

Name MUS Index No. _____

Candidate's Signature _____

Date _____

233/2

CHEMISTRY

PAPER 2

THEORY

SEPTEMBER 2021

2 HOURS

KASSU JET 2021
CHEMISTRY PAPER 2
Kenya Certificate of Secondary Education (K.C.S.E)

INSTRUCTIONS TO CANDIDATES

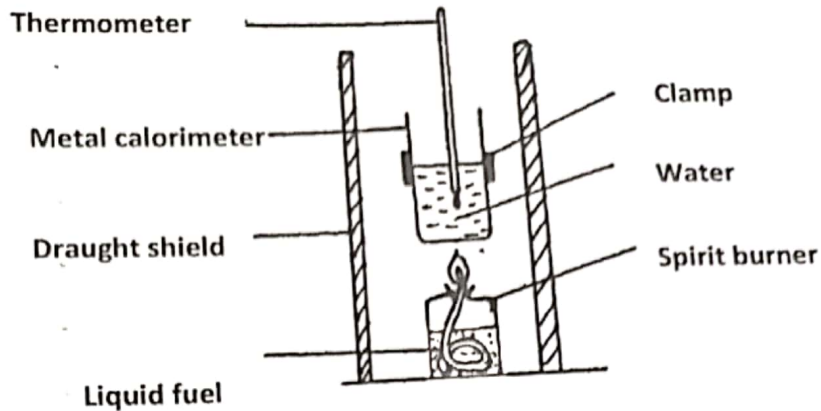
1. Write your name and index number in the spaces provided above.
2. Sign and write the date of examination in the spaces provided above.
3. Answer all the questions in the spaces provided.
4. Mathematical tables and silent electronic calculators may be used.
5. All working **must** be clearly shown where necessary.

FOR EXAMINER'S USE ONLY

QUESTION	MAXIMUM SCORE	CANDIDATE'S SCORE
1	12	
2	11	
3	11	
4	16	
5	14	
6	16	
Total score	80	

This paper consists of 13 printed pages

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°C
 Final temperature of water = 31.5°C
 Mass of ethanol burnt = 1.50 g
 Density of water = 1 g/cm^3
 Specific heat capacity = $4.2 \text{ Jg}^{-1}\text{K}^{-1}$

(1 mark)

(a) Define molar heat of combustion.

Its the enthalpy change that occurs when one mole of a substance is completely burned in oxygen. ✓ (1)

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

$$M C \Delta T$$

$$\Delta T = (31.5 - 12) = 19.5 \text{ } \checkmark \frac{1}{2}$$

$$(0.5 \text{ kg} \times 19.5 \text{ K} \times 4.2 \text{ kJg}^{-1}\text{K}^{-1}) \text{ kJ } \checkmark \frac{1}{2}$$

$$40.95 \text{ kJ } \checkmark 1$$

(ii) Find the molar enthalpy of combustion of ethanol.

(C = 12, H = 1, O = 16)

RFM of $C_2H_5OH = 46 \checkmark$

(2 marks)

Moles of $C_2H_5OH = \frac{1.50}{4.6}$

$= 0.0326 \checkmark$

$= -1255.8 \text{ kJ mol}^{-1}$

$0.0326 \text{ moles} \Rightarrow 40.95 \text{ kJ}$
 $(40.95 \div 0.0326) \checkmark$

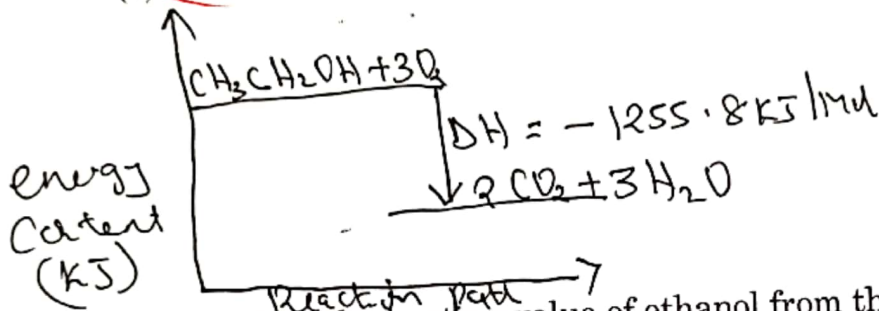
(c) An accurate value for ΔH_c of ethanol is $-1368 \text{ kJ mol}^{-1}$. State two sources of errors for the low figure obtained. (2 marks)

- Heat lost to the surrounding is not accounted for
- faulty apparatus

ACCEPT any other

Any 2

(d) Draw an energy level diagram for the combustion of ethanol. (2 marks)



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

Molar enthalpy of Combustion

RFM

$\left(\frac{1255.8}{46}\right) \text{ kJ g}^{-1} \checkmark$

$27.3 \text{ kJ g}^{-1} \checkmark$

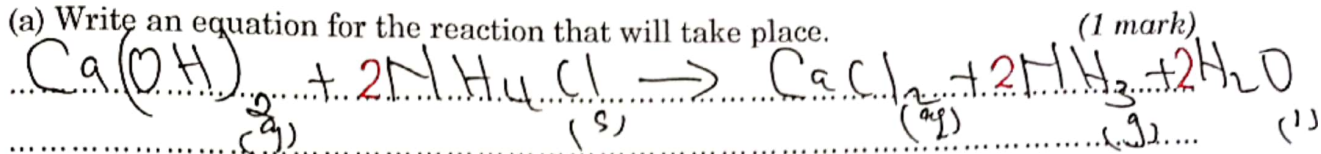
(f) State one factor that one may consider when choosing kerosene as a fuel in Eldoret town. (1 mark)

- Heating Value
- Availability
- ease of storage
- " " transportation
- COST
- environmental effects
- Rate of Combustion

Any 1

2. Ammonia can be prepared in the lab by reaction of Calcium hydroxide and an ammonium salt.

(a) Write an equation for the reaction that will take place. (1 mark)



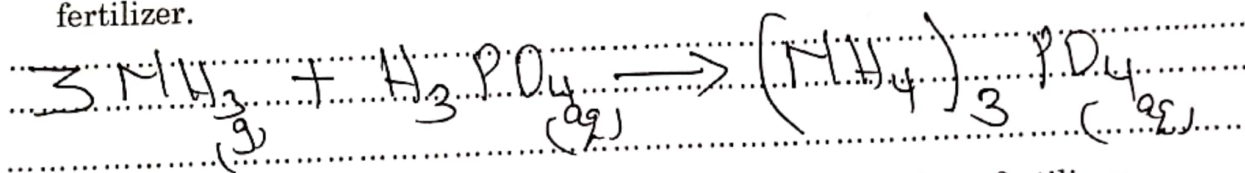
(b) Calculate the volume of ammonia produced at room temperature and pressure given that 20g of calcium hydroxide reacted fully. (Ca = 40, H = 1, O = 16, N = 14, MGV = 24dm³) (3 marks)

Moles of $\text{Ca(OH)}_2 = \frac{20}{74} = 0.2702$ (1)

From Mole ratio
Moles of $\text{NH}_3 = (0.2702 \times 2) = 0.5404$ (1)

Volume of $\text{NH}_3 = (0.5404 \times 24) = 12.9696 \text{ dm}^3$ (1)

(c) (i) Write an equation to show how ammonia is used to make phosphate fertilizer. (1 mark)



(ii) Determine the percentage by mass of Nitrogen in the above fertilizer. (1 mark)

RFM (N = 14, H = 1, P = 31, O = 16) = 149

% of N = $\left(\frac{42}{149} \times 100\right) = 28.1879\%$ (1)

(iii) State the importance of using ammonium phosphate over urea as a fertilizer (1 mark)

It has Nitrogen and Phosphorus which are essential for plant growth while Urea has only Nitrogen. (1)

(d) Describe how the presence of nitrate ions can be determined in a solution using concentrated Sulphuric (VI) acid as one of the reagents.

Place some little amount of suspected solution in a boiling tube. Add equal amount of freshly prepared iron(II) sulphate. Heat the boiling tube and add conc. H₂SO₄.

(e) State **one** danger of continued use of Nitrogenous fertilizers.
 Brown ring is formed.

Leads to eutrophication.

(1 mark)

3. (a) Define solubility.

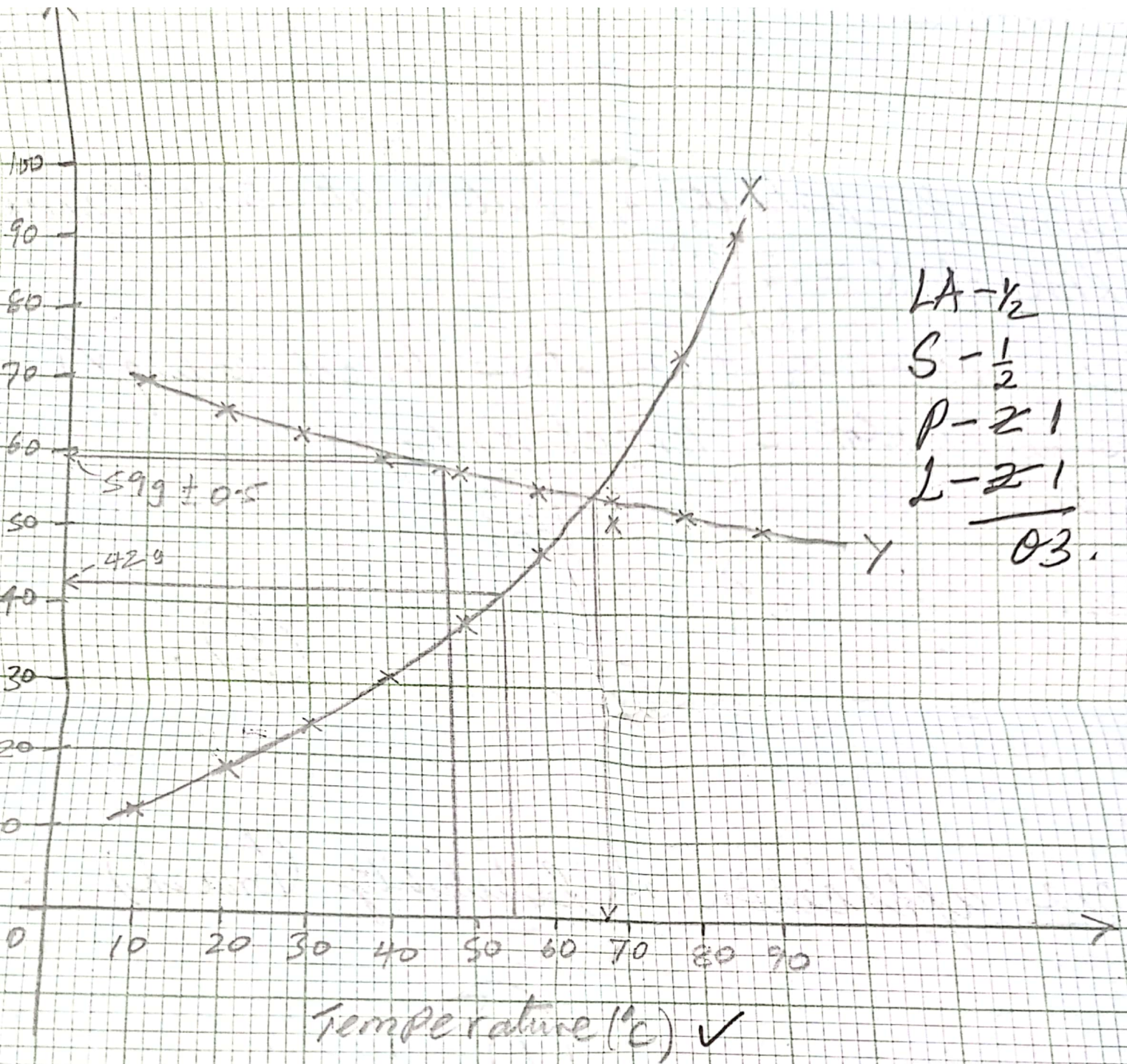
It is the maximum mass of solute required to saturate 100g of the solvent at a particular temp.

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

Temperature (°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)



pto

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

(1 mark)

67°C ± 0.5

①

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

Y → Solubility of gases decreases with increase in temperature. At higher temperature, kinetic energy of the gas molecules, they leave the solution.

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

$$\left(\frac{59 \pm 0.5}{2} \right) =$$

(2 marks)

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

not to show on graph ✓
value ✓

(1 mark)

(vi) State one application of solubility.

- ① Salting out of Soap
 - ② Purification of Common Salt
 - ③ Fractional Crystallisation
- Any one

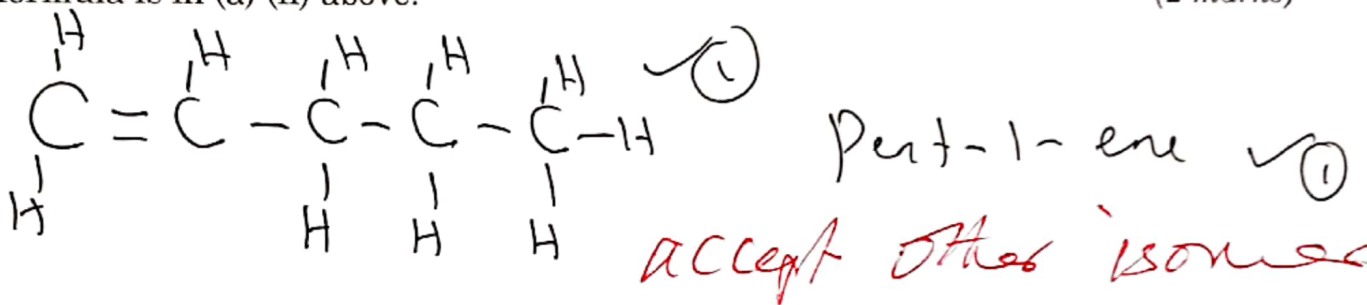
4. (a) (i) What is meant by isomerism?
 It is the existence of compounds having the same molecular formula but different structures. (1 mark)

(ii) A hydrocarbon sample is found to contain 83.3% carbon and 16.7% hydrogen. If the relative molecular mass of the compound is 72.0, determine its molecular formula. (C = 12, H = 1) (3 marks)

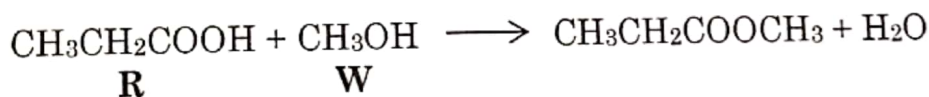
Elements	C	H
% Composition	83.3	16.7
Molar mass	12	1
Moles $\left(\frac{83.3}{12}\right)$	6.9417	$\left(\frac{16.7}{1}\right) = 16.7$
Moles $\times \frac{12}{12}$	1	2

$E.F = CH_2$
 $M.F = (E.F)_n$
 $(CH_2)_n = 72$
 $n = 5$
 $M.F = C_5H_{10}$

(iii) Draw the structural formula and name the compound whose molecular formula is in (a) (ii) above. (2 marks)



(g) Study the chemical equation below and answer the questions that follow.



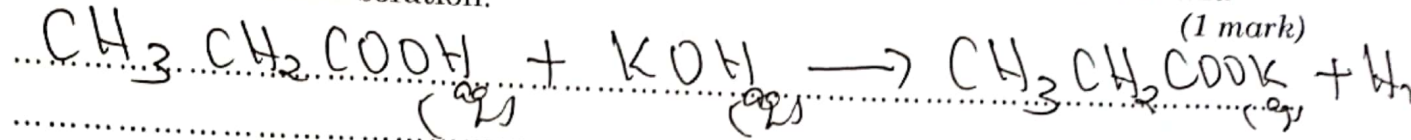
(i) Name the type of reaction represented by the above equation. (1 mark)

Esterification (1)

(ii) State two conditions in the reaction above. (2 marks)

Concentrated Sulphuric (VI) acid - Catalyst

(iii) Write an equation for the reaction between the compound labelled R and potassium hydroxide solution. (1 mark)



(iv) Name the type of reaction in b (iii) above. (1 mark)

Neutralisation

(v) Give three differences between the reactions named in b (i) and b (iv) above. (3 marks)

Neutralisation	Esterification
- Between Acid & alkali	- Between Alcohol & Alkanoic acid
- Product not Pleasant	- Product has a pleasant smell
- Conc. H_2SO_4 used as catalyst	- Conc. H_2SO_4 used as catalyst

(h) 4 grams of methanol (CH_3OH) requires 93.5 kJ of heat to vaporise completely. Calculate the heat required to vaporise one mole of methanol completely. (2 marks)

(C = 12.0, H = 1.0, O = 16.0)

$$\text{Moles of Methanol} = \frac{4}{32} = 0.125 \text{ mole}$$

$$= 7480 \text{ kJ/mole}$$

$$0.125 \text{ mole} \rightarrow 93.5 \text{ kJ}$$

$$1 \text{ mole} = \frac{93.5}{0.125} = 748 \text{ kJ}$$

5. a) Rubidium, atomic number 37 belongs to the same group as sodium.

(i) Explain why the element cannot occur free in nature. (1 mark)

It's very reactive hence forms compound such as oxide

the element would be stored in the laboratory (1 mark)
 Under Paraffin (0.1) | Toluene (1)

(iii) Predict one physical property of Rubidium which is the same as that of transition metals such as iron. (1 mark)

Conducts electricity (1)

(iv) State two observations you expect when Rubidium is added to water. (2 marks)

Meets in a silvery ball (by 2)
 - hissing sound
 - liquid on the surface

(v) What safety measure should be taken when adding Rubidium to water? (1 mark)

Use small amounts (1)

(vi) 43g of Rubidium was added to 1000cm³ of water, Calculate the volume of 0.5M sulphuric (VI) acid needed to neutralize 25cm³ of the solution (3 marks)

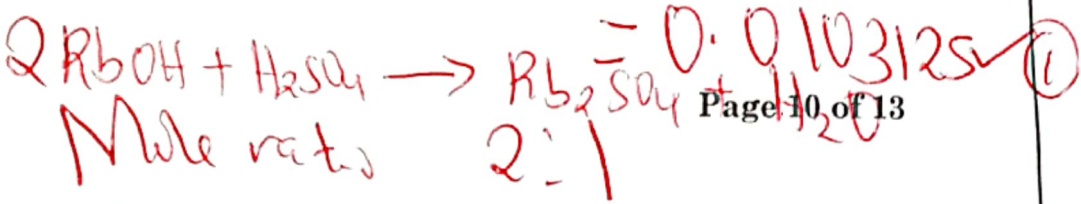
(Rb = 86, O = 16, H = 1, S = 32)



Molarity of RbOH = $\frac{43g}{103}$
 = 0.4175 M

Moles of RbOH = $\frac{25 \times 0.4175}{1000}$
 = 0.0103125 (1)

Volume = $\frac{0.005156 \times 100}{0.5}$
 = 10.312 cm³ (1)



2 → 0.0103125
 1 = $\frac{0.0103125}{2}$ = 0.005156 Mole (1)

(b) Describe an experiment you can use to show that chlorine is more reactive than iodine. (2 marks)

Bubble Cl_2 through a solution of KI.
 Brown solution / ppt indicates that Cl_2 displaces Iodine.

(c) Aluminum Oxide is amphoteric and insoluble in water

(i) What do you understand by the term amphoteric oxide? (1 mark)

Reacts with both alkalis & acids.

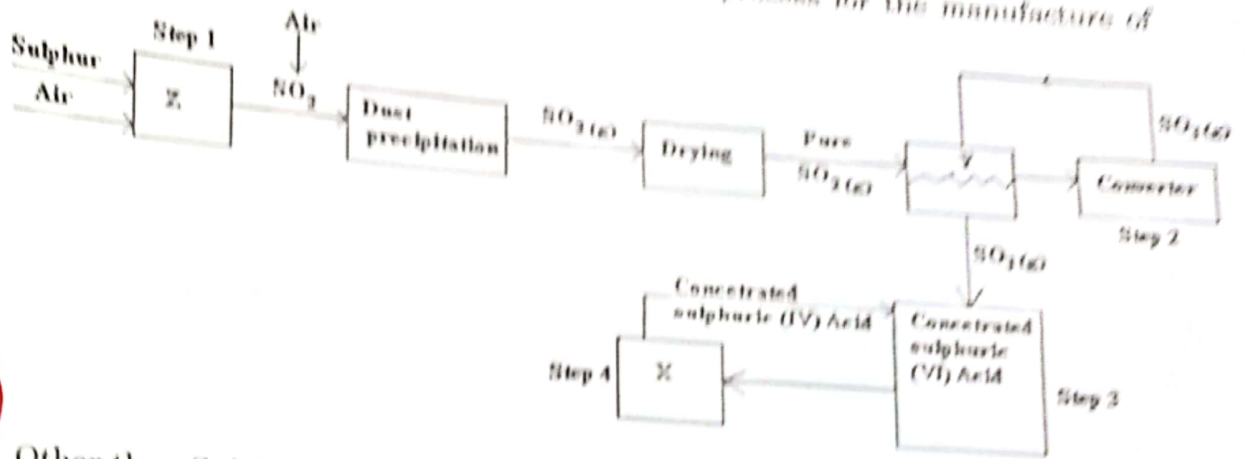
(ii) Describe how to show that Aluminium oxide is amphoteric. (2 marks)

Int two different test tubes, having NaOH / KOH & acid, add Al_2O_3 .
 Al_2O_3 dissolves in both solutions.

6. (a) Complete the table below to show the observation made and property when concentrated sulphuric (VI) acid is added to the following substances. (4 marks)

Substance	Observation	Property of Acid
sugar	Black charred mass ✓	Dehydrating agent ✓
Potassium nitrate crystals	Brown fumes / yellow liquid ✓	less volatile ✓

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



(i) Other than Sulphur state another substance that can be used (1 mark)

Lead(II) Sulphide // Zinc Sulphide // Hydrogen Sulphide

(ii) Both platinum and vanadium (v) oxide can be used as catalyst, explain why vanadium (V) oxide is preferred over platinum in the process (1 mark)

Cheaper / less expensive
less easily poisoned by impurities

(iii) Give the name of chambers labeled

X Absorption Chamber

Y Heat exchange

(iv) State two uses of sulphuric(VI) Acid .

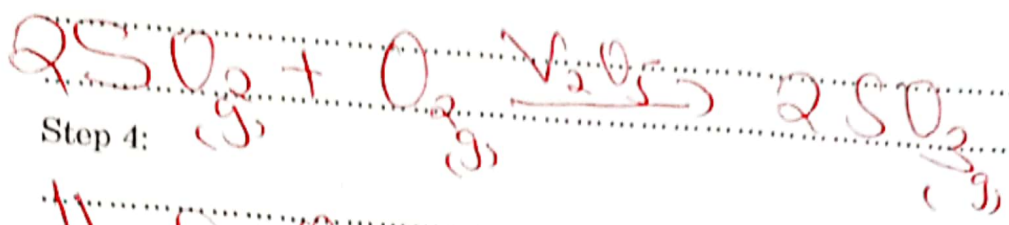
Making dyes & paint
lead acid accumulator / battery
Making soaps, detergent
// of Sulphate agriculture fertilizers

(2 marks)

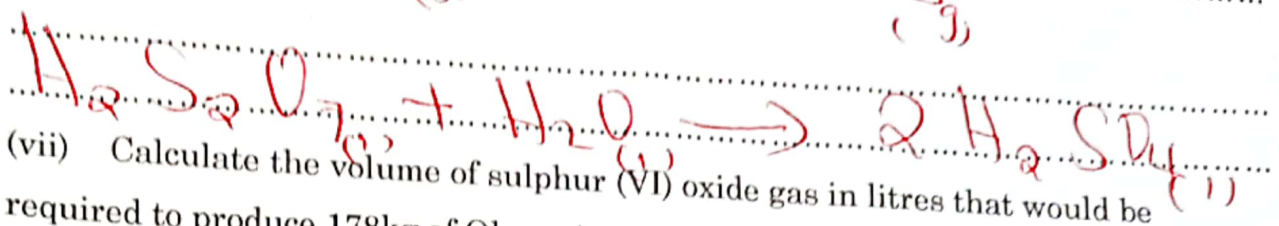
- Crushing
- ✓ Recycling back any unreacted SO_2 back
- ✓ Recycling SO_3 in conc H_2SO_4 instead of H_2O
- ✓ Desulfurizing SO_3 in conc H_2SO_4 instead of H_2O

(vi) Write the balanced equations for the reactions in;
Step 2:

(2 marks)



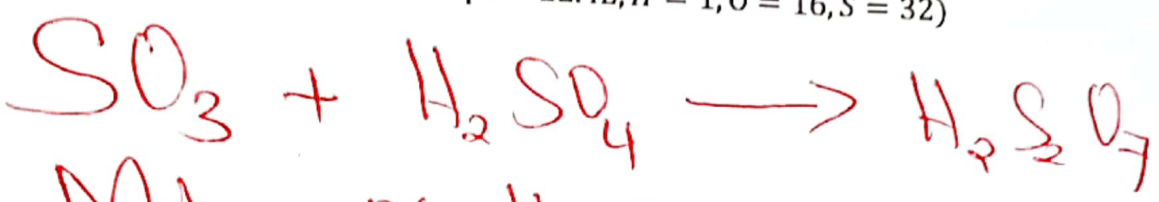
Step 4:



(vii) 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)

(3 marks)



$$\text{Moles of } H_2S_2O_7 = \frac{178000}{178} = 1000 \text{ moles}$$

$$\text{Moles of } SO_2 = 1:1$$

$$1 \text{ mole} \rightarrow 22.4 \text{ L} \quad \text{①}$$

$$1000 \text{ moles} = (22.4 \times 1000)$$

$$= 22400 \text{ litres} \quad \text{①}$$