

**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  $\text{KMnO}_4$  solution diluted from 20  $\text{cm}^3$  to 500  $\text{cm}^3$

VV:  $\text{H}_2\text{O}_2$  solution made by diluting 13.9  $\text{cm}^3$  of commercial hydrogen peroxide to 500  $\text{cm}^3$

ZZ: 2.0 M  $\text{H}_2\text{SO}_4$

Summary:

Volume of pipette = 25  $\text{cm}^3$

25  $\text{cm}^3$  of acidified VV required 22.40  $\text{cm}^3$  of UU for complete oxidation

Questions

(a) Write half reaction equations

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

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

(b) Calculate the molarity of solution:

(i) UU

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

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  $\text{MnO}_4^-$  reacts with 5 mol  $\text{H}_2\text{O}_2$

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

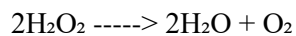
Moles of  $\text{H}_2\text{O}_2 = 5/2 \times 0.000448 = 0.00112 \text{ mol}$

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

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

(c) Volume strength of commercial  $\text{H}_2\text{O}_2$

From decomposition:



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

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

$$\text{O}_2 \text{ evolved} = (22.4 \times 0.0448 \times 2) = 2.007 \text{ dm}^3$$

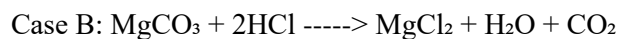
$$\text{Volume strength} = 2.007$$

2. You are provided with:

B<sub>1</sub>: 1 M HCl

B<sub>2</sub>: 0.2 g magnesium

B<sub>3</sub>: 1 g magnesium carbonate



Given:

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

$$\text{(a) Heat evolved} = mc\Delta T$$

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  $\text{MgCO}_3$

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  $\text{Al}^{3+}$  |

| 1(ii) | Add dilute  $\text{HNO}_3$  and  $\text{AgNO}_3$  to second portion | White precipitate forms  
| Presence of  $\text{Cl}^-$  |

| 2 | Add hydrochloric acid to residue from step 1 | Effervescence observed, gas evolved with pungent smell | Presence of  $\text{CO}_3^{2-}$  |

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

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

| 4 | Confirmatory tests for each ion |  $\text{Al}^{3+}$  confirmed by amphoteric ppt,  $\text{AgNO}_3$  ppt confirms  $\text{Cl}^-$  |  
Confirm presence of  $\text{Al}^{3+}$  and  $\text{Cl}^-$  |

Conclusion:

The two cations in the sample K are  $\text{Al}^{3+}$  and  $\text{Fe}^{2+}$ ; the anions are  $\text{Cl}^-$  and  $\text{CO}_3^{2-}$ .