Marking Scheme KCSE 2016

2016 CHEMISTRY

PAPER 1

No. 1. A student investigated the effect of an electric current by passing it through some substances. The student used inert electrodes, and connected a bulb to the circuit. The table below shows the substances used and their states.

Experiment	Substance	State
1	Potassium Carbonate	Solid
2	Copper (II) sulphate	Solution
3	Sugar	Solution
4	Lead (II) iodide	Molten

(a) In which experiment did the bulb not light? (1 mark)

- *1 and 3*

(b) Explain your answer in (a) above. (2 marks)

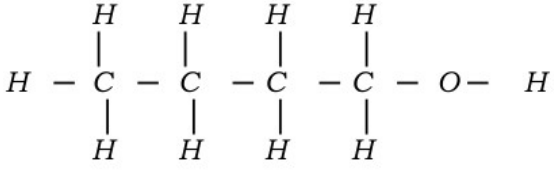
- *In 1 ions K_2CO_3 are held rigidly within the crystal cannot move (no mobile ions) In 3 sugar exist as molecule hence no mobile ions.*

No.2.An alknal has the following composition by mass: hydrogen 13.5%, oxygen 21.6% and carbon 64.9%

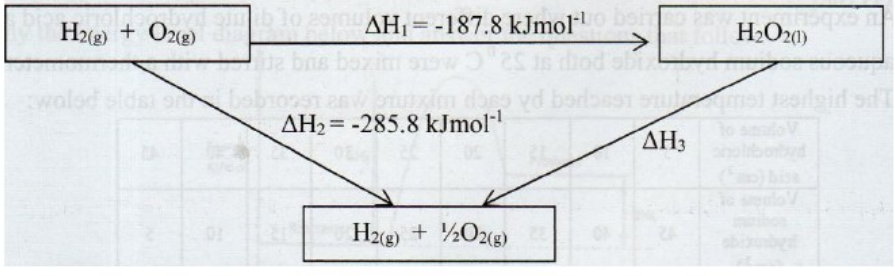
(a)Determine the empirical formula of the alcohol(C=12.0; H=1.0' 0=16.0). (2mks)

- *[E.F.= C_4H_9OH]*

(b)Given that empirical formula and the molecular formula of the alkanol are the same,draw the structure of the alkonol



No. 3. The figure below shows an energy cycle.



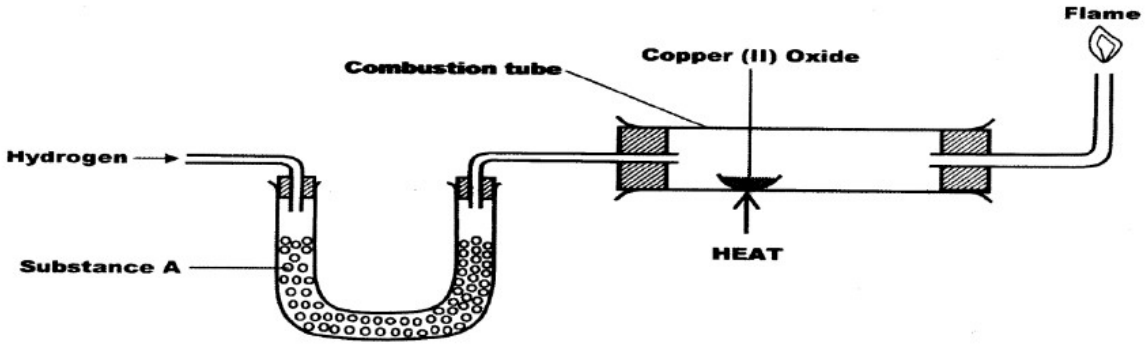
Give the name of the enthalpy change ΔH_1. (1 mark)

- Enthalpy of formation of hydrogen peroxide or enthalpy of formation

(b)Determine the value of ΔH_3.(2 marks)

- $\Delta H_1 + \Delta H_3 = \Delta H_2 \Longrightarrow \Delta H_2 = \Delta H_2 - \Delta H_1$
- $= -285.8 - (-187.8) = 187.8 - 285.8 = -98$ kJmol^{-1}

4.The set up below was used to investigate the reaction between dry hydrogen gas and copper



(a) Name substance A.(1 mark)

- *Fused anhydrous calcium chloride*
- *Cao: fused $CaCl_2$*

(b) State the observation made in the combustion tube. (1 mark)

- *Black CuO changes to brown Cu metal*
- *Formation of colourless liquid on the cooler parts of the combustion tube.*

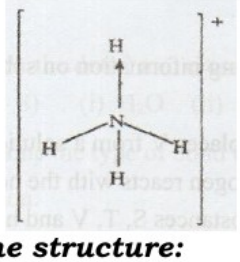
(c) Explain the observation stated in (b) above. (1 mark)

- *Copper (II) oxide is reduced by hydrogen to copper metal while hydrogen is oxidized to water / CuO reduced to Cu / H_2 Oxidized to H_2O*

No. 5. Starting with sodium metal, describe how a sample of crystals of sodium hydrogen carbonate may be prepared. (3 marks)

- React sodium with water to get sodium hydroxide. Bubble into this solution excess carbon (IV) oxide to get sodium hydrogen carbonate

No. 6. Ammonium ion has the following structure

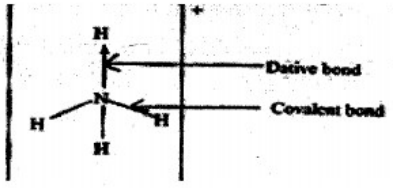


Label on the structure:

(a) covalent bond;

(b) coordinate (dative) bond.

(a) and (b)



No. 7.When 8.53g of sodium nitrate were heated in an open test-tube, the mass of oxygen gas produced was 0.83 g . Given the equation of the reaction as 2NaNO 3 (s) -> 2NaNO 2 (s) + O 2 (g)
Calculate the percentage of sodium nitrate that was converted to sodium nitrite. (Na = 23.0, N = 14.0, O = 16.0) (3 marks)

Moles of oxygen = 0.83 = 0.026 (½) / 0.0259375

Moles of $NaNO_3$ = 2 x 0.026 / 0.051875

0.05 (½) / 0.051875

R. M .M $NaCO_3$ = 85 (½)

Mass of $NaNO_3$ = converted $\frac{0.052 \times 85}{4.41}$ */ 4.4094 (½)*

$\frac{4.41 \times 100}{8.53}$

= 51. 693%5 = 51.7%

No.8. Aluminium is both malleable and ductile.

(a)What is meant by?

(i) Malleable: ***(1 mark)***

- *Can be hammered into sheets.*

(ii)Ductile ***(1 mark)***

- *Can be drawn into wires.*

(b)State One use of aluminium based on:

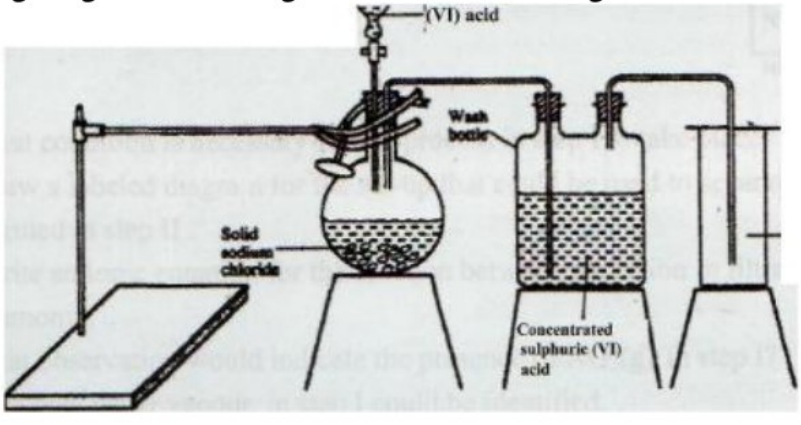
(i)malleability ***(½ marks)***

- *Making of sufurias/ motor vehicle parts/ aeroplane parts,window / door flames, cups, plates, packaging materials, pans, making sheets/ roof.*

(ii)ductility ***(½ marks)***

- *electricity cables/ wires.*

No. 9.The diagram below represents the set-up that was used to prepare and collect hydrogen chloride gas in the laboratory.



State the purpose of concentrated sulphuric (VI) acid in the wash bottle.
(1 mark)

- *It is a drying agent.*

Write an equation for the reaction between dry hydrogen chloride gas and heated iron. (1 mark)

- $Fe_{(s)} + 2HCl_{(g)} \rightarrow FeCl_{2(s)} + H_{2(g)}$

No. 10 . Iron (III) oxide was found to be contaminated with copper (II) sulphate. Describe how a pure sample of iron (III) oxide can be obtained. (3 marks)

- *Add water to dissolve $CUSO_4$, Fe_2O_3 doesn't dissolve*
- *Filter out the undissolved Fe_2O_3*
- *Wash the residue with plenty of water ro remove traces of the filtrate.*
- *Dry the residue between the filter papers*

No.11.a)Complete the nuclear equation below: (1 mark)

$$^{131}_{53}I \rightarrow {}^{131}_{54}Xe + \text{----------}$$

$$^{131}_{53}I \rightarrow {}^{131}_{54}Xe + {}^{0}_{-1}e$$

(b)The half-life of I is 8 days.
Determine the mass of $^{131}_{53}I$ remaining if 50 grammes decayed for 40 days (1 mark)

- *50g 25g 12.5g 6.25g 3.125g 1.5625g*

  Or $NW = 0.4(\frac{1}{2})^n$

  $NW = 50 \times (\frac{1}{2})^5 = 1.5625g$

(c)Give one harmful effect of radioisotopes. (1 mark)

- *Instant / cause death*
- *Cause cancer*
- *Cause gene mutation*

No. 12. During an experiment, chlorine gas was bubbled into a solution of potassium iodide.

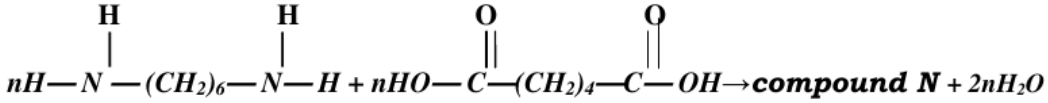
(a)State the observations made. (1 mark)

- *Solution turned from colourless to dark brown*
- *Greenish yellow / pale green colour of Cl_2 disappears*
- *Brown solution / black solid is deposited*

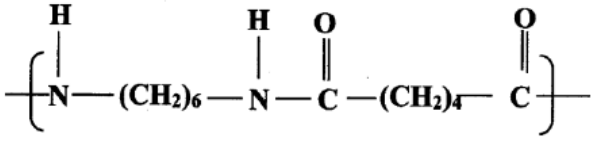
(b)Using an ionic equation, explain why the reaction is redox. (2 marks)

- $Cl_{2\,(aq)} + 2I^-_{(aq)} \rightarrow I_{2\,(aq)} + 2Cl^-_{(aq)}$
- ***Explanation;*** *Iodine oxidation state changes from -1 to 0 hence oxidation while Cl_2 0.5 changes from 0 to -1 hence reduction / increase is ON and decrease is ON or movement of electrons Cl_2 gains e's where lose*

No.13.(a)Draw the structure of compound N formed in the following reaction.



ANSWER



(b) Give one use of compound N. (1mk)

- *Making synthetic fibres such as for: - Ropes*
- *Blouses*
- *Stockings*
- *Undergarments Trousers*

No. 14.When fuels burn in the internal combustion engine at high temperature, one of the products formed is nitrogen (II) oxide.

(a) Write the equation for the formation of nitrogen (II) oxide. (1 mark)

- $N_{2(}g) + 0_{2(}g) \rightarrow 2NO_{(g)}$

(b) Give a reason why nitrogen (II) oxide is not formed at room temperature. (1 mark)

- *Nitrogen atoms in the molecule are joined by strong triple covalent bond that requires a lot of energy to break than provided at room temperature*

(c) Describe how formation of nitrogen (II) oxide in the internal combustion engine leads to gaseous pollution. (2 mark)

- Nitrogen (II) oxide reacts with oxygen in air to form nitrogen (IV) oxide that dissolves in water vapour causing acid rain.

15.Sodium hydroxide can be prepared by the following methods; I and II.

I. Sodium metal + cold water → Sodium hydroxide + Hydrogen

II. Concentrated Sodium chloride —Process A→ Sodium hydroxide + Chlorine + Hydrogen

(a) Name one precaution that needs to be taken in method I. (1 mark)

- *Small piece of sodium metal (pea size) with a lot of water*
- *Perform the experiment wearing goggles.*

(b) Give the name of process A. (1 mark)

- *Electrolysis*

(c) Give one use of sodium hydroxide. **(1 mark)**

- *Manufacture of paper (soften), soaps and detergents*
- *Fractional distillation of liquid air*
- *Extraction of aluminium metal*
- *Manufacture of bleaching agents eg NaOCl paper, textiles, oil refinery*
- *Making herbicides on weed killers*
- *Textile industry to soften*

No. 16.The atomic number of sulphur is 16. Write the electron arrangement of sulphur in the following: (2 marks)

(a) H2S

- *2.8.8*

(b) SO_3^{2-}

- *2.8.2*

No. 17. A compound whose general formula is M(OH)3 reacts as shown by the equation below.

$$M(OH)_{3(s)} + OH^-_{4\,(aq)} \qquad M(OH)^-_{4(aq)}$$

$$M(OH)_{3(s)} + 3H^+_{(aq)} \longrightarrow M^{3+}_{(aq)} + 3H_2O_{(i)}$$

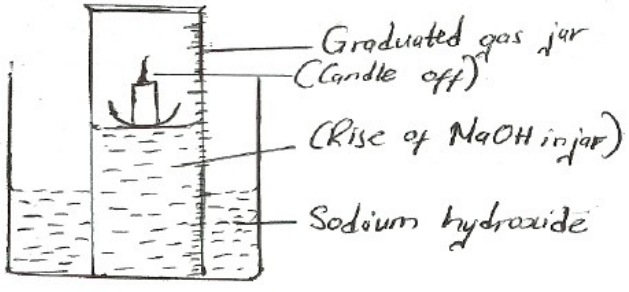
(a) What name is given to compounds which behave like M(OH) 3 in the two reactions. (1 mark)

- Amphoteric

(b) Name two elements whose hydroxides behave like that of M. (2 marks)

- Lead, Zinc and Aluminium

No.18.A water trough, aqueous sodium hydroxide, burning candle, watch class and a graduated gas jar were used in an experimental set up to determine the percentage of active part of air. Draw a labeled diagram of the set up at the end of the experiment.



No. 19.In an experiment on rates of reaction, potassium carbonate was reacted with dilute sulphuric (VI) acid.

(a) What would be the effect of an increase in the concentration of the acid on the rate of the reaction? (1 mark

- The rate of reaction increases. This is because when the concentration is high: the number of collisions between particles is also high hence reacts faster,

(b) Explain why the rate of reaction is found to increase with temperature. (2 mark

- Increase in temperature results in increase in the kinetic energy of the particles. This makes particles move faster and collide frequently leading to faster rate of reaction.

No. 20. 60 cm3 of oxygen gas diffused through a porous partition in 50 seconds. How long would it take 60cm3 of sulphur (IV) oxide gas to diffuse through the same partition under the same conditions? (S = 32.0, 0 = 16.0) (3 marks)

$$\frac{\text{Time for } SO^2}{\text{Time for } O^2}$$

$$= \sqrt{\frac{R.M.MSO_2}{R.M.MO_2}}$$

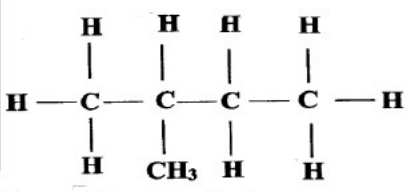
$R.M.M \text{ of } SO_2 = 64$
$R.M.M \text{ of } O_2 = 32$

$$\frac{\text{Time for } SO_2}{50}$$

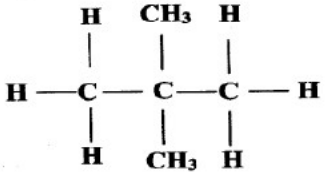
$$= \sqrt{\frac{64}{32}}$$

$\text{Time for } SO_2 = 70.7 \text{ seconds}$

No. 21. Draw and name the isomers of pentane.(3 marks)

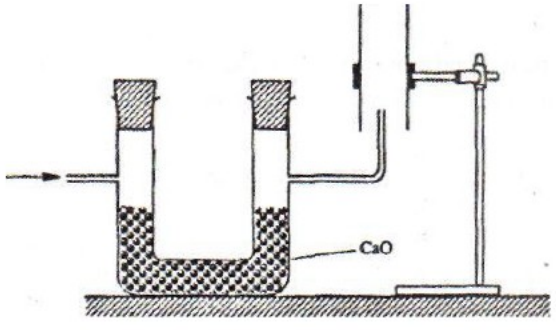


and



Name: 2-methylbutane *Name: 2,2 dimethylpropane*

No. 22.The set-up below was used to collect a dry sample of a gas



Give two reasons why the set-up cannot be used to collect carbon (IV) oxide gas. (2 marks)

- *It is denser than air*
- *It will react with calcium oxide since CO_2 is acidic and CaO is basic*

No. 23. Given the following substances: wood ash, lemon juice and sodium chloride.

(a) Name one commercial indicator that can be used to show whether wood ash, lemon juice and sodium chloride are acidic, basic or neutral. (1 mark)

(b) Classify the substances in 15(a) above as acids, bases or neutral. (2 marks

No. 24. Describe how a solid sample of potassium sulphate can be prepared starting with 200cm3of 2M potassium hydroxide. (3 marks)

- Vol of 2KOH = 100cm3 (or mols = $\frac{0.4}{2}$ = 0.2
- Mix the $KOH_{(aq)}$ and H_2SO_4 acid
- Concentrate the mixture/ heat the mixture
- Crystalise the solution (or heating the solution to dryness)
- Dry crystals

No. 25. Charcoal is a fuel that is commonly used for cooking. When it burns it forms two oxides.

(a) Name the two oxides. (2 marks)

- *Carbon (IV) oxide /CO_2/ carbon dioxide*
- *Carbon (II) oxide/ CO/ carbon monoxide*

(b) State one use of the two oxides. (1 mark)

- *Fire extinguisher/ photosynthesis*
- *Refrigeration*
- *Solvay process*
- *Fizzy drinks*
- *Food preservation*
- *Extraction of metals*
- *Manufacture of methanol*
- *Manufacture of fuel (water, gas)*

NO. 26.Hydrogen sulphide is a highly toxic and flammable gas. It is normally prepared in a fume chamber.

(a) Name two reagents that can be used to prepare hydrogen sulphide in the laboratory.(1 mark)

- *Iron (II) sulphide or conc sulphide / copper sulphide (Accp formula: Fes/ HCl)*
- *Hydrochloric acid or lead (II) sulphide/ HNO_3*

(b) One of the uses of hydrogen sulphide is to produce sulphur as shown in the following equation: 2H2S(g) + S02 (g) -> 3S(s) + 2H20(1)
Identify the reducing agent in this reaction and give a reason for your answer. (1 mark)

- *Hydrogen sulphide*
- *The sulphur changes from -2 to zero/ (it reduces SO_2 to S) i.e. +4 to 0 / sulphur lost e's in the H_2S to form sulphur*

(c) Other than production of sulphuric (VI) acid, state one commercial use of sulphur.(1 mark)

- *Vulcanization of rubber*
- *Manufacture of sulphur drugs*
- *Manufacture of gun powder/ match sticks / explosives/ fungicides*

No. 27. Describe an experimental procedure that can be used to extract oil from nut seeds. (2 marks)

- Crush grind using a pestle and mortar, add suitable solvent of propanone ethanol alcohol and stir to dissolve oil. Filter the mixture to obtain a solution of the oil. Leave the solution in the sun for propanode to evaporate leaving the oil.

No. 28 . A mixture contains ammonium chloride, copper (II) oxide and sodium chloride. Describe how each of the substances can be obtained form the mixture. (3 marks)

- *Heat the mixture to sublime the NH_4Cl. Add water to dissolve the NaCl. Copper (II) oxide does not dissolve. Filter and evaporate the filtrate to obtain sodium chloride.*

No. 29 . When a student was stung by a nettle plant, a teacher applied an aqueous solution of ammonia to the affected area of the skin and the student was relieved of pain. Explain. (2 marks)

- *The product from nettle plant is acidic; aqueous ammonia solution being basic neutralize the acidic product*

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.

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

(a) Give reasons why the melting point of:

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

- Metalic 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 odur/valence electrons in W than in T
- W is more electropositive than R
- Reactivating of groups elements. Increases down the group

(c) Write an equation for the reaction between T and excess oxygen. (1 mark)

- $4T_{(s)} + 5O_{2\,(g)} \longrightarrow 2T_2O_{5(g)}$

(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)

$2R_{(s)} + 2H_2O_{(l)} \longrightarrow 2ROH_{(aq)} + H_{2\,(g)}$

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

Moles of R = 2 x 0.025
= 0.05moles

RAM = $\frac{1.15}{0.09}$ = 23

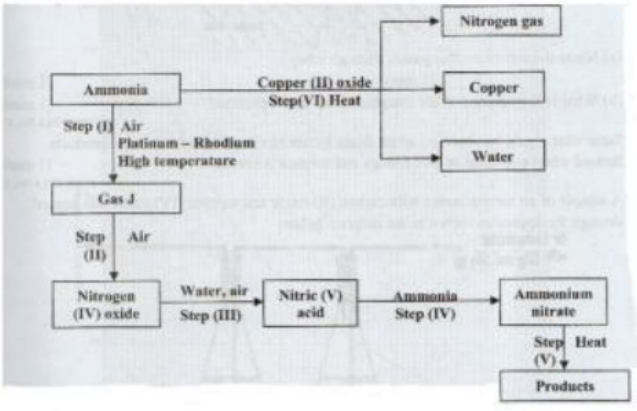
(e) Give one use of element V. (1 mark)

- *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 CO_2*
- *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 – 196^0 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)

- *$4NH_{3\,(g)} + 3\,CUO \rightarrow 2N_{2\,(g)} + 3H_2O_{(l)} + 3\,Cu$*
- *Oxidation no of N in ammonia increases from -3 to 0*
- *Oxidation number of reducing agent increases*
- *Oxidation number Cu decreases from + 2 to O hence an oxidizing agent Ammonia is a reducing agent*

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

- *$NH_4NO_{3(s)\ or\ (aq)} \rightarrow N_2O_{\,(g)} + 2H_2O_{\,(g\ or\ l)}$*

(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 Zn^{2+}** (1 mark)*

- *G or G^{2+}*

(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)

- $E^{2+}_{(ag)} + 2OH^{-}_{(ag)} \rightarrow E(OH)_{2(s)}$

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

$$CO2\ (g) + 3H_2(g) \rightleftharpoons CH_3OH_{(g)} + H_2O(g)$$

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 tare 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 posses more activation energy

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

$$2H_2O_2(aq) \rightarrow 2H_2O(l) + O_2(g)$$

In an experiment, the rate of decomposition of hydrogen peroxide was found to be 6.0×10^{-8} mol dm^{-3} S^{-1}.

(i)Calculate the number of moles per dm3 of hydrogen peroxide that had decomposed within the first 2 minutes (2mks)

- No. of seconds = 2 x 60 = 120 Sec

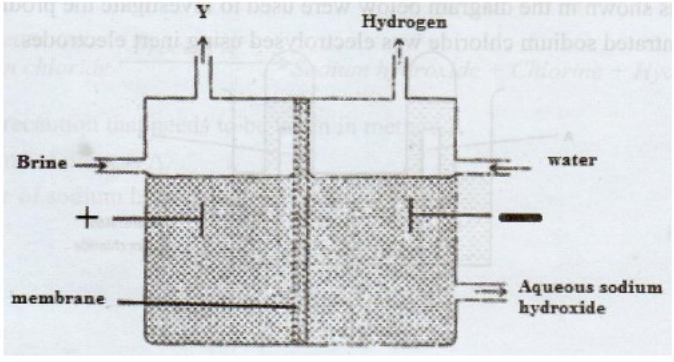
Moles of H_2O_2 decomposed

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

(ii) In another experiment, the rate of decomposition was found to be 1.8×10^{-7} mol $dm^{-3}S^{-1}$. 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 electolysing brine.



(i) Identify gas Y. ***(1mk)***

- *Chlorine or Cl*

(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^{-2} are preferentially discharged liberating Cl_2 gas. Na^+ migrate to anode through the membrane , they combine with OH to from NaOH*

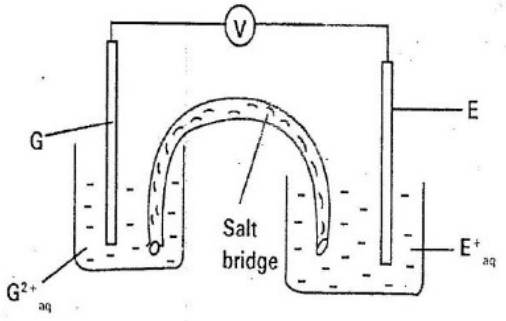
(iii)One of the uses of sodium hydroxide is in manufacture of soaps. State one other use of sodium hydroxide. (1mk)

- *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 $E^\theta V$
$D^{2+}_{(aq)} + 2e \longrightarrow D_{(s)}$	-0.13
$E^{+}_{(aq)} + e \longrightarrow E_{(s)}$	+0.80
$F^{3+}_{(aq)} + e \longrightarrow F^{2+}_{(aq)}$	+0.68
$G^{2+}_{(aq)}\ 2e \longrightarrow G_{(s)}$	-2.87
$H^{2+}_{(aq)} + 2e \longrightarrow H_{(s)}$	+0.34
$J^{+}_{(aq)} + e \longrightarrow J_{(s)}$	-2.71

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



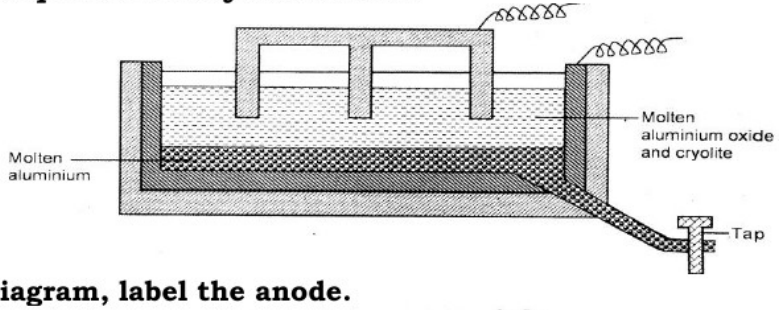
(ii) Calculate the emf of the cell constructed in (i) above. (2mks)

- *E = Ered – Eox = + 0.80- (-2087) = + 3.67v*

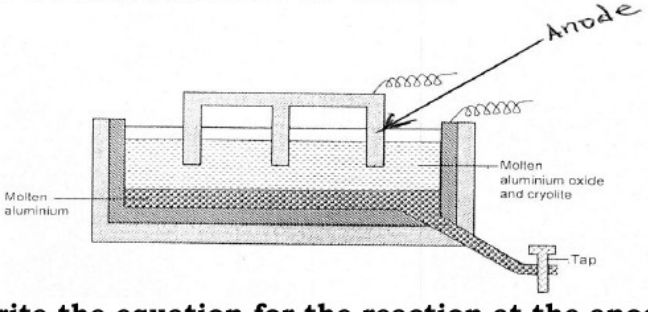
(iii)Why is it not advisable to store a solution containing E^+ ions in the container made of H? (2mks)

- *H has a high tendancy 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)

- $2O^{2-}_{(1)} \rightarrow O_{2(g)} + 4e^-$

(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.*

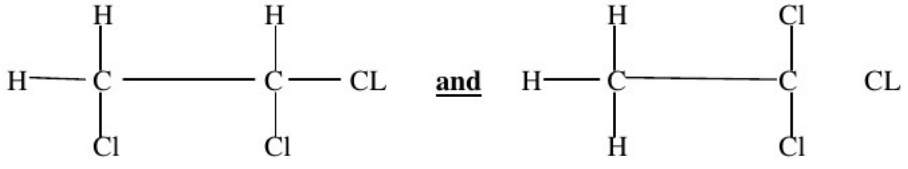
(f)State two properties of duralumin that makes it suitable for use in aircraft industry.(2 marks)

- *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 C2H3CL3 (2marks)

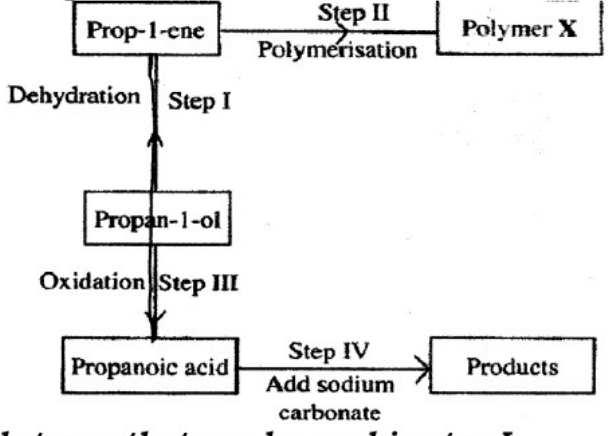


b) Describe two chemical tests that can be used to distinguish between ethane and ethane. (4marks)

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

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

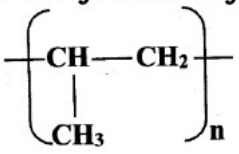
Use it to answer the questions that follow.



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. (1mark)

- $Na_2CO_{3(aq)} + 2CH_3CH_2COOH_{(aq)} \rightarrow 2CH_3CH_2COONa_{(aq)} + H_2O_{(l)} + CO_{2(g)}$

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

- $2C_3H_7OH_{(l)} + 9O_{2(g)} \rightarrow 6CO_{2(g)} + 8H_2O_{(l)}$

Moles of $CO_2 = \frac{18}{24}$

Moles of $CH_3CH_2CH_2OH = \frac{18}{24} \times \frac{1}{3}$

R.M.M of $CH_3CH_2CH_2OH = 60$

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

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

(i) Potassium

- $2\ KNO_{3\ (s)} \xrightarrow{heat} 2KNO_{2\ (s)} + 0_{2(g)}$

(ii) Silver

- $2\ AgNO_{3(s)} \xrightarrow{heat} 2\ Ag_{(s)} + 2NO_{2\ (g)} + O_{2\ (g)}$

(b) The table below gives information about elements Ai, 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. Ai is greater than that of A2;

- *A_2 has greater atomic number than A_1*
- *A_2 has greater nucleus charge than A_1*
- *A_2 has more protons than A_1*
- *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)

- *A_4 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)

- A_2

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