1. Below is part of the periodic table. The letters are not the actual symbols of the elements. Study it and answer the questions that follow.

							Q
C	E	G			L	N	
D	F						

a. i. State and explain the difference in the melting points of D and F (2mks)

F has a higher melting point than D because it has a greater nuclear charge/ more delocalised

ii. Explain the difference in the atomic radii of G and N (2mks)

G has a larger atomic radius than N. N has a greater nuclear charge thus pulls electrons closer to the nucleus reducing the atomic radius

iii. Select the element that is the strongest reducing agent. Explain. (2mk)

D has the largest atomic radius thus easily loses its electrons.

iv. Compare the nature of the aqueous solution of the oxide of C and that of L. explain. (2mks)

Oxide of C is basic/alkaline while oxide of L is acidic. This is because oxide of C dissolves in water to form OH^- while oxide of L H^+

b. Study the table below and answer the questions that follow.

SUBSTANCE	M.P(K)	B.P(K)	ELECTRICAL CONDUCTIVITY	
			SOLID	MOLTEN
J	365	463	NIL	NIL
K	1323	2773	GOOD	GOOD
L	1046	1680	NIL	GOOD
M	2156	2776	NIL	NIL

c. Which of the substances J, K, L and M represent the following;

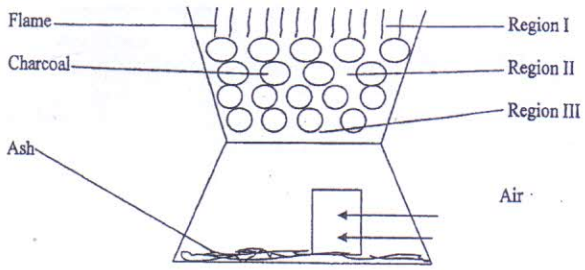
i. Silicon (IV) oxide..... M ..... (1mk)

ii. Barium sulphate..... L ..... (1mk)

d. In terms of structure and bonding, explain why silicon (IV) Chloride ($SiCl_4$) is a liquid at room temperature while Magnesium ($MgCl_2$) is a solid. (2mks)

$SiCl_4$ contain simple molecular structure with weak van-der-waals forces while $MgCl_2$ has giant ionic structure with stronger ionic bond

2. The diagram below represents a charcoal burner. Study it and answer the questions that follow.



a. Write equations for the reactions taking place at (3mks)

I. $2CO_{(g)} + O_{2(g)} \longrightarrow 2CO_{2(g)}$ ✓I Check on states must be balanced.

II. $CO_{2(g)} + C_{(s)} \longrightarrow 2CO_{(g)}$ ✓I

III. $C_{(s)} + O_{2(g)} \longrightarrow CO_{2(g)}$ ✓I

b. State the color of the flame. (1mk)

Blue ✓I

~~pH = 8, 9, 10 Reject the range~~

c. The ash that collects in the lower compartment was dissolved in water and filtered.

i. Suggest the PH of the solution. (1mk)

pH = 8, 9 or 10 ✓I Reject the range.

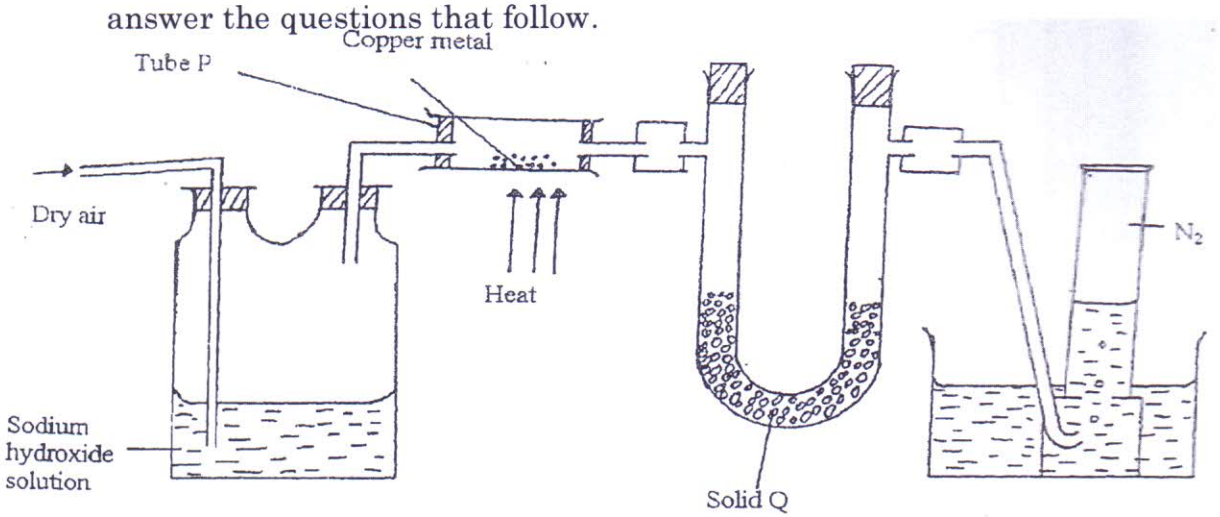
d. Carbon (II) oxide can be prepared in the laboratory by a process represented below.

$$(COOH)_2 \xrightarrow{Con H_2SO_4} CO_{2\,g)} + CO_{(g)} + H_2O_{(l)}$$

i. What role does concentrate Sulphuric (VI) acid play in the reaction.
(1mk)
Dehydrating agent | Removes elements of water from oxalic acid. ✓I

ii. How would you remove carbon (IV) oxide from carbon (II) oxide?
(1mk)
Pass the gaseous mixture through KOH or NaOH ✓I

3. The diagram below represents a set-up that was to obtain dry nitrogen from air. Study it and answer the questions that follow.



i. State the observation in the in the tube P
(1mk)
A black solid | deposit is formed ✓I

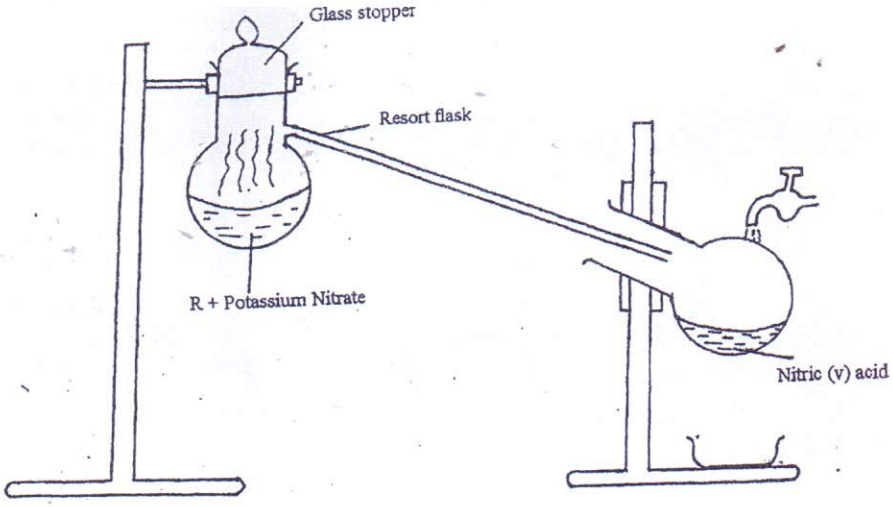
ii. What is the purpose of $NaOH_{(aq)}$?
(1mk)
To absorb $CO_{2(g)}$ ✓I

iii. Write an equation for the reaction which took place in tube P
(1mk)
$2Cu_{(s)} + O_{2(g)} \longrightarrow 2CuO_{(s)}$ ✓I must be balanced

iv. Give the name of one impurity in the nitrogen gas obtained.
(1mk)
Noble gas | Argon ✓I

v. Why is liquid nitrogen used for storage of semen for artificial insemination?
(1mk)
Has a low temperature ✓I

b. The set-up below was used to prepare nitric acid



i. Give the name of liquid R (1mk)

Concentrated sulphuric (VI) acid Penalize fully dil. H_2SO_4.

ii. Write an equation for the reaction which took place in the glass retort. (1mk)

$KNO_{3(aq)} + H_2SO_{4(l)} \longrightarrow KHSO_{4(s)} + HNO_{3(aq)}$

iii. Explain the following

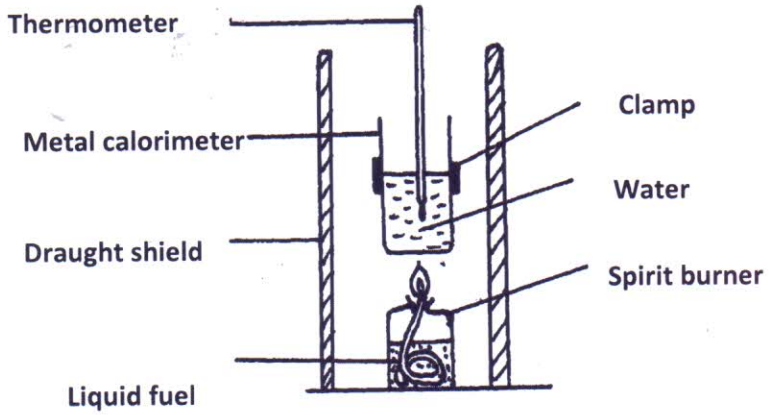
a. Nitric acid is not stored in transparent glass. (2mks)

Easily decomposes when exposed to light hence forming $NO_{2(g)}$ and $H_2O_{(l)}$.

b. The reaction between copper metal with 50% nitric acid (one volume of acid added to an equal volume of water) in an open test tube forms brown fumes. (2mks)

NO gas produced reacts with atmospheric air (O_2) forming $NO_{2(g)}$ which is brown in colour.

4. The diagram below shows the set-up of the apparatus used by a student to determine the enthalpy change of combustion of ethanol. The heat produced by burning fuel warms a known mass of water.



Results
Volume of water in the beaker = 500 cm^3
Initial temperature of water= 12^0C
Final temperature of water = 31.5^0C
Mass of ethanol burnt = 1.50g
Density of water = 1 g/cm^3
Specific heat capacity = 4.2 $Jg^{-1}K^{-1}$

(a) Define molar heat of combustion. *(1 mark)*

Enthalpy change that occurs when 1 mole of a substance is completely burnt in oxygen

(b) (i) Calculate the heat required to raise the temperature of the water from 12^0C to 31.5^0C. *(2 marks)*

MCΔT $\Delta T = 31.5 - 12$
$= 19.5^\circ C$

$500\,g \times \frac{4.2\,J}{g\,K} \times 19.5\,K$

$= 40,950\,J$ or $40.95\,kJ$

(ii) Find the molar enthalpy of combustion of ethanol. *(2 marks)*
$(C = 12, H = 1, O = 16)$ RFM of $C_2H_5OH = 46$ ✓½

Moles of $C_2H_5OH = \frac{1.5}{46}$ ✓½

$= 0.0326$ moles

If 0.0326 = 40.95 kJ

1 mole = ?

$\frac{1 \times 40.95}{0.0326}$ ✓½

$= -1,256.1 \text{ kJmol}^{-1}$ ✓½

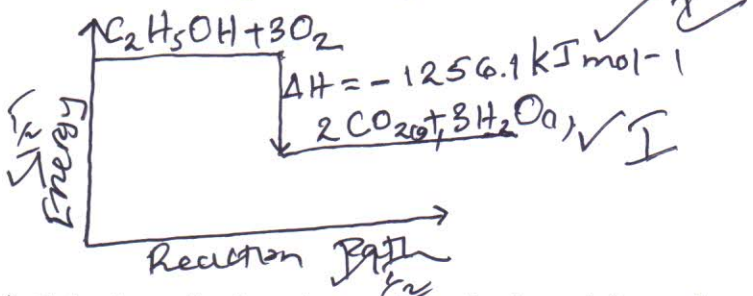
OR

$= -1,256,134.97 \text{ Jmol}^{-1}$

(c) An accurate value for ΔH_C of ethanol is -1368 kJmol^{-1}. State **two** sources of errors for the low figure obtained. *(2 marks)*

* Heat lost to the surrounding is not accounted for ✓I
* Faulty apparatus ✓I

(d) Draw an energy level diagram for the combustion of ethanol. *(3 marks)*



✓I ✓½ ✓½

(e) Calculate the heating value of ethanol from the above experiment.
$(C = 12, H = 1, O = 16)$ *(2 marks)*

$= \frac{-1,256.1}{46}$ ✓I

$= 27.31 \text{ kJg}^{-1}$ ✓I

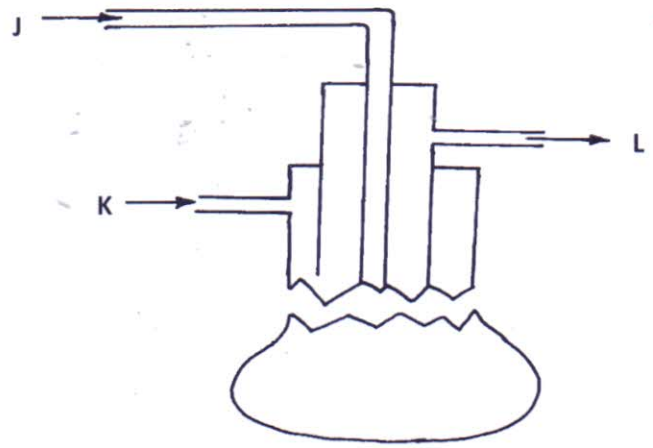
(f) State one factor that one may consider when choosing kerosene as a fuel in Kisii town. *(1 mark)*

* Heating value
* Availability
* Easy of Storage
* Cost
* Rate of Combustion Ease.

Ease of transportation

any one relevant award (1mk) ✓I

5. a) Sulphur is extracted from underground deposits by a process in which three concentric pipes are sunk down to the deposits as shown below



i. Give the name of the process mentioned above (1mark)

Frasch process ✓ 1

ii. State two physical properties of Sulphur that makes it to be extracted by this method (2marks).

- Low melting point of 113°C ✓ 1
- Insoluble in water ✓ 1
- less denser in water

Any two a word 1mk

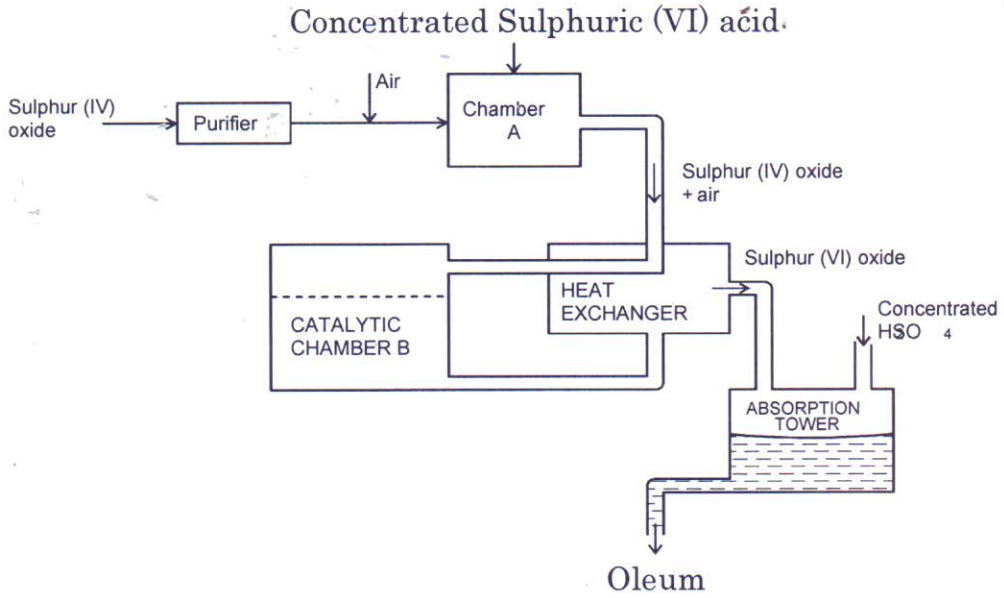
iii. Why is it necessary to use superheated water in this process (1mark)

To melt the sulphur ✓ 1

iv. During Frasch process molten sulphur flows out through the middle pipe but not through the outer pipe. Give a reason (1mark)

Molten sulphur would have lost heat to the surrounding hence solidify ✓ in the middle pipe, sulphur cannot solidify since hot air in the inner pipe and hot water in the outer pipe ✓ maintain high temperature.

b. The diagram below shows part of the processes in the manufacture of sulphuric (VI) acid. Study and answer the questions that follow.



i. Write an equation for the formation of Sulphur (IV) oxide from Sulphur. (1mk)

$S_{(s)} + O_{2(g)} \rightarrow SO_{2(g)}$ ✓ I

ii. What is the role of concentrated sulphuric (VI) acid in chamber A.(1 mark)

To dry SO_2 and air ✓½ ✓½

Reject: Dry the gases.

iii. Name two catalyst that can be used in the catalytic chamber B. (2 marks)

- Platinum wire ✓
- Vanadium (V) oxide ✓ I

Reject state symbols

iv. Give **two** reasons why during the manufacture of sulphuric (VI) acid, Sulphur (VI) Oxide, is dissolved in concentrated Sulphuric (VI) acid instead of dissolving in water (2 marks)

- Excessive heat generated boils the acid forming a mist of fine droplets of H_2SO_4 in air ✓ I
- In water the acid condenses slowly ✓

c. Explain one way in which Sulphur (IV) oxide is a pollutant. (1mark)

SO_2 dissolves in moisture in air forming H_2SO_3 which is further oxidised to H_2SO_4 by oxygen in air ✓½ and comes down as acid rain

d. What observation will be made when a few drops of concentrated sulphuric (VI) acid are added to crystals of sugar? Explain your answer. (2marks).

White/brown crystals of sugar turns to black because sugar is reduced to carbon. ✓1 ✓1

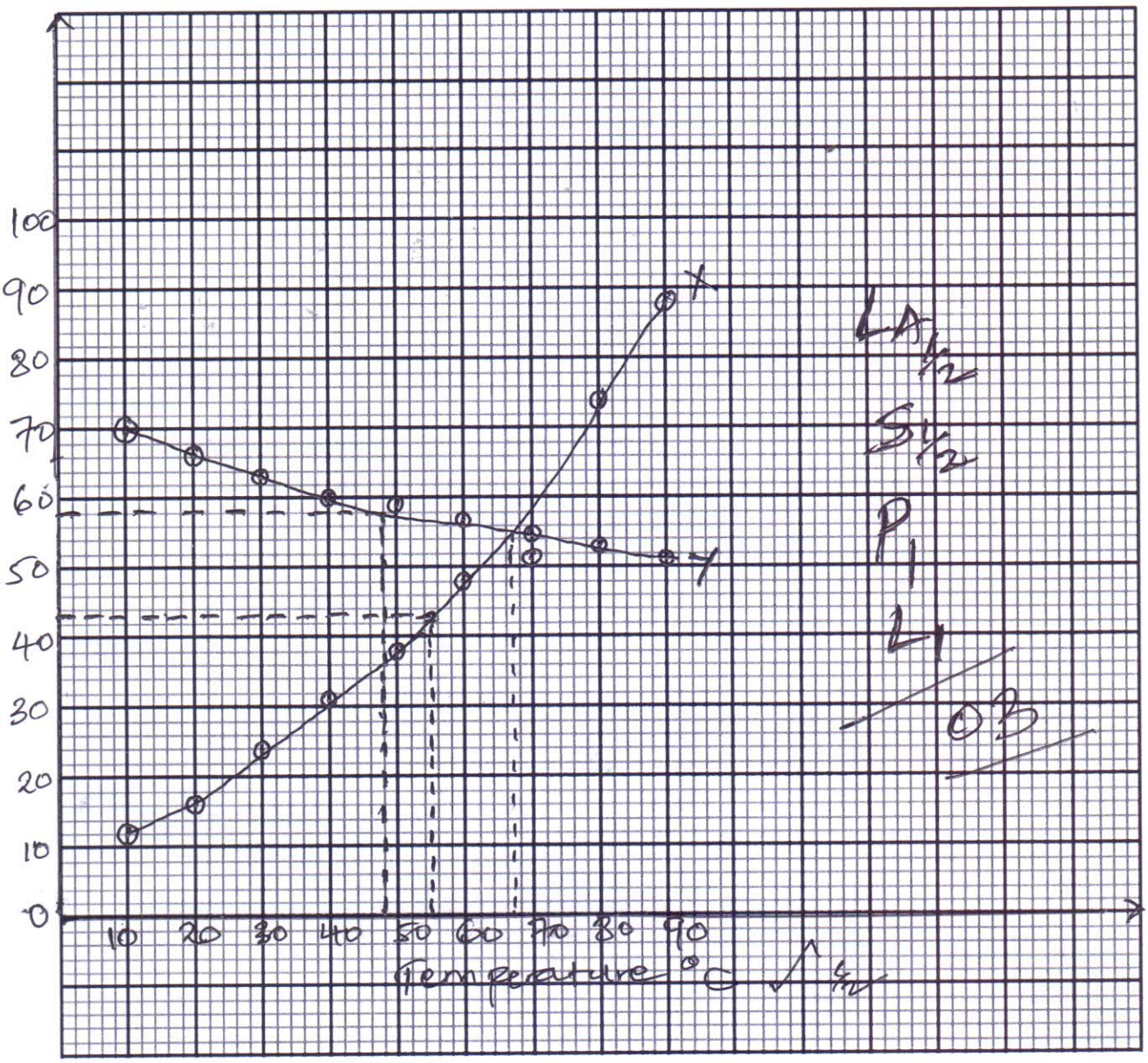
6. (a) Define solubility. (1 mark)

This is the maximum mass of a solute required to saturate 100g of the solvent at a particular temperature. ✓1

(b) The table below shows solubility of two salts X and Y at varying temperatures.

Temperature (^{0}C)	10	20	30	40	50	60	70	80	90
Solubility of Y (g/100g water)	70.0	66.0	63.0	60.0	59.0	56.5	54.5	53	51
Solubility of X (g/100g water)	12.0	18.0	24.0	31.0	38.0	48.0	51.0	74.0	88.0

(i) Draw the graph of solubility against temperature. *(3 marks)*



(ii) At what temperature is the solubility of both X and Y the same? *(1 mark)*

67.0°C ± 0.5 ✓ 1

(iii) Which of the substances X and Y is likely to be a gas? Explain. *(2 marks)*

Y ✓ This is because solubility of gases decreases with increase in temperature ✓

(iv) What is the mass of Y that would dissolve in 50g of water at 48°C? *(1 mark)*

$\frac{58 \pm 0.5}{2}$ ✓ ½ must be shown on the graph ½

(v) Determine the solubility of salt X at 55°C? *(2 marks)*

43 ± 0.5 g/100 g H_2O ✓I

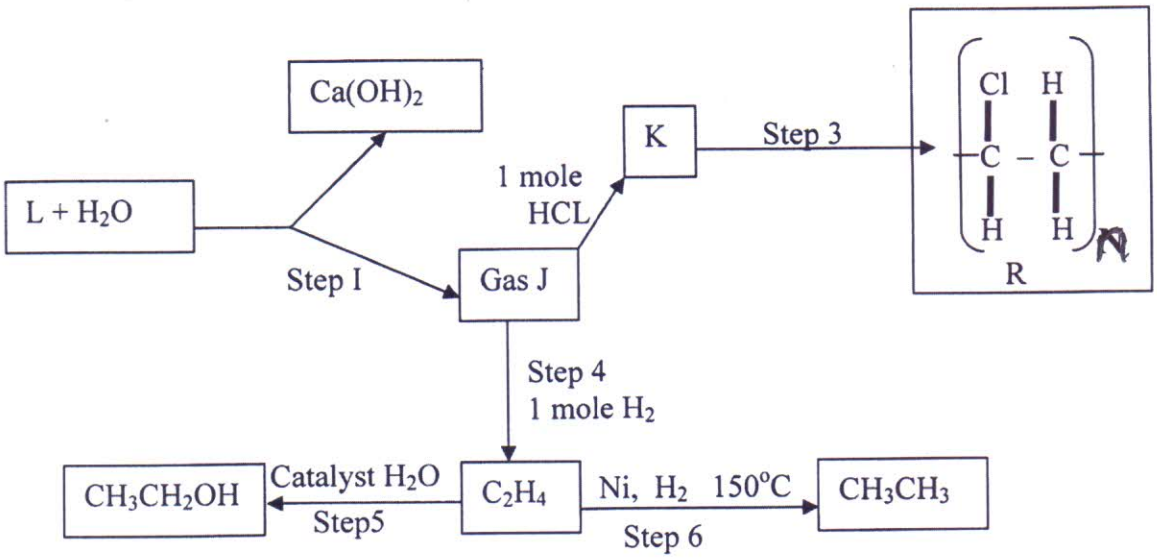
Must be shown on the graph ✓I

(vi) State *one* application of solubility. *(1 mark)*

- Salting out of soap - Fractional crystallization
- Purification of common salt

Any one award ✓1

7. Study the flow chart below and answer the questions that follow. a(1mk)



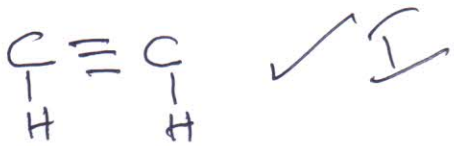
i) Identify reagent I ✓I (1mk)

Calcium carbide

ii) Name the catalyst used in step 5 ✓I (1mk)

Phosphoric (V) acid

iii) Draw the structural formula of gas J (1mk)



✓I

iv) What name is given to the process that takes place in step 5 (1mk)

Hydrolysis ✓I