

CHAMPIONS JET EXAMINATIONS

Kenya Certificate of Secondary Education

233/2

Chemistry (Theory)

Paper 2

July, 2024

Time: 2 Hours

Name: MARKING SCHEME Adm No:

Index. No: Stream: School:

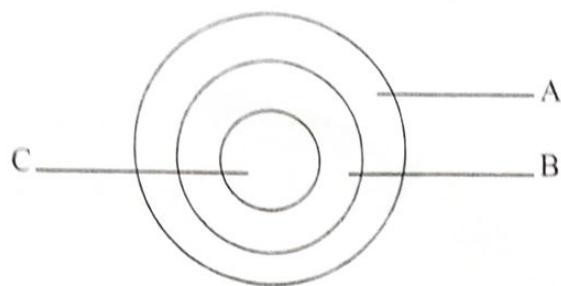
Instructions to candidates

- (a) Write your name, admission number, index number, stream and school in the spaces provided above.
- (b) Answer **ALL** the questions in the spaces provided and calculations **MUST** be clearly shown.
- (c) This paper consists of **13 printed pages**; please check the question paper to ascertain that all the pages are printed as indicated and that no questions are missing.

FOR EXAMINER'S USE ONLY

Questions	Maximum Score	Candidate's Score
1	11	
2	13	
3	14	
4	11	
5	10	
6	08	
7	13	
TOTAL	80	

1. The diagram below represents a cross section of the apparatus used to extract sulphur from its deposits. Study it and answer the questions that follow.



- (i) Name the material passing through the part marked C. (1 mark)

Hot compressed air. ✓

1

- (ii) State the role of the substances that pass through the part labeled A. (1 mark)

To melt sulphur ✓

1

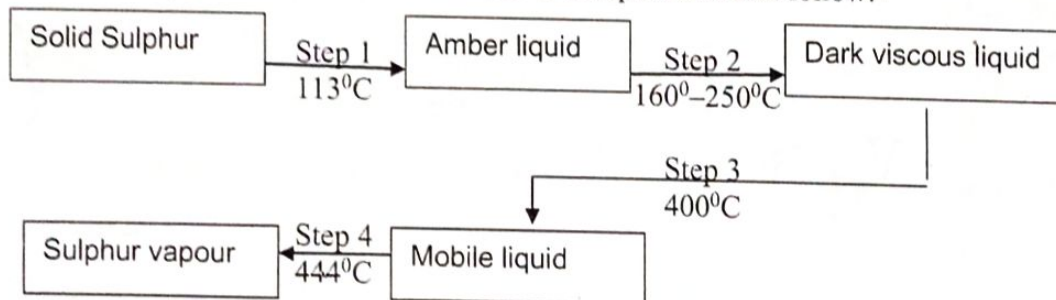
- (iii) Give two reasons as to why the shown method of sulphur extraction is possible. (2 marks)

- Sulphur has low melting point ✓

- Sulphur does not dissolve in water. ✓

2

- (b) Study the scheme below and answer the questions that follow:-



- (i) Explain the observations made in:-

- a) Step 1

(2 marks)

Sulphur melts to give a mobile amber liquid. The intermolecular forces holding S₈ molecules together are broken. ✓

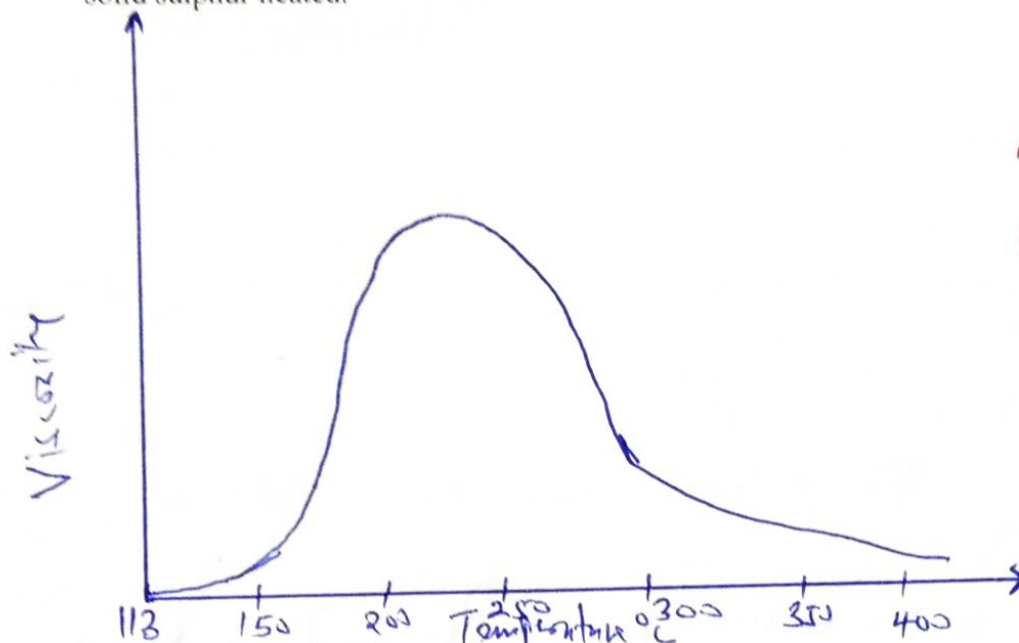
2

b) Step 3

(2 marks)

The colour becomes brighter and the liquid becomes more mobile.
Long chains start to break up to form smaller units.

c) Represent the information in the flow-chart using a graph of viscosity against temperature when solid sulphur heated. (2 marks)



A - 1
C - 1
2

d) State two uses of sulphur.

(1 mark)

- Making gun powder, match sticks
- Manufacture of fireworks
- Vulcanization of rubber
- Manufacture of fungicides
- Manufacture of medicines
- Making artificial hair colours or dyes
- Manufacture of Sulphuric (VI) acid.
- For making bleaching agents.

2 correct x 1/2

11

2. The table below shows properties of some elements. The letters do not represent the actual symbols of the elements. Study the information in the table and answer the questions that follow.

Element	Atomic Number	Melting Point $^{\circ}\text{C}$	Boiling Point $^{\circ}\text{C}$
P	13	660	2470
Q	9	-220	-188
R	19	63.7	774
S	17	-101	-34.1
T	12	650	1110
U	14	1410	2360
V	11	97.8	890
W	18	-189	-186

- (a) Select the element with the highest ionization energy.

(1 mark)

W ✓

- (b) How do the atomic radii of the following elements compare. Explain your answer.

- (i) S and T.

(2 marks)

S has a smaller atomic radius than T. S has more protons than T hence ~~more~~ higher nuclear charge. ✓ 2

- (ii) R and V.

(2 marks)

R has a larger atomic radius than V. R has more occupied energy levels than V. ✓ 2

- (c) How do the reactivities of Q and S with V compare. Explain your answer.

(2 marks)

Q reacts with V faster than S. Q has a smaller atomic size than S hence higher electron affinity. ✓ 2

- (d)

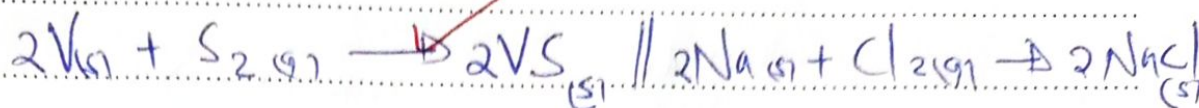
- (i) Write the formula of the compound formed between P and S

(1 mark)

PS_3 // AlCl_3 ✓ 1

(ii) Write an equation for the reaction between V and S

(1 mark)



(iii) State and explain how the boiling points of the compounds formed in d (i) and (ii) above compare.

(2 marks)

B.P of (ii) is higher than (i). VS has giant ionic structure with strong ionic bond while PS_2 molecules are held by weak van der Waals forces.

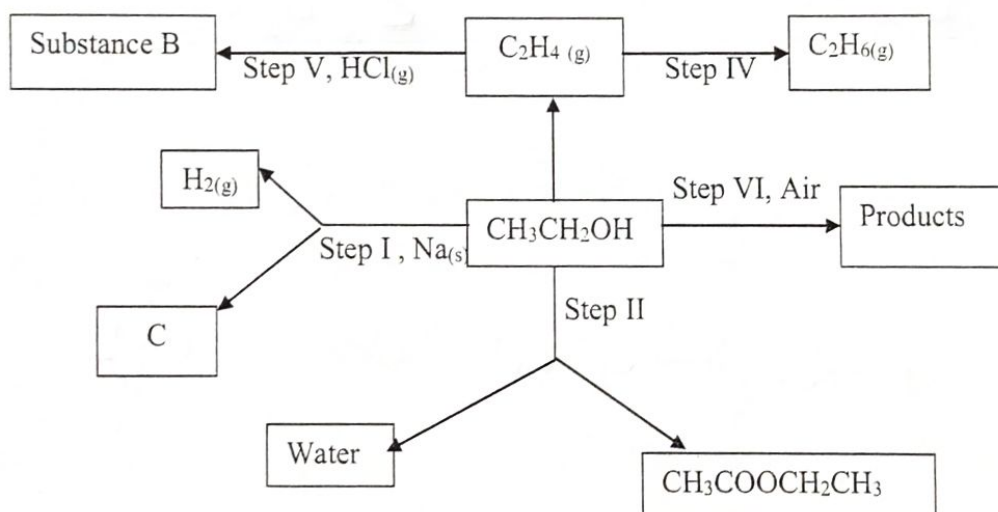
(e) What would be the effect of aqueous solution of compounds formed in d (i) and (ii) above on litmus papers. Explain.

(2 marks)

Solution of compound in d(i) changes blue litmus paper red while solution of in d(ii) has no effect on litmus papers. Sn in d(i) hydrolyses to produce HCl while Sn in d(ii) is neutral.

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3. a) Study the flow chart below and answer the questions that follow



(i) Describe how the reaction in **step II** is carried out in the lab.

(2 marks)

$\text{CH}_3\text{CH}_2\text{OH}$ is reacted with CH_3COOH , drops of conc H_2SO_4 added and the mixture is warmed.

(ii) Substance B

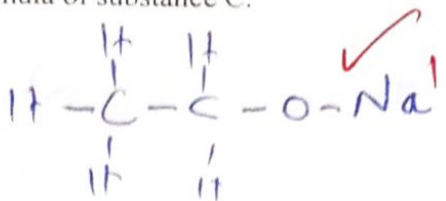
(1 mark)

chloroethane.

(iii) Name and draw the structural formula of substance C.

(2 marks)

Sodium ethoxide



2

(iv) Give the reagent and condition in step IV

(1 mark)

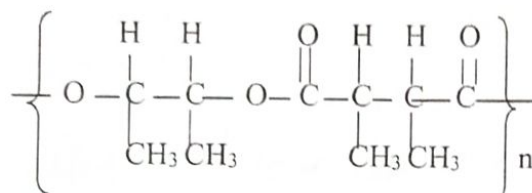
Reagent

Hydrogen gas

condition

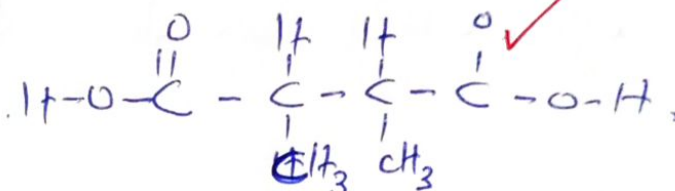
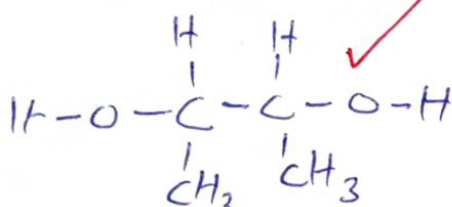
Ni / Pt catalyst
Temp 150-250°C

(b) The repeating unit of a polymer P is shown below



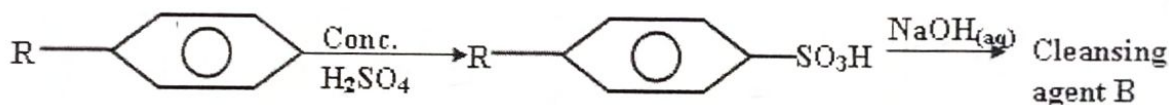
Draw the structures of two compounds which react together to form polymer P

(2 marks)



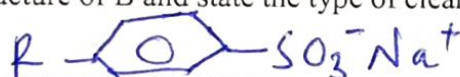
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(c) The scheme below represents the manufacture of a cleansing agent.



i) Draw the structure of B and state the type of cleansing agent for which it belongs.

Structure



(1 mark)

Type

Soapless detergent.

(1 mark)

ii) State one disadvantage of using B as a cleansing agent.

(1 mark)

Does not form lather with hard water.

iii) Describe how a cleansing agent removes dirt from linen

(3 marks)

During washing, the non polar end of the soapless detergent dissolves grease forming micelles while the polar end dissolves in water lowering its surface tension making the dirt get dislodged from the surface and washed off by rinsing.

4. a) Use the standard electrode potential for elements A, B, C, D and F given below to answer the questions that follow. The elements do not represent the actual symbols of the elements.

	$E^\ominus_{\text{Volts}}$
$A^{2+}_{(aq)} + 2e \rightleftharpoons A_{(s)}$	-2.90
$B^{2+}_{(aq)} + 2e \rightleftharpoons B_{(s)}$	-2.38
$C_{2(g)} + 2e \rightleftharpoons 2C^{-}_{(aq)}$	+0.91
$D^{2+}_{(aq)} + 2e \rightleftharpoons D_{(s)}$	+0.34
$F_{2(g)} + e \rightleftharpoons 2F^{-}_{(aq)}$	+2.87

- i) Identify the element which is the weakest oxidizing agent. (1 mark)

A ✓ 1

- ii) Write the cell representation for the electrochemical cell that would give the least e.m.f. (1 mark)

$A | A^{2+}_{(aq)} // B^{2+}_{(aq)} | B_{(s)}$ ✓ $E = +0.52V$ 1

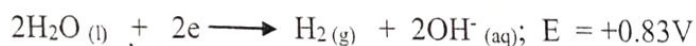
- iii) Determine the e.m.f for element D if B is used as the reference electrode. (1 mark)

$+2.72V$ ✓ 1

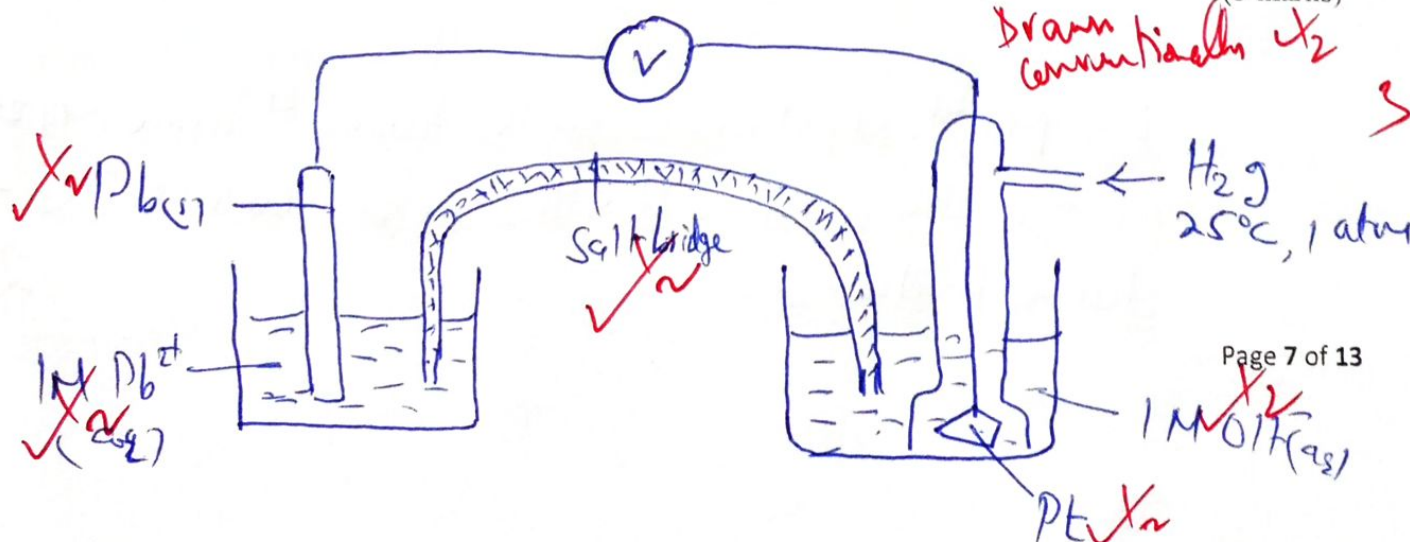
- iv) Can a solution of D be stored in a container of A? Show your working. (2 marks)

$D^{2+}_{(aq)} + A_{(s)} \rightarrow D_{(s)} + A^{2+}_{(aq)}$ ✓
 $E_{\text{reaction}} = +0.34 - -2.90 = +3.24V$ ✓
No, reaction will occur. 2

- b) The standard reduction potentials of two half-cells are:



Draw a labelled diagram of an electrochemical cell that can be constructed using the two half-cells (3 marks)



- (c) During the electrolysis of molten lead (II) chloride, a current of 1.5 amperes was passed for 49.5 minutes. How many grams of chlorine gas were produced? ($Cl=35.5$, $1F=96500C$). (3 marks)

$$\text{Mass} = \frac{1.5 \times 2970 \times 71}{2 \times 96500} = 1.6389g$$

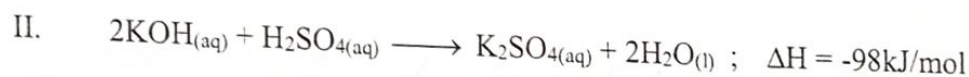
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5. a) Define molar heat of fusion

(1 mark)

Amount of heat energy required to convert one mole of a solid substance to a liquid at its melting point.

- (b) (i) Study the neutralization reactions below and answer the questions that follow

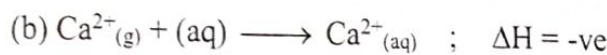
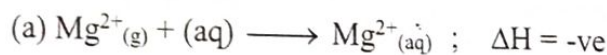


State and explain the difference in the heats of neutralization for the two reactions

The heat of neutralization for reaction I is (2 marks)

higher than that of II. Reaction I involves hydration energy of K^+ and OH^- ions and neutralization energy while II involves only neutralization energy.

- (ii) Study reactions below and answer the questions that follow:



Which reaction has a higher ΔH value. Explain (2 marks)

For Mg^{2+} . Mg^{2+} ions is smaller than Ca^{2+} hence Mg^{2+} ion form stronger forces of attraction with water than Ca^{2+} ion during hydration.

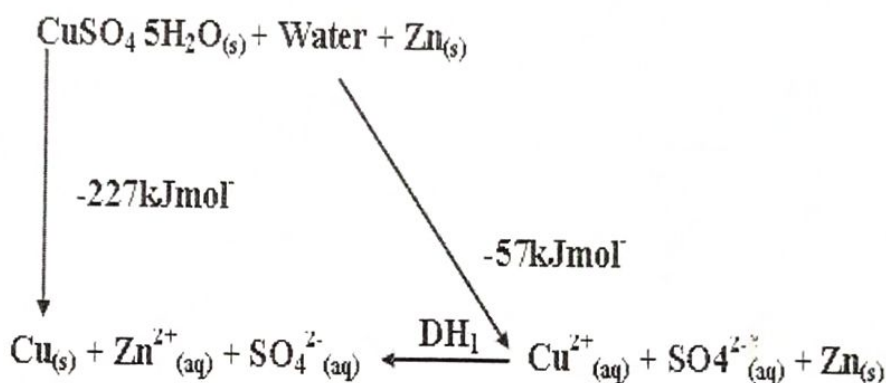
- (iii) Methane burns easily and quickly in air. However, it needs to be ignited before it begins to burn. Give a reason (1 mark)

Ignition provides A.E for the combustion reaction to begin.

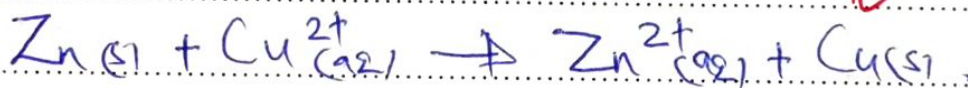
- c) When Zinc is placed in aqueous Copper (II) sulphate solution, Zinc displaces copper. Explain (1 mark)

Zn is more reactive than Cu hence displaces it from its solution.

- d) The cycle diagram below represents enthalpies of solution and displacement. Study it and answer the questions that follow.



- i) Write an ionic equation for the displacement reaction between copper II ions and Zinc atoms (1 mark)

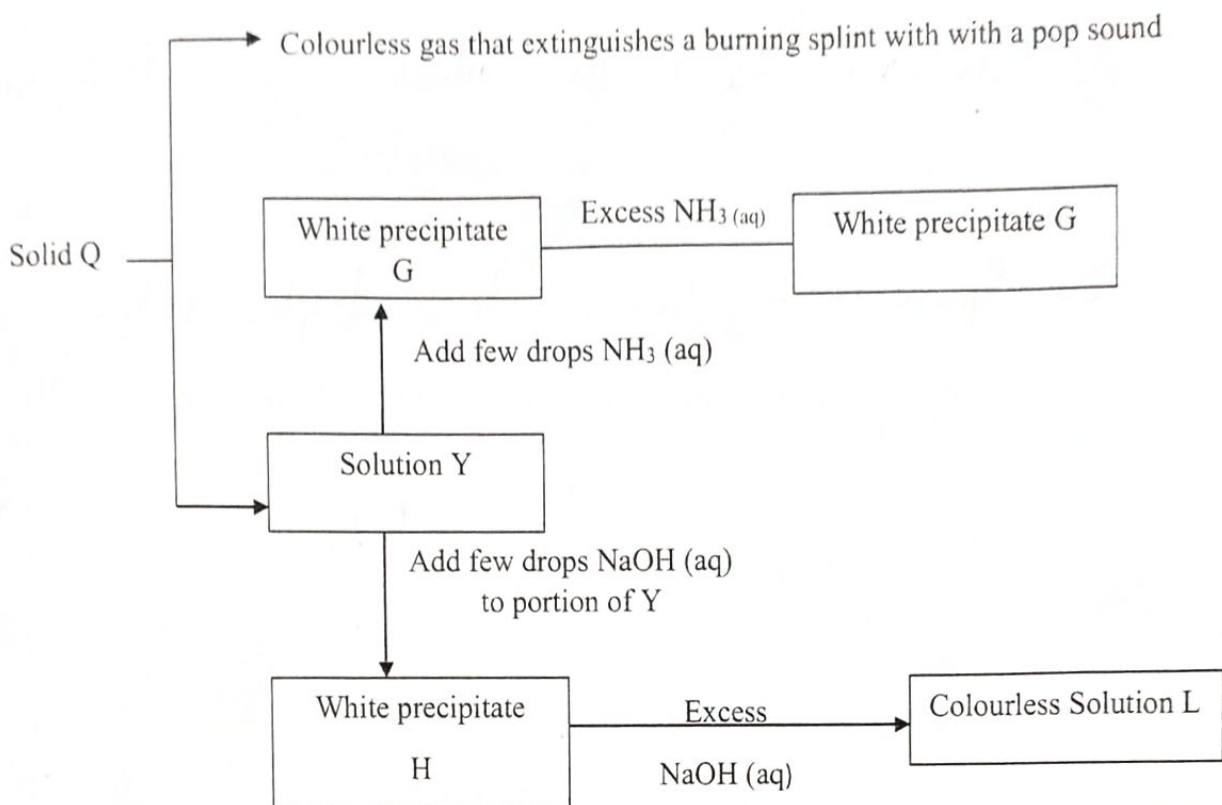


- ii) Calculate ΔH_1 for the reaction above (2 marks)

$\Delta H_1 = -227 + 57$
 $= -170 \text{ kJ mol}^{-1}$

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6. (a) Study the reaction scheme below and answer the questions that follow.



(i) Name solid Q.

(1 mark)

Aluminium / Al

(ii) Write the formulae of the cation present in solution L.

(1 mark)

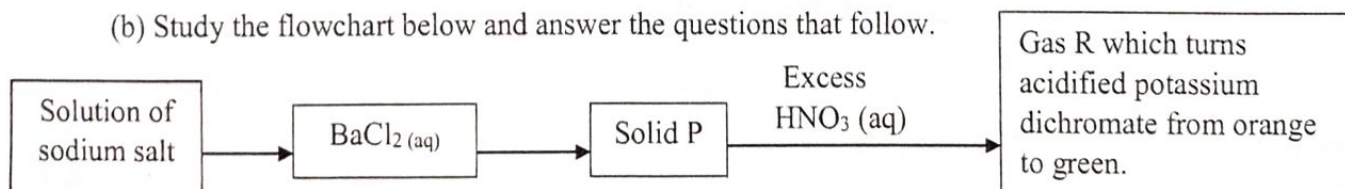
Al^{3+}

(iii) Write an ionic equation for the formation of the white precipitate H.

(1 mark)

$Al^{3+}_{(aq)} + 3OH^{-}_{(aq)} \rightarrow Al(OH)_3_{(s)}$

(b) Study the flowchart below and answer the questions that follow.



(i) Name

I. Solid P.

(1 mark)

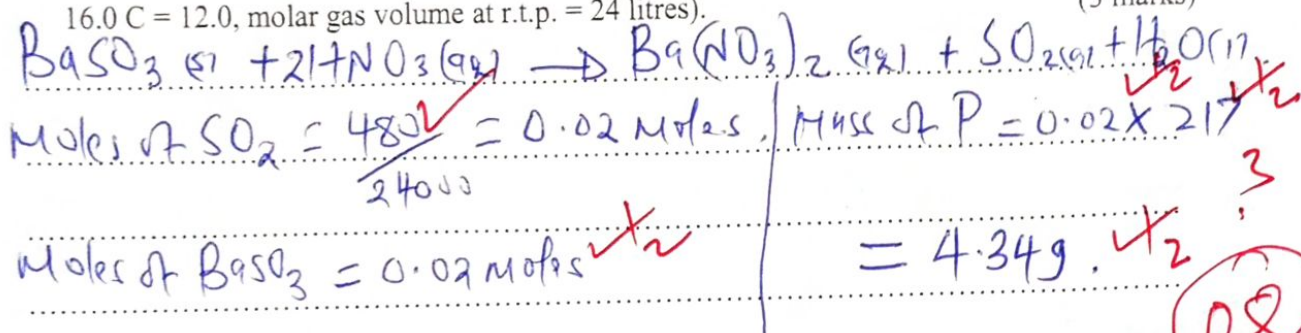
Barium sulphite ✓ / BaSO_3

II. Gas R

(1 mark)

Sulphur (IV) oxide ✓ / SO_2

- (ii) During the reaction in 480cm^3 of gas R was produced. Calculate the mass of solid P which reacted with excess nitric acid at room temperature and pressure) ($\text{Ba} = 137.0$, $\text{S} = 32.0$, $\text{O} = 16.0$, $\text{C} = 12.0$, molar gas volume at r.t.p. = 24 litres). (3 marks)



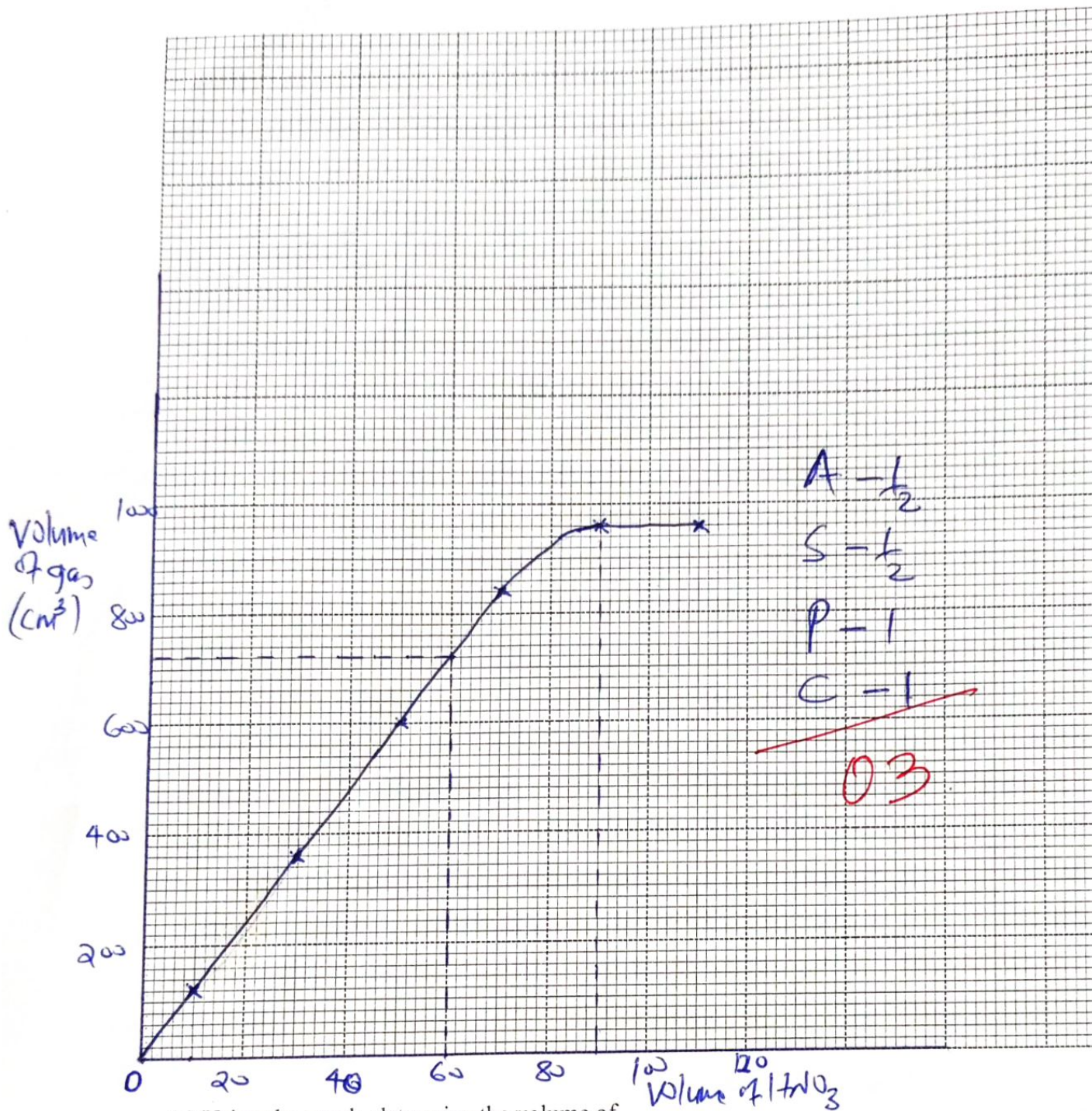
7. The table below shows the volume of nitrogen (IV) oxide produced when different volumes of 1M Nitric (V) acid- were each reacted with 4.14g of lead at room temperature.

Volume of 1M nitric (V) acid	10	30	50	70	90	110
Volume of nitrogen (IV) oxide (cm^3)	120	360	600	840	960	960

- (a) Explain how the rate of the reaction between lead and nitric (V) acid would be affected if the temperature of the reaction mixture was lowered. (2 marks)

Rate of reaction decreases / reduces. Lowering the temperature lowers the activation energy, this lowers rate of successful collision. 2

- (b) On the grid provided below plot a graph of the volume of the gas produced (vertical axis) against volume of acid. (3 marks)



(c) Using the graph, determine the volume of

(i) Nitrogen (iv) oxide produced when 60cm³ of 1M Nitric (V) acid were reacted with 4.14g of lead. (1 mark)

$$720 \text{ cm}^3 + 20 \text{ cm}^3$$

(ii) 1M Nitric (V) acid which would react completely with 4.14g of lead. (1 mark)

$$90 \text{ cm}^3$$

(d) Using the answer in c (ii) above, determine;

(i) the volume of 1M Nitric (V) acid that would react completely with one mole of lead. (Pb = 207) (2 marks)

$$4.14 \text{ g of Pb} \rightarrow 90 \text{ cm}^3 \text{ of HNO}_3$$

$$207 \text{ g of Pb} \rightarrow \frac{207 \times 90}{4.14} = 4500 \text{ cm}^3$$

(ii) the volume of nitrogen (IV) oxide produced when one mole of lead reacts with excess 1M Nitric (V) and acid at room temperature. (1 mark)

$$4.14 \text{ g of Pb} \rightarrow 960 \text{ cm}^3$$

$$207 \text{ g} \rightarrow \frac{207 \times 960}{4.14} = 48000 \text{ cm}^3$$

(e) Calculate the number of moles of

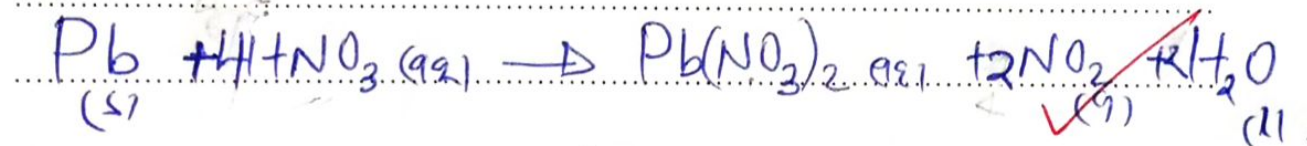
i) 1M Nitric (IV) acid reacted with one mole of lead. (1 mark)

$$\text{Moles} = \frac{4500}{1000} = 4.5 \text{ moles}$$

(ii) Nitrogen (IV) oxide produced when one mole of lead were reacted with excess nitric acid. (Molar gas volume is 24,000 cm³) (1 mark)

$$\text{Moles} = \frac{48000}{24000} = 2 \text{ moles}$$

f) using the answers obtained in e (i) and (ii), write the equation for the reaction between lead and nitric acid given that one mole of lead ii nitrate and one mole of water were also produced. (1 mark)



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