CHEMISTRY 233/2
APRIL 2024

FORM FOUR : CHEMISTRY PAPER 2 ASSIGNMENT

NAME: ---------- **INDEX NO:** ----------

SIGNATURE: ---------- **DATE:** ----------

INSTRUCTIONS TO CANDIDATES.

(a) Write your name and Index number in the spaces provided above.
(b) Sign and write the examination date on the spaces provided above.
(c) Answer all the questions in the spaces provided.
(d) All workings must be clearly shown where necessary.
(e) KNEC mathematical tables and non-programmable electronic calculators may be used.
(f) Candidates should check the question paper to ascertain that all the pages are pri
(g) nted as indicated and that no questions are missing.
(h) Candidates must answer the questions in English.

For Examiners use only.

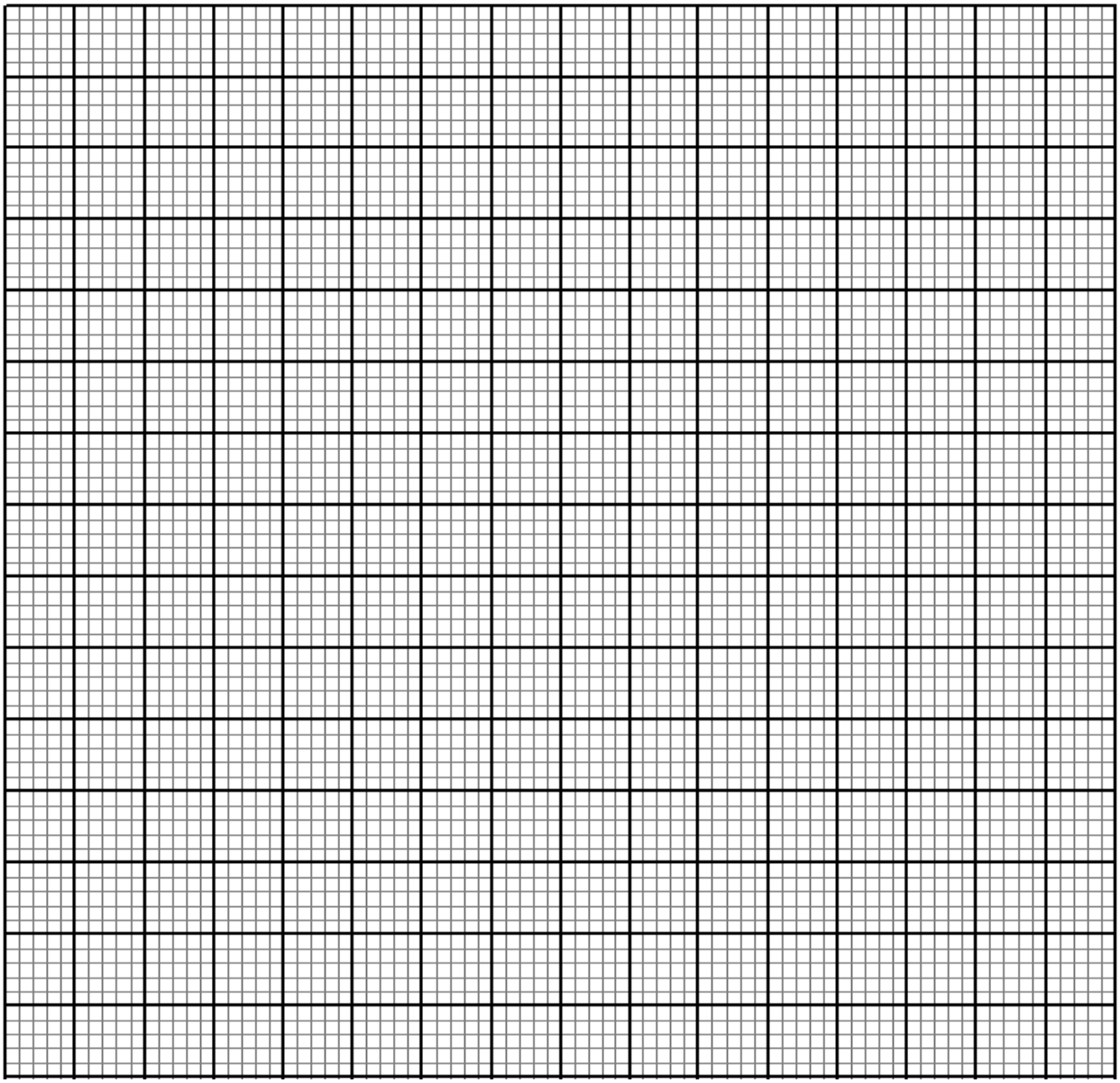
Question	Maximum score	Candidate's score
1-12		

This paper has 18 printed pages

1..The table below shows the solubility of lead ii nitrate and potassium nitrate at different temperatures. Study it and answer questions that follow

Temperature ^0C	0	20	40	60	80	100
Solubility of $Pb(NO_3)$ in g/100g of water	37.5	52.5	69.0	87.5	110.0	131.0
Solubility of KNO_3 in g/100g of water	12.5	32.5	62.5	110.0	137.5	

(a) On the same grid plot a graph of solubility of lead ii nitrate and potassium nitrate in g/100 of water against temperature in ^0C(4mks)



(b)From the graph determine the point at which;

I. The solubility of the two salts is the same (1mk)

II. The solubility of lead ii nitrate is 58.0g/100g of water (1mk)

c)The mass of the crystals that would be formed if the saturated solution was cooled from 80^0C to 30^0C (3mks)

d)A water sample is suspected to contain lead (ii) ions. Describe how the presence of lead ions would be confirmed using sodium hydroxide solution and potassium iodide solution(2mks)

2. (a) The results below were obtained in an experiment conducted by form 3 students from Ratansi secondary school using magnesium.

Mass of the crucible + Lid =19.52g
Mass of the crucible + Lid + Magnesium ribbon =20.36g
Mass of the crucible + Lid + magnesium oxide = 20.92g

(i) Use the results to find the percentage mass of magnesium and oxygen in magnesium oxide. (2mks)

(ii) Determine the empirical formula of magnesium oxide. (Mg=24, O= 16.0)

(b) Sodium hydroxide pellet were accidentally mixed with sodium chloride, 8.8g of the mixture were dissolved in water to make one litre of solution. 50cm^3 of the solution was neutralized by 20.0cm^3 and 0.25M sulphuric (VI) acid

i. Write an equation for the reaction that took place. (1mk)

ii. Calculate the:

I. Number of moles of the substance that reacted with sulphuric (VI) acid. (2mks)

II. Number of moles of the substance that would react with sulphuric (VI) acid in the one litre solution. (1mk)

iii. The percentage of sodium chloride in the mixture. (2mks)

3.(a) Use the bond energies given in the table below to calculate the enthalpy change for the reaction.

(2mks)

$C2H_{6(g)} + Br_{2(g)} \longrightarrow C_2H_5Br_{(g)} + HBr_{(g)}$

Bond	C – H	C - Br	Br – Br	H- Br
Bond energy KJ/mol	413	280	193	635

(b) On the space provided below, sketch the cooling curve that would be obtained when a boiling tube Containing water at 80^0C is immersed in a freezing mixture maintained at 10^0C. (2mks)

(c) 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. (2mks)

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

(d) 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. (2mks)

4.. The combustion of propane can be represented by the following equation:

$C_3H_{8\,(g)} + 5O_{2\,(g)} \longrightarrow 3CO_{2\,(g)} + 4H_2O_{(l)}$

a) i) Define the term 'molar enthalpy of combustion' of a compound. (1mk)

ii) Use the thermo chemical equations below to answer the questions that follow.

1. $C_{(graphite)(s)} + O_{2\,(g)} \longrightarrow CO_{2\,(g)}$ $\Delta H_1 = -393.5$kJ/mole

2. $H_{2\,(g)} + \frac{1}{2}O_{2\,(g)} \longrightarrow H_2O_{(l)}$ $\Delta H_2 = -285.8$kJ/mole

3. $3C_{(graphite)(s)} + 4H_{2\,(g)} \longrightarrow C_3H_{8\,(g)}$ $\Delta H_3 = -103.7$kJ/mole

I. Name the type of enthalpy change represented by ΔH_3. (1mk)

II. Draw an energy level diagram for the reaction represented by equation 1. (3mks)

iii) Using energy cycle diagram, calculate the molar enthalpy of combustion of propane. (3mks)

b) The enthalpy of formation of ethanol (CH_3CH_2OH) is -3239Kj/mole. Use the bond energies given below to calculate the bond energy of formation of O-H. (3mks)

C-C = -346kJ/mole

C-H = -414kJ/mole

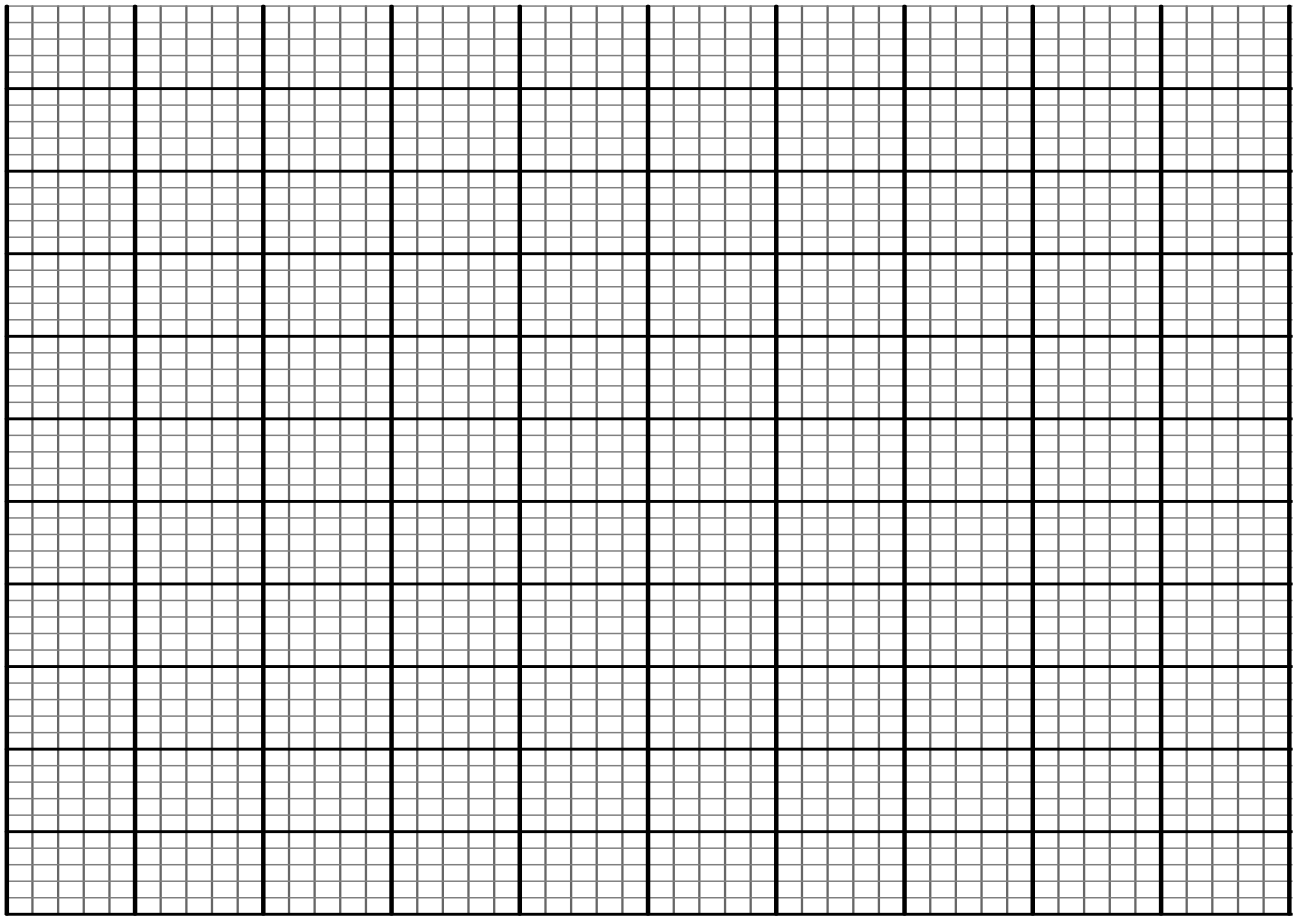
C-O = -360kJ/mole

5.. Equal volumes of dilute sulphuric (vi) acid of various concentrations were placed in five test tubes. 0.26g of zinc granules was used in each experiment and time taken for each experiment to be completed noted. The table below shows the results obtained.

Acid concentration	0.25M	1.5M	1.6M	2.6M	3.5M
Time in sec	500	250	67.5	40	30
$\frac{1}{time(s^{-1})}$					

a) i) Complete the table above by calculating $\frac{1}{time}$ (2mks

ii) Using the grid provided plot a graph of $\frac{1}{time(s^{-1})}$ against concentration of the acid. (3mks)



iii) Using the graph determine the rate of reaction when the concentration is 1.5M. (1mk)

iv) Briefly explain the relationship between the rate of reaction and concentration. (2mks)

v) Identify any other condition if carried would increase the rate of reaction between Zinc and Dilute suplhuric (vi) acid. (1mk)

b) What volume of hydrogen gas is evolved when all the zinc is reacted with excess dilute sulphuric (vi) acid. (Zn = 65.4, molar gas volume = 22.4 litres) (

6. . (a) 50cm^3 of 1M copper (II) Sulphate solution was placed in a 100cm^3 plastic beaker. The temperature of the solution was measured. Excess metal A powder was added to the solution, the mixture stirred and the maximum temperature was repeated using powder of metal B and C. The results obtained are given in the table below.

	A	**B**	**C**
Maximum temperature ^oC	2.63	31.7	22.0
Initial temperature (^oC)	22.0	22.0	22.0

(i) Arrange the metal A, B, C and Copper in order of reactivity starting with the least reactive. Give reasons for the order. (3 marks)

(ii) Other than temperature change, state one other observation that was made when the most reactive metal was added to the copper (II) Sulphate solution. (1 mk)

(b) The Standard enthalpy change of formation of methanol is -239Kjmol-1

(i) Write the thermal chemical equation for the standard enthalpy change of formation of methanol. (1 mk)

(ii) Use the following data to calculate the enthalpy change for the manufacture of methanol from carbon (II) oxide and hydrogen. (3 mks)

$CO_{(g)} + ½\ O_{2(g)} \longrightarrow CO_2$; $\Delta H^e = -283Kj/mol$

$H_{2(g)} + ½\ O_{2(g)} \longrightarrow H_2O_{(l);} = \Delta H^e = -286Kj/mol$

$CH_3OH + {}^3/_2 \longrightarrow CO_{2(g)} + 2H_2O; \Delta H^e = -715Kj/mol$

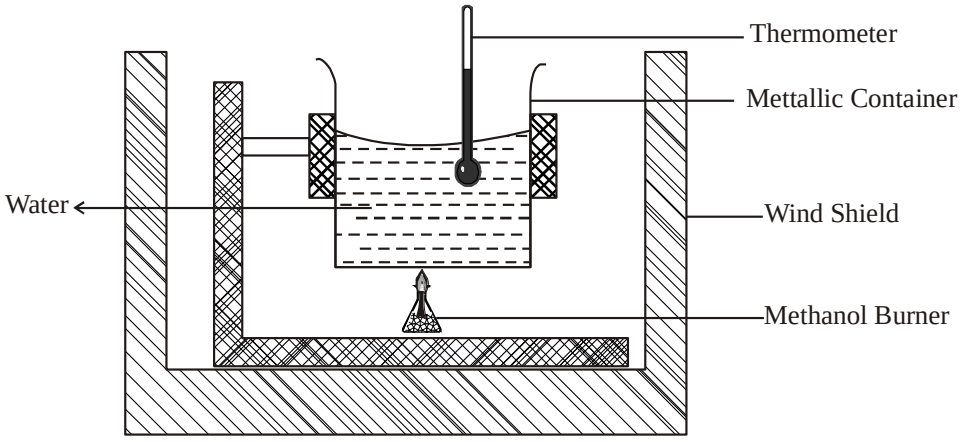
(c) Study the information given in the table below and answer the questions that follow.

Bond	Bond energy ($Kjmol^{-1}$
C – H	414
Cl – Cl	244
C – Cl	326
H - Cl	431

Calculate the enthalpy change for the reaction. (3 mks)

7. (a) What is the molar heat of combustion of a substance? (1mark)

The experiment below was set up to determine the molar heat of combustion of methanol.



The following data was obtained from the above experiment.

Mass of burner + methanol before burning	=	62.74g
Mass of burner + methanol after burning	=	62.36g
Final temperature of water	=	38.5^0C
Initial temperature of water	=	23.5^0C
Volume of water used	=	$100cm^3$

i) From the above results work out the molar heat of combustion of methanol. (3marks)

(Density of water =1g/cm^3, C = 12, O=16, H= 1.0)
Specific heat capacity of solution 4.2Kj K^{-1}_g K^{-1})

ii) Write a thermo chemical equation for this reaction. (1mark)

Explain why the value obtained in (i) above may be lower than the actual value. (1mark)

a) Study the data given below

$C_3H_{8(g)} + 5O_{2(g)} \longrightarrow 3CO_{2(g)} + 4H_2O_{(l)}$ $\Delta H = -2209$ KJmol^{-1}

$H_{2(g)} + ½ O_{2(g)} \longrightarrow H_2O_{(l)}$ $\Delta H = -286$KJmol^{-1}

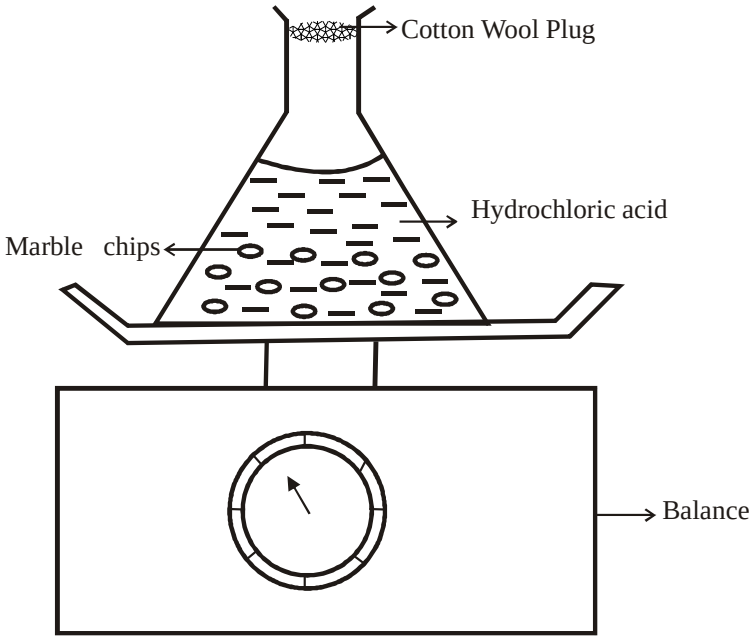
$C_{(s)} + O_{2(g)} \longrightarrow CO_{2(g)}$ $\Delta H = -406$KJmol^{-1}

Use this information to find the heat of formation of propane. (3marks)

What do you understand by the term heating value of a given fuel? (1mark)

State two factors you consider when choosing a fuel. (1mark)

8. The set up below is used to measure the change in mass during the course of the reaction between dilute hydrochloric acid (Excess) and marble chips at 22^0C.



Changes in mass were noted at one minute intervals and were as follows;

Time (Min)	1	2	3	4	5	6	7
Loss in mass (g)	0.26	0.46	0.60	0.69	0.73	0.73	0.73

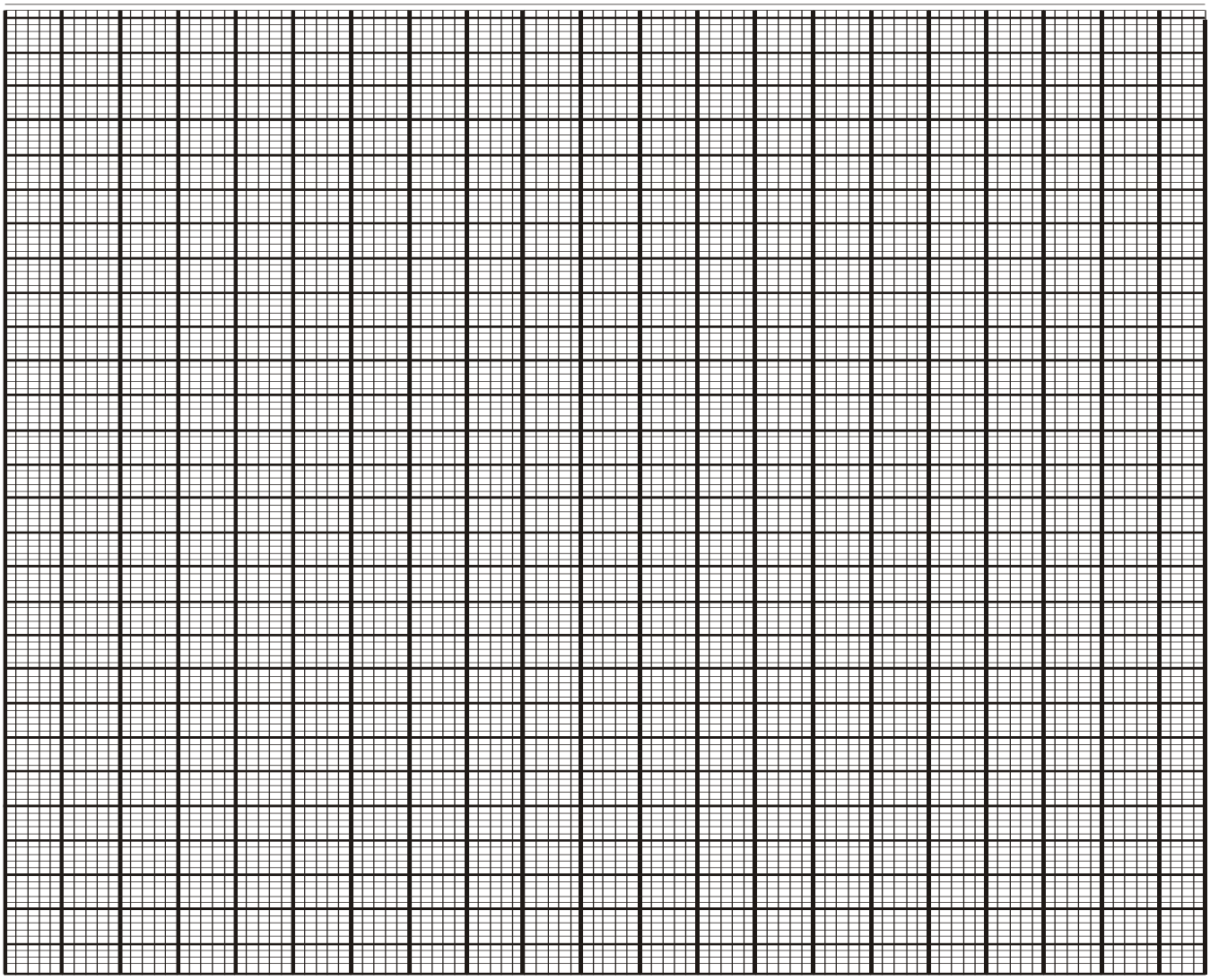
a) Write an equation for the reaction taking place in the flask. (1mark)

Give a reason why the mass of the flask charged with time? (1mark)

What is the role of cotton wool at the mouth of the flask? (1mark)

Explain why it is not advisable to use dilute sulphuric (VI) acid with marble chips in this experiment (1mark)

Plot a graph of loss in mass (vertical axis) against time. Label the curve 22^0C (3marks)



On the same axis in (e) above sketch the graph you would expect to obtain if the experiment was repeated at 35^0C. Label the curve 35^0C. (1mark)

b) State what would happen if the marble chips were replaced with the same mass of marble powder. Explain your answer. (1mark)

c) Determine the volume of carbon (IV) oxide produced if 0.12g of marble chips was reacted with excess dilute hydrochloric acid. (Experiment done at room temperature and pressure. Molar gas volume at r.t.p = 24dm^3,Ca = 40.0,O = 16, C = 12.0) (2marks)

9. In an experiment ,0.71g of hydrated sodium carbonate ($Na_2CO_3.XH_2O$) was treated with dilute nitric v acid and the gas evolved was carbon iv oxide which was measured using a syringe at stp.The volume of carbon iv oxide obtained was 56cm^3
a.Write the equation for the reaction between anhydrous sodium carbonate and dilute nitric v acid (1mk)

b. Calculate the number of moles of carbon iv oxide gas collected at s.t.p (molar gas volume at stp=22,400) (2mks)

c.Calculate the mass of anhydrous sodium carbonate reacted (3mks)

d.Calculate the mass of water in 0.715g of hydrated sodium carbonate (1mk)

e. Determine the R.F.M of hydrated sodium carbonate, hence the value of X (3mks)

10 .a) Sulphur occurs naturally in two different forms called allotropes;

(i) What are allotropes? **1mark**

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(ii) The two allotropes of sulphur are stable at different temperatures, as shown in the equation below.

$$\text{Rhombic sulphur} \underset{\text{Below } 95.5^0\text{C}}{\overset{\text{Above } 95.5^0\text{C}}{\rightleftharpoons}} \text{Monoclinic sulphur}$$

Give a name to the temperature 95.5^0C **1mark**

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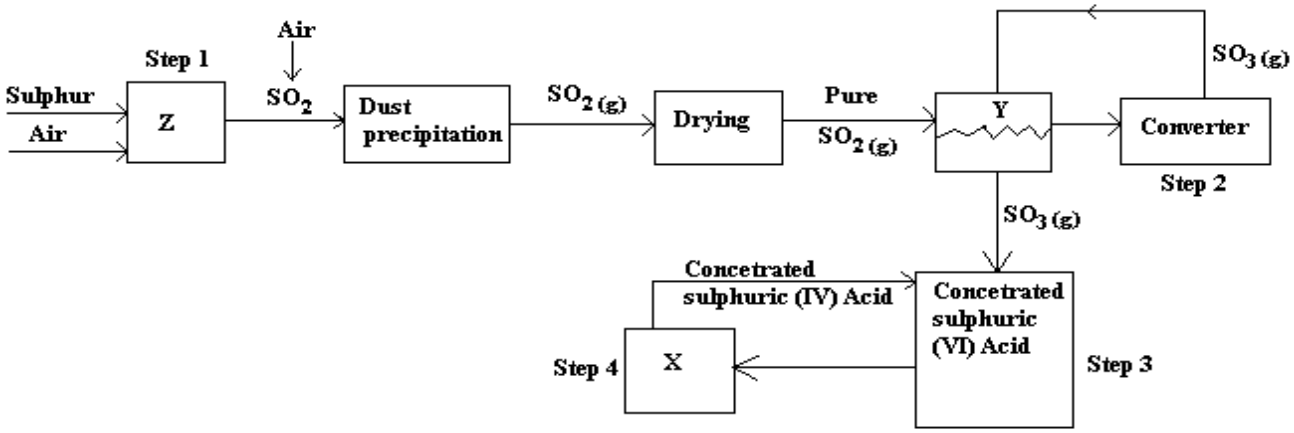
b) Below is a flow chart diagram for the contact process for the manufacture of sulphuric (VI) acid.



(c) Give the name of chambers labeled **1 ½ mark**

X

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Y

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Z

…….

(d) State the three conditions in the converter. **1 ½ mark**

(e) Explain why gases are passed through ; **2marks**
I – The dust precipitator and drying power

II- The chamber labeled Y Write the balanced equations for the reactions in;**3marks**

Step 2:

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Step 3:

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Step 4:

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c) Calculate the volume of sulphur (VI) oxide gas in litres that would be required to produce 178kg of Oleum in step 3. (Molar gas volume at s.t.p.=22.4l, H=1, O=16, S=32) **3marks**

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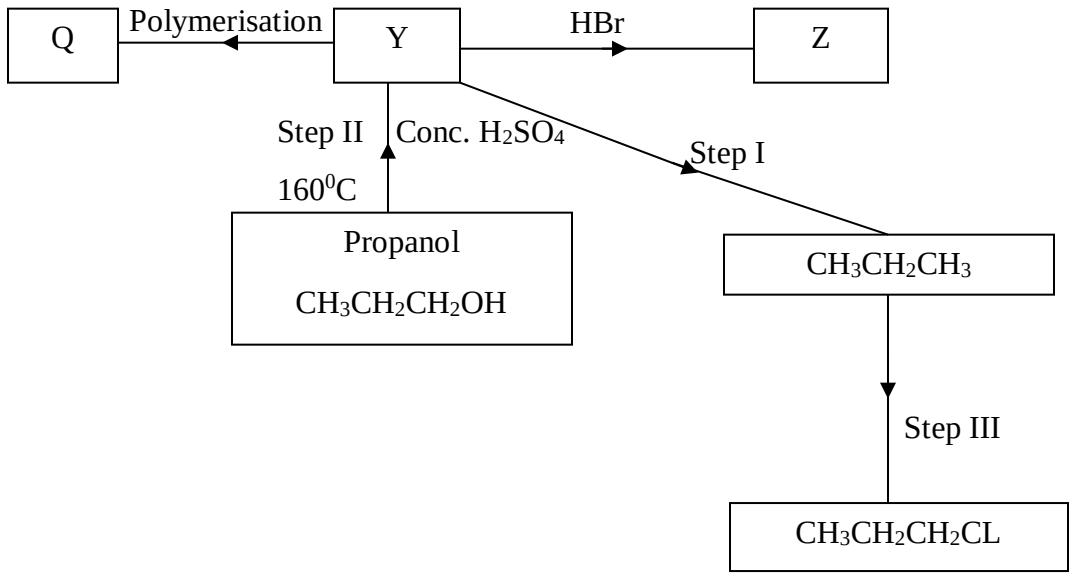
11. Below is a scheme of some reactions of propanol. Study it and answer the questions that follow.



(a) State the reagents and conditions required to effect step I **3marks**

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(b) Draw the structural formulae and name product Z. **1mark**

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(c) Name product Q **1mark**

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(d) Explain how product Y can be distinguished from the product formed after step I has taken place. **2marks**

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(e) What name is given to the process in Step II and step III **2marks**

Step II

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Step III

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(f) (i) Define the term hydrocarbon **1mark**

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(ii) Draw the structure of 1, 2 – dibromopropane **1mark**