Candidate's Name: .....

Signature: .....

Random No.						Personal No.		

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

545/3
CHEMISTRY
(PRACTICAL)
Oct./Nov. 2020
2 hours

Guvda

UGANDA NATIONAL EXAMINATIONS BOARD

Uganda Certificate of Education

CHEMISTRY PRACTICAL

Paper 3

2 hours

INSTRUCTIONS TO CANDIDATES:

*Answer **both** questions. Answers are to be written in the spaces provided in this booklet. All your work **must** be in **blue** or **black** ink. Any work done in **pencil** will **not** be marked **except** drawings.*

*You are **not** allowed to use reference books (i.e. text books, booklets on qualitative analysis etc.).*

All working must be clearly shown.

Mathematical tables and silent non-programmable scientific calculators may be used.

For Examiners' Use Only		
Q.1		
Q.2		
Total		

1. You are provided with the following:

BA1 which is a 0.1 M hydrochloric acid solution.

BA2 which is a solution of an impure sample of potassium hydrogencarbonate made by dissolving 10.0 g of the impure salt in water to make 1 dm^3 of solution.

The mole ratio of the reaction between hydrochloric acid and potassium hydrogencarbonate is **1:1**.

You are required to determine the percentage purity of the potassium hydrogencarbonate sample.

Procedure:

Pipette 25.0 cm^3 (or 20.0 cm^3) of **BA2** into a clean conical flask.

Add 2-3 drops of methyl orange indicator and titrate the solution with **BA1** from the burette. Record your results in table **1**.

Repeat the procedure until you obtain consistent results.

Table 1

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

Titration number	1	2	3
Final burette reading (cm^3)	14.50	14.60	29.00
Initial burette reading (cm^3)	0.00	0.00	14.60
Volume of **BA1** used (cm^3)	14.50	14.60	14.40

Range is ±5 w.r.t centres average. (7½ marks)

(a) (i) State the volumes of **BA1** used to calculate the average volume. (½ mark)

14.50, 14.60, 14.40 Range ±0.2

Accept two values indicated

(ii) Calculate the average volume of **BA1** used. (2½ marks)

$\frac{14.50 + 14.60 + 14.40}{3}$

$= 14.50\ cm^3$

.....cm^3.

2

Two Columns only filled. Award: – Range – Accuracy.

1 Column only filled in table. Deny: – Range – Accuracy.

No final burette reading shown. Award: – IBR – Range. Deny: – subtraction – Accuracy.

No IBR indicated. Award: – FBR – Range. Deny: W of BA1 used – Accuracy.

Value of BA1 missing. Award: FBR IBR

1 decimal place. No decimal place (No mark)

Award. Correct subtraction with or without decimal point.

±0.1 ±0.2 ±0.3 ±0.4 ±0.5

(b) Calculate the;

(i) number of moles of hydrochloric acid that reacted. *(03 marks)*

Reject: Reacts with

1000 cm³ of HCl contains 0.1 moles. ✓

14.50 cm³ of HCl contains $\frac{14.5 \times 0.1}{1000}$ ✓ 3

Reject: cm or cm²

$= 1.45 \times 10^{-3}$ moles ✓

Atleast 3 decimal places.

(ii) number of moles of potassium hydrogencarbonate that reacted with the hydrochloric acid in **BA1**. *(02 marks)*

Since 1 mole of HCl reacts with 1 mole of $KHCO_3$ ✓ 2

moles of $KHCO_3$ that reacted $= 1.45 \times 10^{-3}$ moles. ✓

Atleast 3 decimal places.

(iii) concentration of potassium hydrogencarbonate in moles per dm^3 in **BA2**. *(03 marks)*

20.0 cm³ of BA2 contain 1.45×10^{-3} moles ✓

1000 cm³ / 1 dm³ will contain $\frac{1.45 \times 10^{-3}}{20.0} \times 1000$ ✓ 3

Here Concentration of BA2 w.r.t. $KHCO_3 = 0.0725$ ✓

Atleast 2 decimal places

08

(c) Determine the percentage purity of the potassium hydrogencarbonate sample. (*H=1; C=12; O=16; K=39*) *(06 marks)*

Rfm of $KHCO_3 = 39+1+12+48$ ✓

$= 100$.

1 mole of $KHCO_3$ weighs 100g ✓

∴ 0.0725 moles weigh 0.0725×100 ✓

$= 7.25g$ ✓

Hence percentage purity of $KHCO_3 = \frac{7.25}{10} \times 100$

$= 72.5\%$

Accept (70 – 90)%

06

2. You are provided with substance **T** which contains **two** cations and **one** anion.

Carry out the following tests in table **2** to identify the cations and the anion in **T**. Identify any gas(es) evolved.

Record your observations and deductions in the table.

Table 2 *(25 marks)*

	TESTS	OBSERVATIONS	DEDUCTIONS
(a)	Heat **two** spatula end-fuls of **T** strongly in a dry test tube.	A colourless gas evolved turned blue litmus paper red and lime water milky Residue was yellow when hot and white when cold.	CO_2 evolved. $\therefore CO_3^{2-}$ or HCO_3^- ZnO formed. $\therefore Zn^{2+}$ suspected.
(b)	To **two** spatula end-fuls of **T** in a test tube, add dilute nitric acid drop-wise until there is no further change. Add dilute sodium hydroxide solution drop-wise to the resultant solution until the alkali is in excess. Filter and keep both the filtrate and residue.	Vigorous effervescence or A colourless gas which turned blue litmus paper red and lime water milky A colourless solution formed. White ppt insoluble in excess or White residue and A colourless filtrate.	CO_2 evolved $\therefore CO_3^{2-}$ Mg^{2+}, Ca^{2+} Al^{3+}, Zn^{2+}, Pb^{2+} any two correct

4½

6

10½

TESTS	OBSERVATIONS	DEDUCTIONS	
(c) To the filtrate, add dilute nitric acid drop-wise until the solution is just acidic. Divide the acidified solution into **three** parts and test as follows:	A white ppt which dissolved in acid to give a colourless solution.	Al^{3+}, Zn^{2+}, Pb^{2+} any two correct.	02
(i) To the **first** part of the acidified solution, add dilute sodium hydroxide solution drop-wise until in excess.	White ppt soluble in excess NaOH.	Amphoteric hydroxide formed Zn^{2+}, Pb^{2+} or Al^{3+}	2½
(ii) To the **second** part of the acidified solution, add 2-3 drops of potassium iodide solution.	No apparent change. or colourless solution remains or No observable change or No yellow ppt formed	Pb^{2+} absent $\therefore$ Zn^{2+} or Al^{3+} suspected	02
(iii) To the **third** part of the acidified solution, carry out a test of your own choice in order to confirm one of the cations in **T**. ~~Add~~ Aqueous ammonia was added until in excess	White ppt soluble in excess forming a colourless solution	$Zn(OH)_2$ formed by $[Zn(NH_3)_4]^{2+}$ formed. $\therefore$ Zn^{2+} confirmed	2½
			09

TESTS	OBSERVATIONS	DEDUCTIONS
(d) Wash the residue with distilled water and then dissolve it in dilute nitric acid.	Residue dissolved to form a colourless solution ✓	Mg^{2+}, Ca^{2+} ✓ Both indicated
Divide the solution into **two** parts and test as follows:		
(i) To the **first** part, add dilute sodium hydroxide solution drop-wise until in excess.	A white ppt ✓ insoluble in excess ✓	Mg^{2+} ✓, Ca^{2+} ✓ suspected
(ii) To the **second** part, add dilute ammonia solution drop-wise until in excess.	No observable change. ✓	Ca^{2+} ✓ confirmed

03

01

(e) (i) The cations in **T** are Zn^{2+} and Ca^{2+}

(ii) The anion in **T** is CO_3^{2-}.

END