THE UNITED REPUBLIC OF TANZANIA

NATIONAL EXAMINATIONS COUNCIL OF TANZANIA

ADVANCED CERTIFICATE OF SECONDARY EDUCATION EXAMINATION

132/3C **CHEMISTRY 3C**

(ACTUAL PRACTICAL C)

(For Both School and Private Candidates)

Time : 3:30 Hours **ANSWERS** **Year : 2023**

Instructions

1. This paper consists of three questions, answer all questions
2. All writing should be in **blue** or **black** ink.
3. Communication devices and any unauthorised materials are **not** allowed in the examination room.
4. Write your **Examination Number** on every page of your answer booklet(s).

1. You are provided with the following:

B1: A solution of H_2O_2 prepared by diluting 1.00 cm^3 with distilled water to form 250 cm^3 of an aqueous solution;

B2: A solution of $KMnO_4$ made by dissolving 0.79 g in 250 cm^3 of distilled water;

B3: A dilute H_2SO_4.

Procedure summary:

B1 (H_2O_2) is titrated against B2 ($KMnO_4$) in acidic medium.

Questions

(a) **Write the two half reaction equations for the experiment.**

Oxidation: $H_2O_2 \rightarrow O_2 + 2H^+ + 2e^-$

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

(b) **Write a balanced ionic equation for the whole process.**

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

(c) **Calculate the concentration of the original solution of hydrogen peroxide in g dm^{-3}.**

Moles of $KMnO_4$ in 250 cm^3 = 0.79 ÷ 158 = 0.005 mol.

Concentration = 0.005 ÷ 0.25 = 0.02 M.

From the equation: $2MnO_4^-$ react with $5H_2O_2$.

So 1 mole of $KMnO_4$ reacts with 2.5 moles of H_2O_2.

If mean titre of B2 = 25 cm^3 (0.025 dm^3), then moles $KMnO_4$ = $0.02 \times 0.025 = 5.0 \times 10^{-4}$ mol.

Moles H_2O_2 = $2.5 \times 5.0 \times 10^{-4} = 1.25 \times 10^{-3}$ mol.

If B1 pipetted was 25 cm^3 (0.025 dm^3), concentration = $1.25 \times 10^{-3} \div 0.025 = 0.05$ M.

Mass concentration = 0.05 × 34 = 1.7 g dm^{-3}.

(d) **Calculate the volume of oxygen gas produced at s.t.p when B1 reacted with an acidified B2.**

From equation: $5H_2O_2 \rightarrow 5O_2$.

Thus 1 mol H_2O_2 produces 1 mol O_2.

Moles of H_2O_2 in 25 cm^3 = 1.25×10^{-3} mol.

Moles O_2 = 1.25×10^{-3} mol.

Volume of O_2 at s.t.p = $1.25 \times 10^{-3} \times 22.4$ dm^3 = 0.028 dm^3 = 28 cm^3.

2. You are provided with the following:

S: 0.5 M sodium thiosulphate solution.

T: 0.1 M nitric acid.

Theory: $S_2O_3^{2-} + 2H^+ \rightarrow SO_2 + S\downarrow + H_2O$

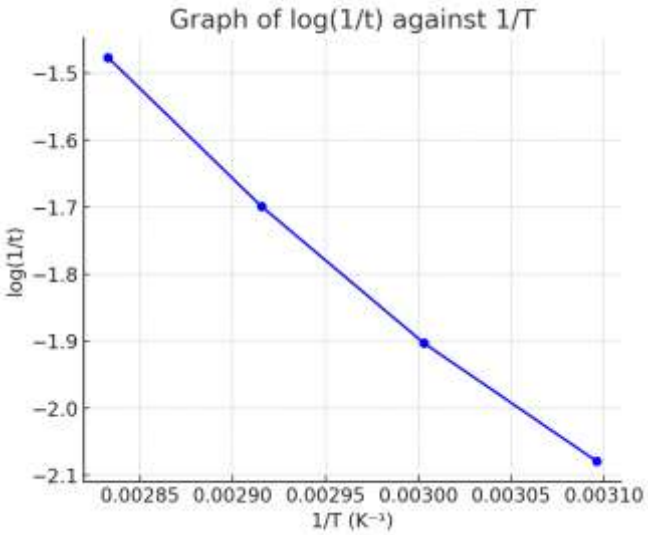
The reaction time is measured until the cross mark disappears.

Table 1 calculations (example with times in seconds):

T (°C)	T (K)	Time t (sec)	1/t (s^{-1})	log(1/t)
50	323	120	0.0083	-2.08
60	333	80	0.0125	-1.90
70	343	50	0.0200	-1.70
80	353	30	0.0333	-1.48

(a) **Plot graph of log(1/t) vs 1/T.**

This graph will be a straight line with negative slope.



(b) **Determine the slope of the graph.**

Slope = $\Delta \log(1/t) \div \Delta(1/T)$.

From data: $(-1.48 - -2.08) \div (1/353 - 1/323)$.

$= 0.60 \div (0.00283 - 0.00310)$.

$= 0.60 \div -0.00027 = -2222$.

(c) **Using Arrhenius equation, determine activation energy.**

Arrhenius: slope = $-Ea / (2.303R)$.

$Ea = -\text{slope} \times 2.303R$.

$R = 8.314 \text{ J mol}^{-1} \text{ K}^{-1}$.

$Ea = 2222 \times 2.303 \times 8.314 \approx 42.5 \text{ kJ mol}^{-1}$.

Table 2: Experimental Table

S/n	Experiment	Observations	Inferences
(a)	Observe sample Z	White crystalline solid	Inorganic metallic salt
(b)	Heat small portion of the sample in a dry test tube	Colourless gas turns lime water milky	Presence of carbonate (CO_3^{2-}) anion
(c)	Perform a flame test	Yellow flame observed	Presence of sodium ion (Na^+)

(d)	Add concentrated sulphuric acid to the dry sample	Effervescence with colourless gas that turns lime water milky	Confirms carbonate (CO_3^{2-}) anion
(e)	To the small portion of the prepared solution, add HCl followed by barium chloride solution	White precipitate insoluble in dilute HCl	Presence of sulphate (SO_4^{2-}) anion
(f)	To the small portion of the prepared solution, add excess ammonia solution and then pass hydrogen sulphide gas slowly for one minute	Black precipitate observed	Presence of Cu^{2+} ion
(g)	Perform confirmatory tests for cations present in the sample	Blue solution with aqueous ammonia confirms Cu^{2+}, yellow flame confirms Na^+	Cations are Na^+ and Cu^{2+}

Questions

(i) **Write the molecular formula for the sample.**

Since the anion is SO_4^{2-} and cations are Na^+ and Cu^{2+}, the molecular formula is **$Na_2Cu(SO_4)_2$**.

(ii) **What are the cations and anion in the sample?**

Cations: Sodium ion (Na^+) and Copper(II) ion (Cu^{2+}).

Anion: Sulphate ion (SO_4^{2-}).