

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

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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.

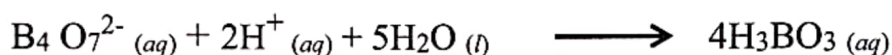
Solid **T**, which is sodium tetraborate decahydrate, $\text{Na}_2\text{B}_4\text{O}_7 \cdot 10\text{H}_2\text{O}$.

You are required to;

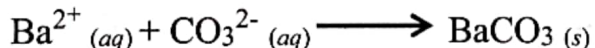
- (i) standardise the solution of hydrochloric acid, **FA1**.
- (ii) determine the composition of the mixture in **FA2**.

Theory

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



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



PART I

Procedure

Weigh accurately 2.4 g of solid **T** and transfer it into a beaker. Add about 100 cm³ of hot water and stir to dissolve. Transfer the solution into a 250 cm³ 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 . ($\frac{1}{2}$ mark)

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

($4\frac{1}{2}$ marks)

- (a) (i) Record the volumes of **FA1** used for calculating the average volume. ($\frac{1}{2}$ mark)

..... cm^3

- (ii) Calculate the average volume of **FA1** used. ($2\frac{1}{2}$ marks)

.....

..... cm^3

- (b) Calculate the concentration of;

- (i) **FA4** in mol dm^{-3} . ($2\frac{1}{2}$ marks)

($\text{Na} = 23$; $\text{B} = 11$; $\text{O} = 16$; $\text{H} = 1$)

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(ii) **FA1** in mol dm⁻³.

(3½ marks)

PART III

Procedure

Pipette 25.0 cm³ (or 20.0 cm³) of **FA2** into a conical flask, add 6.0 cm³ 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 =cm³. (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. ($\frac{1}{2}$ mark)

.....cm³.

- (ii) Calculate the average volume of **FA1** used. ($2\frac{1}{2}$ marks)

.....
..... cm³.

- (b) Calculate the number of moles of;

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

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.....

- (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. ($2\frac{1}{2}$ 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.

(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. Keep both the filtrate and the residue. 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. Test:		
(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 . Test:		

- (f) (i) The cations in **X** areand
- (ii) The anions in **X** areand

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 1 cm ³ of M in a test tube, add 2 cm 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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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 ($-10 - 110\text{ }^\circ\text{C}$).
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% , 1.18 g/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.