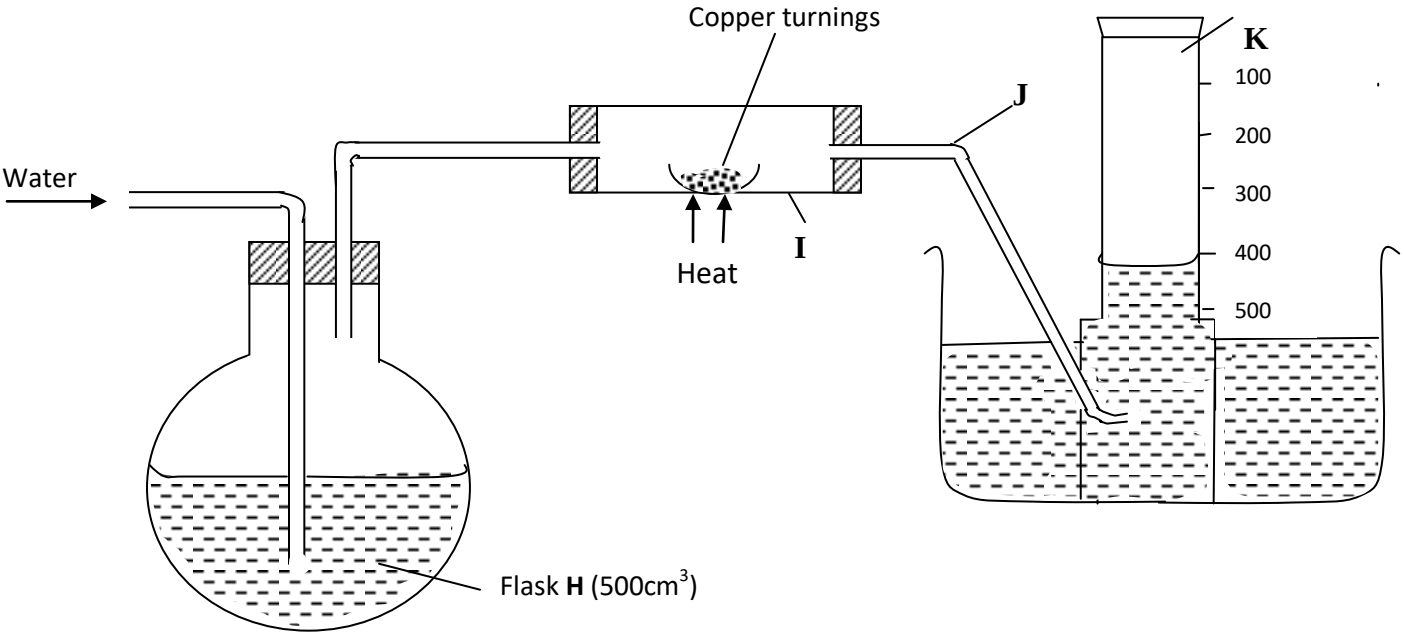
233/2
CHEMISTRY
Paper 2
TERM 2 2019
Time: 2 hours

MARKING SCHEME

1. A. In an experiment to determine the percentage of oxygen in air, the apparatus below were set up. Study the set up and the information provided to answer the questions that follow.



A 500cm^3 measuring cylinder **K** was filled with water and assembled for gas collection. Copper turnings were heated red hot and water was slowly passed into 500cm^3 flask **H** until it reached the 500cm^3 mark. A colourless gas was collected in **K**.

(i) What was the purpose of passing water into flask **H**? **(1 mark)**

To displace air in flask H over the hot copper turnings.

(ii) What observations were made in the tube **I**? **(1 mark)**

The brown solid changes to black

(iii) Name one of the gases that is likely to be found in **J**. **(1 mark)**

Nitrogen, carbon (IV) oxide, argon, (Xeron, neon) ***(Any one)***

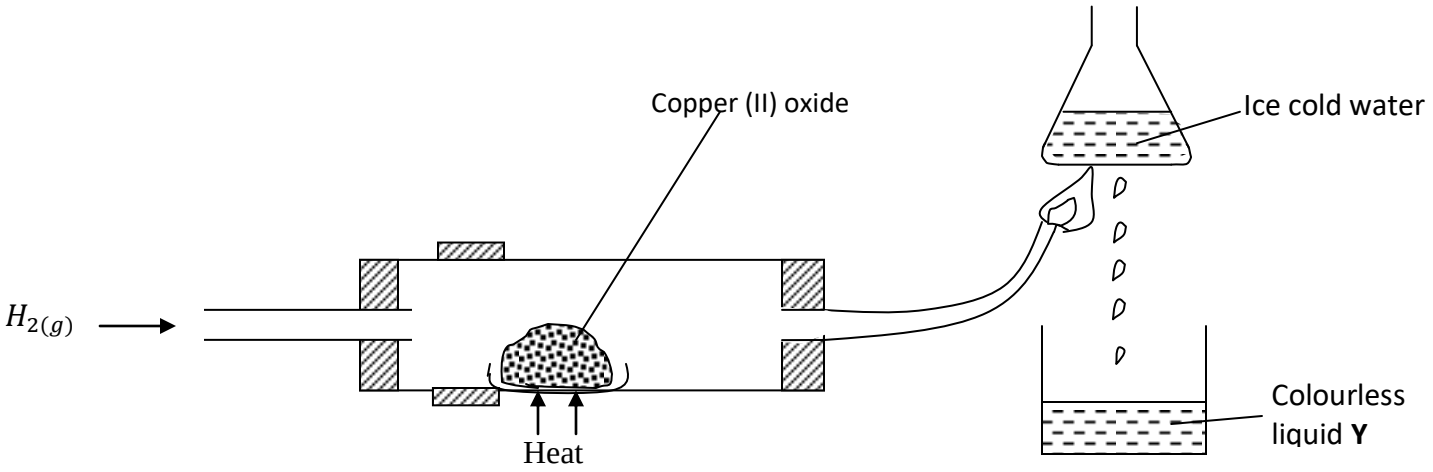
(iv) What was the volume of the gas collected in the measuring cylinder at the end of the experiment? **(1 mark)**

410cm³

(v) Calculate the percentage of oxygen in air using the above results. **(2 marks)**

$$\frac{(500 \times 410)}{500} \times 100 = \frac{90 \times 100}{500} = 18\%$$ ✓1 ✓1

B. Study the diagram below and answer the questions that follow.



(a) Give ***one*** observation made in the combustion tube after some time. **(1 mark)**

Black CuO turns to red-brown Cu.

(b) Write an equation for the formation of the colourless liquid **Y**. **(1 mark)**

$$2H_{2(g)} + O_{2(g)} \longrightarrow 2H_2O_{(l)}$$

(c) What was the aim of the above experiment as demonstrated in the combustion tube? Explain. **(2 marks)**

To determine the reducing property of hydrogen. ✓1 ***Hydrogen is above Cu in the reactivity series, thus it reduces the oxygen from CuO.*** ✓1

2. Use the information below to answer the questions that follow. The letters are not the actual symbols of the elements.

Element	Atomic No.	M.P^{0}C	B.P^{0}C	Ionic radius (nm)
P	11	98	890	0.095
Q	12	650	1110	0.065

R	13	660	2470	0.050
S	14	1410	2360	0.041
T	15	44.2 & 590	280	0.034
U	16	113 & 119	445	0.184
V	17	-101	-35	0.181
W	18	-189	-186	-

(a) (i) Write the electronic configuration of the atoms represented by letters **T** and **W**. **(1 mark)**

T - 2.8.5 ✓½
W - 2.8.8 ✓½

(ii) State the nature of the oxides of the elements represented by **Q** and **U**. **(2 marks)**

Q - Basic Oxide ✓**1**
U - Acidic oxide ✓**1**

(b) Why does the elements represented by the letters **T** and **U** have two values of melting points? **(1 mark)**

The two elements exhibit allotropy.

(c) Explain the following observations in terms of structure and bonding.

(i) There is an increase in boiling point from **P** to **R**. **(2 marks)**

There is gradual increase in the strength of the metallic bonds ✓**1** ***due to the increase in the number of delocalized (valence) electrons in the element*** ✓**1**

(ii) Element **S** has a high boiling point. **(2 marks)**

The atomic radius of V is smaller than that of U. ✓**1** ***V has more protons therefore has a stronger nuclear attraction hence the smaller atomic radius.*** ✓**1**

(iii) There is a decrease in boiling points from **U** to **W**. **(2 marks)**

Elements U, V and W have simple molecular structures ✓**1** ***in which the molecules are held by weak Van der waals forces. The Van der waals*** ✓**1** ***forces weaken from U to W.***

(d) (i) Compare the atomic radius of **U** and **V**. **(1 mark)**

The atomic radius of V is smaller than that of U. ✓**1**

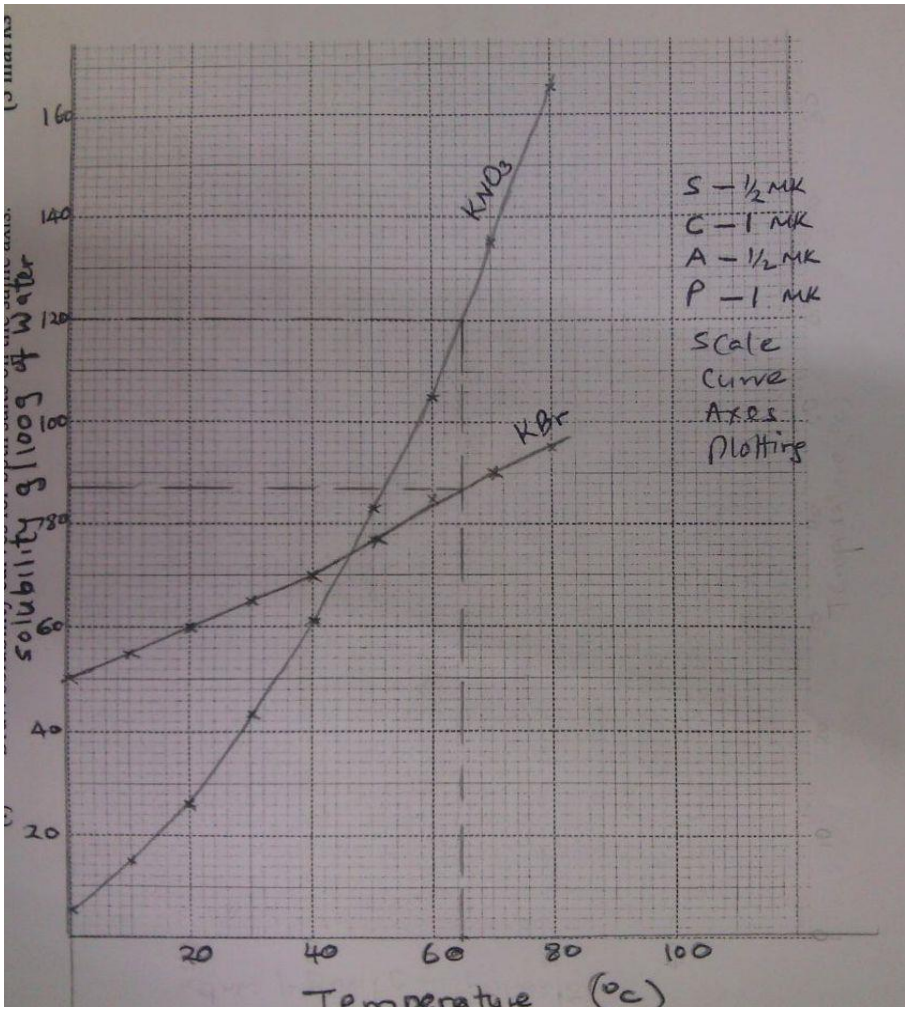
(ii) Why is there no ionic for **W** reported in the table? **(1 mark)**

It has a stable electron configuration hence does not ionize.

3. (a) The solubilities of potassium nitrate and potassium bromide at different temperatures was determined. The following data was obtained.

Temperature ^0C		0	10	20	30	40	50	60	70	80
Solubility g/100g H_2O	KNO_3	5	15	26	43	61	83	105	135	165
	KB_r	50	55	60	65	70	77	85	90	95

(i) Draw solubility curves for both salts on the same axis. **(3 marks)**



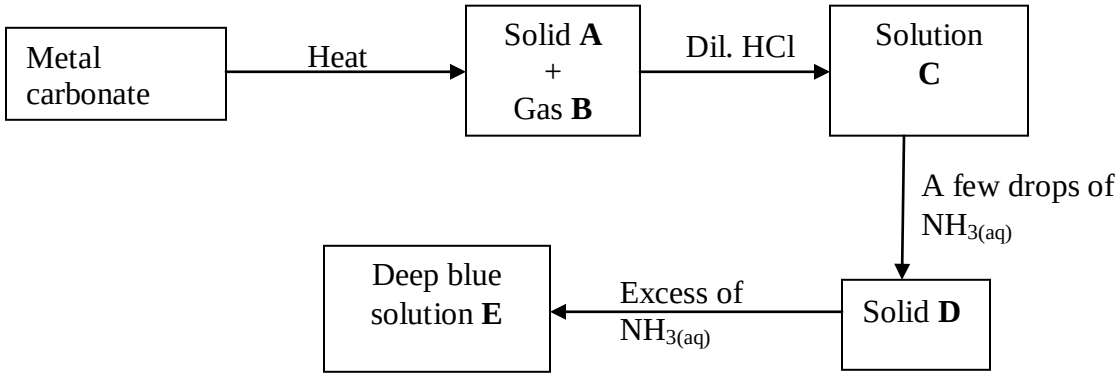
KBr – 87g/100g of water $\pm$ ***1*** ✓½

(iii) 100g of a saturated solution of potassium nitrate at 70^0C was cooled to 20^0C. What mass of the crystals will be crystallized? **(2 marks)**

At 70^0C solubility = 135g/100g of water
If 235g contain 135g of salt
100g contain 135g
$\frac{100 \times 135}{235} = 57.4468g$ ✓½

At 20^0C solubility = 26g/100g of water
If 126g contain 26g of salt
100g contain ?
$\frac{100 \times 26}{126} = 20.6349g$ ✓½
Mass which will crystallized
57.4468 – 20.6349
= 36.8119g

(b) Study the flow chart below and answer the questions that follow.



(i) Write an equation for the formation of solid **A** and gas **B**. **(1 mark)**

$$CuCO_{3(s)} \xrightarrow{heat} CuO_{(s)} + CO_{2(g)}$$

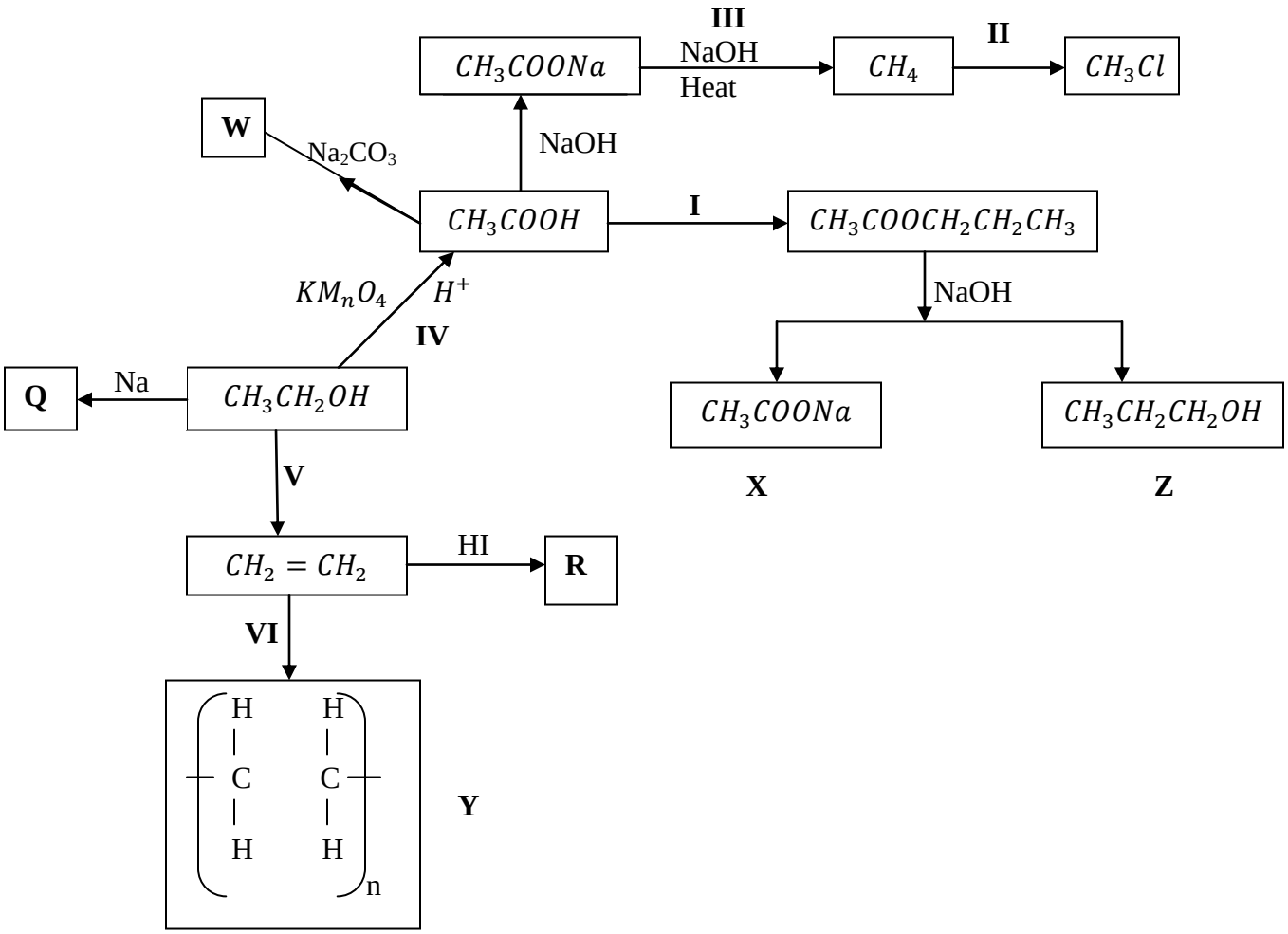
(ii) Name;

Solution **C** - ***Copper (II) chloride*** **(1 mark)**
Solid **D** - ***Copper (II) hydroxide*** **(1 mark)**

(c) Write the formula of the complex ion in solution **E**. **(1 mark)**

$\left(Cu(NH_3)_4\right)^{2+}$

4. Study the flow chart below and answer the questions that follow.



(a) Name substance. **(3 marks)**

X - ***Sodium ethonoate*** ✓***1***

Q - ***Sodium ethoxide*** ✓***1***

R - ***Iodoethane*** ✓***1***

(b) Write down an equation for the reaction represented by step III. **(1 mark)**

$$CH_3COONa_{(s)} + NaOH_{(aq)} \longrightarrow CH_{4(g)} + Na_2CO_{3(s)}$$

(c) What are the conditions and reagent required for steps?

(i) **I** **(2 marks)**

Reagent - ***Propan-l-ol*** ✓***1***

Condition - ***Conc. H_2SO_4*** ✓***1***

(ii) **IV** **(2 marks)**

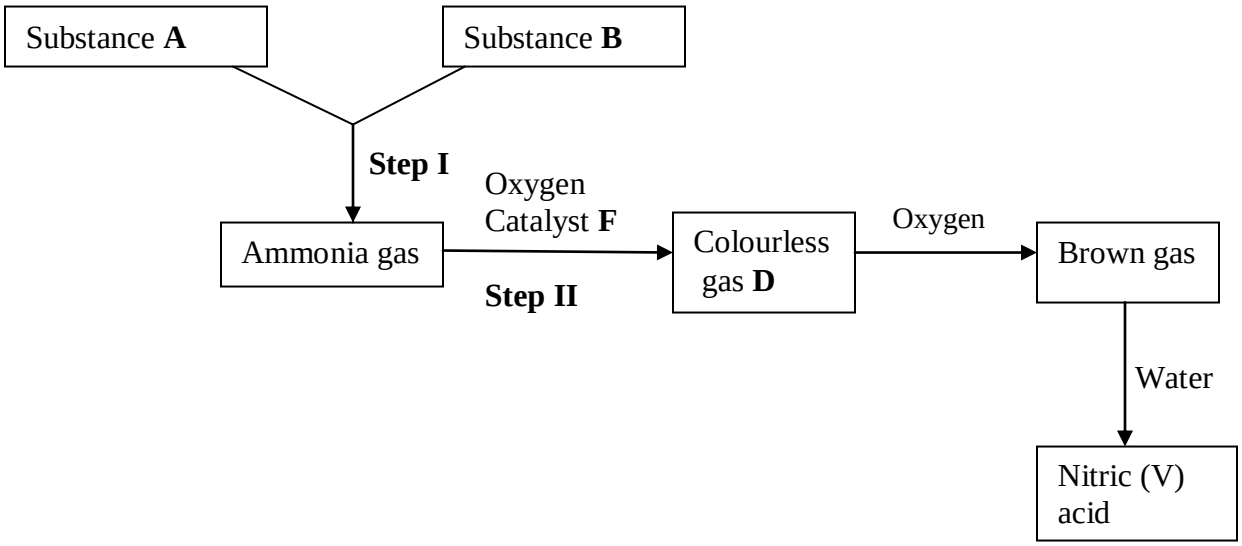
Reagent - ***Conc. H_2SO_4*** ✓*1*

Condition - **Temp 160 – 180^{0}C** ✓*1*

(b) Name the process represented by: **(4 marks)**

I - ***Esterification***
II - ***Substitution***
IV - ***Oxidation***
V - ***Dehydration***

5. **I.** Study the scheme below and answer the questions that follow.



(a) Identify substances. **(3 marks)**

A - ***Hydrogen***
B - ***Nitrogen***
D - ***NO***

(b) State the catalyst necessary for; **(2 marks)**

Step **I** - ***Iron finely divided / iron***
Step **II** - ***Platinum – rhodium catalyst***

(c) Write a balanced chemical equation for taking place in step **II**. **(1 mark)**

$$4NH_{(3)} + SO_2 \longrightarrow 2NO_{(g)} + 6H_2O$$

(d) Write two balanced chemical equations for the reaction between chlorine Gas and;

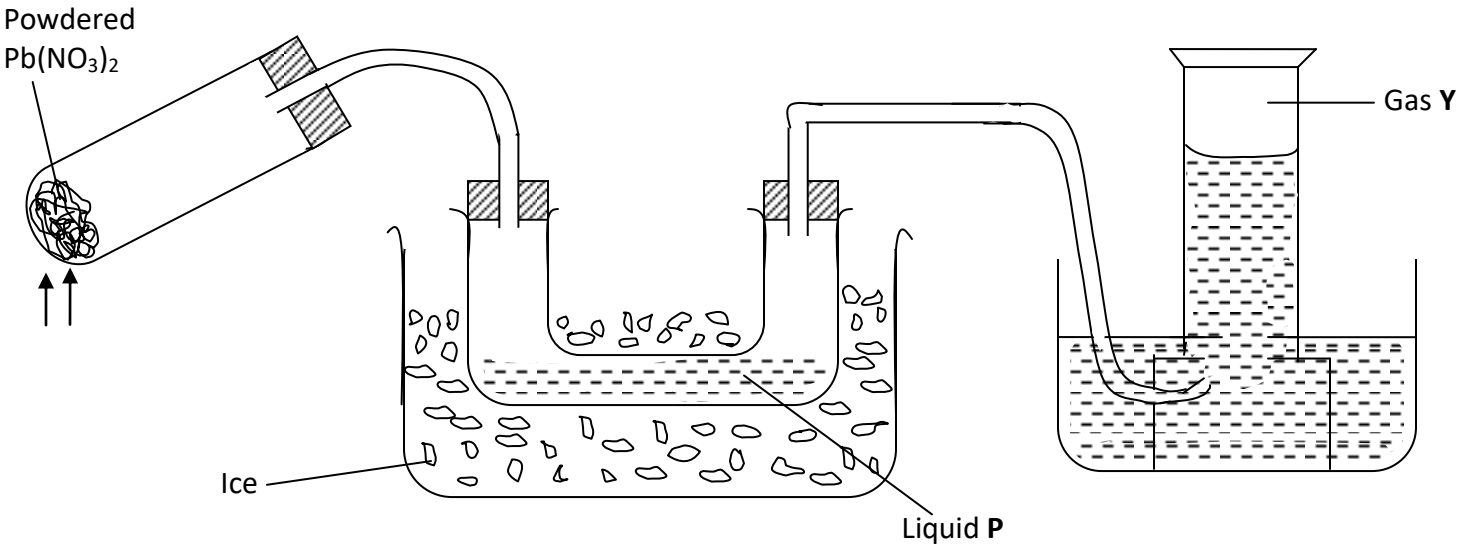
(i) Hot and concentrated sodium hydroxide. **(1 mark)**

$$6NaOH_{(aq)} + 3Cl_{2(g)} \longrightarrow NaClO_{3(aq)} + 5NaCl_{(aq)} + H_2O_{(l)}$$

(ii) Dilute and cold sodium hydroxide. **(1 mark)**

$$2NaOH_{(aq)} + Cl_2 \longrightarrow NaOCl + NaCl + H_2O$$

II. The diagram below shows an experiment in which the Lead (II) nitrate crystals are heated.



(a) Name; **(2 marks)**

(i) Liquid **P** - ***dinitrogen tetra oxide***
(ii) Gas **Y** - ***oxygen***

(b) Write a balanced chemical equation for the decomposition of Lead (II) nitrate. **(1 mark)**

$$2Pb(NO_3)_2 \longrightarrow 2PbO_{(s)} + 4NO_{2(s)} + O_{2(g)}$$

(c) Explain how you can distinguish between nitrogen (II) oxide and nitrogen (I) oxide. **(2 marks)**

- ***Nitrogen (V) oxide relights a glowing splint while nitrogen (II) oxide does not.***
- ***N_2O has xtic sweet smell, while. NO_2 is odourless.***

6. **I.** Study the standard electrode potentials given below and answer the questions that follow.

$D^{2+}{}_{(aq)} + 2e^- \rightleftharpoons D_{(s)} \qquad E^\theta = -2.92V$

$G^{2+}{}_{(aq)} + 2e^- \rightleftharpoons G_{(s)} \qquad E^\theta = -2.36V$

$\frac{1}{2}J^{2+}{}_{(g)} + e^- \rightleftharpoons J_{(s)} \quad E^\theta = 0.00V$

$M^{2+}{}_{(aq)} + 2e^- \rightleftharpoons M_{(s)} \quad E^\theta = +0.34V$

$\frac{1}{2}R^{2+}{}_{(aq)} + e^- \rightleftharpoons R_{(s)} \quad E^\theta = 2.87V$

(a) Identify the strongest:

(i) Reducing agent ***D*** **(1 mark)**

(ii) Oxidizing agent $\boldsymbol{R^{2+}}$ **(1 mark)**

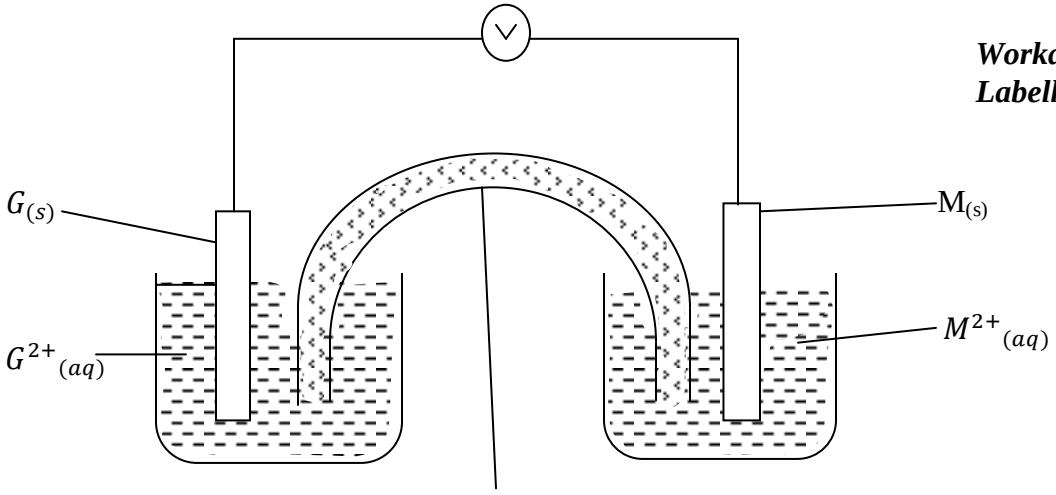
(b) Calculate the e.m.f of a cell made of G and M. **(2 marks)**

$$\boldsymbol{e.m.f = E^\theta R - E^\theta O}$$
$$\boldsymbol{= +0.34 - {}^-2.36}$$
$$\boldsymbol{= +2.70V}$$

(c) Write the cell representation for the above cell in (b). **(1 mark)**

$\boldsymbol{G_{(s)} \left/ G^{2+}{}_{(aq)} \right\| M^{2+}{}_{(aq)} \left/ M_{(s)} \right. ; E = +2.70V}$ ***Penalize for lack of states and E value***

(d) Draw a cell diagram for the cell in (b) above. **(2 marks)**



Workability ✓1
Labelling ✓1

(e) Write the cell reac wn cell diagram in (d) above. **(1 mark)**

$\boldsymbol{G_{(s)} + M^{2+}{}_{(aq)} \longrightarrow G^{2+}{}_{(aq)} + M_{(s)} \; ; E = +2.70V}$

II. Electrolysis of aqueous solution of metal M resulted in the deposition of 1.07g of metal upon passage of a current of 1.32 amperes for 75 minutes.

(M = 52, 1F = 96500C)

(i) Calculate the quantity of electricity passed through the cell. **(1 mark)**

$\boldsymbol{Q = 1t}$
$\boldsymbol{= 1.32 \times 75 \times 60}$ ✓ ½
$\boldsymbol{= 5940C}$ ✓ ½

(ii) Calculate the charge on the metal ion. **(3 marks)**

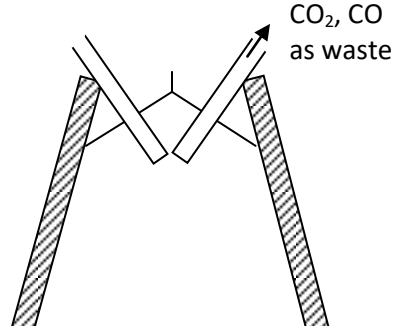
If 1.07g is departed by 5940C
52g " "
$\frac{52 \times 5940}{1.07} = 288,672.8972C$ ✓*1*

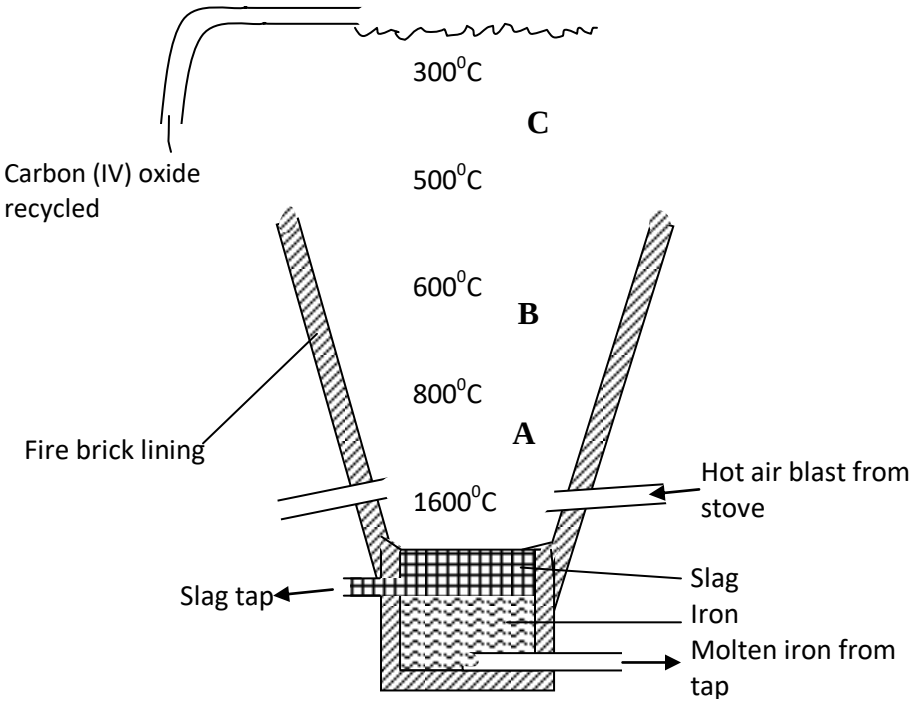
If 1F is 96500C
? " 288672.8972C

$\frac{1 \times 288,672.8972}{96500}$ ✓1

$= 2.994$
$\simeq 3$
$+3$ ✓ 1

7. Extraction of iron involves two main processes, smelting and refining. Below is the blast furnace which is used to smelt iron from its ore.





(a) (i) What does the word smelt mean? **(1 mark)**

Extraction of a metal from its ore using a reducing agent and heat.

(ii) Name the reducing agent in the process. **(1 mark)**

Carbon (in form of coke)

(iii) What is the role of the hot air blast in the process? **(2 marks)**

Hot air reacts with coke to form carbon (IV) oxide producing a lot of heat which melts the iron formed in the blast furnace.

(b) Write equations for the reactions that take place at the region marked A, B and C. **(3 marks)**

A $C_{(s)} + O_{(2)} \longrightarrow CO_{2(g)}$

B $CO_{2(g)} + C_{(s)} \longrightarrow 2\,CO_{(g)}$

C $2Fe_2O_{3(s)} + 3C_{(s)} \longrightarrow 4Fe_{(s)} + 3CO_{2(g)}$

(c) What is the purpose of limestone in the extraction process? **(1 mark)**

To remove silica impurities in the ore.

(f) Write equations to show how impurities are removed from the ore.

(3 marks)

$$CaCO_{3(s)} \xrightarrow{\text{heat}} CaO_{(s)} + CO_{2(g)}$$

$$CaO_{(s)} + SiO_{2(s)} \longrightarrow CaSiO_{3(s)}$$

$$Al_2O_{3(s)} + CaO_{(s)} \longrightarrow \underset{\textit{slag}}{CaAl_2O_{4(s)}}$$