P525/3
Chemistry
Paper 3
July - August 2019
3 ¼ hours

UGANDA MUSLIM TEACHERS' ASSOCIATION

UMTA JOINT MOCK EXAMINATIONS 2019

Name ..... MARKING GUIDE .....

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 |
| 29 | 34 | 17 | 80 |
| | | | |

You are provided with the following;

**FA1** which is a solution containing $3.16gl^{-1}$ of potassium manganite (VII).

**FA2**, which is a solution of ammonium iron (II) sulphate – 6 – water.

Solid T, which is impure potassium chlorate (V) ($KClO_3$)
2M sulphuric acid

**You are required to;**

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

**Theory**

In acidic medium, chlorate (V) ions react with iron (II) ions according to the following equation.

$$ClO_3^-(aq) + 6Fe^{2+}(aq) + 6H^+_{(aq)} \longrightarrow 6Fe^{3+}(aq) + Cl^-(aq) + 3H_2O(l)$$

$$5Fe^{2+}_{(aq)} + MnO_4^-{}_{(aq)} + 8H^+ \longrightarrow 5Fe^{3+}_{(aq)} + 4H_2O_{(aq)} + Mn^{2+}_{(aq)}.$$

**Procedure A:**

a) Pipette $10cm^3$ of FA2 into a clean conical flask followed by an equal volume of 2M sulphuric acid and then titrate the mixture 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) 01/2

| Experiment | I | II | III |
|---|---|---|---|
| Final burette reading /$cm^3$ | 10.00 ✓ | 24.90 ✓ | 29.90 ✓ |
| Initial burette reading /$cm^3$ | 0.00 ✓ | 15.00 ✓ | 20.00 ✓ |
| Volume of FA 1 used /$cm^3$ | 10.00 ✓ | 9.90 ✓ | 9.90 ✓ |

(4½ marks) 04½ 2dp (Awa Deny)

Titre values used to calculate average volume of **FA1** (½ marks) 01/2

..... 9.90 and 9.90 ✓ .....

Therefore Average volume of **FA1** = ..... $\frac{9.90+9.90}{2} = 9.90$ ✓ ✓ ✓ $cm^3$. (2 ½ marks) 02½

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

**Questions**

08

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

(K = 39, O = 16, Mn = 55)

R.F.M of $KMnO_4$ = (39×1) + (55×1) + (16×4) = 158

158g of $KMnO_4$ contains 1 mole

3.16g of $KMnO_4$ contains $\frac{(3.16\times1)}{158}$ moles = 0.02 moles

1000cm³ of $FA_1$ contains 0.02 mole of $MnO_4^-$

9.9 cm³ of $FA_1$ contain $\frac{(0.02\times9.9)}{1000}$ moles of $MnO_4^-$

mole ratio of $MnO_4^-$ : $Fe^{2+}$ is 1:5

moles of $Fe^{2+}$ that reacted = $\frac{(5\times0.02\times9.9)}{1000}$ moles (04)

10cm³ of $FA_2$ contains $\frac{(5\times0.02\times9.9)}{1000}$ moles

1000cm³ of $FA_2$ contains $\frac{(5\times0.02\times9.9\times1000)}{1000\times10}$ moles of $Fe^{2+}$

= 0.099M

**Procedure B**

b) Weigh accurately 0.5g of T and add about 100cm³ of water in a beaker. Stir to dissolve and transfer the contents of the beaker into a 250cm³ volumetric flask. Make up to the mark with distilled water. Label the resultant solution **FA3**.

c) Pipette 10cm³ of **FA3** into a conical flask. Add 35cm³ of **FA2** using a measuring cylinder followed by an equal volume of **2M** sulphuric acid. Heat the mixture to about 85°C and then cool in cold water for 3 minutes. Titrate the cold mixture with solution **FA1** 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 | = 40.50 g | 1 dp or 2 dp. |
| Mass of empty bottle alone | = 40.00 g | (02) |
| Mass of T alone | = 0.50 g | |
| Volume of pipette used | = 10.0 cm³ | (2marks) |

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| Experiment | I | II | III |
|---|---|---|---|
| Final burette reading /cm³ | 25.20 | 35.20 | 30.20 |
| Initial burette reading /cm³ | 0.00 | 10.00 | 5.00 |
| Volume of FA 1 used /cm³ | 25.20 | 25.20 | 25.20 |

04½

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

25.20 and 25.20 cm³ (½ marks)

Therefore average volume of **FA1** used = $\frac{25.20 + 25.20}{2}$ cm³

= 25.20 cm³ (2½ marks) 02½

± 0.1
± 0.2
± 0.3
± 0.4
± 0.5

**Questions**

d) Calculate the number of moles of ;

i) Excess iron (II) ions in **FA2** that reacted with manganate (VII) ions.

1000cm³ of $FA_1$ Contains 0.02 moles of $MnO_4^-$ (2½ marks)

25.20 cm³ of $FA_1$ Contains $\frac{0.02 \times 25.20}{1000}$ moles of $MnO_4^-$

Mole ratio of $MnO_4^-$ : $Fe^{2+}$ is 1:5 02

Moles of excess $Fe^{2+}$ that reacted = $\frac{5 \times 0.02 \times 25.2}{1000}$ mole

= $2.52 \times 10^{-3}$ moles

ii) Iron (II) ions that reacted with 10cm³ of chlorate (V) ions in **FA3**.

(1½ marks)

1000cm³ of $FA_2$ contains 0.099 moles of $Fe^{2+}$

35cm³ of $FA_2$ Contains $\frac{0.099 \times 35}{1000}$ moles of $Fe^{2+}$ 01½

= $3.465 \times 10^{-3}$ moles

Moles of $Fe^{2+}$ that reacted with $ClO_3^-$ = $3.465 \times 10^{-3} - 2.52$

= $9.45 \times 10^{-4}$ moles

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e) Determine the percentage purity of T
(K = 39, Cl = 35.5, O = 16)

(2 ½ marks)

Mole ratio of $ClO_3^-$ : $Fe^{2+}$ is 1:6 ✓

moles of $ClO_3^-$ in T = $\left(\frac{1}{6} \times 9.45 \times 10^{-4}\right)$ moles ✓

= $1.575 \times 10^{-4}$ moles.

R.f.m of $KClO_3$ = (39x1) + (35.5x1) + (16x3) = 122.5 ✓

1 mole of $KClO_3$ weighs 122.5g

$1.575 \times 10^{-4}$ moles of $KClO_3$ weighs $(122.5 \times 1.575 \times 10^{-4})$ g ✓

= 0.0193g

$10cm^3$ of $FA_3$ contains 0.0193 g of $KClO_3$ ✓

$250cm^3$ of $FA_3$ Contains $\left(0.0193 \times \frac{250}{10}\right)$ g of $KClO_3$ ✓ 04

= 0.4825g ✓

Percentage purity of T = $\frac{0.4825}{0.5} \times 100\%$ ✓

= 96.5% ✓

Alternatively

alternatively $10cm^3$ of $FA_3$ Contains $1.575 \times 10^{-4}$ moles of $ClO_3^-$ ✓

$250cm^3$ of $FA_3$ Contain $\left(1.575 \times 10^{-4} \times \frac{250}{10}\right)$ moles of $ClO_3^-$ ✓

= $3.9375 \times 10^{-3}$ moles

1 mole of $KClO_3$ weighs 122.5g

$3.9375 \times 10^{-3}$ moles of $KClO_3$ weighs $(122.5 \times 3.9375 \times 10^{-3})$ g ✓

= 0.482g ✓

Percentage purity of T = $\left(\frac{0.482}{0.5} \times 100\right)\%$ ✓

= 96.5% ✓

04

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 white crystalline solid<br>- Yellow / brown residue<br>- colourless gas turn moist blue litmus paper red and acidified $K_2Cr_2O_7$ from orange to green<br>- Colourless gas with choking smell turns moist red litmus blue and dense white fumes with HCl<br>- colourless liquid turns anhydrous copper(II) sulphate from white to blue<br>- White sublimate | Non-transition metal ions<br>$Fe^{3+}$<br>$SO_2$ ; $SO_4^{2-}$ or $SO_3^{2-}$ present<br>$NH_3$ hence $NH_4^+$ present<br>water of crystallisation (Hydrated salt)<br>Ammonium salt. |
| 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 dropwise until in excess. Warm and filter keep both the filtrate and the residue. | - Brown / yellow solution<br>- Brown ppt insoluble in excess<br>- Brown residue<br>- colourless filtrate<br>- Colourless gas with choking smell turn moist litmus from red to blue and dense fumes with HCl | $Fe^{3+}$<br>$Fe^{3+}$<br>$Fe^{3+}$<br>$Zn^{2+}$, $Pb^{2+}$ or $Al^{3+}$<br>$NH_3$ hence $NH_4^+$ confirmed |
| c) To the filtrate, add dilute nitric acid dropwise until the solution is just acidic. Divide the acidic solution into six parts. | White ppt soluble in the acid | $Zn^{2+}$, $Pb^{2+}$ or $Al^{3+}$ |
| i) To the first part of the acidic solution, add dilute sodium hydroxide solution dropwise until in excess. | White ppt soluble in excess | $Zn^{2+}$, $Pb^{2+}$ or $Al^{3+}$ |
| ii) To the second part of the acidic solution, add dilute ammonia solution drop-wise until in excess. | White ppt insoluble in excess | $Al^{3+}$ 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 so $Al^{3+}$ 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 ✓ (1½) |
| v) To the fifth part of the acidic solution, add 2-3 drops of lead (II) nitrate solution and heat. | white ppt ✓ insoluble on heating ✓ | $SO_4^{2-}$ ✓ (1½) |
| vi) Use the sixth part to carry out a test of your own choice to confirm the anion in **Y**. Barium nitrate solution is added | White ✓ ppt | $SO_4^{2-}$ ✓ confirmed ✓ (2) |
| d) Wash the residue with water and dissolve it in dilute hydrochloric acid and divide the solution into three parts. | Brown/yellow ✓ solution | $Fe^{3+}$ ✓ (1) |
| i) To the first part of the acidic solution, add dilute sodium hydroxide solution drop-wise until in excess. | Brown ✓ ppt insoluble ✓ in excess | $Fe^{3+}$ ✓ ✓ (0½) |
| ii) To the second part of the acidic solution, add dilute ammonia solution dropwise until in excess. | Brown ✓ ppt insoluble ✓ in excess | $Fe^{3+}$ ✓ ✓ (1½) |
| iii) To the third part of the acidic solution add 3-4 drops of potassium thiocyanate solution. | Blood-red ✓ solution | $Fe^{3+}$ ✓ confirmed ✓ (1½) |

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

The anion in **Y** is ..... $SO_4^{2-}$ ✓ (02)

12½

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

| Tests | Observations | Deductions |
|---|---|---|
| a) Burn a spatula end-ful of Q on a porcelain dish or at the end of a spatula. | Q burn with ablue/ yellow non-sooty flame | saturated aliphatic organic compound of low carbon content. (02½) |
| b) Shake 1cm³ of Q with about 2cm³ of water and test with litmus. | Q is miscible/ soluble in water forming colourless solution. - solution turns blue litmus red | - polar organic compound of low molecular mass - Acidic compound probably carboxylic acid (03) |
| c) To 0.5cm³ of Q add 2-3 drops of sodium carbonate solution. | No effervescence occured | Carboxylic acid Confirmed absent (02) |
| d) To 0.5cm³ of Q, add 2-3 drops of acidified potassium dichromate solution and heat. | Orange solution turns to green | Reducing agent probably primary alcohol, secondary alcohol or aldelyde. (02) |
| e) To 0.5cm³ of Q, add 2-3 drops of Brady's reagent. | yellow ppt | Aldelyde present. (01) |
| f) To about 1cm³ 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 | - orange solution turn to green. - sweet fruity smell | - Aldelyde oxidised (Reducing agent) - Ester formed so Aldelyde oxidised to carboxylic acid (02½) |
| g) To about 0.5cm³ of Q, add about 4cm³ of iodine solution followed by sodium hydroxide solution drop-wise until the brown colour of iodine is just discharged. | Yellow ppt | Q is Ethanal (Q is of the form $CH_3\overset{O}{\overset{\|}{C}}-H$) (01) |
| h) To about 1cm³ of Q, add about 5 drops of tollen reagent and heat gently. | Silver mirror was formed. | Q is ethanal (aldelyde confirmed) (02) |

Comment on the nature of Q.

Q is ethanal (01)

alternatively Saturated aliphatic aldelyde of the form $CH_3\overset{O}{\overset{\|}{C}}H$

END

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