THE UNITED REPUBLIC OF TANZANIA
NATIONAL EXAMINATIONS COUNCIL OF TANZANIA
DIPLOMA IN SECONDARY EDUCATTION EXAMINATION

732/2B **CHEMISTRY 2B**

(PRACTICAL 2B)

Time: 3 Hours **ANSWERS** **Year: 2024**

Instructions.

1. This paper consists of sections of **Three (3)** questions.
2. Answer **all** questions.
3. Cellular phones are **note** allowed in the examination room.
4. Write your **examination Number** on every page of your answer booklet(s).

Answer **All** questions.

1. A certain solution labeled **B** whose components have a formula unit of M2CO3 was prepared by dissolving 2.65 g of M2CO3 to make 0.5 dm3 solution. In order to identify the unknown element M in the formula, an 49 experiment is required to be performed using 0.10 M HCl which is kept in the beaker labelled **G**. Methyl orange indicator is also available. Then, follow the following procedure to identify element M.

   Procedure:
   (i) Pipette 20 cm3 or 25 cm3 of **B** and transfer it into a titrating flask. Add three drops of methyl orange indicator.
   (ii) Transfer solution **G** into the burette.
   (iii) Titrate solution **G** against **B** until end point is reached.
   (iv) Repeat procedures (i) to (iii) three more times.

   Questions

(a)(i) What is the volume of the pipette used?

The volume of the pipette used is **25.0 cm³.**

(a)(ii) Present your results in an appropriate table of results

Table of Titration Results

Titration Number	**Final Burette Reading (cm^3)**	**Initial Burette Reading (cm^3)**	**Volume of HCl used (cm^3)**
1	25.00	0.00	25.00
2	25.10	0.10	25.00
3	24.95	0.00	24.95
4	25.05	0.05	25.00

(b) Calculate the average titre volume

Average titre volume = (25.00 + 25.00 + 24.95 + 25.00) ÷ 4
= **25.00 cm³**

(c) Write a balanced chemical equation for the reaction between solutions labelled B and G and the corresponding ionic equation. Include state symbols in both equations

Balanced molecular equation:

$M_2CO_3(aq) + 2HCl(aq) \text{-----> } 2MCl(aq) + CO_2(g) + H_2O(l)$

Balanced ionic equation:

$CO_3^{2-}(aq) + 2H^+(aq) \text{ -----> } CO_2(g) + H_2O(l)$

(d) Calculate the concentration of B in:

(i) g dm^{-3}

Mass of M_2CO_3 used = 2.65 g
Volume of solution = 0.5 dm^3

Concentration (C) = Mass / Volume
C = 2.65 g ÷ 0.5 dm^3
C = **5.30 g dm^{-3}**

(ii) mol dm^{-3}

First, calculate moles of HCl used in titration:

Moles of HCl = M × V
= 0.10 mol dm^{-3} × 25.00 cm^3 ÷ 1000
= 0.00250 mol

From the equation, 1 mol of M_2CO_3 reacts with 2 mol of HCl.

So, moles of M_2CO_3 in 25.00 cm^3:

= 0.00250 mol ÷ 2
= 0.00125 mol

Now, concentration of M_2CO_3 in mol dm^{-3}:

C = n / V
= 0.00125 mol ÷ 0.02500 dm^3
= **0.0500 mol dm^{-3}**

(e) Calculate the molar mass of M_2CO_3 and identify element M

We have:
Concentration = 0.0500 mol dm^{-3}
Mass of M_2CO_3 in 0.5 dm^3 = 2.65 g

Molar mass (M) = (Mass / Moles)

Moles in 0.5 dm^3 = 0.0500 mol dm^{-3} × 0.5 dm^3
= 0.0250 mol

Now, molar mass:

Molar mass = 2.65 g ÷ 0.0250 mol
= **106 g mol^{-1}**

Molar mass of CO_3 = 12 + (16 × 3) = 60 g mol^{-1}
Mass of 2M = 106 – 60 = 46 g mol^{-1}
Mass of one M = 46 ÷ 2 = 23 g mol^{-1}

Element with atomic mass 23 is **Sodium (Na)**

(f) If element M is reacted with water

(i) Write a balanced chemical equation that shows the reaction

$2Na(s) + 2H_2O(l) \text{ -----> } 2NaOH(aq) + H_2(g)$

(ii) Give the colour of the solution when few drops of phenolphthalein (POP) are added to the solution

The solution will turn **pink** indicating an alkaline solution (due to NaOH formed).

2. The order of reaction between $S_2O_3^{2-}$ and H^+ can be established by using solutions 0.16 M $Na_2S_2O_3.5H_2O$ labelled **C** and 1.0 M H_2SO_4 labelled **D**. Use the given facilities; distilled water, stopwatch, 100 cm^3 beaker, 10 cm^3 measuring cylinder, glass rod, and a white piece of paper with a mark "**Z**" to establish the order of reaction with respect to $S_2O_3^{2-}$ and H^+. Perform the activities listed in the given procedure and then answer the questions that follow.

Procedure:

(i) Put a paper with a mark "**Z**" on a working bench and place an empty 100 cm^3 beaker on the top of mark in such a way that the mark is clearly seen from the top of the beaker.

(ii) By using measuring cylinder, measure 4 cm^3 of **C** and 6 cm^3 of distilled water and transfer it in the beaker placed on the mark "**Z**".

(iii) Using measuring cylinder, measure 10 cm^3 of **D** and pour it into the beaker containing **C** and distilled water; and immediately start the stopwatch. (iv) Stir the reaction mixture with the glass rod and record the time taken for the mark "**Z**" to disappear completely.

(iv) Repeat the procedure (i) to (iv) twice except that instead of 4 cm^3 of **C** and 6 cm^3 of distilled water in procedure (ii), use 6 cm^3, 8 cm^3, 10 cm^3 of **C** and 4 cm^3, 2 cm^3 and 0 cm^3 of distilled water.

Questions

(a) **Complete the following table:**

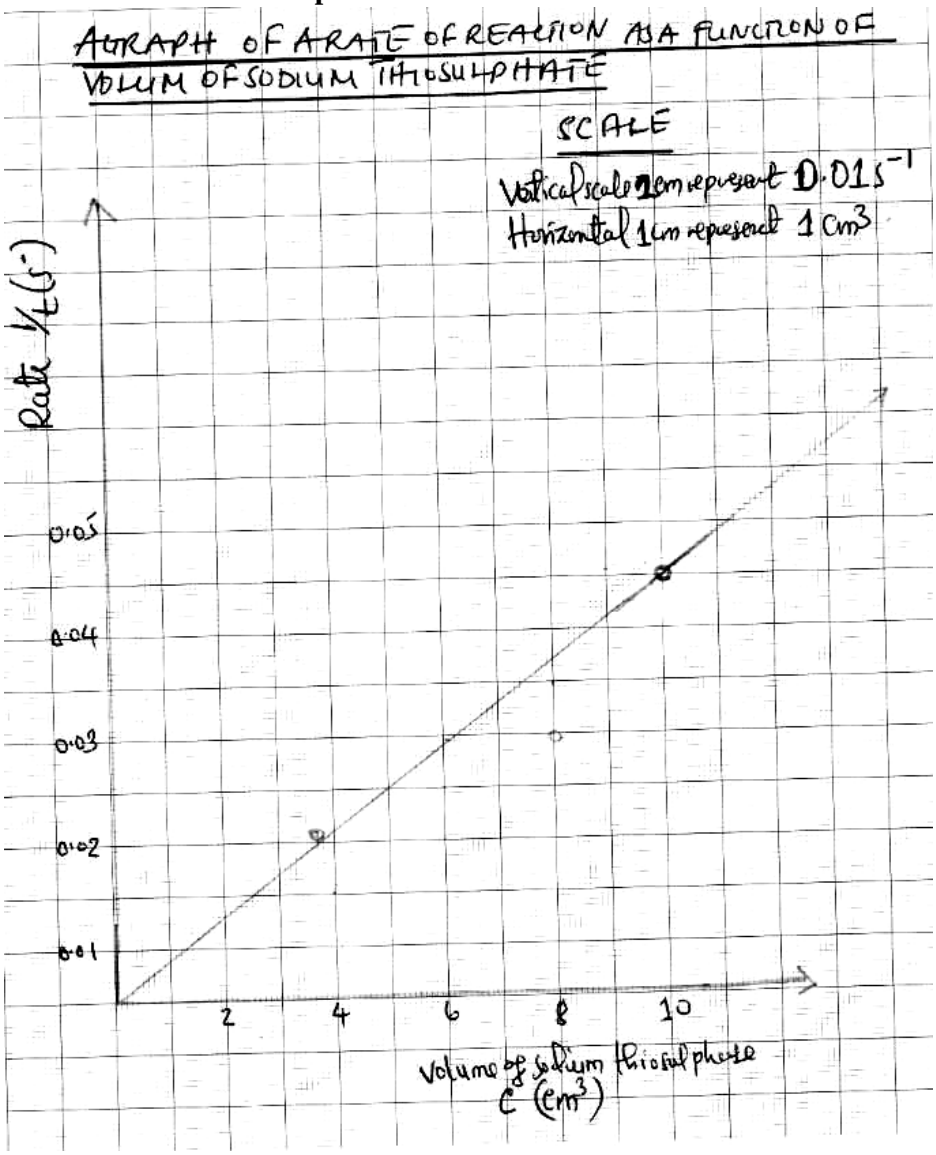
Table of Results

Experiment	**C (cm^3)**	**Water (cm^3)**	**D (cm^3)**	**Time (s)**	**Rate - 1/t (s^{-1})**
1	4	6	10	—	0.000

2	6	4	10	—	0.026
3	8	2	10	—	0.035
4	10	0	10	—	0.017

(b) **Draw the appropriate well labelled graph of rate of reaction as a function of volume of sodium thiosulphate**

(c) **Use the graph in (b) to determine the order of the reaction with respect to the concentration of thiosulphate ions**



From the graph, we observe how the rate of reaction changes with increase in volume (which corresponds to concentration increase since total volume is constant).

Therefore, the reaction is of first order with respect to thiosulphate ions.

3. Salt from Mzee Bayobo's factory was brought in the laboratory with the aim of identifying the cation and the anion present in the sample. For the sake of record, the sample was labeled **O**. Perform qualitative analysis procedure to identify the cation and the anion present in the sample. Base your experiment on the following tests and answer the questions that follow:
   (i) Appearance of sample **O**.
   (ii) Action of heat on sample **O** in a test tube.
   (iii) Action of dilute sulphuric or hydrochloric acid to solid sample.
   (iv) Action of concentrated sulphuric acid on solid sample.
   (v) Flame test.
   (vi) Solubility of the sample.
   (vii) Confirmatory test for the anion.
   (viii) Confirmatory test for the cation.

   Questions

   (a) Table showing qualitative analysis results:

Test	**Observation**	**Inference**
(i) Appearance of sample O	Blue crystalline solid	Possible presence of copper(II) salt
(ii) Action of heat on sample O in a test tube	Sample turns black, brown gas released	Presence of copper(II) carbonate
(iii) Action of dilute sulphuric acid to solid sample	Effervescence observed, colorless gas produced turns lime water milky	Presence of carbonate ion (CO_3^{2-})
(iv) Action of concentrated sulphuric acid on solid sample	Brown gas (likely sulphur dioxide) evolved, and solid turns black	Presence of copper(II) salt
(v) Flame test	Green-blue flame	Presence of Cu^{2+} ion
(vi) Solubility of the sample	Soluble in water, blue solution formed	Confirms copper(II) salt
(vii) Confirmatory test for the anion	Addition of acidified barium chloride solution forms white precipitate	Confirms presence of carbonate ion (CO_3^{2-})

(viii) Confirmatory test for the cation	Addition of excess ammonia produces deep blue solution	Confirms presence of Cu^{2+} ion

(b) The cation present in the unknown salt is **Cu^{2+} (copper(II) ion)** and the anion present is **CO_3^{2-} (carbonate ion)**.

(c) Reaction equation for test (iii):
$CuCO_3(s) + H_2SO_4(aq) \text{-----> } CuSO_4(aq) + CO_2(g) + H_2O(l)$