P525/3
Chemistry
Paper 3
July - August 2022
3 ¼ hours

UGANDA MUSLIM TEACHERS' ASSOCIATION

UMTA JOINT MOCK EXAMINATIONS 2022

Name .....

Centre/Index No. .....Signature .....

UGANDA ADVANCED CERTIFICATE OF EDUCATION
Chemistry
Paper 3
3 hours 15 Minutes

INSTRUCTIONS TO CANDIDATES:

- *This paper consists of three compulsory questions.*
- *All questions must be answered in the spaces provided.*
- *Mathematical tables (3 – figure tables) and silent non-programmable scientific electronic calculators may be used.*
- *Candidates are advised to read through the paper and cross check with the apparatus and chemicals provided in the first fifteen minutes.*

For Examiners' use only			
Q. 1	Q. 2	Q. 3	Total

1. You are provided with the following;

FA1 which is 1M hydrochloric acid solution

FA2 which is approximately 1M sodium hydroxide solution

FA3 which is a 0.1Msulphuric acid

Solid T, which is impure tribasic acid H_3X

You are required to;

- **Standardize solution FA2 using FA1**
- **Determine the percentage purity of solid T using FA2 and FA3.**

Theory

Sodium hydroxide reacts with the acids according to the equations below:

$NaOH_{(aq)} + HCl_{(aq)} \longrightarrow NaCl_{(aq)} + H_2O_{(l)}$

$3NaOH_{(aq)} + H_3X_{(aq)} \longrightarrow Na_3X_{(aq)} + 3H_2O_{(l)}$

Procedure A:

a) Pipette $10cm^3$ of **FA2** into a clean conical flask followed by 2drops of phenolphthalein indicator and then titrate with **FA1** from the burette until the end point. Repeat the titration until you obtain consistent readings. Enter your results in the table I below:

Table I

Volume of pipette used = ..10.0.. cm^3 (½ marks)

1 dp Reg. zero or more than 1 dp.

Experiment	I	II	III
Final burette reading /cm^3	9.90	19.90	29.90
Initial burette reading /cm^3	0.00	10.00	20.00
Volume of **FA 1** used /cm^3	9.90	9.90	9.90

(4½ marks)

2 dps and the last digit is zero.

Titre values used to calculate average volume of FA1 (½ marks)

9.90 and 9.90 ± 0.1 ± 0.2 ± 0.3 ± 0.4 ± 0.5

Therefore Average volume of FA1 = $\frac{9.90+9.90}{2}$ = 9.90 cm^3. (2 ½ marks)

Questions

Calculate the molar concentration of in **FA2.** (4 ½ marks)

$1000cm^3$ of FA1 contains 1mole of HCl

$9.90cm^3$ of FA1 contains (1×9.90) moles of HCl $= 9.9 \times 10^{-3}$ moles

1mole of HCl reacted with 1mole NaOH

9.9×10^{-3} mole of HCl reacted with $(9.9 \times 10^{-3} \times 1)$ mole of NaOH $= 9.9 \times 10^{-3}$ mole

$10.0cm^3$ of FA2 contains 9.9×10^{-3} moles of NaOH

$1000cm^3$ of FA2 contains $\frac{(9.9 \times 10^{-3} \times 1000)}{10.0}$ moles of NaOH

$= 0.99M$

Allow the range of 0.1

Around if the values are ±0.3 of the trial values.

Procedure B

b) Weigh accurately 3.4g of **T** and add about $50cm^3$ of water in a beaker. Stir to dissolve and transfer the contents of the beaker into a $250cm^3$ volumetric flask. Make up to the mark with distilled water. Label the resultant solution **FA4**.

c) Pipette $10cm^3$ of **FA4** into a conical flask. Add $10cm^3$ of **FA2** using a measuring cylinder. Titrate the mixture with solution **FA3** from the burette until the end point. Repeat the titration until you obtain consistent readings. Enter your results in table II below.

Table II

Mass of empty bottle + **T** = 23.40 ✓ ✓ .....g

Mass of empty bottle alone = 20.0 ✓ ✓ .....g

Mass of **T** alone = 3.40 ✓ ✓ .....g

Volume of pipette used = 10.0 ✓ .....cm^3 (2marks) (2)

All 2 dps.

Experiment	**I**	**II**	**III**
Final burette reading /cm^3	39.10	49.00	44.00
Initial burette reading /cm^3	0.00	10.00	5.00
Volume of **FA3** used /cm^3	39.10 ✓	39.00 ✓	39.00 ✓

(4½)

Rej: 1dp - The value must be in the central range of ±0.3

Titre values used to calculate average volume of **FA1** used are

39.00 and 39.00 ✓ cm^3 (½ marks) (½)

Therefore average volume of **FA1** used = $\frac{39.00+39.00}{2}$ ✓ ✓ cm^3

= 39.00 cm^3 (2½ marks) (2½)

± 0.1 ✓✓
± 0.2 ✓
± 0.3 ✓
± 0.4 ✓
± 0.5 ✗

Allow only the range of ±0.1

Questions

d) Calculate the number of moles of;

i) sulphuric acid that reacted with the excess sodium hydroxide in **FA4**. (1½ marks)

1000cm^3 of FA3 contains 0.1mole of H_2SO_4 ✓

39.00cm^3 of FA3 contains $\frac{(0.1 \times 39.00)}{1000}$ moles of H_2SO_4 ✓

= 3.9×10^{-3} moles ✓ (1½)

(ii) Sodium hydroxide in $10cm^3$ of **FA2** added to **FA4** (1½ marks)

$2NaOH_{(aq)} + H_2SO_{4(aq)} \longrightarrow Na_2SO_{4(aq)} + 2H_2O_{(l)}$

1mole of H_2SO_4 reacted with 2moles of NaOH ✓

3.9×10^{-3} moles of H_2SO_4 reacted with $2 \times 3.9 \times 10^{-3}$ moles of NaOH ✓

= ⊗ ⊗ = 7.8×10^{-3} moles (1½)

Ignore the equation

ii) tribasic acid in $10cm^3$ of **FA4** that reacted with sodium hydroxide (1marks)

moles added $= \left(\frac{10 \times 0.99}{1000}\right)$ moles $= (9.9 \times 10^{-3})$

moles of NaOH that reacted with T $= (9.9 \times 10^{-3} - 7.8 \times 10^{-3}) =$

3moles of NaOH reacted with 1mole of T

2.1×10^{-3} moles of NaOH reacted with $\left(\frac{2.1 \times 10^{-3} \times 1}{3}\right)$ moles

$= 7.0 \times 10^{-4}$ moles (2½)

Allow mole ratio of 1:1 and the subsequent calculations

e) Determine the percentage purity of T (H=1 X= 189) (2½ marks)

$10cm^3$ of FA4 contains 7.0×10^{-4} moles of T

$250cm^3$ of FA4 contains $(7.0 \times 10^{-4} \times 250)$ moles of T $= 0.0175$ mole

Rfm of T $= (1 \times 3) + (189) = 192$

1mole of T weighs 192g

0.0175 moles of T weigh (192×0.0175) g $= 3.36$g

% age purity $= \frac{\text{mass of pure T}}{\text{mass of sample}} \times 100\%$

$= \frac{3.36}{3.4} \times 100\% = 98.8\%$ (4)

2. You are provided with substance **Y** which contains three cations and one anion. You are required to carry out the following tests on **Y** to identify the cations and anion in it. Identify any gases evolved. Record your observations and deductions in the table below.

Tests	Observations	Deductions
a). Heat a spatula end-ful of **Y** in a dry test tube until there is no further change.	Y is a mixture of white and brown crystals. Either brown or white - Colourless gas that turns damp red litmus paper blue and dense white fumes with HCl - Colourless gas that turns damp acidified litmus red and acidified $K_2Cr_2O_7$ from orange to green	Zn^{2+}, Al^{3+}, Fe^{3+} or Pb^{2+} NH_3, NH_4^+ SO_2, SO_4^{2-} Deny without acidified MnO_4^- Allow: MnO_4^-
b) Shake two spatula end-ful of **Y** in a boiling tube with about $3cm^3$ of water. Add dilute sodium hydroxide solution to the mixture drop wise until in excess. Warm and filter keep both the filtrate and the residue.	- Brown solution - Brown ppt insoluble in excess sodium hydroxide - Colourless gas that turns damp red litmus paper blue and form dense white fumes with HCl - Brown residue - Colourless filtrate	Fe^{3+} Fe^{3+} NH_3 : NH_4^+ Fe^{3+} Zn^{2+}, Al^{3+} or Pb^{2+}

c) To the filtrate, add dilute nitric acid drop wise until the solution is just acidic. Divide the acidic solution into six parts.	White precipitate Soluble forming colourless solution	Zn^{2+}, Al^{3+} or Pb^{2+}
i) To the first part of the acidic solution, add dilute sodium hydroxide solution drop wise until in excess.	White precipitate soluble forming Colourless solution	Zn^{2+}, Al^{3+} or Pb^{2+}
ii) To the second part of the acidic solution, add dilute ammonia solution drop-wise until in excess.	White precipitate insoluble	Al^{3+} or Pb^{2+}
iii) To the third part of the acidic solution, add 2-3 drops of potassium iodide solution.	No observable change	Pb^{2+} absent ∴ Al^{3+} present
iv) To the fourth part of the acidic solution, add 2-3 drops of litmus solution followed by ammonia solution drop-wise until in excess.	Blue lake solution	Al^{3+} confirmed present.
v) To the fifth part of the acidic solution, add 2-3 drops of lead (II) nitrate solution and heat.	White precipitate insoluble on heating	SO_4^{2-}
vi) Use the sixth part to carry out a test of your own choice to confirm the anion in **Y** Add $Ba(NO_3)_2$ followed by HNO_3	White precipitate insoluble in the acid.	SO_4^{2-} confirmed
d) Wash the residue with water and dissolve it in dilute hydrochloric acid and divide the solution into three parts.	Brown solution	Fe^{3+}

Allow dissolve

Answer: solution for soluble or dissolve.

Deny precipitate.

Allow AC^{3+} present.

All: $BaCl_2$ followed by HCl with or without nitric acid

i) To the first part of the acidic solution, add dilute sodium hydroxide solution drop-wise until in excess.	Brown precipitate insoluble	Fe^{3+}
ii) To the second part of the acidic solution, add dilute ammonia solution drop wise until in excess.	Brown precipitate insoluble	Fe^{3+}
iii) To the third part of the acidic solution add 3-4 drops of potassium thiocyanate solution.	Blood-red Colouration	Fe^{3+} Confirmed

Allow ppt for precipitate.

The cations in **Y** are NH_4^+, Al^{3+} and Fe^{3+}

The anion in **Y** is SO_4^{2-}

3. You are provided with an organic compound **Q**. You are required to identify the nature of compound **Q**. Carry out the following tests on the compound and record your observations and deductions in the table below.

Tests	Observations	Deductions
• Burn a spatula end-ful of **Q** on a porcelain dish or at the end of a spatula. (2)	**Q** burns with a yellow non-sooty flame	**Q** is a saturated aliphatic organic compound of low carbon content.
• Shake 1cm^3 of **Q** with about 2cm^3 of water and test with litmus. (3)	Miscible with water Has no effect on the litmus paper	polar organic compound of low molecular mass Neutral organic compound probably alcohol or carbonyl
• To 0.5cm^3 of **Q** add 2-3 drops of sodium carbonate solution. (1)	No effervescence or No bubbles	carboxylic acid absent.
• To 0.5cm^3 of **Q**, add 2-3 drops of acidified potassium dichromate solution and heat. (2½)	The orange solution turns green	Reducing agent Probably Primary alcohol, Secondary alcohol or aldehyde

• To 0.5cm^3 of **Q**, add 2-3 drops of Brady's reagent. (2)	No yellow precipitate or No observable change	Carbonyl compound absent.
• To about 1cm^3 of **Q**, add acidified potassium dichromate solution and heat. Then add ethanol followed by 4-5 drops of concentrated sulphuric acid. Pour the mixture into a small beaker of cold water (2½)	Sweety fruity smell. Ignore sweety fruity.	Ester formed. Primary alcohol oxidised to Carboxylic acid
• To about 0.5cm^3 of **Q**, add about 4cm^3 of iodine solution followed by sodium hydroxide solution drop-wise until the brown color of iodine is just discharged. Warm the mixture and allow to stand. (2)	Yellow precipitate	~~Primary al.~~ Ethanol.
• To about 1cm^3 of **Q**, add about 5 drops of tollen reagent and heat gently (2)	No Silver mirror	Aldehyde absent

Comment on the nature of **Q** (1½)

Q is a saturated aliphatic primary alcohol with methyl group on the same carbon as the hydroxyl group

Or Q is ethanol.

END