Name…… ……Adm No:……MARKING SCHEME……..

233/2
CHEMISTRY
PAPER 2
THEORY
SEPTEMBER, 2021
TIME: 2 HOURS

Candidate's Signature ……..…
Date: ……

MOMALICHE 3 CYCLE 8-2021

Kenya Certificate of Secondary Education (K.C.S.E.)

INSTRUCTIONS TO CANDIDATES

- Write your name and Index number in spaces provided above.
- Sign and write the date of examination in the spaces provided above
- Answer all the questions in the spaces provided above.
- KNEC Mathematical tables and silent electronic calculators may be used.
- All working must be clearly shown where necessary.
- Candidates should answer the questions in English.

For Examiners Use Only

Question	Maximum score	Candidate's score
1	10	
2	12	
3	11	
4	14	
5	11	
6	10	
7	11	
Total score	80	

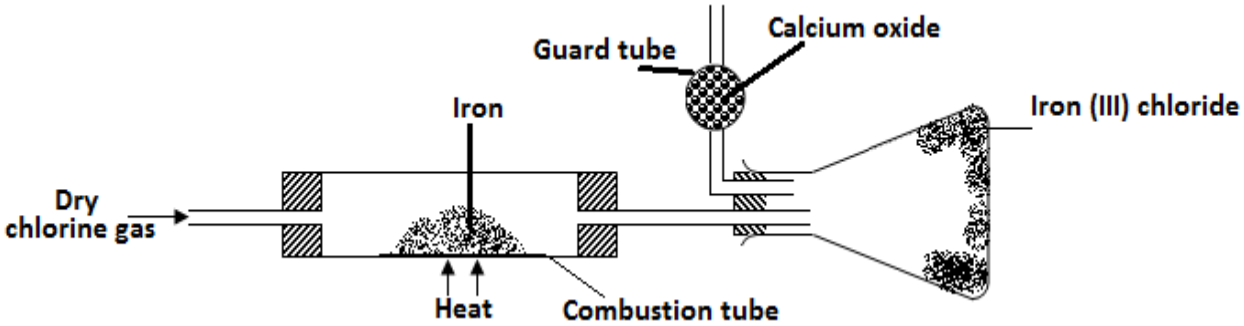
This paper consists of 15 printed pages. Candidates should check to ascertain that all pages are printed as indicated and that no questions are missing.

1.(a) Give the name of one reagent which when reacted with concentrated hydrochloric acid produces chlorine gas
(1mk)

-potassium manganate (VII) ✔¹

- Lead (IV) oxide
- Manganese (IV) oxide
- Calcium chlorate ($CaOCl_2$)

(b) A student set out to prepare iron (lll) chloride using apparatus shown in the diagram below



(i) Explain why it is necessary to pass chlorine gas through the apparatus before heating begins? (1mk)

To remove all the oxygen which would react with iron to form iron (III) oxide instead of iron (III) chloride. ✔¹

(ii) Why is calcium oxide most preferred to calcium (II) chloride. (1mk)

-Absorbs both water✔½ and chlorine gas✔½

(iii)What property of iron (III) chloride makes it possible to be collected as shown in the diagram
(1mk)

-Iron (III) chloride sublimes✔¹

(iv) The total mass of iron (III) chloride formed was found to be 0.5g. Calculate the volume of chlorine gas that reacted with iron. (Fe = 56, Cl = 35.5 and molar gas volume at r.t.p is 24,000 cm^3)
(3mks)

Fe :Cl_2 :$FeCl_3$

2: 3 : 2✔½

RMM $FeCl_3$ = 162.5✔½

Moles of $FeCl_3$ $\frac{0.5}{162.5}$ = 0.003✔½

$\frac{3x.0.003}{2}$ ✔½= 3 x 0.003 = 0.0045✔½

Vol of Cl_2= 0.0045 x 24000 = 110.8cm^3✔½

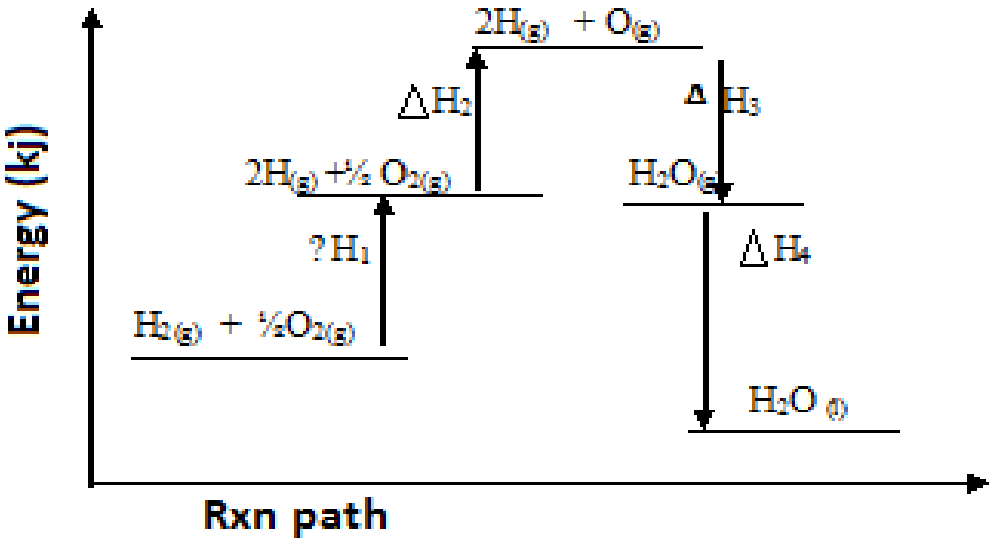
(c) When hydrogen sulphide gas passed through a solution of iron (III) chloride the following observation was made;
The colour of the solution changed from reddish brown to green and yellow solid was deposited. Explain these observations
(2mks)

- Fe^{3+} is reduced to Fe^{2+};✔¹ H_2S is oxidized✔¹ to sulphur

(d) State and explain the observations that would be made if a moist blue-litmus paper was placed in a gas jar full of chlorine gas
(2mks)

-Turns, red then white because chlorine is acidic and a bleaching agent in presence of water.

2. Study the energy level diagram below and answer the questions that follow.



(a) (i) Which ΔH values have a positive sign. 1mk)

- **ΔH_1 ✔½ & ΔH_2 ✔½**

(ii) Which ΔH values have a negative sign (1mk)

- **ΔH_3 ✔½ & ΔH_4 ✔½**

(iii) What chemical changes is being represented by (2mks)

$\triangle H_1$ – **Atomisation ✔¹**

$\triangle H_4$ - **Condensation ✔¹**

(b) The hydration energy of Al^{3+} and Cl^- are -4690 and -364kJmol^{-1} respectively. The heat of solution of alluminium chloride is -332kJ mol^{-1}.

Calculate the lattice energy of alluminium chloride
(2mks)

ΔH latt + -4690 + (3x -364) = -332 ✔¹

ΔH latt – 5782 = -332

ΔH latt - = +5450kJmol^{-1} ✔¹

(c) When one mole of butanol is burnt. 2676kJ are liberated .

(i) Calculate the heating value of butanol.(C=12,H=1,O=16)
(2mks)

C_4H_9OH =4x12+10x1+16=74✔½

$$\text{Heating value}=\frac{2676\ kJ/mole}{74g/mole}\ ✔^{1} = 36.16Kj/g$$

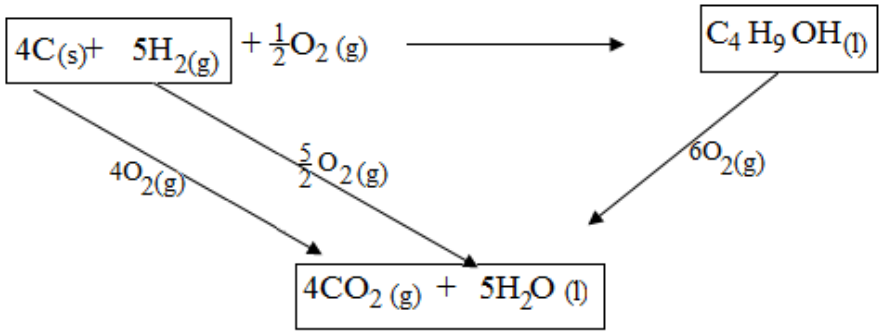
(i) Write a chemical reaction for combustion of butanol.
(1mk)

$$2C_4H_9OH + 12\ O_2\ (g) \longrightarrow 8\ CO_2(g) + 10\ H_2O\ (l)\ ✔^{1}$$

(ii) Considering the following heats of combustion

- $\Delta H^{\theta}C$ (Graphite) = -393kJ mol^{-1}
- $\Delta H^{\theta}C$ (H_2) $_{(g)}$ = -286kJ mol^{-1}
- $\Delta H^{\theta}C$ (Butanol) = -2676kJ mol^{-1}

Using an energy level diagram,calculate the enthalpy of formation of butanol. (3mks)



✔¹

ΔH_f + -2676 = (4 x -393) + (5 x -286) ✔¹

ΔH_f = -1572 + -1430 + 2676 = -326kJ mol^{-1} ✔¹

3. I) The table below shows properties of some elements represented by symbols W,X,Y and Z. Study the information in the table and answer the questions that follows

Element	No. Of protons	Atomic radius(nm)	Boiling point ^{0}C
W	2	0.93	-269
X	10	1.31	-246
Y	18	1.54	-186
Z	36	1.89	-152

a) Write down the electron arrangement for elements W and X . (1mk)

W 2 ✔½

X 2 .8 ✔½

b) In which group of the periodic table are the elements in the table above?Give the

name of the group.
(2 mks)

Group VIII ✔¹
Noble gases ✔¹

c) Explain why the atomic radius of W is smaller than that of X. (1mks)

X has more/2 energy levels than W (1 energy levels). ✔¹

d) State **one** use of element X. (1mk)

Use in making neon advertising coloured signs ✔¹
Used to make high voltage indicators
Neon and helium are used in making gas lasers
Liquid helium is an economical refrigerant

II. The section below represents part of the periodic table. Study it and answer the questions that follow. The letters are not the actual symbol of the elements.

				Q				
X			B	H		M	T	
Y		A					V	
Z							S	

a) **Select** the most reactive non-metal.
(1mk)

T ✔¹

b) Give the name of the elements occupying region A
(1mk)

-Transition elements ✔¹

b) **Explain** why the atomic radius of **T** is smaller than that of **M**. (2mks)

T has more protons(18) ✔¹hence higher nuclear charge than M (17 protons) attracting ✔¹outermost electrons closer to the nucleaus reducing the atomic radius

c) Compare the electrical conductivity of element X and B.
(2mks)

B has higher conductivity✔¹,it has 3 delocalised electrons X has 1 delocalised electrons

✔¹

4. (i) (a) Write the chemical name for rust. (1 mk)

-Hydrated iron (III)oxide ✔¹

(b) State any **two** ways of preventing rusting.
(2 mks)

-Electroplating,Alloying, ✔¹Galvanizin,Painting,Oiling and greasing ✔¹

(c) Give a reason why vehicles based in Mombasa rust faster than those based in
Limuru. (1 mk)

-Salty water in Mombasa unlike in Limuru✔¹

(d) Oxygen to obtained by fractional distillation of liquid air. Name **two** other gases
which are obtained during the distillation.
(1 mk)

-Nitrogen,Argon ✔¹

(ii) In an experiment to determine the solubility of sodium chloride, 5cm^3 of a saturated solution of sodium chloride of mass 5.35g were placed in a volumetric flask and diluted to a total of 250 cm^3. 25 cm^3 of the dilute solution reacted completely with 24cm^3 of 0.1 $moldm^3$ silver nitrate solution. Calculate:

(a) Moles of silver nitrate in 24cm^3 of solution.

(1 mk)

$$\frac{24 \times 0.1}{1000} \checkmark ½ = 0.0024 \text{ moles} \checkmark ½$$

(b) Moles of sodium chloride to 25cm^3 of solution. (2mks)

NaCl : $AgNO_3$
1:1 ✔1

0.0024 moles of NaCl ✔1

(c) Moles of sodium chloride in 250 cm^3 of solution. (1 mk)

$$\frac{0.0024X250}{25} \checkmark ½ = 0.024 \text{ moles} \checkmark ½$$

(d) Mass of sodium chloride in 5 cm^3 of the original saturated sodium chloride solution

(1 mk)

NaCl =23+35.5 =58.5g✔½

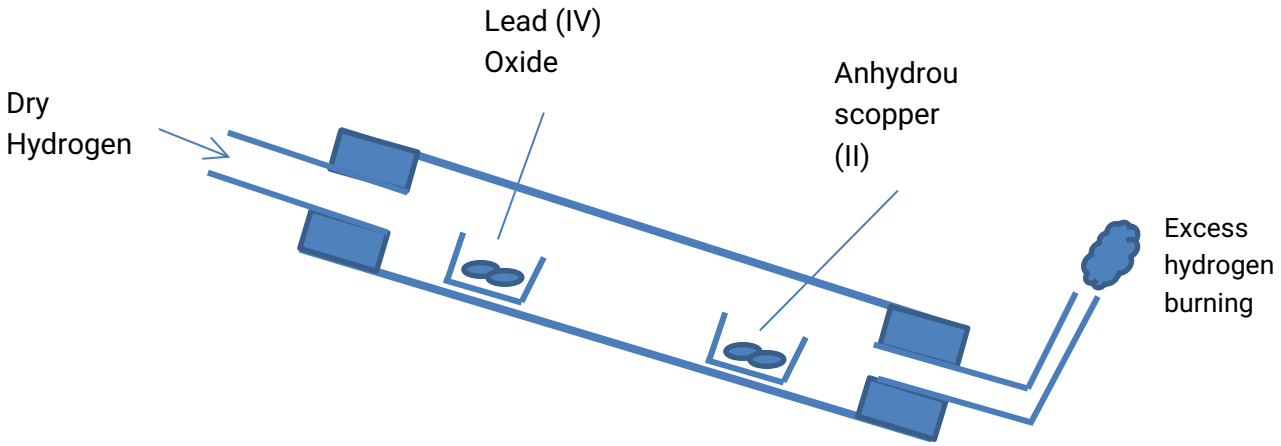
Mass =58.5 x 0.024 =1.404g✔½

(e) Solubility of sodium chloride. (1 mk)

Mass of water =5.35-1.404 =3.946g

$$\text{Solubility} = \frac{1.404 \times 100}{3.946} \checkmark ½ = 35.58\text{g/100g of water} \checkmark ½$$

(i) The apparatus below was used to investigate the effect of dry hydrogen gas on hot lead (II) oxide.



(a) What is observed in the combustion tube at the end of the experiment? (1mk)

-A grey solid ✔¹

-White anhydrous copper(II) sulphate turns blue

(b) Why should the tube be slanting? (1 mk)

-To prevent any liquid collecting in the cooler parts of the combustion tube coming back and cracking the hot part of the tube ✔¹

(c) State any precaution to be observed when doing this experiment. (1 mk)

-Pass hydrogen through the tube to drive out any air to prevent explosion

-Hot lead metal must be cooled in a stream of hydrogen to prevent re-oxidation of the hot metal. ✔¹

5. a) Read the following passage and answer the questions.
A salt K was heated with slaked lime (calcium hydroxide). A colourless gas L with a characteristic smell and turns red litmus paper blue was evolved. A large quantity of this gas was passed through an inverted filter funnel into Copper(II)sulphate solution, and a deep blue solution M was obtained.
(i)Identify gas L
(1 mk)

Ammonia ✔¹

(ii)What is K most likely to be?
(1 mk)

Ammonium chloride ✔¹

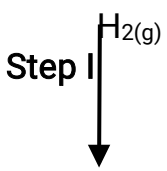
(iii)Write an equation for the reaction between K and slaked lime
(1 mk)

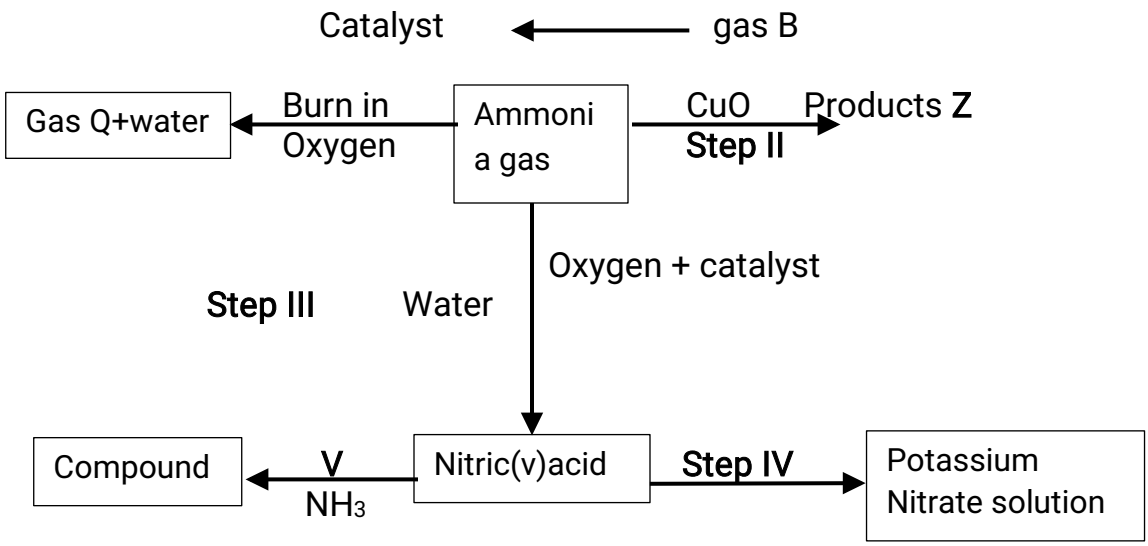
$Ca(OH)_2(s)+NH_4Cl(s) \rightarrow CaCl_2(aq)+H_2O(l)+2NH_3(g)$ ✔¹

(iv)Write an ionic equation for the reaction with copper(II)sulphate forming the deep blue solution
(1 mks)

$Cu(OH)_{2(s)} + 4NH_{3(aq)} \rightarrow [Cu(NH_3)_4]^{2+}_{(aq)}+2OH^-_{(aq)}$ ✔¹

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





(i) State **one** source of gas B (1 mk)

Fractional distillation of liquid air ✔¹

(ii) Name the catalysts used in; (2 mks)

a) Step I

Finely divided Iron ✔¹

b) Step III

Platinum or platinum rhodium ✔¹

(iii) Write chemical equations for reactions in; (3 mks)

a) Step I

$N_{2(g)}+3H_{2(g)} \xrightarrow{Fe} 2NH_{3(g)}$ ✔¹

b) Step II ✔¹

$2NH_{3(g)}+3CuO_{(s)} \rightarrow N_{2(g)}+3H_2O_{(l)}+3Cu_{(s)}$

c) Step V

$NH_{3(aq)} + HNO_{3(aq)} \rightarrow NH_4NO_{3(aq)}$ ✔¹

(iv) Identify any other gas that can be used instead of Ammonia in step II (1 mk)

Hydrogen/Carbon(II)oxide ✔¹

(v) State **one** use of gas Q (1mk)

- ✔ **Used in the Haber process in the manufacture of ammonia. ✔¹**
- ✔ **Due to its inert nature, it is mixed with argon to fill electric bulbs (to avoid soot formation).**
- ✔ **In liquid state it is used as an inert refrigerant e.g. storage of semen for artificial insemination.**
- ✔ **Due to its inert nature, it is used in food preservation particularly for canned products i.e. it prevents combination of oxygen and oil which tends to enhance rusting.**
- ✔ **It is used in oil field operation called enhanced oil recovery where it helps to force oil from subterranean deposits.**

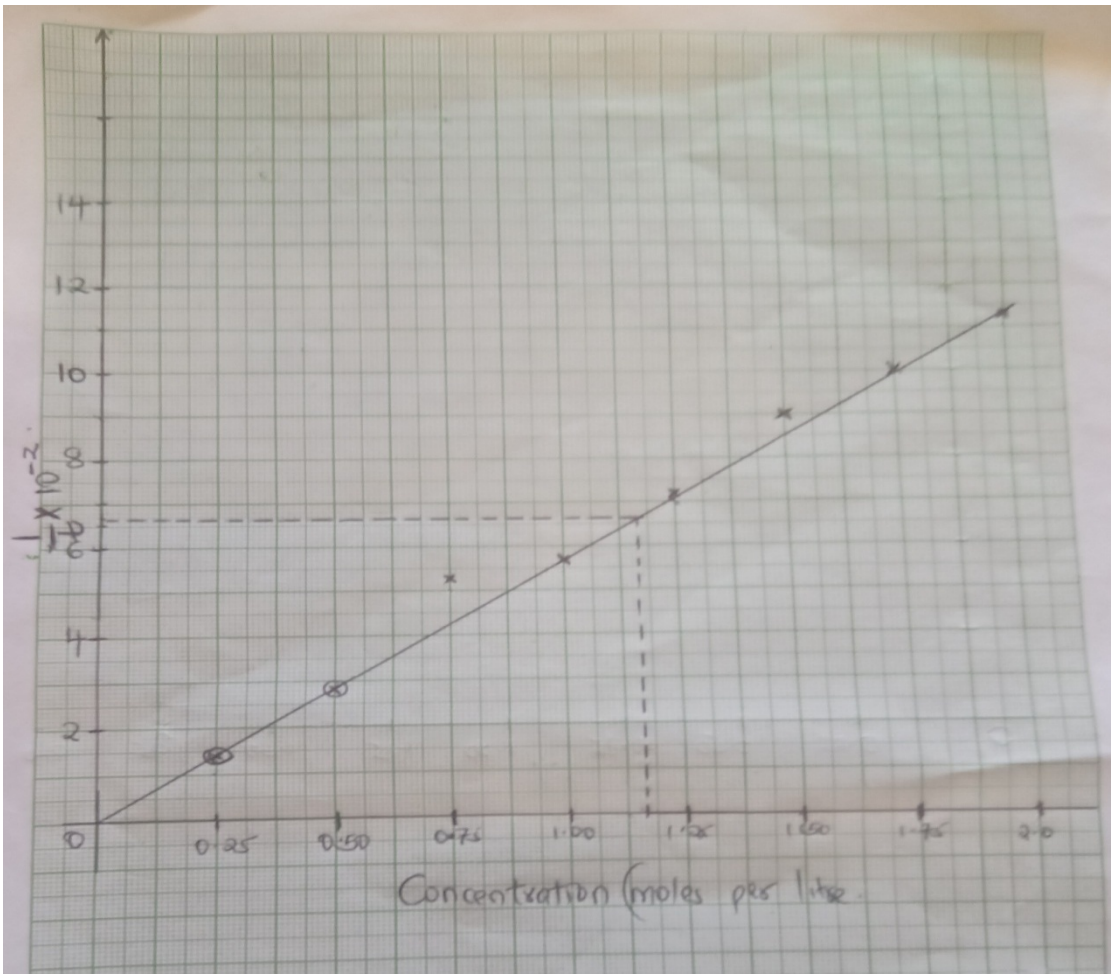
6. An experiment was carried out using magnesium ribbon and dilute hydrochloric acid of different concentrations. The time needed to produce $50cm^3$ of the gas for every experiment was recorded in a table.

Concentration of HCl (moles per litre)	2.0	1.75	1.50	1.25	1.00	0.75	0.50	0.25
Time (seconds)	8.8	10.0	11.7	14.0	17.5	18.7	35.0	70.0
$\frac{1}{time}$ (Sec^{-1})	**0.1140**	**0.1000**	**0.0854**	**0.0714**	**0.0571**	**0.0534**	**0.0286**	**0.0143**
$\frac{1}{t} \times 10^{-2}$	**11.4**	**10.0**	**8.54**	**7.14**	**5.71**	**5.34**	**2.86**	**1.43**

d) Complete the table above for $^1/_{time}$. ✔½ mark each calculation (4mks)

e) Plot a graph of rate i.e $^1/_{time}$ against concentration.

(3mks



f) From your graph determine the concentration needed to produce 50cm^3 of hydrogen gas when time is 15.0 seconds
(2mks)

T=15

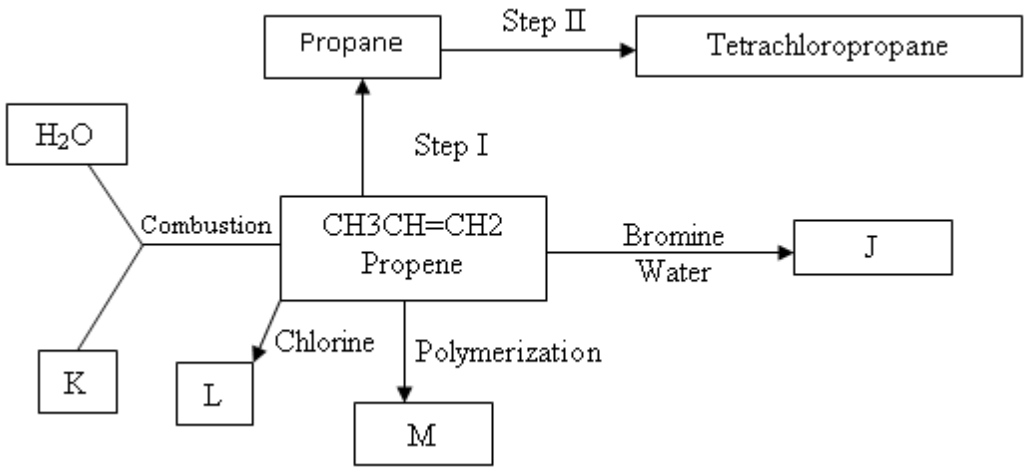
$\frac{1}{15} = 0.0667$ ✔✔[1]

= 1.1625

g) From your graph state the relationship between the rate of reaction and concentration. Give a reason.

Rate of reaction increases with increase in concentration ✔[1] (1mks)

7. The flow diagram below shows a reaction scheme starting from propene.



(a) Name the process in step 1 (1 Mark)

-**Hydrogenation** ✔¹

(b) State the reagent and condition necessary for step1 to occur

Reagent: **Hydrogen gas.**✔¹ (1 Mark)

Condition: - **Nickel catalyst/platinum** ✔¹ (1 Mark)

- 180-200^{o}C Reject range

(c) Give the names of the following substances.

J- **2 –bromopropane** ✔½

K – **Carbon (IV) oxide** ✔½

L-**1,2-dichloropropane** ✔½

M- **Polypropene** ✔½ (2 Marks)

(d) Write the equation for the reaction that produces substance L. (1 Mark)

CH_3- CH= CH_2 +Cl_2 ⟶ CH_3 –CH Cl –CH_2 Cl✔¹

(e) State the type of reaction that occurs in step I. - (1 Mark)

-**Addition** ✔¹

(f) Write the equation for complete combustion of propene. (1 Mark)

-**2 C_3H_6 (g) + 9 $O_{2\,(g)}$ ⟶ 6$CO_{2\,(g)}$ +6 H_2O(l)**

(g) (i) Give **one** use of substances M. (1 Mark)

-**Making buckets**✔¹
- **Making plastic chairs and tables.**

(ii) State the environmental effects of the continued use of plastics to the environment .Explain. (2 Marks)

- **They lead to environmental when they are burned causing pollution.**✔¹
- **They are non- biodegradable since bacteria cannot decompose them hence they persist in the environment**

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