Signature: .....

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

P525/3
CHEMISTRY
PRACTICAL
Paper 3
Nov./Dec. 2015
$3^1/_4$ hours

# UGANDA NATIONAL EXAMINATIONS BOARD

## Uganda Advanced Certificate of Education

## CHEMISTRY PRACTICAL

## Paper 3

3 hours 15 minutes

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**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. text books, 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 the apparatus and chemicals that they may need.*

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|---|---|---|---|
| Q.1 | Q.2 | Q.3 | Total |
| 25 | 26 | 16 | 67 |
| | | | |

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1. You are provided with the following:

**FA1**, which is Potassium manganate (VII) solution.
**FA2**, which is a solution of ethanedioic acid in dilute sulphuric acid.

You are required to determine the activation energy, E, of the reaction between potassium manganate (VII) and ethanedioic acid in acidic medium. 2

Potassium manganate (VII) reacts with ethanedioic acid in acidic medium according to the following equation;

$$2MnO_4^-(aq) + 5C_2O_4^{2-}(aq) + 16H^+(aq) \longrightarrow 2Mn^{2+}(aq) + 10CO_2(g) + 8H_2O(l)$$ 2

Completion of the reaction is indicated by the purple manganate (VII) solution becoming colourless.
The rate constant of a reaction, **k**, is related to its activation energy, **E** by the equation $k = Ae^{-E/RT}$ 2

Where **A** is a constant, **R** the molar gas constant, **T**, the absolute temperature and **e** the base of natural logarithm. 1

**Procedure:**

(a) Run 25.0 $cm^3$ of **FA2** from a burette into a conical flask and heat the solution to a temperature, **x** = $80^0C$.

(b) Add 25.0 $cm^3$ of **FA1** to the hot solution and simultaneously start the stop clock (watch).

(c) Shake to mix and leave to stand.

(d) Note and record the time, **t**, taken for the solution to turn colourless.

(e) Repeat procedures (a) to (d) for the temperature **x** = 70, 60, 50, $40^0C$ and room temperature.

(f) Record your results in the table below.

| Temperature, **x** ($^oC$) | 80 | 70 | 60 | 50 | 40 | Room temperature = 24 |
|---|---|---|---|---|---|---|
| Temperature **T** (K) | 353 | 343 | 333 | 323 | 313 | 297.5 |
| $^1/_T$ ($K^{-1}$) $\times 10^{-3}$ | 2.83 | 2.92 | 3.00 | 3.10 | 3.19 | 3.36 |
| Time , **t** (s) | 12.0 | 18.0 | 24.5 | 42.0 | 74.0 | 191.0 |
| $Log_{10}$ t | 1.08 | 1.26 | 1.39 | 1.62 | 1.87 | 2.28 |

- For time recorded to no decimal place deny marks up to a maximum of 3 mks.
- For Mixed decimal place deny up to max. of 2
- For values of time deny if values are in decreasing
- Deny marks for negative values of $log_{10}$ t.
- Deny mark for room temperature above $40^oC$ and the value of time less than

**Questions:** (16 marks)

(a) Calculate:

(i) T from T = x + 273
(ii) reciprocal of **T**.
(iii) $log_{10}$**t**.

Record the values in the table above.



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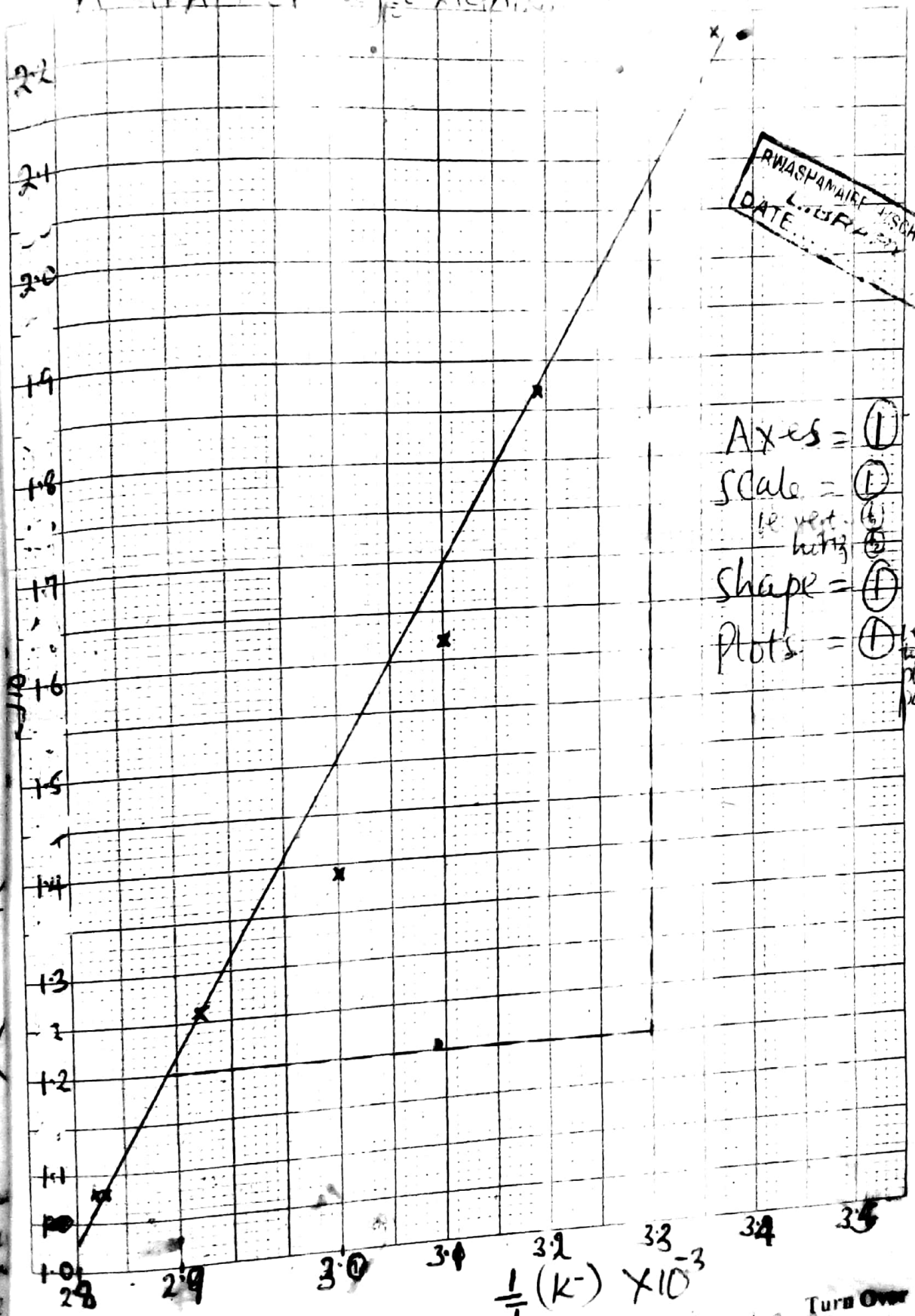
(b) Plot a graph of $\log_{10}t$ against $1/T$ (... marks)




Axes = 1
Scale = 1
i.e. vert. 1
horiz 1
Shape = 1
Plots = 1 i.e. any two correctly plotted points

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Figure unit if not given
- But penalise for wrong unit

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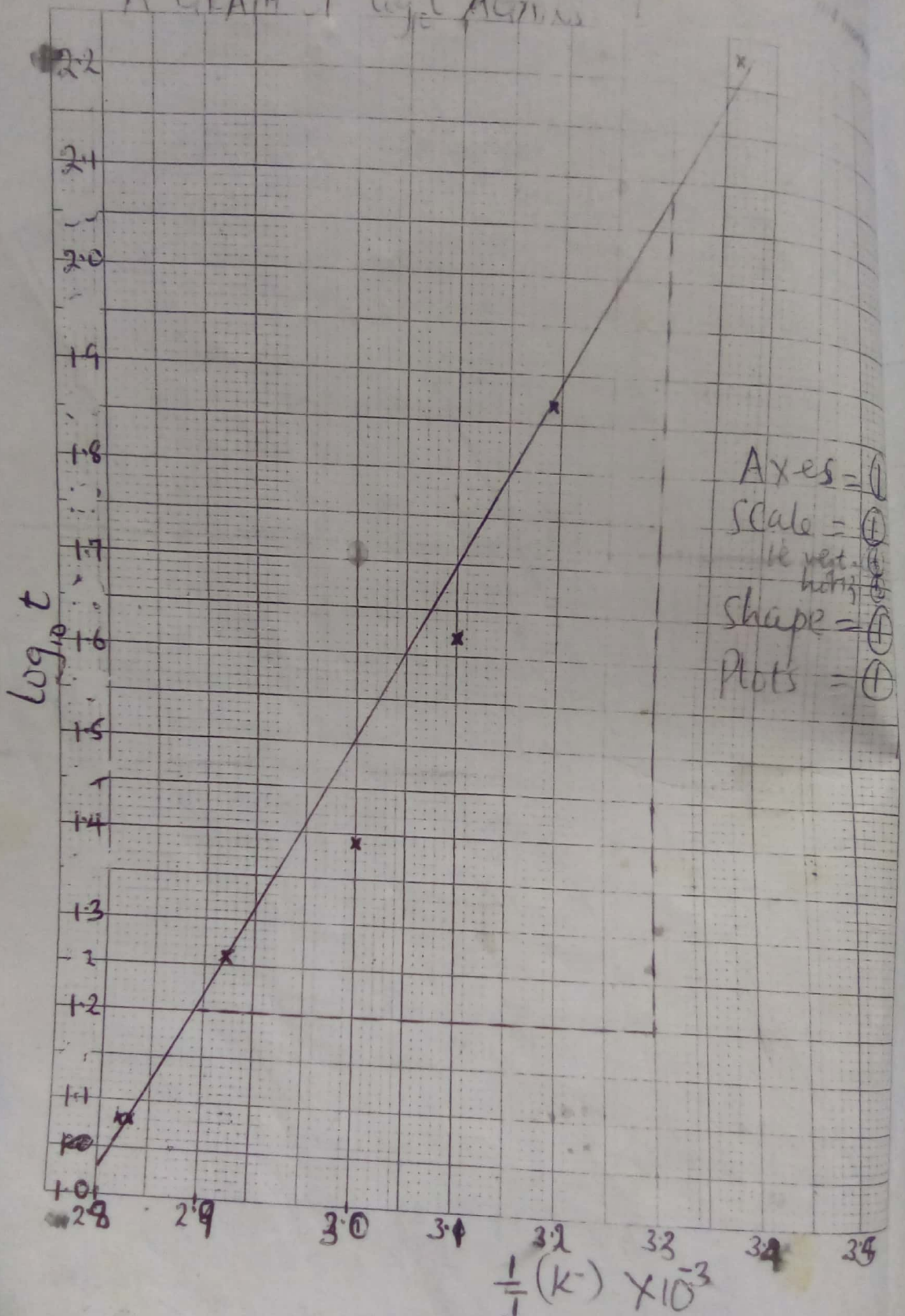
(b) Plot a graph of $\log_{10} t$ against $^1/_T$

A GRAPH of $\log_{10} t$ against




Ignore unit if not given

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(c) Determine the slope, **S**, of the graph. *(03 marks)*

Showing the slope on the graph. ie

Slope = $\frac{2.08 - 1.20}{(3.30 - 2.84) \times 10^{-3}}$

$= 2.146 \times 10^{3}$ K

(d) Calculate the activation energy **E**, from the expression *(02 marks)*

$$S = \frac{E}{2.3R}, \text{ where, } R = 8.314 \text{ JK}^{-1} \text{ mol}^{-1}$$

$2.146 \times 10^{3} = \frac{E}{2.3 \times 8.314}$

$E = 2.146 \times 10^{3} \times 2.3 \times 8.314$

$= 41036.24 \text{ JMol}^{-1}$ OR $41.036 \text{ kJ}$

**2.** You are provided with substance, **K**, which contains **two** cations and **two** anions. Carry out the following tests on **K** and identify the cations and anions in it.
Identify any gases evolved. Record your observations and deductions in the table below. *(26 marks)*

| TESTS | OBSERVATIONS | DEDUCTIONS |
|---|---|---|
| (a) Heat a spatula endful of **K** in a dry test tube. | Purple/violet vapour forms purple/black sublimate. Vapour turns blue litmus to red. Yellow residue when hot and white when cold. | Iodine gas given off $I^-$. ZnO formed. |
| (b) Shake **three** spatula end-fuls of **K** with about 5 $cm^3$ of water and filter. Keep both the filtrate and the residue. | Colourless filtrate. White residue | Non transition metal ions (OR $Zn^{2+}$, $Ca^{2+}$, $Mg^{2+}$, $Ba^{2+}$, $Al^{3+}$, $Pb^{2+}$) |



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| TESTS | OBSERVATIONS | DEDUCTIONS | |
|---|---|---|---|
| (c) Divide the filtrate into **seven** parts. | | | |
| (i) To the **first** part of the filtrate, add dilute sodium hydroxide solution dropwise until in excess. | White precipitate insoluble in excess. | $Mg^{2+}$, $Ca^{2+}$, $Ba^{2+}$ probably present | 2 |
| (ii) To the **second** part of the filtrate, add dilute ammonia solution dropwise until in excess and allow to stand. | White precipitate insoluble in excess. | $Ba^{2+}$, $Mg^{2+}$ suspected. Deduct if $Ca^{2+}$ is given | 1½ |
| (iii) To the **third** part of the filtrate add 2-3 drops of dilute sulphuric acid. | White precipitate | $Ba^{2+}$ suspected. | 01 |
| (iv) To the **fourth** part of the filtrate add 2-3 drops of potassium chromate (VI) solution followed by 2-3 drops of ethanoic acid. Allow the mixture to stand. | Yellow precipitate insoluble in ethanoic acid | $Ba^{2+}$ Confirmed. No Mark for deduction if insoluble is not mentioned | 1½ |
| (v) To the **fifth** part of the filtrate add copper turnings followed by 2-3 drops of concentrated sulphuric acid and heat the mixture. | Brown vapour/fumes. or Reddish-brown fumes Purple/violet vapour | $NO_2$ gas ∴ $NO_3^-$ present. $I_2$ gas ∴ $I^-$ | 03 |
| (vi) To the **sixth** part of the filtrate add 2-3 drops of dilute nitric acid then 2-3 drops of silver nitrate solution followed by dilute ammonia solution dropwise until in excess. | Pale-yellow precipitate insoluble in excess ammonia solution | $I^-$ suspected. → Reject $Br^-$ bse it was not suspected in (V) above. → No Mark for deduction if insoluble is missing | 1½ |

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| TESTS | OBSERVATIONS | DEDUCTIONS | |
|---|---|---|---|
| (vii) To the **seventh** part of the filtrate add 2-3 drops of lead (II) nitrate solution. | Yellow precipitate | $I^-$ Confirmed | (1½) |
| d) Wash the residue with water and then dissolve it in dilute hydrochloric acid. Divide the acidic solution into **three** parts. | Residue dissolves to form a colourless solution | Non transition metal cations (OR. $Al^{3+}$, $Zn^{2+}$, $Ca^{2+}$, $Mg^{2+}$, $Ba^{2+}$, $Sn^{2+}$, $Sn^{4+}$) Reject: $Pb^{2+}$ bse it doesnt dissolve in HCl | (1) |
| (i) To the **first** part of the acidic solution add dilute sodium hydroxide solution dropwise until in excess. | White precipitate soluble to form a colourless solution. | $Al^{3+}$, $Zn^{2+}$ Reject: $Pb^{2+}$ | (02) |
| (ii) To the **second** part of the acidic solution add dilute ammonia solution dropwise until in excess. | White precipitate soluble to form a colourless solution | $Zn^{2+}$ No mark if soluble is missing. | (1½) |
| (iii) To the **third** part of the acidic solution add a small amount of solid ammonium chloride. Shake and add 2-3 drops of disodium hydrogen phosphate solution followed by dilute ammonia solution dropwise until in excess. | White precipitate soluble in excess ammonia to form a colourless solution | $Zn^{2+}$ Confirmed. No mark if soluble in $NH_3(aq)$ is missing | (02) |

confirmed in (h)(iv)

(e) Cations in **K** are $Ba^{2+}$, $Zn^{2+}$ → Confirmed in (c)(iii) (01)

and the anions in **K** are $NO_3^-$, $I^-$ (01)

Confirmed in C(v) → Confirmed in C(vii)

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3. You are provided with an organic compound M. You are required to determine the nature of **M.** Carry out the following tests on M and record your observations and deductions in the table below. *(16 marks)*

| TESTS | OBSERVATIONS | DEDUCTIONS |
|---|---|---|
| (a) Burn a small amount of **M** on the tip of a dry spatula or dry porcelain. | White solid burns with a blue non-sooty flame. | Aliphatic saturated compound. |
| (b) (i) Shake a half spatula endful of **M** with about 2 $cm^3$ of dilute sodium hydroxide solution. | Dissolves to form a colourless solution | Acidic compu (OR Carboxylic a alcohol) Acc. sal of acid Reje |
| (ii) Shake a half spatula endful of **M** with about 2 $cm^3$ of water and add 2-3 drops of litmus solution. | Dissolves to form a colourless solution. Solution turns litmus solution to red. | Polar compu Acidic compun probably carbo acid. Accept salt of Reject phenol |
| (c) Shake a spatula endful of **M** with about 5 $cm^3$ of water and divide the solution into three parts. | | |
| (i) To the **first** part of the solution add 2-3 drops of sodium hydrogen carbonate solution. | Effervescence / colourless gas bubbles given off. | Carboxylic acid probably present. |
| (ii) To the **second** part of the solution add 2-3 drops of 2 - 4 dinitrophenylhydrazine (Brady's) solution. | No observable change. OR. No yellow precipitate | Aldehyde, Ket absent. (Acc. Carbonyl absent). Deny 1 mark if Ketone included |



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| TESTS | OBSERVATIONS | DEDUCTIONS | |
|---|---|---|---|
| (iii) To the **third** part of the solution add 2-3 drops of Iron (III) chloride solution and warm. | No observable change. OR No purple coloration | Phenol absent | (02) |
| (d) Dissolve a spatula endful of **M**, in about 5 $cm^3$ of water. To the solution add about 1-2 $cm^3$ of dilute sodium hydroxide solution. Heat the mixture, cool, add 2-3 drops of silver nitrate solution and filter. Keep both the filtrate and residue. | White precipitate Accept; White residue | $Cl^-$ released. | (1½) |
| (e) To the residue add dilute ammonia solution dropwise until in excess. | Residue dissolves to give a colourless solution | $Cl^-$ present | (01) |
| (f) To the filtrate add about equal volume of ethanol followed by 3-4 drops of concentrated sulphuric acid. Heat the mixture and cool. | Sweet fruity smell. | Ester formed/ Esterification occurs. ∴ Carboxylic acid confirmed. | (2½) |

(g) State the nature of **M**.

M is aliphatic Carboxylic acid with a Chloro group/Chlorine atom. (1½)

Reject chloride

OR M is aliphatic compound with both a Carboxyl/Carboxylate group and Chloro group

END



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MARKING GUIDE

Candidate's Name: P525/3/011

Signature: .....

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P525/3
CHEMISTRY
(PRACTICAL)
Paper 3
Nov. /Dec. 2014
3¼ hours.

UGANDA NATIONAL EXAMINATIONS BOARD

**Uganda Advanced Certificate of Education**

CHEMISTRY PRACTICAL

**Paper 3**

3 hours 15 minutes

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**INSTRUCTIONS TO CANDIDATES:**

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|---|---|---|---|
| Q.1 | Q.2 | Q.3 | Total |
| 29 | 24 | 16 | 67 |
| | | | |

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1. You are provided with the following:

**FA1**, which is a solution containing iodine.

**FA2**, which is a 0.1 M sodium thiosulphate solution.

Solid **X**, which is a reducing agent, molecular mass = 126.

Solid **Q**.

You are required to standardize **FA1**, and use it to determine the mole ratio for the reaction between iodine and **X**.

Iodine reacts with thiosulphate according to the following equation.

$$2\,S_2O_3^{2-}{}_{(aq)} + I_{2\,(aq)} \longrightarrow S_4O_6^{2-}{}_{(aq)} + 2I^-{}_{(aq)}$$

(a) **Standardising FA1**

**PROCEDURE**

Pipette 10.0 $cm^3$ of **FA1** into a conical flask and titrate with **FA2** using starch as the indicator.

Repeat the titration until you obtain consistent results.

(i) Record your results in the table below.

(ii) Record the volume of pipette used 10.00 $cm^3$.

(½ mark)

| | | | |
|---|---|---|---|
| Final burette reading ($cm^3$) | 9.90 | 19.70 | 15.00 |
| Initial burette reading ($cm^3$) | 0.00 | 9.90 | 5.20 |
| Volume of **FA2** used ($cm^3$) | 9.90 | 9.80 | 9.80 |

(4½ marks)

(iii) Record the titre values used to calculate average volume of **FA2** used 9.80, 9.80, 9.80 $cm^3$. (½ mark)

(iv) Work out the average volume of **FA2** used $\frac{9.80+9.80}{2} = 9.80\,cm^3$ $cm^3$. (2½ marks)

(v) Calculate the concentration of iodine in moles per litre of **FA1**. (2½ marks)

1000$cm^3$ of FA2 Solution contain 0.1 Moles of $S_2O_3^{2-}$

9.8$cm^3$ of FA2 Solution contain $\frac{0.1 \times 9.8}{1000}$ moles of $S_2O_3$

$= 9.8 \times 10^{-4}$ moles

2 moles of $S_2O_3^{2-}$ react with 1 mole of $I_2$

Thus No of moles of $I_2$ in 25$cm^3$ of FA1 $= \frac{1}{2} \times 9.8 \times 10^{-4}$ mol

10$cm^3$ of FA1 contain $\frac{1}{2} \times 9.8 \times 10^{-4}$ moles of $I_2$

1000$cm^3$ of FA1 contain $\frac{1}{2} \times \frac{9.8 \times 10^{-4} \times 1000}{10}$

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(b) Determining the mole ratio for the reaction between iodine and X.

**PROCEDURE**

Weigh accurately about 1.6 g of **X** into a 250 cm³ volumetric flask. Add some distilled water and shake to dissolve. Make the solution to the mark by adding distilled water. Label the solution **FA3**.

Pipette 10.0 cm³ of **FA3** into a conical flask. Add 20 cm³ of **FA1** using a measuring cylinder, followed by two spatula end-fuls of solid **Q** and shake the mixture well.

Titrate the excess iodine in the mixture with **FA2** using starch solution as the indicator.

Repeat the titration until you obtain consistent results.

(i) Record your results in the table below.

(ii) Record the mass of the weighing container + X 15.00 g (½ mark)

(iii) Record the mass of the weighing container 14.40 g (½ mark)

(iv) Record the mass of X used 1.60 g (½ mark)

(v) Record the volume of pipette used 10.00 cm³ (½ mark)

| | | | |
|---|---|---|---|
| Final burette reading (cm³) | 9.50 | 18.90 | 27.30 |
| Initial burette reading (cm³) | 0.00 | 9.50 | 18.90 |
| Volume of FA2 used (cm³) | 9.50 | 9.40 | 9.40 |

(4½ marks)

(vi) Record the titre values used to calculate average volume of **FA2** used 9.40, 9.40 cm³ (½ mark)

(vii) Work out the average volume of **FA2** used ..... cm³. (2½ marks)

$\frac{9.40+9.40}{2} = 9.40\ cm^3$

(c) Calculate the number of moles of:

(i) excess iodine in **FA1** that reacted with the thiosulphate ions in **FA2**. (02 marks)

moles of $S_2O_3^{2-}$ in 9.4 cm³ $= \frac{0.1 \times 9.4}{1000}$ moles

mole ratio $S_2O_3^{2-} : I_2 = 2:1$

Moles of $I_2$ that reacted $= \frac{1}{2} \times \frac{0.1 \times 9.4}{1000} = 0.0047$ moles

(ii) iodine that reacted with X. (2½ marks)

Original moles of $I_2 = \frac{20 \times 0.049}{1000} = 0.0098$ moles

moles of $I_2$ that reacted with X $= 0.0098 - 0.0047$

$= 0.00051$



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(d) Determine the:

(i) number of moles of X that reacted. (1½ marks)

Moles of X in 250 cm³ = $\frac{1.6}{121}$ = 0.0127

250 cm³ of FA3 contain 0.0127 moles

10 cm³ of FA3 contain $\frac{0.0127 \times 10}{250}$ = 0.000508

(ii) reaction mole ratio between X and iodine. (01 mark)

| | X | : | $I_2$ |
|---|---|---|---|
| Moles | 0.000508 | : | 0.00051 |
| | $\frac{0.000508}{0.000508}$ | : | $\frac{0.00051}{0.00051}$ |
| | 1 | : | 1 |

Mole ratio X : $I_2$ = 1 : 1

2. You are provided with substance Y, which contains two cations and two anions. You are required to carry out the following tests on Y and identify the anions and cations in it.

Record your observations and deductions in the table below. (24 marks)

| | TESTS | OBSERVATIONS | DEDUCTIONS |
|---|---|---|---|
| (a) | Heat two spatula end-fuls of Y strongly in a dry test tube. | Colourless liquid that turned anhydrous copper(II) sulphate blue. Colourless gas that turns blue litmus red and lime water milky. Yellow residue when hot and white when cold. | Water of crystallisation: A hydrate. $CO_2$ gas; $CO_3^{2-}$, $HCO_3^-$. ZnO |
| (b) | To three spatula end-fuls of Y, add dilute nitric acid drop-wise until there is no further change and warm. | Effervescence of colourless gas that turns blue litmus red and lime water milky | $CO_2$; $CO_3^{2-}$ |
| (c) | To the solution from (b) add dilute sodium hydroxide solution drop-wise until there is no further change. | White precipitate insoluble in excess | $Mg^{2+}$, $Ba^{2+}$, Ca |
| | Filter the mixture. Keep both the filtrate and the residue. | Colourless filtrate. White residue: | $Zn^{2+}$, $Pb^{2+}$, $Al^{3+}$; $Ba^{2+}$, $Mg^{2+}$, Ca |



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| | TESTS | OBSERVATIONS | DEDUCTIONS | |
|---|---|---|---|---|
| (d) (i) | To the filtrate, add dilute nitric acid until the solution is just acidic and divide the acidic filtrate into **six** parts.<br>To the **first** part of the acidified solution, add 2-3 drops of silver nitrate solution followed by dilute ammonia drop-wise until in excess. | White precipitate soluble in excess to form a colourless solution.<br>Yellow precipitate insoluble in excess. | $Pb^{2+}$, $Al^{3+}$, $Zn^{2+}$, $Sn^{2+}$, $Sn^{4+}$<br>$Br^-$, $I^-$ | 1<br>1½ |
| (ii) | To the **second** part of the acidified filtrate, add 6 drops of concentrated sulphuric acid and warm. To the mixture add sodium thiosulphate solution. | Brown solution formed which turns to colourless on adding $Na_2S_2O_3$ solution | $I_2$ given off<br>$I^-$ | 1½ |
| (iii) | To the **third** part of the acidified filtrate, add 2-3 drops of lead(II) nitrate solution. | Yellow precipitate | $I^-$ confirmed. | 1 |
| (iv) | To the **fourth** part of the acidified filtrate, add sodium hydroxide solution drop-wise until in excess. | White precipitate soluble in excess to form a colourless solution. | $Pb^{2+}$, $Zn^{2+}$, $Al^{3+}$, $Sn^{2+}$, $Sn^{4+}$. | 1½ |
| (v) | To the **fifth** part of the acidified filtrate, add ammonia solution drop-wise until in excess. | White precipitate soluble to form colourless solution | $Zn^{2+}$ | 1½ |

$SO_4^{2-}$



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| | TESTS | OBSERVATIONS | DEDUCTIONS |
|---|---|---|---|
| (vi) | To the sixth part of the acidified solution, add a spatula end-ful of ammonium chloride, followed by 3-4 drops of disodium hydrogen phosphate followed by drop -wise addition of ammonia solution until in excess. | White precipitate soluble in excess ammonia forming a colourless solution | $Zn^{2+}$ confirmed |
| (e) | Wash the residue and dissolve it in dilute hydrochloric acid and divide the solution into three parts. | Dissolves to give a colourless solution | $Ba^{2+}$, $Ca^{2+}$, $Mg^{2+}$. |
| (i) | To the first part of the acidic solution, add dilute sodium hydroxide solution drop-wise until in excess. | White precipitate insoluble in excess. | $Ba^{2+}$, $Mg$ $Ca^{2+}$. |
| (ii) | To the second part of the acidic solution, add ammonia solution drop-wise until in excess. | White precipitate insoluble | $Ba^{2+}$, $Mg$ |
| (iii) | To the third part of the acidified solution, add 2-3 drops of potassium chromate(VI) solution. | Yellow precipitate | $Ba^{2+}$ Confirmed. |



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(f) (i) The anions in Y are:

$CO_3^{2-}$, $I^-$ (1)

(ii) The cations in Y are:

$Ba^{2+}$, $Zn^{2+}$ (1)

You are provided with an organic compound Z. You are required to identify the nature of the compound. Carry out the following tests on the compound and record your observations and deductions in the table below. *(16 marks)* 2 pmu

| | TESTS | OBSERVATIONS | DEDUCTIONS | |
|---|---|---|---|---|
| (a) | Burn a spatula end-ful of **Z** on a porcelain dish (or at the end of a spatula). | Colourless that burns with a yellow sooty flame. | Aromatic compound. or. Aliphatic unsaturated comp. or. Aliphatic Comp with high C:H. | 2 |
| (b) | Shake 1 $cm^3$ of **Z** with about 2 $cm^3$ of water and test with litmus paper. Divide the mixture into **four** parts. | Dissolves in water to give a colourless solution which has no effect on litmus. | Polar aliphatic compound of low molecular mass. - Neutral comp; alcohol, carbonyl, ester. | 2 |
| (i) | To the **first** part of the mixture, add 2-3 drops of sodium carbonate solution. | No observable change / No effervescence | Carboxylic acid absent | (1) |
| (ii) | To the **second** part of the mixture, add 2-3 drops of neutral iron(III) chloride solutions. | No observable change. | Phenol absent. | (1) |
| (iii) | To the **third** part of the mixture, add 2-3 drops of 2,4 – dinitrophenyl–hydrazine solution (Brady's reagent). | No observable change. | Ketone, aldehyde absent. | (1½) |



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| | TESTS | OBSERVATIONS | DEDUCTIONS |
|---|---|---|---|
| (iv) | To the fourth part of the mixture, add 2-3 drops of acidified potassium dichromate(VI) solution and heat the mixture. | No observable change | Primary alcohol secondary alcohol absent |
| (c) | To about 1 $cm^3$ of **Z**, add 4 drops of Lucas reagent. | Cloudy solution formed immediately | Tertiary alcohol |
| (d) | To about 1 $cm^3$ of **Z** add about an equal volume of ethanoic acid followed by 4-5 drops of concentrated sulphuric acid. Heat the mixture and pour it into a beaker of water. | Sweet fruity smell. | Ester formed ∴ ~~Tertiary~~ alcohol present. |
| (e) | To about 1 $cm^3$ of **Z** add about 1 $cm^3$ of concentrated sulphuric acid. Heat the mixture and pass the gas produced through acidified potassium manganate(VII) solution. | Purple colour of potassium manganate (VII) turns to colourless | Alkene formed from an alcohol. OR. Alcohol dehydrated to alkene |

(f) Comment on the nature of **Z**

Z is aliphatic tertiary alcohol.

Total:

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P525/3 Inst. Sch.
CHEMISTRY
Practical
Instructions
Nov./Dec. 2014

# UGANDA NATIONAL EXAMINATIONS BOARD

## Uganda Advanced Certificate of Education

## CHEMISTRY PRACTICAL INSTRUCTIONS

**P525/3 Inst. Sch.**

November/December, 2014

**CONFIDENTIAL**

**Great care should be taken that the information given below does not reach the candidates either directly or indirectly.**

## INSTRUCTIONS FOR PREPARING APPARATUS AND CHEMICALS

**N.B:** The Headteacher **must** ensure that the teacher responsible for preparing the apparatus and chemicals, hands in his/her trial results properly sealed in a separate envelope and **firmly** fastened (attached) to the candidates' scripts envelope(s).

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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 differences.

2. Candidates are not allowed to use reference books (i.e. text books, booklets on qualitative analysis etc.) during the 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 (10.0 $cm^3$)
   1 volumetric flask (250 $cm^3$)
   1 measuring cylinder (25 $cm^3$ or 50 $cm^3$ or 100 $cm^3$)
   2 conical flasks
   8 test tubes
   1 piece of filter paper
   100 $cm^3$ of **FA1**
   100 $cm^3$ of **FA2**
   3.0 g of **Q**
   2.0 g of **X**
   2.0 g of **Y**
   5.0 $cms^3$ of **Z**
   Starch indicator (freshly prepared)

**Easy access to:**

- heat source
- a weighing balance reading to at least one decimal place.
- common reagents for identifying gases, cations, anions and organic compounds.

**FA1** is prepared by dissolving 21.2 g of potassium iodide in 500 $cm^3$ of distilled water and adding 12.8 g of iodine crystals and diluting with distilled water to make one litre of solution.

**FA2** is prepared by dissolving 24.8 g of **W** in distilled water to make one litre of solution.

Substances **Q, W, X, Y** and **Z** will be provided by UNEB.

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P525/3
CHEMISTRY
(PRACTICAL)
Paper 3
Nov. / Dec. 2013
3¼ hours

...number anywhere on this booklet.)

# UGANDA NATIONAL EXAMINATIONS BOARD

## 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. text books, Books on qualitative analysis, etc.) should* **not** *be used.*

*Candidates are* **not** *allowed to start working with the apparatus for the first 15minutes. This time is to enable candidates to read the question paper and make sure they have all the apparatus and chemicals that they may need*

| For Examiners' Use Only | | | |
|---|---|---|---|
| Q.1 | Q.2 | Q.3 | Total |
| 25 | 27 | 15 | 67 |
| | | | |

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Turn Over

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1. You are provided with the following:

**FA1**, which is a solution containing 3.2 g of sodium hydroxide per litre.
**FA2**, which is a solution containing 3.5 g of potassium manganate(VII) per litre.

Solid **Q**, which is an acid salt of ethanedioic acid, $MH_x(C_2O_4)_y$.

You are required to determine the ratio of $x$ to $y$ ($x$:$y$) in the formula of **Q**.

Manganate(VII) ions react with ethanedioate ions according to the following equation.

$$2MnO_4^-(aq) + 5C_2O_4^{2-}(aq) + 16H^+(aq) \rightarrow 2Mn^{2+}(aq) + 8H_2O(l) + 10CO_2(g)$$

(*Where necessary use: H =1, C =12, O = 16, Na = 23, K = 39, Mn = 55*)

**Procedure A**:

Weigh accurately about 1.5 g of **Q** and dissolve in minimum amount of distilled water. Transfer the solution into a 250 $cm^3$ volumetric flask and add distilled water to make a 250 $cm^3$ solution. Label the solution **FA3**.

**Results**:

Mass of container + **Q**.....11.50.....g (½ mark)

Mass of empty container.....10.00.....g (½ mark)

Mass of **Q** used.....1.50.....g (½ mark)

**Procedure B**:

Pipette 20.0 (or 25.0 $cm^3$) of **FA3** into a conical flask. Add 2-3 drops of phenolphthalein indicator and titrate the mixture with **FA1** from the burette.

Repeat the titration until you obtain consistent results.

Record your results in the table below.

**Results**:

Volume of pipette used.....25.0.....$cm^3$. (½ mark)

**Table I**

| | | | |
|---|---|---|---|
| Final burette reading ($cm^3$) | 20.00 | 21.60 | 39.70 |
| Initial burette reading ($cm^3$) | 0.00 | 1.70 | 19.90 |
| Volume of **FA1** used ($cm^3$) | 20.00 | 19.90 | 19.80 |

(03 marks)

Volumes of **FA1** used in calculating average volume.

.....19.90, 19.80.....

Average volume of **FA1** used.....$\frac{19.90 + 19.80}{2}$ = 19.85 $cm^3$.....$cm^3$. (½ mark) (2½ marks)



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**Questions:**

(a) Calculate the

(i) molarity of FA1. (1½ marks)

Relative formula mass of NaOH = 23 + 16 + 1 = 40

Molarity = $\frac{3.2}{40}$ = 0.08M

(1½)

(ii) molarity of FA3 in terms of x. (2½ marks)

$H^+_{(aq)} + OH_{(aq)} \longrightarrow H_2O_{(l)}$

1000cm³ of FA1 solution contain 0.08 moles

19.85cm³ of FA1 solution contain $\frac{0.08 \times 19.85}{1000}$

Reaction mole ratio $H^+ : OH = 1:1$

No of moles of OH in 25cm³ = $\frac{0.08 \times 19.85}{1000}$

~~moles of H⁺ react with $\frac{0.08 \times 19.85}{1000}$ moles of NaOH~~

25cm³ of H⁺ contain $\frac{0.08 \times 19.85}{1000}$

1000cm³ of H⁺ contain $\frac{0.08 \times 19.85 \times 1000}{25}$ = 0.06352M

∴ moles of H⁺ are given by molarity

∴ 0.06352 moles of H⁺ are given by = $\frac{0.06352}{x}$ M

(2½)

**Procedure C:**

Pipette 20.0 (or 25.0 cm³) of **FA3** into a conical flask. Add equal volume of 2M sulphuric acid and heat the mixture to almost boiling. Titrate the hot solution with FA2. Repeat the titration until you obtain consistent results.

Record your results in the table below.

**Results:**

Volume of pipette used 25.0 cm³. (½ mark)

(½)

**Table II**

| | | | |
|---|---|---|---|
| Final burette reading (cm³) | 19.30 | 38.50 | 19.80 |
| Initial burette reading (cm³) | 0.00 | 19.30 | 0.70 |
| Volume of **FA2** used (cm³) | 19.30 | 19.20 | 19.10 |

(03 marks)

(3)

Volumes of **FA2** used in calculating average volume

19.20, 19.10 cm³. (½ mark)

(½)

Average volume of **FA2** used $\frac{19.20 + 19.10}{2}$ = 19.15cm³ cm³. (2½ marks)

(2½)

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**Questions:**

(b) Calculate the

(i) molarity of solution **FA3** in terms of $y$. (4½ marks)

~~Molarity of FA2~~ RFM of $KMnO_4$ = 39 + 55 + (16 × 4) = 158

Molarity of FA2 = $\frac{3.5}{158}$ = 0.0222M

Moles of FA2 that reacted = $\frac{0.022 \times 19.15}{1000}$

Reaction ratio $MnO_4^-$ : $C_2O_4^{2-}$ = 2 : 5

No of moles of $C_2O_4^{2-}$ in 25cm³ = $\frac{5}{2} \times \frac{0.022 \times 19.15}{1000}$

1 mole of Q gives $\frac{1}{y}$ moles of $C_2O_4^{2-}$

No of moles of Q in 25cm³ = $\frac{1}{y} \times \frac{5}{2} \times \frac{0.022 \times 19.15}{1000}$

25cm³ of Q contains $\frac{0.022 \times 19.15 \times 5}{1000}$

1000cm³ of Q contains $\frac{0.022 \times 19.15 \times 5}{1000}$

(4½)

(ii) ratio of $x$ to $y$ ($x : y$). (2 marks)

Molarity of Q in (a) (ii) = Molarity of Q in b

$\frac{0.06352}{x} = \frac{0.0422}{y}$

$\frac{x}{y} = \frac{0.06352}{0.0422}$

$\frac{x}{y} = 1.5$

$x : y = 3 : 2$

2. You are provided with substance **W** which contains **two** cations and **two** anions. You are to identify the cations and anions in **W**. Carry out the tests below on **W** and record your observations and deductions in the table. Identify any gas(es) evolved. (27 marks)

| TESTS | OBSERVATIONS | DEDUCTIONS |
|---|---|---|
| (a) Heat **one** spatula end-ful of **W** strongly in a dry test tube until there is no further change. | Colourless liquid / Condensate that turns anhydrous Copper (II) sulphate to blue. Colourless gas that turns blue litmus red and lime water milky. Reddish-brown residue when hot and yellow when cold. ~~Black residue~~ | Hydrated salt. $CO_2$ gas. $CO_3^{2-}$, HCO or $C_2O_4^{2-}$. PbO, or $Fe_2O_3$. MnO |
| (b) To a spatula end-ful of **W**, add 2-3 drops of concentrated sulphuric acid and warm. | Effervescence / gas bubbles of Colourless gas that turns blue litmus to red and lime water milky. (4) | $CO_2$ gas. $CO_3^{2-}$, HC. Reject $C_2O_4^{2-}$ |

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Table Continues...

| TESTS | OBSERVATIONS | DEDUCTIONS | |
|---|---|---|---|
| (c)To **two** spatula end-fuls of **W**, add dilute nitric acid until there is no further change. Add sodium hydroxide drop-wise until in excess. Filter and keep the filtrate. | Effervescence / gas bubbles of colourless gas that turns lime water milky. White precipitate insoluble in excess; turns brown. Colourless filtrate. Brown residue | $CO_2$ gas. $CO_3^{2-}$ Confirmed. Reject: $HCO_3^-$. $Mn^{2+}$. $Pb^{2+}$, $Al^{3+}$, $Zn^{2+}$, $Sn^{2+}$, $Sn^{4+}$. Reject $Ca^{2+}$, $Ba^{2+}$, $Mg^{2+}$ | 05 |
| (d)To the filtrate add dilute nitric acid until the solution is just acidic. Divide the resultant solution into **four** parts. | White precipitate soluble in excess acid to form a colourless solution. | $Pb^{2+}$, $Al^{3+}$, $Zn^{2+}$, $Sn^{2+}$, $Sn^{4+}$ probably present | 1½ |
| (i)To the **first** part of the acidic solution, add sodium hydroxide solution drop-wise until in excess. | White precipitate soluble in excess to form a colourless solution. | $Pb^{2+}$, $Al^{3+}$, $Zn^{2+}$, $Sn^{4+}$, $Sn^{2+}$ probably present. | 01 |
| (ii)To the **second** part of the acidic solution, add aqueous ammonia drop-wise until in excess. | White precipitate insoluble in excess. | $Pb^{2+}$, $Al^{3+}$, Accept: $Sn^{2+}$, $Sn^{4+}$ | 1 |
| (iii)To the **third** part of the acidic solution add dilute sulphuric acid. | White precipitate. | $Pb^{2+}$ probably present. | 01 |
| (iv)Use the **fourth** part of the acidic solution to carry out a test of your choice to confirm one of the cations in **W**. Add 3drops of Potassium iodide solution. | Yellow precipitate | $Pb^{2+}$ Confirmed | 1½ |
| Add potassium chromate (VI) followed by sodium hydroxide | Yellow ppt | | |

Turn Over

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OR: Add a soluble chloride eg HCl and heat | white ppt soluble / insoluble

Table Continues...

| TESTS | OBSERVATIONS | DEDUCTIONS |
|---|---|---|
| (e)To **two** spatula end-fuls of **W**, add about 5 $cm^3$ of water, shake and filter. Divide the filtrate into **five** parts. | Colourless filtrate<br>White residue | Non-transition metal ions present $Al^{3+}$, $Pb^{2+}$, $Zn^{2+}$, $Mg^{2+}$, $Ca^{2+}$, $Ba^{2+}$ in both residue & filtrate |
| (i)To the **first** part of the filtrate add sodium hydroxide drop-wise until in excess. | White precipitate insoluble in excess, turns brown | $Mn^{2+}$ probably present<br>No mark for deduction if insoluble is not given |
| (ii)To the **second** part of the filtrate, add aqueous ammonia drop-wise until in excess. | White precipitate, turns ~~brown~~ insoluble in excess; turns brown | $Mn^{2+}$ probably present.<br>Deny mark for deduction if insoluble is not given |
| (iii)Use the **third** part of the filtrate to carry out a test of your own choice to confirm one of the cations in **W**. Add concentrated nitric acid followed by solid sodium bismuthate. | - Insist on order of addn of reagents.<br>- Reject sodium bismuthate solution.<br>- If $PbO_2$ is used, insist on heat.<br>Purple solution | $Mn^{2+}$ Confirmed |
| OR Add Conc $HNO_3$ followed by solid $PbO_2$ and heat. | | |
| (iv)To the **fourth** part of the filtrate, add 2-3 drops of lead(II) nitrate solution and heat. | White precipitate insoluble on heating.<br>Non mark if insoluble is missing | $Cl^-$ absent; $SO_4^{2-}$, $SO_3^{2-}$ probably present. |
| (v)Use the **fifth** part of the filtrate to carry out a test of your own choice to confirm one of the anions in **W**. Add barium nitrate solution followed by dilute nitric acid | If acid is added first, give full mark for white ppt<br>White precipitate insoluble in the acid | $SO_4^{2-}$ Confirm |

(f) Identify the

(i) cations in **W** $Mn^{2+}$, $Pb^{2+}$ ..... (01 mark)

(ii) anions in **W** $SO_4^{2-}$, $CO_3^{2-}$ ..... (01 mark)



Total = 27M

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3. You are provided with an organic substance T. You are required to determine the nature of **T**. Carry out the following tests on **T** and record your observations and deductions in the table below. *(15 marks)*

| TESTS | OBSERVATIONS | DEDUCTIONS |
|---|---|---|
| (a) Burn a small amount of **T** on a spatula end or on a crucible lid. | White solid / crystals burn with a yellow sooty flame. | Aromatic compound. Accept: Aliphatic. Unsaturated / Compd with high C : H ratio. (2) |
| (b) To a spatula end-ful of **T** in a test tube, add 3 $cm^3$ of sodium hydroxide solution, followed by dilute sulphuric acid. | Dissolves in sodium hydroxide to form a colourless solution. On adding dilute sulphuric acid a white ppt / solid is formed. | Acidic compound probably phenol, carboxylic acid. (1½) |
| (c) To a spatula end-ful of **T** in a test tube, add about 4 $cm^3$ of water, warm the mixture and test the solution with litmus. Divide the solution into **five** parts. | Insoluble in cold water, but dissolves on warming forming a colourless solution that turns blue litmus to red. | High molecular mass compound probably phenol, carboxylic acid. (01) |
| (i) To the **first** portion of the solution, add a half a spatula end-ful of sodium carbonate. | No effervescence / No observable change. | Carboxylic acid absent. (01) |
| (ii) To the **second** portion of the solution, add neutral iron(III) chloride solution. | Purple / violet solution formed. | Phenol confirmed present. (2) |



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Table Continues...

| TESTS | OBSERVATIONS | DEDUCTIONS |
|---|---|---|
| (iii)To the **third** portion of the solution add 3- 4 drops of acidified potassium manganate(VII) solution and warm. | Purple Colour of pope potassium Manganate (VII) turns to Colourless | Primary alcohol Secondary alcohol or aldehyde probably present |
| (iv)To the **fourth** portion of the solution, add 2-3 drops of 2, 4-dinitrophenyl hydrazine. | Orange precipitate is formed. | Aldehyde probably present. |
| (v)To the **fifth** portion of the solution add, Fehling's solution and heat. | Red precipitate / Reddish-brown / brown precipitate. | Aldehyde present. |
| (d)To about 3 $cm^3$ of silver nitrate solution, add 2 drops of sodium hydroxide solution, followed by ammonia solution until the precipitate just dissolves. Add a spatula end-ful of **T**, shake and heat in a water bath for about five minutes. | Silver Mirror formed | Aldehyde Confirmed present. |

(e) Comment on the nature of **T**.

T is aromatic compound with phenol and aldehyde group.

OR: T is aromatic aldehyde with a phenol group

OR: T is phenol with and aldehyde group.

END

Total = 15M



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GA[illegible] INSTR[illegible]

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In addition to the fittings and substances ordinarily concerned in a Chem. laboratory, each candidate will require:

1 Volumetric flask (250 cm³)
1 burette (50 cm³)
1 pipette 25 cm³ (or 20 cm³)
2 conical flasks
8 test tubes
100 cm³ of 2M sulphuric acid
Phenolphthalein Indicator
100 cm³ of FA1
100 cm³ of FA2
2 g of Q
3 g of W
2 g of T
2 pieces of filter paper

Easy access to
- Heat source
- Weighing balance reading to at least one decimal point
- Reagents for identifying cations, anions and organic compounds

FA1 is prepared by dissolving 3.2 g of substance P in distilled water to make 1 litre of solution.

FA2 is prepared by dissolving 3.5 g of substance R in distilled water to make 1 litre of soln

30 25

Substances P, Q R, T and W will [illegible] INSTR[illegible]

P525 /3
CHEMISTRY
( PRACTICAL )
Paper 3
Nov. / Dec. 2012
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.*

*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. text books, 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 the apparatus and chemicals that they may need.*

| For Examiners' Use Only | | | |
|---|---|---|---|
| Q.1 | Q.2 | Q.3 | Total |
| 27 | 26 | 14 | 67 |
| | | | |

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1. You are provided with the following:

**GA1**, which is potassium manganate(VII) solution of unknown concentration.

2 **GA2**, which is a 0.05 M solution of diammonium iron(II) sulphate

3 Solid, **X**, which is an ethanedioate ( oxalate) with the formula ;

$$\begin{array}{l} CO_2Y \\ | \\ CO_2Y \end{array}$$

You are required to standardise **GA1** and use it to determine the atomic mass of **Y**.

In acid medium, manganate(VII) ions oxidises iron(II) to iron(III) and ethanedioate ( $C_2O_4^{2-}$ ) ions to carbon dioxide.

The manganate(VII) ions are reduced to manganese(II) ions and wa

**Procedure A:**

Weigh accurately about 1.0 g of **X** and dissolve it in about 100 cm water in a 250 $cm^3$ volumetric flask. Make the solution to the mar adding distilled water. Label this solution **GA3**. (02

**Results:**

Mass of weighing container + **X** = 2.60 g ✓ (½)

Mass of weighing container = 1.70 g ✓ (½)

Mass of **X** used = 0.90 g ✓ Accept (½)

Deny marks if masses are no to no decimal place

**Procedure B:**

Pipette 25.0 $cm^3$ ( or 20.0 ) $cm^3$ of **GA2** into a conical flask and add equal volume of 2M sulphuric acid. Titrate the mixture with **GA1**.

Repeat the titration until you obtain consistent results.

Record your results in Table I. (6½



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**Results:**

Volume of pipette used ..... 20.00 ..... $cm^3$. (½)

Accept value with 2 decimal place or 1 decimal place

**Table I**

| | | | |
|---|---|---|---|
| Final burette reading ($cm^3$) | 10.50 | 20.90 | 31.20 |
| Initial burette reading ($cm^3$) | 0.00 | 10.50 | 20.90 |
| Volume of **GA1** used ($cm^3$) | 10.50 | 10.40 | 10.30 |

(3)

→ 2 decimal places with correct subtraction = (3) → No decimal place (=0)

→ 1 decimal place with correct subtr. award (1½)

Titre values used for calculating average volume of **GA1** used ..... 10.30, 10.40 (only in the range ±0.1) ..... $cm^3$. (½)

Average volume of **GA1** used $\frac{10.30 + 10.40}{2}$ = 10.35 $cm^3$. (2½)

**Procedure C:** Av. vol for pipette of 25cm3 = 12.9cm3

±0.1 (2½)
±0.2 (2)
±0.3 (1½)
±0.4 (1)
±0.5 (½)
±≥0.6 (0)

Pipette 25.0 $cm^3$ (or 20.0) $cm^3$ of **GA3** into a conical flask and add an equal volume of 2M sulphuric acid. Warm the mixture to about 60 °C and titrate the warm solution with **GA1**.

Repeat the titration until you obtain consistent results.

Record your results in Table **II**. *(6½ marks)*

**Results:**

Volume of pipette used ..... 20.00 ..... $cm^3$. (½)

**Table II**

| | | | |
|---|---|---|---|
| Final burette reading ($cm^3$) | 12.20 | 24.20 | 12.30 |
| Initial burette reading ($cm^3$) | 0.00 | 12.20 | 0.40 |
| Volume of **GA1** used ($cm^3$) | 12.20 | 12.00 | 11.90 |

(3)

As for table 1

Titre values used for calculating average volume of **GA1** used. ..... 12.00, 11.90 ..... $cm^3$. (½)

Average volume of **GA1** used $\frac{12.00 + 11.90}{2}$ = 11.95 $cm^3$. (2½)

As for table 1

Turn Over



Av. vol. for pipette of 25cm3 = 14.9cm3

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**Questions:**

(a) Write the overall ionic equation for the reaction between manganate(VII) ions and (1½ marks)

(i) iron(II) ions.

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

- No mark for balancing
- Deduct ½ mk if states are wrongly missing (1½ marks)

(ii) ethanedioate ( oxalate) ions.

$2MnO_4^-{}_{(aq)} + 16H^+_{(aq)} + 5C_2O_4^{2-}{}_{(aq)} \longrightarrow 2Mn^{2+}_{(aq)} + 8H_2O_{(l)}$

(b) Determine the:

(i) number of moles of manganate(VII) ions that reacted with the iron(II) ions. (02 marks)

1000cm³ of GA2 solution contain 0.05 moles of $Fe^{2+}$

20cm³ of GA2 solution contain $\frac{0.05 \times 20}{1000}$

Reaction mole ratio $MnO_4^- : Fe^{2+} = 1:5$

∴ No of moles of $MnO_4^-$ that reacted $= \frac{1}{5} \times \frac{0.05 \times 20}{1000}$

$= 2 \times 10^{-4}$ moles

(ii) molar concentration of **GA1**. (02 marks)

10.35cm³ of GA1 solution contain $2 \times 10^{-4}$ moles

1000cm³ of GA1 solution contain $\frac{2 \times 10^{-4} \times 1000}{10.35}$

$= 0.01932M$



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(c) Calculate the:

(i) concentration of the ethanedioate ( oxalate ) in **GA3** in moles per $dm^3$.

(03 marks)

1000cm³ of GA1 solution contains 0.01932 moles of $MnO_4^-$

11.95cm³ of GA1 solution contains $\frac{0.01932 \times 11.95}{1000}$

Mole ratio $MnO_4^- : C_2O_4^{2-} = 2 : 5$

∴ No of moles of $C_2O_4^{2-}$ in 20cm³ = $\frac{5}{2} \times \frac{0.01932 \times 11.95}{1000}$

20cm³ of GA3 contain $\frac{5}{2} \times \frac{0.01932 \times 11.95}{1000}$ moles of $C_2O_4^{2-}$

1000cm³ of GA3 contain $\frac{5}{2} \times \frac{0.01932 \times 11.95}{1000} \times \frac{1000}{20} = 0.029M$

2½

(ii) molar mass of **X**.

(02 marks)

250cm³ of GA3 contain 0.9g

→ 0.029 moles

1000cm³ of GA3 contain $\frac{0.9 \times 1000}{250} = 3.6g$

→ $\frac{0.029 \times 1000}{1000}$ mole

weigh 0.9g 0.029 moles of X weigh 3.6g

weigh 1 mole of X weighs $\frac{3.6}{0.029} = 124$

$\frac{1 \times 3.6}{0.029} = 124$

Accept answer not units

2

(iii) relative atomic mass of **Y**. [ C = 12; O = 16 ] (02 marks)

$Y_2C_2O_4 = 124$

$2Y + (12 \times 2) + (16 \times 4) = 124$

$2Y + 88 = 124$

$2Y = 124 - 88$

$Y = 36/2 = 18$

$Y = 18$

Reject answer with units

2

Total 27 Ma

**2.** **You are provided with substance W which contains two cations and two anions. You are required to carry out the following tests on W and to identify the anions and cations in W. Record your observations and deductions in the table below.** $(CH_3COO)_2Ni_{(s)} \xrightarrow{heat} NiO_{(s)} + CH_3COCH_{3(g)} + CO_{2(g)}$ (24 marks)

| TESTS | OBSERVATIONS | DEDUCTIONS |
|---|---|---|
| (a) Heat two spatula endfuls of **W** strongly in a dry test tube. Colourless condensate liquid turned anhydrous copper (II) sulphate blue. Colourless gas turned blue litmus red and acidified $K_2Cr_2O_7$ solution from orange to green. | RWU DATE | Water given off from a hydrated compound. Sulphur dioxide gas given off probably $SO_3^{2-}$, $SO_4^{2-}$ |
| Colourless with sweet smell. Solid turned from green | Reject fruity smell | Propanone vapour given off probably $CH_3COO^-$ / Acetate ion |

Max 5

Turn Over

5

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Table Continues...

| TESTS | OBSERVATIONS | DEDUCTIONS |
|---|---|---|
| (b) To two spatula endfuls of **W** in a dry test tube, add 5 drops of concentrated sulphuric acid and warm. | Colourless gas turned blue litmus red; Vinegar smell Sharp Reject fruity smell. | Probably acetate ion or $CH_3COO^-$ |
| (c) Dissolve three spatula endfuls of **W** in about 5 $cm^3$ of water to make a solution. | Dissolves to give a green solution | |
| (i) Use 1 $cm^3$ of the solution of **W** to carry out a test of your own choice to confirm one of the anions in **W**. To the solution, add aqueous Iron(III) chloride solution and heat. Add few drops of conc. sulphuric acid followed by ethanol and heat mixture. | Reddish-brown solution gives a brown precipitate. Sweet-fruity smell | $CH_3COO^-$ confirmed |
| (ii) To the remaining solution of **W** add dilute sodium hydroxide solution drop-wise until there is no further change. Filter and keep both the filtrate and the residue. | Green precipitate insoluble in excess. Colourless filtrate. Green residue. | $Ni^{2+}$, $Fe^{2+}$ Reject $Cu^{2+}$. $Al^{3+}$, $Pb^{2+}$, $Zn^{2+}$ Reject $Ca^{2+}$, $Ba^{2+}$. $Ni^{2+}$ $Fe^{2+}$ Reject $Cu^{2+}$. |
| (d) Add dilute hydrochloric acid drop-wise to the filtrate until the solution is just acidic. Divide the solution into four portions. | White precipitate dissolves in the whole solution hydrochloric acid to form a colourless soln | $Al^{3+}$, $Zn^{2+}$ Reject $Pb^{2+}$ if form a ppt with HCl |
| (i) To the first portion of the acidified filtrate, add dilute sodium hydroxide solution drop-wise until in excess. | White precipitate dissolves to form a colourless solution. | $Al^{3+}$, $Zn^{2+}$, Reject $Pb^{2+}$ if it forms a white ppt with HCl |

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| TESTS | OBSERVATIONS | DEDUCTIONS | |
|---|---|---|---|
| (ii) To the **second** portion of the acidified filtrate, add potassium iodide solution. | No observable change. | $Pb^{2+}$ absent. Reject $Al^{3+}$ present | 1 |
| (iii) To the **third** portion of the acidified filtrate, add 5 drops of litmus solution followed by dilute ammonia solution drop-wise until in excess. | Blue solution/ blue lake. | $Al^{3+}$ confirmed | 1½ |
| (iv) To the **fourth** portion of the acidified filtrate, add 5 drops of barium nitrate solution. | White precipitate | $SO_4^{2-}$ confirmed | 1 |
| (e) Wash the residue with water and dissolve in dilute hydrochloric acid. Divide the acidic solution into three portions. | Dissolved to give a green solution | $Ni^{2+}$, $Fe^{2+}$ probably present. Reject $Cu^{2+}$, $Cr^{3+}$ bse the green ppt in (c)(ii) was insoluble in NaOH | |
| (i) To the **first** portion of the acidic solution, add sodium hydroxide solution drop-wise until in excess. | Green precipitate insoluble in excess. | $Ni^{2+}$, $Fe^{2+}$ probably present. Deny them if $Cr^{3+}$, $Cu^{2+}$ are given | 2½ |
| (ii) To the **second** portion of the acidic solution, add dilute ammonia solution drop-wise until in excess. | Green precipitate dissolves to give a light ~~green~~ blue solution. | $Ni^{2+}$ probably present. | 2 |
| (iii) Use the **third** portion of the acidic solution to carry out a test of your own to confirm one of the cations in **W**. Add excess ammonia solution followed by ~~dimethylglyoxime solution~~ | Red precipitate | $Ni^{2+}$ confirmed | 2 |

(f) (i) The cations in **W** are $Ni^{2+}$, $Al^{3+}$ ..... *(01 mark)* 1

(ii) The anions in **W** are $CH_3COO^-$, $SO_4^{2-}$ ..... *(01 mark)* 1



**Turn Over**

Total = 26mk

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3. You are provided with an organic substance **T**. You are required to identify the nature of substance **T**. Carry out the following tests on **T** and record your observations and deductions in the table below. *(12 marks)*

| TESTS | OBSERVATIONS | DEDUCTIONS |
|---|---|---|
| (a) Burn a spatula endful of **T** in a porcelain dish or at the end of a spatula. | White crystalline solid ~~[illegible]~~ burns with a yellow sooty flame. | Aromatic Cmpd OR Unsaturated aliphatic cmpd OR aliphatic cmpd high C:H ratio |
| (b) Shake **two** spatula endfuls of **T** with about $5cm^3$ of water. Warm and test with litmus. | Insoluble in cold water but slightly soluble on warming. Solution has no effect on litmus. | High molecular compound/ probably alde/ carbonyl |
| (c) Dissolve **two** spatula endfuls of **T** in about $5\ cm^3$ of methanol and divide the solution into **four** parts. | | |
| (i) To the **first** part of the solution, add 2 – 3 drops of iron (III) chloride solution. | No observable change. Accept no white/purple precipitation | Phenol absent |
| (ii) To the **second** part of the solution add 2 – 3 drops of Brady's reagent. | Yellow (orange) precipitate | Carbonyl compound pres. (or ketone, alde) |
| (iii) To the **third** part of the solution, add about $1\ cm^3$ of Fehlings solution and boil. | No observable change. Accept no reddish-brown ppt) | Alkanal (alde) absent. Ketone pres. |
| (iv) To the **fourth** part of the solution, add about $1\ cm^3$ of iodine solution, followed by drop-wise addition of sodium hydroxide solution until the solution is pale yellow and warm. | No observable change OR No yellow precipitate | No methyl gr. attached to the carbonyl group |

(d) Comment on the nature of **T**. *(03 marks)*

T is Aromatic Ketone without a methyl group attached to the carbon carrying the functional group.

END

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P525 / 3 Inst. Sch.
CHEMISTRY
Practical
Instructions
Nov / Dec. 2012

# UGANDA NATIONAL EXAMINATIONS BOARD

## Uganda Advanced Certificate of Education

## CHEMISTRY PRACTICAL INSTRUCTIONS

**P525/3 Inst. Sch.**

November / December, 2012

**CONFIDENTIAL**

**Great care should be taken that the information given below does not reach the candidates either directly or indirectly.**

**NB:** The headteacher **must** ensure that the teacher responsible for preparing the apparatus hands in his/her trial results properly sealed in a separate envelope and firmly fastened (attached) to the candidates' scripts envelope(s).

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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 the examination.

3. In addition to the fittings, apparatus 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 thermometer ($^{-}10 - 110\ ^{o}C$)
2 conical flasks.
8 test tubes

200 $cm^3$ of 2.0 M sulphuric acid.
100 $cm^3$ of **GA1**
100 $cm^3$ of **GA2**
1.2 g of **X**
3.0 g of **W**
2.0 g of **T**

**Easy access to:**

- heat source.
- weighing balance reading, to at least **one** decimal point.
- common reagents for identifying gases, cations, anions and organic compounds..

**GA1** is prepared by dissolving 3.10g of potassium manganate(VII) in water to make one litre of solution.

**GA2** is prepared by dissolving 19.6g of **F** in water to make one litre of solution.

Substances; **F**, **T**, **W** and **X** will be provided by **UNEB**.

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Signature: .....

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| | | | | | | | |

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

P525/3
CHEMISTRY
(PRACTICAL)
Paper 3
Nov. / Dec. 2011
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.*

*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. text books, 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 the apparatus and chemicals that they may need.*

| For Examiners' Use Only | | | |
|---|---|---|---|
| Q.1 | Q.2 | Q.3 | Total |
| 26 | 27 | 14 | 67 |
| | | | |

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Turn Over

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1. You are provided with solids **F** and **G**.

You are required to determine the:

(i) depression in the freezing point of **F**

(ii) freezing point depression constant, $K_f$ per kg of **F**.

**Procedure:**

(a) Pour about 200 $cm^3$ of water into a 250 $cm^3$ beaker. Heat the water to boiling on a tripod stand.

In the meantime, weigh separately and accurately about 5.0g of **F** and 1.0g of **G**. Record the results of your measurements in the space provided below.

*(03 mark*

***Results:***

Mass of container + **F** = 5.95 g ✓

Mass of empty container = 0.95 g ✓

Mass of **F** = 5.00 g ✓

Mass of container + **G** = 1.60 ✓

Mass of empty container = 0.60 ✓ (3M

Mass of **G** = 1.00 g ✓

Deny marks if Masses are recorded to no dec

(b) Transfer the whole of **F** into a clean dry boiling tube. Immerse the boiling tube containing **F** into the beaker of hot water and continue heating the water until the whole of **F** melts.

Insert a thermometer in the liquid formed and heat to about 87 °C. Remove the boiling tube from the hot water and start the stop clock when its temperature drops to 85°C.

Allow the liquid to cool while stirring with the thermometer and record its temperature after every half a minute for three minutes. Enter your results in the table on page 3.

(c) Transfer the whole of **G** into the boiling tube containing **F**. Immerse the boiling tube into the beaker of hot water and continue heating the water until the mixture melts. Continue heating until the temperature of the molten mixture is about 87°C. Remove the boiling tube from the hot water and start the stop clock when the temperature of mixture drops to 85°C.

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While stirring gently with the thermometer, allow the mixture to cool and record its temperature after every half a minute for three minutes.

Enter your results in the table below. *(07 marks)*

| Time (minutes) | 0.0 | 0.5 | 1.0 | 1.5 | 2.0 | 2.5 | 3.0 |
|---|---|---|---|---|---|---|---|
| Temperature of Pure F (°C) | 85·0 | 81·0 | 79·0 | 78·5 | 78·5 | 78·5 | 78·5 |
| Temperature of mixture of F and G (°C). | 85·0 | 79·5 | 76·0 | 72·0 | 70·5 | 70·0 | 69·0 |

7

- Values recorded to no decimal place deny 2 mks (1 mark for a row)
- Values recorded to 1 dcpl and no dcpl. deny 1 mk ($\frac{1}{2}$ for a row)
- If values for F are not constant after 1 min deny $\frac{1}{2}$ mk.
- If values for F & G constant, deny $\frac{1}{2}$ mk.
- Deny 3 mks if values of F & G are higher than those of pure F.

**Questions:-**

(a) Plot on the same axes, a graph of temperature of

(i) pure **F** against time.

(ii) mixture of **F** and **G** against time.

*Use graph paper next page* → page 4. *(06 marks)*

(b) Describe the shapes of the graphs you have drawn. *(05 marks)*

Both graphs are curves; The graph of pure F is higher than that of mixture of F and G. The graph of pure F becomes constant after some time; Graph of mixture keeps dropping or continues to drop.

3

(c) From your graphs, read off the temperature after 2.5 minutes of

(i) pure **F** 78·5 °C 1 *(01 mark)*

(ii) mixture of **F** and **G** 70·0°C 1 *(01 mark)*

Obtained from the graph.

(d) Use the temperatures you have obtained in (c) above to determine the depression in the freezing point of **F**. *(01 mark)*

78·5 − 70·0 = 8·5°C

1

If temp of F is lower than that of mixture, award for subtraction and −ve value but if values are interchanged and forces the answer to be +ve value, deny marks.

**Turn Over**

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While stirring gently with the thermometer, allow the mixture to cool and record its temperature after every half a minute for three minutes. *(07 marks)*

Enter your results in the table below.

| Time (minutes) | 0.0 | 0.5 | 1.0 | 1.5 | 2.0 | 2.5 | 3.0 |
|---|---|---|---|---|---|---|---|
| Temperature of Pure F (°C) | 85.0 | 81.0 | 79.0 | 78.5 | 78.5 | 78.5 | 78.5 |
| Temperature of mixture of F and G (°C). | 85.0 | 79.5 | 76.0 | 72.0 | 70.5 | 70.0 | 69.0 |

- Values recorded to no decimal place deny 2 mks (1 mark for 2 f
- Values recorded to 1 dcpl and no dcpl. deny 1 mk (1 f
- if values for F are not constant after 1.5 min deny 1 2
- If values for F & G constant, deny 1 2
- Deny 3 mks if values of F & G are than those of pure F.

**Questions:-**

(a) Plot on the same axes, a graph of temperature of

(i) pure F against time.

(ii) mixture of F and G against time. *(06 marks)*

*Use graph paper next page* → page 4.

(b) Describe the shapes of the graphs you have drawn. *(05 marks)*

Both graphs are curves;
The graph of pure F is higher than that of mixture of F and G.
The graph of pure F becomes constant after some time; Graph of mixture keeps dropping or continues to drop.

(c) From your graphs, read off the temperature after 2.5 minutes of

(i) pure F ..... 78.5°C ✓ (1) *(01 mark)* } Obtain for G

(ii) mixture of F and G ..... 70.0°C ✓ (1) *(01 mark)*

(d) Use the temperatures you have obtained in (c) above to determine the depression in the freezing point of F. *(01 mark)*

78.5 − 70.0 = 8.5°C ✓

If temp of F is lower than that of mixture, award for subtraction and −ve value but if values are interchanged and the answer to be +ve value deny award

**Turn Over**

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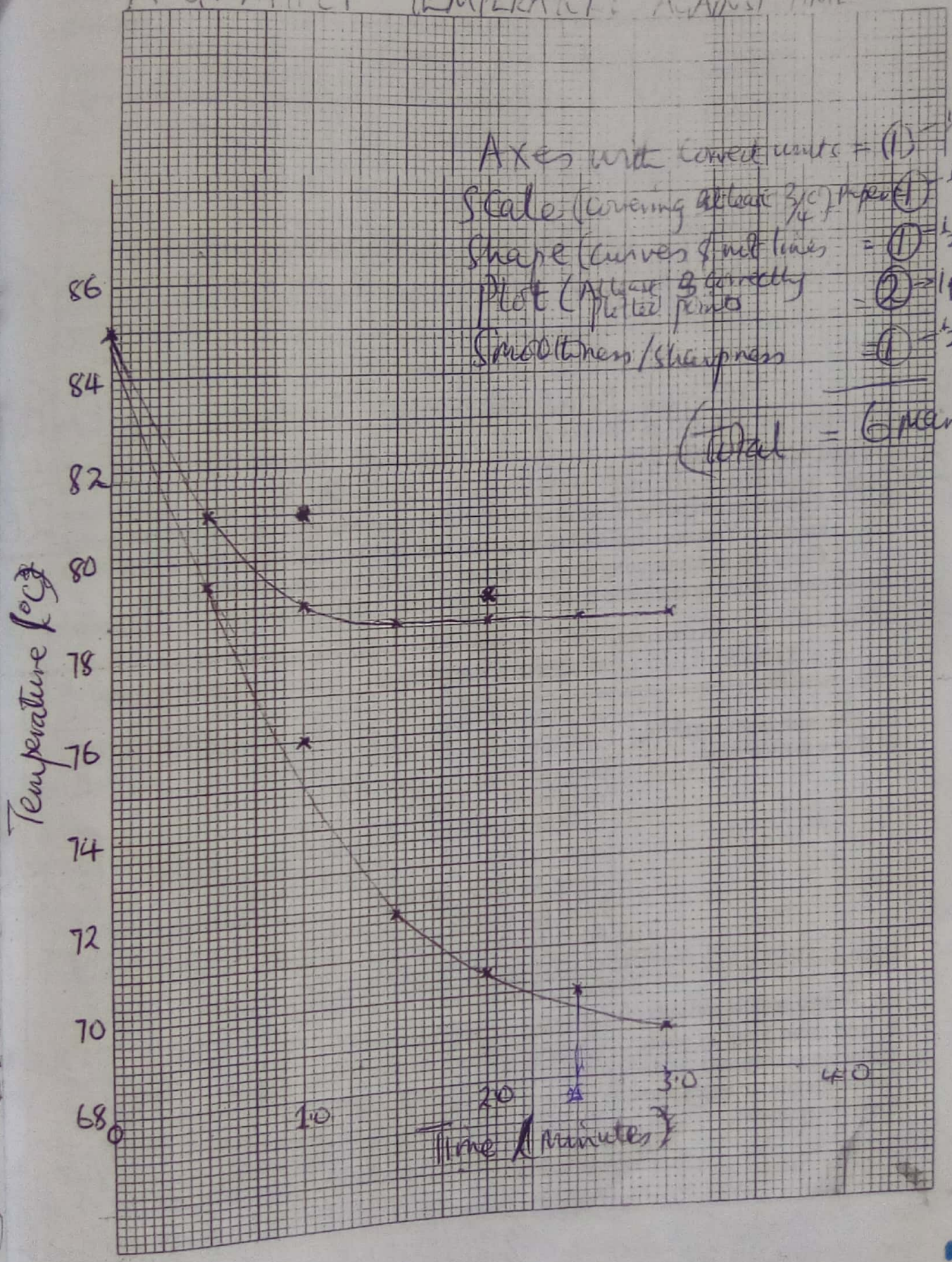
A GRAPH OF TEMPERATURE AGAINST TIME

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(e) Calculate the freezing point depression constant, $K_f$ per kg of F. *(Relative molecular formula of solid G is 152.)* *(04 marks)*

5.00g of F dissolve 1 mol of G
100g of F dissolve 1 x 100/5
= 200g.
200g of G causes a depression of 8.5°C
152g of G causes a depression of 8.5 x 152/1000
= 6.46°C
∴ Freezing point depression constant = 6.46°C mol⁻¹kg
(Accept values from 3.46 – 9.4 ie ± 3)

formula is used, award maximum of 2 marks. Accept answer without units

2

**2.** You are provided with substance **P** which contains two cations and two anions. You are required to identify the cations and the anions in **P**. Carry out the following tests on **P** and record your observations and deductions in the table below. Identify any gas(es) evolved. *(25 marks)*

| TESTS | OBSERVATIONS | DEDUCTIONS |
|---|---|---|
| (a) Heat one spatula end-ful of **P** in a dry test tube. | Colourless liquid/ condensate turns anhydrous copper(II) sulphate blue. Colourless gas turns blue litmus red and lime water milky. White fumes; Colourless gas which turns acidified potassium dichromate(VI) solution green. (insist on acidified) | Hydrated salt/ water of crystallisation. Gas is carbon dioxide $CO_3^{2-}$, $HCO_3^-$, $C_2O_4^{2-}$ or $CH_3COO^-$. $SO_3^{2-}(g)$, $SO_2(g)$, $SO_4^{2-}$/$SO_3^{2-}$ |
| (b) To two spatula end-fuls of **P**, add about 5 cm³ of water. Shake vigorously and filter. Divide the filtrate into 5 parts. Keep the residue. | Green solid turns black/brown residue. | Residue probably CuO, FeO, NiO (for black) and $Fe_2O_3$ (for brown) |
| | Green filtrate. Reject: green solution. Green residue. Reject: Green solid, Green ppt, Green suspension. | Transition metal ion probably $Cu^{2+}$, $Fe^{2+}$, $Ni^{2+}$ or $Cr^{3+}$ in both filtrate and residue. |



Turn Over

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| TESTS | OBSERVATIONS | DEDUCTIONS | |
|---|---|---|---|
| (i) To the **first** part of the filtrate, add dilute sodium hydroxide solution drop-wise until in excess. | Green precipitate insoluble in excess<br>Ignore: turns to brown | Probably $Ni^{2+}$, $Fe^{2+}$ (Any one) | 1½ |
| (ii) To the **second** part of the filtrate, add dilute ammonia solution drop-wise until in excess. | Green precipitate insoluble in excess; turns brown<br>Ignore reddish- | $Fe^{2+}$ | 2 |
| (iii) To the **third** part of the filtrate, add 3 – 4 drops of concentrated nitric acid followed by 2 – 3 drops of potassium thiocyanate. | Green solution turns yellow (or orange); then blood-red on addition of $KSCN_{(aq)}$.<br>Accept red solid<br>Reject reddish-brown | $Fe^{2+}$ oxidised to $Fe^{3+}$ (for yellow soln)<br>∴ $Fe^{2+}$ confirmed<br>Reject $Fe^{2+}$ confirmed if yellow soln is not mentioned) | 2 |
| (iv) To the **fourth** part of the filtrate, add 2 – 3 drops of lead(II) nitrate solution. Heat and allow to cool. | White precipitate insoluble on heating | $Cl^-$ absent; or $SO_4^{2-}$, $SO_3^{2-}$ suspected.<br>Reject $CO_3^{2-}$ | 1½ |
| (v) Use the **fifth** part of the filtrate to carry out a test of your own choice to confirm one of the anions in **P**.<br>Add barium nitrate solution followed by dilute nitric acid.<br>Accept $BaCl_2$/HCl (If acid is added first, award full mark for white ppt) | White precipitate insoluble in the acid | $SO_4^{2-}$ confirmed. | 2 |
| (c) Wash the residue with water and dissolve it in dilute hydrochloric acid. Divide the resultant solution into **three** portions. | Effervescence/bubbles of colourless gas which turns blue litmus red and lime water milky<br>Green solution formed. | Gas is $CO_2$<br>∴ $CO_3^{2-}$ confirmed<br>Deny ½ mark if $HCO_3^-$ is given.<br>Probably $Ni^{2+}$, $Cu^{2+}$ or $Fe^{2+}$. | 3½ |



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| TESTS | OBSERVATIONS | DEDUCTIONS |
|---|---|---|
| (i) To the **first** portion of the solution, add dilute sodium hydroxide solution drop-wise until in excess. | Green precipitate insoluble in excess. | Probably $Ni^{2+}$; $Fe^{2+}$ suspected. |
| (ii) To the **second** portion of the solution, add dilute ammonia solution drop-wise until in excess. | Green precipitate soluble in excess giving a pale-blue solution. | Probably $Ni^{2+}$ present. Award ½ mark if observation is complete |
| (iii) Use the **third** portion of the solution to carry out a test of your own choice to confirm one of the cations in **P**. Add aqueous ammonia followed 2 drops of dimethyl glyoxime solution | Red precipitate | $Ni^{2+}$ confirmed. |

If order is reversed deny the mark

Reject ammonia, pink ppt, red colouration

Deny mark for wrong spelling of reagent

(d) Identify the:

(i) cations in **P** ..... $Ni^{2+}$ and $Fe^{2+}$ ..... (01 mark)

Confirmed in C(iii) Confirmed in b)(ii)

(ii) anions in **P** ..... $SO_4^{2-}$ and $CO_3^{2-}$ ..... (01 mark)

In b(v) Confirmed in (C)

3. You are provided with an organic substance **W**. You are required to determine the nature of **W**.
Carry out the following tests on **W** and record your observations and deductions in the table below. *(12 marks)*

| TESTS | OBSERVATIONS | DEDUCTIONS |
|---|---|---|
| (a) Burn a small amount of **W** on a spatula end or on a crucible lid. | White solid burns with a yellow sooty flame | Aromatic (or aliphatic unsaturated) compound. (or aliphatic compd with high C : H ratio |

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| TESTS | OBSERVATIONS | DEDUCTIONS | |
|---|---|---|---|
| (b) Add a spatula end-ful of **W** to about 5 $cm^3$ of dilute sodium hydroxide solution and shake. | Readily soluble to form a colourless solution | Probably acidic compound. OR. Aromatic carboxylic acid, Phenol suspected. | 2 |
| (c) To a spatula end-ful of **W** in a test tube add about 5 $cm^3$ of water. Shake vigorously and warm. Test the solution with litmus paper and divide into **three** equal portions. | Slightly soluble in cold water and soluble on warming. Solution formed turns blue litmus red | Phenol, aromatic carboxylic acid suspected. | 2½ |
| (i) To the **first** portion of the solution add 2–3 drops of 2,4 dinitro phenyl hydrazine. 25 pinkfect solution turns yellow, orange. | No observable change. OR No yellow/orange ppt. | Carbonyl compound absent OR. Ketone, aldehyde absent. | 1½ |
| (ii) To the **second** portion of the solution, add 2–3 drops of iron(III) chloride solution. | Violet / purple colouration | Phenol present. | 1½ |
| (iii) To the **third** portion of the solution, add a spatula end-ful of solid sodium hydrogen carbonate. | Effervescence / bubbles of colourless gas. | Carboxylic acid present | 1 |
| (d) To 2$cm^3$ of ethanol, add a spatula end-ful of **W** and shake. Add 3– 4 drops of concentrated sulphuric acid and warm the mixture. | Sweet-fruity smell. | Esterification occurs. Carboxylic acid confirmed. | 2 |

(e) Comment on the nature of **W**. Aromatic compound with a hydroxy group attached to benzene ring. Also contains the -COOH group. → Confirmed in C(ii) or (d) (02 marks) 1½

OR: Aromatic carboxylic acid with a hydroxy group.

OR phenol with a carboxylic acid group

14



END

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| TESTS | OBSERVATIONS | DEDUCTIONS |
|---|---|---|
| (b) Add a spatula end-ful of **W** to about 5 $cm^3$ of dilute sodium hydroxide solution and shake. | Readily soluble to form a colourless solution | Possibly acidic compound. OR. Aromatic carboxylic acid, Phenol suspected. |
| (c) To a spatula end-ful of **W** in a test tube add about 5 $cm^3$ of water. Shake vigorously and warm. Test the solution with litmus paper and divide into **three** equal portions. | Slightly soluble in cold water and soluble on warming. Solution formed turns blue litmus red. | Phenol, aromatic carboxylic acid suspected. |
| (i) To the **first** portion of the solution add 2–3 drops of 2,4 dinitro phenyl hydrazine. 25 pin Reject solution turns yellow, orange | No observable change. OR No yellow/orange ppt. | Carbonyl compound absent OR. Ketone, aldehyde absent. |
| (ii) To the **second** portion of the solution, add 2–3 drops of iron(III) chloride solution. | Violet / purple colouration | Phenol present. |
| (iii) To the **third** portion of the solution, add a spatula end-ful of solid sodium hydrogen carbonate. | Effervescence / bubbles of colourless gas. | Carboxylic acid present |
| (d) To 2$cm^3$ of ethanol, add a spatula end-ful of **W** and shake. Add 3–4 drops of concentrated sulphuric acid and warm the mixture. | Sweet-fruity smell. | Esterification occurs Carboxylic acid confirmed. |

(e) Comment on the nature of **W**. Aromatic compound with a hydroxy group attached to benzene ring. Also contains the -COOH group. OR: Aromatic carboxylic acid with a hydroxy group. → Confirmed (ii) and (iii) (02 marks)



OR phenol with a carboxylic acid group.

END

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P525/3 Inst. Sc.
CHEMISTRY
Practical Instructions
Paper 3
Nov. / Dec. 2010

# UGANDA NATIONAL EXAMINATIONS BOARD

## Uganda Advanced Certificate of Education

## CHEMISTRY PRACTICAL INSTRUCTIONS

**(P525/3 Inst. Sc.)**

November / December, 2010

**CONFIDENTIAL**

**Great care should be taken that the information given below does not reach the candidates either directly or indirectly.**

## INSTRUCTIONS FOR PREPARING APPARATUS AND CHEMICALS

[ **NB:** The head teacher must ensure that the teacher responsible for preparing the apparatus hands, in his/her trial results properly sealed in a separate envelope and **firmly** fastened ( attached) to the candidates' scripts envelope(s). ]

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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 the 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 $cm^3$ or 20 $cm^3$ )

   2 conical flasks.

   1 measuring cylinder ( 100 ml).

   1 beaker (250 ml)

   8 test tubes

   50 $cm^3$ of 2M hydrochloric acid labelled **FA3**

   100 $cm^3$ of **FA1**

   100 $cm^3$ of **FA2**

   Phenolphthalein indicator

   2g of **T**

   2g of **W**

   3 $cm^3$ of **P**

**Easy access to:**

- Heat source.
- Common reagents for identifying gases, cations, anions and organic compounds.

**FA1** is prepared by diluting 50 $cm^3$ of **F** to make one litre of solution.

**FA2** is prepared by diluting 45.5 $cm^3$ of **G** to make one litre of solution.

Substances **F, G, P, T** and **W** will be provided by **UNEB.**



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Name ....TUMUSIIME IGNATIUS.... Centre/Index No. P525 / 011

Signature .....

P525/3
CHEMISTRY
(PRACTICAL)
Paper 3
Nov. / Dec. 2010
3¼ hours.

# UGANDA NATIONAL EXAMINATIONS BOARD

## 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. text books, 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 the apparatus and chemicals that they may need.*

| For Examiners' Use Only | | | |
|---|---|---|---|
| Q.1 | Q.2 | Q.3 | Total |
| 26 | 27 | 14 | 67 |
| | | | |

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1. You are provided with the following

**FA1**, which is a 0.1 M hydrochloric acid

**FA2**, which is approximately a 0.1 M sodium hydroxide solution.

**FA3**, which is a 2M hydrochloric acid.

Solid **W**, which is an impure metal carbonate.

You are required to standardize **FA2** and use it to determine the percentage of the impurity in **W**.

**Procedure:**

(a) Pipette 20 ( or 25 $cm^3$ ) of **FA2** into a conical flask. Titrate with **FA1** using phenolphthalein as the indicator. Repeat the titration until you obtain consistent results.

Record your results in table 1 below.

**Table 1** Accept vol recorded to 1dcpl, ...

Volume of pipette used 20.00 $cm^3$. (½ mark)

| | | | |
|---|---|---|---|
| Final burette reading ($cm^3$) | 19.80 | 39.50 | 19.70 |
| Initial burette reading ($cm^3$) | 0.00 | 19.80 | 0.00 |
| Volume of **FA1** used ($cm^3$) | 19.80 | 19.70 | 19.70 |

- Table filled to 2 dcp, with correct subtraction award (4½ marks)
- Deduct ½ mark for every wrong subtraction
- Any values reported to 1 dcp during ... up to max of 1½ marks
- Any data not to be recorded ...

Titre values used for calculating the average volume of **FA1** used.

19.70, 19.70 (Any two values within ±0.1) (½ mark)

Average volume of **FA1** used. 19.70 ±0.1 $cm^3$. (2½ marks)

For pipette of 25mls, Ave. = 24.68 $cm^3$ ±0.2 ±0.3 ±0.5 ≥0.5

**Question:**

Calculate the concentration in moles per litre of solution **FA2**. (02 marks)

No of moles of FA1 that reacted = $\frac{0.1 \times 19.70}{1000}$

Equation:

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

Reaction mole ratio NaOH : HCl = 1 : 1

∴ No. of moles in 20 $cm^3$ of FA2 = $\frac{0.1 \times 19.70}{1000}$

20 $cm^3$ of FA2 solution contains $\frac{0.1 \times 19.70}{1000}$

∴ 1000 $cm^3$ of FA2 soln contains ...

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Molarity of FA2 = 0.0955 ≈ 0.099

(b) Weigh 1.5g of **W** and dissolve it in 20.0 $cm^3$ of **FA3** in a beaker. Add 80 $cm^3$ of distilled water and label this solution **FA4**. Pipette 20 ( or 25 $cm^3$ ) of **FA2** into a conical flask and titrate it with **FA4** using phenolphthalein as the indicator. Record your results in Table 2 below.

*Results:*

Mass of container + **W** = 11.50 (½ mark) (½)

Mass of empty container = 10.00 (½ mark) (½)

Mass of **W** used = 1.50 (½ mark) (½)

Volume of pipette used 20.00 $cm^3$ (½ mark) (½)

**Table 2**

| | | | |
|---|---|---|---|
| Final burette reading ($cm^3$) | 11.50 | 23.00 | 34.50 |
| Initial burette reading ($cm^3$) | 0.00 | 11.50 | 23.00 |
| Volume of **FA4** used ($cm^3$) | 11.50 | 11.50 | 11.50 |

As in Table 1. (4½ marks) (4½)

Titre values used for calculating the average volume of **FA4** used.

11.50, 11.50, 11.50 (½ mark) (½)

Average volume of **FA4** used 11.50 $cm^3$. (2½ marks) (2½)

For 25ml pipt Average = 14.4 $cm^3$

**Questions:**

(a) Calculate the

(i) number of moles of hydrochloric acid that was in 100 $cm^3$ of **FA4**. FA2 that reacted = 20 $cm^3$ (02 marks)

No of moles of HCl ~~in 11.50 $cm^3$~~ = $\frac{0.099 \times 20}{1000}$

Reaction mole ratio NaOH : HCl = 1 : 1

No of moles of HCl in 11.50 $cm^3$ = $\frac{0.099 \times 20}{1000}$

∴ No. of moles of HCl in 100 $cm^3$ of FA4;

11.5 $cm^3$ of HCl in FA4 contain $\frac{0.099 \times 20}{1000}$

100 $cm^3$ of HCl in FA4 contain $\frac{0.099 \times 20 \times 100}{1000 \times 11.5}$

= 0.0172 moles (2)

(No of moles ...) 1½



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(ii) number of moles of the metal carbonate that reacted. (the metal carbonate reacts with hydrochloric acid in the ratio; 1:2)

Original no of moles of HCl added = $\frac{26 \times 2}{100} = 0.04$ (02 marks)

∴ No of moles of HCl that reacted with the carbonate = 0.04 − 0.0172 = 0.0228 moles

∴ No of moles of Metal Carbonate that reacted = $\frac{1}{2} \times 0.0228$ = 0.0114 M

(b) Determine the percentage of the impurity in **W**. (*Relative Formula mass of the metal carbonate = 100*)

Mass of Metal carbonate = 0.0114 × 100 = 1.14 g (2½ marks)

Mass of Impurity = 1.5 − 1.14 = 0.36 g

Percentage Impurity = $\frac{\text{Mass of impurity}}{\text{Mass of given carbonate}} \times 100$

= $\frac{0.36}{1.5} \times 100$ = 24 %

2. You are provided with substance **T** which contains **three** cations and **one** anion. You are required to carry out the following tests on **T** to identify the cations and anion in it. Identify any gases evolved.

Record your observations and deductions in the table below. (27 marks)

| TESTS | OBSERVATIONS | DEDUCTIONS |
|---|---|---|
| (a) Heat a spatula end-ful of **T** in a dry test tube until there is no further change. | Melts to form a blue solution. Colourless vapour condenses to colourless liquid that turns anhydrous copper (II) sulphate blue. White fumes which turn blue litmus red and pale $K_2Cr_2O_7$ green. White sublimate forms on cooler parts of the tube. The white solid ~~turned to white~~ (brown) | Water of crystallisation or hydrated salt. $SO_2$ gas ∴ $SO_3^{2-}$, $SO_4^{2-}$ |
| (b) Shake two spatula end-fuls of **T** with about 3 $cm^3$ 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. | Blue solution. Blue precipitate turns black on heating. Colourless gas turned red litmus blue, forms dense white fumes with conc. HCl. Colourless filtrate. Black residue. | Probably CuO. $Cu^{2+}$. $NH_3(g)$ ∴ $NH_4^+$ Deny NH4+ if conc. HCl used. $Al^{3+}$, $Pb^{2+}$, $Sn^{2+}$, $Sn^{4+}$, $Zn^{2+}$ |

Rejected HCl

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| TESTS | OBSERVATIONS | DEDUCTIONS |
|---|---|---|
| (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 to ~~excess~~ Colourless gas ~~of~~ solution | $Al^{3+}$, $Pb^{2+}$, $Zn^{2+}$, $Sn^{2+}$, $Sn^{4+}$ suspected [illegible] |
| (i) To the **first** part of the acidic solution, add dilute sodium hydroxide solution drop-wise until in excess. Warm the mixture. | White precipitate soluble in excess to give a colourless solution. Colourless gas which turns red litmus blue and forms dense white fumes with conc. HCl. | $Al^{3+}$, $Pb^{2+}$, $Zn^{2+}$, $Sn^{2+}$, $Sn^{4+}$ Reject Anion: Any extra wrong cation ca[illegible] the correct one) $NH_3$ gas ∴ $NH_4^+$ Confirmed ½ mark strictly on $NH_4^+$ |
| (ii) To the **second** part of the solution, add dilute ammonia solution drop-wise until in excess. | White precipitate insoluble in excess | $Pb^{2+}$, $Al^{3+}$, $Sn^{2+}$, $Sn^{4+}$ probably present |
| (iii) To the **third** part of acidic solution, add 2 – 3 drops of potassium iodide solution. | No observable Change Accept: No yellow ppt, soln remains colourless. Reject: No change, no observation | $Pb^{2+}$ absent. Insist on $Pb^{2+}$ absent |
| (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. | ~~Pink solution~~. Blue precipitate soluble to form a blue lake/ blue solution. | $Al^{3+}$ Confirmed |

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| TESTS | OBSERVATIONS | DEDUCTIONS |
|---|---|---|
| (v) To the **fifth** part, add 2 –3 drops of lead(II) ethanoate solution. | White precipitate | Probably $Cl^-$, $SO_4^{2-}$ probably present. Accept: [illegible] Reject: $CO_3^{2-}$, $SO_3^{2-}$ [illegible] |
| (vi) Use the **sixth** part to carry out a test of your own choice to confirm the anion in **T**. Add Barium nitrate solution or Barium chloride solution. If Acid is given, ignore | White precipitate | $SO_4^{2-}$ Confirmed |
| (d) Wash the residue with water and dissolve it in dilute hydrochloric acid and divide the solution into **three** parts. | Dissolves to give a blue solution. Accept: green soln | $Cu^{2+}$ suspected. → $Ni^{2+}$, $Cu^{2+}$, $Cr^{3+}$, $Fe^{2+}$ |
| (i) To the **first** part of the acidic solution, add dilute sodium hydroxide solution ~~drop~~-wise until in excess. | Blue precipitate insoluble in excess. | $Cu^{2+}$ suspected. |
| (ii) To the **second** part of the acidic solution, add dilute ammonia solution dropwise until in excess. | Blue precipitate dissolves to give a deep-blue solution | $Cu^{2+}$ probably present. |
| (iii) To the **third** part of the acidic solution, add 2–3 drops of potassium hexacyanoferrate (II) solution. | ~~Dark red~~ maroon/brown precipitate. Accept: Reddish brown ppt. Reject: brownish-red. | $Cu^{2+}$ Confirmed |



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(c) (i) The anion in **T** is $SO_4^{2-}$

(ii) The cations in **T** are $Al^{3+}$, $NH_4^+$, $Cu^{2+}$

3. You are provided with an organic substance **P**. You are required to determine the nature of **P**.
Carry out the following tests on **P** and record your observations and deductions in the table below. *(14 marks)*

| TESTS | OBSERVATIONS | DEDUCTIONS |
|---|---|---|
| (a) Burn a small amount of **P** on a spatula end or in a porcelain dish. | Colourless liquid Burns with a yellow non-sooty flame. | Saturated aliphatic (low C:H ratio) compound. |
| (b) To about 1 $cm^3$ of **P**, add about 2 $cm^3$ of water, shake and test the mixture with litmus. Divide the mixture into **three** parts. | Miscible/soluble/dissolves in water to give a colourless solution which has no effect on litmus | Neutral compd with low molecular mass alkanols/alkanals alkanones probably present. |
| (i) To the **first** part of the mixture, add 2–3 drops of Brady's reagent. | No observable change. Accept: No yellow/orange ppt. | Carbonyl compound absent. Accept; Propane, aldehyde |
| (ii) To the **second** part of the mixture, add 2–3 drops of iron(III) chloride solution. | No observable change Accept: Colour of $FeCl_3$ remains brown | Phenol/a ~~Ethanoic acid~~ absent. |
| (c) To the **third** part of the mixture from (b) above, add 2–3 drops of acidified potassium dichromate(VI) solution. Heat the mixture and divide the solution into **two** parts. | Orange solution turned green. | Primary, secondary alkanol probably present. Reject aldehyde (if given cancel ½ mark). |



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| | | |
|---|---|---|
| (i) To the **first** part of the solution, add 2 – 3 drops of Brady's reagent. | Yellow precipitate | Primary or Secondary alkanol oxidized to carbonyl compound |
| (ii) To the **second** part of the solution, add 2 –3 drops of Tollen's reagent and warm. | No observable change. Accept: No silver mirror formed | Secondary alkanol oxidized to alkanone. Reject: Primary alkanol. Accept: absent |
| (d) To about 0.5 $cm^3$ of **P**, add 2 – 3 drops of Lucas reagent. | Cloudiness after a short time (5–10 min) Accept: turbid Reject: two layers of soln, white ppt | Secondary alkanol present. |
| (e) To about 0.5 $cm^3$ of **P**, add 2 –3 drops of sodium hydroxide solution followed by iodine solution until the solution is pale yellow. Warm the mixture and allow to stand. | Yellow/orange precipitate | Contains a methyl radical adjacent to the carbon carrying the functional group. $R-\underset{OH}{CH}-CH_3$ |

(f) Comment on the nature of **P**.

P is aliphatic (mentioned in (i)) secondary alkanol (deduced in (d)) with the structure $R-\underset{OH}{CH}-CH_3$ (deduced in (c)) (deduced in (e))

(2)

(14)

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P525/3
CHEMISTRY
(PRACTICAL)
Paper 3
Nov./Dec. 2009
3¼hours

# UGANDA NATIONAL EXAMINATIONS BOARD

## 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. text books, 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 the apparatus and chemicals that they may need.*

| For Examiners' Use Only | | | |
|---|---|---|---|
| Q. 1 | Q. 2 | Q. 3 | Total |
| 25½ | 29½ | 15 | 70 |
| | | | |

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1. You are provided with the following:

**FA1**, which is a 0.012 M potassium iodate solution.

**W**, which is sodium thiosulphate, $Na_2S_2O_3 \cdot 5H_2O$.

**Z**, which is a liquid bleaching agent containing chlorate(I).

You are required to prepare and standardise a solution of sodium thiosulphate and use it to determine the mass of chlorine required to produce 1 $dm^3$ of the bleaching agent.

Potassium iodate reacts with sodium thiosulphate according to the following equation;

$$IO_3^-{}_{(aq)} + 6S_2O_3^{2-}{}_{(aq)} + 6H^+{}_{(aq)} \longrightarrow I^-{}_{(aq)} + 3S_4O_6^{2-}{}_{(aq)} + 3H_2O_{(l)}$$

Chlorate(1) reacts with potassium iodide to form iodine according to the following equation;

$$ClO^-{}_{(aq)} + 2I^-{}_{(aq)} + 2H^+{}_{(aq)} \longrightarrow I_{2(aq)} + Cl^-{}_{(aq)} + H_2O_{(l)}.$$

And iodine reacts with sodium thiosulphate according to the following equation;

$$I_{2(aq)} + 2S_2O_3^{2-}{}_{(aq)} \longrightarrow S_4O_6^{2-}{}_{(aq)} + 2I^-{}_{(aq)}.$$

**Procedure:**

(a) Weigh about 6.0 g of **W** and dissolve it in about 100 $cm^3$ of distilled water. Transfer the solution to a 250 $cm^3$ volumetric flask and make it up to the mark with distilled water. Label the solution **FA2**.

Pipette 25.0 (or 20.0) $cm^3$ of **FA1** into a conical flask. Add 20 $cm^3$ of 1M sulphuric acid, followed by 20 $cm^3$ of 0.5 M potassium iodide solution. Titrate the mixture with **FA2** until the brown colour changes to yellow. Add 1 $cm^3$ of starch indicator and continue the titration until the solution turns colourless.

Repeat the titration until you obtain consistent results.

(i) Record your results in Table **A**.

**Results:**

Volume of pipette used .....20.00..... $cm^3$.

Accept volume of pipette recorded to 1 decimal

Average ~~for~~ Volume ~~of~~ of pipette 25 cm3; Convert ie 2



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**Table A**

| | | | |
|---|---|---|---|
| Final burette reading ($cm^3$) | 18.10 | 36.10 | 36.70 |
| Initial burette reading ($cm^3$) | 0.30 | 18.10 | 19.00 |
| Volume of **FA2** used ($cm^3$) | 17.80 | 18.00 | 17.70 |

Volumes of **FA2** used in calculating average volume

17.80, 17.70 ..... $cm^3$

Average volume of **FA2** used 17.75 ..... $cm^3$

**Question:**

(ii) Calculate the morality of **FA2**.

Moles of $IO_3^-$ in 1000 $cm^3$ = 0.012

Moles of $IO_3^-$ in 20.00 $cm^3$ = $\frac{0.012 \times 20}{1000}$

Moles of $S_2O_3^{2-}$ in 17.75 $cm^3$ = $\frac{6 \times 0.012 \times 20}{1000}$

Molarity of FA2 = $\frac{6 \times 0.012 \times 20 \times 1000}{1000 \quad 17.75}$

= 0.08M

(b) Measure 10 $cm^3$ of **Z** into a 250 $cm^3$ volumetric flask. Add distilled water up to the mark. Label the solution **FA3**.

Pipette 25.0 (or 20.0) $cm^3$ of **FA3** into a conical flask. Add 10 $cm^3$ of 0.5 M potassium iodide solution, followed by 10 $cm^3$ of 1 M sulphuric acid. Titrate the mixture with **FA2** until the mixture turns yellow. Add 1 $cm^3$ of starch indicator and continue with the titration until the solution turns colourless.

Repeat the titration until you obtain consistent results.



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Record your results in Table B below.

**Results:**

Volume of pipette used: 20 cc ($cm^3$)

**Table B**

| | | | |
|---|---|---|---|
| Final burette reading ($cm^3$) | 8.10 | 16.20 | 24.3 |
| Initial burette reading ($cm^3$) | 0.00 | 8.10 | 16.2 |
| Volume of **FA2** used ($cm^3$) | 8.10 | 8.10 | 8.1 |

Volumes of **FA2** used for calculating average volume: 8.10, 8.10, 8.10 $cm^3$

Average volume of **FA2** used $\frac{8.1+8.1+8.1}{3} = 8.1$ $cm^3$

**Questions:**

(c) Calculate:

(i) the number of moles of iodine liberated.

Moles of FA2 used $= \frac{8.10 \times 0.08}{1000}$

∴ Moles of Iodine liberated $= \frac{1}{2} \times \frac{0.08 \times 8}{1000}$

$= 3.24 \times 10$

(ii) the number of moles of chloride ions that would be liberated from 10 $cm^3$ of **Z**.

Ratio $I_2 : Cl^-$ = 1 : 1

∴ No of moles of $Cl^-$ liberated by $20 cm^3$ = 3.2

Moles of FA3 in $250 cm^3$ =

$\frac{250 \times 3.24 \times 10^{-4}}{20}$

$= 0.00405$

These moles are in $10 cm^3$ = 0.0

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(iii) the number of moles of chlorine required to produce 1 $dm^3$ of **Z**.

Moles of in $10cm^3$ = 0.00405

So Moles in $1000cm^3$ = $\frac{100 \times 4.05 \times 10^{-3}}{10}$ (1)

= 0.405 moles

1 mole of $Cl_2$ gives 2 moles of $Cl^-$

∴ No of moles of $Cl_2$ = $\frac{1}{2} \times 0.405$ (½)

= 0.2025 moles (½)

(iv) Determine the mass of chlorine required to produce 1 $dm^3$ of **Z**.
[$Cl$ = 35.5]

Relative molecular mass of $Cl_2$ = 35.5×2 = 71 (½)

Mass of Chlorine = 0.2025×71 (½)

= 14.38g (½)

3½

**2.** You are provided with substance, **Y**, which contains two cations and two anions. Carry out the following tests on **Y** and identify the cations and anions in it. Identify any gases evolved. Record your observations and deductions in the table below.

25½

| TESTS | OBSERVATIONS | DEDUCTIONS |
|---|---|---|
| (a) Heat one spatula endful of **Y** strongly in a dry test tube. | Colourless vapour condensed to colourless liquid which turns anhydrous copper(II) sulphate blue. Colourless gas which turns blue litmus red and lime water milky. | Water of Crystallisation ∴ a hydrate. Carbon dioxide. $CO_3^{2-}$, $HCO_3^-$, $C_2O_4^{2-}$ Reject $CO_3^{2-}$ it's lime water not mentioned |
| (b) To two spatula endfuls of **Y** in a test tube, add about 5 $cm^3$ of water, shake and filter. Keep both the residue and the filtrate. Divide the filtrate into five parts. | Black residue remains. Colourless filtrate. Reject: Coloured solns, white solutions. Green residue. Reject: green solid with gelatin ppt | $MnO_2$, CuO, FeO, $Fe_3O_4$, NiO. Non-transition metal ions probably $Pb^{2+}$, $Zn^{2+}$, $Al^{3+}$. Reject: $Mn^{2+}$. Transition metal ion probably $Cu^{2+}$, $Ni^{2+}$, $Fe^{2+}$, $Cr^{3+}$ |

(5)

(2)



Turn Over

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| | | |
|---|---|---|
| (i) To the first part of the filtrate, add dilute sodium hydroxide solution drop-wise until in excess. | White precipitate insoluble in excess; turns brown on standing | Probably $Mn^{2+}$ present |
| (ii) To the second part of the filtrate, add dilute ammonia solution drop-wise until in excess. | White precipitate insoluble in excess, turns brown on standing | Probably $Mn^{2+}$ present. (Give $Ag^{+}$ if insoluble is not mentioned, deny ½) |
| (iii) Use the third part of the solution to carry out a test of your own choice to confirm one of the cations present in Y. (order matters →) | | |
| Add concentrated nitric acid followed by solid sodium bismuthate | Purple solution | $Mn^{2+}$ confirmed. |
| (iv) To the fourth part of the filtrate, add 2-3 drops of lead (II) nitrate solution. | White precipitate | $SO_4^{2-}$, $Cl^-$, $CO_3^{2-}$, $SO_3^{2-}$ |
| (a) Use the fifth part of the filtrate to carry out a test of your own choice to confirm one of the anions present in Y. | if order is reversed give full marks if white ppt | |
| Add barium chloride solution followed by dilute hydrochloric acid OR $Ba(NO_3)_2$ followed by dil. $HNO_3$ | White precipitate insoluble in the acid | $SO_4^{2-}$ confirmed |
| (c) Wash the residue and dissolve it in dilute hydrochloric acid. Divide the solution into four parts. | Effervescence; colourless gas which turns blue litmus red and lime water milky | Carbon dioxide; $CO_3^{2-}$ confirmed |
| (i) To the first part of the solution, add dilute sodium hydroxide solution drop-wise until in excess. | A ~~green-blue~~ solution remains (Accept blue or green solution) | $Cu^{2+}$ (→ $Ni^{2+}$, $Co^{2+}$, $Fe^{2+}$, $Cr^{3+}$) |
| | Pale-blue precipitate which does not dissolve in excess | Probably $Cu^{2+}$ present |

OR: $Ba(NO_3)_2$ follow. by $HNO_3$

OR: conc. $HNO_3$ & $PbO_2$ & heat

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| | | |
|---|---|---|
| (ii) To the second part of the solution, add dilute ammonia solution drop-wise until in excess. | Blue precipitate soluble in excess to form a deep-blue solution | $Cu^{2+}$ suspected. |
| (iii) To the third part of the solution, add 2-3 drops of potassium thiocyanate. | A greenish-brown solution<br>Accept green to brown<br>Deny mixture of blue and brown | $Cu^{2+}$ suspected. (1) |
| (iv) Use the fourth part of the solution to carry out a test of your own choice to identify one of the cations in **Y**. Add potassium iodide solution OR Potassium hexacyanoferrate II) soln<br>Accept Potassium ferrocyanide | White precipitate and brown soln<br>Maroon/dark-brown ppt | $Cu^{2+}$ confirmed (2) |

Reject hexacyanoferrate II) only

(d) (i) The cations present in **Y** are ..... $Mn^{2+}$ and $Cu^{2+}$ ..... (2)

(ii) The anions present in **Y** are ..... $SO_4^{2-}$ and $CO_3^{2-}$ ..... $7\frac{1}{2}$

$29\frac{1}{2}$

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

| TESTS | OBSERVATIONS | DEDUCTIONS |
|---|---|---|
| (a) Burn a spatula endful of **K** on a porcelain dish or at the end of a spatula. | Burns with a yellow sooty flame<br>Reject smoking. | Aromatic compound<br>Accept high C:H ratio or unsaturated comp. (1½) |
| (b) Transfer two spatula endfuls of **K** to a test tube containing 5 $cm^3$ of water, warm the mixture and test with litmus. Divide the warm solution into four parts | Sparingly soluble in water.<br>Solution turns blue litmus red<br>Accept pink or orange | Phenol or Carboxylic acid probably present<br>Accept sulfuric acid (3) |
| (c) To the first part of the warm solution add 2–3 drops of sodium carbonate solution. | Slight effervescence<br>Accept bubbles | Carboxylic acid probably present<br>Deny acid if phenol is mentioned (1½) |

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| | | |
|---|---|---|
| (ii) To the **second** part of the solution add 2–3 drops of iron(III) chloride solution. | No observable change OR No violet colour formed | Phenol absent |
| (iii) To the **third** part of the solution add 2–3 drops of potassium dichromate(VI) solution and warm. | No observable change Accept orange to green (K2Cr2O7 acidified) | Aldehyde, primary / secondary alcohol absent OR Reducing agent absent Ignore ketone if |
| (c) Dissolve **one** spatula endful of **K** in 2 $cm^3$ of methanol and add 2–3 drops of Brady's reagent. | No observable change or No yellow/orange precipitate Reject: orange/yellow colour of Brady's reagent formed, precipitate | Carbonyl / Compound absent Accept: ketone, aldehyde absent |
| (d) To a spatula endful of **K**, add about 5 drops of ethanol followed by 2–3 drops of concentrated sulphuric acid. Heat the mixture and pour it into a small beaker of cold water. Allow to stand. | Sweet / fruity smelling liquid | Carboxylic acid present |
| (e) To a spatula endful of **K** in a test tube, add 3 $cm^3$ of water, warm and add 2–3 drops of acidified potassium manganate(VII) solution. | Purple solution turns to colourless Accept silver or decolourised / turns to colourless | Compound unsaturated Accept: C=C, C≡C |

) Comment on the nature of **K**

K is Aromatic Unsaturated Carboxylic acid

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

Signature .....

P525 / 3
CHEMISTRY
(PRACTICAL)
Paper 3
Nov. / Dec. 2008
3¼ hours

# UGANDA NATIONAL EXAMINATIONS BOARD

## 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, slide rules and silent non-programmable calculators may be used.*

*Reference books (i.e. text books. 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 the apparatus and chemicals that they may need.*

| For Examiners' Use Only | | | |
|---|---|---|---|
| Q.1 | Q.2 | Q.3 | Total |
| 24 | 30 | 15 | 69 |
| | | | |

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I. You are provided with the following:

**FA1**, which is aqueous ammonia.

**FA2**, which is trichloromethane.

**FA3**, which is 0.5 M hydrochloric acid.

**FA4**, which is 0.05 M hydrochloric acid.

You are required to determine the **distribution ( partition ) coefficient** of ammonia between water and trichloromethane.

**Procedure:**

Add 10 $cm^3$ of **FA1** to 50 $cm^3$ of **FA2** in a conical flask. To this mixt add 50 $cm^3$ of distilled water. Shake the mixture vigorously for about 5 minu and then allow it to stand for about 10 minutes.

Carefully decant the upper (aqueous) layer into a boiling tube ( or small coni flask / beaker). Transfer the lower ( organic ) layer into another boiling tu ( or small flask / beaker ) and cover.

Read and record room temperature in the results.

(i) Pipette 10$cm^3$ of the aqueous layer into a clean conical flask.

Add 2 to 3 drops of phenolphthalein indicator and titrate with **FA3**.

Repeat the titration until you obtain consistent results. Record your results in table 1.

**Results:**

Room temperature ..... 30.0 ✓ ..... $^0C$.

**Table 1**

| | | | |
|---|---|---|---|
| Final burette reading ($cm^3$) | 32.50 ✓ | 42.50 ✓ | |
| Initial burette reading ($cm^3$) | 0.00 ✓ | 10.00 ✓ | |
| Volume of **FA3** used ($cm^3$) | 32.50 ✓ | 32.50 ✓ | |

Values used = 32.50, 32.50 $cm^3$ ✓

Average volume of **FA3** used ..... $\frac{32.50 + 32.50}{2}$ ✓ ..... $cm^3$

= 32.50 ✓ ±0.2 ±0.4 ±0.6

- Deduct ~~1 mk~~ ½ for every wrong subtraction ~~up to 1½ mks~~
- Values recorded to no decimal place award only 1 mk for correct subtraction.
- Any value above 50 mls, deny ½ mk and deny for subtraction.
- Deduct ½ mk for ~~every~~ table recorded to 1 decimal place up to 1½ mks
- Taking best readings which differ by ±0.1, award ½ mk
- Expression for average vol. award ½ mk

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(ii) Pipette 10cm$^3$ of the organic layer into a clean conical flask. Add 2 to 3 drops of phenolphthalein and titrate it with **FA4**. Repeat the titration until you obtain consistent results.

Record your results in table 2.

**Table 2**

| | | | |
|---|---|---|---|
| Final burette reading (cm$^3$) | 5.50 ✓ | 11.50 ✓ | |
| Initial burette reading (cm$^3$) | 0.00 ✓ | 6.00 ✓ | |
| Volume of **FA4** used (cm$^3$) | 5.50 ✓ | 5.50 ✓ | |

(3)

Values used = 5.50, 5.50 cm$^3$ ✓ (½)

Average volume of **FA4** used $\frac{5.50+5.50}{2}$ ✓ cm$^3$. (½)

= 5.50 cm$^3$ ✓✓ ±0.2 (1½) ±0.4 (1) ±0.6 (½)

← Same as in table 1

**Questions:**

(a) Calculate the molar concentration of ammonia in the aqueous layer.

1000 cm$^3$ of FA3 Contain 0.5 moles

32.50 cm$^3$ of FA3 Contain $\frac{0.5 \times 32.50}{1000}$ moles ✓ (01)

= $1.625 \times 10^{-3}$ moles

Equation:

$NH_4OH_{(aq)} + HCl_{(aq)} \longrightarrow NH_4Cl_{(aq)} + H_2O_{(l)}$ ✓ (½)

Accept: $NH_{3(aq)} + HCl_{(aq)} \longrightarrow NH_4Cl_{(aq)}$

OR: $OH^-_{(aq)} + H^+_{(aq)} \longrightarrow H_2O_{(l)}$

Reaction mole ratio $NH_{3(aq)} : HCl_{(aq)} = 1:1$ ✓ (½)

∴ No of moles of FA1 in 10cm$^3$ = $1.625 \times 10^{-3}$ moles ✓ (1)

10 cm$^3$ of FA1 Contain $1.625 \times 10^{-3}$ moles (1)

∴ 1000cm$^3$ of FA1 Contain $\frac{1.625 \times 10^{-3} \times 1000}{10}$ ✓

= 1.625 (1)

∴ Molarity = 1.625 Mol dm$^{-3}$ ✓

Turn Over

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(b) Calculate the molar concentration of ammonia in the organic layer

Molarity of FA1

100cm³ of FA4

5.0cm³ of FA4 contain $\frac{0.5 \times 5.0}{100}$

= 0.0275 M

No of moles of FA1 in 10cm³ = 0.00275 since

reaction ratio of $NH_{3(aq)}$ : HCl = 1 : 1

10cm³ of FA1 contain 0.00275 moles

1000cm³ of FA1 contain $\frac{0.00275 \times 1000}{10}$ = 0.0

∴ Molarity of FA1 = 0.0275

(c) Determine the value of the **distribution coefficient** of ammonia between water and trichloromethane at the temperature you have recorded.

Distribution Coefficient = $\frac{\text{Concentration of ammonia in}}{\text{Concentration of ammonia in}}$

Hence $K_D = \frac{1.625}{0.0275}$

= 59.09

$K_D$ = 59.09

Accept $K_D = \frac{[NH_{3(aq)}] \text{ in water}}{[NH_{3(aq)}] \text{ in } CHCl_3}$

Reject ( ) to mean square brackets.

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You are provided with substance **Y** which contains **two** cations and **two** anions. You are required to carry out the following tests on **Y** to identify the cations and anions in it. Identify any gases evolved.

Record your observations and deductions in the table below.

| TESTS | OBSERVATIONS | DEDUCTIONS |
|---|---|---|
| (a) Heat strongly **one** spatula endful of **Y** in a dry test tube. | White powder turned yellow (hot), white (cold). Colourless condensate/liquid which turns anhydrous Copper(II) Sulphate blue. Colourless gas turning blue litmus red and lime water milky. Yellow residue turned white on cooling. | Transition metal ions absent/or non transition metal ions or $Mg^{2+}$, $Ca^{2+}$, $Pb^{2+}$, $Zn^{2+}$. Water of Crystallisation : hydrate. Carbon dioxide gas : $CO_3^{2-}$, $HCO_3^-$, $C_2O_4^{2-}$ $ZnO$ formed : $Zn^{2+}$ Max 4½ |
| (b) To **one** spatula endful of **Y** in a test tube, add 2 to 3 drops of concentrated sulphuric acid. | Effervescence or bubbles/misty fumes with a choking smell turned wet blue litmus red, formed dense white fumes with ammonia gas. | Hydrogen Chloride gas. Acidic gas probably $Cl^-$ present 3½ |
| (c) To **two** spatula endfuls of **Y**, add about 5cm³ of water. Shake vigorously and filter. Keep both **residue** and **filtrate**. | Partly dissolves to form a colourless filtrate and white residue. Reject: Clear solution, white ppt, white solid | Transition metal ions absent or Non-transition metal ions present. Accept a list of non-transition metal ions eg $Mg^{2+}$, $Ca^{2+}$, $Al^{3+}$, $Zn^{2+}$, $Pb^{2+}$ etc 1½ |

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*Table continues...*

| TESTS | OBSERVATIONS | DEDUCTIONS |
|---|---|---|
| (d) Divide the filtrate into **six** portions.<br>(i) To the **first** portion of the filtrate, add dilute sodium hydroxide solution dropwise until in excess. | White precipitate insoluble in excess | $Mg^{2+}$, $Ca^{2+}$, $Ba^{2+}$ suspected<br>Am |
| (ii) To the **second** portion of the filtrate, add aqueous ammonia dropwise until in excess. | White precipitate insoluble in excess | $Mg^{2+}$, $Ba^{2+}$ suspected.<br>reject $Ca^{2+}$ bcs it shows no observ change. |
| (iii) To the **third** portion of the filtrate, add a spatula endful of solid ammonium chloride, followed by 3 to 4 drops of disodium hydrogen phosphate solution and then ammonia solution dropwise until in excess. | White precipitate insoluble in excess ammonia<br>Insoluble must be mentioned | $Mg^{2+}$, $Ba^{2+}$ Suspected. |
| (iv) To the **fourth** portion of the filtrate, add 2 to 3 drops of potassium chromate(VI) solution followed by 2 to 3 drops of dilute sodium hydroxide solution | Yellow precipitate insoluble in excess alkali<br>Reject: orange ppt | $Ba^{2+}$ Confirmed<br>if insoluble is mis deny mark for $Ba^{2+}$ |

reject iddi AgN



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Table Continues...

| TESTS | OBSERVATIONS | DEDUCTIONS |
|---|---|---|
| (v) To the **fifth** portion of the filtrate, add 2 to 3 drops of lead(II) nitrate solution, followed by dilute nitric acid. | White precipitate insoluble in the acid | $SO_4^{2-}$, $Cl^-$ suspected. (2) |
| (vi) Use the **sixth** portion of the filtrate to carry out a test of your own choice to confirm one of the anions in **Y**<br>Add Silver nitrate solution followed by dilute nitric acid<br>~~OR: Add $AgNO_3(aq)$ and warm followed by dilute nitric acid and then aqueous ammonia~~ | OR Add dil HNO3 followed by dilute AgNO3 and white ppt<br>White precipitate insoluble in the acid<br>~~White precipitate soluble in nitric acid but soluble in aqueous ammonia~~ (forming and disappears on adding) | $Cl^-$<br>$Cl^-$ confirmed (2) |
| (e) Wash the residue with a little water. Transfer the residue into a test tube and dissolve in dilute nitric acid. Divide the solution into three portions. | Effervescence, Colourless gas which turned lime water milky and ~~solution turned~~ A Colourless solution formed. | Carbon dioxide gas<br>∴ $CO_3^{2-}$ (2)<br>Reject $HCO_3^-$ or $C_2O_4^{2-}$<br>→ $Ba^{2+}$, $Mg^{2+}$, $Al^{3+}$, $Zn^{2+}$, $Ca^{2+}$ |

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*Table Continues....*

| TESTS | OBSERVATIONS | DEDUCTIONS |
|---|---|---|
| (i) To the **first** portion of the solution, add dilute sodium hydroxide solution dropwise until in excess. | White precipitate soluble in excess to form a colourless solution | $Zn^{2+}$, $Pb^{2+}$, $Al^{3+}$ suspected |
| (ii) To the **second** portion of the solution, add aqueous ammonia dropwise until in excess. | White precipitate soluble in excess to form a colourless solution | $Zn^{2+}$ suspected |
| (iii) Use the **third** portion of the solution to carry out a test of your own choice to confirm one of the cations in the solution. Add solid ammonium chloride followed by disodium hydrogen phosphate and aqueous ammonia. Order of addition of reagents matters | White precipitate insoluble in aqueous ammonia | $Zn^{2+}$ Confirmed |

(f) Identify:

(i) the cations in **Y**. $Ba^{2+}$, $Zn^{2+}$

(ii) the anions in **Y** $Cl^-$, $CO_3^{2-}$

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3. You are provided with an organic substance Z. You are required to determine the nature of Z.

Carry out the following tests on Z and record your observations and deductions in the table below.

| TESTS | OBSERVATIONS | DEDUCTIONS |
|---|---|---|
| (a) Burn a small amount of Z on a crucible lid or spatula end. | Colourless liquid burns with a yellow non-sooty flame<br>Reject: orange flame, non-luminous flame | Aliphatic Saturated Compound (or with low C:H)<br>Accept: low Carbon Content for C:H)<br>Reject: low MM to mean low C:H |
| (b) To about 1 $cm^3$ of Z, add about 1 $cm^3$ of dilute sodium hydroxide solution | No observable Change<br>OR. Readily miscible /soluble ~~in water~~ to form a colourless solution. | Probably Carboxylic acid, ketone, aldehyde, alcohol |
| (c) To about 1 $cm^3$ of Z, add 2to 3 drops of neutral iron(III) chloride solution and warm.<br><br>Accept No brown ppt<br>∴ $CH_3COO^-$ absent | No Observable Change<br>- No violet/purple colouration<br>- Accept the brown colour of neutral Iron(III) Chloride remains/persists<br>- or Z acquires brown colour of Iron(III) Chloride<br>- Reject: Yellow/brown solution formed<br>- Reject orange solution to retain the colour of $FeCl_3$ | Phenol or $CH_3COO^-$ absent |

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| TESTS | OBSERVATIONS | DEDUCTIONS |
|---|---|---|
| (d) To about 1 $cm^3$ of Z, add about 1 $cm^3$ of water. Shake and allow to stand. Test the resultant solution with litmus paper and divide the solution into two portions. | Miscible [illegible] water to form a Colourless solution that turns blue litmus red. Reject: alcohol solution | Carboxylic acid present. Acid [illegible] of homologous |
| (i) To the first portion of the solution, add 1$cm^3$ of sodium hydrogen carbonate solution. | Effervescence; Colourless gas that turned lime water milky and blue litmus red Colourless solution remained | Carboxylic acid Confirmed |
| (ii) To the second portion of the solution, add 2 to 3 drops of 2,4 dinitrophenyl hydrazine solution ( Brady's reagent ). | Yellow/orange precipitate | Methanoic (HCOOH) acid Confirmed or $H-\overset{O}{\overset{\|\|}{C}}-$ |
| (e) To about 0.5 $cm^3$ of Z, add about 1$cm^3$ of Tollen's reagent, warm and allow the mixture to stand. | Immediate Cloudness followed by a silver mirror on warming Reject: grey precipitate Reject: black ppt, white ppt | Methanoic acid Confirmed. Reject Carboxylic acid |



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(f) From your results above, deduce the nature of compound **Z**. 2

Saturated aliphatic monobasic acid / Methanoic acid

1.5

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Name .....

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Centre / Index No. P525/3/020

P525 / 3
CHEMISTRY
Paper 3
Nov. / Dec. 2006
3¼ hours

# UGANDA NATIONAL EXAMINATIONS BOARD

## Uganda Advanced Certificate of Education

CHEMISTRY

( PRACTICAL TEST )

**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, slide rules and silent non-programmable calculators may be used.*

*Reference books ( i.e. text books. 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 the apparatus and chemicals that they may need.*

| For Examiner's Use Only | | | |
|---|---|---|---|
| Q.1 | Q.2 | Q.3 | Total |
| 25 | 28 | 16 | |
| | | | |

**Turn Over**

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1. You are provided with the following:

**FA1**, which is approximately a **1.0 M sodium** hydroxide solution.

**FA2**, which is a 1.0 M hydrochloric acid.

**FA3**, which is a 0.02 M hydrochloric acid.

**Q**, which is an acidic solid.

You are required to determine the percentage of the acid in **Q**.

**Procedure A:**

Pipette 25.0 (or 20.0) $cm^3$ of **FA1** into a conical flask and titrate it with **FA2** using phenolphthalein indicator. Repeat the titration until you get consistent results.

Record your results in **Table A** below.

**Results:**

Volume of pipette used ....20.00 ✓.... $cm^3$. (½)

**Table A**

| | | | |
|---|---|---|---|
| Final burette reading ($cm^3$) | 18.30 ✓ | 33.90 ✓ | |
| Initial burette reading ($cm^3$) | 2.70 ✓ | 18.30 ✓ | |
| Volume of **FA2** used ($cm^3$) | 15.60 ✓ | 15.60 ✓ | |

(3)

Average volume of **FA2** used ..... $cm^3$.

Volumes of FA2 used for calculating the average titre 15.60, 15.60 ✓ (½)

Average titre value 15.60 ± 0.1 ✓✓ (2½) (2)
(for 20.00 cm³) (or 19.50 for 25.00 cm³ pipette)

± 0.2 ✓ (2) (1½)

± 0.3 ✓ (1½) (1)

± 0.4 ✓ (1) (½)

± 0.5 ✓ (½)

> 0.5 = (0)

- For each 1 dcp deny ½ mk.
- For no dcp award zero
- Deny ½ mark for each wrong subtraction up to maximum of 1 mk
- 3 marks for table filled to 2 dpl and correct subtraction
- 1½ for table filled to 1 dcp & 2 dcpl

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Calculate the molar concentration of sodium hydroxide in **FA1**.

Moles of HCl in FA2 $= \frac{1.0 \times 15.60}{1000}$ (1)

Concentration of NaOH in FA1 $= \frac{1.0 \times 15.60 \times 1000}{1000 \times 20}$ (1)

$= 0.78M$ (½)

(Deny the last ½ mark if was outside the accuracy range)

**Procedure B:**

Weigh accurately 1.5 g of **Q** and transfer it to a conical flask containing about 25 $cm^3$ of distilled water. Add 25 $cm^3$ of **FA1** and boil the mixture gently for about 15 minutes ( **add more water during the boiling to maintain the volume nearly constant if necessary**.)

Cool and transfer the mixture into a 250 $cm^3$ volumetric flask. Dilute with distilled water to the mark. Label the solution **FA4**.

Pipette 25.0 ( or 20.0) $cm^3$ of **FA4** into a conical flask and titrate with **FA3**, using phenolphthalein indicator.

Repeat the titration until you obtain consistent results. Record your results in table **B** below.

**Results:**

Volume of pipette used 20.00 $cm^3$ (Accept for 1dcp & no dcpl) (½)

**Table B**

| | | | |
|---|---|---|---|
| Final burette reading ($cm^3$) | 12.50 | 25.80 | 39.10 |
| Initial burette reading ($cm^3$) | 0.00 | 12.50 | 25.80 |
| Volume of **FA3** used ($cm^3$) | 12.50 | 13.30 | 13.30 |

(3)

(or 16.63 for 25.0 $cm^3$)

Average titre value $= 13.30 \pm 0.20$ (2½)

$\pm 0.40$ (1) (2)

$\pm 0.60$ (2) (1½)

$\pm 0.80$ (1)

$\pm 1.0$

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Volume of **FA3** used for calculation of the average titre values.....

13.30, 13.30 $cm^3$ ..... $cm^3$.

Average volume of **FA3** used 13.30 ± 0.20 ..... $cm^3$.
± 0.40
± 0.60
± 0.50
± 1.00

**Questions:**

(a) Calculate:

(i) the number of moles of excess sodium hydroxide that did not react with the acid in **Q**.

Moles of HCl in 13.30 $cm^3$ $= \frac{13.3 \times 0.02}{1000}$

Moles of NaOH in 20 $cm^3$ of FA4

$= \frac{13.30 \times 0.02}{1000}$

∴ In 250 $cm^3$ $= \frac{250 \times 13.30 \times 0.02}{20 \quad 1000}$

∴ Moles of excess NaOH = $3.325 \times 10^{-3}$ moles

(Deny last ½ mark if was outside accurate range)

(ii) the number of moles of sodium hydroxide that reacted with the acid in **Q**.

No. of moles of NaOH used = $\frac{0.78 \times 25}{1000}$

$= 1.95 \times 10^{-2}$ moles

(Deny ½ mark above, if was outside accurate range)

∴ No. of moles of NaOH that reacted with the acid in Q = $1.95 \times 10^{-2} - 3.325 \times 10^{-3}$

$= 1.62 \times 10^{-2}$ moles

To get this, must have original moles − excess moles in 250 $cm^3$)

(a) **Determine:**

(i) the mass of the acid in **Q** that reacted with sodium hydroxide ( Relative molecular mass of the acid in **Q** is 126, 1 mole of the acid in **Q** reacts with 2 moles of sodium hydroxide).

No. of moles of acid in Q

$= \frac{1}{2} \times 1.62 \times 10^{-2}$ (1)

$= 8.1 \times 10^{-3}$ moles (½)

Mass of acid in Q $= 8.1 \times 10^{-3} \times 126$ (1)

$= 1.02$ g (½)

(ii) the percentage of the acid in **Q**.

% of acid in Q $= \frac{1.02 \times 100}{1.5}$ (1)

$= 68.0\%$ (½)

(Deny last ½ mark if % was outside accuracy range)

T $\boxed{2.5}$



Turn Over

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2. You are provided with substance **R**, which contains **two** cations and two anions. You are required to identify the cations and anions in **R**.

Carry out the following tests on **R** and record your observations and deductions in the table below. Identify any gases evolved.

| TESTS | OBSERVATIONS | DEDUCTIONS |
|---|---|---|
| (a) Heat **one** spatula end-ful of **R** in a dry test tube. | Green solid turned black on heating. Colourless condensate turned anhydrous copper (II) sulphate blue. Misty vapour turned blue litmus red and lime water milky. Black residue | Transition metal ions probably $Ni^{2+}$, $Cu^{2+}$, $Fe^{2+}$ (deduct ½ mark for water of crystallisation) ∴ hydrate. $CO_2$ gas ∴ $CO_3^{2-}$ suspected ∴ CuO, NiO, FeO. Reject $CrO_3$ |
| (b) To **one** spatula end-ful of **R** in a dry test tube, add 2–3 drops of concentrated sulphuric acid and warm gently. | Effervescence; colourless gas turned lime water milky. Gas has a sharp vinegar smell. Accept acetic acid smell. Deny ½ mark in absence of vinegar smell | Gas is $CO_2$; (test and lime water must be carried) ∴ $CO_3^{2-}$. Probably ethanoic acid vapour ∴ $CH_3COO^-$ suspected |
| (c) Put **two** spatula end-fulls of **R**, in a test tube. Add about 5 $cm^3$ of water, shake well and filter. Keep both filtrate and residue. | Residue was green. Filtrate was green | $Fe^{2+}$, $Ni^{2+}$, $Cu^{2+}$, $Cr^{3+}$ suspected in residue and filtrate (for each wrong deduct ½ mk) |



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| TESTS | OBSERVATIONS | DEDUCTIONS |
|---|---|---|
| (d) Divide the filtrate into **four** portions. | | |
| (i) To the **first** portion of the filtrate, add 5 drops of neutral iron(III) chloride solution and heat gently to boiling. | ~~Green precipitate~~ Reddish brown solution Accept yellow brown Reddish brown ppt precipitate on boiling Accept brown ppt Deny for red ppt | $CH_3COO^-$ Confirmed |
| (ii) To the **second** portion of the filtrate, add dilute sodium hydroxide solution drop-wise until in excess. Heat the mixture. | Green precipitate formed insoluble in excess. No observable change on heating | Probably $Ni^{2+}$ For each wrong ion, deny ½ Reject $Fe^{2+}$ because $Fe(OH)_2$ changes. |
| (iii) To the **third** portion of the filtrate, add ammonia solution drop-wise until in excess. | Green ppt dissolved in excess forming a pale-blue solution Reject purple | $Ni^{2+}$ |
| (iv) Use the **fourth** portion of the filtrate, to carry out a test of your own choice to confirm one of the cations in **R**. Add ammonia solution (until alkaline), followed by 2 drops of dimethyl glyoxime solution (Deny ½ mark if ammonia solution is not mentioned) | Red precipitate (Accept pink ppt) Reject pink ppt | $Ni^{2+}$ Confirmed |



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*Table Continues...*

| TESTS | OBSERVATIONS | DEDUCTIONS |
|---|---|---|
| (e) Wash the residue with a little water. Transfer into a test tube and dissolve in dilute hydrochloric acid. Divide the solution into **three** portions. | Dissolved with effervescence. Colourless gas that turned blue litmus pink and lime water milky. A green soln was formed | gas is $CO_2$ (g) ✓ $CO_3^{2-}$ present ✓ Reject $HCO_3^-$ ✓ $Fe^{2+}$, $Cu^{2+}$, $Ni^{2+}$ suspected ✓ |
| (i) To the **first** portion of the solution, add dilute sodium hydroxide solution drop-wise until in excess and heat the mixture. | Blue precipitate ✓ insoluble in excess ✓ turned black on heating ✓ | $Cu^{2+}$ ✓ ✓ ✓ CuO |
| (ii) To the **second** portion of the solution, add ammonia solution drop-wise until in excess. | Blue precipitate ✓ dissolved in excess to form a deep-blue solution ✓ Deduct ½ mark if deep is not mentioned | $Cu^{2+}$ present ✓ $[Cu(NH_3)_4]^{2+}$ formed ✓ |
| (iii) Use the **third** portion of the solution to carry out a test of your own choice to confirm the cation in the residue. Add 3 drops of potassium hexacyanoferrate (II) ($K_4[Fe(CN)_6]$) OR Add potassium iodide solution OR KI followed by $Na_2S_2O_3$ Reject ammonia soln | Chocolate brown / Maroon / dark-brown ppt ✓ white ppt ✓ white ppt and brown solution | $Cu^{2+}$ confirmed ✓ |

(3) (2) (1½) (1½)



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(b) Determine:

(i) the mass of the acid in **Q** that reacted with sodium hydroxide ( Relative molecular mass of the acid in **Q** is 126, 1 mole of the acid in **Q** reacts with 2 moles of sodium hydroxide).

No. of moles of acid in Q

$= \frac{1}{2} \times 1.62 \times 10^{-2}$ (1)

$= 8.1 \times 10^{-3}$ moles (½)

Mass of acid in Q $= 8.1 \times 10^{-3} \times 126$ (1)

$= 1.02$ g (½)

(ii) the percentage of the acid in **Q**.

% of acid in Q $= \frac{1.02 \times 100}{1.5}$ (1)

$= 68.0\%$ (½)

(Deny last ½ mark if % was outside accuracy range.)

T 2.5

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2. You are provided with substance **R**, which contains **two** cations and **two** anions. You are required to identify the cations and anions in **R**.

Carry out the following tests on **R** and record your observations and deductions in the table below. Identify any gases evolved.

| TESTS | OBSERVATIONS | DEDUCTIONS |
|---|---|---|
| (a) Heat **one** spatula end-ful of **R** in a dry test tube. | Green solid turned black on heating. Colourless condensate turned anhydrous copper (II) sulphate blue. Misty vapour turned blue litmus red and lime water milky. Black residue | Transition metal ions probably $Ni^{2+}$, $Cu^{2+}$, $Fe^{2+}$ or $Cr^{3+}$ (deduct ½ mark for wrong ion) Water of crystallisation ∴ hydrate. $CO_2$ gas ∴ $CO_3^{2-}$ suspected ∴ CuO, NiO, FeO Reject $CrO_3$ |
| (b) To **one** spatula end-ful of **R** in a dry test tube, add 2–3 drops of concentrated sulphuric acid and warm gently. | Effervescence; colourless gas turned lime water milky. Gas has a sharp vinegar smell. Accept acetic acid smell. Deny ½ mark in absence of vinegar smell. | Gas is $CO_2$; (test with lime water must be carried out) ∴ $CO_3^{2-}$ Probably ethanoic acid vapour ∴ $CH_3COO^-$ suspected |
| (c) Put **two** spatula end-fulls of **R**, in a test tube. Add about 5 $cm^3$ of water, shake well and filter. Keep both filtrate and residue. | Residue was green. Filtrate was green | $Fe^{2+}$, $Ni^{2+}$, $Cu^{2+}$, $Cr^{3+}$ suspected in residue and filtrate (for each wrong ion deduct ½ mk) |



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(f) Identify:

(i) the cations in **R**. $Ni^{2+}$ ..... $Cu^{2+}$ (if only confirmed in (e)(ii)) ..... (2)

(ii) the anions in **R** $CH_3COO^-$ ..... $CO_3^{2-}$ ..... (Confirmed in (i)) (Confirmed in (e)(ii))

28

3. You are provided with an organic substance **W**. You are required to identify the nature of **W**.

Carry out the following tests on **W** and record your observations and deductions in the table below.

| TESTS | OBSERVATIONS | DEDUCTIONS |
|---|---|---|
| (a) Burn a small amount of **W** on a crucible lid or spatula end. | Colourless liquid that burns with a blue non-sooty flame. | Saturated Aliphatic Compd with low molecular mass low (or with C:H ratio or saturated aliphatic Compd). (2) |
| (b) To 5 drops of **W**, add about 1 $cm^3$ of water and shake. Test the mixture with litmus. | Dissolved to form a colourless soln. The solution has no effect on litmus (Reject neutral to litmus) | Neutral, polar compd with low molecular mass probably alkanol, or Carbonyl compound (2) Accept ester, |
| (c) To 5 drops of **W**, add 2 – 3 drops of acidified potassium manganate (VII) solution and warm. | purple solution turns to colourless. Give only ½ mk for decolorised or discharged | W is a reducing agent probably 1°, 2° alkanol or alkanal. Accept for oxidation. Manganese(VII) ion have been reduced to Manganese(II) ion (3½) |



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*Table Continues...*

| TESTS | OBSERVATIONS | DEDUCTIONS |
|---|---|---|
| (d) To 5 drops of **W**, add 1 $cm^3$ of iodine solution, followed by dilute sodium hydroxide drop-wise until the mixture is pale yellow. Warm, then cool under running tap. | Pale-yellow precipitate | Alkanol of type $CH_3-CH$ or ethanol present; yellow ppt is $CHI_3$ |
| (e) To 5 drops of **W**, add 2 – 3 drops of Brady's reagent. OR Add conc. $H_2SO_4$ and heat (½) | No observable change. Reject yellow soln formed. Colourless gas that turns acidified $K_2Cr_2O_7$ from purple to colourless | Carbonyl compound absent |
| (f) Carry out a test of your own choice to confirm the functional group in **W**. To a few drops of W, add 3 drops of ethanoic acid followed by 2 drops of conc. sulphuric acid and warm. Add PCl₅ or sodium metal | Colourless soln with pleasant fruity (sweet) smell. White fumes of HCl which form dense white fumes with ammonia. Effervescence of colourless gas which burns with a pop sound | Ester formed. Alcohol confirmed (2) |

(g) Comment on the nature of **W**.

W is aliphatic primary or secondary alcohol of the type $CH_3-CH$ (OH) ✓

Give if (e) fails

10

END

Total 69

P525 / 3
CHEMISTRY
PRACTICAL
Paper 3
Nov. / Dec. 2005
3 hours 15 minutes

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# UGANDA NATIONAL EXAMINATIONS BOARD

## Uganda Advanced Certificate of Education

## CHEMISTRY

## PRACTICAL TEST

**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, slide rules and non-programmable calculators may be used.*

*Reference books ( i.e. text books, 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 the apparatus and chemicals that they may need.*

Where necessary, use ( Na = 23 ; Cl = 35.5 ; O = 16 ) Fe = 56, S = 32, H = 1, C = 12

| For Examiner's Use Only | | | |
|---|---|---|---|
| Q.1 | Q.2 | Q.3 | Total |
| 30 | 20 | 20 | 70 |
| | | | |

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Turn Over

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1. You are provided with the following:

**FA1** which is approximately 0.02 M potassium manganate(VII) solution ;

**FA2** which is a solution containing 6.6 g of sodium ethanedioate, $Na_2C_2O_4$ per litre ;

**FA3** which is a 2M sulphuric acid;

Solid **T**, which is hydrated iron(II) sulphate.

You are required to determine the:

(i) concentration of potassium manganate(VII) in **FA1**.

(ii) number of moles of water of crystallisation in **T**.

Potassium manganate(VII) reacts with sodium ethanedioate in the ratio of 2:5

**Procedure:**

(a) Pipette 25.0 (or 20.0) $cm^3$ of **FA2** into a conical flask. Add an equal volume of **FA3** and heat the mixture to about 60 °C.

Titrate the hot mixture with **FA1** until a permanent faint pink colouration is obtained.

Repeat the titration until you obtain consistent results. Record your results in the table below.

*Results:*

Volume of pipette used .....25.00 ✓.....$cm^3$.

| | | | | |
|---|---|---|---|---|
| Final burette reading ($cm^3$) | 21.90 | 43.90 | 27.00 ✓ | 49.00 ✓ |
| Initial burette reading ($cm^3$) | 0.00 | 21.90 | 5.00 ✓ | 27.00 ✓ |
| Volume of **FA1** used ($cm^3$) | 21.90 | 22.00 | 22.00 ✓ | 22.00 ✓ |

Average volume of **FA1** used ..... (the values 22.00cm³, 22.00cm³) ..... cm³.

$\frac{22.0+22.0}{2} = 22.00cm^3$ ✓

**Questions:**

(a) (i) Write an equation for the reaction between potassium manganate(VII) and sodium ethanedioate.

$2MnO_4^-(aq) + 16H^+(aq) + 5C_2O_4^{2-}(aq) \rightarrow 2Mn^{2+}(aq) + 8H_2O(l) + 10$ ✓

(ii) Ahead. RFM of $Na_2C_2O_4 = (23\times2)+(12\times2)+(16\times4)$ ✓

$= 134$ ✓

Moles of $Na_2C_2O_4$ in 6.60g $= \frac{6.6}{134}$ ✓ $= 0.0493$

$= 0.05$ Mol

1000cm³ of $C_2O_4^{2-}$ soln contain 0.05 moles

25cm³ of $C_2O_4^{2-}$ soln contain $\frac{0.05\times25}{}$

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Ratio $MnO_4^- : C_2O_4^{2-}$ 2:5 ✓ (½)

(ii) Calculate the molar concentration of potassium manganate(VII) in **FA1**.

No of moles in 22.0cm³ = $\frac{2}{5} \times \frac{0.05 \times 25}{1000}$ ✓ (1)

∴ In 1000cm³ there are $\frac{2}{5} \times \frac{0.05 \times 25 \times 1000}{1000}$ ✓ (1)

$\frac{22}{}$

= 0.0227 moles ≈ 0.023

∴ Molarity of FA1 = 0.023 Mol dm⁻³ ✓ (1)

(b) Weigh out accurately about 8.8g of **T** and dissolve it in about 50cm³ of **FA3**. Transfer the solution quantitatively to a 250cm³ volumetric flask and make it up to the mark with distilled water. Label the solution as **FA4**.
Pipette 25.0 (or 20.0)cm³ of **FA4** into a conical flask. Add the same volume of **FA3** and titrate the mixture with **FA1**.
Repeat the titration until you obtain consistent titre values.

*Results*:

Mass of **T** and **bottle** ....27.30✓.... g ✓

Mass of **bottle** ....18.50✓.... g ✓

Mass of **T** ....8.80✓.... g ✓ (1½)

Volume of pipette used ....25.00✓.... cm³.

| | | | | |
|---|---|---|---|---|
| Final burette reading (cm³) | 27.60 | 37.00 | 42.50 | |
| Initial burette reading (cm³) | 0.00 | 9.50 | 15.00 | |
| Volume of **FA1** used (cm³) | 27.60 | 27.50 | 27.50 | |

(3)

titre values = 27.50, 27.50

Average volume of **FA1** used .... cm³.

$\frac{27.5 + 27.5}{2}$

= 27.50cm³ ✓ (2)

18.5
4.4
22.9



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**Questions:**

(a) Calculate the molar concentration of iron(II) sulphate in **FA4**.

1000 cm³ of FA4 solution contain 0.023 mole

27.5 cm³ of FA1 contain $\frac{0.023 \times 27.5}{1000}$ mole

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

Reaction ratio $Fe^{2+} : MnO_4^- = 5 : 1$

No of moles in 25 cm³ $= \frac{5 \times 27.5 \times 0.023}{1000}$ mole

∴ In 1000 cm³ there are $\frac{5 \times 0.023 \times 27.5 \times 1000}{1000 \times 25} = 0.$

Molarity of FA4 = 0.127 mole

(b) Determine the number of molecules of water of crystallisation in T.

250 cm³ of T dissolved 8.8 g

∴ 1000 cm³ of T dissolved $\frac{8.8 \times 1000}{250}$

$= 35.2$ g $t^{-1}$ (1)

R.F.M of $FeSO_4 \cdot xH_2O = \frac{35.2}{0.127}$ (1)

$= 277$

$FeSO_4 \cdot xH_2O = 277$

$56 + 32 + (16 \times 4) + 18x = 277$

$152 + 18x = 277$ (1)

$18x = 277 - 152$ (1)

$18x = 125$

$x = \frac{125}{18}$

$x = 6.9427$ (1)

Formula is $FeSO_4 \cdot 7H_2O$.

30



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$Al_2(SO_4)_3$, $FeSO_4 \cdot 7H_2O$, $Na_2S_2O_3 \cdot 2H_2O$

You are provided with substance **Z**, which contains two cations and two anions.

You are required to identify the cations and the anions in **Z**. Carry out the following tests on **Z** and record your observations and deductions in the table below. Identify any gas(es) evolved.

| TESTS | OBSERVATIONS | DEDUCTIONS | |
|---|---|---|---|
| (a) Heat **one** spatula endful of **Z** in a dry test tube. | Colourless liquid that turned blue anhydrous Copper(II) sulphate blue. Colourless gas, turned blue litmus red and acidified $K_2Cr_2O_7$ green | water of crystallisation ∴ a hydrated salt. $SO_2$ gas ∴ $SO_3^{2-}$, $SO_4^{2-}$ suspected | 6½ |
| (b) Dissolve **three** spatula-endfuls of **Z** in water. Divide the solution into four parts. | White fumes, Yellow sublimate, Reddish-brown residue | $Fe_2O_3$ | |
| (i) To the **first** part of the solution, add dilute hydrochloric acid. | No observable change | $Pb^{2+}$, $Ag^+$, $Hg^{2+}$ absent. | 1 |
| (ii) To the **second** part of the solution, add iron (III) chloride. | No observable change | | ½ |
| (iii) To the **third** part of the solution, add barium nitrate solution. | White precipitate | $SO_4^{2-}$, $CO_3^{2-}$ or $SO_3^{2-}$ suspected. | 1½ |
| (iv) To the **fourth** part of the solution, add dilute sodium hydroxide solution drop-wise until in excess and filter. Keep both the filtrate and the residue. | Dirty green gelatinous precipitate persist in excess. White precipitate dissolves in excess | $Fe^{2+}$ suspected. $Al^{3+}$, $Zn^{2+}$, $Sn^{2+}$ suspected. | 3½ |



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| TESTS | OBSERVATIONS | DEDUCTIONS |
|---|---|---|
| (c) Acidify the filtrate with dilute hydrochloric acid and divide it into **three** portions.<br>(i) To the **first** portion of the acidified filtrate, add dilute sodium hydroxide solution drop-wise until in excess | No observable change. | $Al(OH)_4^-$, $Zn(OH)_4^{2-}$ formed. |
| (ii) To the **second** portion of the acidified filtrate, add dilute ammonia solution drop-wise until in excess. | No observable change. | $Al(OH)_4^-$, $Zn(OH)_4^{2-}$ formed. |
| (iii) To the **third** portion of the acidified filtrate, add 2 – 3 drops of potassium iodide. | No observable change | $Pb^{2+}$ absent. |
| (d) Wash the residue and dissolve it in dilute hydrochloric acid. Divide the resultant solution into **two** parts.<br>(i) To the **first** part of the resultant solution, add dilute sodium hydroxide solution until in excess. | Dirty green gelatinous precipitate insoluble in excess | $Fe^{2+}$ suspected |
| (ii) To the **second** part of the resultant solution, add dilute ammonia solution drop-wise until in excess. | Dirty green gelatinous precipitate insoluble in excess | $Fe^{2+}$ |

(f) Identify the ions in substance Z

(i) Cations $Fe^{2+}$, $Al^{3+}$

(ii) Anions $SO_4^{2-}$

(ii) Calculate the molar concentration of potassium manganate(VII) in **FA1**.

No of moles in 22.00cm³ = 2/5 × 0.05 × 25 / 1000

∴ In 1000cm³ there are 2/5 × 0.05 × 25 × 1000 / 1000 / 22

= 0.0227 moles ≈ 0.023

∴ Molarity of FA1 = 0.023 Moldm⁻³

(b) Weigh out accurately about 8.8g of **T** and dissolve it in about 50cm³ of **FA3**. Transfer the solution quantitatively to a 250cm³ volumetric flask and make it up to the mark with distilled water. Label the solution as **FA4**.

Pipette 25.0 (or 20.0 )cm³ of **FA4** into a conical flask. Add the same volume of **FA3** and titrate the mixture with **FA1**. Repeat the titration until you obtain consistent titre values.

*Results*:

Mass of **T** and **bottle** 27.30 g

Mass of **bottle** 18.50 g

Mass of **T** 8.80 g

Volume of pipette used 25.00 cm³.

| | | | | |
|---|---|---|---|---|
| Final burette reading (cm³) | 27.60 | 37.00 | 42.50 | |
| Initial burette reading (cm³) | 0.00 | 9.50 | 15.00 | |
| Volume of **FA1** used (cm³) | 27.60 | 27.50 | 27.50 | |

Titre values = 27.50, 27.50

Average volume of **FA1** used ..... cm³.

(27.5 + 27.5) / 2 = 27.50cm³

18.5
4.4
22.9



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**Questions:**

(a) Calculate the molar concentration of iron(II) sulphate in **FA4**.

1000 cm³ of FA4 solution contain 0.023 moles

27.5 cm³ of FA1 contain $\frac{0.023 \times 27.5}{1000}$ moles

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

Reaction ratio $Fe^{2+} : MnO_4^-$ = 5 : 1

No of moles in 25 cm³ = $\frac{5 \times 27.5 \times 0.023}{1000}$ moles

∴ In 1000 cm³ there are $\frac{5 \times 0.023 \times 27.5 \times 1000}{1000 \times 25}$

Molarity of FA4 = 0.127 mol

(b) Determine the number of molecules of water of crystallisation in T.

250 cm³ of T dissolved 8.8 g

1000 cm³ of T dissolved $\frac{8.8 \times 1000}{250}$

= 35.2 g l⁻¹

RFM of $FeSO_4 \cdot xH_2O$ = $\frac{35.2}{0.127}$

= 277

$FeSO_4 \cdot xH_2O$ = 277

56 + 32 + (16×4) + 18x = 277

152 + 18x = 277

18x = 277 − 152

18x = 125

x = $\frac{125}{18}$

x = 6.9437 ≈ 7

Formula is $FeSO_4 \cdot 7H_2O$.

30



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You are provided with substance **Z**, which contains two cations and two anions.

You are required to identify the cations and the anions in **Z**. Carry out the following tests on **Z** and record your observations and deductions in the table below. Identify any gas(es) evolved.

| TESTS | OBSERVATIONS | DEDUCTIONS | |
|---|---|---|---|
| (a) Heat **one** spatula endful of **Z** in a dry test tube. | Colourless liquid that turned blue anhydrous copper(II) sulphate blue. Colourless gas turned blue litmus red and acidified $K_2Cr_2O_7$ green. | Water of crystallisation ∴ A hydrated salt. $SO_2$ gas. ∴ $SO_3^{2-}$, $SO_4^{2-}$ suspected | 6½ |
| (b) Dissolve **three** spatula-endfuls of **Z** in water. Divide the solution into four parts. | White fumes. Yellow sublimate. Reddish-brown residue | $Fe_2O_3$ | |
| (i) To the **first** part of the solution, add dilute hydrochloric acid. | No observable change | $Pb^{2+}$, $Ag^+$, $Hg^{2+}$ absent. | 1 |
| (ii) To the **second** part of the solution, add iron (III) chloride. | No observable change. | | ½ |
| (iii) To the **third** part of the solution, add barium nitrate solution. | White precipitate | $SO_4^{2-}$, $CO_3^{2-}$ or $SO_3^{2-}$ suspected. | 1½ |
| (iv) To the **fourth** part of the solution, add dilute sodium hydroxide solution drop-wise until in excess and filter. Keep both the filtrate and the residue. | Dirty green gelatinous precipitate persists in excess. White precipitate dissolves in excess | $Fe^{2+}$ suspected. $Al^{3+}$, $Zn^{2+}$, $Sn^{2+}$ suspected. | 3½ |



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Continued ...

| TESTS | OBSERVATIONS | DEDUCTIONS |
|---|---|---|
| (c) Acidify the filtrate with dilute hydrochloric acid and divide it into **three** portions. (i) To the **first** portion of the acidified filtrate, add dilute sodium hydroxide solution drop-wise until in excess. | No observable change. | $Al(OH)_4^-$, $Zn(OH)_4^{2-}$ formed. |
| (ii) To the **second** portion of the acidified filtrate, add dilute ammonia solution drop-wise until in excess. | No observable Change. | $Al(OH)_4^-$, $Zn(OH)_4^{2-}$ formed. |
| (iii) To the **third** portion of the acidified filtrate, add 2 – 3 drops of potassium iodide. | No observable Change | $Pb^{2+}$ absent. |
| (d) Wash the residue and dissolve it in dilute hydrochloric acid. Divide the resultant solution into **two** parts. (i) To the **first** part of the resultant solution, add dilute sodium hydroxide solution until in excess. | Dirty green gelatinous precipitate insoluble in excess | $Fe^{2+}$ suspect |
| (ii) To the **second** part of the resultant solution, add dilute ammonia solution drop-wise until in excess. | Dirty green gelatinous precipitate insoluble in excess | $Fe^{2+}$ |

(f) Identify the ions in substance **Z**.

(i) Cations ..... $Fe^{2+}$, $Al^{3+}$

(ii) Anions ..... $SO_4^{2-}$

1

2



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You are provided with an organic substance, **K**. You are required to determine the nature of substance **K**.

Carry out the following tests on **K** and record your observations and deductions in the table below. Identify any gas(es) evolved.

| TESTS | OBSERVATIONS | DEDUCTIONS |
|---|---|---|
| (a) Burn a small amount of **K** on a spatula end or in a porcelain dish. | Colourless liquid that burns with a blue non-sooty flame | Aliphatic saturated compound with low molecular mass or with low |
| (b) Add 6 drops of **K** to about 3cm$^3$ of water, shake and allow to stand. Divide the solution into **three** parts: | Miscible with water/dissolves to form a colourless solution that has no effect on litmus. | Polar, neutral compound probably alcohol, aldehyde, ketone or ester |
| (i) To the **first** part of the solution, add 2 – 3 drops of sodium hydrogen carbonate solution. | Dissolves without effervescence | Carboxylic acid absent. |
| (ii) To the **second** part of the solution, add 2 – 3 drops of iron(III) chloride solution. | No observable change | ~~Carbonyl compound absent~~ Phenol absent/ & $CH_3COO^-$ absent |
| (iii) To the **third** part of the solution, add 2 – 3 drops of Brady's reagent. | No observable change /or no yellow ppt | Carbonyl compound absent. ~~x is a reducing agent~~ |
| (c) Add 2 – 3 drops of acidified potassium dichromate(VI) solution to 2cm$^3$ of **K** in a test tube and then heat. Divide the resultant Solution into **two** parts: | Solution turned from orange to green | Primary, secondary alcohol oxidised to carbonyl compound |

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*Continued ...*

| TESTS | OBSERVATIONS | DEDUCTIONS |
|---|---|---|
| (i) To the **first** part of the resultant solution, add Brady's reagent. | Orange / yellow precipitate | Carbonyl compound present Hence primary, secondary alcohol suspected |
| (ii) To the **second** part of the resultant solution, add Tollen's reagent and warm. | No Observable Change | Aldehyde absent. ∴ K is not a primary alcohol. |
| (d) To about 0.5 $cm^3$ of **K**, add about 4$cm^3$ of iodine solution followed by sodium hydroxide drop-wise until the colour of the iodine disappears. Heat and allow to stand. | Yellow precipitate | $CHI_3$ formed from an alcohol ∴ Secondary alcohol of the type: $R-\underset{OH}{C}-CH_3$ |
| (e) To about 1$cm^3$ of **K**, add about 5 drops of Lucas' reagent. | Cloudy solution formed within 5-10 minutes OR No immediate cloudy solution | Secondary alcohol present OR Not tertiary alcohol. |

(f) Comment on the nature of **K**.

K is a saturated aliphatic secondary alcohol with the structure: $R-\underset{OH}{C}-CH_3$

(2)

20

**END.**



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MARKING SCHEME

525/3
CTICAL
MISTRY
per 3
Dec. 2003
hours

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# UGANDA NATIONAL EXAMINATIONS BOARD

## Uganda Advanced Certificate of Education

CHEMISTRY

(PRINCIPAL SUBJECT)

PRACTICAL TEST

**Paper 3**

3 hours 15 minutes

**NSTRUCTIONS:**

*Answer* **all** *questions.*

*Record your answers on this question paper in the spaces provided.*

*Mathematical tables, slide rules and non-programmable calculators may be used.*

*Reference books (i.e Text books, 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 the apparatus and chemicals that they may need.*

*Where necessary, use (Na = 23; Cl 35.5; O = 16).*

**For Examiner's Use Only**

| Q1 | Q2 | Q3 | Total |
|---|---|---|---|
| | | | |
| | | | |

**Turn Over**

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1. You are provided with the following:

**FA1** which is a commercial bleach solution.

**FA2** which is a 0.1 M sodium thiosulphate solution.

10% potassium iodide solution.

2.0 M sulphuric acid.

You are required to determine the sodium hypochlorite content of the commercial bleaching agent.

Sodium hypochlorite reacts with potassium iodide according to the following equation:

$$OCl^-_{(aq)} + 2I^-_{(aq)} + 2H^+_{(aq)} \longrightarrow I_{2(aq)} + Cl^-_{(aq)} + H_2O_{(l)}.$$

The iodine liberated can be titrated with sodium thiosulphate solution.

**Procedure**

Pipette 15.0 $cm^3$ of **FA1** into a 250 $cm^3$ volumetric flask and dilute with water to the mark. Pipette 25$cm^3$ of the diluted **FA1** into a conical flask, add about 15 $cm^3$ of the 2M sulphuric acid and about 15$cm^3$ of the potassium iodide solution. Titrate the iodine liberated with **FA2** using starch indicator. Repeat the titration until you obtain consistent results. Record your results in the table below.

Volume of pipette used ~~25.00cm³~~ 25.00 ✓ $cm^3$

Burette reading

| | | | |
|---|---|---|---|
| Final burette reading ($cm^3$) | 11.60 | 23.20 ✓ | 34.60 ✓ |
| Initial burette reading ($cm^3$) | 0.00 | 11.60 ✓ | 23.10 ✓ |
| Volume of **FA2** used ($cm^3$) | 11.60 | 11.50 ✓ | 11.50 ✓ (3) |

Average volume of **FA2** used

Titre values to calculate average volume = 11.50, 11.50 (1)

$$\frac{11.50 + 11.50}{2} = 11.50cm^3$$

Reference to accuracy

±0.1 (2)
±0.2 (2)
±0.3 (1)
±0.4 (1)
±0.5 (1)
>±0.6 (0)



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ate the:

(a) number of moles of **FA2** used.

1000cm³ of FA2 solution contains 0·1 mole.

11·50cm³ of FA2 solution contains $\frac{0.1 \times 11.50}{1000}$

= 0·00115 moles

(02)

(b) concentration of sodium hypochlorite in the diluted **FA1** in moles/l.

$2S_2O_3^{2-}(aq) + I_2(aq) \longrightarrow S_4O_6^{2-}(aq) + 2I^-(aq)$

Molar ratio $S_2O_3^{2-} : I_2 = 2:1$

∴ Moles of $I_2$ liberated = $\frac{1}{2} \times 0.00115$

= 0·000575 moles

(08½)

1 mole of $I_2$ is liberated by 1 mole of $OCl^-$

∴ 0·000575 moles $I_2$ will be liberated by 0·000575 moles of $OCl^-$

∴ No of moles of $OCl^-$ in 25cm³ of FA1 = 0·000575 moles

25cm³ of NaOCl solution contain 0·000575 moles

∴ 1000cm³ of NaOCl solution contain $\frac{0.000575 \times 1000}{25}$

= 0·023 mol l⁻¹

(c) concentration of sodium hypochlorite in **FA1** in g/l.

[Na = 23, Cl = 35.5, O = 16]

25cm³ of diluted FA1 contained 0·000575 moles of $OCl^-$

250cm³ of FA1 contains $\frac{0.000575 \times 250}{25}$

= 0·00575 moles.

(N.B. When a soln is diluted no moles does not change
moles in 25cm³ = moles in 15cm³)

Thus 15·00cm³ of original FA1 contained 0·00575 moles of $OCl^-$

1000cm³ of FA1 contains $\frac{0.00575 \times 1000}{15.0}$

(08)

= 0·383 mol l⁻¹ of NaOCl

RFM of NaOCl = 23+16+35·5

= 74·5

1 mole of NaOCl weighs 74·5g.

0·383 moles of NaOCl weigh 74·5 × 0·383

= 28·53 g l⁻¹

(02)

Turn Over

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2. You are provided with a substance **Y** which contains two anions and two cations. You are required to identify the cations and the anions in **Y**. Carry out the following tests on Y and record your observations and deductions in the table below. Identify any gases evolved.

| TEST | OBSERVATIONS | DEDUCTIONS |
|---|---|---|
| (a) Heat a spatula end-full of **Y** strongly in a dry test tube. | Y is a green solid. Colourless liquid that turned anhydrous copper(VI) sulphate blue. Colourless gas that turned lime water milky and turning blue. Another colourless gas that turned acidified potassium dichromate from orange to green. Black residue remained. | Transition metal cations probably $Cu^{2+}$, $Cr^{3+}$, $Ni^{2+}$. Water of crystallisation. Y is hydrated. $CO_2$ gas ∴ $CO_3^{2-}$ or $C_2O_4^{2-}$. $SO_2$ gas ∴ $SO_4^{2-}$. ($CuO$, Ni) |
| (b) Place two spatula end-fulls of **Y** in a test tube, add about 5 $cm^3$ of water, shake and filter. Keep both the filtrate and the residue. Divide the filtrate into five portions. | | |
| (i) To the first portion of the filtrate, add dilute sodium hydroxide dropwise until in excess. | Green-blue filtrate. Brown residue. Effervescence of a colourless gas that turned lime water milky. Blue ppt insoluble in excess | $Cu^{2+}$, $Fe^{2+}$, $Ni^{2+}$. $Fe(OH)_3$; $MnO_2$. $CO_2$; $CO_3^{2-}$. $Cu^{2+}$, |
| (ii) To the second portion of the filtrate, add dilute ammonia solution drop-wise until in excess. | Blue precipitate soluble to form a deep-blue solution | $Cu(NH_3)_4^{2+}$; Cu |
| (iii) To the third portion of the filtrate, add few drops of hexacyanoferrate (II) solution. | Dark-brown precipitate | $Cu^{2+}$ Confirmed |
| (iv) To the fourth portion of the filtrate, add 2 drops of lead (II) nitrate solution and warm. | White precipitate insoluble on warming | $Cl^-$ absent; $SO_4^{2-}$, $CO_3^{2-}$. $SO_3^{2-}$ |
| (v) Use the fifth portion of the filtrate to confirm one of the anions in **Y**. Add dilute nitric acid followed by barium nitrate solution or dil HCl/$BaCl_2$ | White precipitate insoluble in dilute nitric acid | $SO_4^{2-}$ Confirm |



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| TEST | OBSERVATIONS | DEDUCTIONS |
|---|---|---|
| (c) Wash the residue with water. Heat a small portion of the residue strongly in a dry test tube. | Brown residue remains | ($Fe(OH)_3$ ; $Fe_2O_3$ ; $MnO_2$) |
| (d) Transfer the rest of the residue to a test tube and dissolve it in dilute hydrochloric acid. Divide the solution into three parts. | Residue dissolved to give green-yellow | $Fe^{3+}$ |
| (i) To the first part of the solution, add dilute sodium hydroxide solution drop-wise until in excess. | Brown precipitate insoluble in excess | $Fe^{3+}$ |
| (ii) To the second part of the solution, add dilute ammonia solution dropwise until in excess. | Brown precipitate insoluble in excess | $Fe^{3+}$ |
| (iii) To the third part of the solution, add 2-3 drops of potassium thiocyanate solution. | Blood-red solution | $Fe^{3+}$ Confirmed |

Identify the ions in substance Y.

cations: $Cu^{2+}$ ; $Fe^{3+}$ . 2

anions: $CO_3^{2-}$ ; $SO_4^{2-}$

2

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3. You are provided with substance Z which is an organic compound. You are required to determine the nature of Z. Carry out the following tests and identify any gases evolved. Record your observations and deductions in the table below.

| TEST | OBSERVATIONS | DEDUCTIONS |
|---|---|---|
| (a) Add 2 $cm^3$ of distilled water to 1 $cm^3$ of Z. Test the mixture with litmus paper. | Z dissolved in water to form a colourless liquid solution. The solution had no effect on litmus. | Polar, neutral compound with low molecular mass pr aldehyde, ketone, |
| (b) Burn a small amount of Z on a watch glass. | Colourless liquid that burnt with a blue non-sooty flame | Aliphatic, Saturated compound with low molecular mass (or |
| (c) To 3 $cm^3$ of Brady's reagent add 2 drops of Z. | Yellow precipitate | aldehyde, ketone or C=O functional |
| (d) To 4 $cm^3$ of saturated sodium hydrogen sulphite solution add 2 $cm^3$ of Z. | White precipitate | Aldehyde, or Keto Ketone, $CH_3$ C=O ; C=O |
| (e) To 5 drops of Z add 4 $cm^3$ of iodine solution followed by dropwise addition of dilute sodium hydroxide solution until the brown iodine colour just disappears. Warm the mixture gently. | Yellow precipitate | Ketone of the type $CH_3$ C-R or Ethanal. Yellow ppt is $CHI_3$ |
| (f) To 3 $cm^3$ of Z add 1 $cm^3$ of acidified potassium dichromate and warm the mixture. | No observable change | Ethanal absent ∴ Ketone present. |
| (g) To 3 $cm^3$ of silver nitrate solution add 2 drops of dilute sodium hydroxide. Then add ammonia solution dropwise until the precipitate just dissolves. Add 5 $cm^3$ of Z and warm. | No observable change. or No silver mirror formed | Alkanal absent ∴ Alkanone present |

From your results above, deduce the nature of compound Z.

Z is an aliphatic, saturated ketone with R the low molecular mass and structure $CH_3$ C=O

END

IACE PS 28/3 (1)

- 1 Pipette 25 cm³ or 20 cm³
- 1 burette 50 cm³
- 17 cm³ FA1 (on 8 small beakers)
- 100 cm³ FA2 (8 Medium sized beakers)
- 60 cm³ of 2.0M $H_2SO_4$ (8 beakers)
- 1% Starch solution
- 60 cm³ of 10% Potassium Iodide (8 beakers)
- 4 g of Y (8 pieces of paper)
- 2 conical flasks (3 conical flasks)
- 5 cm³ Z (on 8 small beakers)
- 6 test tubes (12 test tubes, 2 boiling tubes)

Access to:

- Reagents for identifying cations, anions and organic compounds
- Source of heat

FA1 is to be issued as it is written
further dilution
FA2 is made by dissolving 24.8g of
to make 1 litre of soln.
Substances FA1, K, Y & Z will be
provided by UNEB.

- $KMnO_4/H^+$ – Distilled $H_2O$ (2 beakers)
- bromine $H_2O$ – Lime $H_2O$
- Neutral – Benedict's reagent
- Iron(II) chloride – NaOH (aq)
- Potassium ferrate(III) – Tollen's reagent
- Cont... – Potassium bismuthate
- $Na_2CO_3$
- $NaHCO_3$
- $PCl_5$
- $CH_3COOH$ (aq)
- Dimethyl gly
- $NH_4Cl$
- $NH_3$ (aq)
- Conc $H_2SO_4$
- Conc HCl
- Disodium dihydrogen ... Nitrate

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2003

- 600 cm3 BA1
- 600 cm3 BA2
- 3g of Y
- Methyl orange indicator
- 1 burette 50 cm3
- 1 pipette 25 cm3 or 20 cm3
- 6 test tubes
- Filter paper

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Access to reagents for identifying cations and anions

BA1 is made by dissolving 14.39 of P to make 1 litre of solution

BA2 is 0.1M HCl acid 8.6mls in 1

Substances Y and P will be provided

UNBB

14.39

NaOH (aq)
$NH_3$ (aq)
KI (aq)
$Pb(NO_3)_2$
$Ba(NO_3)_2$
$BaCl_2$
dil. HCl
dil $H_2SO_4$
dil. $HNO_3$
Conc $NH_3$
Conc HCl
Acidified KMnO4

BA1 } Medium sized beakers
BA2 }
- Methyl orange
- Y on a piece of paper
- Potassium ferric (III)
- Acidified ferric (II)
- $AgNO_3$ (aq)