

Candidate's Name:.....

Signature:.....

Random No.

Personal No.

--	--	--	--	--	--	--	--

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

P525/3
CHEMISTRY
(Practical)
Paper 3
11/Dec. 2019
3 ¼ 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 ball point pens. Any work done in pencil will not be marked except drawings.

Write your answers on this question paper in the spaces provided.

Mathematical tables and silent non-programmable scientific electronic calculator are allowed.

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 arrangements to have all the apparatus and chemicals that they may need.

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

1. You are provided with the following:
- FA1**, which is a solution containing 39.2 g per litre of ammonium ferrous sulphate, $(\text{NH}_4)_2\text{SO}_4 \cdot \text{FeSO}_4 \cdot 6\text{H}_2\text{O}$.
 - FA2**, which is a solution of potassium manganate(VII) of unknown concentration.
 - 2 M sulphuric acid.
 - Solid W.

You are required to determine the;

- concentration of **FA2** in moles per litre.
 - stoichiometric ratio of reaction between Fe^{2+} ions in **FA1** and **W**.
- Manganate(VII) ions reacts with iron(II) ions in acidic medium according to the following equation.



PROCEDURE:

PART I:

Pipette 25.0 cm³ (or 20.0 cm³) of **FA1** into a conical flask, then add 20 cm³ of 2 M sulphuric acid.

Titrate the mixture with **FA2** from the burette until the end point.

Repeat the titration until you obtain consistent results.

Record your results in Table 1.

Results:

Volume of pipette used 25.0 ✓ $\frac{1}{2}$ cm³. (E1) (½ mark)

Table 1

Final burette reading (cm ³)	25.20	25.00	33.00
Initial burette reading (cm ³)	0.00	0.00	7.90
Volume of FA2 used (cm ³)	25.00	25.00	25.10

✓ ✓ ✓ (4½ marks)

Record the titre values used to calculate average volume of **FA2** used.

..... 25.00, 25.10 ✓ cm³. (01) (½ mark)

Average volume of **FA2** used $\frac{25.00 + 25.10}{2} = 25.05$ ✓ cm³. (02) (2½ marks)

0.1 ✓
0.2 ✓
0.3 ✓
0.4 ✓
0.5 ✓

Questions:

Calculate the concentration of manganate(VII) ions in FA2 per litre of solution.

(H = 1; N = 14; O = 16; S = 32; Fe = 56)

(7½ marks)

$$\text{Rfm. of } (NH_4)_2SO_4 \cdot FeSO_4 \cdot 6H_2O$$

$$(14 \times 2) + (1 \times 8 \times 2) + 32 + (56 \times 1) + 32 + (16 \times 4) + (1 \times 2 \times 6)$$

$$= 392$$

392 g of ammonium ferrous sulphate contains 1 mole

39.2 g of ammonium ferrous sulphate contains $\frac{1 \times 39.2}{392}$ moles

$$= 0.1 \text{ M}$$

1000 cm³ of FA₁ contains 0.1 moles of Fe²⁺

25 cm³ of FA₁ contains $\frac{0.1 \times 25}{1000}$ moles of Fe²⁺

5 moles of Fe²⁺ reacts with 1 mole of MnO₄⁻

$$0.0025 \text{ moles of Fe}^{2+} \text{ reacts with } \left(\frac{1}{5} \times 0.0025 \right) \text{ moles of MnO}_4^-$$

$$= 0.0005 \text{ moles}$$

PART II:

PROCEDURE:

25.05 cm³ of FA₁ contains 0.0005 moles of MnO₄⁻
 1000 cm³ of FA₁ contains $\frac{0.0005 \times 1000}{25.05}$ moles
 Weigh accurately about 0.5 g of W and place it in a beaker. 25.05 = 1.996 g
 Add to it about 50 cm³ of distilled water and stir to dissolve. Transfer the contents of the beaker into a 250 cm³ volumetric flask. Add exactly 150 cm³ of FA1 and top up with distilled water to the mark. Shake and allow to stand for about 5 minutes. Label the resultant solution FA3.

Pipette 25.0 cm³ (or 20.0 cm³) of FA3 into a conical flask followed by 10 cm³ of 2 M sulphuric acid and then titrate with FA2 until the end point.

Repeat the titration until you obtain consistent results.

Record your results in Table 2.

Results:

Mass of W and the weighing bottle..... 33.50 g (½ mark)
 Mass of empty weighing bottle 33.00 g (½ mark)
 Mass of W used 0.50 g (½ mark)
 Volume of pipette used..... 25.0 cm³ (½ mark)

Table 2

Final burette reading (cm ³)	12.50	11.50	22.80
Initial burette reading (cm ³)	1.10	0.30	11.50
Volume of FA2 used (cm ³)	11.40	11.20	11.30

Record the titre values used to calculate average volume of FA2 used. (1/2 mark)
 11.20 and 11.30 cm³. (01)

Average volume of FA2 used $\frac{11.20 + 11.30}{2}$ (2 1/2 marks)
 = 11.25 cm³.

Questions:

(a) Calculate the number of moles of;

(i) excess iron(II) ions that reacted with manganate(VII) ions in FA2. (3 1/2 marks)

1000 cm³ of FA2 contains 1.996×10^{-2} moles of MnO₄⁻ ions. (01 ✓)

11.25 cm³ of FA2 contains $\left(\frac{1.996 \times 10^{-2} \times 11.25}{1000} \right)$ moles of MnO₄⁻ ions. (01 ✓)
 = 2.246×10^{-4} moles.

1 mole of MnO₄⁻ reacts with 5 moles of Fe²⁺.

2.246×10^{-4} moles of MnO₄⁻ reacts with $\left(5 \times 2.246 \times 10^{-4} \right)$ moles of Fe²⁺.
 = 1.122×10^{-3} moles. (02 ✓)

(ii) excess iron(II) ions contained in 250 cm³ in FA3. (2 1/2 marks)

25 cm³ of FA3 contains 1.122×10^{-3} moles.

250 cm³ of FA3 contains $\left(\frac{1.122 \times 10^{-3} \times 250}{25} \right)$ moles.
 = 1.122×10^{-2} moles. (021 ✓)

(iii) Iron(II) ions that reacted with W. (3 1/2 marks)

1000 cm³ of FA1 contains 0.1 moles of Fe²⁺. (01 ✓)

150 cm³ of FA1 contains $\left(\frac{0.1 \times 150}{1000} \right)$ moles of Fe²⁺.
 = 0.015 moles.

Excess of moles of Fe²⁺ in 250 = (total moles of Fe²⁺ added in W - moles of Fe²⁺ reacted in W)

$(0.015 - 1.122 \times 10^{-2})$

= 0.0038 moles (02 ✓)

- (ii) Determine the reaction ratio between Iron(II) ions and W. (3 1/2 marks)
(Relative formula mass of W = 270)

2.70 g of W contains 1 mole ✓

0.5 g of W contains $\left(\frac{1 \times 0.5}{270} \right)$ moles ✓

Thus $\text{Fe}^{2+} : \text{W} = 0.00185 \text{ moles}$ ✓

$0.0038 : 0.0018$

$\frac{0.0038}{0.0018} : \frac{0.0018}{0.0018}$ ✓

2.05

2

1

1

0.2

31

$T = 38$

Conditions

- Volume of pipette should be recorded to $\pm 0.01 \text{ cm}^3$
- Titration table of results
 - Values from the table must be within the Centre range $\pm 5.0 \text{ cm}^3$
 - If not, deny all columns out of the Centre range
 - Reject any values recorded above 50.00 cm^3 of the burette
- Choice of values; must be from the table and within Centre range and to ± 0.1
 - Reject any values outside Centre range
- for weighing, the mass of container should be above 0.005

Turn Over

2. You are provided with substance X which contains two cations and two anions. You are required to identify the ions in X.

Carry out the following tests and identify any gas(es) evolved.

Record your observations and deductions in Table 3.

(26 marks)

Table 3

TESTS	OBSERVATIONS	DEDUCTIONS
(a) Heat two spatula end-fuls of X in a dry test tube, first gently, then strongly until there is no further change. Allow it to cool.	Green powdery solid Colourless gas turns moist blue litmus paper red and lime water milky Yellow residue when hot and white on cooling Black residue	CO_2 ✓ CO_3^{2-} ✓ HCO_3^- , $\text{C}_2\text{O}_4^{2-}$ CH_3COO^- ZnO ✓ Zn^{2+} FeO ✓ Fe^{2+} (0.5) CuO ✓ Cu^{2+} , NiO ✓ Ni^{2+}
(b) To two spatula end-fuls of X, add about 10 cm ³ of water. Shake well and filter. Keep both the filtrate and the residue. Divide the filtrate into four parts.	Green filtrate Green residue	Cu^{2+} ✓ Fe^{2+} ✓ Ni^{2+} ✓ Cr^{3+} ✓ Cu^{2+} ✓ Fe^{2+} ✓ Ni^{2+} ✓ Cr^{3+} ✓ (0.2)
(c) To the first part of the solution, add sodium hydroxide solution drop-wise until in excess.	Green ppt insoluble	Ni^{2+} ✓ Fe^{2+} ✓ (0.2)

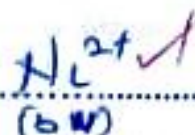
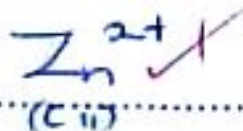
TESTS	OBSERVATIONS	DEDUCTIONS
(ii) To the second part of the solution, add aqueous ammonia drop-wise until in excess. Add 2-3 drops of dimethyl glyoxime to the mixture.	Green ppt soluble in excess forming a blue solution Red ppt (accept fine ppt)	Ni^{2+} confirmed
(iii) To the third part of the solution, add dilute nitric acid followed by a few drops of lead(II) nitrate solution and warm.	White ppt insoluble on warming	SO_4^{2-}
(iv) Use the fourth part of the solution to carry out a test of your own to confirm one of the anions in X. TEST Add dilute nitric acid followed by Barium nitrate solution or $\text{Ba}(\text{NO}_3)_2$ + dil. HNO_3	White ppt white ppt insoluble in acid	SO_4^{2-} confirmed
(c) Dissolve the residue in 5 cm ³ of dilute nitric acid and divide the solution into two parts.	Bubbles of a colourless gas turns moist blue litmus paper red and lime water milky Green solution formed	CO_3^{2-} confirmed Ni^{2+} , Cr^{3+} , Fe^{2+} , Cu^{2+}

TESTS	OBSERVATIONS	DEDUCTIONS
(i) To the first part of the solution, add sodium hydroxide solution drop-wise until in excess.	White ppt soluble forming colourless solution Green ppt insoluble in excess	Zn^{2+} , Al^{3+} , Pb^{2+} H^{+} , Fe^{2+} (3)
(ii) To the second part of the solution, add solid ammonium chloride followed by 2-3 drops of disodium hydrogen phosphate. Add ammonia solution to the mixture drop-wise until in excess.	White ppt soluble forming a colourless solution	Zn^{2+} Confirmed (5 1/2)

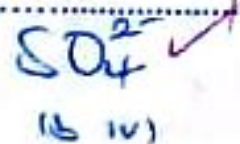
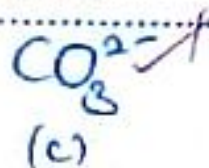
Questions:

(d) Identify the;

(i) cations in X



(ii) anions in X



(02)

$T = 26$

3. You are provided with substance M which is an organic compound. You are required to determine the nature of M. Carry out the following tests and identify any gas(es) evolved. Record your observations and deductions in Table 4.

(16 marks)

TESTS	OBSERVATIONS	DEDUCTIONS
(a) Burn a small amount of M on a spatula end.	Burns with a yellow non-sooty flame	Aliphatic Saturated Cpd with low carbon content
(b) To 2 cm ³ of M, add 3 cm ³ of water and shake. Divide the mixture into three parts.	Soluble/miscible dissolves forming a colourless solution	Polar Cpd (e.g. example alcohol, carbonyl or low molecular mass)
(i) To the first part of the solution add 2-3 drops of iron(II) chloride solution.	No observable change	M is not an oxidising agent
(ii) To the second part of the solution add 3 - 4 drops of neutral iron(III) chloride solution.	No observable change	phenol absent
(iii) To the third part of the solution add 2-3 drops of acidified potassium dichromate solution and warm.	Orange solution turns green	Aldehyde, primary alcohol, secondary alcohol methanol are present (Reducing agent present)

Turn Over

TESTS	OBSERVATIONS	DEDUCTIONS
(c) To 0.5 cm ³ of M in a test tube add, 2-3 drops of 2,4- dinitrophenyl hydrazine solution (Brady's reagent).	<u>Pale yellow ppt</u> <u>No observable change</u>	Primary alcohol or Secondary alcohol with methyl group attached to carbon with -OH group. accept alcohol. (01)
(d) To about 1 cm ³ of M, add 2 cm ³ of ethanoic acid followed by 3 drops of concentrated sulphuric acid and heat. Pour the products in a beaker of cold water.	<u>Sweet fruity smell</u> accept pleasant / sweet smell	primary alcohol Secondary alcohol present neg. alcohol present (01)
(e) To 0.5 cm ³ of M, add 2 cm ³ of sodium hydroxide solution followed by aqueous iodine dropwise until in excess. Warm the mixture and leave to stand.	<u>Pale yellow ppt</u>	primary alcohol or secondary alcohol with methyl group attached to carbon atom with -OH group. accept ethanol. (01)
(f) To 1 cm ³ of M, add 3 cm ³ of Luca's reagent and shake, and leave it to stand.	<u>Solution turns cloudy with in ten minutes (5-10)</u>	Secondary alcohol or $\text{CH}_3-\underset{\text{R}}{\text{C}}-\text{OH}$ (01)

(g) Describe the nature of M. neg. cloudiness, turbidness
white ppt.

M is aliphatic secondary methyl alcohol
(1) (2) (1)

OR Alcohol of structure $\text{CH}_3-\underset{\text{R}}{\text{C}}-\text{OH}$

T = 16

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 difference.
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 cm³).
- 1 pipette (25.0 cm³ or 20.0 cm³).
- 1 Volumetric flask (250 cm³).
- 1 measuring cylinder (50 cm³ or 100 cm³).
- 1 stop clock.
- 2 conical flasks.
- 8 test tubes.
- 1 piece of filter paper.
- 250 cm³ of FA1.
- 120 cm³ of FA2.
- 100 cm³ of a 2 M sulphuric acid.
- 5.0 cm³ of M.
- 0.6 g of W.
- 2.5 g of X.

is access to:

- Heat source.
- Weighing balance weighing to at least one decimal point.
- Common reagents for identifying gases, cations, anions and organic compounds.
- Distilled water.

, is prepared by dissolving 39.2 g of substance N in distilled water to make 100 cm³ of solution.

, is prepared by dissolving 3.2 g of substance P in distilled water to make 100 cm³ of solution.

ances M, N, P, W and X will be provided by UNEB.