Candidate's Name : .....

Signature : .....

| Random No. | | | | | Personal No. | | |
|---|---|---|---|---|---|---|---|
| | | | | | | | |

*(Do not write your School /Centre Name or Number anywhere on this booklet.)*

**P525/3**
**CHEMISTRY**
**Paper 3**
**(Practical)**
**Nov./Dec. 2023**
3¼ hours

# UGANDA NATIONAL EXAMINATIONS BOARD

## Uganda Advanced Certificate of Education

CHEMISTRY

**Paper 3**
(Practical)

3 hours 15 minutes

**INSTRUCTIONS TO CANDIDATES:**

*Answer* **all** *questions. Use* **blue** *or* **black** *ink. Any work done in pencil will* **not** *be marked* **except** *drawings.*

*All your answers* **must** *be written in the spaces provided.*

*Mathematical tables and silent non-programmable scientific calculators may be used.*

*Reference books (i.e. text books, booklets on qualitative analysis etc.) should* **not** *be used.*

*You are* **not** *allowed to start working with the apparatus for the first* **15 minutes**. *This time is to enable you read the question paper and make sure you have all the apparatus and chemicals that you may need.*

| For Examiners' Use Only | | | |
|---|---|---|---|
| Q.1 | Q.2 | Q.3 | Total |
| | | | |
| | | | |



**Turn Over**

1. You are provided with the following:

**FA1**, which is a solution of hydrochloric acid of an unknown concentration.

**FA2**, which is a solution containing 5 g of a mixture of sodium hydroxide and anhydrous sodium carbonate in a litre.

**FA3**, which is a solution of barium chloride.

Solid **T**, which is sodium tetraborate decahydrate, $\mathbf{Na_2B_4O_7 \cdot 10H_2O}$.

You are required to;

(i) standardise the solution of hydrochloric acid, **FA1**.

(ii) determine the composition of the mixture in **FA2**.

**Theory**

A solution of sodium tetraborate reacts with hydrochloric acid according to the following equation:

$$B_4O_7^{2-}{}_{(aq)} + 2H^+{}_{(aq)} + 5H_2O_{(l)} \longrightarrow 4H_3BO_3{}_{(aq)}$$

When **FA3** is added to **FA2**, the carbonate ions in **FA2** are precipitated out according to the following equation:

$$Ba^{2+}{}_{(aq)} + CO_3^{2-}{}_{(aq)} \longrightarrow BaCO_3{}_{(s)}$$

**PART I**

**Procedure**

Weigh accurately 2.4 g of solid **T** and transfer it into a beaker. Add about 100 $cm^3$ of hot water and stir to dissolve. Transfer the solution into a 250 $cm^3$ volumetric flask and fill up to the mark with distilled water.
Label the solution **FA4**.

**Results**

Mass of the weighing container + **T** = .....g (½ *mark*)

Mass of the weighing container alone = .....g (½ *mark*)

Mass of **T** weighed = .....g (½ *mark*)

**PART II**

**Procedure**

Pipette 25.0 $cm^3$ (or 20.0 $cm^3$) of **FA4** into a conical flask. Add 2-3 drops of methyl orange indicator and titrate with **FA1** from the burette until the end-point.

Repeat the titration to obtain consistent results and record your results in table **1**.

**Results**

**Table 1**

Volume of pipette used = .....$cm^3$. *(½ mark)*

| **Titration number** | **1** | **2** | **3** |
|---|---|---|---|
| Final burette reading ($cm^3$) | | | |
| Initial burette reading ($cm^3$) | | | |
| Volume of **FA1** used ($cm^3$) | | | |

*(4½ marks)*

(a) (i) Record the volumes of **FA1** used for calculating the average volume. *(½ mark)*

.....$cm^3$

(ii) Calculate the average volume of **FA1** used. *(2½ marks)*

.....

..... $cm^3$

(b) Calculate the concentration of;

(i) **FA4** in mol $dm^{-3}$. *(2½ marks)*

*(Na =23; B = 11; O = 16; H = 1)*

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(ii) **FA1** in mol $dm^{-3}$. *(3½ marks)*

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**PART III**

**Procedure**

Pipette 25.0 $cm^3$ (or 20.0 $cm^3$) of **FA2** into a conical flask, add 6.0 $cm^3$ of **FA3**, shake and allow to stand for **one** minute. Add 4 – 5 drops of phenolphthalein indicator and titrate the solution with **FA1** from the burette until the end-point. Repeat the titration until you obtain consistent results.

Record your results in table **2**.

**Results**

**Table 2**

Volume of pipette used = .....$cm^3$. *(½ mark)*

| **Titration number** | **1** | **2** | **3** |
|---|---|---|---|
| Final burette reading ($cm^3$) | | | |
| Initial burette reading ($cm^3$) | | | |
| Volume of **FA1** used ($cm^3$) | | | |

*(4½ marks)*

(a) (i) Record the volumes of **FA1** used for calculating the average volume. *(½ mark)*

.....cm$^3$.

(ii) Calculate the average volume of **FA1** used. *(2½ marks)*

.....

..... cm$^3$.

(b) Calculate the number of moles of;

(i) hydrochloric acid that reacted. *(01 mark)*

.....

.....

.....

.....

(ii) sodium hydroxide that reacted. *(02 marks)*

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(c) Determine the mass of;

(i) sodium hydroxide in **FA2** in grammes per litre. *(2½ marks)*

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(ii) sodium carbonate in **FA2** in grammes per litre. *(01 mark)*

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**2.** You are provided with substance **X** which contains **two** cations and **two** anions. Carry out the following tests to identify the cations and anions present in **X**. Identify any gas(es) evolved.

Record your observations and deductions in table **3**. *(30 marks)*

**Table 3**

| TESTS | OBSERVATIONS | DEDUCTIONS |
|---|---|---|
| (a) Heat **two** spatula end-fuls of **X** in a dry test tube strongly until there is no further change. | | |
| (b) To **two** spatula end-fuls of **X** in a test tube, add 4 $cm^3$ of distilled water, shake and filter.<br>Keep both the filtrate and the residue.<br>Divide the filtrate into **three** portions. | | |
| (i) To the **first** portion, add 2 – 3 drops of barium nitrate solution followed by dilute nitric acid until in excess. | | |

| TESTS | OBSERVATIONS | DEDUCTIONS |
|---|---|---|
| (ii) To the **second** portion, add 3-4 drops of iodine solution. | | |
| (iii) To the **third** portion, add dilute hydrochloric acid and warm. | | |
| (c) Wash the residue in (b) with little distilled water and dissolve it in dilute nitric acid. Add dilute sodium hydroxide solution drop-wise until in excess and then filter. Keep the residue for use in part (e). | | |
| (d) To the filtrate from part (c), add dilute nitric acid drop-wise until the solution is just acidic. Divide the solution into **four** portions. | | |
| (i) To the **first** portion of the acidified solution, add dilute sodium hydroxide solution drop-wise until in excess. | | |

| TESTS | OBSERVATIONS | DEDUCTIONS |
|---|---|---|
| (ii) To the **second** portion of the acidified solution, add dilute ammonia solution drop-wise until in excess. | | |
| (iii) To the **third** portion of the acidified solution, add 2-3 drops of dilute sulphuric acid. | | |
| (iv) Use the **fourth** portion of the acidified solution to carry out a test of your own choice to confirm one of the cations in **X**.<br>**Test:**<br>.....<br>.....<br>.....<br>.....<br>..... | | |
| (e) Wash the residue from part (c) with dilute sodium hydroxide, transfer it into a test tube, add dilute nitric acid and shake to dissolve. Divide the resulting solution into **four** portions. | | |
| (i) To the **first** portion, add dilute sodium hydroxide solution drop-wise until in excess. | | |

| TESTS | OBSERVATIONS | DEDUCTIONS |
|---|---|---|
| (ii) To the **second** portion, add dilute ammonia solution drop-wise until in excess. | | |
| (iii) To the **third** portion, add 3-4 drops of sodium sulphate solution. | | |
| (iv) Use the **fourth** portion to carry out a test of your own choice to confirm the second cation in **X**.<br>**Test:**<br>.....<br>.....<br>.....<br>.....<br>..... | | |

(f) (i) The cations in **X** are .....**and** .....

(ii) The anions in **X** are .....**and** .....

3. You are provided with substance **M**, which is an organic compound. You are required to carry out the tests in table **4** and determine the nature of **M**.

Record your observations and deductions in the table. *(20 marks)*

**Table 4**

| | TESTS | OBSERVATIONS | DEDUCTIONS |
|---|---|---|---|
| (a) | Burn a small amount of **M** on a spatula-end or in a porcelain dish. | | |
| (b) | To 1cm$^3$ of **M** in a test tube, add 2cm$^3$ of distilled water and shake. Test the mixture with litmus paper. | | |
| (c) | To 0.5 cm$^3$ of **M**, add one spatula end-ful of solid sodium carbonate. | | |
| (d) | To 0.5 cm$^3$ of **M**, add 2-3 drops of neutral iron(III) chloride solution. | | |
| (e) | To about 0.5 cm$^3$ of **M**, add 2-3 drops of Brady's reagent. | | |
| (f) | To 3 cm$^3$ of **M**, add 2-3 drops of acidified potassium dichromate solution and warm. Divide the resultant solution into **two** portions. | | |

| TESTS | OBSERVATIONS | DEDUCTIONS |
|---|---|---|
| (i) To the **first** portion, add 2-3 drops of Brady's reagent. | | |
| (ii) To the **second** portion, add 1 $cm^3$ of Fehling's solution and heat. | | |
| (g) To about 1 $cm^3$ of **M**, add an equal volume of ethanoic acid followed by 2-3 drops of concentrated sulphuric acid and warm the mixture. | | |
| (h) To about 1 $cm^3$ of **M**, add 2 $cm^3$ of iodine solution and shake to mix, then add dilute sodium hydroxide solution drop-wise until the brown colour of iodine is just discharged. Allow to stand. | | |

(i) Describe the nature of **M**.

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**END**

1. The description of the reagents and chemicals specified below does **not** necessarily correspond with the description in the question paper. Candidates must **not** be informed of the differences.

2. Candidates are **not** allowed to use reference books (i.e. text books, booklets on qualitative analysis etc.) during examination.

3. In addition to the fittings and substances ordinarily contained in a chemistry laboratory, each candidate will require:

1 burette (50 $cm^3$).
1 pipette (25.0 $cm^3$ or 20.0 $cm^3$).
2 conical flasks.
1 volumetric flask (250 $cm^3$).
1 measuring cylinder (100 $cm^3$ or 50 $cm^3$).
1 measuring cylinder (10 $cm^3$).
1 thermometer (-10 – 110 °C).
1 stop clock/watch.
4 beakers (250 $cm^3$).
500 $cm^3$ of distilled water.
8 test tubes.
2 pieces of filter papers.
labels.
200 $cm^3$ of **FA1**.
100 $cm^3$ of **FA2**.
30 $cm^3$ of **FA3**.
2.6 g of **T**.— Borax.
2.5 g of **X**.
10 $cm^3$ of **M**.

**Easy access to:**
- Heat source.
- Common reagents for identifying of gases, cations, anions and organic compounds.
- Phenolphthalein and methyl orange indicators.
- Weighing balance reading to at least one decimal place.

**FA1**, is prepared by diluting 8.6 $cm^3$ of concentrated hydrochloric acid (36%, 1.18g /$cm^3$) with distilled water to make 1 litre of solution.
**FA2**, is prepared by dissolving 2.4 g of **Y** and 2.6 g of **W** in distilled water to make 1 litre of solution.

**FA3**, is prepared by dissolving 24.4 g of **V** in distilled water to make 1 litre of solution.
**M, V, T, X, Y** and **W** will be provided by **UNEB**.