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

**732/2** **CHEMISTRY 2A**

**(PRACTICAL 2A)**

**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).

1. An acidic compound with a coded chemical formula HX is useful for small scale industries; therefore, it has to be identified and its exact concentration must be known. A beaker labeled **C** contains a solution prepared by dissolving 0.9125 g of HX in 100 $cm^3$ of solution. You are also provided with a standard solution in a beaker labeled **D** prepared by dissolving 1.00 g of NaOH in 250 $cm^3$ of solution and methyl orange as an indicator. Perform the activities listed in the procedure in order to identify the concentration of HX.

   **Procedure:**

   (i) Pipette 20 cm3 or 25 cm3 of solution **D** and transfer it into a titrating flask. Add three drops of methyl orange indicator in the titrating flask.

   (ii) Titrate this mixture with solution **C** until a permanent colour change is observed.

   (iii) Repeat procedures (i) - (ii) for three times.

**Questions**

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

The volume of the pipette used is **25.0 $cm^3$**.

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

Table of Results

| **Titration Number** | **Final Burette Reading ($cm^3$)** | **Initial Burette Reading ($cm^3$)** | **Volume of C used ($cm^3$)** |
|---|---|---|---|
| 1 | 10.00 | 0.00 | 10.00 |
| 2 | 20.00 | 10.00 | 10.00 |
| 3 | 30.00 | 20.00 | 10.00 |

**(b) Calculate the average titre volume of C.**

Average titre volume of C =
(10.00 + 10.00 + 10.00) ÷ 3 = **10.00 $cm^3$**

**(c) With state symbols included, write a balanced chemical equation for the reaction between solutions contained in bottles labeled C and D.**

$HX(aq) + NaOH(aq) \text{-----> } NaX(aq) + H_2O(l)$

**(d) Calculate the concentration of NaOH in solution D in moles per $dm^3$.**

Given:
Mass of NaOH = 1.00 g
Volume of solution = 250 $cm^3$ = 0.250 $dm^3$
Molar mass of NaOH = 23.0 + 16.0 + 1.0 = 40.0 g/mol

Number of moles of NaOH = mass ÷ molar mass
= 1.00 g ÷ 40.0 g/mol
= 0.025 mol

Concentration = moles ÷ volume
= 0.025 mol ÷ 0.250 $dm^3$
= **0.100 mol/$dm^3$**

**(e) Identify element X in compound HX.**

Since the molar ratio from the balanced equation is 1:1, and we can use the formula:

Number of moles of NaOH in 25.0 $cm^3$ = (0.100 mol/$dm^3$ × 25.0 $cm^3$) ÷ 1000
= 0.0025 mol

Number of moles of HX in 10.00 $cm^3$ = same, 0.0025 mol
Total volume of solution C = 100.0 $cm^3$
Mass of HX = 0.9125 g

Molar mass of HX = mass ÷ moles in 100.0 $cm^3$
First find concentration in mol/$dm^3$:

Since 10.00 $cm^3$ contains 0.0025 mol,
100.0 $cm^3$ contains = 0.0025 mol × 100.0 ÷ 10.00
= 0.025 mol

Now, molar mass = mass ÷ moles
= 0.9125 g ÷ 0.025 mol
= 36.5 g/mol

Now subtract mass of H (1.0 g/mol):
X = 36.5 – 1.0 = 35.5 g/mol

The element with a relative atomic mass of 35.5 is **chlorine (Cl)**.

**(f) Write a balanced chemical equation representing the reaction which will occur when X is reacted with water.**

$Cl_2(g) + H_2O(l)$ -----> $HCl(aq) + HOCl(aq)$

2. You are given an assignment to find out the order and molecularity of different substances in the laboratory. The teacher gave you the following material in order to help you determine the molecularity and order of reaction through experiment.
   **P1**: Solution containing 40 g $dm^{-3}$ of $Na_2S_2O_3 \cdot 5H_2O$;
   **P2**: A solution of 0.5 M $H_2SO_4$;
   Distilled water, stopwatch, white paper with a mark "**X**" and other relevant materials.
   Perform the experiment using the following procedure and answer the questions that follow:

   **Procedure:**
   (i) Put white paper with a mark "X" on a working bench and place a 50 $cm^3$ beaker on top of mark X in such a way that the mark is clearly seen from the top of the beaker.
   (ii) Measure 2 $cm^3$ of **P1** and 8 $cm^3$ of distilled water and transfer them in the beaker placed on white paper with mark "**X**".
   (iii) Measure 10 $cm^3$ of **P2** and pour it into the beaker containing **P1** and distilled water and immediately start the stopwatch.
   (iv) Record the time taken to cause enough precipitation to cloudy the mark "**X**".

(v) Repeat procedure (i) to (iv) twice except that instead of 2 $cm^3$ of **P1** and 8$cm^3$ of distilled water in procedure (ii), use 4 $cm^3$ and 8 $cm^3$ of **P1** and 6 $cm^3$ and 2 $cm^3$ of distilled water respectively.

**Questions**

**(a) Complete the following table**

Table of Results

| Experiment | P1 ($cm^3$) | Water ($cm^3$) | P2 ($cm^3$) | Time t (s) | Rate (1/t) ($s^{-1}$) |
|---|---|---|---|---|---|
| 1 | 2 | 8 | 10 | 410 | 0.00244 |
| 2 | 4 | 6 | 10 | 155 | 0.00645 |
| 3 | 8 | 2 | 10 | 59 | 0.01695 |

**(b) Write the balanced ionic equation representing the reaction taking place in this experiment**

The reaction occurring is:

$S_2O_3^{2-}(aq) + 2H^+(aq) \text{-----> } SO_2(g) + S(s) + H_2O(l)$

**(c) Find the value of molecularity from the ionic equation in part (b)**

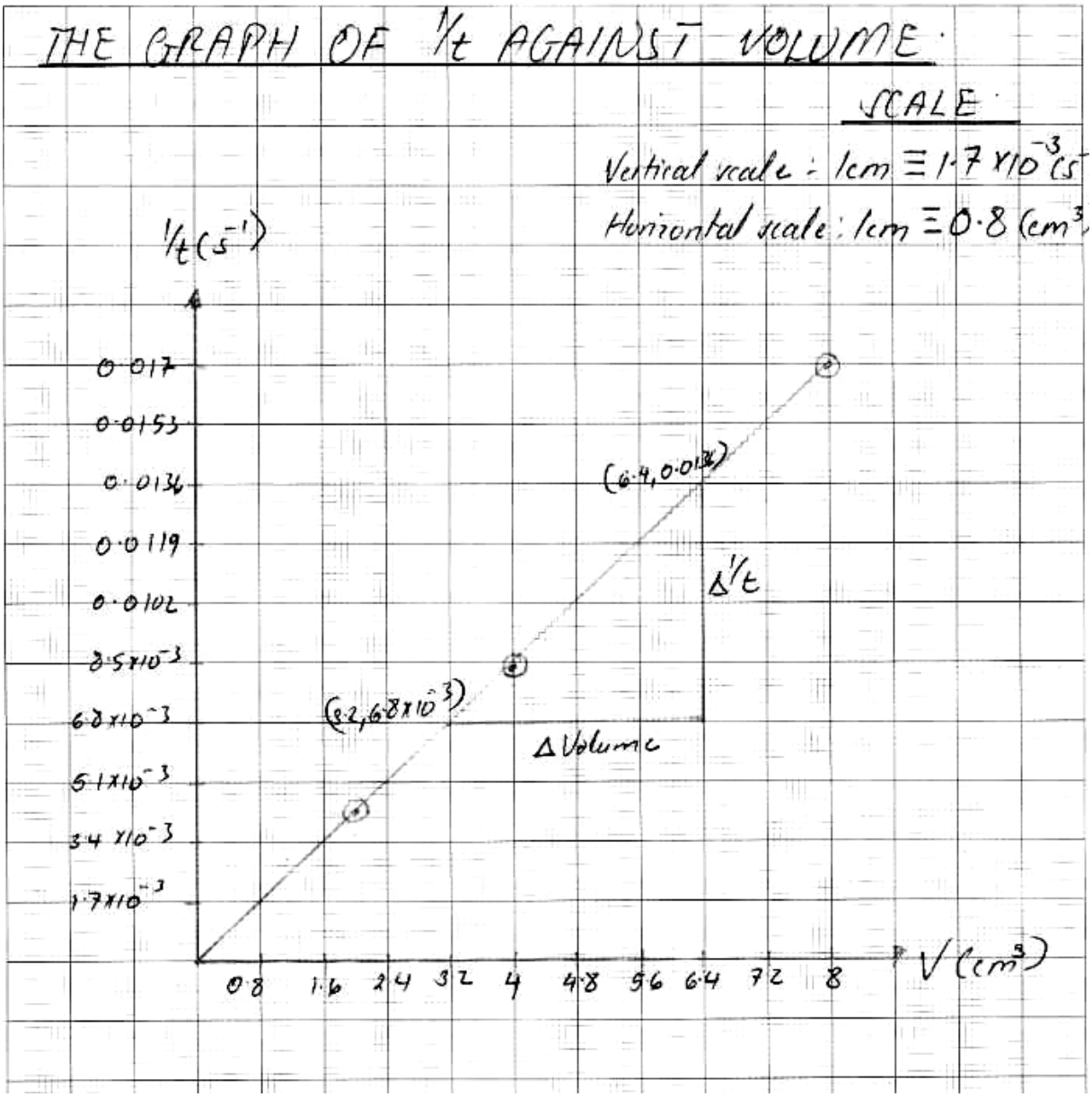
From the balanced ionic equation:
1 mole of thiosulphate ions reacts with 2 moles of hydrogen ions.
By adding the total number of reacting particles (1 $S_2O_3^{2-}$ + 2 $H^+$) we get:

Molecularity = **3**

**(d) Plot a graph of Rate (1/t) against Volume of sodium thiosulphate (P1)**

Using the following points:

| Volume of P1 ($cm^3$) | Rate (1/t) ($s^{-1}$) |
|---|---|
| 2 | 0.00244 |
| 4 | 0.00645 |
| 8 | 0.01695 |




**(e) From the graph in part (d), give the order of reaction with respect to sodium thiosulphate**
Since the graph of rate (1/t) against the volume of sodium thiosulphate is a straight line passing through the origin, this indicates a **first-order reaction with respect to sodium thiosulphate.**

3. Ms. Maturo brought sample **N** of unknown salt in your laboratory and asked you to identify the cation and the anion present in the sample. This is very important for her salt factory. In the process of identification of the sample, base your procedure on the listed tests and then answer the questions that follow:
   (i) Appearance of sample **N**.
   (ii) Action of heat on sample **N** in a test tube.
   (iii) Action of dilute sulphuric acid on the 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.

**Questions**
(a) Prepare a relevant table showing the qualitative analysis results.
(b) What are the cation and anion present in the unknown sample?
(c) Write the reaction equation to indicate what took place in test (iii)

**(a) Prepare a relevant table showing the qualitative analysis results**

Table of Qualitative Analysis Results

| Test | Observation | Inference |
|---|---|---|
| (i) Appearance of sample N | White crystalline solid | Possible sodium or carbonate salt |
| (ii) Action of heat on sample N | No observable change | Stable to heat; excludes salts that decompose easily |
| (iii) Action of dilute sulphuric acid on solid | Effervescence observed; colourless, odourless gas evolved, turns lime water milky | Presence of carbonate anion ($CO_3^{2-}$) releasing $CO_2$ gas |
| (iv) Action of concentrated sulphuric acid | Effervescence, gas evolved, turns lime water milky | Further confirms carbonate anion producing $CO_2$ gas |
| (v) Flame test | Yellow flame | Presence of sodium cation ($Na^+$) |
| (vi) Solubility of the sample | Readily soluble in water | Indicates most likely a sodium salt |
| (vii) Confirmatory test for the anion (add acid, then lime water) | Effervescence observed; gas turns lime water milky | Confirms carbonate anion ($CO_3^{2-}$) |

**(b) What are the cation and anion present in the unknown sample?**
The **cation present is sodium ion ($Na^+$)** and the **anion present is carbonate ion ($CO_3^{2-}$)**.

**(c) Write the reaction equation to indicate what took place in test (iii)**
The reaction between the carbonate salt and dilute sulphuric acid is:
$Na_2CO_3(s) + H_2SO_4(aq) \text{-----> } Na_2SO_4(aq) + CO_2(g) + H_2O(l)$