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Centre No	Personal No

P525/3

CHEMISTRY

Paper 3

(Practical)

3 1/4 hours

*Proposed marking guide*

### ASSHU ANKOLE JOINT MOCK EXAMINATIONS 2024

#### 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 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 chemical that you may need.

For Examiners' Use only.			
Q1	Q2	Q3	TOTAL
X	X	X	X
32	30	18	80

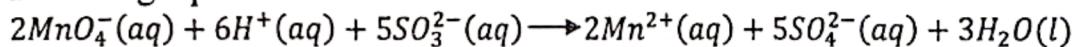
1. You are provided with the following:  
 FA1, which is a solution containing 0.4g of potassium manganate (VII) in 250cm<sup>3</sup>  
 FA2, Which is a solution of sulphite ions of an unknown concentration.  
 Solid Z, which is a salt of the formula MYO<sub>4</sub>  
 1M sulphuric acid  
 5% potassium iodide solution.  
 Starch solution.

You are required to;

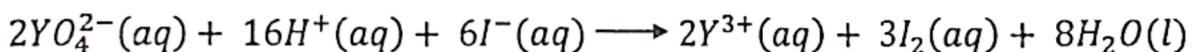
- i) Standardize the solution of sulphite ions, FA2.
- ii) Determine the percentage by mass of element Y in solid Z.

### Theory:

In acidic medium, Manganate(VII) ions react with sulphite ions according to the following equation.



Ions in solid Z oxidize potassium iodide solution in acidic medium to liberate iodine according to the following equation.



The iodine liberated reacts with sulphite ions according to the following equation.



### PART I

#### Procedure:

- a) Using a burette, transfer exactly 25.0cm<sup>3</sup> of FA2 into an empty beaker followed by 75cm<sup>3</sup> of distilled water. Mix well and label the resultant solution FA3.
- b) Pipette 25.0(or 20.0)cm<sup>3</sup> of FA1 into a conical flask, followed by an equal volume of 1M sulphuric acid. Titrate the mixture with FA3 from the burette until the endpoint. Repeat the titration until you obtain consistent results.
  - i) Record the volume of pipette used and burette readings in table 1 below.

Volume of pipette used ..... 25.0 cm<sup>3</sup> (1) (½ mark)

Accept 25 cm<sup>3</sup> or 25.00 cm<sup>3</sup>

Table 1

Titration number	1	2	3
Final burette reading (cm <sup>3</sup> )	25.90 ✓	28.50 ✓	32.00 ✓
Initial burette reading (cm <sup>3</sup> )	0.30 ✓	3.20 ✓	6.70 ✓
Volume of FA3 used (cm <sup>3</sup> )	25.60 ✓	25.30 ✓	25.30 ✓

Centre range  $\pm 3.00$  (4 ½ marks)

- ii) Record the volumes of FA3 that you will use to calculate the average volume. (½ mark)

..... 25.30, 25.30 ✓ cm<sup>3</sup> (1)

- iii) Calculate the average volume of FA3 used. (2 ½ marks)

$$\frac{(25.30 + 25.30)}{2} = 25.30 \text{ cm}^3 \quad (2\frac{1}{2})$$

$\pm 0.1$  2½  
 $\pm 0.2$  02  
 $\pm 0.3$  1½  
 $\pm 0.4$  01  
 $\pm 0.5$  1 ✓

### Questions.

Calculate the;

- i) Number of moles of sulphite ions contained in 100cm<sup>3</sup> of FA3 (K

$$= 39, \text{Mn} = 55, \text{O} = 16) \quad (4 \frac{1}{2} \text{ marks})$$

$$\text{Molar mass of KMnO}_4 = (39 \times 1) + (55 \times 1) + (16 \times 4) \\ = 158g \quad (1)$$

158g of KMnO<sub>4</sub> contain 1 mole ✓

$$0.4g \text{ of KMnO}_4 \text{ contain } \left( \frac{1 \times 0.4}{158} \right) \text{ moles}$$

$$= 0.0025316455696 \text{ moles of MnO}_4^-$$

250cm<sup>3</sup> of FA1 contain 0.0025316455696 moles of MnO<sub>4</sub><sup>-</sup>

$$25 \text{ cm}^3 \text{ of FA1 contain } \left( \frac{0.0025316455696 \times 25}{250} \right) \text{ moles of MnO}_4^- \text{ ions} \\ = 0.0002531645596 \text{ moles of MnO}_4^- \text{ ions}$$

2 moles of MnO<sub>4</sub><sup>-</sup> react with 5 moles of SO<sub>3</sub><sup>2-</sup> ions

$$0.0002531645596 \text{ moles of MnO}_4^- \text{ react with } \left( \frac{5 \times 0.0002531645569}{2} \right) \text{ moles of SO}_3^{2-} \\ = 0.0006329113924 \text{ moles of SO}_3^{2-}$$

25.30cm<sup>3</sup> of FA3 contain 0.0006329113924 moles of SO<sub>3</sub><sup>2-</sup> ions

$$100 \text{ cm}^3 \text{ of FA3 contain } \left( \frac{0.0006329113924 \times 100}{25.30} \right) \text{ moles of SO}_3^{2-} \text{ ions}$$

If average volume of FA3 is  $\frac{3}{2} = 0.0025016260569$  moles of SO<sub>3</sub><sup>2-</sup> ions  
 wrong, deny this mark on first answer)

ii) Molar concentration of sulphite ions in FA2 (2 marks)

~~25 cm<sup>3</sup> of FA2 contain 0.0025016260569 moles of SO<sub>3</sub><sup>2-</sup> ions~~

~~1000 cm<sup>3</sup> of FA2 contain  $(0.0025016260569 \times 1000) / 25$  moles of SO<sub>3</sub><sup>2-</sup> ions~~

~~= 0.100065042 mol dm<sup>-3</sup>~~

(v2)

## PART II

### Procedure:

- c) Weigh accurately 2.6g of Z. Dissolve it in about 100cm<sup>3</sup> of distilled water and transfer the solution into a 250cm<sup>3</sup> volumetric flask. Make the solution up to the mark with distilled water and label it FA4.
- d) Pipette 25.0(or 20.0)cm<sup>3</sup> of FA4 into a conical flask, add an equal volume of 1M sulphuric acid using a measuring cylinder, followed by 15cm<sup>3</sup> of 5% potassium iodide solution. Titrate the iodine liberated with FA2 from the burette using starch as indicator  
Repeat the titration until you obtain consistent results.

- i) Record the volume of pipette and burette readings in table 2 below
- Results.

Mass of weighing bottle + z = ..... 9.3 ✓ g (½ mark)

~~Must be recorded~~ Mass of empty weighing bottle = ..... 6.7 ✓ g (½ mark)

~~to the same d.p.s~~ Mass of Z weighed = ..... 2.6 ✓ g (½ mark) (0.2)

~~Consider uniformity~~ Volume of pipette used = ..... 25.0 ✓ cm<sup>3</sup> (½ mark)  
Accept 25 cm<sup>3</sup> and 25.00 cm<sup>3</sup>

Table 2

Titration number	1	2	3
Final burette reading (cm <sup>3</sup> )	20.50 ✓	40.50 ✓	26.80 ✓
Initial burette reading (cm <sup>3</sup> )	0.10 ✓	20.50 ✓	6.80 ✓
Volume of FA2 used (cm <sup>3</sup> )	20.40 ✓	20.00 ✓	20.00 ✓

By 00.00  
09.00 Centre Range  $\pm 3.00\text{cm}^3$  (4 ½ marks)  
20.45 By all the  
20.06 Deny all marks in  
table if a student is  
out of centre range

- all recorded to  
two d.p.s  
- final burette  
reading  $\leq 50$

- i) Record the volumes of FA2 that you will use to calculate the average volume. *Consider consistency here* (½ mark)
- ..... 20.00, 20.00  $\rightarrow \frac{1}{2}$  for no consistency  $\text{cm}^3$  (½)
- ..... Should be the same or  $\pm 0.1$  (difference) (½)

- ii) Calculate the average volume of FA2 used. (2 ½ marks)

$$\frac{(20.00 + 20.00)}{2} = 20.00 \text{ cm}^3 \quad (2\frac{1}{2})$$

$\pm 0.1$   $\frac{1}{2}$   
 $\pm 0.2$  02  
 $\pm 0.3$  1½  
 $\pm 0.4$  01  
 $\pm 0.5$  ½

### Questions

- a) Calculate the;

- i) Number of moles of iodine liberated by FA4 (2 marks)

1000 cm<sup>3</sup> of FA2 contain 0.100065042 moles of  $\text{SO}_3^{2-}$  ions

20.00 cm<sup>3</sup> of FA2 contain  $(\frac{0.100065042 \times 20.00}{1000})$  moles of  $\text{SO}_3^{2-}$  ions

$$= 0.00200130084 \text{ moles of } \text{SO}_3^{2-} \text{ ions}$$

being  $\frac{1}{2}$  mole of  $\text{SO}_3^{2-}$  ions reacts with 1 mole of  $\text{I}_2$

for no wrong answer average

$$0.00200130084 \text{ moles of } \text{SO}_3^{2-} \text{ ions react with } (\frac{1 \times 0.00200130084}{1}) \text{ moles of } \text{I}_2$$

$$= 0.00200130084 \text{ moles of } \text{I}_2$$

- ii) Molar concentration of FA4. (2 marks)

3 moles of  $\text{I}_2$  are liberated by 2 moles of  $\text{IO}_4^{2-}$  ions

$$0.00200130084 \text{ moles of } \text{I}_2 \text{ are liberated by } (\frac{2 \times 0.00200130084}{3}) \text{ moles of } \text{IO}_4^{2-}$$

$$= 0.00133420056 \text{ moles of } \text{IO}_4^{2-}$$

25 cm<sup>3</sup> of FA4 contain 0.00133420056 moles of  $\text{IO}_4^{2-}$  ions

$$1000 \text{ cm}^3 \text{ of FA4 contain } (\frac{0.00133420056 \times 1000}{25}) \text{ moles of } \text{IO}_4^{2-}$$

$$= 0.0533680224 \text{ mol dm}^{-3}$$

- b) Determine the mass of element Y in one mole of Z and hence its

- percentage. ( $M = 79, O = 16$ ) (4 marks)

250 cm<sup>3</sup> of FA4 contain 2.6 g of Z  $\text{IO}_4^{2-}$  ions

$$1000 \text{ cm}^3 \text{ of FA4 contain } (\frac{2.6 \times 1000}{250}) \text{ g of } \text{IO}_4^{2-} \text{ ions}$$

$$= 10.4 \text{ g of } \text{IO}_4^{2-} \text{ ions}$$

(Any  $\frac{1}{2}$  for no units)

.....0.053684.....

.....0.053680224 moles of  $\text{YO}_4^-$  ions weigh 10.49.

.....1 mole of  $\text{YO}_4^-$  ions weighs  $(\frac{10.4 \times 1}{0.053680224})$  g.....

$$= 194.87 \checkmark$$

$$\text{M} \text{YO}_4 = 194.87 \checkmark$$

$$79 + 1 + (16 \times 4) = 194.87$$

$$Y = 51.87 \checkmark$$

$$\text{Percentage of Y in Z} = \frac{51.87 \checkmark}{194.87} \times 100 = 26.62 \checkmark$$

(D4)

2. You are provided with substance W which contains two cations and two anions. Carry out the following tests to identify the cations and anions present in W. Identify any gases evolved.

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

**Table 3** In all cases, allow Ppt  $\rightarrow$  PPT, P.P.T, PPT

Tests	Observations	Deductions
a) Heat two spatula endfuls of W in a dry test tube strongly until there is no further change.	<p>A colourless gas; turns moist blue litmus paper red and lime water milky and brown fumes; turns moist blue litmus paper red and bleaches it. A yellow solid residue when hot and turns white on cooling.</p> <p>Consider only one gas identified, <del>detected</del> and tested</p> <p>eg - yellow substance or solid</p> <p>Ignore irrelevant information</p>	$\text{CO}_2$ gas; $\text{CO}_3^{2-}$ , $\text{C}_2\text{O}_4^{2-}$ , $\text{HCO}_3^-$ , $\text{CH}_3\text{COO}^-$ $\text{Br}_2$ vapour; $\text{Br}^-$ $\$ \text{ZnO}$ formed; $\text{Zn}^{2+}$
b) To two spatula endfuls of W in a test tube add about 4cm <sup>3</sup> of distilled water, shake	<p>partially dissolves to give j</p> <p>A colourless filtrate</p>	$\text{Ca}^{2+}$ , $\text{Zn}^{2+}$ , $\text{Pb}^{2+}$ , $\text{Mg}^{2+}$ , <del><math>\text{Ba}^{2+}</math></del> , $\text{Al}^{3+}$ , $\text{Sn}^{2+}$ , $\text{Sn}^{4+}$

thoroughly and filter. Keep both the filtrate and residue. Divide the filtrate into four parts.	A white residue ✓	$Pb^{2+}$ , $Ca^{2+}$ , $Zn^{2+}$ , $Mg^{2+}$ , $Ba^{2+}$ , $Al^{3+}$ , $Sn^{2+}$ or $Sn^{4+}$	Any 2 1½
i) To the first part, add 2 – 3 drops of barium nitrate solution	No observable change	$Cl^-$ , $Br^-$ , $I^-$ Any 2	01
ii) To the second part, add silver nitrate solution, followed by dilute nitric acid	A pale yellow precipitate insoluble in acid	$Br^-$	1½
iii) To the third part, add 3 -4 drops of copper (II) sulphate solution and allow to stand.	A pale greenish-blue precipitate which turns black on standing	$Br^-$	01
iv) Use the fourth part to carry out a test of your own choice so as to confirm one of the anions in W  Test: Little bleaching powder is added followed	An orange solution in the organic layer,	$Br^-$ Confirmed	1½

Accept: Lead (II) nitrate solution white precipitate

b) dilute nitric acid and then 5 drops of chloroform		
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 the alkali is in excess and then filter.  Keep the residue for use in part (e)	<p>Dissolves with effervescence / bubbles of a colourless gas that turns moist blue litmus paper red and the water milky.</p> <p>A colourless solution formed.</p> <p>A white precipitate insoluble.</p> <p>A colourless filtrate.</p> <p>A white residue.</p>	<p><math>\text{CO}_2</math> gas ✓ +  <math>\text{CO}_3^{2-}</math> confirmed</p> <p><math>\text{Zn}^{2+}, \text{Ca}^{2+}, \text{Mg}^{2+}, \text{Ba}^{2+}, \text{Al}^{3+}, \text{Pb}^{2+}, \text{Sn}^{2+}</math> or <math>\text{Sn}^{4+}</math> Any 2  <math>\text{Ca}^{2+}, \text{Mg}^{2+}</math> or <math>\text{Ba}^{2+}</math> Any 2  <math>\text{Zn}^{2+}, \text{Pb}^{2+}, \text{Al}^{3+}, \text{Sn}^{2+}</math> or <math>\text{Sn}^{4+}</math> Any 2  <math>\text{Mg}^{2+}, \text{Ca}^{2+}</math> or <math>\text{Ba}^{2+}</math> Any 2</p>
d) To the filtrate from part (c), add dilute nitric acid dropwise until the solution is just acidic. Divide the solution into four parts	<p>A white precipitate soluble to form a colourless solution</p>	$\text{Zn}^{2+}, \text{Pb}^{2+}, \text{Al}^{3+}, \text{Sn}^{2+}$ or $\text{Sn}^{4+}$
i) To the first part of the acidified filtrate, add dilute sulphuric acid.	No observable change ✓	$\text{Zn}^{2+}, \text{Al}^{3+}$ ✓ $\text{Sn}^{2+}$ or $\text{Sn}^{4+}$
ii) To the second part of the acidified filtrate add aqueous ammonia solution	<p>A white precipitate soluble to form a colourless solution</p>	$\text{Zn}^{2+}$ ✓

dropwise until in excess		
iii) To the third part of the acidified filtrate, add 3 – 4 drops of potassium hexacyanoferrate (II) solution	A white <del>↓</del> precipitate	$Zn^{2+}$ <del>↓</del> ①
iv) Use the fourth part of the solution to carry out a test of your own choice to confirm one of the cations in W.	<del>Test: Little solid <math>Ag^+</math> ammonium chloride is added and shaken to dissolve; followed by 3 drops of dilute hydrogen phosphate solution and then aqueous ammonia drop-wise until in excess</del>  A white precipitate soluble in aqueous ammonia to form a colourless solution	$Zn^{2+}$ <del>↓</del> Confirmed ②
c) Wash the residue from (c) with dilute sodium hydroxide, transfer it into a test tube and add dilute nitric acid to dissolve. Divide the resultant solution into four parts.	Dissolves to form a colourless solution	$Ba^{2+}$ , $Ca^{2+}$ , $Mg^{2+}$ <del>↓</del> ③

i) To the first part, add 2 – 3 drops of dilute sulphuric acid	A white <del>✓</del> precipitate	$\text{Ca}^{2+}$ or $\text{Ba}^{2+}$	01
ii) To the second part, add aqueous ammonia solution dropwise until in excess	No observable <del>✓</del> change	$\text{Ca}^{2+}$ <del>✓</del>	01
iii) To the third part, add half a spatula of solid ammonium chloride followed by disodium hydrogen phosphate solution, then aqueous ammonia solution dropwise until in excess.	A white <del>✓</del> precipitate <del>insoluble</del> in ammonia solution	$\text{Ca}^{2+}$ <del>✓</del>	1½
iv) Use the fourth part to carry out a test of your own choice to confirm the second cation in W.  Test:  <del>reject use of the formula</del> 3 drops of ammonium oxalate solution are added followed by dilute nitric acid	A white <del>✓</del> precipitate <del>soluble</del> <del>✓</del> to form a colourless solution	$\text{Ca}^{2+}$ <del>✓</del> Confirmed	02

Accept: Ammonium Oxalate solution and nitric acid

f) Identify the:

- i) Cations in W .....  $Zn^{2+}$  ✓ and  $Ca^{2+}$  ✓ (02) None if confirmed in their respective tests
- ii) Anions in W .....  $Br^-$  ✓ and  $CO_3^{2-}$  ✓

3. You are provided with substance Y which is organic. You are required to identify the nature of Y. Carry out the following tests on Y and record your observations and deductions in table 4 below. (18 marks)

Tests	Observations	Deductions
a) Burn a small amount of Y on a spatula end or porcelain dish. <i>Accept distilled soluble</i>	<i>Yellow initial colour</i> BURNS WITH A YELLOW NON-SOOTY FLAME	<del>Aliphatic</del> <del>saturated</del> <del>Compound with a low</del> <del>Carbon Content</del> present <span style="margin-left: 20px;">(02)</span>
b) To 1cm <sup>3</sup> of Y add about 4cm <sup>3</sup> of distilled water, shake and divide the mixture into three parts.	MISCELLANEOUS WITH WATER TO FORM A COLOURLESS SOLUTION	POLAR <del>Aliphatic</del> <del>Compound with</del> <del>low molecular mass.</del> alcohols, carbonyl, carboxylic acid present <span style="margin-left: 20px;">(02)</span>
i) To the first part, add a spatula endful of magnesium powder.	No observable change   No bubbles of a colourless gas	CARBOXYLIC acid absent <span style="margin-left: 20px;">(01)</span>
ii) To the second part, add neutral iron (III) chloride solution	No observable change ✓	Phenol absent <span style="margin-left: 20px;">(01)</span>
iii) To the third part, add Fehling's solution and warm.	No observable change ✓	ALDEHYDE absent <span style="margin-left: 20px;">(01)</span>
c) To 1cm <sup>3</sup> of Y, add		

<p>Acidified potassium dichromate (VI) solution and heat. Keep the products for part (d)</p>	<p>Orange solution turns green</p>	<p>Reducing compound present. Primary or secondary alcohol present</p>
<p>d) To the products from (c), add Fehling's solution and heat.</p>	<p>Red precipitate formed Accept reddish brown precipitate</p>	<p>Primary alcohol oxidised to aldehyde.</p>
<p>e) Use a portion of Y to carry out a test of your own choice to confirm the class of the functional group of Y</p> <p>Test:</p> <p>To <math>1\text{cm}^3</math> of Y was added <math>1\text{cm}^3</math> of Lucas reagent</p>	<p>No observable change</p>	<p>Primary alcohol confirmed present</p>
<p>f) To about <math>1\text{cm}^3</math> of Y add an equal volume of ethanoic acid followed by 3 drops of concentrated sulphuric acid and warm the mixture. Pour the products in a beaker of cold</p>	<p>A sweet fruity smell</p>	<p>Ester formed. Esterification reaction Primary alcohol present. <math>\text{R}'-\text{CO}_2\text{R}</math> - alcohol present must carry the class of alcohol</p>

water.		
g) To 1cm <sup>3</sup> of Y, add 3cm <sup>3</sup> of iodine solution followed by sodium hydroxide solution drop wise until the colour of iodine is discharged, and allow to stand for 2 minutes.	No observable change X	CHI <sub>3</sub> not formed Primary alcohol with no methyl group attached to the carbon carrying a hydroxyl group is present <i>(D)</i>
h) To 1cm <sup>3</sup> of Y, add 3 drops of concentrated sulphuric acid and heat the mixture. Pass the vapour through alkaline potassium manganate(VII) solution	Purple solution turns colourless. A colourless gas turns purple X solution Colourless	Aliphatic primary alcohol dehydrated to an alkene. <i>(E)</i>
i) To 1cm <sup>3</sup> of Y, add, 2, 4-dinitrophenyl hydrazine solution.	No observable change X	carbonyl compound absent <i>(D)</i>
j) Describe the nature of Y.	Y is an aliphatic primary alcohol of a probable structure RCH <sub>2</sub> CH <sub>2</sub> OH	<i>(1 1/2)</i>

- END -