Name ……..……Adm No……
Class……School……Sign……Date…

LANJET JOINT EVALUATION TEST, 2021

Kenya Certificate of Secondary Education.

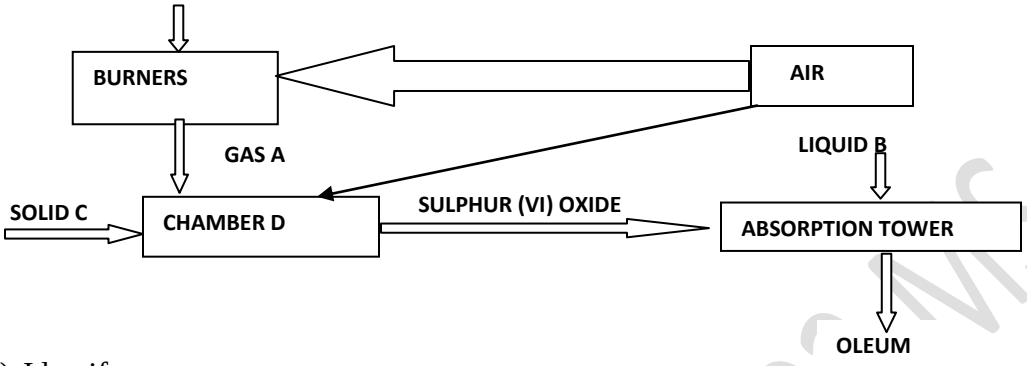
233/2
CHEMISTRY MARKING SCHEME
PAPER 2
(THEORY)
TIME: 2HOURS.

FOR EXAMINER'S USE ONLY.

Questions	Maximum score	Candidates score
1	13	
2	11	
3	13	
4	13	
5	12	
6	10	
7	8	
Total score	**80**	

1. Sulphuric (VI) acid can be prepared using hydrogen sulphide as shown in flow chart below. Study it and answer the questions that follow.

DRY HYDROGEN SULPHIDE



(a) Identify:

(i) Gas **A**: **sulphur (IV) oxide (SO_2)** (1 mark)

(ii) Liquid **B**: **concentrated sulphuric (VI) acid (conc.H_2SO_4).**(1 mark)

(b) (i) What function does solid C play in the chamber **D**? (1mark)

It speeds up the rate of reaction

(ii) Write an equation for the reaction in chamber **D**. (1 mark)

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

(c) Explain the observations made if hydrogen sulphide gas is bubbled through copper (II) nitrate solution.(2 marks)

A black solid is formed the blue solution fades to form a colourless solution Copper (II) ions are reduced to Copper (II) Sulphide

(d) Write an ionic equation for the confirmatory test for hydrogen sulphide gas.(1 mark)

$$Pb^{2+}_{(aq)} + H_2S_{(g)} \longrightarrow PBS_{(s)} + 2H^{+}_{(aq)}$$

(e) Write a chemical equation to show the formation of concentrated Sulphuric (VI) acid from the oleum. (1 mark)

$$H_2S_2O_{7(l)} + H_2O_{(l)} \longrightarrow 2H_2SO_{4(l)}$$

(f) Explain why in contact process SO_3 gas is not directly dissolved in water to make concentrated sulphuric (VI) acid.(2 marks)

Because the reaction is exothermic, it boils the acid to form acid fumes

(g) Name the main pollutant from the process above and how it is controlled. (2 marks)

Sulphur (IV) oxide. Chimney are fitted with calcium oxide or calcium hydroxide which react with it Or **recycled back to the system**

(h) State two factors that increases the yield of sulphur (vi) oxide using the equation below. (1 marks)

$$2SO_{2(g)} + O_{2(g)} \rightleftharpoons 2SO_{3(g)} \quad -ve$$

Increase in pressure

Decrease in temperature

Increase in concentration of reactants

2.a) During an experiment a student added soap solution to separate samples of water until lather was formed. Below is a table showing the volumes of soap solution that was required to form lather

with 100cm^3 of each sample of water before and after boiling the samples.

	Volume (cm^3) of soap required by water sample		
	X	**Y**	**Z**
Before boiling	4.5	19.5	22.5
After boiling	4.5	19.5	4.5

i) State the most likely source of water sample X. ($^1/_2$ mark)

Rain water

ii) Identify a salt most likely to be present in water sample Y. ($^1/_2$ mark)

$CaSO_4$ or $MgSO_4$

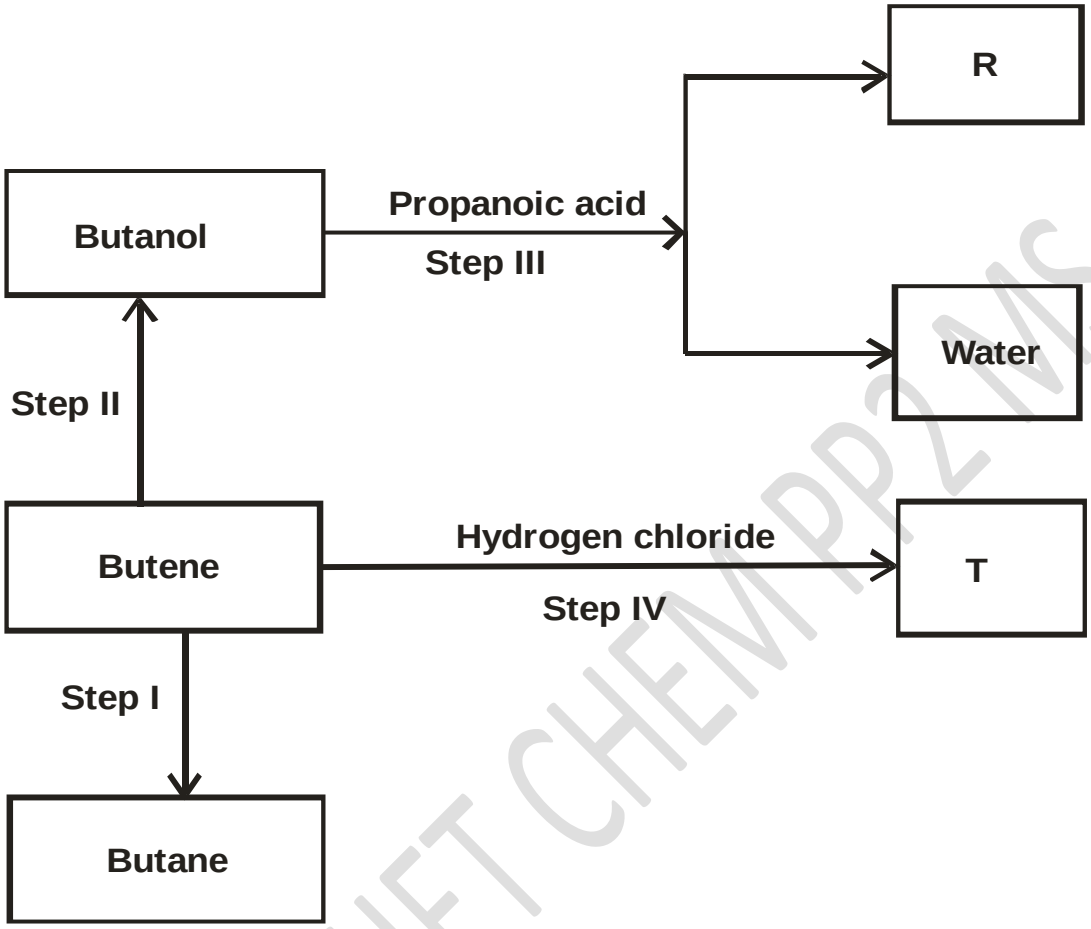
iii) Write an equation for the reaction that may have occurred in water sample Z when it was being boiled. (1 mark)

$Ca(HCO_3)_{2(aq)} \rightarrow CaCO_{3(s)} + H_2O_{(l)} + CO_{2(g)}$

or

$Mg(HCO_3)_{2(aq)} \rightarrow MgCO_{3(s)} + H_2O + CO_2$

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



i) Name the types of reaction that occurs in steps I and II

Step I : **Hydrogenation** ($^1/_2$ mark)

Step II :**Hydrolysis** ($^1/_2$ mark)

ii) What conditions are necessary for the reaction you have named in (i) above? ($1^1/_2$ mark)

Nickel catalyst
Temperature 150 – 250 ℃
Pressure 200 – 250 atmospheres

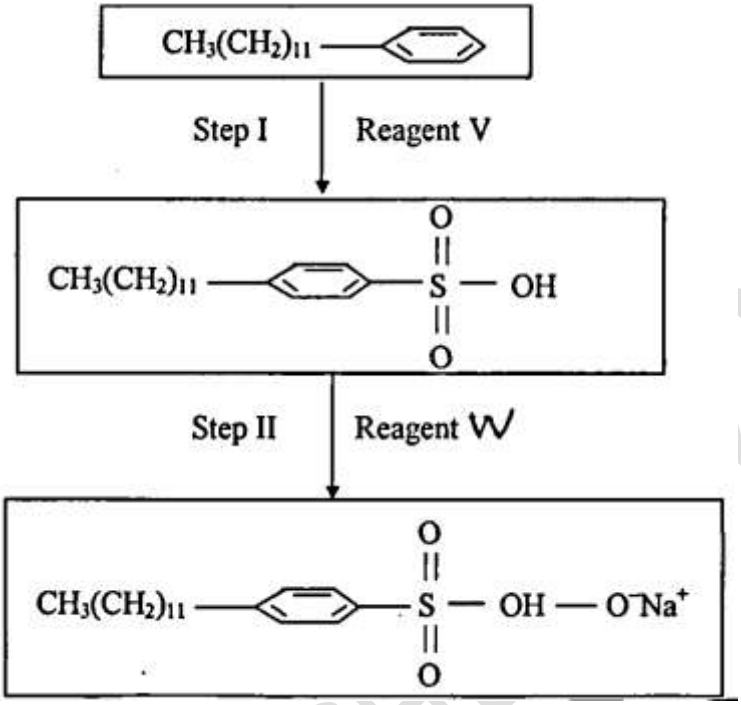
iii) Write a chemical equation for the reaction that takes place in step IV (1 mark)

$C_4H_8 + HCl \rightarrow C_4H_9Cl$

iv) Why is substance R used in some soaps? ($^1/_2$ mark)

It is used to give/make the soaps to have good pleasant/fruity smell

c) The flow diagram below shows some of the steps followed during the industrial manufacture of a detergent.



i) What is a detergent? (1 mark)

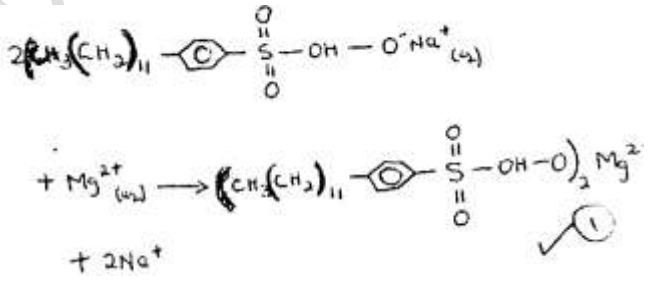
Substance that improves the cleaning property of water

ii) Identify reagents V and W (2 marks)

I) Reagent V **concentrated sulphuric (VI) acid, H_2SO_4**

II) Reagent W **sodium hydroxide solution (NaOH)**

iii) Write an equation for the reaction that may occur when the detergent is added to water containing magnesium ions. (1 mark)



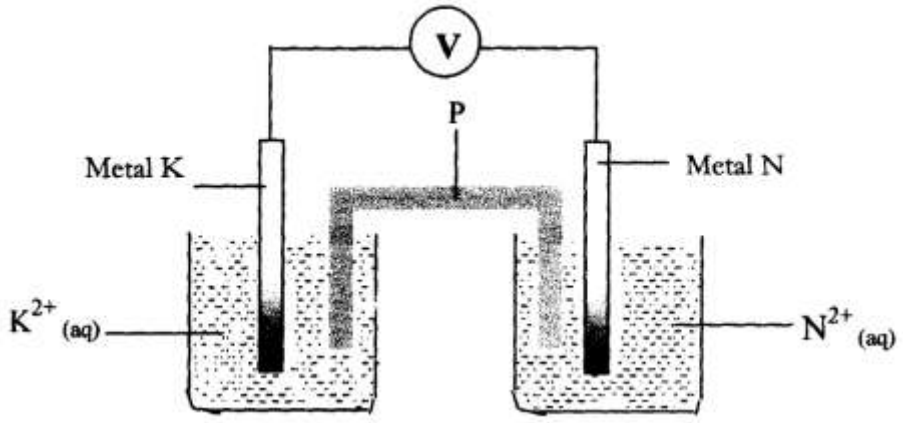
iv) State **one** advantage of using the above detergent. (1 mark)

Lathers easily with both soft and hard water
does not form scum with hard water.

3. Metals **K** and **N** were connected to form a cell as shown in the diagram below. Their reduction potentials are as shown below:

$K^{+}_{(aq)} / K_{(s)} \equiv - 0.17V$

$N^{+}_{(aq)} / N_{(s)} = + 1.1\ 6V$



I. Write the equation for the half-cell reaction that occurs at

Metal **K** electrode (1mark)

$K_{(s)} \longrightarrow K^{2+}_{(aq)} + 2e^{-}$

Metal **N** electrode (1mark)

$N^{2+}_{(aq)} + 2e \longrightarrow N_{(s)}$

II Identify **P** and state its role in the above setup

(i). Identity of **P** (1mark)

Salt bridge

(iii) . Role of **P** in the setup. (1mark)

i) ***Complete the circuit by making contact between the two half-cells***

ii) ***Balance the ions in each half cell by providing for the ions used and the ones produced during electrolysis***

III. On the diagram, show the flow of (1 mark)

I. Electrons

II. Current.

IV Calculate cell potential (E) for the cell represented in the setup above

$$E\ cell = E_{Red} - E_{oxid}$$

$$= +1.16 - (-0.17) = +1.33V$$

(b) The table gives the standard redox potentials for a number of half reactions. Use it to answer the questions that follow:-

	(E^{θ}/Volts)
$Zn^{2+}_{(aq)} + 2e^- \rightleftharpoons Zn_{(s)}$	-0.76
$Fe^{2+}_{(aq)} + 2e^- \rightleftharpoons Fe_{(s)}$	-0.44
$I^{2+}_{(l)} + 2e^- \rightleftharpoons 2I^-_{(aq)}$	+0.54
$Fe^{3+}_{(aq)} + e^- \rightleftharpoons Fe^{2+}_{(aq)}$	+0.77
$Ag^+ + e^- \rightleftharpoons Ag_{(s)}$	+0.88

(i) Relative to which half-cell reaction are the above electrode potentials expressed? ($^1/_2$ mark)

$H^+_{(aq)} + e^- \rightleftharpoons ½\ H_{2(g)}$

(ii) Calculate the e.m.f of the cell made up by combining the $I_{2(l)}/2I^-_{(aq)}$ electrode and

$Zn^{2+}_{(aq)}/Zn_{(s)}$ electrode . (1marks)

E cell = 0.76 + 0.54 = +1.3 volt

(ii) Which of the substances listed in the above table is :- (1marks)

I. The strongest oxidising agent

Ag^+

II. The strongest reducing agent

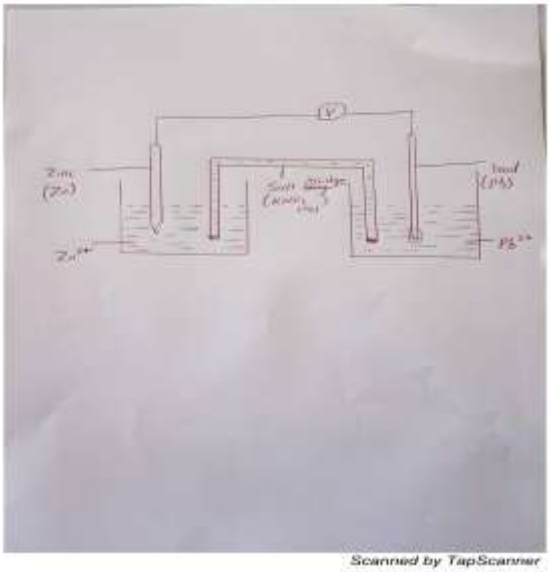
Zn

(iv) Which substances could be used to convert iodide ions to iodine? Write balanced equations for any possible conversions (1mark)

Fe^{3+} or Ag^+

$$2\,Fe^{3+} + 2I^- \longrightarrow 2Fe^{2+} + I_2 \quad E^0 = +0.23$$

(v) draw a cell diagram formed between zinc and lead. (2marks)



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c) A steady current of 2.5A was passed for 15 minutes through a cell containing divalent ions M^{2+}. During this process 0.74g of metal M was deposited (IF = 96500C)

i) Calculate the quantity of electricity passed in this cell (1mark)

Q =it

=2.5 x15x60

=2250c

ii) Determine the relative atomic mass of **M** (2marks)

$$M^{2+}_{(aq)} + 2e \longrightarrow M_{(s)}$$

coulombs =2x96500 =193000c

if 2250c=0.74g

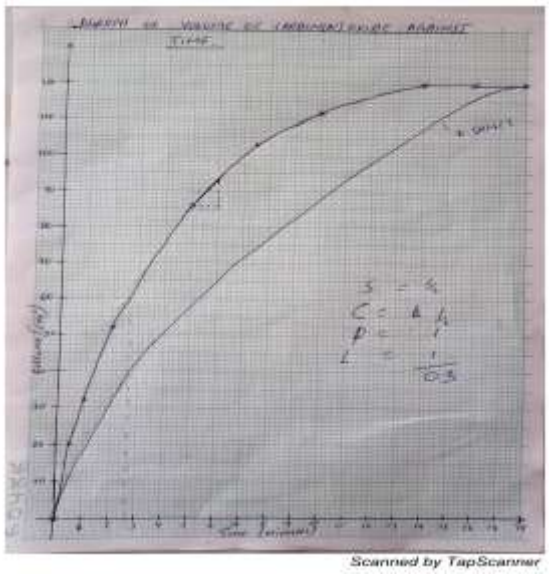
193000c=$\frac{193000\times0.74}{2250}$ =63.48

4.In an experiment, a student measured the amount of gas produced with time when excess 1.0 M hydrochloric acid was reacted with 0.42 g of a carbonate, XCO_3 and obtained the following results.

(Note: The reaction was carried out at room temperature)

Time (minutes)	Volume of carbon (IV) oxide, cm^3
0.0	0
0.5	20
1.0	32
2.0	52
5.0	86
7.5	103
10.0	112
12.0	118
14.0	120
16.0	120
18.0	120

a)On the graph paper provided, draw a graph of volume of carbon (IV) oxide against time.
{3 marks}



b) From the graph,

i) determine the time at which half the original mass of marble chips will have reacted. {1 mark}

$\frac{120}{2}$ **=60cm^3**

2.7 minutes

ii) determine the reaction rate between the 5th and 6th minutes. {2 marks}

rate = $\frac{93-86}{6-5}$

=7cm^3 /minute

c) i)Write the equation for the reaction that takes place. {1 mark}

$2HCl_{(aq)} + XCO_{3(s)} \longrightarrow XCl_{2(aq)} + H_2O_{(l)} + CO_{2(g)}$

ii) Calculate the total number of moles of carbon (IV) oxide produced in this reaction.

(Molar gas volume at r.t.p = 24 dm^3) (2 marks)

If 24000cm3 = 1mole

120cm3 $= \frac{120cm3 \times 1\ mole}{24000cm3}$ **= 0.005moles**

iii) Determine the relative molecular mass of XCO_3. (2 marks)

R.F.M $= \frac{MASS}{MOLE}$

$= \frac{0.42}{0.005}$

=84

iv)Determine the relative atomic mass of X. (1 mark)

X+12+3×16=84

X =84-60

=24

d) On the same graph paper, draw a sketch of the curve that would be obtained if 0.5 M hydrochloric acid was used. Label the curve A. (1 mark)

5. Sodium metal tarnishes when exposed to air to form a white powder on its surface. A small piece of sodium metal was dropped into 30 g of propanol and 2400cm^3 of hydrogen gas produced at room temperature and pressure .The unreacted propanol was evaporated and white solid remained .(molar Gas Volume at room temperature and pressure =24dm^3 Na=23 , C=12 , O= 16)

a) (i)Give the name of the white powder formed on the original piece of sodium metal. (1 mark)

Sodium carbonate

(ii)Explain how the white solid was formed. (2marks)

Sodium reacts with oxygen to form sodium oxide

Sodium oxide dissolves in water vapour to form sodium hydroxide

Sodium hydroxide absorbs carbon (IV) oxide from the atmosphere to form sodium carbonate which appears as the white substance.

b) (i)White down the chemical equation for the reaction between propanol and sodium metal. (2marks)

$$2C_3H_7OH_{(l)} + 2Na_{(s)} \longrightarrow 2C_3H_7ONa_{(aq)} + H_{2(g)}$$

(ii)Determine the mass of sodium that reacted with propanol. (2marks)

Moles of H_2 produced $= \frac{2400}{24000}$

$=0.1$ mole

Mole ratio Na : H_2

2 : 1

0.1×2 : 0.1

0.2 mole of hydrogen gas

Mass = moles ×R.A.M

$=0.2\times23=4.6g$

(iii) What mass of propanol was evaporated? (2 marks)

Mole ratio C_3H_7OH : H_2

2 : 1

0.1×2 :0.1

0.2 moles

Mass of propanol that reacted = $0.2\times(12\times3+8\times1+16\times1)=12g$

Mass of propanol that evaporated= 30-12 =18g

(iv)The propanol was evaporated at 97^0c and the white solid remained unaffected at this temperature. What is the difference in structure of propanol and white solid? (1 mark)

Propanol has simple molecular structure with hydrogen bonds among molecules while white solid (sodium propoxide) has giant ionic structure with strong ionic bond.

c) (i)Name the inorganic liquid which liberates hydrogen gas with sodium metal.

Water

(ii)State two differences you would observe if similar pieces of sodium metal were dropped separately into beakers containing equal amount of propanol and liquid named in (i) above respectively. (2marks)

Propanol	**water**
Sinks and stream of bubbles are observed	**Floats ,darts on water, hissing sound is heard**

6. The figure below is a section of periodic table. Study and answer the question that follow .the letters do not represent the actual symbol of elements.

A								
					D		**I**	E
F	**G**		**H**					
J								

a) (i) Select the element which belong to the same chemical family. (1 mark)

F and **G**

(ii)Identify the strongest reducing element. (1mark)

J

b)(i)The chloride of **H** vaporizes easily while the oxide of **H** has a high melting point. Explain the observation in terms of structure and bonding. (2marks)

Chlorides of H has simple molecular structure with weak van der waals forces among molecules while oxides of H has a giant ionic structure with strong ionic bonds.

(ii)Blue and red litmus paper were dropped into solution of chloride of H, state and explain the observations made. (2marks)

Blue litmus paper turned red and red litmus paper remained red, this is because chloride of H hydrolyses water producing hydrogen ions (H^+) which makes solution acidic; water is hydrolyzed forming hydrochloric acid.

c) K^- has ionic configuration of **2:8:8**

(i) Give the chemical family name to which element **K** belong. (1mark)

Halogen

(ii) Place element K on the above periodic table. (1mark)

Period 3 group (VII)

d) The first and second ionization energies of element **G** at random are 665kjmol$^-$ and 560 kjmol$^-$

(i) Define the term the ionization energy. (1mark)

It is the minimum amount of energy required by an element to lose an electron from the outermost energy level in gaseous state.

(ii) Write equations for the first and second ionization energies for element **G indicating their energies**. (1 mark)

1^{st} G $\longrightarrow$ $G^+ + e$ + 560kjmol$^-$

2^{nd} G^+ $\longrightarrow$ $G^{2+} + e$ +665kjmol$^-$

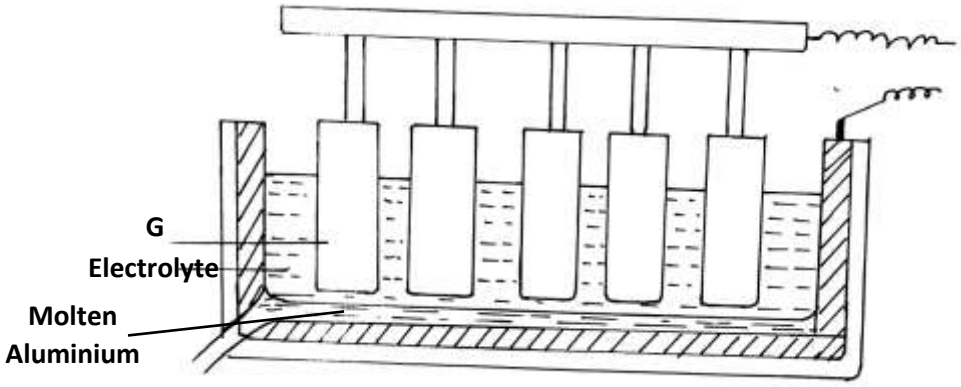
(iii) Explain your answer in (ii) above. (1mark)

Second ionization energy is more than first because as number of electron decreases remaining electron are strongly attracted to the nucleus thus more energy is needed to remove.

e) Explain the difference in the atomic radii of **D** and **I.** (2marks)

Atomic radius of D is larger than I; I has more proton (9) thus high nuclear attraction, outermost energy level is strongly attracted to the nucleus reducing atomic radius compared to D which has 7 protons thus less nuclear attraction.

7. The diagram below illustrates the Hall's cell for the extraction of Aluminium. Study it and answer the questions that follow.



(a) (i) Name the electrode labeled **G** **anode** (1mark)

(b) Electrolysis is carried at 800 – 900^{0}C and newly formed Aluminium is tapped off as a liquid. What does this indicate about the melting point of Aluminium? (1 mark)

The melting point of aluminium is less than 800^{0}c

(c) (i) Give the ionic equations for the reaction that takes place at the cathode. (1 mark)

$$Al^{3+}_{(l)} + 3e^- \longrightarrow Al_{(l)}$$

(ii) The anode has to be replaced frequently. Explain. (1mark)

Because it is made up of graphite which reacts with oxygen gas produced there forming carbon (IV) oxide at high temperature.

d) Cryolite is used in the extraction of aluminium from bauxite. State its function. (1mk)

It is used to lower the melting point of aluminium oxide from 2015 to 800^{0}c

d) A piece of unpolished aluminium foil is not attacked by water and steam. Explain. (1mk)

Because it has a coating of aluminium oxide which is insoluble in water, steam

e) (i) The basic raw material for extraction of aluminium is bauxite. Name two major impurities in bauxite. (1 mark)

Iron (III) oxide

silca/ sand/ silcon (IV) oxide

(ii) State one property of duralium that make it more suitable than pure aluminium in aeroplane construction. (1 mark)

It is harder and have higher tensile strength