1 **Figure 1** shows part of the periodic table of elements. The letters are not the actual symbols of elements.

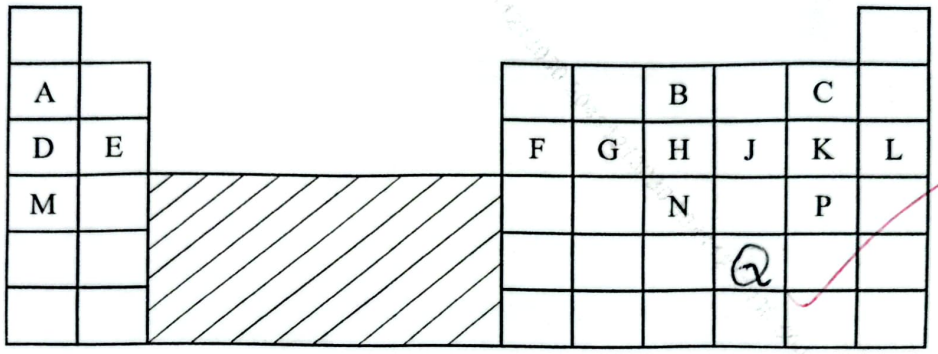


Figure 1

(a) Element **Q** belongs to period **5** and group **VI**. Place the element in the correct position in **Figure 1**. (1 mark)

(b) Consider the following ions: J^{2-}, K^{-} and M^{+}.

(i) Write the electron arrangements for each. (2 marks)

I. J^{2-} 2.8.8

II. K^{-} 2.8.8

III. M^{+} 2.8.8

3 correct – 2mks
2 correct – 1mk
1 correct – ½mk.

(ii) Select the ion with the largest ionic radius. Give a reason. (2 marks)

(S^{2-}) J^{2-} It has the lowest nuclear charge / effective nuclear charge / Lowest No of Protons

(c) Complete **Table 1** by filling in the formula of the compound formed and the type of bond between the elements shown.

Table 1

Element	Formula of compound	Type of bond
A and **B**	A_3B / Li_3N	Ionic / Electrovalent
G and **C**	GC_4 / SiF_4	Covalent

(1 ½ marks)

(1 ½ marks)

(d) Explain the following observations.

(i) Electrical conductivity of element **F** is higher than that of element **E**. (1 mark)

F has more delocalised electrons than E / F has 3 delocalised electrons while E has 2 electrons.

(ii) Element **M** is a stronger reducing agent than element **D**. (1 mark)

M is more readily / easily loses electrons / M has a lower I.E / M is more electropositive or the reverse

(iii) The melting point of element **H** is lower than that of element **N**. (1 mark)

H has smaller atomic size so weaker / less / fewer intermolecular forces / Van-der-Waal forces than N. or (N opposite)

2 **Figure 2** shows the steps in the Contact process.

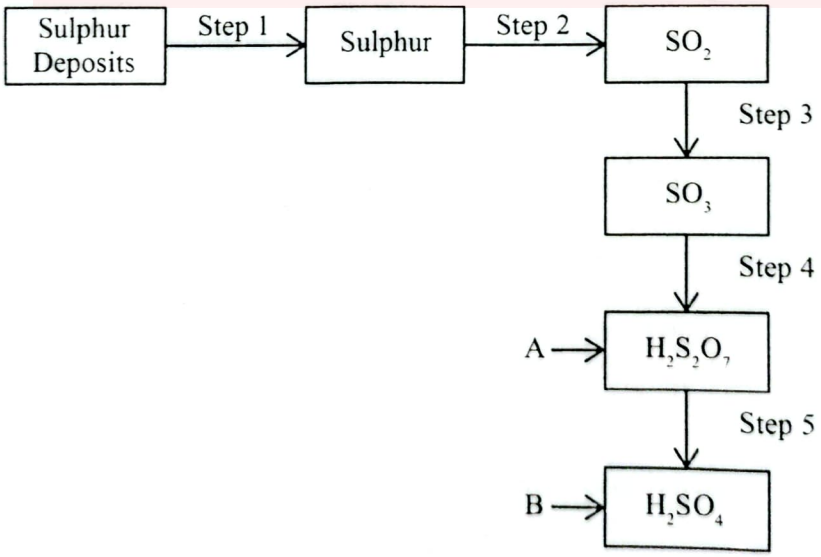
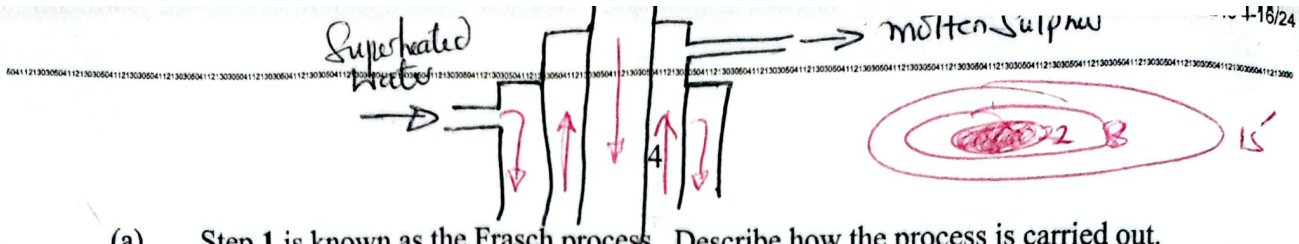


Figure 2



(a) Step **1** is known as the Frasch process. Describe how the process is carried out. (3 marks)

3 concentric pipes are drilled to the underground sulphur deposits ✓½ Superheated water 170°c is pumped thru the outermost pipe to melt ✓½ sulphur. Hot compressed air (10-15 atm) is then forced ✓½ thru the innermost pipe to pump/push/force ✓1 the molten sulphur out thru the middle pipe (2nd pipe) ✓1½

(b) State the optimum conditions used in step **3**. (3 marks)

Catalyst – Vanadium ✓1 oxide (V_2O_5) / platinum Pt / platinised asbestos

Pressure – 2-3 atm ✓1

Temp – 400 – 450°C ✓1

(c) Identify substance:

(i) **A**; (1 mark)

Concentrated sulphuric VI acid / $H_2SO_{4(l)}$ / H_2SO_4 ✓1 reject sulphuric acid

Award sulphuric VI acid.

(ii) **B**. (1 mark)

Water / H_2O ✓1

(d) Name the process that occurs in step **2**. (1 mark)

Oxidation / Roasting / Combustion / Burning ✓1

(e) When concentrated sulphuric(VI) acid is added to glucose, a black solid is formed.

(i) Identify the black solid. (1 mark)

Carbon ($C_{(s)}$) ✓1 reject Charcoal (Coal) Coke

(ii) State the property of concentrated sulphuric(VI) acid illustrated in this reaction. (1 mark)

Dehydrating agent // Dehydration ✓1

3 The formulae of three organic compounds, each having two carbon atoms are:

Compound	A	B	C
Formula	C_2H_4	C_2H_2	C_2H_6

The compounds belong to different homologous series.

(a) State what is meant by the term *homologous series*. (1 mark)

Compounds with the same general formulae but differing with a CH_2 group.

(b) Compound **B** is the first member of its homologous series. Write the formula of the fifth member of the same series. (2 marks)

C_6H_{10} / $H-C\equiv C-\overset{H}{\underset{H}{C}}-\overset{H}{\underset{H}{C}}-\overset{H}{\underset{H}{C}}-\overset{H}{\underset{H}{C}}-H$ or isomers

(c) Explain why compound **A** is described as being unsaturated. (1 mark)

Has a double bond $C=C$ / Carbon does not have the maximum number of hydrogen atoms.

(d) The flowchart in **Figure 3** shows reactions involving compound **B**.

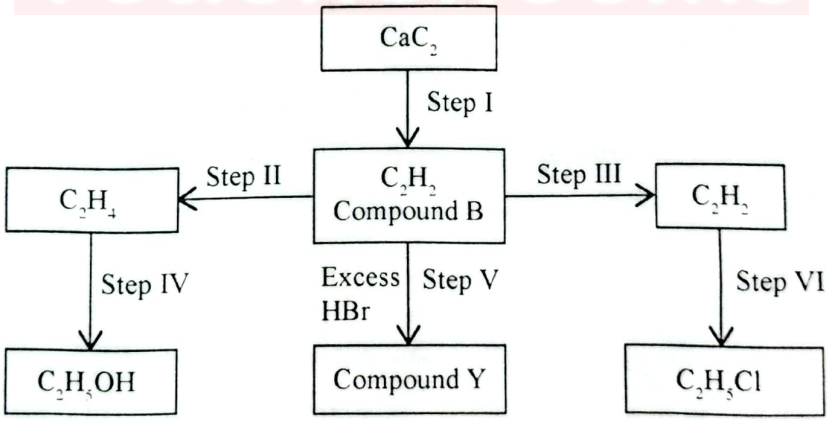


Figure 3

(i) Give the name of the reagent used in:

I. Step **I**; (1 mark)

Water (H_2O)

II. Step **II**. (1 mark)

Hydration / ~~Hydrolysis~~ . Hydrogen H_2 .

(ii) Identify the type of reaction that takes place in:

I. Step **IV**; (1 mark)

Hydration / Hydrolysis

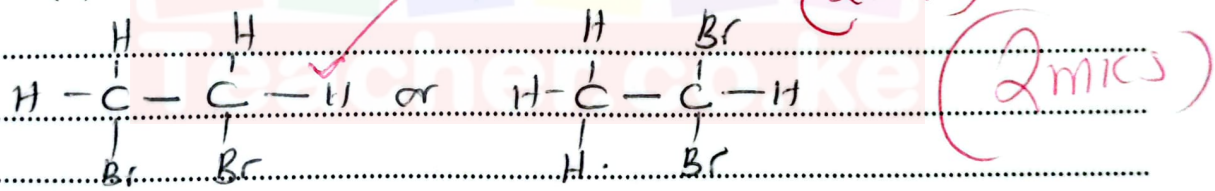
II. Step **VI**. (1 mark)

(iii) State the conditions necessary for carrying out:

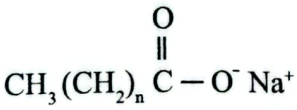
I. Step **III**; (1 mark)

II. Step **VI**. (1 mark)

(iv) Draw the structure of compound **Y**. (1 mark)



(e) The following is a structure of a soap.



(i) Give the name of the main raw material used in making soaps. (1 mark)

Fat / oil ✓ reject lipids / fatty acids

(ii) Given two soaps, one with n = 16 and the other with n = 10, explain which one of the soaps is more effective in washing clothes. (2 marks)

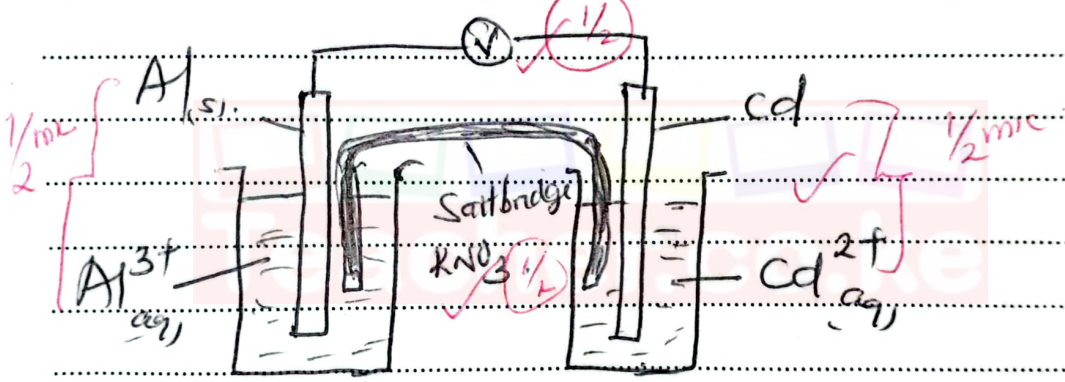
The soap with n = 16 ✓ it has a longer tail / (3 mks)
hydrophobic carbon chain which interacts with non-polar dirt (grease)
more effectively. ✓

4 **Table 2** shows standard reduction potentials for given half cells.

Table 2

Half cell reaction		E^{θ}, Volts
I	$Ni^{2+} + 2e \longrightarrow Ni$	– 0.25
II	$Cd^{2-} + 2e \longrightarrow Cd$	– 0.40
III	$Al^{3+} + 3e \longrightarrow Al$	–1.66
IV	$MnO_4^- + 8H^+ + 5e \longrightarrow Mn^{2+} + 4H_2O$	+1.52
V	$Fe^{2+} + 2e \longrightarrow Fe$	– 0.44
VI	$Ag^- + e \longrightarrow Ag$	+ 0.80

(a) (i) Draw a labelled diagram of an electrochemical cell using half cells **II** and **III**. (2 marks)



(ii) Calculate the e.m.f of the cell. (1 mark)

$E_{cell} = E_{red} - E_{oxid}$

$= -0.40 - (-1.66)$

$= +1.26\,V$

(iii) Write the equation for the electrochemical cell. (1 mark)

$2Al_{(s)} + 3Cd^{2+}_{(aq)} \longrightarrow 2Al^{3+}_{(aq)} + 3Cd_{(s)}$

(b) **Table 3** shows colours of aqueous ions.

Table 3

Ions	Colour
Manganese(II)	Almost colourless
Manganate(VII)	Purple
Nickel(II)	Green

State the observations made when a nickel rod is left standing in a beaker containing aqueous potassium manganate(VII). Explain. (2 marks)

Nickel dissolves / reacts / corrode ½
Purple to colourless.

Observations:

The colour of soln changes from purple to green (1)

Explanation:

Colour of Manganate VII changes to almost colourless ½
because Manganese is reduced by nickel which is a
strong reducing agent. The colour of soln
changes to green because nickel rod is oxidized to
Ni^{2+} ions. ½

or $2MnO_4^-_{(aq)} + 16H^+_{(aq)} + 5Ni_{(s)} \rightarrow 5Ni^{2+}_{(aq)} + 2Mn^{2+} + 8H_2O$ (1)

Purple Green.

(c) (i) One of the uses of electrolysis is in electroplating. State **one** other use. (1 mark)

- Extraction of some metals / more reactive / Na, Al
- Purification of metals
- Synthesis of Chemicals eg H_2 O_2 NaOH Cl_2
- Anodizing of Aluminium.

(ii) Silver is used to electroplate metals such as iron. State **two** properties of silver that make it suitable for this application. (2 marks)

(1) It is attractive / Shiny / Beautiful / pleasant to see. ½

(2) Reacts slowly / Less reactive / Doesn't corrode ½

reject Unreactive

(iii) **Figure 4** shows a set-up of an electrolytic cell used to electroplate an iron rod using silver.

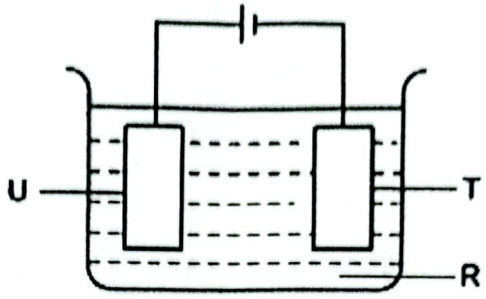


Figure 4

Identify **R**, **T** and **U** in **Figure 4**. (3 marks)

R: Silver fluoride / Silver acetate / Silver sulphate Ag_2SO_4 Silver Nitrate solution $AgNO_3$ / ~~Silver Sulphate~~ ~~Ag_2SO_4~~ / $Ag^+_{(aq)}$.

reject Silver soln.

T: Iron rod (Fe)

U: Silver (Ag)

5 (a) Explain how each of the following affects the rate of reaction:

(i) decrease in temperature; ($1\frac{1}{2}$ marks)

Leads to decrease in the rate of reaction because the K.E of the reactants is reduced leading to decreased number of effective / successful / fruitful collisions.

(ii) increase in surface area. ($1\frac{1}{2}$ marks)

Leads to increase in the rate of reaction because there is increased contact area for more successful / fruitful effective collision to take place.

(b) Using a 250 ml volumetric flask, a burette and 12.0 M hydrochloric acid, describe how a standard solution containing 250 cm³ of 0.5 M hydrochloric acid can be prepared. (3 marks)

$C_1V_1 = C_2V_2$ ½ = 10.4 cm ½

$12.0\text{ M} \times V_1 = 0.5\text{ M} \times 250\text{ cm}^3$

Place 10.4 cm³ of 12.0 M HCl in a 250 ml volumetric flask and top up to 250 ml mark with distilled water. The soln formed is 0.5 M HCl.

(c) 5.0 g of zinc powder was reacted with 25.0 cm³ of 0.5 M hydrochloric acid. The volume of gas produced was measured every 10 seconds. **Table 4** shows the data obtained.

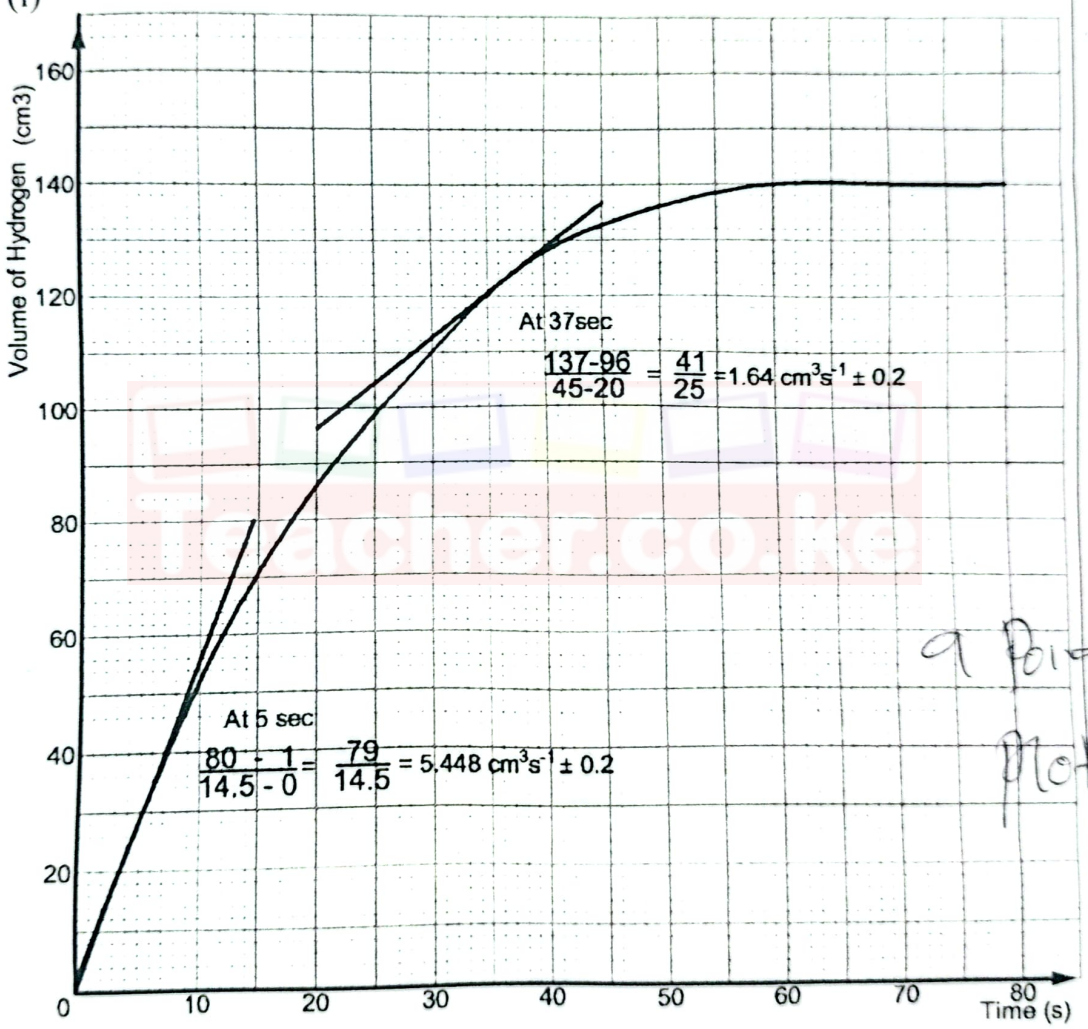
Table 4

Time (seconds)	0	10	20	30	40	50	60	70	80
Volume of hydrogen gas (cm³)	0	52	86	110	128	136	140	140	140

Question	Responses	Marks

Time (Seconds)	0	10	20	30	40	50	60	70	80
Volume of hydrogen gas (cm^3)	0	52	86	110	128	136	140	140	140

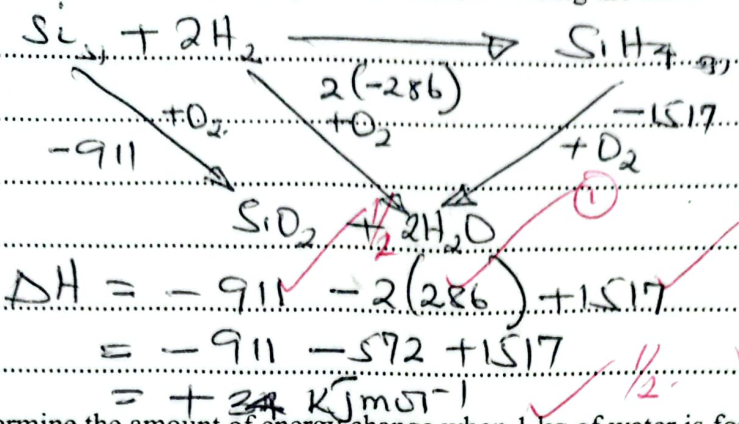
(i)



3 marks

Scale (1)
Labelling (1)
Curve (1)

Calculate the enthalpy change for this reaction using the information in **Table 5**. (3 marks)



(c) Determine the amount of energy change when 1 kg of water is formed.

(H = 1.0; O = 16.0). (1 mark)

18g → -286 KJ
1000g → ?
1000 X -286 / 18 = -15888.89 KJ = -15888.9 KJ
½ ½
ignore the sign
15889.

(d) Heating value of a fuel is the amount of heat energy released when 1 g of a substance undergoes combustion. Calculate the heating value of carbon and hydrogen using the following information.

$C(s) + O_2(g) \longrightarrow CO_2(g)$; $\Delta H_c^\theta = -393$ kJmol^{-1}

$H_2(g) + \frac{1}{2}O_2(g) \longrightarrow H_2O(l)$; $\Delta H_c^\theta = -286$ kJmol^{-1}

(C = 12.0; H = 1.0; O = 16.0).

(i) Carbon. (1 mark)

12g = -393KJ
1g = ?
1g X -393 / 12 = -32.75KJ/g
½ ½
ignore the sign.

(ii) Hydrogen. (1 mark)

2g = -286KJ
1g = ?
1 X -286 KJ / 2 = -143KJ/g
½ ½

(e) Metals **V**, **W** and **X** displace copper from its compounds. Describe an experiment that can be carried out to arrange the three metals in order of their reactivity with copper using aqueous copper(II) sulphate and a thermometer. (3 marks)

- Place equal volumes/moles/particular volume of aqueous $CuSO_4$ in 3 beakers.
- To each beaker add excess of each metal powder
- The reaction with the highest temperature is the most reactive metal.

7 (a) There are two types of water hardness. One type is permanent hardness caused by the presence of calcium and magnesium ions.

(i) I. Give the name of the other type of water hardness. (1 mark)

Temporary

II. Name the ion responsible for the type of water hardness named above. (1 mark)

HCO_3^- (Hydrogen Carbonate)

(ii) State **one** natural source of calcium ions in river water. (1 mark)

Dissolution of Calcium containing rocks/Limestone/Gypsum by water and acid rain.

(iii) Describe how ion exchange can be used to remove permanent hardness in water. (2 marks)

Ion exchange uses resins containing either Sodium or hydrogen ions that exchange with Mg^{2+} and Ca^{2+} ions hard water is passed thru the resin and ions are replaced with Sodium or hydrogen.

(b) **Figure 5** shows solubility curves of KNO_3 and KCl in grams per 100 g of water.

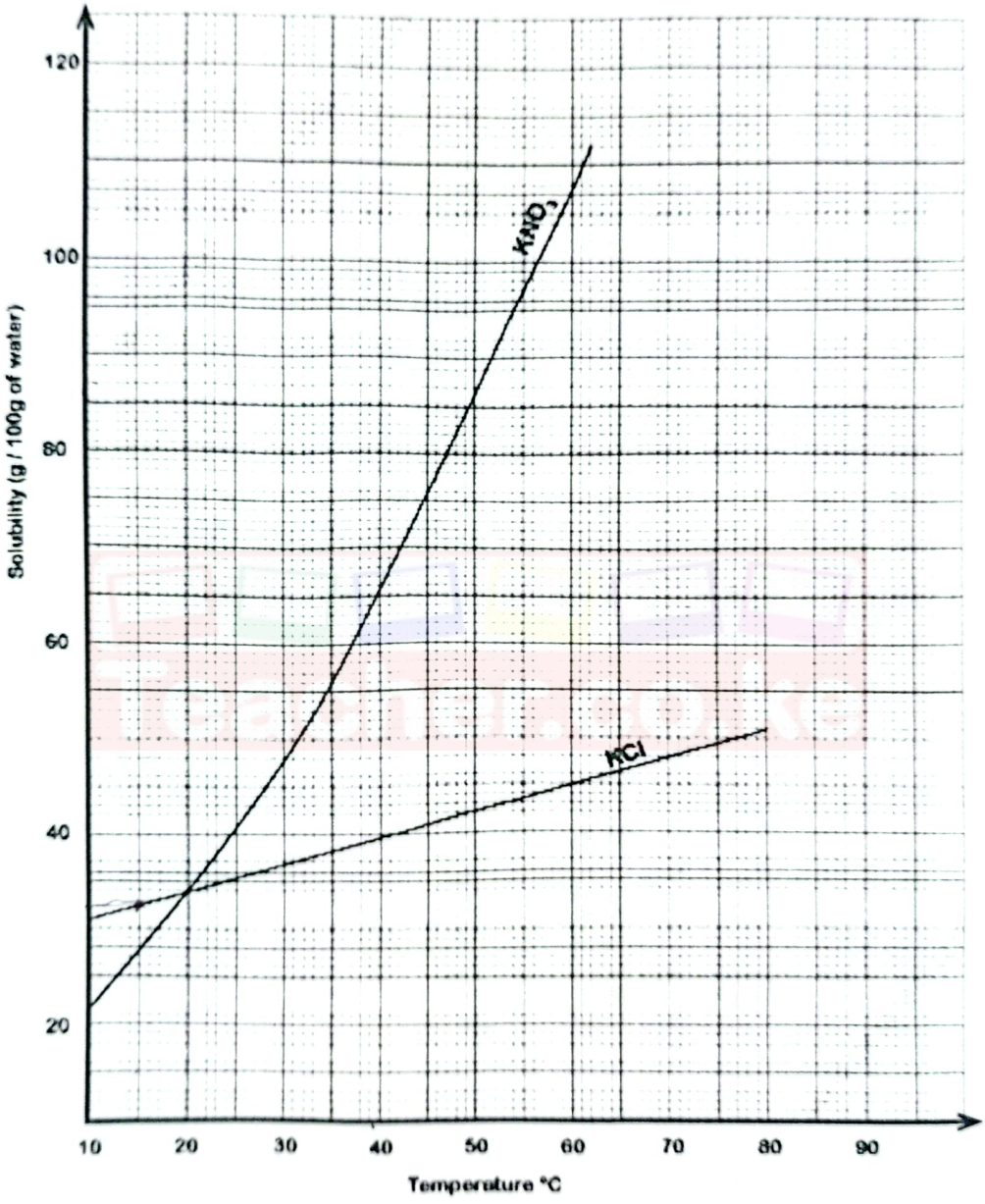


Figure 5

(i) State the temperature at which the solubility of potassium chloride is the same as that of potassium nitrate. (1 mark)

20°C ± 1°C. (1)

(ii) A solution that contains 40 g of potassium chloride in 100 g of H_2O is cooled slowly from 75 °C.

I. State the temperature at which crystals start to form. (1 mark)

40°C ± 1°C

II. Determine the mass of potassium chloride that will form if the solution is cooled to 15 °C. (1 mark)

40.0 − 32.5

= 7.5g ± 0.5g.

(iii) 40 g of potassium nitrate is dissolved in 50 g of water at room temperature. If the mixture is slowly heated, determine the lowest temperature at which all the solid dissolves. (2 marks)

40g ⟶ 50g of water

? ⟵ 100g of water

$\frac{100g \times 40g}{50g}$ = 80g/100g of water

T = 46°C ± 1°C

THIS IS THE LAST PRINTED PAGE.