Name: ......Marking Scheme......................... Class: .... Adm.No. ....

School: .... Date: ....

Sign:...

233/2
CHEMISTRY
Paper 2
DECEMBER 2021
Time: 2 hours

MOKASA II JOINT EXAMINATION-2021

Kenya Certificate to Secondary Education

CHEMISTRY PAPER 2

TIME: 2 HOURS

INSTRUCTIONS TO CANDIDATES

- · Write your name, admission number, date and school in the spaces provided.
- Answer all the questions in the spaces provided.
- All working must be clearly shown where necessary.
- Scientific calculators may be used.

FOR OFFICIAL USE ONLY

QUESTION	MAXIMUM SCORE	CANDIDATES SCORE
1	13	
2	10	
3	10	
4	11	
5	12	
6	12	
7	12	
TOTAL	80	

This paper consists of **13** printed pages. Candidates are advised to check and to make sure all pages are as indicated and no question is missing.

1.

I.

(a) The grid below represents part of the periodic table. Study the information in it and answer the questions that follow. The letters do not represent the actual symbols of the elements.

								I
	G					A	J	
F	B		C		D	E	K	
							L	
						H	M	

(i) Select an element that can form an ion with a charge of -2. Given a reason for your answer. **(1 mark)**

A - Reacts by gaining 2 electrons.

(ii) What type of structure would the oxide of G have? **(1 mark)**

Giant ionic structure

(iii) How does the reactivity of H and E compare? Give a reason for your answer. **(1 mark)**

E is more reactive than H / H is less reactive than E. E can easily gain electron / E has higher electron affinity than H/ E is more electronegative than H.

(b) 1.3g of B reacts completely when heated. 1.2 litres of chlorine gas at s.t.p (1 mole of any gas at s.t.p occupies 22.4 litres at s.t.p)

(i) Write an equation for the reaction between B and chlorine. **(1 mark)**

$$B_{(s)} + Cl_{2(g)} \longrightarrow BCl_{2(s)} \quad // \quad Mg_{(s)} + Cl_{2(g)} \longrightarrow MgCl_{2(s)}$$
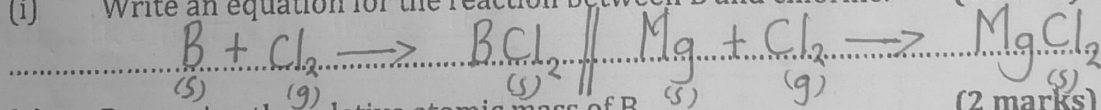
(ii) Determine the relative atomic mass of B. **(2 marks)**

$22.4 L \longrightarrow 1 mole$

$1.2 L \longrightarrow ?$

$\dfrac{1.2 \times 1}{22.4} = 0.05357 \text{ moles}$

mole ratio 1:1

moles of B $\Rightarrow 0.05357$

$1.3g \longrightarrow 0.05357 \text{ mol}$

$? \longrightarrow 1 mol$

$\dfrac{1.3 \times 1}{0.05357} = 24.267$

ans $\Rightarrow 24.2673$

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(c) Explain how you would expect the following to compare.

(i) Atomic radius of F and B (1 mark)

F has a larger atomic radius than B/B has a smaller atomic radius than F. B has more protons than F thus higher nuclear force of attractions.

(ii) The pH value of the aqueous solution of the oxide of B and D. (2 marks)

B solution has pH above 7 while D has p solution has pH below 7

II. Study the information below and answer the questions (the letters do not represent the actual symbols of the elements).

Elements	Electronic configuration	LE (kJ/mol)
J	2.1	519
K	2.8.1	494
L	2.8.8.1	418

(a) What is ionization energy? (1 mark)

Energy required/gained when an atom gains an electron in the outermost energy level in gaseous state.

(b) Explain why element L has the lowest ionization energy. (1 mark)

L Has the largest atomic radius

(c) Write an equation for the reaction between K and water. (1 mark)

$2K_{(s)} + 2H_2O_{(l)} \rightarrow 2KOH_{(aq)} + H_{2(g)}$ / $2Na_{(s)} + 2H_2O_{(l)} \rightarrow 2NaOH_{(aq)} + H_{2(g)}$
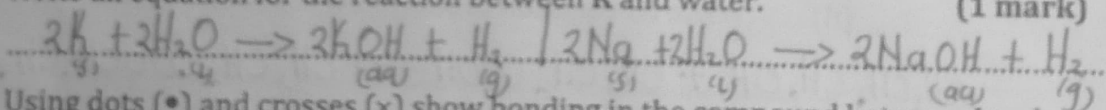
(d) Using dots (•) and crosses (×) show bonding in the compound between J and chlorine. (1 mark)

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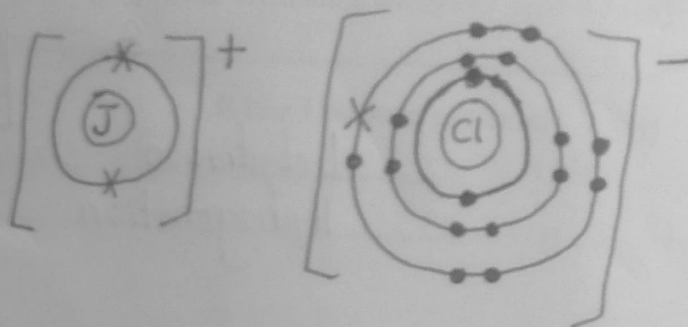
2. (a) Explain how one could distinguish between ethane and ethene gases using bromine water. **(2 marks)**

Bubble the the two gases in two different test-tube containing bromine water. With ethene bromine water changes from yellow to colourless while ethane has no effect on bromine water.

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

V

B

Na

Polymerization

$CH_3CH_2CH_2OH$ ——I——> $CH_3CH = CH_2$ ——Br_2——> F

CH_3CH_2COOH

II

$W + H_2O$
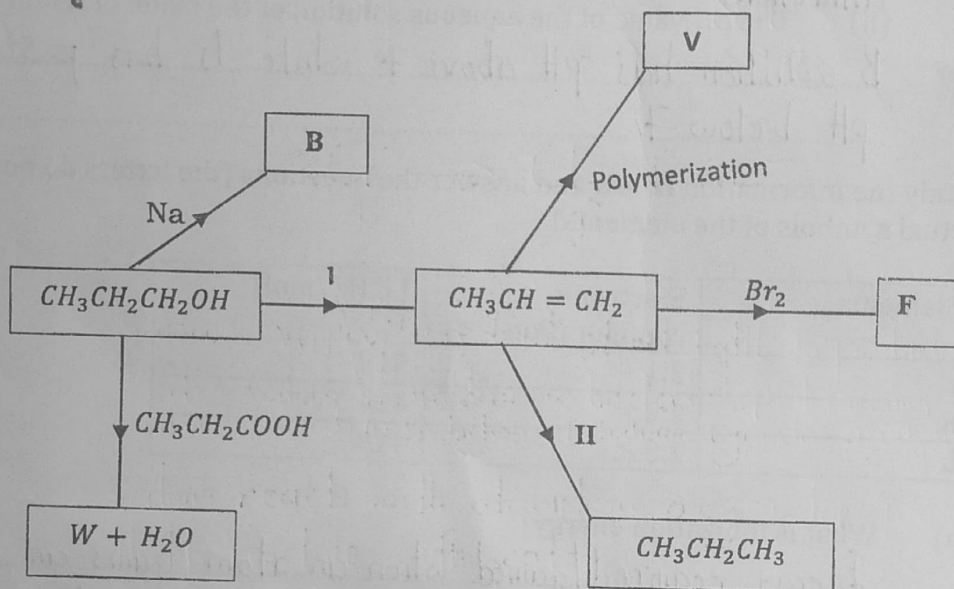
$CH_3CH_2CH_3$

(i) Identify substances **B** and **F** by giving their names. **(2 marks)**

B *Sodium propoxide | $CH_3CH_2CH_2ONa$*

F *1,2-dibromopropane | $CH_3CHBrCH_2Br$*

$H - \overset{H}{\underset{H}{C}} - \overset{H}{\underset{Br}{C}} - \overset{Br}{\underset{H}{C}} - H$

(ii) Write an equation to show how substance **W** and water are formed. **(1 mark)**

$CH_3CH_2CH_2OH + CH_3CH_2COOH \rightarrow CH_3CH_2COOCH_2CH_2CH_3 + H_2O$
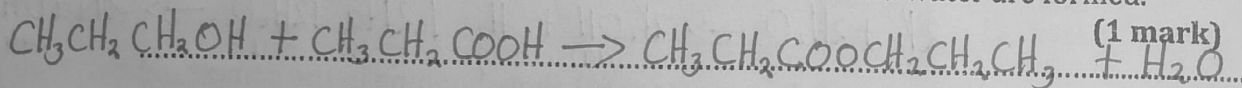
(iii) Give the general formula of the polymer **V**. **(1 mark)**

$\left[\begin{array}{c} H \\ | \\ -C- \\ | \\ H \end{array} \begin{array}{c} H \\ | \\ C- \\ | \\ H-C-H \\ | \\ H \end{array}\right]_n$ or $\left[\begin{array}{c} CH_2 - CH \\ | \\ CH_3 \end{array}\right]_n$
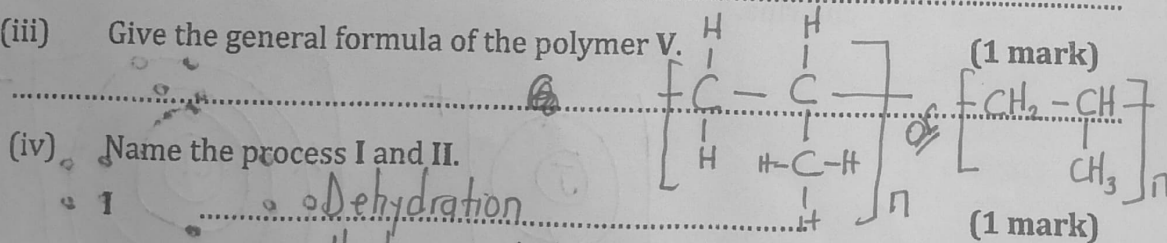
(iv) Name the process **I** and **II**.

I *Dehydration* **(1 mark)**

II *Hydrogenation* **(1 mark)**

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(v)   Give the conditions required for the process named above to occur.

I   ...Conc. Sulphuric (VI) acid................................   (1 mark)

II   ....Nickel catalyst, temp 150 – 250°C   (1 mark)
         or Palladium

3.   The diagram below shows the extraction of sodium metal using the Down's cell. Study it
      and answer the questions that follow.
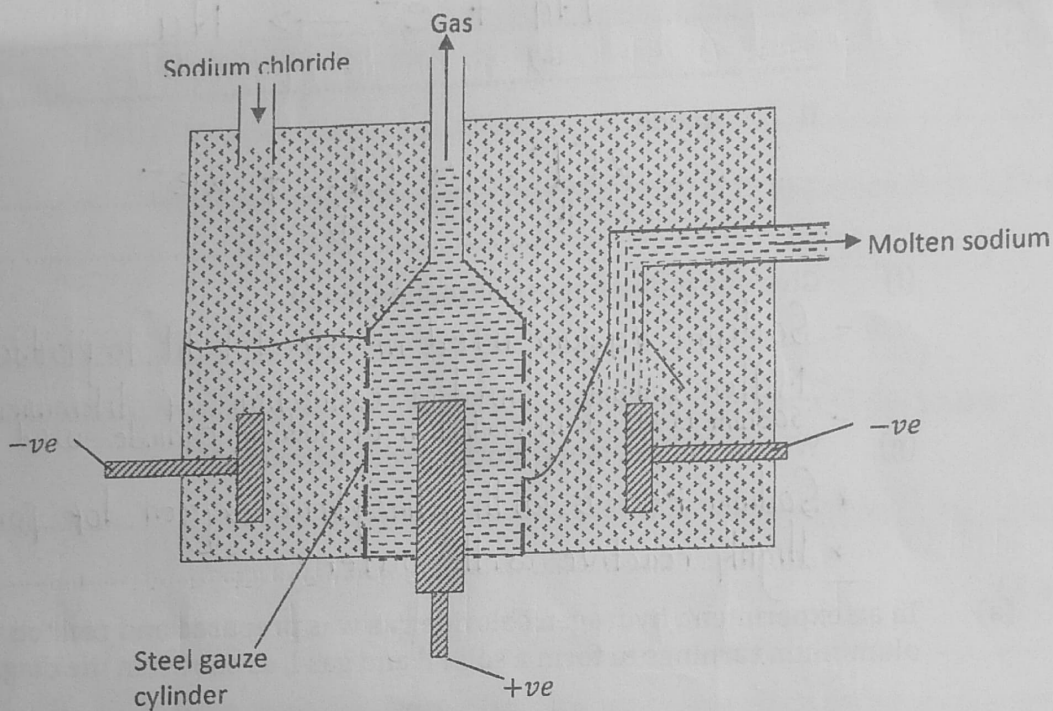
(a)   Explain why in this process sodium chloride is mixed with calcium chloride.
                                                                                                            (2 marks)
      To lower the m.p of NaCl from 800°C to 600°C in order
      to save on cost of production.

(b)   Why is the anode made of graphite and not iron?   (1 mark)
      Graphite is inert thus does not react with chlorine while Iron is
      reactive and would react with chlorine.

(c)   State **two** properties of sodium metal that make it possible for it to be collected as
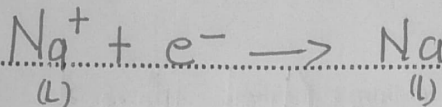   shown in the diagram.   (2 marks)
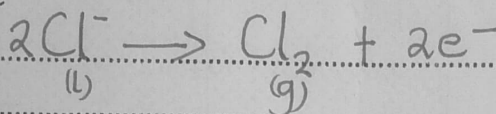
      Has lower density than the electrolyte.

*   Has m.p below 600°C

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(d) What is the function of the steel gauze cylinder? **(1 mark)**

Prevent sodium and chlorine from recombining & reacting

(e) Write ionic equations for the reactions which take place at;

I Cathode **(1 mark)**

$$Na^+_{(l)} + e^- \longrightarrow Na_{(l)}$$

II Anode **(1 mark)**

$$2Cl^-_{(l)} \longrightarrow Cl_{2(g)} + 2e^-$$

(f) Give one industrial use of sodium metal. **(1 mark)**

- Sodium vapour used in street light to produce yellow glow
- Molten sodium is used in extraction of titanium
- Sodium is used in production of sodium cyanide used in extraction of gold.

(g) Why is sodium metal stored under kerosene? **(1 mark)**

* Sodium reacts with atmospheric oxygen to form oxides
* Highly reactive with water

4. (a) In an experiment, hydrogen chloride gas was prepared and reacted with aluminium turnings to form a solid P and gas L as shown in the diagram.
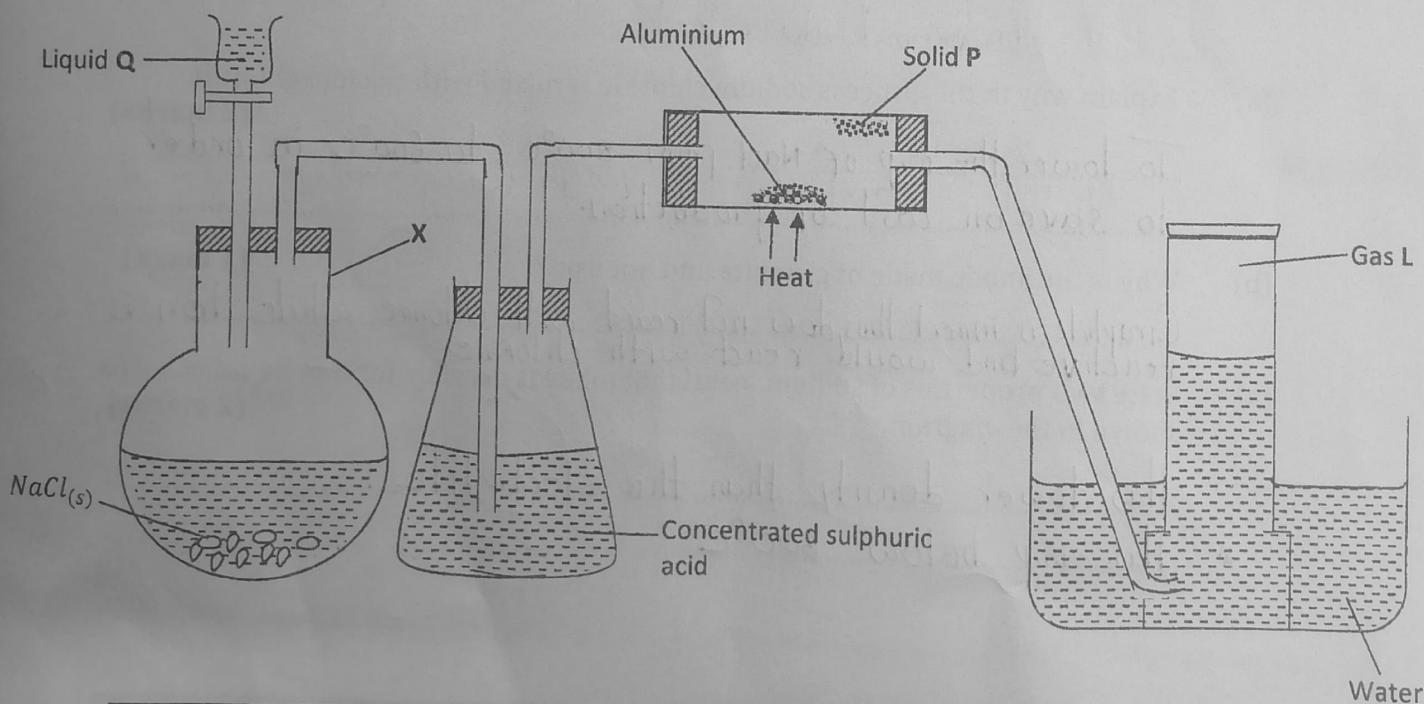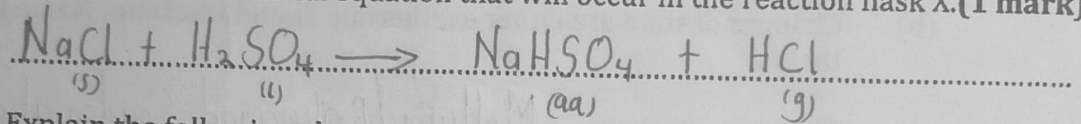
(i)   Name:

Solid P - ......Aluminium Chloride.......................   (1 mark)

Gas L - ....Hydrogen......................................   (1 mark)

Liquid Q - ......Conc. Sulphuric (vi) acid..............   (1 mark)

(ii)   Give the name of another substance that could serve the same purpose as
       the concentrated sulphuric acid.   (1 mark)

......Anhydrous Calcium chloride.......................................

(iii) Write a chemical equation that will occur in the reaction flask X.(1 mark)

$$NaCl + H_2SO_4 \longrightarrow NaHSO_4 + HCl$$
$$_{(s)} \qquad _{(l)} \qquad\qquad _{(aq)} \qquad _{(g)}$$

(b)   Explain the following observations:-

(i)   When blue litmus paper was dipped into the water in the beaker at the
       end of the experiment it turned red.   (1 mark)

Unreacted HCl gas dissolves in the water to form
$HCl_{(aq)}$ acid.

(ii)   Solid P collects away from the heated aluminium.   (1 mark)

.Aluminium chloride sublimes on heating.............................

(c)   (i)   Write an equation for the reaction that takes place between ammonia gas
              and hydrogen chloride gas.   (1 mark)

$$NH_3 + HCl \longrightarrow NH_4Cl$$
$$_{(g)} \quad _{(g)} \qquad\qquad _{(g)}$$
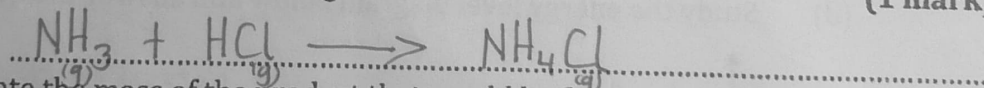
(d)   Calculate the mass of the product that would be formed when 4000 cm³ of
       hydrogen chloride gas reacts completely with excess ammonia gas.
       (H = 1, N = 14, Cl = 35.5, Molar gas volume at r.t.p = 24 litres)   (3 marks)

$1 mole \longrightarrow 24,000 cm^3$ $1 mole \longrightarrow 53.5g$
$? \longrightarrow 4,000 cm^3$ $0.16667 moles \longrightarrow ?$

$\dfrac{4000 \times 1}{24,000} = 0.16667 moles$

mole ratio HCl : NH₄Cl
                1 : 1

moles of NH₄Cl ⟹ 0.16667

$\dfrac{53.5 \times 0.16667}{1}$

$8.9168g$

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5. (a) Distinguish between exothermic and endothermic reaction.

(1 mark)

Exothermic

A reaction that releases/produces heat to the sorounding/environment

(1 mark)

Endothermic

A reaction that abosorbs heat from the environment

(b) Changes of state are either exothermic or endothermic. Name a change of state that is;

(i) exothermic .... Freezing and Condensation... **(1 mark)**

(ii) endothermic ... Melting and Boiling .... **(1 mark)**

(c) When pure water is heated at 1 atmospheric pressure at sea level, the temperature of the water does not rise beyond 100°C even with continued heating. Explain this observation. **(2 marks)**

The B.p of pure water at 1 atm at sea level is 100°C

(d) Study the energy level diagram below and answer the questions that follow.
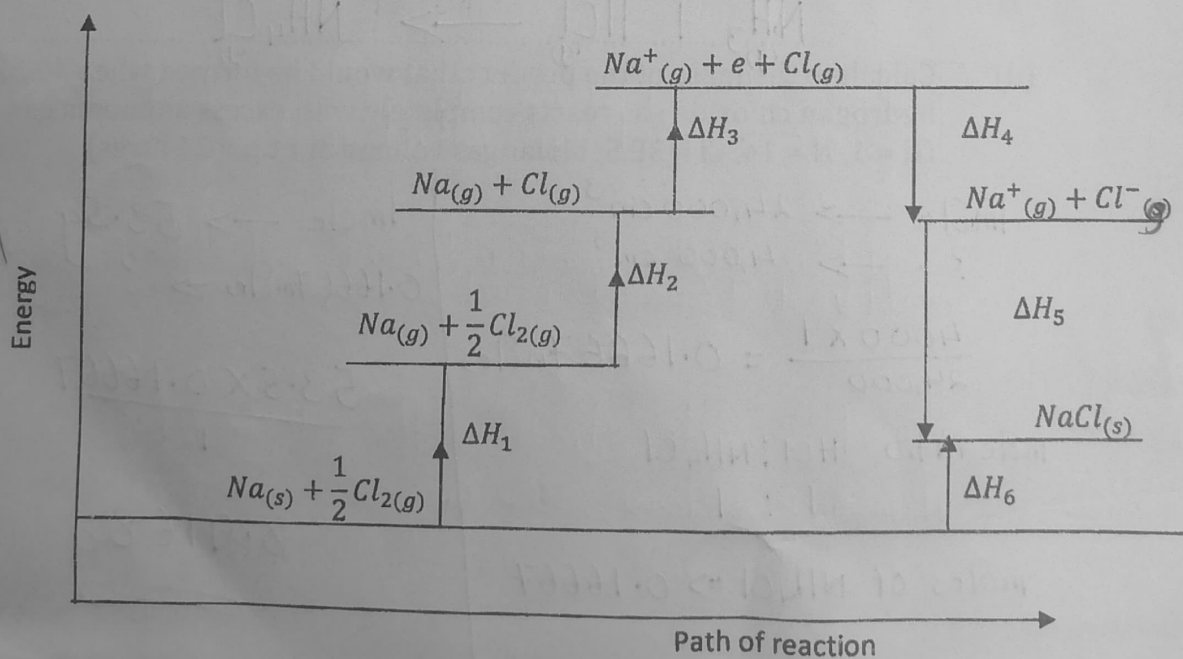
(i) Give the names of the energy changes represented by ΔH_1 ΔH_4 ΔH_5 ΔH_6

ΔH_1 ......~~lattice~~ Atomization of Sodium.......... (1 mark)

ΔH_4 ......Electron affinity of Chlorine.......... (1 mark)

ΔH_5 ......Lattice formation.......... (1 mark)

ΔH_6 ......Formation of NaCl.......... (1 mark)

(ii) When is ΔH_5 endothermic? (1 mark)

During dissociation of ~~&~~ ionic compounds to gaseous ions....

(iii) Show the relationship between ΔH_1 ΔH_2 ΔH_3 ΔH_4 ΔH_5 and ΔH_6. (1 mark)

$$\Delta H_6 = \Delta H_1 + \Delta H_2 + \Delta H_3 + \Delta H_4 + \Delta H_5$$

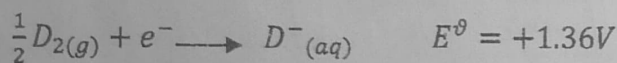6. (a) What is the electronic arrangement of nitrogen in NO_3^- ? (1 mark)
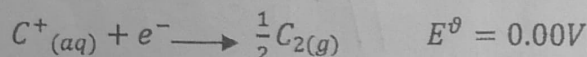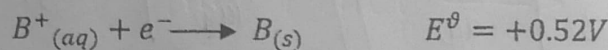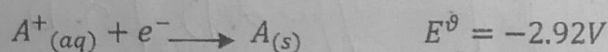
$$x + -2 \times 3 = -1$$

$$x = +6 - 1$$

$$x = +5$$

ans = 2

(b) Study the standard electrode potentials below and answer the questions that follow. (The letters do not represent the actual symbols of the elements.

$A^+{}_{(aq)} + e^- \longrightarrow A_{(s)}$ $\qquad E^\vartheta = -2.92V$

$B^+{}_{(aq)} + e^- \longrightarrow B_{(s)}$ $\qquad E^\vartheta = +0.52V$

$C^+{}_{(aq)} + e^- \longrightarrow \frac{1}{2}C_{2(g)}$ $\qquad E^\vartheta = 0.00V$

$\frac{1}{2}D_{2(g)} + e^- \longrightarrow D^-{}_{(aq)}$ $\qquad E^\vartheta = +1.36V$

$E^{2+}{}_{(aq)} + 2e^- \longrightarrow E_{(s)}$ $\qquad E^\vartheta = -0.44V$
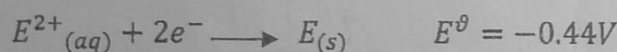
(i) With reasons, identify the;
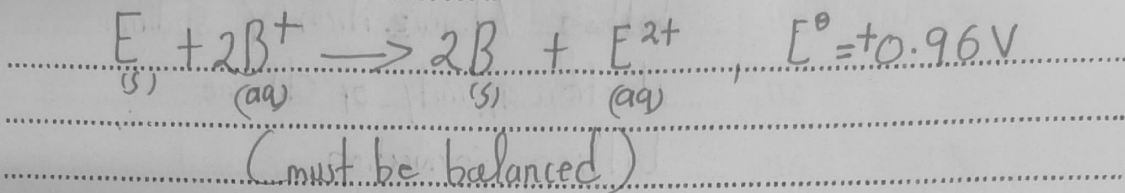
I Strongest reducing agent. (1 mark)

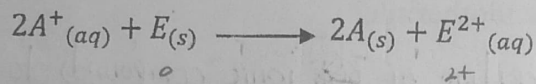A(s). Can easily lose electron. most electropositive. most negative

II the reference electrode. (1 mark)

C₂. Has E^ϑ of 0.00V

(ii)   Write the overall equation for the reaction that will be obtained when half cells of B and E are connected.   **(1 mark)**

$$E_{(s)} + 2B^+_{(aq)} \longrightarrow 2B_{(s)} + E^{2+}_{(aq)} \quad , \quad E^\theta = +0.96\,V$$

_____ (must be balanced) _____

(iv)   Explain whether the reaction represented below can take place.   **(2 marks)**

$$2A^+_{(aq)} + E_{(s)} \longrightarrow 2A_{(s)} + E^{2+}_{(aq)}$$
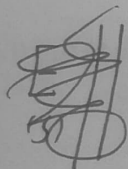
Reaction cannot take place. A is more reactive than E thus E cannot displace A from its solution.

or

$$-2.96 + 0.44 = -2.52$$

Cannot take place. Has a negative E^θ value

(v)   Draw the cell diagram obtained when the half cells in (ii) are combined.   **(2 marks)**

$$E_{(s)} \,\big|\, E^{2+}_{(aq)} \,\big|\big|\, 2B^+_{(aq)} \,\big|\, 2B_{(s)} \quad , \quad E^\theta = +0.96\,V$$
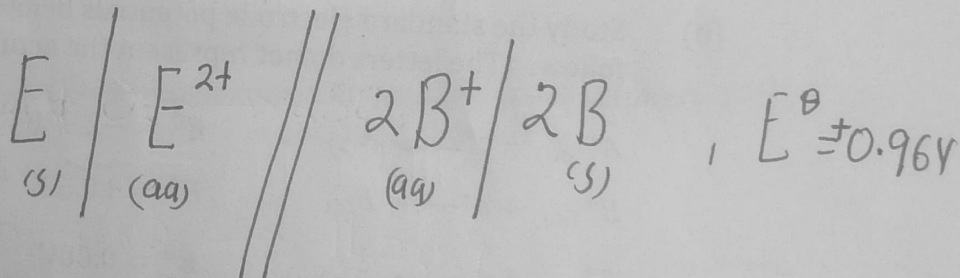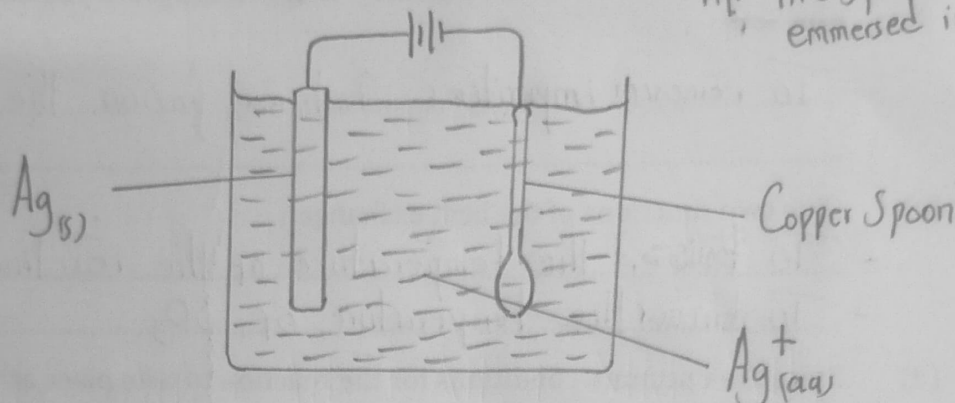
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(c) In an experiment to electroplate a copper spoon with silver, a current of 0.5A was passed for 18 minutes.

(i) Sketch a diagram to show how the experiment was carried out. **(2 marks)**

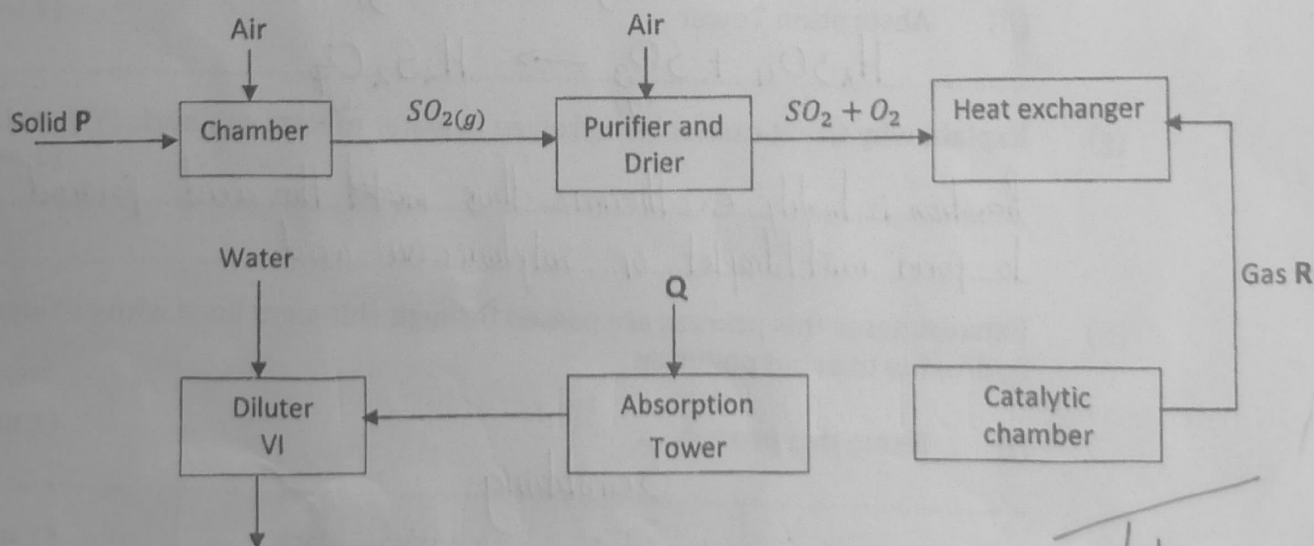N/B The spoon must be emmersed in the electrolyte

$Ag_{(s)}$

Copper Spoon

$Ag^+_{(aq)}$

(ii) Calculate the amount of silver deposited on the spoon. (IF = 96500C, Ag = 108) **(2 marks)**

$Q = 0.5 \times 18 \times 60$

$540C$

$96500C \longrightarrow 108g$

$540C \longrightarrow ?$

$\dfrac{108 \times 540}{96500}$

$= 0.6044g$

7. The flow chart below shows the stages involved in manufacture of sulphuric (VI) acid by the contact process. Study it and answer the questions that follow.

(a) Apart from Sulphur, identify other substance that can be used as solid P.
(1 mark)

Zinc blende /ZnS , Galena/PbS , Copper pyrite/CuFeS₂

(b) What is the function of the purifier? ~~Why are the gases passed through the purifier?~~
(1 mark)

To remove impurities which may poison the catalyst

(c) Give **two** functions of the heat exchanger.
(1 mark)
- To Raise the temperature of the reacting gases (SO₂ + O₂)
- To lower the temperature of SO₃

(d) State the optimum conditions for the reaction to take place at the catalytic chamber.
(1 mark)

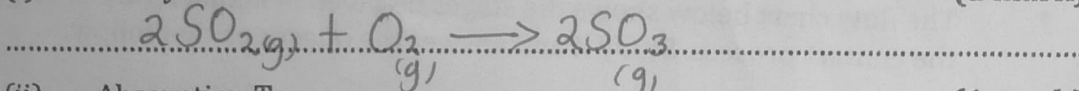Catalyst Vanadium (V) oxide , Pressure 2-3 atm
Temperature 450°C

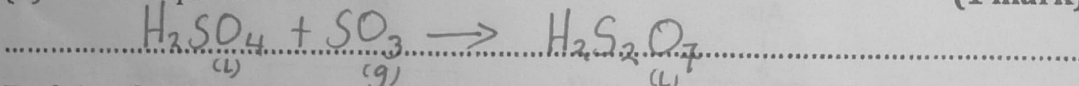(e) Name;

(i) gas R. Sulphur(VI) oxide
(1 mark)

(ii) substance Q Conc. Sulphuric(VI) acid
(1 mark)

(f) Write equations for reactions taking place at the:-

(i) Catalytic chamber
(1 mark)

$$2SO_{2(g)} + O_{2(g)} \longrightarrow 2SO_{3(g)}$$

(ii) Absorption Tower
(1 mark)

$$H_2SO_{4(L)} + SO_{3(g)} \longrightarrow H_2S_2O_{7(L)}$$

(g) Explain why Gas **R** cannot be dissolved in water to form sulphuric (VI) acid.
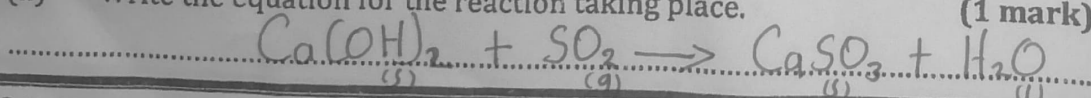(1 mark)

Reaction is highly exothermic thus ~~the acid~~ the acid formed boils to form mist/droplet of sulphuric(VI) acid

(h) Exhaust gases this process are passed through chimneys lined with calcium hydroxide to avoid pollution.

(i) Name this process
(1 mark)

Scrubbing

(ii) Write the equation for the reaction taking place.
(1 mark)

$$Ca(OH)_{2(s)} + SO_{2(g)} \longrightarrow CaSO_{3(s)} + H_2O_{(L)}$$

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(i) State the observation made when concentrated sulphuric (VI) acid is poured into a beaker containing sugar crystals. Name the property of conc. sulphuric acid.

(1 mark)

Black solid is formed / Sugar turns from brown to black

Dehydrating