

CHEMISTRY PAPER 2

No. 1. Use the information in the table below to answer the questions that follow. The letters do not represent the actual symbols of the elements.

<i>Element</i>	<i>Atomic Number</i>	<i>Meltrng Point (CC)</i>
<i>R</i>	<i>11</i>	<i>97.8</i>
<i>S</i>	<i>12</i>	<i>650.0</i>
<i>T</i>	<i>15</i>	<i>44.0</i>
<i>U</i>	<i>17</i>	<i>-102</i>
<i>V</i>	<i>18</i>	<i>-189</i>
<i>W</i>	<i>19</i>	<i>64.0</i>

(a) Give reasons why the melting point of:

(i) S is higher than that of R; (1 mark)

❖ Metallic bonds in S are stronger than in R

(ii) V is lower than that of U. (2 marks)

❖ V is monoatomic while U is diatomic

❖ The Van der Waals force in V are weaker than in U

(b) How does the reactivity of W with Chlorine compare with that of R with chlorine? (2 marks)

Explain.

❖ W reacts more vigorously

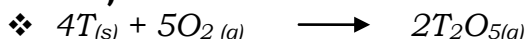
❖ It is easier to lose the outer/valence electrons in W than in R

❖ W is more electropositive than R

❖ Reactivity of groups elements. Increases down the group

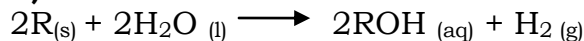
(c) Write an equation for the reaction between T and excess oxygen.

(1 mark)



(d) When 1.15g of R were reacted with water, 600cm³ of gas was produced. Determine the relative atomic mass of R. (Molar gas volume = 24 000 cm³).

(3 marks)



$$\text{Moles of gas} = \frac{600}{24000} = 0.025 \text{ moles}$$

$$\text{Moles of R} = 2 \times 0.025 = 0.05 \text{ moles}$$

$$\text{RAM} = \frac{1.15}{0.05} = 23$$

(e) Give one use of element V. (1 mark)

❖ Used in florescent bulbs / lumbs

❖ Used in arc welding

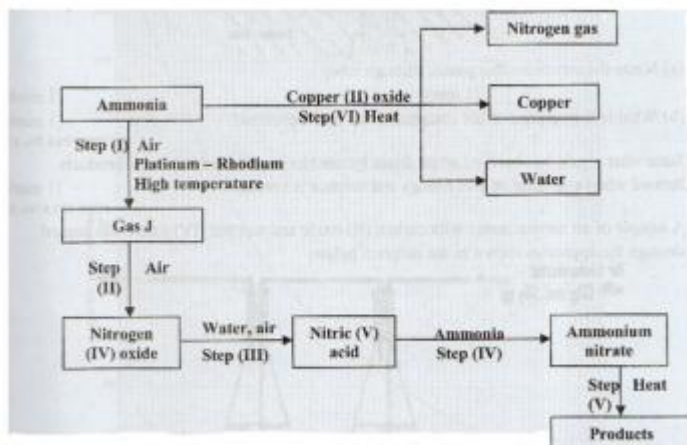
❖ Used in fire extinguishers

❖ Used as a preservative in museum

No. 2 .Describe the process by which Nitrogen is obtained from air on a large scale. (4 marks)

- ❖ Filter the air/ electrostatic precipitation/ Purify the air
- ❖ Pass air through NaOH in KOH to remove CO₂
- ❖ Cool to remove to remove water vapour
- ❖ Cool the remaining gases from a liquid air
- ❖ Perform fractural distillation of liquid air
- ❖ Nitrogen is collected at – 196^o C

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



(i) Identify gas J.(1 mark)

- ❖ Nitrogen II Oxide (NO)

(ii) Using oxidation numbers, show that ammonia is the reducing agent in step (VI)(2 marks)

- ❖ $4\text{NH}_3(g) + 3\text{CuO} \rightarrow 2\text{N}_2(g) + 3\text{H}_2\text{O}(l) + 3\text{Cu}$
- ❖ Oxidation no of N in ammonia increases from -3 to 0
- ❖ Oxidation number of reducing agent increases
- ❖ Oxidation number Cu decreases from + 2 to 0 hence an oxidizing agent
Ammonia is a reducing agent

(iii) Write the equation for the reaction that occurs in step (V). (1 mark)

- ❖ $\text{NH}_4\text{NO}_3(s) \text{ or } (aq) \rightarrow \text{N}_2\text{O}(g) + 2\text{H}_2\text{O}(g \text{ or } l)$

(iv) Give one use of ammonium nitrate. (1 mark)

- ❖ Fertilizer
- ❖ Explosive

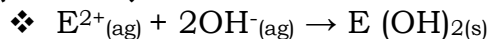
(c) The table below shows the observations made when aqueous ammonia was added to cations of elements E, F and G until in excess.

Cation of	Addition of a few drops of Aqueous ammonia.	Addition of excess aqueous ammonia
E	White precipitate	Insoluble
F	No precipitate	No precipitate
G	White precipitate	Dissolves

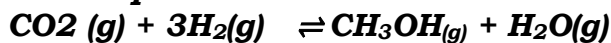
(i) Select the cation that is likely to be Zn²⁺ (1 mark)

- ❖ G or G²⁺

(ii) Given that the formula of the cation of element E is E^{2+} , write the ionic equation for the reaction between $E^{2+}(aq)$ and aqueous ammonia. (1 mark)



No.3.(a) Methanol is manufactured from carbon (IV) oxide and hydrogen gas according to the equation:



The reaction is carried out in the presence of a chromium catalyst at 700K and 30kPa. Under these conditions, equilibrium is reached when 2% of the carbon (IV) oxide is converted to methanol

(i) How does the rate of the forward reaction compare with that of the reverse reaction when 2% of the carbon (IV) oxide is converted to methanol? (1 mk)

❖ Rate of forward reaction is equal to rate of backward reaction

(ii) Explain how each of the following would affect the yield of methanol:

I Reduction in pressure (2mks)

❖ Production will reduce since equilibrium will shift backward so as to raise the pressure.

II Using a more efficient catalyst (2mks)

❖ No change in amount of methanol since a catalyst will help reaction to come to equilibrium

(iii) If the reaction is carried out at 500K and 30kPa, the percentage of carbon (IV) oxide converted to methanol is higher than 2%

I what is the sign of ΔH for the reaction? Give a reason (2mks)

❖ Negative: the reaction is exothermic since it requires low temperature to be fast.

II Explain why in practice the reaction is carried out at 700K but NOT at 500K (1mk)

❖ To ensure that the reacting particles possess more activation energy

(b) Hydrogen peroxide decomposes according to the following equation:



In an experiment, the rate of decomposition of hydrogen peroxide was found to be $6.0 \times 10^{-8} \text{ mol dm}^{-3} \text{ s}^{-1}$.

(i) Calculate the number of moles per dm^3 of hydrogen peroxide that had decomposed within the first 2 minutes (2mks)

❖ No. of seconds = $2 \times 60 = 120 \text{ Sec}$

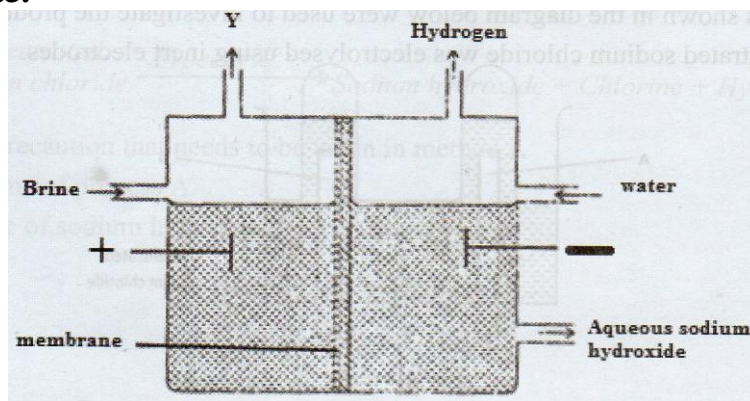
Moles of H_2O_2 decomposed

$$= 120 \times 6.0 \times 10^{-8} = 7.20 \times 10^{-6}$$

(ii) In another experiment, the rate of decomposition was found to be $1.8 \times 10^{-7} \text{ mol dm}^{-3} \text{ s}^{-1}$. The difference in the two rates could have been caused by addition of a catalyst. State, giving reasons, one other factor that may have caused the difference in two rates of decomposition (2 marks)

❖ Concentration of H_2O_2 may be higher since concentration increases the rate of reaction.

No.4. The set up below can be used to produce sodium hydroxide by electrolysis of brine.



(i) Identify gas Y. (1mk)

❖ Chlorine or Cl_2

(ii) Describe how aqueous sodium hydroxide is formed in setup above. (2mks)

❖ Na^+ and H^+ migrate to the cathode. The H^+ ions are preferentially discharged liberating hydrogen gas. Cl^- and OH^- migrate to anode. The Cl^- are preferentially discharged liberating Cl_2 gas. Na^+ migrate to anode through the membrane, they combine with OH^- to form NaOH

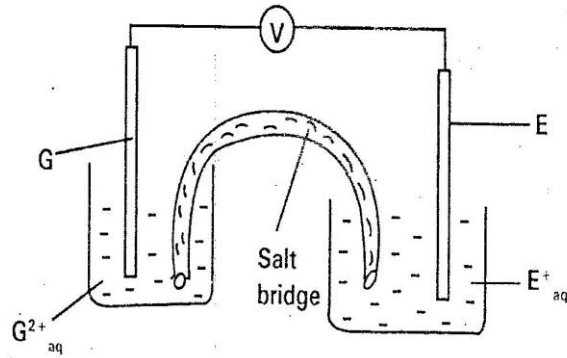
(iii) One of the uses of sodium hydroxide is in manufacture of soaps. State one other use of sodium hydroxide. (1mk)

- ❖ Glass making
- ❖ Separating components of air.
- ❖ Manufacture of soda lime, NaOCl and NaClO_3
- ❖ Purification of bauxite
- ❖ Used in science lab.

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

Half reactions	Electrode potential E^θ / V
$\text{D}_{(\text{aq})}^{2+} + 2e \longrightarrow \text{D}_{(\text{s})}$	-0.13
$\text{E}_{(\text{aq})}^+ + e \longrightarrow \text{E}_{(\text{s})}$	+0.80
$\text{F}_{(\text{aq})}^{3+} + e \longrightarrow \text{F}_{(\text{aq})}^{2+}$	+0.68
$\text{G}_{(\text{aq})}^{2+} + 2e \longrightarrow \text{G}_{(\text{s})}$	-2.87
$\text{H}_{(\text{aq})}^{2+} + 2e \longrightarrow \text{H}_{(\text{s})}$	+0.34
$\text{J}_{(\text{aq})}^+ + e \longrightarrow \text{J}_{(\text{s})}$	-2.71

(i) Construct an electrochemical cell that will produce the highest emf. (3mks)



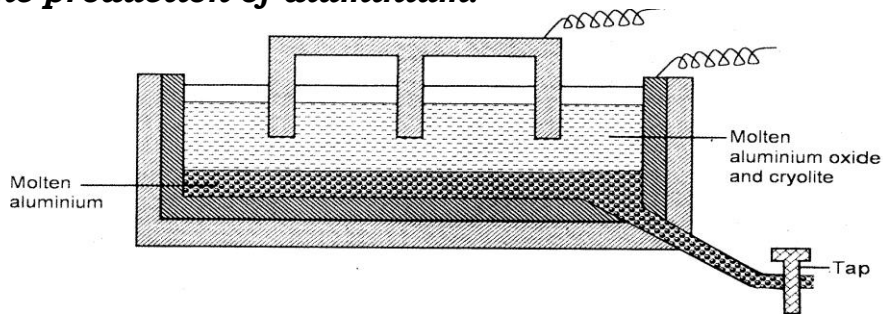
(ii) Calculate the emf of the cell constructed in (i) above. (2mks)

$$E = E_{red} - E_{ox} = + 0.80 - (-2.087) = + 3.67v$$

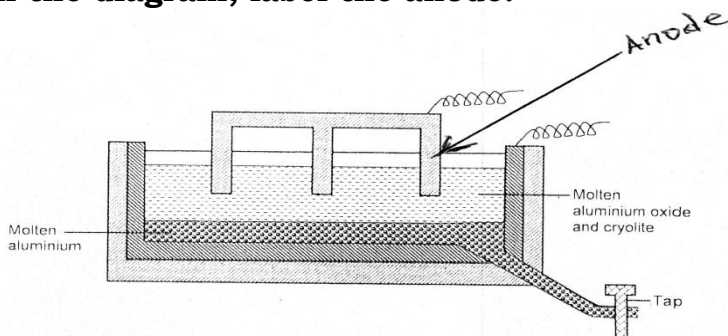
(iii) Why is it not advisable to store a solution containing E^+ ions in the container made of H? (2mks)

❖ H has a high tendency to lose electrons hence will react with the solution by displacing E^+ ions

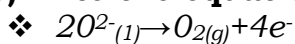
No.5. The diagram below represents a set up of an electrolytic cell that can be used in the production of aluminium.



(a) On the diagram, label the anode.



(b) Write the equation for the reaction at the anode. (1 mark)



(c) Give a reason why the electrolytic process is not carried out below 950°C. (1 mark)

❖ Aluminium oxide would solidify hence the ions will not be free to conduct current.

(d) Give a reason why the production of aluminium is not carried out using reduction process (1 mark)

❖ The common reducing agents such as carbon cannot reduce aluminium oxide.

(e) Give two reasons why only the aluminium ions are discharged. (2 marks)

- ❖ They are in higher concentration than Na^+ from cryolite
- ❖ Aluminium is lower than sodium in electrochemical series.

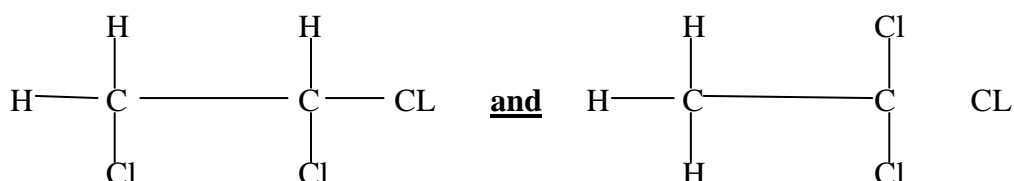
(f) State two properties of duralumin that makes it suitable for use in aircraft industry. (2 marks)

- ❖ It is stronger than pure aluminium
- ❖ It is light

(g) Name two environmental effects caused by extraction of aluminium. (2 marks)

- ❖ It causes land degradation due to mining the ores from deep down from the earth.
- ❖ Carbon (IV) Oxide produced cause global warming.

No.6.a) Draw the structural formula for all the isomers of $\text{C}_2\text{H}_3\text{Cl}_3$ (2marks)

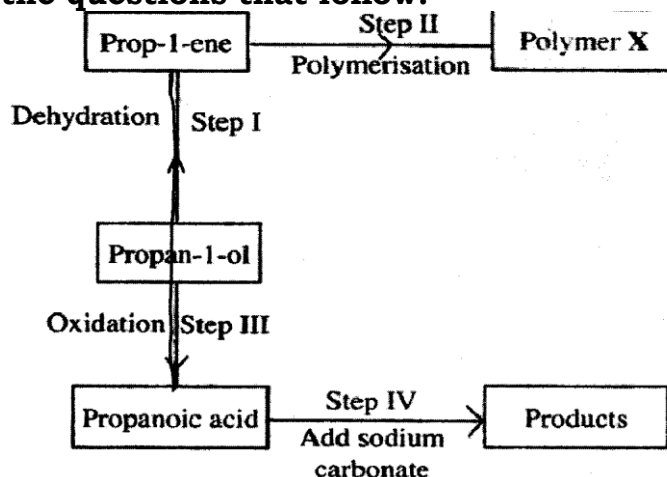


b) Describe two chemical tests that can be used to distinguish between ethane and ethene. (4marks)

- ❖ Add a few drops of acidified potassium dichromate with ethene the solution changes from orange to green while in ethane the solution remains orange
- ❖ Add a few drops of acidified potassium manganate with ethene solution changes from purple to colourless while in ethane the solution remains purple.

c) The following scheme represents various reactions starting with propan-1-ol.

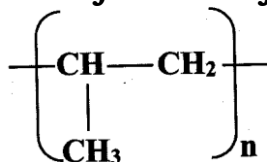
Use it to answer the questions that follow.



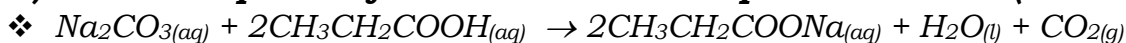
i) Name one substance that can be used in step I. (1mark)

- ❖ Concentrated sulphuric (VI) acid / Al_2O_3 / concentrated phosphoric (V)

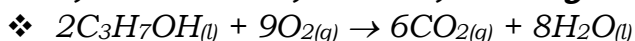
ii) Give the general formula of X. (1 mark)



iii) Write the equation for the reaction in step IV. (1 mark)



iv) Calculate the mass of propan-1-ol which when burnt completely in air at room temperature and pressure would produce 18 dm³ of gas. (C = 12.0; O = 16.0; H = 1.0; Molar gas volume = 24 dm³) (3 marks)



$$\text{Moles of CO}_2 = \frac{18}{24}$$

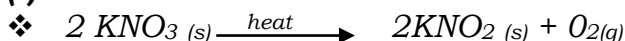
$$\text{Moles of CH}_3\text{CH}_2\text{CH}_2\text{OH} = \frac{18}{24} \times \frac{1}{3}$$

$$\text{R.M.M of CH}_3\text{CH}_2\text{CH}_2\text{OH} = 60$$

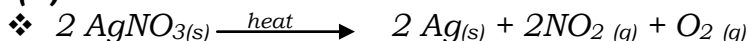
$$\text{Mass of propan-1-OL} = \frac{18}{24} \times \frac{1}{3} \times 60 = 15\text{g}$$

No. 7. (a) Write an equation to show the effect of heat on the nitrate of: (2 marks)

(i) Potassium



(ii) Silver



(b) The table below gives information about elements A₁, A₂, A₃, and A₄

Element	Atomic Number	Atomic Radius (nm)	Ionic radius (nm)
A ₁	3	0.134	0.074
A ₂	5	0.090	0.012
A ₃	13	0.143	0.050
A ₄	17	0.099	0.181

i) In which period of the periodic table is element A₂? Give a reason. (2 marks)

❖ Period 2, two energy levels

(ii) Explain why the atomic radius of:

I. A₁ is greater than that of A₂;

❖ A₂ has greater atomic number than A₁

❖ A₂ has greater nucleus charge than A₁

❖ A₂ has more protons than A₁

❖ Therefore across the period from left to right nuclear charge, exert greater pull on electrons hence reduction in size.

II. A₄ is smaller than its ionic radius. (2 marks)

❖ A₄ gains electrons, incoming electron is repelled by existing electrons then electrons cloud increases.

(iii) Select the element which is in the same group as A3.(1 mark)

❖ A₂

(iv) Using dots (•) and crosses(x) to represent outermost electrons, draw a diagram to show the bonding in the compound formed when A₁ reacts with A₄. (1 mark)

