hyd... ...ne apparatus for the ...
...estionsthat follow.

NAME: ..... ADM NO: .....

SCHOOL: .....CANDIDATE SIGN: .....

DATE: .....

233/2
CHEMISTRY PAPER 2
THEORY
APRIL-2023
TIME: 2 HRS

MOMALICHE 2 CYCLE 10-2023.
Kenya Certificate of Secondary Education (KCSE)

INSTRUCTIONS TO CANDIDATES

- Write your **Name, Admission Number** and **School** in the spaces provided above.
- Answer **all** the questions in the spaces provided after each question.
- Mathematical tables and non-programmable electronic calculators may be used.
- **ALL** working must be clearly shown where necessary.

FOR EXAMINER'S USE ONLY

QUESTIONS	MAX SCORE	CANDIDATE'S SCORE
1	12	
2	10	
3	13	
4	11	
5	13	
6	12	
7	9	
TOTAL	80	

1. The grid below forms part of the periodic table. Study it and answer the questions that follow. The letters do not represent the actual symbols of the elements

P				T	V	W	Y	M
	Q		S	U		X		
	R						Z	

a) Write the general name given to the element P belong. **(1mark)**

Alkali metals

b) An element N has an atomic number of 15. Write down its electronic arrangement and hence fix it in its right position on the grid above. **(1mark)**

Electronic arrangement

2.8.5

c) Compare the size of the atom of R and that of its ion. Explain your answer. **(2mks)**

R has a bigger atomic size than its ions because R looses electrons hence an energy level lost therefore making the size of its ion to be small than the atom.

d) Give the formula of the compound formed between **(1mark)**

i. P and W P_2W

ii. T and Y TY_4

e) Compare the melting points of element Q and S. Explain **(2Mks)**

S has higher melting point than Q. This is because S has a stronger metallic bond than Q (3 electrons in outermost energy level) requiring alot of heat to break the bond in S than Q

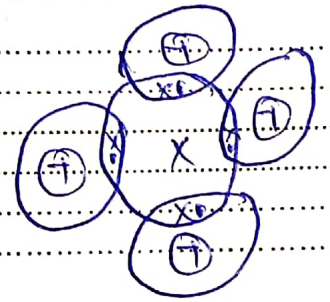
f) State the least reactive element in the grid. Give a reason for your answer **(1mk)**

M. It is stable doesn't need to react with other elements to gain stability.

g) Give two advantages that element S has over element Q in making electric cables **(2mks)**

(i) It is ductile
(ii) Does not corrode
(iii) Has higher electrical conductivity than Q.

h) Draw (a) dot (.) and cross (x) diagram to represent the bonding in compound formed between T and Y **(2 marks)**



2. a) Study the table below and answer the questions that follow

Bond type	bond energy $kJmol^{-1}$
C-C	346
C = C	610
C-H	413
C-Br	280
Br-Br	193

i) Calculate the enthalpy change for the following reaction **(3 marks)**

$C_2H_{4(g)} + Br_{2(g)} \longrightarrow C_2H_4Br_{2(g)}$

Bond breaking
C=C-1
C-H=4
Br-Br-1
$= 610 + 4(413) + 193$
$= 2455$ ✓

Bond formation
C-C = 1 x 346
C-Br = 2 x 280
C-H = 4 x 413
$= 2558$ ✓

$\Delta H = 2455 - 2558$
$\simeq -103 KJmol^{-1}$

ii) Name the type of reaction that took place in (a) above **(1mark)**

Exothermic Reaction
Addition Reaction.

b) Butane C_4H_{10} cannot be prepared directly from its elements but its standard heat of formation (ΔH_f^{θ}) can be obtained indirectly.

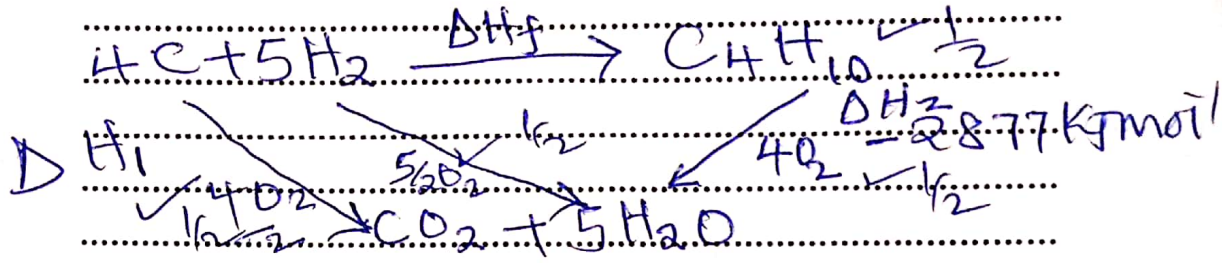
The following heats of combustion are given.

ΔH_C^θ (Carbon) = -393kJ/mol

ΔH_C^θ (Hydrogen) = -286kJ/mol

ΔH_C^θ (Butane) =-2877kJ/mol

i) Draw an energy cycle diagram linking the heat of formation of butane with its heat of combustion and the heat of combustion of its constituents elements. **(1mk)**



ii) Calculate the heat of formation of butane ΔH_f^θ (C_4H_{10}) **(2mks)**

$\Delta H_1 = \Delta H_f + \Delta H_2$

$\Delta H_f = \Delta H_1 - \Delta H_2$

$4(-393) + 5(-286) - (-2877)$

$-3802 + 2877$

$= -125\ KJmol^{-1}$

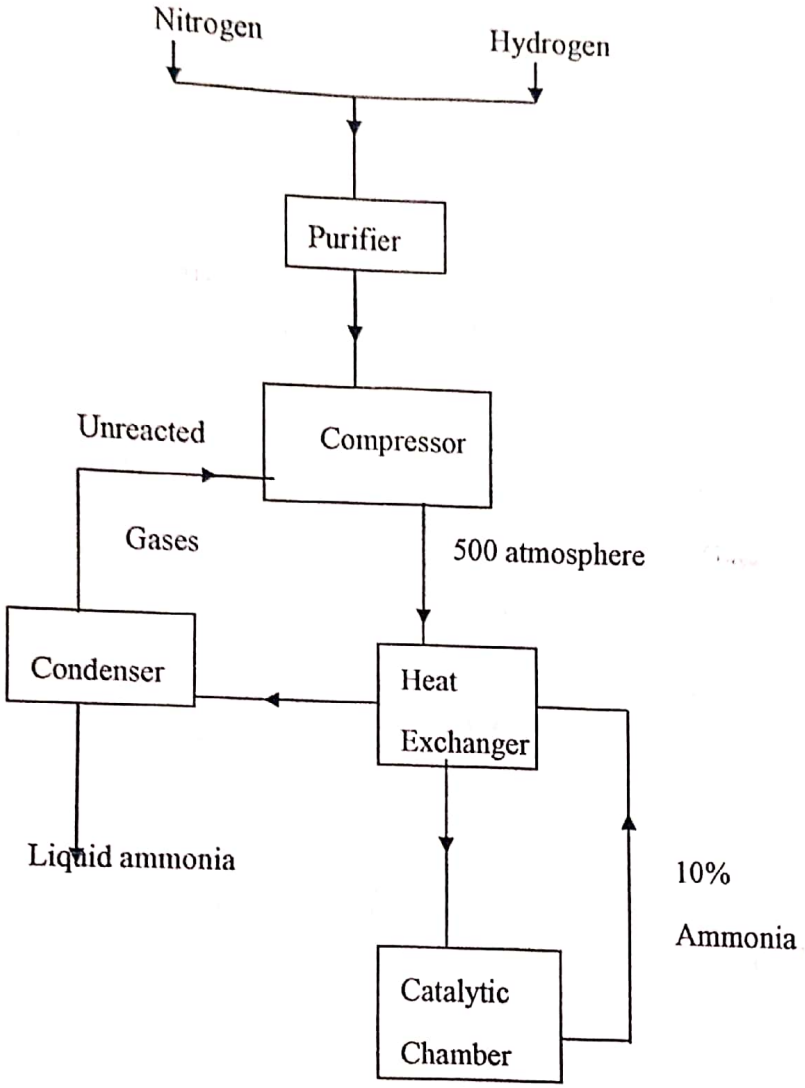
c) Given that the lattice enthalpy of potassium chloride is +690kJ/mol and hydration enthalpies of K^+ and Cl^- are -322kJ and -364kJ respectively. Calculate the enthalpy of solution of potassium chloride. **(3 mks)**

$\Delta H_{sol} = \Delta H_{latt} + \Delta H_{hyd}$

$= 690 + 322 + -(364)$

$= 690 - 686 = +4\ KJmol^{-1}$

3. The diagram below represents the Haber process for the manufacture of ammonia. Study it and answer the questions that follow.



a) Name any two impurities removed by the purifier. (1mark)

Carbon(IV) oxide
Sulphur (IV) oxide } any two ½ mk each
Dust particles

b) The catalyst used in the process is finely divided iron. Why iron is finely divided? (1mk)

To increase its surface Area

c) In the Haber process the conversion of nitrogen and hydrogen into ammonia is only 10%.

The remaining unreacted gases are recycled. What is the advantage of this? (1mk)

Reduces wastage

d) A part from iron catalyst and pressure of 500 atmospheres, name any other condition required for this process. (1mk)

Temperature of 450–500 °C (NB range)

e) Give any two uses of ammonia (1mk)

As nitrogenous fertilizer

softening of hard water

f) In the manufacture of nitric (v) acid from ammonia and air, ammonia is catalytically oxidized to nitrogen (ii) oxide

(i) Name the catalyst used in this reaction (1mk)

Platinum – rhodium catalyst

(ii) Write a balanced chemical equation for the reaction between ammonia and air. (1mk)

$4NH_{3(g)} + 5O_{2(g)} \rightarrow 4NO + 6H_2O_{(g)}$

(iii) State one environmental problem likely to be faced in an area where nitric (v) acid manufacturing plant is located. (1mark)

NO reacts with O_2 to form NO_2 which dissolves in moisture forming HNO_3 falls as acid rain. which cause death of sea life

g) (i) In the preparation of chlorine gas in a school laboratory, either manganese (IV) oxide or potassium manganate(VII) may be used on concentrated hydrochloric acid. State one advantage of potassium manganate (VII) over manganese (IV) oxide in this reaction. (1mark)

Heat is not required.

(ii) State and explain what would be observed when dry litmus papers are dipped in a gas jar of chlorine.
(1mark)

There would be no change in both litmus papers: Dry chlorine doesn't have acidic property hence do not bleach.

(iii) Freshly prepared chlorine water bleaches but chlorine water exposed to sunlight for sometime does not bleach. Explain.
(2marks)

Freshly prepared chlorine water has chloric(I) acid and therefore bleaches. But when exposed to sunlight chloric(I) acid decompases into hydrochloric acid and oxygen gas is released.

(iv) When preparing hydrogen chloride gas from sodium chloride and sulphuric (VI) acid, two conditions are necessary. State the conditions.
(1mark)

(i) Heat
(ii) The acid must be concentrated.

4. A label on the bottle containing Sulphuric (IV) acid has the following information
   - Density = 1.836 g/cm3
   - Percentage purity = 98%
   - Relative formula mass = 98

(a) Calculate:

i. The concentration of the acid
(3 mks)

Mass of acid in 1cm³ = 1.836g ✓
Mass of acid in 1000 cm³ = 1000 × 1.836 / 1 = 1836g ✓

Mass of pure acid = 98/100 × 1836 = 1799.28g ✓

M = Mass / RMM
= 1799.28 / 98
= 18.36M ✓

ii) The volume of concentrated sulphuric (IV) acid that should be diluted to produce 2 litres of 2 M Sulphiric (IV) acid (2 mks)

$M_1V_1 = M_2V_2$ | $M_2 = 2M$ | $V_1 = 2 \times 2$

$M_1 = 18.36$ | $V_2 = 2L$ | 18.36

$V_1 = ?$ | $V_1 = \frac{M_2V_2}{M_1}$ | $= 0.21786\ L$

(b) A solution of sodium hydroxide was found to contain 12.4g/dm³ of sodium hydroxide. 25cm³ of this solution reacted with 15cm³ of a solution of sulphuric (VI) acid. (Na=23.0, H=1.0, S=32.0, O=16.0)

(i) Find the molarity of the sodium hydroxide solution. (1 mark)

$g/L = \text{Molarity} \times RFM$

$M = \frac{12.4}{40} = 0.31M$

(ii) Calculate the number of moles of sodium hydroxide solution used. (1 mark)

If $1000cm^3 = 0.31$

$25cm^3 = ?$

$\frac{25 \times 0.31}{1000} = 0.00775$ moles

(iii) Calculate the number of moles of the acid used. (1 mark)

$2NaOH + H_2SO_4 \rightarrow Na_2SO_4 + H_2O$

Mole ratio

$NaOH : H_2SO_4$

$2 \quad 1$

$\frac{0.00775}{2} = 0.003875$

(iv) Determine the concentration of the sulphuric (VI) acid solution in g/dm³. (3marks)

If $15cm^3 = 0.003875$

$1000cm^3 = ?$

$\frac{1000 \times 0.003875}{15}$

$= 0.25833M$

$= 0.26M$

RFM of $H_2SO_4 = 98$

$g/L = M \times RFM$

0.26×98

$25.32g/L$

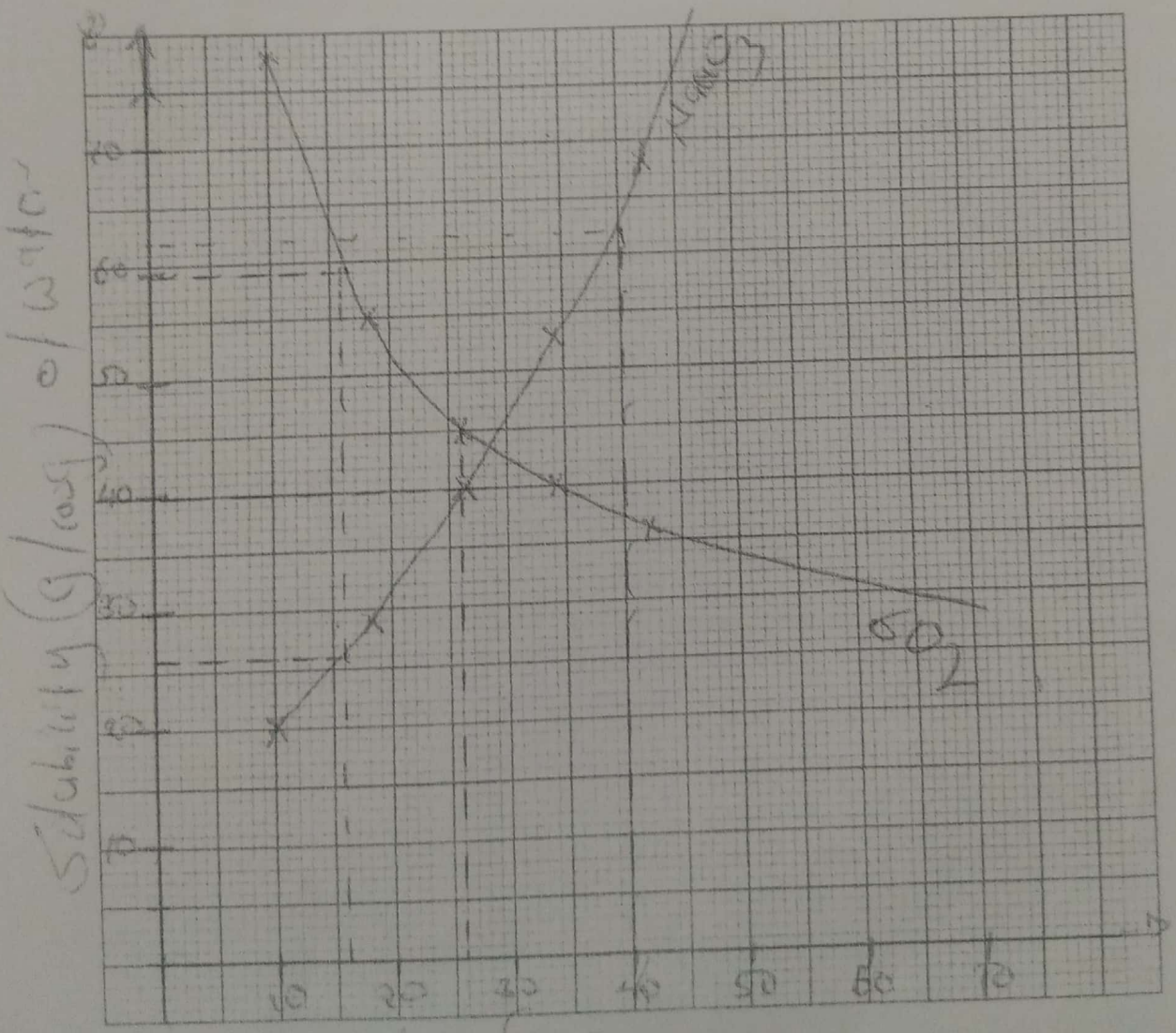
5. Define a saturated solution. (1 mark)

A solution that cannot dissolve anymore solute at a particular temperature.

(b) The table below represent the solubilities of sodium nitrate and Sulphur (IV) oxide at different temperatures.

Temp (°C)	10	18	26	34	42
Solubility of Sodium Nitrate (g/ 100g of water)	20	29	40	53	68
Solubility of Sulphur (IV) Oxide (g/ 100g of water)	78	55	45	40	36

On the grid provided below, plot a graph of solubilities of sodium nitrate and Sulphur (IV) oxide against temperature. (4 marks)



Using the graph;

i. Determine the solubility of Sulphur (IV) oxide at 16°C. (½ mark)

59g/100g ±1 of water must be shown on graph

ii. The concentration, in moles per litre, of sodium nitrate at 16 °C. (assume density of solution is 1 g/cm³) (Na=23, 0=16, N=14). (3 marks)

At 16°C 26g/100g of water ½

100cm³ 26g
1000cm³ = ?

$\frac{1000 \times 26}{100} = 260$

RFM = 23 + 14 + (16 × 3)
85g

$M = \frac{2.70}{85} = 3.0588M$

iii. Mass of crystals formed when a solution of sodium hydroxide is cooled from 40°C to 26°C. (2 marks)

At 40°C = 62g/100 water ✓½ | at 26°C = 40g/100g water ✓½

Mass = 62 − 40 ✓½
= 22g ✓½

iv. What is the relationship between solubility of sodium nitrate and temperature? (1 mark)

As temperature increases solubility of $NaNO_3$ increases (1MK)

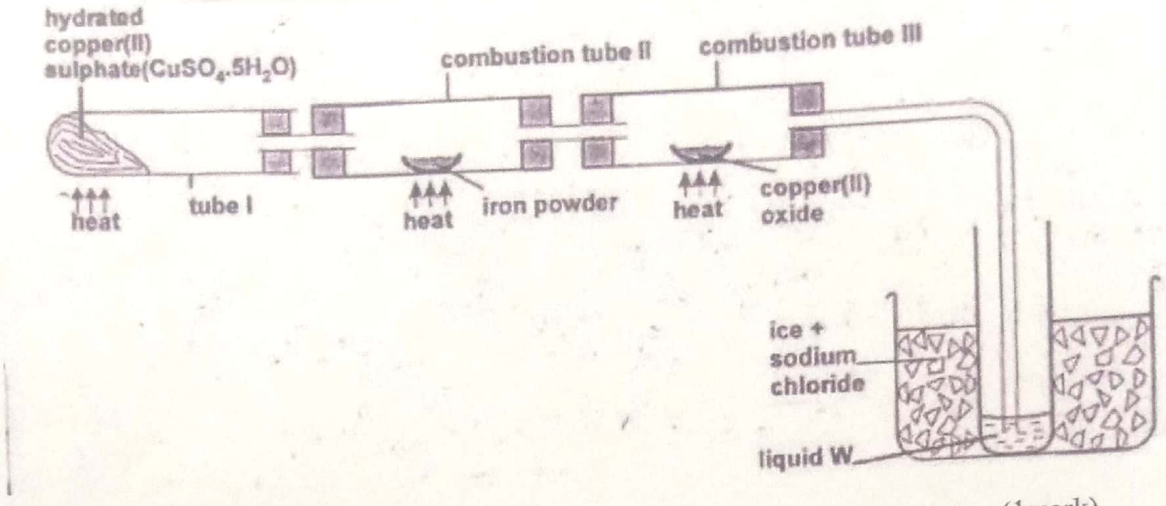
(c) Give one advantage of hard water. (½ mark)

(i) used in brewing
(ii) Provides Calcium - essential nutrient.

(d) Explain why the reaction between 1g of sodium carbonate with 2M hydrochloric acid is faster than between 1g of sodium carbonate with 2M ethanoic acid. (1 mark)

HCl is a strong acid, CH_3COOH is a weak acid CH_3COOH partially dissociates while HCl dissociates fully since some energy is used in fully ionising of CH_3COOH.

6.The diagram below shows the apparatus for the preparation of gas A and investigate on its properties . Study it and answer thequestionsthat follow.



(1mark)

a)(i)NamegasA.

Hydrogen

(ii)suggest property of gas A under investigation (1mark)

Reducing property

(iii)Writechemical equationsfor the reactionsinthe; (1mark)

BoilingtubeI

$CuSO_4.5H_2O \xrightarrow{heat} CuSO_{4(s)} + 5H_2O_{(l)}$

(1 mark)

CombustiontubeII

$3Fe_{(s)} + H_2O_{(l)} \longrightarrow Fe_3O_4 + 4H_{2(g)}$

b)(i)Stateandexplaintheobservationmadein (1mark)

TubeI.

Blue solid turns white/colourless liquid is formed at cooler part of test tube. Crystallisation $CuSO_4.5H_2O$ losses water of

(1 mark)

CombustiontubeII

Black solid turns brown. Copper(II) oxide reduced by $H_{2(g)}$ to copper metal.

c) (i)Whatistheuseofhydratedcopper(II)sulphateintheexperiment? (1mark)

To produce steam

(ii)Nameoneothersubstancethat comesoutoftubeIII. (1mark)

Hydrogen

(iii)Nameliquid W. (1mark)

Water

(iv)Whatistheroleofsodiumchlorideintheice(freezingmixture) (1mark)

Decrease freezing point of water.

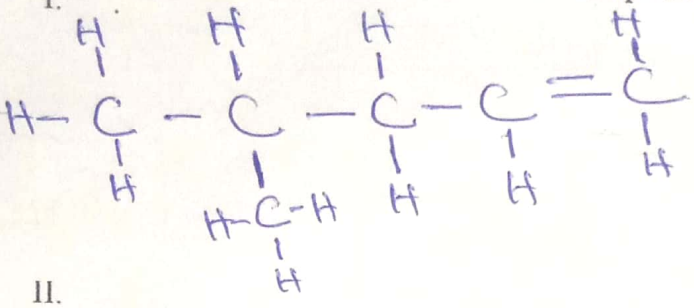
7. Study the condensed formulae below and answer the questions that follow

(a) I $CH_3CH(CH_3)CH_2CHCH_2$

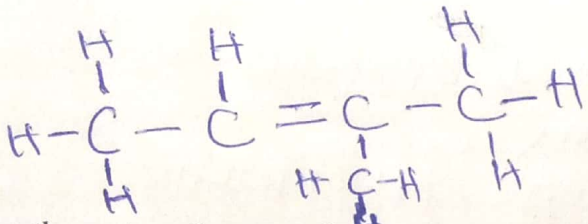
II $CH_3CHCH(CH_3)CH_3$

i. Draw the structural formula of each of the compounds I and II (2mks)

I.



II.



ii. Give the systematic name of each of the compounds represented by the formulae above (2mks)

I 4-methylpent-1-ene

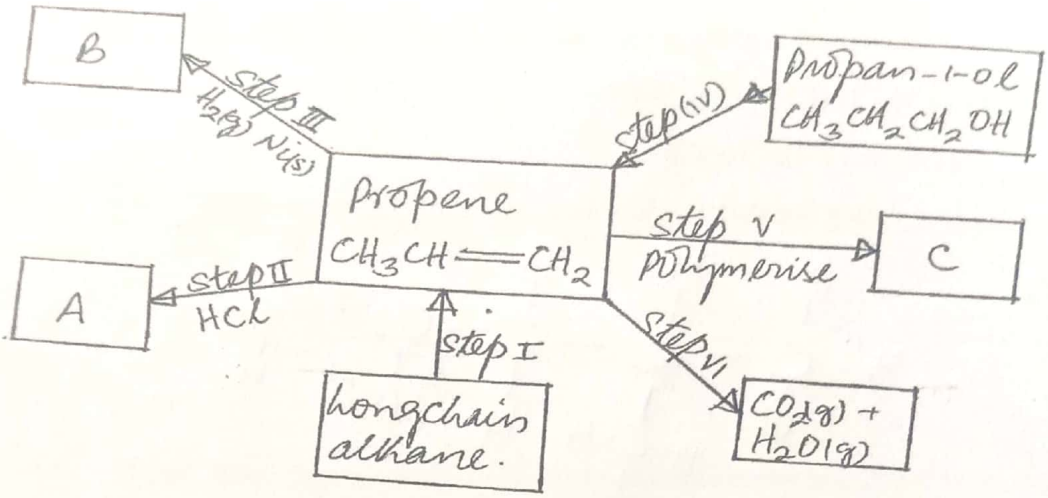
II 2-methylbut-2-ene

iii. To which homologous series does the compound represented by I belong (1/2 mk)

.....

..... Alkenes

(b) The flow chart below shows some reactions starting with a long chain alkane. Study it and answer the questions that follows.



i. Name substance (1 1/2 mks)

A 1,2-dichloro propane

B propane

C polythene / poly propene

ii. What is the name given to the process represented by

Step I Cracking (½ mk)

Step III Hydrogenation (½ mk)

Step IV Dehydration (½ mk)

Step VI Combustion (½ mk)

iii. Write down the chemical equation represented by the reaction in step VI (1mk)

$$2C_3H_6(g) + 9O_2(g) \longrightarrow 6CO_2(g) + 6H_2O(l)$$