

BSJE 2021

CHEMISTRY

PAPER 2

233/2

MARKING SCHEME

CONFIDENTIAL

1. (a) The table **below** shows the ions of elements **W, X, Y, Z** and their electron arrangement.

The letters do not represent the actual symbols of the element.

Ion	Electron configuration
$8W^-$	2.8.8
X^{2+}	2.8.8
Y^{3+}	2.8
Z^{2-}	2.8

- (i) Which two elements belong to the same period? Give a reason. (2marks)

W and Y Have three energy levels;

- (ii) In which group of the periodic table does Y belong? (1mark)

Group III

- (iii) Write the formula of the compound formed between W and X (1mark)

XW_2

- (iv) What type of bond is formed between W and X. Explain. (2marks)

Ionic bond;
There is complete transfer of 2 electrons from X to W.

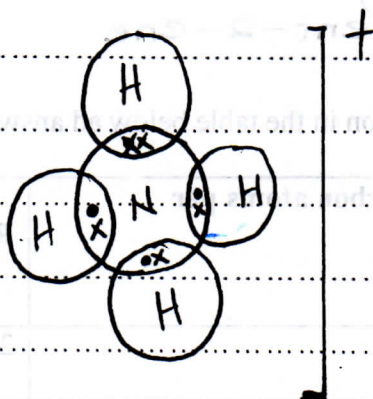
- (b) (i) What is a coordinate bond. (1mark)

Type of bond in which the Shared pair of electrons forming the bond is Contributed by only one of the atoms forming the bond.

- (ii) Draw a dot (.) cross (X) diagram to show bonding in the Ammonium ion.

NH_4^+ ion (N = 7, H = 1)

(2marks)



- c) Aluminum chloride and sodium chloride are both chlorides of period 3 elements.

Use this information to explain the following observations.

- (i) A solution of AlCl_3 in water turns blue litmus paper red while that of sodium chloride does not (1 marks)

AlCl_3 is hydrolysed in water to form HCl and $\text{Al}(\text{OH})_3$; while NaCl is not hydrolysed; HCl is acidic.

- (ii) The melting point of sodium chloride (801°C) is higher than that of AlCl_3 (180°C).

(1marks)

NaCl has a giant ionic structure with stronger ionic bonds while AlCl_3 has simple molecular structure with weaker intermolecular forces.

2. (a) Give the names of the following compounds.

(i) $\text{CH}_3\text{COOCH}_2\text{CH}_3$ (1 mark)

Ethylethanoate

(ii) $\text{CH}_3\text{CHCHCH}_2\text{CH}_3$ (1 mark)

Pent-2-ene

b) Study the information in the table below and answer the questions that follow.

No. of carbon atoms per molecule	Relative molecular mass of hydrogen
2	28
3	42
4	56

(i) Write the general formula of the hydrocarbons in the table. (1 mark)

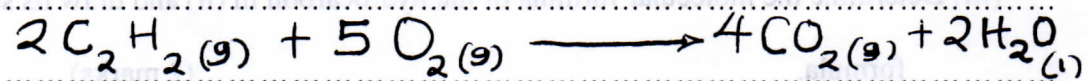
C_nH_{2n}

(ii) Predict the relative molecular mass of the hydrocarbon with 5 carbon

atoms. (1 mark)

70

- (ii) Write an equation for complete combustion of $\text{CH} \equiv \text{CH}$ (1 mark)



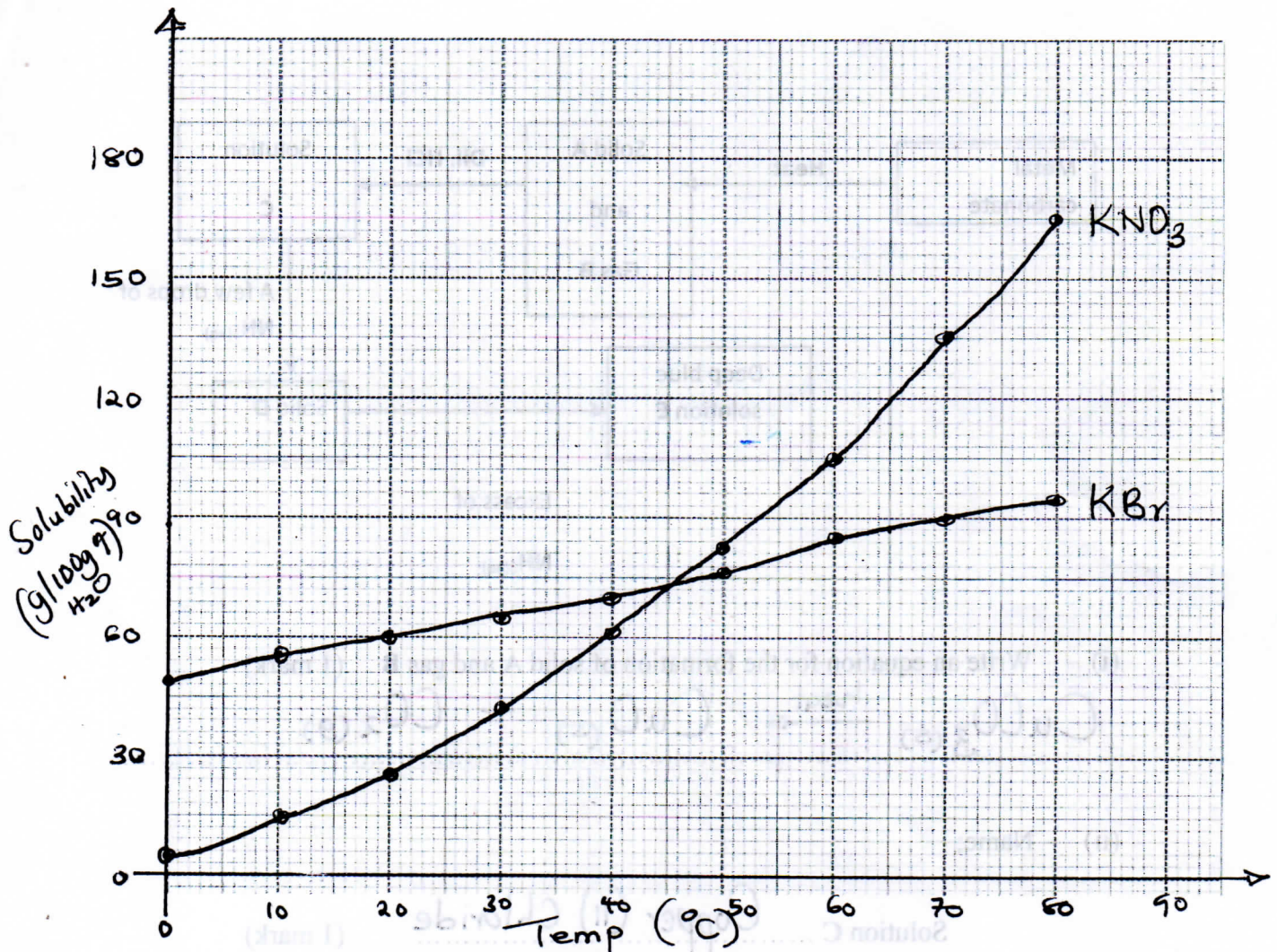
- (iii) Explain one disadvantage of the continued use of items in step III. (1 mark)

pollute the Environment as they do not decompose easily. (They are non-biodegradable - Cannot be digested by microorganisms.)

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

Temperature $^{\circ}\text{C}$		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
	KBr	50	55	60	65	70	77	85	90	95

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



(ii) What was the solubility of each salt at 65°C (1 mark)

KBr - 87 g / 100g of H₂O

KNO₃ - 120 g / 100g of H₂O

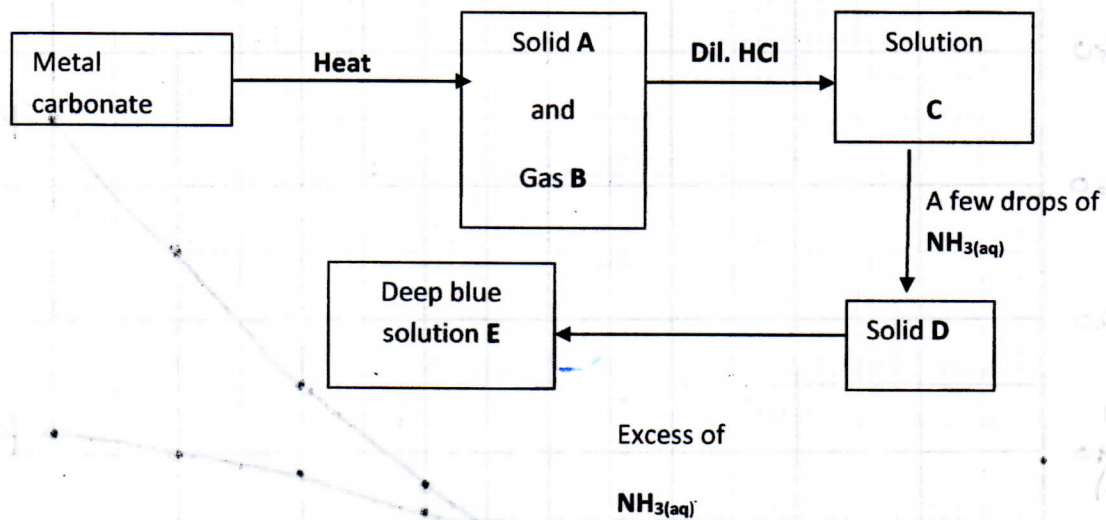
(iii) 100g of a saturated solution of potassium nitrate at 70°C was cooled to

20°C. What mass of the crystals will be crystallized? (2 marks)

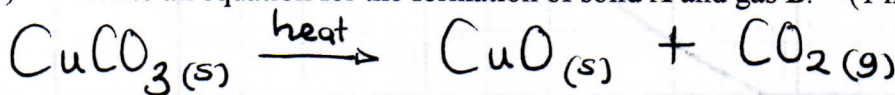
@ 70°C → 135g (135 - 26)g

@ 20°C - 26g = 109g

(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)

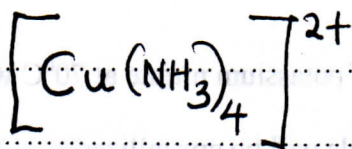


(ii) Name;

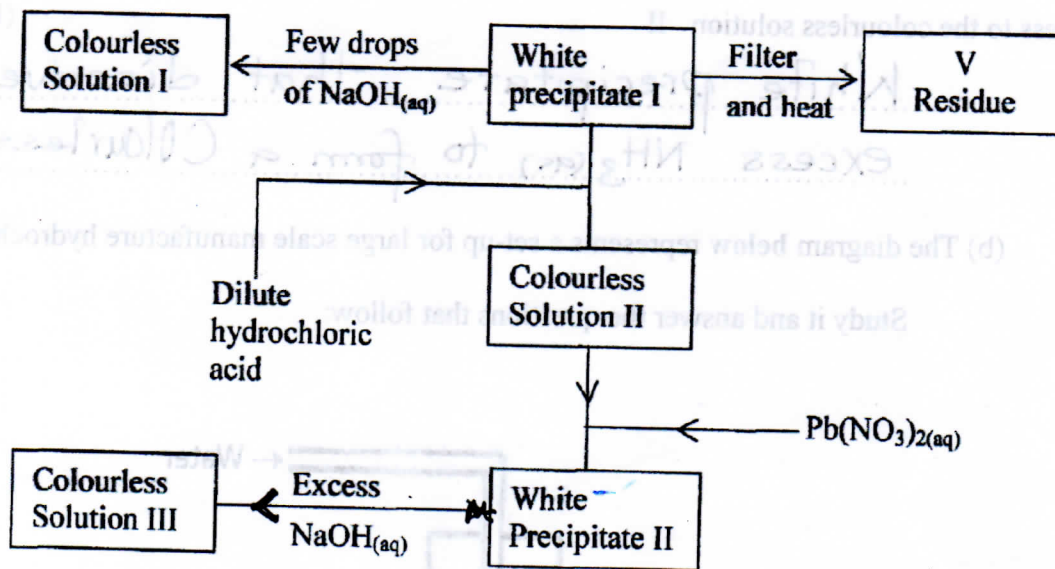
Solution C ... Copper (II) chloride (1 mark)

Solid D ... Copper (II) hydroxide (1 mark)

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



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



Residue V was yellow when hot and white when cold.

(i) Identify

i White precipitate I. (1mark)

Zinc hydroxide, $Zn(OH)_2$

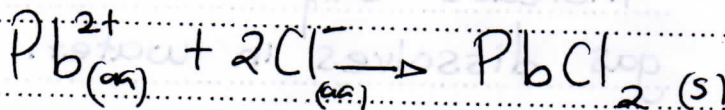
ii Solution II. (1mark)

$ZnCl_2$

iii Residue V. (1mark)

ZnO

(ii) Write an ionic equation for the reaction of solution II with $Pb(NO_3)_2(aq)$. (1 mark)

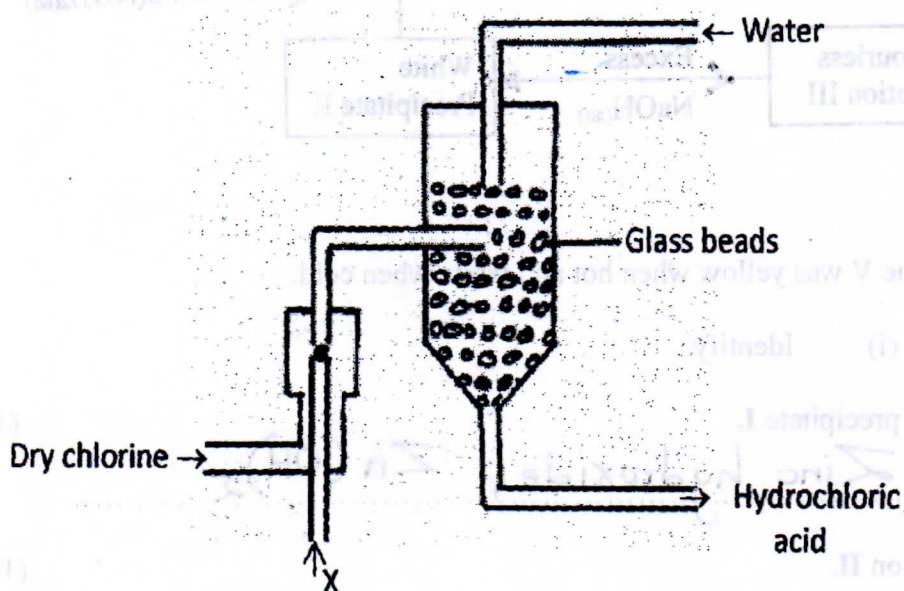


- (iii) Write observations that would be made when ammonia solution is added drop-wise till in excess to the colourless solution II (1 mark)

White precipitate that dissolves in excess $\text{NH}_3(\text{aq})$ to form a colourless solution.

- (b) The diagram below represents a set-up for large scale manufacture hydrochloric acid.

Study it and answer the questions that follow:



- (i) Name substance X. (1 mark)

Dry Hydrogen gas

- (ii) What is the purpose of glass beads? (1 mark)

Increase surface area over which HCl gas dissolves in water.

- (iii) Give one source of substance X used in the above process. (1 mark)

- Cracking of long chain hydrocarbons;
- Reacting Methane gas with Steam;

(iv) Give two uses of hydrochloric acid. (2marks)

Sewage treatment ; Treatment of water

Removing rust from metal ;
making dyes, drugs & photographic materials.

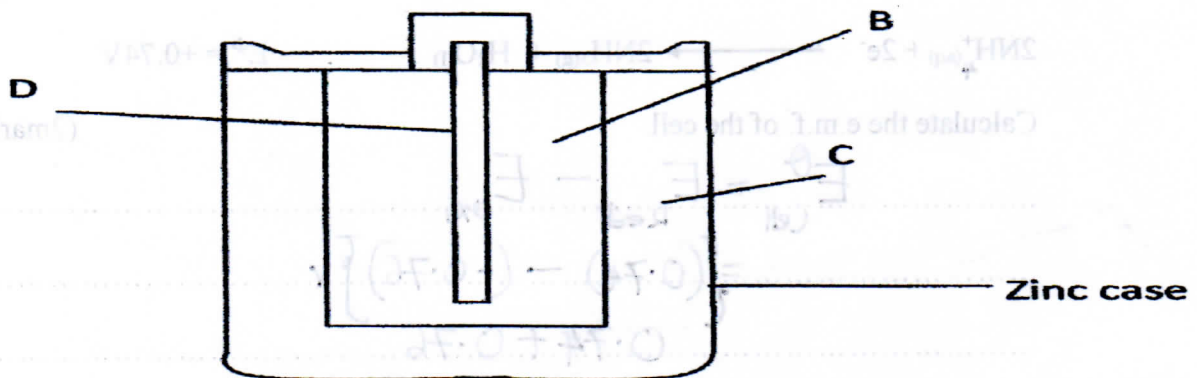
(c) The table below shows the ammeter readings obtained when two different electrolytes the same concentration was tested.

Electrolyte	Ammeter reading (Amps)
Hydrochloric acid	4.0
Ethanoic acid	1.2

Why does Ethanoic acid give a lower ammeter reading? Explain your answer (2marks)

Ethanoic acid is a weak acid ; It dissociates partially to yield few ions hence low ammeter reading.

5. The figure below shows parts of Le'Clanche cell (dry cell).



(a) Name:

(i) Substance D

Carbon (graphite) rod;

(1mark)

(ii) Mixture B

Powdered Carbon and Manganese (iv) Oxide

(1mark)

(iii) Electrolyte C

Ammonium Chloride and Zinc Chloride paste.

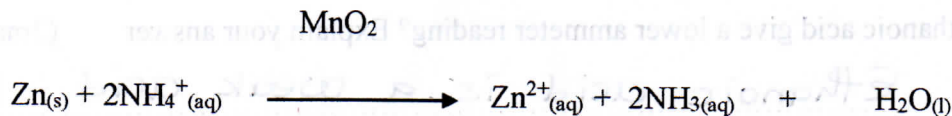
(1mark)

(b) In the cell, the electrolyte is a paste. Explain.

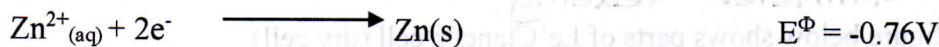
(1mark)

Solid NH_4Cl is a poor electrolyte
(no free ions).

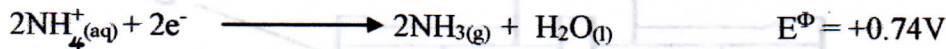
(c) The following reaction occurs when the cell is in use.



Given that:



MnO_2

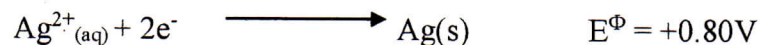
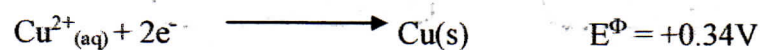
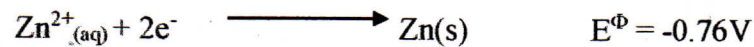


Calculate the e.m.f. of the cell.

(2marks)

$$\begin{aligned} E^\ominus_{\text{Cell}} &= E_{\text{Red}} - E_{\text{Oxi}} \\ &= \{(0.74) - (-0.76)\} \text{V} \\ &= 0.74 + 0.76 \\ &= \underline{\underline{+1.5\text{V}}} \end{aligned}$$

(d) Use the standard reduction electrode potentials given below to answer the questions that follow.



The metal copper, zinc, silver and lead were placed in different solutions as shown:-

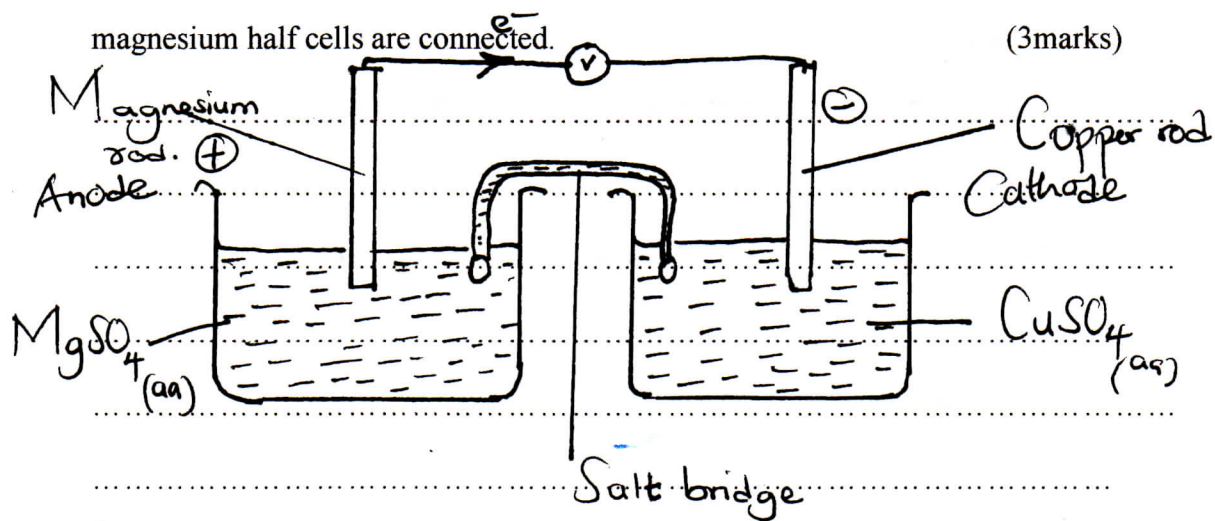
Metal	Metal ion	Reaction / No reaction
Cu	$\text{Ag}^{+}_{(\text{aq})}$	✓
Zn	$\text{Cu}^{2+}_{(\text{aq})}$	✓
Ag	$\text{Pb}^{2+}_{(\text{aq})}$	✗
Pb	$\text{Zn}^{2+}_{(\text{aq})}$	✗

(i) Indicate in the table with a tick (✓) where a reaction occurs and a cross (x) where no reaction occurs. (2marks)

(ii) Identify the strongest reducing agent. (1mark)

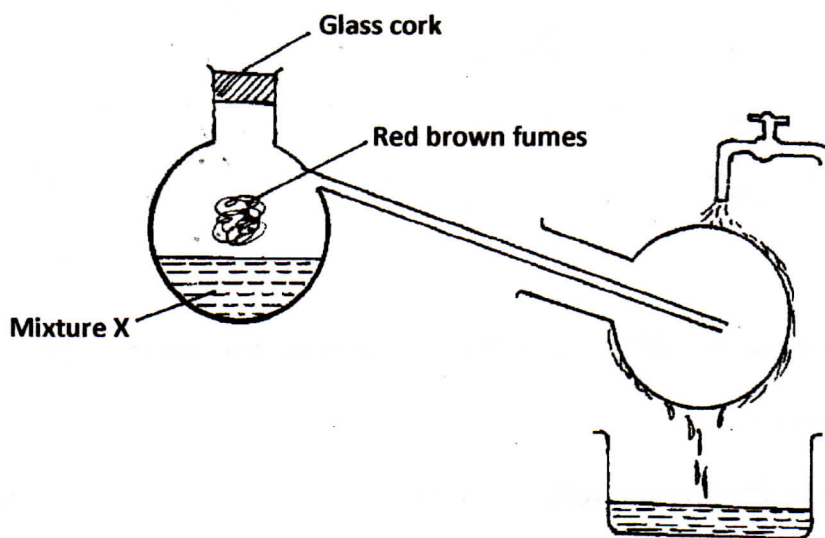
.....
 Zn

(e) (i) Draw a well labeled diagram of the electrochemical cell when copper and



(ii) On the diagram you have drawn in e(i) above, label the anode and the cathode and also show the direction of flow of electrons. (2marks)

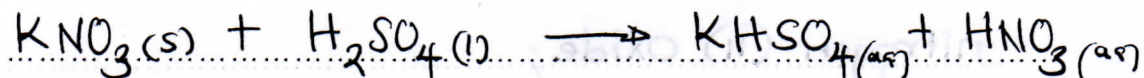
6.) The set up below is used to prepare nitric acid



(i) Name the reagents in mixture X (1mark)

Potassium nitrate
Conc Sulphuric (VI) acid

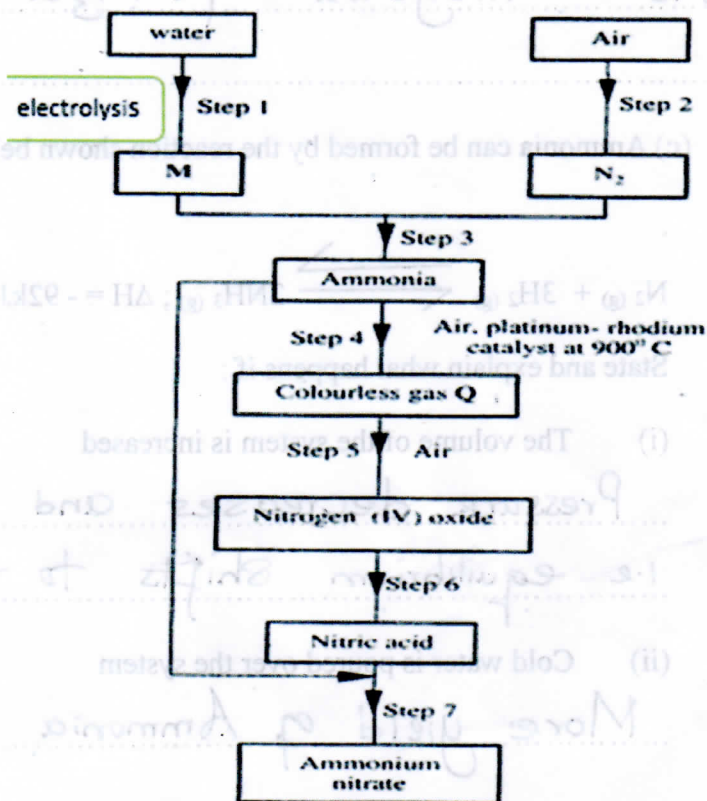
(ii) Write an equation for the reaction which takes place in the glass retort (1mark)



(iii) Explain the reason why the apparatus used is all glass and why heating should be gentle as possible. (2marks)

- HNO_3 attacks rubber and Cork connections;
- Heating should be gentle to minimise thermal decomposition of HNO_3 .

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



(i) Name element M. (1 mark)

Hydrogen

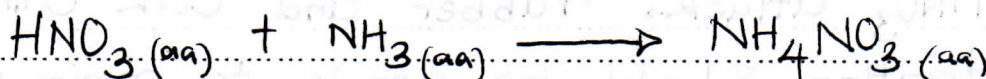
(ii) Why is it necessary to use excess air in step 4? (1 mark)

To ensure all ammonia is converted to nitrogen (II) oxide;

(iii) Identify gas Q. (1 mark)

NO, nitrogen (II) oxide

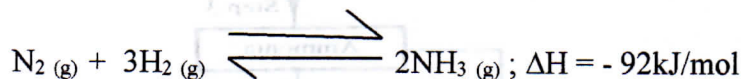
(iv) Write an equation for the reaction in step 7. (1 mark)



(v) Give one use of ammonium nitrate. (1 mark)

As a nitrogenous fertilizer.

(c) Ammonia can be formed by the reaction shown below



State and explain what happens if:

(i) The volume of the system is increased (1 mark)

Pressure decreases and less ammonia yield
i.e. equilibrium shifts to the left hand side.

(ii) Cold water is poured over the system (1 mark)

More yield of Ammonia, which is favoured

by decrease in temperature.

7. In an experiment to determine the heat of combustion of compound X, a pupil used heat from the burning compound of X to heat 100cm^3 of water in a beaker. He obtained the following results.

- (a) Volume of water in the beaker = 100cm^3
- (b) Initial temperature of water = 17°C
- (c) Final temperature of water = 42°C
- (d) Initial mass of burner + compound X = 10.5g
- (e) Final mass of burner + compound X = 10.2g

(i) Determine the mass of the compound burnt?

1 mark

$$10.5 - 10.2 = 0.3\text{g}$$

(ii) Calculate the rise in temperature?

(1 mark)

$$(42 - 17)^\circ\text{C} \\ = 25^\circ\text{C}$$

(iii) Determine the amount of heat produced by the compound

(specific heat capacity $4200\text{J g}^{-1} \text{K}^{-1}$, density of $\text{H}_2\text{O} = 1\text{g/cm}^3$) (2 marks)

$$\Delta H = MC\Delta T \\ = 100 \times 4200 \times 25 \\ = \underline{\underline{1.05 \times 10^7 \text{J}}}$$

(iv) Calculate the molar heat of combustions of compound X

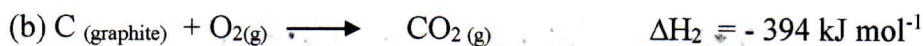
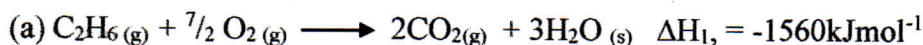
(R.m.m of X = 256)

(2marks)

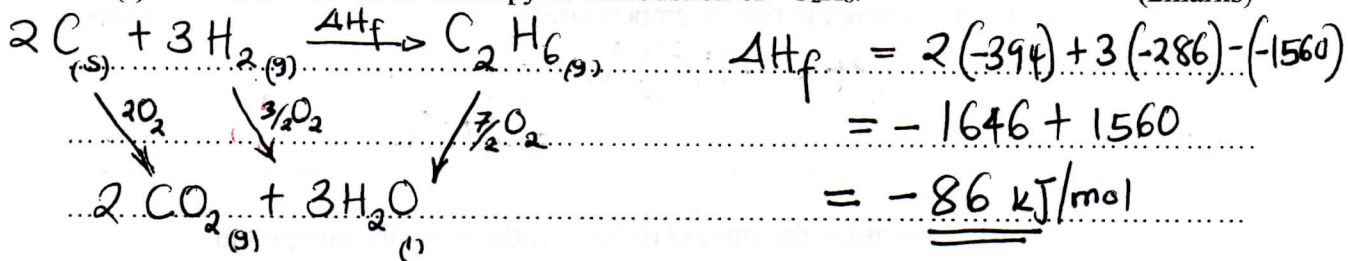
$$\begin{aligned} \text{Moles} &= \frac{\text{Mass}}{\text{RMM}} \\ &= \frac{0.3}{256} = 0.001171 \text{ moles} \end{aligned}$$

$$\begin{aligned} 0.001171 &\text{ mole} \longrightarrow 1.05 \times 10^7 \text{ J} \\ \frac{1.05 \times 10^7}{0.001171} &= -8.96 \times 10^9 \text{ J/mol} \end{aligned}$$

(iii) Use the following thermochemical equations below to answer the questions that follow.



(I) Calculate the molar enthalpy of ^{formation} combustion of C_2H_6 . (2marks)



(ii) Draw an energy level diagram for the reaction represented by equation (i) above (3marks)

