Candidate's Name : ..... NAME .....

Signature: ..... JBSantu JSW .....

Random No.					Personal No.		
1	9	6	8		5	0	0

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

P525/3
CHEMISTRY
(Practical)
Nov./Dec. 2022
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. Use* **blue** *or* **black** *ink. Any work done in pencil will* **not** *be marked* **except** *drawings.*

All your answers **must** *be written in the spaces provided.*

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

Reference books (i.e. text books, booklets on qualitative analysis etc.) should **not** *be used.*

You are **not** *allowed to start working with the apparatus for the first* **15 minutes**. *This time is to enable candidates 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
30	30	20	80

1. You are provided with the following:

FA1, which is a solution of hydrochloric acid.

Metal **X**.

Substance **Y**, which is an oxide of **X**, with a formula **XO**.

You are required to determine the enthalpy change for the reduction of the oxide of **X** and comment on your answer.

PART I

Procedure

Weigh accurately about 1.2 g of **X**.

Using a measuring cylinder, transfer 100 cm^3 of **FA1** into a plastic beaker or cup. Read and record its initial temperature, in table 1.

Add at once the 1.2 g of **X** into **FA1** in the plastic beaker or cup and at the same time, start the stop clock or watch.

Stir gently with the thermometer and record the temperature of the mixture after every half-minute in table 1, up to the fourth minute.

Results

Mass of weighing container + **X** = ... 34.7 ✓ ..... g *(½ mark)*

Mass of weighing container alone = ... 33.5 ✓ ..... g *(½ mark)* (1 ½)

Mass of **X** used = ... 1.2 ✓ ..... g *(½ mark)*

Table 1

Time (minutes)	0	½	1	1½	2	2½	3	3½	4
Temperature of solution (°C)	27.0 ✓	45.0 ✓	56.5 ✓	63.0 ✓	66.0 ✓	68.0 ✓	~~67.5~~ 67.5 ✓	66.5 ✓	65.0 ✓

(4 ½)

(4½ marks)

Trend Increases then decrease

Correct to 1 d.p

PART II

Procedure

Weigh accurately about 2.0 g of **Y**.

Using a measuring cylinder, transfer 100 cm^3 of **FA1** into a plastic beaker or cup. Read and record its initial temperature, in table **2**.

Add at once the 2.0 g of **Y** into **FA1** in the plastic beaker or cup and at the same time, start the stop clock or watch.

Stir gently with the thermometer and record the temperature of the solution after every half-minute in table **2**, up to the fourth minute.

Results

Mass of weighing container + **Y** = ... 35.7 ✓ ..... g (½ mark)

Mass of weighing container alone = ... 33.5 ✓ ..... g (½ mark) (1+½)

Mass of **Y** used = ... 2.0 ✓ ..... g (½ mark)

Table 2

Time (minutes)	0	½	1	1½	2	2½	3	3½	4
Temperature of solution (°C)	27.0 ✓	30.0 ✓	32.0 ✓	32.0 ✓	32.0 ✓	32.0 ✓	32.0 ✓	32.0 ✓	31.5 ✓

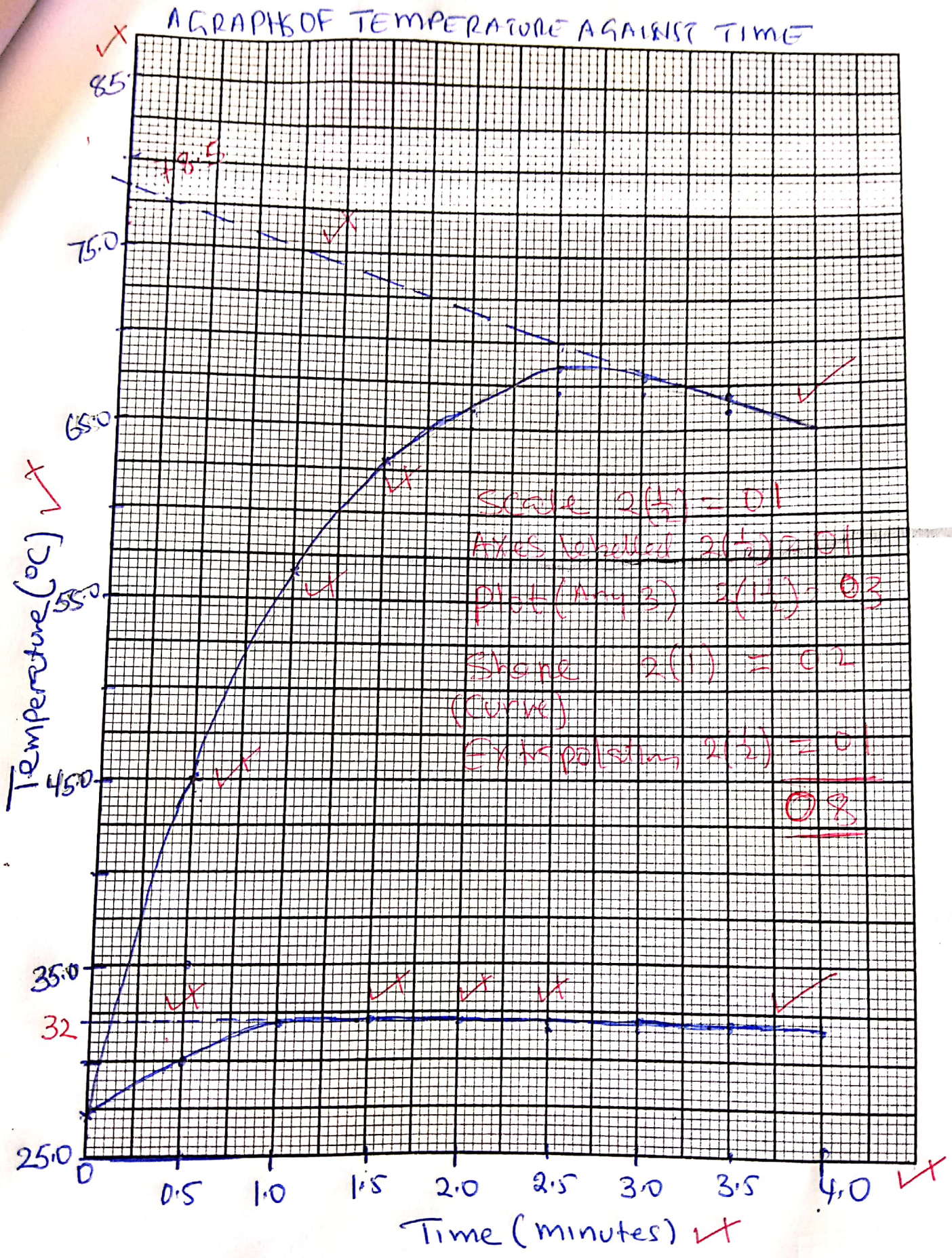
(4½)

(4½ marks)

(a) (i) Plot on the same axes, graphs of temperature against time for results obtained in both **Part I** and **Part II**. (07 marks)

(*Graph paper is provided on page 4.*)

06


A GRAPH OF TEMPERATURE AGAINST TIME
85
75.0
65.0
55.0
45.0
35.0
32
25.0
Temperature (°C)
0
0.5
1.0
1.5
2.0
2.5
3.0
3.5
4.0
Time (minutes)
79.5
Scale 2(½) = 01
Axes labelled 2(½) = 01
plot (Any 3) 2(1½) = 03
Shape (Curve) 2(1) = 02
Extrapolation 2(½) = 01
08

(ii) From your graphs, determine the maximum temperature change for each reaction. *(03 marks)*

PART I

Maximum temperature change = 87.5 − 27 = 60.5 °C ✓ ✓

PART II

Maximum temperature change = 32.0 − 27 = 5°C ✓ ✓

must be from the graph, Ref if extra portion is wrong. (02)

(iii) Calculate the heat of reaction in **Part I** and **Part II**.

[*Specific heat capacity of the solution* = 4.2 $Jg^{-1}K^{-1}$ *and its density* = 1 g cm^{-3} *in each case, equation of the reactions of* **X** *and* **Y** *are as follows:*

$X_{(s)} + 2\,HCl_{(aq)} \longrightarrow XCl_{2\,(aq)} + H_{2\,(g)}$

$XO_{(s)} + 2\,HCl_{(aq)} \longrightarrow XCl_{2\,(aq)} + H_2O_{(l)}$]

Part I: *(01 mark)*

Heat change = mass × specific heat capacity × temperature change

= (100 × 1) × 4.2 × 60.5 ✓

Heat of reaction = −25410 Joules (01)

= −25.41 Kj ✓

Ref of sign and unit missing

Part II: *(01 mark)*

Heat change = mass × specific heat capacity × temp change

= (100 × 1) × 4.2 × 5° ✓

Heat of reaction = −2100 Joules

= −2.1 Kj ✓ (01)

Ref of sign and unit missing

(04)

(iv) Calculate the molar heat of reactions in **Part I** and **Part II**.
(**X** = 24, *O* = 16) *(03 marks)*

PART I

1.2g of X evolves 25.41 KJ ✓

24g of X evolves $\frac{25.41 \times 24}{1.2}$ ✓ = 508.2 Kjmol^{-1} ✓ (1 1/2)

molar heat of reaction = −508.2 Kjmol^{-1} ✓

PART I

Rej if sign and unit are missing

molar mass of XO = 24 + 16 = 40g ✓

2.0g of XO evolves 2.1 KJ ✓ (1 1/2)

40g of XO evolves $\frac{2.1 \times 40}{2.0}$ ✓ = 42 Kjmol^{-1} ✓

molar heat of reaction = −42 Kjmol^{-1} ✓

Rej if sign and unit are missing.

(b) Determine the heat energy change for the reaction.

$XO_{(s)} + H_{2(g)} \longrightarrow X_{(s)} + H_2O_{(l)}$ *(02 marks)*

$XO_{(s)} + 2HCl_{(aq)} \longrightarrow XCl_{2(aq)} + H_2O_{(l)}$ ✓ $\Delta H = -42$ Kjmol^{-1} ✓

$+ \quad XCl_{2(aq)} + H_{2(g)} \longrightarrow X_{(s)} + 2HCl_{(aq)}$ ✓ $\Delta H = +508.2$ Kjmol^{-1} ✓

$XO_{(s)} + H_{2(g)} \longrightarrow X_{(s)} + H_2O_{(l)}$ $\Delta H = +466.2$ Kjmol^{-1} ✓

(02)

(c) Comment on your answer in (b). *(01 mark)*

The reduction of XO to X is not feasible ✓

because the enthalpy of reaction is endothermic ✓

06

T = 30

2. You are provided with substance **D** which contains **two** cations and **two** anions.
You are required to carry out the tests in table **3** to identify the cations and anions in **D**. Identify any gas(es) evolved.
Record your observations and deductions in the table.

Table 3 *(30 marks)*

TESTS	OBSERVATIONS	DEDUCTIONS
(a) To **two** spatula end-fuls of **D** in a test tube, add dilute nitric acid until there is no further change.	Green powdered solid dissolves to form a green solution with effervescence of a colourless gas that turns lime water milky, blue litmus red ✓✓✓✓	Cu^{2+}, Ni^{2+} ✓ or Fe^{2+} or Cr^{3+} Anyone suspected ✓ CO_2 ✓ evolved CO_3^{2-} ✓ or HCO_3^- Anyone present (3½)
(b) To **two** spatula end-fuls of **D** in a test tube, add about 5 cm^3 of **distilled water**, shake well and filter. Keep both the filtrate and the residue.	Partly soluble ✓ green residue ✓ colourless filtrate ✓	Cu^{2+} ✓, Ni^{2+} ✓, Fe^{2+} Cr^{3+} suspected non coloured ✓ metal ions present e.g Al^{3+} Pb^{2+} Zn^{2+} 02
(c) Divide the filtrate into **three** parts. (i) To the **first** part, add silver nitrate solution followed by dilute nitric acid.	Yellow ✓ precipitate ✓ soluble ✓ in dilute nitric acid	PO_4^{3-} ✓ suspected 1½
(ii) To the **second** part, add aqueous iron(II) chloride solution.	Pale yellow precipitate ✓	PO_4^{3-} ✓ suspected 01

08

TESTS	OBSERVATIONS	DEDUCTIONS
(iii) Use the **third** part of the filtrate to carry out a test of your own choice to confirm one of the anions in **D**. **Test:** To the third part Concentrated nitric acid was added followed by Ammonium molybdate and dilute aqueous ammonia solution	Yellow precipitate Soluble in aqueous ammonia	PO_4^{3-} Confirmed present 2½
(d) Wash the residue twice with water. Transfer it into a test tube, add dilute nitric acid and warm. Add dilute sodium hydroxide solution drop-wise until in excess. Filter and keep both the filtrate and the residue.	Dissolves to form a green solution with effervescence of colourless gas that turns blue litmus red and turns lime water milky. Green ppt insoluble in excess Green residue Colourless filtrate	Cu^{2+}, Ni^{2+} Fe^{2+} or Cr^{3+} suspected CO_2 evolved CO_3^{2-} Confirmed Ni^{2+} or Fe^{2+} 05 Ni^{2+} or Fe^{2+} Al^{3+}, Pb^{2+}, Zn^{2+}, Sn^{2+}
(e) To the filtrate from part (d), add dilute nitric acid drop-wise until the solution is just acidic. Divide the solution into **three** parts.	White precipitate soluble in dilute nitric acid	Al^{3+} Pb^{2+} Zn^{2+} Sn^{2+} (01) Sn^{4+} Suspected

8½

TESTS	OBSERVATIONS	DEDUCTIONS
(i) To the **first** part of the acidified filtrate, add dilute sodium hydroxide solution drop-wise until in excess.	White precipitate ✓ ✓ Soluble ✓	Al^{3+}, Pb^{2+}, Zn^{2+} ✓ Sn^{2+} or Sn^{4+} Suspected Any one (1 ½)
(ii) To the **second** part of the acidified filtrate, add dilute ammonia solution drop-wise until in excess.	White precipitate ✓ ✓ Soluble ✓	Zn^{2+} ✓ present (1 ½)
(iii) Use the **third** part of the acidified filtrate to carry out a test of your own choice to confirm one of the cations in **D**. **Test:** To the third part solid Ammonium Chloride was added followed ✓ by disodium hydrogen phosphate solution ✓ and excess ammonia solution ✓	White precipitate ✓ ✓ Soluble ✓ in excess ammonia	Zn^{2+} ✓ Confirmed (2 ½)
(f) Dissolve the residue in part (d) in a minimum amount of dilute nitric acid. Divide the resultant solution into **three** parts.	Green residue dissolves ✓ to form a green ✓ solution	Ni^{2+} ✓ or Fe^{2+} suspected present (01)

6 ½

TESTS	OBSERVATIONS	DEDUCTIONS
(i) To the **first** part, add dilute sodium hydroxide solution drop-wise until in excess.	Green precipitate ✓ Insoluble ✓ in excess ✓	Ni^{2+} ✓ an Fe^{2+} Suspected present (1½)
(ii) To the **second** part, add dilute ammonia solution drop-wise until in excess.	Green precipitate ✓ soluble ✓ to form a pale blue ✓ solution	Ni^{2+} ✓ present (1½)
(iii) Use the **third** part to carry out a test of your own choice to confirm the second cation in **D**. **Test:** excess To the third, Ammonia solution was added ✓ followed by dimethylglyoxime solution	Red/bright ✓ Pink precipitate	Ni^{2+} ✓ Confirmed present (02)

(g) (i) The cations in **D** are Zn^{2+} ✓ (e(iii)) and Ni^{2+} ✓ (f(iii)) (02)

(ii) The anions in **D** are CO_3^{2-} ✓ (d) and PO_4^{3-} c(iii)

(07)

T = 30

3. You are provided with substance **L**, which is an **organic compound**. You are required to carry out the tests in table 4 to determine the nature of **L**. Record your observations and deductions in the table.

Table 4 *(20 marks)*

TESTS	OBSERVATIONS	DEDUCTIONS	
(a) Burn a small amount of **L** on a spatula-end or in porcelain dish.	A colourless liquid burns with a yellow sooty flame	Aromatic compound or Aliphatic compound with high Carbon content	02
(b) To about 1 cm^3 of **L**, add about 2 cm^3 of distilled water. Shake the mixture and test with litmus. Divide the mixture into **four** parts. (i) To the **first** part, add 2-3 drops of 2, 4 - dinitrophenyl **hydrazine solution.**	Miscible to form a colourless solution no effect on both blue and red litmus paper no observable change / no yellow precipitate formed	Polar Aliphatic compound Neutral compound present. Carbonyl Compound absent	2½ 02
(ii) To the **second** part, add a half a spatula endful of solid sodium hydrogencarbonate.	no observable change / no effervescence of a colourless gas	Carboxylic acid absent	02
(iii) To the **third** part, add 2-3 drops of neutral iron(III) chloride solution.	no observable change / no purple colouration formed	Phenol absent	02
(iv) To the **fourth** part, add 2-3 drops of acidified potassium dichromate solution and heat.	no observable change / orange solution persisted on heating	Reducing agent absent or Primary alcohol or Secondary alcohol absent	02

12½

	TESTS	OBSERVATIONS	DEDUCTIONS
(c)	To 1 cm³ of **L** add about an equal volume of ethanoic acid, followed by about 2-3 drops of concentrated sulphuric acid and heat the mixture. Pour it into a beaker of cold water and allow to stand.	Sweet fruity smell ✓	ester formed ✓ Tertiary ✓ alcohol present ✓ 02
(d)	To 1 cm³ of **L**, add 2-3 drops of concentrated sulphuric acid and heat. Pass the vapour evolving into a test tube containing acidified potassium manganate(VII) solution.	White fomes / vapour turns acidified potassium manganate (VII) solution colourless ✓	Tertiary alcohol ✓ dehydrated to form ✓ an alkene ✓ 02
(e)	To 1 cm³ of **L**, add 4 -5 drops of Lucas reagent.	Immediate cloudy solution ✓ formed	Tertiary ✓ alcohol confirmed present 02

(f) Describe the nature of **L**.

Aliphatic ✓ tertiary ✓ alcohol with high carbon content ✓ (1 ½)

7 ½

T = 20

END