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.

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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): H_2O_2 -----> $O_2 + 2H^+ + 2e^-$

Reduction (MnO_4^-): $MnO_4^- + 8H^+ + 5e^-$ -----> $Mn^{2+} + 4H_2O$

(b) Calculate the molarity of solution:

(i) UU

Original: 20 cm^3 of 0.5 M → diluted to 500 cm^3

Moles = $0.5 \times 20 \div 1000 = 0.01$ mol

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

(ii) VV

From the redox equation:

$2MnO_4^- + 5H_2O_2 + 6H^+$ -----> $2Mn^{2+} + 5O_2 + 8H_2O$

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

Moles of $KMnO_4$ = $0.02 \times 22.40 \div 1000 = 0.000448$ mol

Moles of H_2O_2 = $5/2 \times 0.000448 = 0.00112$ mol

Volume of VV = 25 cm^3 = 0.025 dm^3

Molarity of VV = 0.00112 ÷ 0.025 = 0.0448 mol/dm^3

(c) Volume strength of commercial H_2O_2

From decomposition:

$2H_2O_2 \text{ -----> } 2H_2O + O_2$

2 mol (68 g) H_2O_2 gives 22.4 dm^3 O_2

Moles in 1 dm^3 = 0.0448 mol

O_2 evolved = (22.4 × 0.0448 × 2) = 2.007 dm^3

Volume strength = 2.007

2. You are provided with:

B_1: 1 M HCl

B_2: 0.2 g magnesium

B_3: 1 g magnesium carbonate

Case A: $Mg + 2HCl \text{ -----> } MgCl_2 + H_2$

Case B: $MgCO_3 + 2HCl \text{ -----> } MgCl_2 + H_2O + CO_2$

Given:

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

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

Case A:

$T_1 = 25.0°C$, $T_2 = 35.5°C \rightarrow \Delta T = 10.5°C$

Q = 50 × 4.2 × 10.5 = 2205 J = 2.205 kJ

Case B:

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

Q = 50 × 4.2 × 7.0 = 1470 J = 1.470 kJ

(b) Calculate enthalpy of formation of $MgCO_3$

Given:

ΔH_1 (CO_2) = -394 kJ/mol

ΔH_2 (H_2O) = -286 kJ/mol

ΔH (reaction from part b) = -1.470 kJ

Using Hess's Law:

$\Delta Hf(MgCO_3) = \Delta H(CO_2) + \Delta H(H_2O) - \Delta H(\text{reaction})$

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

= -680 + 1.470

= -678.53 kJ/mol

Enthalpy of formation of $MgCO_3$ = -678.53 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

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-}.