Candidate's Name:.....

Signature:.....

Random No.					Personal No.		

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

P525/3
HEMISTRY
(Practical)
Paper 3
. /Dec. 2019
3¼ hours

UGANDA NATIONAL EXAMINATIONS BOARD

Uganda Advanced Certificate of Education

CHEMISTRY

(PRACTICAL)

Paper 3

3 hours 15 minutes

RUCTIONS TO CANDIDATES:

r **all** *questions. Use* **blue** *or* **black** *ball point pens. Any work done in pencil* *t be marked except drawings.*

your answers on this question paper in the spaces provided.

natical tables and silent non-programmable scientific electronic calculator *used.*

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

tes are **not** *allowed to start working with the apparatus for the first* **tes**. *This time is to enable candidates read the question paper and make 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, $(NH_4)_2SO_4 \cdot FeSO_4 \cdot 6H_2O$.

FA2, which is a solution of potassium manganate(VII) of unknown concentration.

2 M sulphuric acid.

Solid **W**.

You are required to determine the;

(i) concentration of **FA2** in moles per litre.
(ii) 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.

$$5Fe^{2+}(aq) + MnO_4^{2-}(aq) + 8H^+(aq) \longrightarrow 5Fe^{3+}(aq) + Mn^{2+}(aq) + 4H_2O(l)$$

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 ✓½ .....cm³. (01½) (½ mark)

Table 1

Final burette reading (cm³)	25.20	25.00	33.00
Initial burette reading (cm³)	0.00	0.00	7.90
Volume of **FA2** used (cm³)	25.00	26.00	25.10

✓✓ ✓✓ ✓✓ (4½) (4½ marks)

Record the titre values used to calculate average volume of **FA2** used. (½ mark)

..... 25.00 , 25.10 ✓1 (01½) .....cm³.

Average volume of **FA2** used.... $\frac{25.00 + 25.10}{2} = 25.05$ ✓ cm³ (02½) (2½ marks)

.....

0 1 ✓½
0 2 ✓
0 3 ✓½
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)*

R/m of $(NH_4)_2SO_4.FeSO_4.6H_2O$

$(14\times2)+(1\times4\times2)+132+(16\times4)+56+32+(16\times4)+(18\times6)$

$= 392$ (01)

392 g of ammonium ferrous sulphate contains 1 mole

39.2 g of ammonium ferrous sulphate contains $\frac{(1\times39.2)}{392}$ moles

$= 0.1$M (01)

1000 cm^3 of FA1 contains 0.1 moles of Fe^{2+}

25 cm^3 of FA1 contains $\frac{(0.1\times25)}{1000}$ moles of Fe^{2+} (01)

5 moles of Fe^{2+} reacts with 1 mole of MnO_4^-

1 mole of Fe^{2+} reacts with $(\frac{1}{5}\times0.0025)$ moles (01) $= 0.0025$ moles

$= 0.0005$ moles

25.05 cm^3 of FA2 contains 0.0005 moles of MnO_4^- (02)

1000 cm^3 of FA2 contains (0.0005×1000) moles

25.05 $= 1.996\times10^{-2}$ moles (01)

PART II:

PROCEDURE:

Weigh accurately about 0.5 g of **W** and place it in a beaker. Add to it about 50 cm^3 of distilled water and stir to dissolve. Transfer the contents of the beaker into a 250 cm^3 volumetric flask. Add exactly 150 cm^3 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 cm^3 (or 20.0 cm^3) of **FA3** into a conical flask followed by 10 cm^3 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) (01½)

Mass of **W** used ..... 0.50 ..... g. (½ mark)

Volume of pipette used ..... 25.0 ..... cm^3. (01½) (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

(04½) (4½ marks)

Record the titre values used to calculate average volume of **FA2** used. (½ mark)

11.20 and 11.30 cm³. (01)

Average volume of **FA2** used $\frac{11.20 + 11.30}{2} = 11.25$ cm³ (2½ marks)

Questions:

(a) Calculate the number of moles of;

(i) excess iron(II) ions that reacted with manganate(VII) ions in **FA2**. (3½ marks)

1000 cm³ of FA2 contains 1.996×10^{-2} moles of MnO_4^-

11.25 cm³ of FA2 contains $\frac{1.996 \times 10^{-2} \times 11.25}{1000} = 2.246 \times 10^{-4}$ moles (01½)

1 mole of MnO_4^- reacts with 5 moles of Fe^{2+}

2.246×10^{-4} moles of MnO_4^- reacts with $\frac{5 \times 2.246 \times 10^{-4}}{1}$

$= 1.122 \times 10^{-3}$ moles. (03)

(ii) excess iron(II) ions contained in 250 cm³ in **FA3**. (2½ marks)

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

250 cm³ of FA3 contains $\frac{1.122 \times 10^{-3} \times 250}{25}$ moles

$= 1.122 \times 10^{-2}$ moles

(02½)

(iii) Iron(II) ions that reacted with **W**. (3½ marks)

1000 cm³ of FA1 contains 0.1 moles of Fe^{2+} (01)

150 cm³ of FA1 contains $\frac{0.1 \times 150}{100}$ moles of Fe^{2+}

$= 0.015$ moles

Excess of moles of Fe^{2+} in 250 = (total moles of Fe^{2+} added in 250 − moles of Fe^{2+} reacted in 250)

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

$= 0.0038$ moles (02)

(b) Determine the reaction ratio between iron(II) ions and W. (3½ marks)
(*Relative formula mass of W = 270*)

270.0 g of W contains 1 mole ✓

0.5 g of W contain $\frac{1 \times 0.5}{270}$ moles ✓ ✓ 0.11/2

= 0.00185 moles

Ions	Fe^{2+} : W
	0.0038 : 0.0018
	0.0038 : 0.0018 ✓
	0.0018 : 0.0018
	2.05 : 1
	2 : 1 ✓

0.2

3½

T = 38

Conditions

→ Volume of pipette should be recorded to 2 d.p ✓ 1 dp
→ Titration table of results
- Values from the table must be within the Concordant 1.0 cm³
- If not, deny all columns out of the Centre range
- Reject any values recorded above 50.00 cm³ the burette

→ Choice of values; must be from the table and with in Centre range and to ± 0.1
- Reject any values out side Centre range

→ for weighing, the mass of Container should be above 0.00 5

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^-, $C_2O_4^{2-}$ CH_3COO^- ZnO : Zn^{2+} FeO : Fe^{2+} Cu_2O : Cu^{2+}, NiO : Ni^{2+} (05)
(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+} (02)
i) To the first part of the solution, add sodium hydroxide solution drop-wise until in excess.	Green ppt insoluble	Ni^{2+}, Fe^{2+} (02)

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 pink 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 $Ba(NO_3)_2$ + 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 wet blue litmus paper red and lime water milky Green solution formed	CO_2 : 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+} Ni^{2+}, 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 (01½)

Questions:

(d) Identify the;

(i) cations in **X** ..... Zn^{2+} (C ii) , Ni^{2+} (b iv) .....

(ii) anions in **X** ..... CO_3^{2-} (c) , SO_4^{2-} (b iv) ..... (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.

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 (02)
(b) To 2 cm³ of M, add 3 cm³ of water and shake. Divide the mixture into three parts.	Soluble/miscible/dissolves forming a colourless solution	Polar cpd (or example alcohol, carboxylic ac low molecular ma
(i) To the first part of the solution add 2-3 drops of iron(II) chloride solution.	No observable change	M is not an oxidizing agent
(ii) To the second part of the solution add 3 - 4 drops of neutral iron(III) chloride solution.	No observable change	phenol absent (0
(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 alcoh methanoic acid present or (Reducing agent present

Turn Ov

TESTS	OBSERVATIONS	DEDUCTIONS
(c) To 0.5 cm³ of M in a test tube add, 2-3 drops of 2,4- dinitrophenyl hydrazine solution (Brady's reagent).	Pale yellow ppt Not observable change	primary alcohol or Secondary alcohol with methyl group attached to carbon atom with -OH group (0½)
(d) To about 1 cm³ of M, add 2 cm³ of ethanoic acid followed by 3 drops of concentrated sulphuric acid and heat. Pour the products in a beaker of cold water.	Sweet fruity smell accept pleasant / sweet smell	primary alcohol Secondary alcohol present Neg. alcohol present (0½)
(e) To 0.5 cm³ of M, add 2 cm³ of sodium hydroxide solution followed by aqueous iodine dropwise until in excess. Warm the mixture and leave to stand.	Pale yellow ppt	primary alcohol or Secondary alcohol with methyl gp attached to carbon atom with -OH gp accept Ethanol (0½)
(f) To 1 cm³ of M, add 3 cm³ of Luca's reagent and shake, and leave it to stand.	Solution turns cloudy within ten minutes (5-10) neg. Cloudiness, turbidness white ppt	Secondary alcohol or $CH_3-\underset{R}{\overset{H}{C}}-OH$ (0½)

(g) Describe the nature of M.

M is aliphatic (C) Secondary (S) methyl (E) alcohol (0½)

OR Alcohol of structure $CH_3-\underset{R}{\overset{H}{C}}-OH$ (0½)

T=16

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 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 cm^3).

   1 pipette (25.0 cm^3 or 20.0 cm^3).

   1 Volumetric flask (250 cm^3).

   1 measuring cylinder (50 cm^3 or 100 cm^3).

   1 stop clock.

   2 conical flasks.

   8 test tubes.

   1 piece of filter paper.

   250 cm^3 of **FA1.**

   120 cm^3 of **FA2.**

   100 cm^3 of a 2 M sulphuric acid.

   5.0 cm^3 of **M.**

   0.6 g of **W.**

   2.5 g of **X.**

isy 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 on of solution.

is prepared by dissolving 3.2 g of substance **P** in distilled water to make on of solution.

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