TERM 2 - 2023
CHEMISTRY – PAPER 2 (233/2)
FORM FOUR (4)
MARKING SCHEME

1. (a) Study the information given below and answer the questions that follow.

Element	Atomic radius (nm)	Ionic radius (nm)	Formula of oxide	Melting point of oxide (°C)	Electrical conductivity of oxide in solid or liquid state
A	0.064	0.136	OA_2	-224	Does not conduct
B	0.117	0.040	BO_2	1710	Does not conduct
C	0.125	0.054	C_2O_3	2045	Conducts in molten state
D	0.110	0.212	D_2O_5	563	Does not conduct
E	0.157	0.095	E_2O	1193	Conducts in molten state

(i) Select **two** elements, whose oxides have giant ionic structure (2 marks)

C and E

(ii) Which element is likely to be silicon? Give a reason. (2 marks)

B. its oxide has a high melting point and a poor conductor of electricity

(iii) Explain why the melting point of the oxide of A is lower than that of the oxide of C (2 marks)

Oxide of A exists as a molecular compound with weak van der waals. Oxide of C is a giant ionic compound with strong ionic bonds.

(iv) State the nature of the solution formed when the oxide of D, **D_2O_5** dissolves in water. (1 mark)

Acidic.

(b) Study the information in the table below and answer the questions that follow (The letters do not represent the actual symbols of the elements)

Element	Electronic configuration	Electron affinity(kJ/mol)
F	2.7	-322
G	2.8.7	-349
H	2.8.18.7	-325

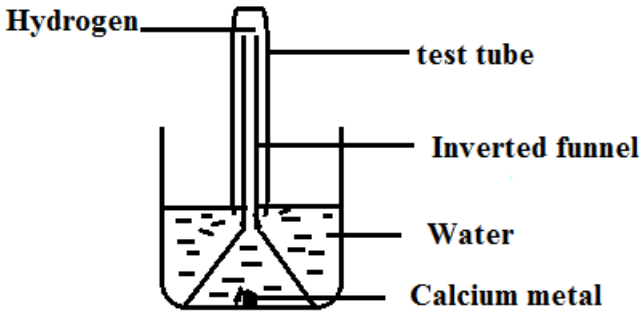
(i) What chemical family do the elements **F, G** and **H** belong? (1 mark)

Halogens

(ii) What is meant by the term electron affinity? (1 mark)

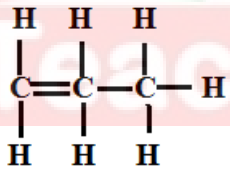
The energy given out/released when an electron attaches to a neutral atom in gaseous state to form an ion.

(c) When a piece of calcium is placed in cold water, it sinks to the bottom and a colourless gas that extinguishes a burning splint with a pop sound is produced. Use a simple diagram to illustrate how this gas can be collected during this experiment. (3 marks)

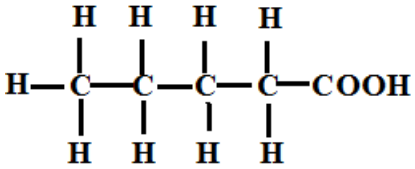


2. (a) Draw the structures of;

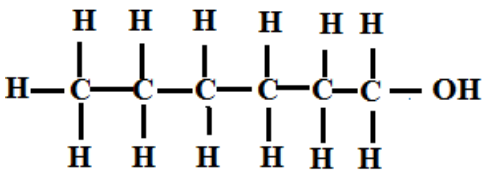
(i) The second member of the alkene homologous series ; (1 mark)



(ii) Pentanoic acid; (1 mark)



(iii) 1-hexanol. (1 mark)



(b) State and explain how propan-1 –ol could be distinguished from propanoic acid (2 marks)

Add a few drops of acidified potassium manganate (VII) to each in separate test tubes. In propan-1 –ol potassium manganate (VII) will change from purple to colourless while in propanoic acid potassium manganate (VII) will remain purple.

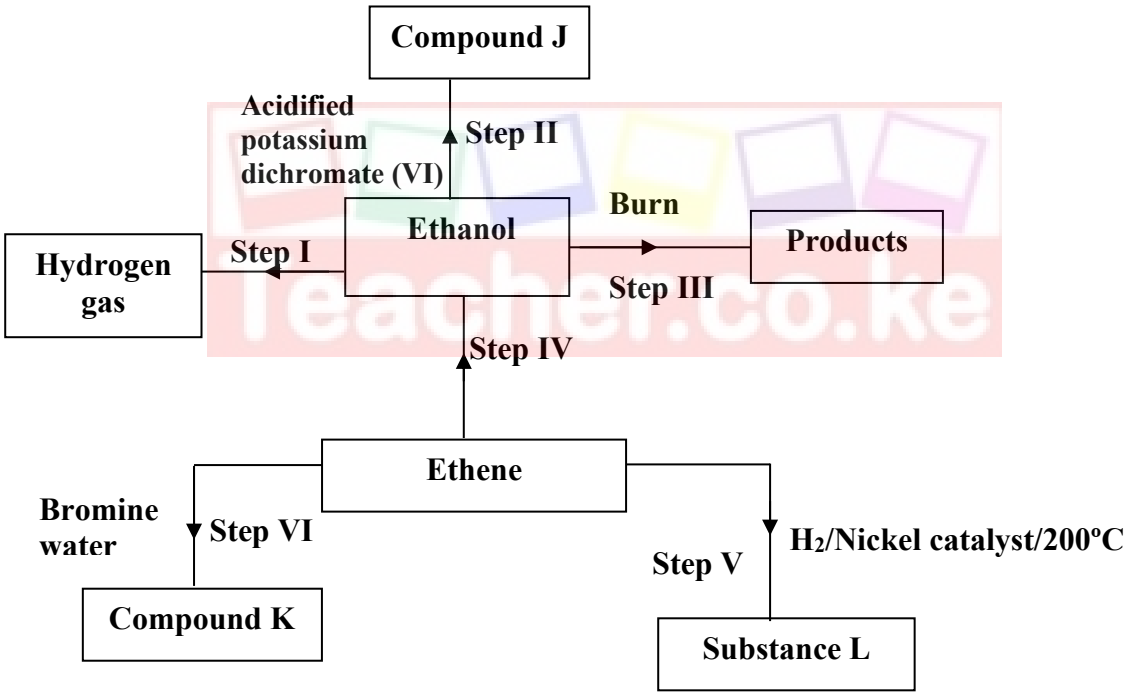
OR

Add a few drops of acidified potassium dichromate (VI) to each in separate test tubes. In propan-1 –ol potassium dichromate (VI) will change from orange to green while in propanoic acid potassium dichromate (VI) will remain orange.

OR

Add sodium hydrogen carbonate/sodium carbonate. In propan-1 –ol no effervescence occurs while in propanoic acid effervescence occurs.

(c) Use the information in the scheme below to answer the questions that follow.



(i) Give the name of;

(I) compound **J** (1 mark)

Ethanoic acid

(II) Compound **K** (1 mark)

2-dibromoethane

(ii) Give the name of the reaction which occurs in step **V** (1 mark)

Hydrogenation

(iii) Write the equation for the chemical reaction in step **III** (1 mark)

$C_2H_5OH_{(l)} + O_2\ (g) \longrightarrow 2CO_2\ (g) + 3H_2O\ (g)$

(iv) Name the reagent(s) and conditions necessary for the reaction step **IV**

Reagent(s) (1 mark)

Water

Condition(s) (1 mark)

300°C, 60 atmospheres pressure, phosphoric (V) acid

(v) State the observations made in step **II** (1 mark)

Acidified potassium dichromate (VI) changes from orange to green.

(d) The two reactions below show how a long chained alkanoic acid can be converted into detergent **M**.

Step I

$$\begin{array}{l} CH_2 - C_{17}H_{35}COOH \\ | \\ CH - C_{17}H_{35}COOH + 3H_2O \longrightarrow 3C_{17}H_{35}COOH + C_3H_8O_3 \\ | \\ CH_2 - C_{17}H_{35}COOH \end{array}$$

Step II

$$3C_{17}H_{35}COOH + 3NaOH \longrightarrow C_{17}H_{35}COONa + 3H_2O$$

(detergent **M**)

(i) Give the name the of reaction in step **II** (1 mark)

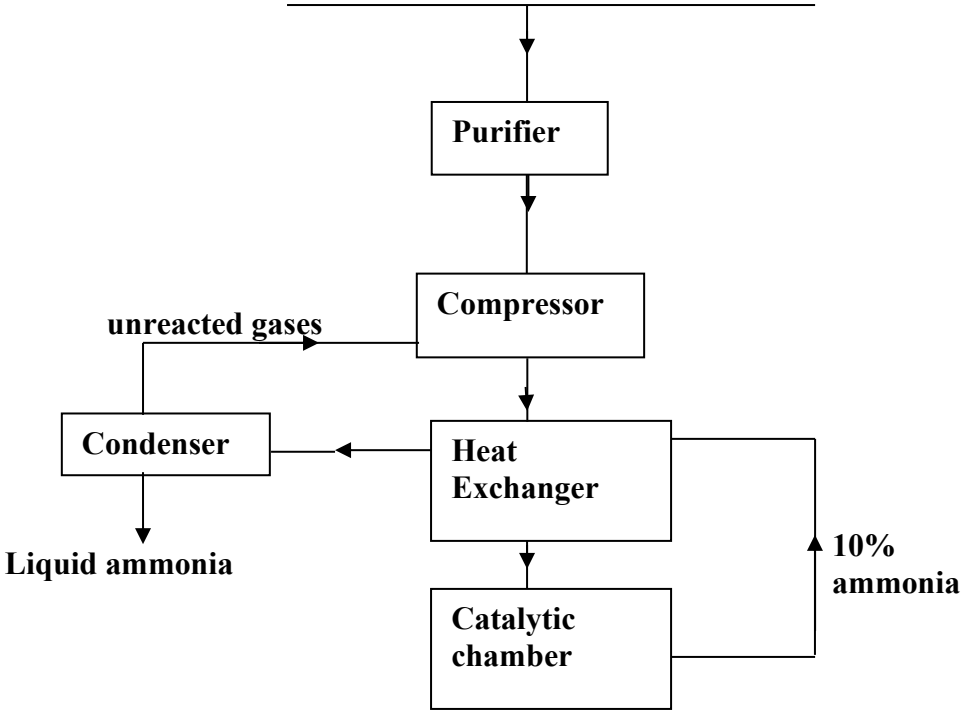
Saponification

(ii) When detergent **M** is added to a beaker containing hard water a scum is formed. Write the formula of the scum. (1 mark)

$(C_{17}H_{35}COO^-)_2\ Ca^{2+}$ Or $(C_{17}H_{35}COO^-)_2\ Mg^{2+}$

3 (a) The diagram below represents an industrial process for the manufacture of ammonia. Study it and answer the questions that follow.

Gas N ↓ **Hydrogen** ↓



(i) Give the name of;

(I) the process above (1 mark)

Haber

(II) Gas **N** (1 mark)

Nitrogen

(ii) Carbon (IV) oxide, sulphur (VI) and dust are the impurities in this process. Give a reason why these impurities are removed. (1 mark)

Poison the catalyst

(iii) Other than iron catalyst, state **two** optimum conditions for this process . (2 marks)

- **Temperature of 450º C,**
- **Pressure of 200 atmospheres**

(iv) Give **two** uses of ammonia (2 marks)

- **As a fertilizer**
- **As a refrigerant**
- **Softening water**

(b) Urea, $(CO(NH_2)_2)$ is prepared by reacting carbon (IV) oxide and ammonia.

(i) Write an equation for the reaction which occurs. (1 mark)

$CO_2(g) + 2NH_3(g) \longrightarrow CO(NH_2)_2\,(aq) + H_2O\,(l)$

(ii) 20 kilograms of urea was applied to a farm and 25 kilograms of ammonium nitrate applied to another farm. Determine the farm enriched with nitrogen.
(C=12, N = 14, O=16, H =1) (4 marks)

Molar mass of urea = 60

Mass of nitrogen 20 kg of urea = $\frac{28\times20}{60}$

=9.33kg

Molar mass of ammonium nitrate = 80

Mass of nitrogen 20 kg of ammonium nitrate = $\frac{28\times20}{60}$

=8.75kg

Farm with urea is enriched with nitrogen since the nitrogen content is higher.

(c) State and explain what would be observed when aqueous ammonia is added dropwise until in excess to a solution of copper (II) chloride. (2 marks)

Blue precipitate soluble in excess to form a deep blue solution.

4. (a) (i) State Le Chatelier's principle (1 mark)

When a chemical system is at equilibrium and one of the factors affecting the equilibrium is altered the equilibrium shifts so as to oppose the change.

(ii) Bromine water can be prepared by dissolving 1 cm^3 of liquid bromine in 100 cm^3 of water. After shaking, the equilibrium below is established.

$Br_2\,(aq) + H_2O\,(l) \rightleftharpoons OBr^-\,(aq) + Br^-\,(aq) + 2H^+\,(aq)$
(Yellow) ***(colourless)***

State and explain the effect of adding sodium hydroxide to the above equilibrium (2 marks)

Sodium hydroxide reacts with hydrogen ions reducing their concentration and this makes the equilibrium shift to the right with the mixture changing from yellow to colourless.

(b) Colloidal sulphur may be formed by reacting sodium thiosulphate and dilute hydrochloric acid as shown in the equation below.

$$Na_2S_2O_3\ (aq) + 2HCl\ (aq) \longrightarrow 2NaCl(aq) + S(s) + SO_2(g) + H_2O\ (l)$$

(i) State and explain the effect of increase in temperature on the rate of the above reaction. (2 marks)

Rate of reaction increases. Increased temperature leads to increased kinetic energy which increases the number of successful collisions

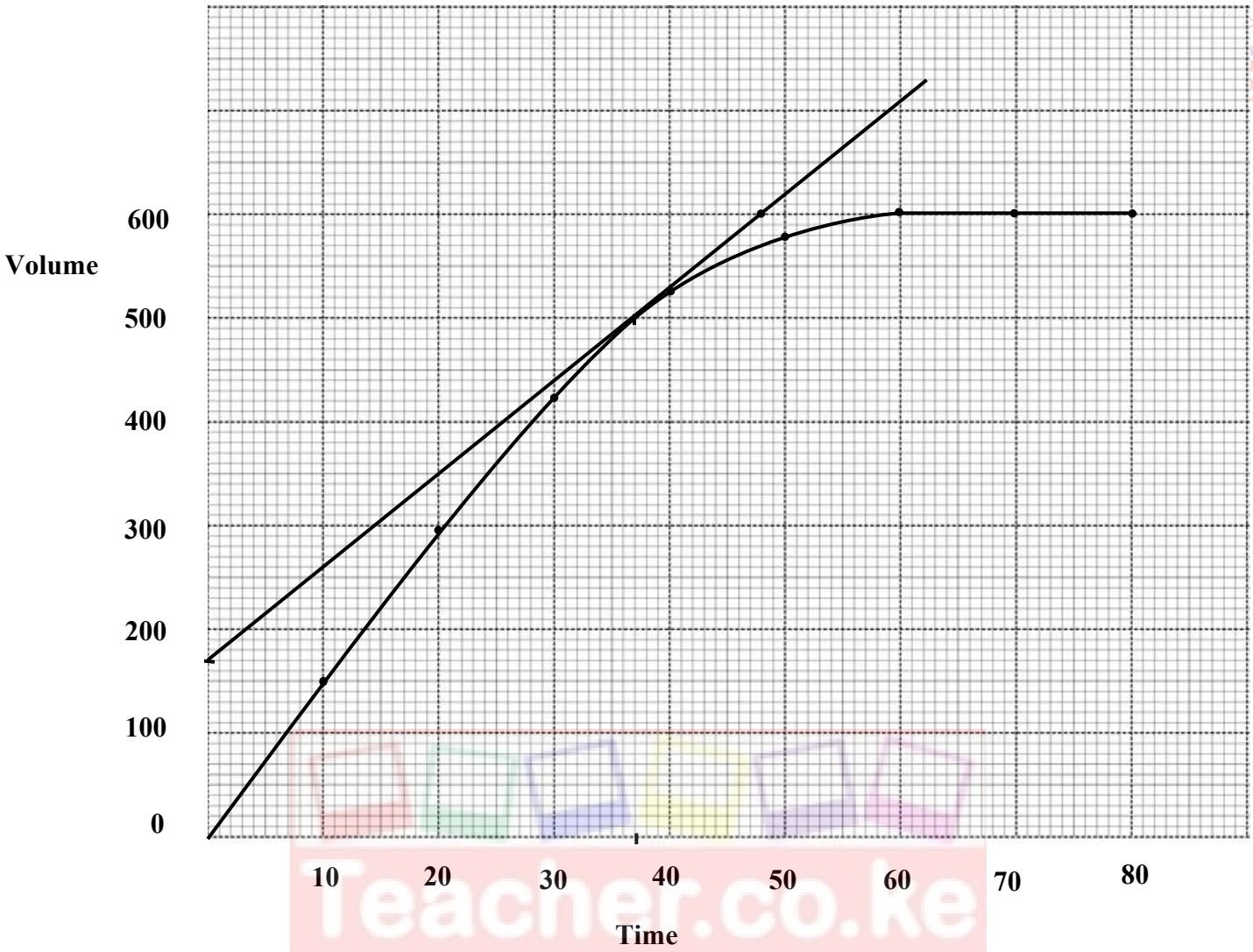
(ii) Other than temperature name **one** factor that can alter the rate of the reaction in b (i) (1 mark)

Concentration

(c) 2.50 grams of a calcium carbonate was reacted with excess 1.8 M hydrochloric acid. The volume of carbon (IV) oxide evolved measured and recorded at 10 second intervals. The results were recorded as shown in the table below.

Time (seconds)	0	10	20	30	40	50	60	70	80
volume of gas (cm^3)	0	150	295	420	525	580	600	600	600

(i) (I) On the grid provided, plot a graph of volume (vertical axis) against time. (3 marks)



(II) From your graph, determine the rate of reaction at 37th second.

(3 marks)

$$\frac{600-170}{37-0} = 11.6216 \text{ cm}^3\text{s}^{-1}$$

5. (a) The table below shows the standard reduction potentials for four half cells. Study it and answer the questions that follow.

Number	Half -reaction	E^0volts
I	$Ag^+_{(aq)} + 2\bar{e} \rightleftharpoons Ag_{(s)}$	+ 0.80
II	$Cu^{2+}_{(aq)} + 2\bar{e} \rightleftharpoons Cu_{(s)}$	+ 0.34
III	$Pb^{2+}_{(aq)} + 2\bar{e} \rightleftharpoons Pb_{(s)}$	- 0.13
IV	$Fe^{2+}_{(aq)} + 2\bar{e} \rightleftharpoons Fe_{(s)}$	- 0.44

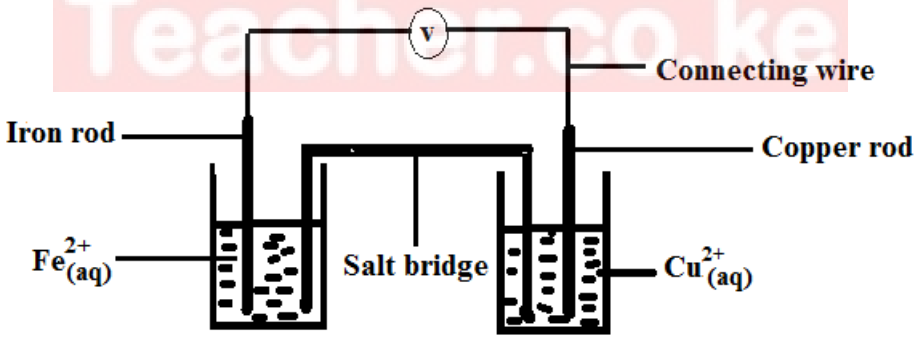
(i) Identify the strongest oxidizing agent (1 mark)

Silver

(ii) Explain why it's not advisable to store a solution of silver nitrate in a container made of lead (2 marks)

Lead is more reactive than silver. Silver ions would accept electrons from lead container as it would undergo oxidation causing the container to wear out.

(iii) In the space provided, draw a labeled diagram of the electrochemical cell that would be obtained when half-cells of copper and iron are combined. (3 marks)



(iv) Calculate the $E^{\ominus}$ of the electrochemical cell constructed in (iii) above. (1 mark)

0.34-(-0.13) =+0.47 V

(b) During the electrolysis of aqueous copper (II) sulphate using copper electrodes, a current of 0.75 A was passed through the cell for 3 hours and 45 minutes.

(i) Write an ionic equation for the reaction that took place at the anode. (1 mark)

$Cu\ (s) \longrightarrow Cu^{2+}(aq) + 2e$

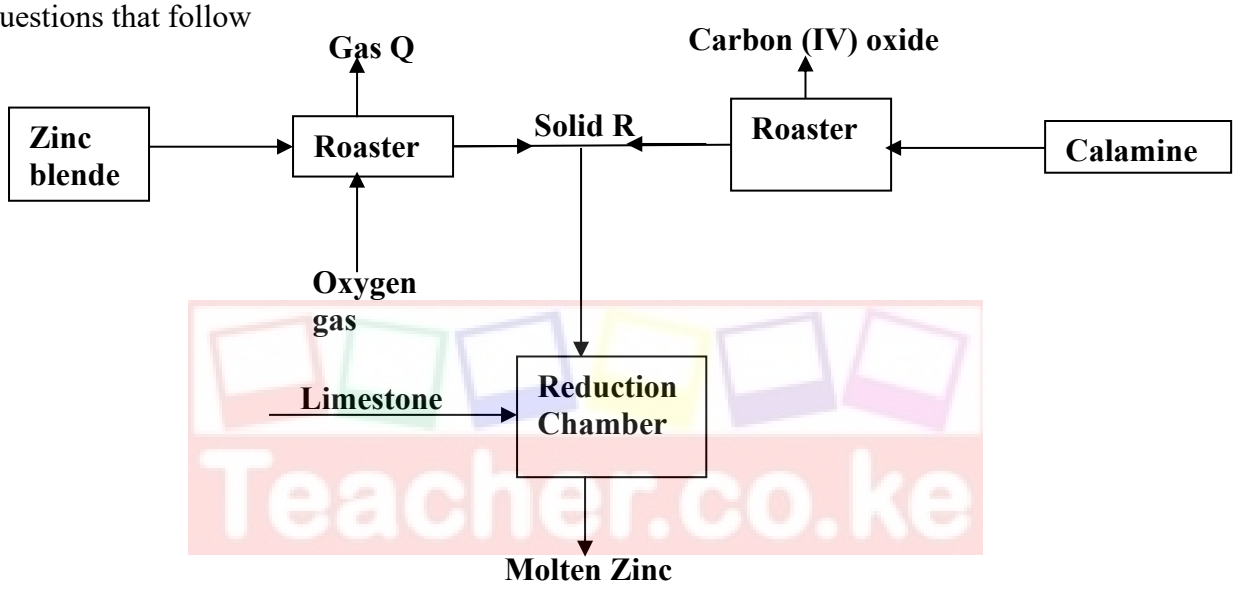
(ii) Determine the change in mass which occurred at the anode as a result of the electrolysis process. (Cu=63.5 1 F = 96,500C) (3 marks)

Q = 0.75× 225×60 = 10 125

$$\textbf{Mass of copper} = \frac{10125 \times 63.5}{193000}$$

= 3.331 g

6. The flow chart below shows the extraction of zinc from zinc ore(s). Study it and answer the questions that follow



(i) Give the formula of the ores;

I zinc blende (1 mark)

ZnS

II Calamine (1 mark)

$ZnCO_3$

(ii) Give the name of;

Solid **R** (1 mark)

Zinc oxide

Gas **Q** (1 mark)

Sulphur (VI) oxide

(iii) Write a chemical equation for the reaction that produces zinc metal (1 mark)

$ZnO\ (s) + CO\ (g) \longrightarrow Zn(l) + CO_2\ (g)$

(iv) What is the purpose of adding limestone in the reduction chamber? (1 mark)

Decomposes upon heating to give carbon (IV) oxide which is in turn reduced to carbon (II) oxide by coke.

(v) Give **two** uses of zinc metal other than galvanizing iron (2 marks)

- **Making brass**
- **Making outer casing of dry cells**
- **Production of die-casting**

(vi) Name **two** other industries that can be established alongside the zinc extraction plant (2 marks)

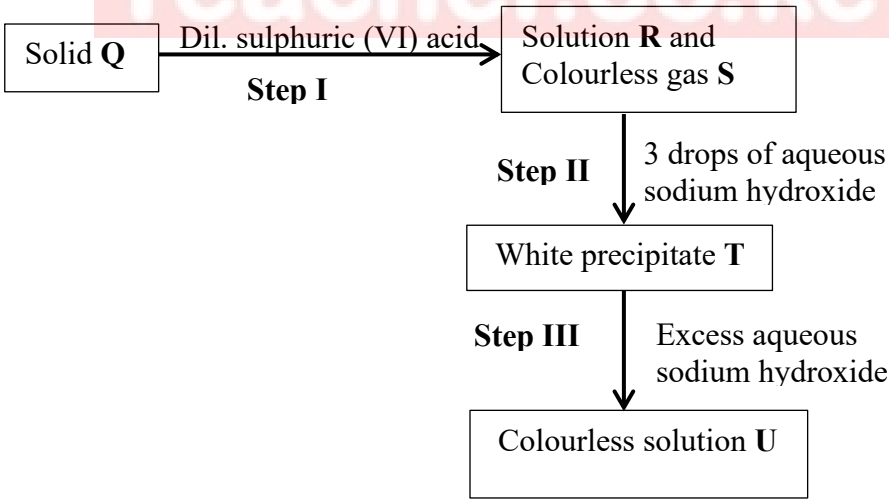
Solvay

Contact

(vii) State **one** way in which the extraction of zinc causes air pollution (1 mark)

Production of sulphur (IV) oxide from heating of zinc blende

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



(i) Identify

I Solid **Q** (1 mark)

Zinc carbonate

II Colourless gas **S** (1 mark)

Carbon (IV) oxide

(ii) Give the formula of the compound in solution **U** (1 mark)

$Zn(OH)_4^{2-}$

(iii) Write the ionic equation for the reaction in step **II** (1 mark)

$Zn^{2+} + 2OH^-(aq) \longrightarrow Zn(OH)_2(s)$

(iv) Give **two** uses of white precipitate **T** (2 marks)

- **Adsorbing agent in medicine**
- **Used in careful dressings to act as a retentive**
- **As an intermediate in industrial processing of pesticides and pigments**

(b) Calculate the number of sulphate ions present in 24.0 cm^3 of 0.25 M aluminium sulphate solution. (L = 6.0×10^{23}) (3 marks)

Moles of aluminium sulphate $= \frac{0.25 \times 24.0}{1000}$

$= 0.006$

Number of SO_4^{2-} ions $= 0.006 \times 6.0 \times 10^{23} \times 3$

$= 1.08 \times 10^{22}$

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