) + \Delta H(\text{H}_2\text{O}) - \Delta H(\text{reaction})$$

$$= -394 + (-286) - (-1.470)$$

$$= -680 + 1.470$$

$$= -678.53 \text{ kJ/mol}$$

Enthalpy of formation of $\text{MgCO}_3 = -678.53 \text{ kJ/mol}$

3. Substance K contains two cations and two anions. Using the experimental information given in the Table, complete the observations and inferences and hence identify the two cations and anions.

S/n	Experiments	Observations	Inferences
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| 1(i) | Add sodium hydroxide to the first portion of clear solution | White gelatinous precipitate forms, insoluble in excess | Presence of Al^{3+} |

| 1(ii) | Add dilute HNO_3 and AgNO_3 to second portion | White precipitate forms
| Presence of Cl^- |

| 2 | Add hydrochloric acid to residue from step 1 | Effervescence observed, gas evolved with pungent smell | Presence of CO_3^{2-} |

| 3(i) | Add dilute sodium hydroxide to first portion of solution in step 2 | Pale green precipitate forms, insoluble in excess | Presence of Fe^{2+} |

| 3(ii) | Add dilute ammonia to second portion of solution in step 2 | Pale green precipitate forms
| Confirms Fe^{2+} |

| 4 | Confirmatory tests for each ion | Al^{3+} confirmed by amphoteric ppt, AgNO_3 ppt confirms Cl^- |
Confirm presence of Al^{3+} and Cl^- |

Conclusion:

The two cations in the sample K are Al^{3+} and Fe^{2+} ; the anions are Cl^- and CO_3^{2-} .