

Candidate's Name: **DOMOTO**

Signature:

Random No.				Personal No.			

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

P525/3
CHEMISTRY
(Practical)
Paper 3
Nov./Dec. 2020
3½ hours



UGANDA NATIONAL EXAMINATIONS BOARD

Uganda Advanced Certificate of Education

CHEMISTRY

(PRACTICAL)

Paper 3

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.

Record your answers on this question paper 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.

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

For Examiners' Use Only			
Q.1	Q.2	Q.3	Total
17	32	18	67

1. You are provided with the following:

FA1, which is a solution containing manganate(VII) ions.

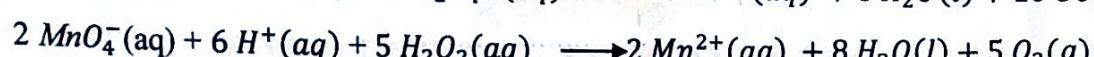
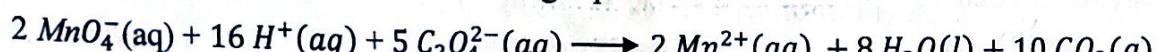
FA2, which is a hydrogen peroxide solution.

Solid **Q**, which is sodium ethanedioate.

2 M sulphuric acid solution.

You are required to standardise **FA1** and use it to determine the concentration of hydrogen peroxide in **FA2**.

Manganate(VII) ions react with ethanedioate ions and hydrogen peroxide in acid media according to the following equations:



PART I

PROCEDURE:

Weigh accurately about 1.3 g of **Q**. Dissolve it in a minimum volume of distilled water and shake well to mix. Transfer the solution into a 250 cm³ volumetric flask and make it up to the mark with distilled water. Label it **FA3**.

Pipette 25.0 (or 20.0) cm³ of **FA3** into a conical flask. Add an equal volume of 2 M sulphuric acid and heat the mixture to about 60 °C.

Titrate the hot solution with **FA1**.

Repeat the titration until you obtain consistent results.

Record your results in Table 1.

- weighing values
should be atleast

to 1dp

- mass of **Q** should
be ± 0.2

RESULTS:

Mass of weighing bottle + **Q** = 5.0 ✓ (½ mark)

Mass of empty weighing bottle = 4.7 ✓ (½ mark)

Mass of **Q** used = 1.3 ✓ (½ mark)

Volume of pipette used = 25/25.0/25.00 cm³. ✓ O2 (½ mark)

Table 1

Final burette reading (cm ³)	19.50 ✗	39.40 ✗	29.40 ✗
Initial burette reading (cm ³)	0.00 ✗	20.00 ✗	10.00 ✗
Volume of FA1 used (cm ³)	19.50 ✗	19.40 ✗	19.40 ✗

- Table values should be (4½ marks)

* 2 dp

✗ correctly subtracted

✗ realistic

✗ not exceeding 50.00 cm³

✗ at a centre range of ± 3.0

(0.6 ½)

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

~~* should be from the table and realistic~~ $19.40, 19.40 \text{ cm}^3$ (½ mark)

(ii) Calculate the average volume of FA1 used.

$$\frac{19.40 + 19.40}{2} = 19.40 \text{ cm}^3 \quad \text{(2½ marks)} \quad \text{* the average must have its expression}$$

(b) Calculate the:

(i) concentration of FA3 in mol dm⁻³ of sodium ethanedioate.

$$RFM Na_2C_2O_4 = (23 \times 2) + (12 \times 2) + (16 \times 4) = 134 \quad \text{(03 marks)}$$

- 250 cm³ FA3 solution contains 1.3g of $\text{C}_2\text{O}_4^{2-}$ ~~OK~~

$$\begin{aligned} - 1000 \text{ cm}^3 \text{ FA3 solution contains } & \cancel{1.3} \\ & \left(\frac{1.3 \times 1000}{250} \right) \text{ g} \\ & = 5.2 \text{ g/L} \end{aligned}$$

- 134g of $\text{C}_2\text{O}_4^{2-}$ contains 1 mole $\text{C}_2\text{O}_4^{2-}$

$$\begin{aligned} - 5.2 \text{ g of } \text{C}_2\text{O}_4^{2-} & \text{ contains } \left(\frac{1.3 \times 5.2}{134} \right) \text{ moles} \\ & = 0.0388 \text{ mol dm}^{-3} \\ & \text{(Must have units)} \end{aligned}$$

RFM does not have units.

$$\begin{aligned} - 134 \text{ g of } \text{C}_2\text{O}_4^{2-} & \text{ contains 1 mole } \text{C}_2\text{O}_4^{2-} \\ - 1.3 \text{ g of } \text{C}_2\text{O}_4^{2-} & \text{ contains } \left(\frac{1.3}{134} \right) \text{ moles} \\ & = 0.0097 \text{ moles} \end{aligned}$$

$$\begin{aligned} - 250 \text{ cm}^3 \text{ of FA3 solution contains } & 0.0097 \text{ moles} \\ - 1000 \text{ cm}^3 \text{ FA3 solution contains } & \left(\frac{0.0097 \times 1000}{250} \right) \text{ moles} \\ & = 0.0388 \text{ mol dm}^{-3} \end{aligned}$$

(ii) number of moles of ethanedioate ions that reacted. (1½ marks)

- 5 moles of $\text{C}_2\text{O}_4^{2-}$ reacted with 2 moles of MnO_4^-

$$- \text{moles of reacted } \text{MnO}_4^- = \frac{2}{5}$$

- 1000 cm³ FA3 solution contains 0.0388 moles $\text{C}_2\text{O}_4^{2-}$

$$\begin{aligned} - 250 \text{ cm}^3 \text{ FA3 solution contains } & \left(\frac{0.0388 \times 250}{1000} \right) \text{ moles} \\ & = 0.0097015 \text{ moles} \end{aligned}$$

0.5

(c) Determine the concentration of FA1 in mol dm⁻³. (2½ marks)

- 5 moles of $\text{C}_2\text{O}_4^{2-}$ reacted with 2 moles of MnO_4^-

$$- \text{Moles of reacted } \text{MnO}_4^- = \left(\frac{2}{5} \times 0.0097015 \right) = 0.0038806 \text{ moles}$$

- 19.4 cm³ FA1 solution contains 0.0038806 moles of MnO_4^-

$$\begin{aligned} - 1000 \text{ cm}^3 \text{ FA1 solution contains } & \left(\frac{0.0038806 \times 1000}{19.4} \right) \text{ moles of } \text{MnO}_4^- \\ & = 0.02 \text{ M} \end{aligned}$$

$$\text{Molarity of FA1} = 0.02 \text{ M}$$

3
(Must have)
units

0.5
10.5

Turn Over

Total = 17

All reagent names must be well spelt.

2. You are provided with substance T, which contains **two cations and two anions**.

You are required to carry out the tests in Table 3 and identify the cations and the anions in T. Identify any gas(es) evolved.

Record your observations and deductions in the table.

any one anion

Table 3

(32 marks)

TESTS	OBSERVATIONS	DEDUCTIONS
(a) Heat a spatula end-ful of T strongly in a dry test tube.	A colourless gas that turns wet blue litmus paper red and lime water milky ✓ A colourless condensate that turns white anhydrous copper(II) sulphate blue ✓ white fumes with sweet odour ✓ that form yellow precipitate with Brady's reagent ✓ - Black residue ✓	$\text{CO}_2(g)$: CO_3^{2-} ✓ HCO_3^- , CH_3COO^- , $\text{C}_2\text{O}_4^{2-}$ hydrated compound water of crystallisation. $\text{CH}_3(\text{COCH}_3)_2(g)$: CH_3COO^- NiO^+ , CuO , FeO : Ni^{2+} , Cu^{2+} , Fe^{2+} Any one oxide
	<i>must have correct spelling</i>	O_6L_2
(b) To two spatula end-fuls of T in a boiling tube, add dilute nitric acid drop-wise until there is no further change. To the resultant solution, add dilute sodium hydroxide drop-wise until in excess. Shake and filter. Keep both the filtrate and residue.	Bubbles effervescence ✓ of a colourless gas that turns wet blue litmus paper red and lime water milky ✓ - Blue solution ✓ - Blue precipitate insoluble ✓ - Colourless filtrate ✓ - Blue residue ✓	$\text{CO}_2(g)$: CO_3^{2-} ✓ confirmed Cu^{2+} Cu^{2+} Al^{3+} , Pb^{2+} , Zn^{2+} any 2 Cu^{2+} ✓ Cu^{2+} is awarded once O_6
(c) To the filtrate, add dilute nitric acid a little at a time until the solution is just acidic. Divide the acidified filtrate into four parts.	white precipitate soluble ✓	Al^{3+} , Pb^{2+} , Zn^{2+} any 2 O_2

TESTS	OBSERVATIONS	DEDUCTIONS
(i) To the first part of the acidified filtrate, add 2 cm ³ of ethanol followed by 2-3 drops of concentrated sulphuric acid and warm the mixture.	sweet fruity smell ✓	Ester formed / Esterification. CH_3COO^- confirmed ✓ 01½
(ii) To the second part of the acidified filtrate, add dilute sodium hydroxide solution drop-wise until in excess.	<u>white precipitate</u> soluble [✓]	Al^{3+} , Pb^{2+} , Zn^{2+} any 2
(iii) To the third part of the acidified filtrate, add dilute ammonia solution drop-wise until in excess.	<u>white precipitate</u> soluble [✓]	Zn^{2+} ✓ 01½
(iv) Use the fourth part of the acidified filtrate to carry out a test of your own choice to confirm one of the cations in T. <u>To test solution, added NH_4Cl (aq) followed by Na_2HPO_4 (aq) and then NH_3 (aq) until in excess</u>	<u>white precipitate</u> [✓] <u>soluble</u> [✓]	Zn^{2+} confirmed. 03
(d) Dissolve the residue from (b) in dilute hydrochloric acid and divide the resultant solution into four parts.	dissolves to form a blue solution [✓]	Cu^{2+} ✓ 01

TESTS	OBSERVATIONS	DEDUCTIONS
(i) To the first part of the resultant solution, add dilute sodium hydroxide solution drop-wise until in excess.	<u>pale blue precipitate ✓</u> <u>insoluble ✓</u>	$\text{Cu}^{2+} \checkmark$ 01 ₂
(ii) To the second part of the resultant solution, add dilute ammonia solution drop-wise until in excess.	<u>Pale blue precipitate ✓</u> <u>Soluble ✗ to form a deep blue solution ✓</u>	$\text{Cu}^{2+} \checkmark$ 02
(iii) To the third part of the resultant solution, add 2-3 drops of potassium iodide solution.	<u>white precipitate ✓</u> <u>in a brown solution ✓</u>	$\text{Cu}^{2+} \checkmark$ 01 ₂
(iv) Use the fourth part of the solution to carry out a test of your own choice so as to confirm the second cation in T. <i>To test solution, added potassium hexacyanoferrate(II) solution ✓</i>	Brown precipitate ✓	$\text{Cu}^{2+} \checkmark$ confirmed 01 ₂

- (e) (i) The cations in T are $\text{Zn}^{2+} (\text{C (iv)}) \checkmark$ and $\text{Cu}^{2+} (\text{d iv}) \checkmark$ 02
(ii) The anions in T are $\text{CH}_3\text{COO}^- (\text{C (i)}) \checkmark$ and $\text{CO}_3^{2-} (\text{b}) \checkmark$ 08t₂

$$\text{Total} = 32$$

3. You are provided with substance R, which is an Organic compound. You are required to carry out the tests in Table 4 and determine the nature of R. Record your observations and deductions in the table.

Table 4

(18 marks)

TESTS	OBSERVATIONS	DEDUCTIONS
(a) Burn a small amount of R on a spatula end or in a porcelain dish.	Non-sooty flame ✓	Aliphatic compound; of low carbon content; it can undergo incomplete combustion due to presence of oxygen in air.
(b) Shake about one spatula end-ful of R with about 5 cm ³ of water. Test the solution with litmus paper and divide the solution into five parts.	Soluble / Dissolves Turns blue litmus paper red ✓	Polar compound; of lower molecular weight Carboxylic acid; / Acidic compound.
(i) To the first part of the solution, add 2-3 drops of iron(III) chloride solution.	No observable change / No purple colouration ✓	Phenol absent.
(ii) To the second part of the solution, add a half spatula end-ful of sodium carbonate.	Bubbles/effervescence of a colourless gas ✓	Carboxylic acid ✓
(iii) To the third part of the solution, add 4-5 drops of 2,4-dinitrophenyl hydrazine solution.	No observable change / No yellow precipitate ✓	Carbonyl compounds absent ✓ Acc: Ketones and aldehydes absent

TEST	OBSERVATIONS	DEDUCTIONS
(iv) To the fourth part of the solution, add 3-4 drops of acidified potassium dichromate(VI) solution.	No observable change ✓	Reducing compound absent. Acc: Primary or secondary alcohol absent. Rej: Aldehydes absent.
(v) To the fifth part of the solution, add about an equal volume of ethanol followed by 2-3 drops of concentrated sulphuric acid and heat the mixture.	Sweet fruity smell ✓	Ester formed / Esterification ✓ Carboxylic acid, Confirmed present

(c) Describe the nature of R.

Aliphatic carboxylic acid ✓

02
eth₂

Total = 18