Marking guide

Name ..... Centre / Index No ...../.....

School ..... Signature .....

P525/3
CHEMISTRY
(PRACTICAL)
Paper 3
July/August 2023
$3^{1}/_{4}$ hours

WAKISSHA JOINT MOCK EXAMINATIONS

Uganda Advanced Certificate of Education

CHEMISTRY
PRACTICAL

Paper 3

3 hours 15 minutes

Instructions to Candidates:

- *Answer* **all** *questions.*
- *Record your answers on this question paper in the spaces provided.*
- *Mathematical tables and silent non-programmable calculators may be used.*
- *Reference books (i.e, textbooks, books 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 to read the question paper and make sure they have all apparatus and chemicals that they may need.*
- *Where necessary use* (Na = 23, N = 14, H = 1, O = 16)

For Examiners' Use Only			
Q.1	Q.2	Q.3	Total
29	33	18	80

1. You are provided with the following;

GA_1, which is a solution made by dissolving 0.4 g sodium nitrite in 250 cm^3 of distilled water.
GA_2, which is a solution of potassium permanganate of unknown concentration.
GA_3, which is 2.0 M sulphuric acid.
Solid **Z** which is an acid of a formula, **T. nH_2O**.

You are required to determine the;

i) the concentration of potassium permanganate in **GA_2** in moles per litre.
ii) find the value of **n** in **$T.nH_2O$**.

Theory

Potassium permanganate reacts with sodium nitrite according to the equation

$$2MnO_4^-{}_{(aq)} + 5NO_2^-{}_{(aq)} + 6H^+{}_{(aq)} \longrightarrow 5NO_3^-{}_{(aq)} + 2Mn^{2+}{}_{(aq)} + 3H_2O_{(l)}$$

The ratio of reaction between MnO_4^- : $T.nH_2O$ is 2:5.

Procedure 1

Pipette **20 or 25 cm^3** of **GA_1** into a clean conical flask. Add equal volume of **GA_3**.
Titrate the resultant solution with **GA_2** from the burette until the end point is reached.
Repeat the titration until you obtain consistent results.
Record your results in the table below.
Volume of pipette used ..... 25.0 ✓ ½ ..... cm^3. *(½ mark)*

Table I

Experiment Number	1	2	3
Final burette reading (cm^3)	11.60	11.50	23.00
Initial burette reading (cm^3)	0.00	0.00	11.50
Volume of **GA_2** used (cm^3)	11.60 ✓	11.50 ✓	11.50 ✓

4½

(4½ marks)

Titre values used for calculating average volume.
..... 11.50, 11.50 cm^3 ✓ ..... 01 *(01 mark)*

Calculate the average volume of **GA_2** used.

Average volume = $\frac{11.50 + 11.50}{2}$ ✓ *(2½ marks)*

= 11.50 cm^3 ✓✓

±0.1	2½ mks
±0.2	02 mks
±0.3	1½ mks
±0.4	01 mk
±0.5	½ mk

Questions

(a) Calculate the number of moles of

(i) Sodium nitrite in **GA_1** that reacted. *(2½ marks)*

RFM $NaNO_2$ = (23×1) + (14×1) + (16×2)
= 69 (no units)

69 g of $NaNO_2$ contains 1 mole
0.4 g of $NaNO_2$ contains $\frac{1 \times 0.4}{69}$
5.797×10^{-3} moles

250 cm^3 of solution contains 5.797
25 cm^3 of solution contains $\frac{5.797}{250}$ 2½
= 5.797_1 moles ✓

(ii) Potassium permanganate in GA_2 that reacted. *(01mark)*

5 moles NO_2^- reacts with 2 moles MnO_4^- ✓

5.797×10^{-4} moles NO_2^- reacts with $\left(\frac{2}{5} \times 5.797 \times 10^{-4}\right)$ ✓

$= 2.31884 \times 10^{-4}$ moles ✓ 01

(b) Determine the concentration of potassium permanganate in GA_2 in moles per litre. *(01mark)*

$11.50cm^3$ of solution contains 2.31884×10^{-4} moles MnO_4^- ✓

$1000cm^3$ of solution contains $\left(2.31884 \times 10^{-4} \times \frac{1000}{11.50}\right)$ ✓

$= 0.020 mol\,l^{-1}$ ✓ 01

Allow for accurate titre value

Procedure 2

Weigh accurately **0.6 g** of **Z** into a clean beaker. Using a measuring cylinder add **100 cm³** of distilled water and stir to dissolve. Transfer the content into a **250 cm³** volumetric flask and make up to the mark with distilled water. Label this solution **GA_4**.

Mass of container + Z = 14.6 ✓ ..... g *(½ mark)*

Mass of container alone = 14.0 ✓ ..... g *(½ mark)*

Mass of solid Z = 0.6 ✓ ..... g *(½ mark)* 1½

Pipette **20** or **25 cm³** of **GA_4** into a conical flask. Add equal volume of **GA_3** and Heat the mixture up to **70°C**. Titrate the hot solution with **GA_2** from the burette until the end point is reached. Repeat the titrations until you obtain consistent results. Record your results in the table below.

Volume of pipette used = 25.0 ✓ ..... cm^3. *(½ mark)* ½

Table II

Experiment Number	1	2	3
Final burette reading (cm^3)	9.70	14.50	24.00
Initial burette reading (cm^3)	0.00	5.00	14.50
Volume of **GA_2** used (cm^3)	9.70 ✓	9.50 ✓	9.50 ✓

4½

(4½ marks)

Titre values for calculating average volume. *(01 mark)*

9.50, 9.50cm^3 ✓

Calculate the average volume of GA_2 used.

$\frac{9.50 + 9.50}{2}$ ✓✓

$9.50 cm^3$ ✓✓

± 0.1 2½ mles
± 0.2 (2 mles)
± 0.3 (1½ mles)
± 0.4 (0 mle)
± 0.5 (½ mle)
(2½ marks)

Questions

(a) Calculate the number of moles of

(i) potassium permanganate in GA_2 that reacted with GA_4. *(01 mark)*

$1000 cm^3$ of soluhon contains 0.02 mols $KMnO_4$

$9.5 cm^3$ of soluhon contains $\left(\frac{0.02 \times 9.5}{1000}\right)$ 01

$= 1.90 \times 10^{-4}$ moles.

(ii) acidic compound of a formula **T. nH_2O** in GA_4 that reacted. *(01 mark)*

2 mols $KMnO_4$ reacts with 5 mols of acid

1.90×10^{-4} mols $KMnO_4$ reacts with $\left(\frac{5}{2} \times 1.90 \times 10^{-4}\right)$ mols

$= 4.75 \times 10^{-4}$ moles 01

b) Determine the;

(i) concentration of acidic compound of a formula **T. nH_2O** in GA_4 in moles per litre. *(01 mark)*

$25 cm^3$ of soluhon contains 4.75×10^{-4} mols acid

$1000 cm^3$ of soluhon contains $\left(\frac{4.75 \times 10^{-4}}{25} \times 1000\right)$ mols

$= 0.019 mol\,l^{-1}$ 01

Award for accurate litre value

(ii) the value of **n** in **T. nH_2O**.

(T = 90, H = 1, O = 16)

(03 marks)

1000cm³ of solution contains 0.019 mols acid

250cm³ of solution contains $\left(\frac{0.019 \times 250}{1000}\right)$

(4.75×10^{-3}) or = 0.00475 mols

0.00475 mols of solution weigh/contains 0.6 g of acid

1 mole of solution contain $\left(\frac{0.6 \times 1}{0.00475}\right)$ g

= 126.3158g ≈ 126

$T \cdot nH_2O = 126$

$90 + n((2\times1) + (16\times1)) = 126$

$18n = 126 - 90$

$18n = 36$

$n = 2$

award 03 if the value is accurate.

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

(33 marks)

Tests	Observations	Deductions
(a) Heat one spatula endful of **T** strongly in a test tube.	White crystalline solid.	Ca^{2+}, Mg^{2+}, Ba^{2+}, NH_4^+, Pb^{2+}, Zn^{2+}, Al^{3+}, Sn^{2+} salts
	Colourless liquid condensate turns white anhydrous $CuSO_4$ blue	water of crystallisation, T is hydrated.
	White fumes with sweet odour; and forms a yellow precipitate with Brady's reagent	CH_3COCH_3 vapour; CH_3COO^- present
	Colourless gas turns moist blue litmus paper red and lime water cloudy	acidic gas CO_2 gas.
(b) To one spatula end full of **T**, add 3 drops of concentrated sulphuric acid and warm.	White fumes with a vinegar smell; turns moist blue litmus paper red	CH_3COO^- present
(c) Dissolve one spatula endfull of **T** in 6 cm³ of distilled water. Divide the resultant solution into **three** portions.	Dissolves to form a colourless solution	salts of Zn^{2+}, Pb^{2+}, Al^{3+}, Sn^{2+}, NH_4^+, Ca^{2+}, Mg^{2+}, Ba^{2+} present

08

1½

2½

yellow hot and white cold residue

ZnO; Zn^{2+} present.

To the **first** portion add few drops of Lead(II) nitrate followed by dilute nitric acid and heat.	A white ~~Precipitate~~ Insoluble ~~in~~ acid and ~~on~~ heating	SO_4^{2-} ✓ ✓	Dl½
ii) To the **second** portion add Barium nitrate solution, followed by dilute nitric acid.	White ~~precipitate~~; Insoluble in acid	SO_4^{2-} ✓ ✓ confirmed present	01
(iii). To the **third** portion add an equal volume of ethanol followed by 3-4 drops of concentrated sulphuric acid and heat, pour the hot content in a beaker of cold water.	Sweet, ~~fruity~~ smell	CH_3COO^- ✓ confirmed present	01
d) Dissolve two spatula endful of **T** in 6 cm^3 of distilled water. To the resultant solution add aqueous ammonia solution dropwise until in excess. Filter and keep both the residue and the filtrate.	Colourless solution White ~~Precipitate~~; Insoluble in excess White ~~residue~~ ✓ Colourless ~~✓~~ filtrate	Zn^{2+}, Pb^{2+}, Al^{3+}, Ba^{2+}, Mg^{2+}, Ca^{2+}, NH_4^+, Sn^{2+} ~~present~~ Al^{3+}, Sn^{2+}, Pb^{2+}, Ba^{2+}, Mg^{2+} present. Pb^{2+}, Al^{3+}, Ba^{2+}, Mg^{2+}, Sn^{2+} Probably present Zn^{2+} ✓ present	04
e) To the filtrate obtained in (d) add dilute nitric acid until it is just acidic. Divide the resultant solution into **three** portions.	White ~~precipitate~~; soluble	Zn^{2+} ✓ present	1½
(i) To the **first** portion add sodium hydroxide solution dropwise until in excess.	White ~~precipitate~~ soluble	Zn^{2+} ✓ present	1½
(ii) To the **second** portion add ammonia solution dropwise until in excess.	White ~~precipitate~~; soluble	Zn^{2+} ✓ present	01½
(iii) Use the **third** portion to carry out a test of your choice to confirm the cation in **T** **Test:** I added solid NH_4Cl, followed by 3 drops of $Na_2HPO_4(aq)$ + excess ammonia solution.	White ~~precipitate~~ soluble in ammonia	Zn^{2+} ✓ ✓ confirmed present	1½

f) Wash the residue with distilled water and dissolve it in dilute nitric acid. Divide the resultant solution into **three** portions.	Dissolves to form a colourless solution	Ba^{2+}, ~~Mg^{2+}~~, Al^{3+}, Pb^{2+}, Sn^{2+} present 01
(i) To the **first** portion, add sodium hydroxide solution dropwise until in excess.	White precipitate; soluble	Al^{3+}, Sn^{2+}, Pb^{2+} present 02
(ii) To the **second** portion add 1 cm^3 of sodium sulphate solution.	No observable change	Al^{3+}, Sn^{2+} present 01
iii) Use the **third** portion to carry out a test of your own choice to confirm the cation in the residue.		
I added 2 drops of dilute nitric acid (hydrochloric acid) followed by 2 drops of Litmus solution and excess ammonia solution	Blue lake solution	Al^{3+} confirmed present 1½

g) Identify the

(i) Cations in T ..... Zn^{2+} in d(iii) and ..... Al^{3+} in f(iii) 02

(ii) Anions in T..... SO_4^{2-} in c(i) and ..... CH_3COO^- in c(iii)

3. You are provided with substance Q which is an organic compound. Carry out the following tests on Q to identify its nature and functional group.

(18marks)

Tests	Observations	Deductions
(a) Burn a small amount of Q on a spatula end or crucible.	Burns with a yellow non-sooty flame	Aliphatic saturated compound with low Carbon: hydrogen ratio
(b) To about 2 g of Q, add 5 cm^3 of water and shake. Divide the resultant solution into eight portions.	Q dissolves in water to form a colourless solution	Polar aliphatic compound with low molecular mass (alcohols, carbonyl, carboxylic esters)
(i) Test the **first** portion with litmus paper.	turns blue litmus paper red	Carboxylic acid or Phenol present.
(ii) To the **second** portion add four drops of iron (III) chloride solution.	No purple colouration	phenol absent

(iii) To the **third** portion add little solid sodium carbonate.	Bubbles of a colourless gas	Carboxylic acid confirmed present
(iv) To the **fourth** portion add 3 drops of acidified potassium permanganate and heat.	Purple solution turns colourless.	Reducing agent present. 1°, 2° alcohol & aldehydes present
(v) To the **fifth** portion add 1 cm^3 of 2, 4-dinitrophenyl-hydrazine solution.	NO observable change	Carbonyl compound absent.
(vi) To the **sixth** portion of solution add 1 cm^3 of Fehling's solution and heat.	NO observable change	Aliphatic aldehyde absent
(vii) To the **seventh** portion of solution add acidified solution of potassium dichromate(VI) and heat, cool and then add Brady's reagent.	Orange solution turns green with $H^+(aq)/Cr_2O_7^{2-}(aq)$	Reducing agent
(viii) To the **eighth** portion add Lucas' reagent.	NO Observable Change	3° alcohol absent

(c) Comment on the nature of Q

Q is a saturated aliphatic carboxylic acid

END