Name: MARKING SCHEME ...... Adm No........... Index No..................

School: .... Class ....

Date: .... Signature: ....

233/1

CHEMISTRY THEORY

PAPER 1

TIME: 2 HOURS

KASSU JET EXAMINATIONS

JUNE 2022

Instructions to Candidates

(a) Write your **Name, Adm Number** and **index number** in the spaces provided above.

(b) Sign and write the date of examination in the spaces provided above

(c) Answer **ALL** the questions in the spaces provided in the question paper

(d) KNEC Mathematical tables and/or electronic calculators may be used for calculations

(e) All working **MUST** be clearly shown where necessary

(f) This paper consists of **12 printed pages**

(g) Candidates should check the question paper to ascertain that all the pages are printed as indicated and that no questions are missing

(h) Candidates should answer the questions in English

FOR EXAMINER'S USE ONLY

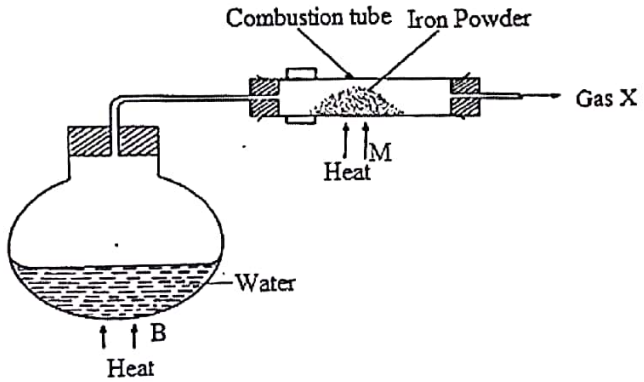| Question	Maximum score	Candidate's score
1 – 29	80	

This paper consists of **12 printed pages**. Candidates should check to ascertain that all pages are printed as indicated and that no questions are missing.

1. Give one danger of abusing bhang (1mark)

Hallucination   Addiction |
Brain damage
Any 1 × 1

2. Give one reason why a conical flask is preferred during a titration experiment over a beaker (1mark)

Has a long neck that prevents splashing of the |
liquid.

3. The atomic number of iron is 26 and its mass number is 56. How many of each of the following particles is in Iron (III) ion?

   i.   Protons....*26* ✓½ .... (½ mark)   *2½*
   ii. Neutrons....*30* ✓1 *(56-26)* .... (1 mark)
   iii. Electrons....*26-3 = 26* ✓1 .... (1mark)

4. Study the diagram below and answer the questions that follow.

Combustion tube Iron Powder
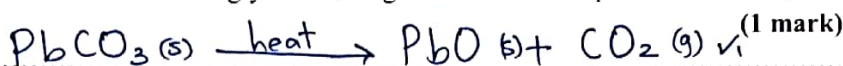Gas X
M
Heat
Water
B
Heat

a) Between point B and point M which one should be heated first? Explain.   (1mark)

B ✓½   *To produce steam - that drives out air* |
from Combustion tube || that reacts with Iron ✓½

b) Write a chemical equation that occurs in the combustion tube   (1mark)

$3Fe_{(s)} + 4H_2O_{(g)} \longrightarrow Fe_3O_4{(s)} + 4H_{2(g)}.$ ✓1 |

c) State and explain the observation made when gas X is passed over heated copper (II) oxide (2 marks)

The black solids changes to brown. ✓1   *2*
CuO is reduced to copper metal ✓1

$8\frac{1}{2}$

5. Lead carbonate was heated strongly in a boiling tube. Write the equation for the reaction that occurred. **(1 mark)**

$$PbCO_{3(s)} \xrightarrow{\text{heat}} PbO_{(s)} + CO_{2(g)} \checkmark_1$$

6. A mixture consists of three solids: lead (II) carbonate, iron filings, and sodium carbonate. Describe how to obtain pure lead (II) carbonate from the mixture. **(3 marks)**

- Spread the mixture on a paper on a flat surface ½
- Carefully pass a magnet over it to remove Iron ½
- Place the remaining mixture in a glass beaker add water and stir. Na_2CO_3 dissolves. ½
- filter the mixture ½
- Wash the residue with distilled water ½
- Dry the $PbCO_3$ residue by placing between filter papers. ½

7. Chlorine gas is prepared in the laboratory by reacting a mixture of Potassium manganate (VII) and substance H. when dry chlorine is passed over heated aluminium foil, a white solid S is formed.

   i. Identify substances H and S **(1 mark)**

   H. Concentrated Hydrochloric acid || HCl ✓½
   S. Aluminium chloride ✓½

   ii. Name the drying agent used to dry chlorine gas **(1 mark)**

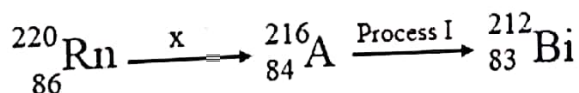   Concentrated Sulphuric (VI) acid ✓1

   iii. State the observation that will be made when chlorine is bubbled through a solution of Iron (II) chloride **(1 mark)**

   The Solution changes from green ½ to orange/yellow ½

8. Diamond and graphite are two allotropes of carbon. Explain how graphite is suitable for the use as a lubricant. **(1 mark)**

   Graphite is made of hexagonal layers connected by weak van der waals ½ forces that enables them to slide over each ½ other.
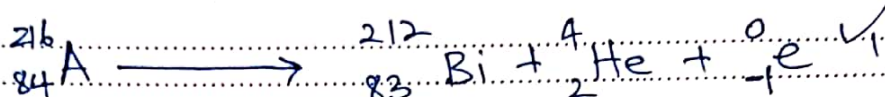
9. The following is a section of a radioactive decay series. Study it and answer the questions that follows

$$^{220}_{86}Rn \xrightarrow{\quad x \quad} ^{216}_{84}A \xrightarrow{\text{Process I}} ^{212}_{83}Bi$$

i. Identify one characteristic of particle X (1mark)

Low Penetrating power ✓₁
Positively charged ✓₁
Any 1 X1

ii. Write the nuclear equation for process I (1mark)

$$^{216}_{84}A \longrightarrow ^{212}_{83}Bi + ^{4}_{2}He + ^{0}_{-1}e \checkmark_1$$

10. You are provided with 200 cm³ of 0.5M lead (II) nitrate solution and 200 cm³ of 0.5M sodium chloride solution. Briefly describe how a dry sample of sodium nitrate crystals can be prepared $Pb(NO_3)_{2(aq)} + 2NaCl_{(aq)} \longrightarrow PbCl_{2(s)} + 2NaNO_{3(aq)}$ (3 marks)
    1mol   2mol

- Measure 100cm³ of 0.5M Pb(NO₃)₂ and place in a beaker ✓½
- Add the 200cm³ of 0.5M NaCl and stir the mixture ✓½
- Filter the mixture and retain the filtrate of NaNO₃ ✓½
- Heat the filtrate to saturation ✓½
- Transfer to evaporating dish and allow to cool and form crystals. ✓½
- Pour off the mother liqour and dry the crystals by placing between filter papers. ✓½
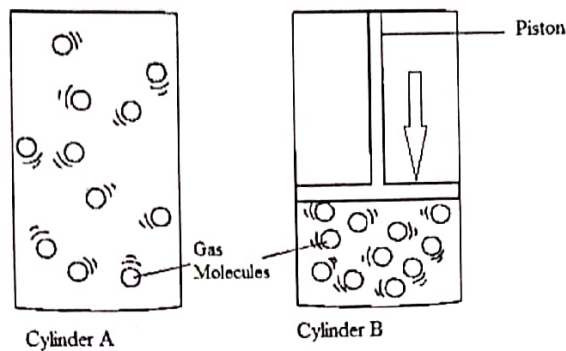
3.

11. In an experiment, 120 cm³ of oxygen diffused through a porous pot in 20 seconds and 200 cm³ of gas Y diffused through the same porous pot in 60 seconds. If the density of oxygen is 1.4291 g/cm³, calculate the density gas Y. (2 marks)

120cm³ O₂ → 20sec.
200cm³ O₂ → ?

$\frac{200}{120} \times 20$
= 100sec.

$\frac{T_Y}{T_{O_2}} = \sqrt{\frac{MM_Y}{MM_{O_2}}} = \sqrt{\frac{d_Y}{d_{O_2}}}$

$T_Y = \sqrt{\frac{d_Y}{1.4291}} \times 100$ ✓½

$60 = \sqrt{\frac{d_Y}{1.1954}} \times 100$

$\sqrt{d_Y} = \frac{60 \times 1.1954}{100}$ ✓½
= 0.7173 ✓½

$d_Y = (0.7173)^2$
= 0.51448 ✓½

2.

12. A given mass of gas was placed in cylinder A as shown below and its volume and pressure measured at constant temperature as V_A and P_A respectively. The same mass was then placed into cylinder B and the piston pushed down as shown. The volume and the pressure exerted on the piston was also measured as V_B and P_B respectively.

7

Cylinder A   Cylinder B

a. State the mathematical expression that gives the correct relationship between the pressure and volume of the gas in both cylinders A and B at constant temperature. **(1mark)**

$$P_A V_A = P_B V_B \checkmark 1$$

1

b. Give one application of gas laws. **(1mark)**
  - Inflating weather balloons ✓
  - Inflating vehicle tires ✓ | aeroplans

1

13. When a certain hydrocarbon is burnt completely in excess oxygen, 3.08 g of carbon (IV) oxide and 0.72 g of water were formed. If the molecular mass of the hydrocarbon is 184, determine the molecular formula of the hydrocarbon. (C=12, H=1) **(3 marks)**

$H(H_2O) = \frac{2}{18} \times 0.72 = 0.08g \checkmark$
$C(CO_2) = \frac{12}{44} \times 3.08 = 0.84g \checkmark$

$Ef = C_1 H_1$
$(EF)_n = MF$
$13n = 184 \checkmark$
$n = \frac{184}{13} = 14$

3

Element	C	H
Mass	0.84	0.08
R.A.M	12	1
Moles	$\frac{0.84}{12}$ ✓ $\frac{1}{2}$	$\frac{0.08}{1}$ ✓
	$= 0.07$ ✓ $\frac{1}{2}$	$= 0.08$ ✓ $\frac{1}{2}$
Ratio	$\frac{0.07}{0.07}$ ✓	$\frac{0.08}{0.07}$ ✓ $\frac{1}{2}$
	$= 1$ $\frac{1}{2}$	$= 1.14 \approx 1$ ✓ $\frac{1}{2}$

$C_{14} H_{14}$ ✓ $\frac{1}{2}$

14. If 25.0cm³ of 0.1M H_2SO_4 solution neutralised a solution containing 1.06g of anhydrous sodium carbonate in 250cm³ of solution, calculate

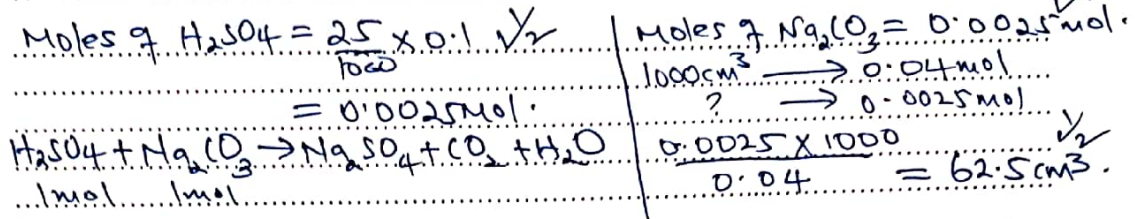a. The molarity of sodium carbonate (Na=23, O=16, C=12) **(1 ½ marks)**

Molarity $= \frac{Mass/L}{RFM}$ $\frac{1}{2}$

$Na_2CO_3 = (2 \times 23) + 12 + (16 \times 3) = 106$

Molarity $= \frac{1.06 \times 4}{10.6}$ ✓ $\frac{1}{2}$

$= 0.04M$ $\frac{1}{2}$

OR.
Moles in 250cm³ $= \frac{1.06}{106} = 0.01$ $\frac{1}{2}$

Molarity $= \frac{1000 \times 0.01}{250}$ $\frac{1}{2}$

$= 0.04M$ $\frac{1}{2}$

1½

6½

CamScanner

b. Volume of sodium carbonate solution used **(1 ½ marks)** ½

Moles of $H_2SO_4 = \dfrac{25 \times 0.1}{1000}$ ½

$= 0.0025\ mol.$

$H_2SO_4 + Na_2CO_3 \rightarrow Na_2SO_4 + CO_2 + H_2O$
   1mol   1mol

Moles of $Na_2CO_3 = 0.0025\ mol$.

$1000cm^3 \longrightarrow 0.04\ mol$ ½
? $\longrightarrow 0.0025\ mol$

$\dfrac{0.0025 \times 1000}{0.04} = 62.5\ cm^3$. ½

1½.

15. The solubility of salt W is 80g/100g of water at a temperature of 90^0C. A solution containing 84g of the salt was cooled to 50^0C.

a) Define solubility **(1mark)**

The amount of solute that saturates 100 g ✓1 of water at a given temperature

1

b) Calculate the total mass of crystals present if the solubility of salt W at 50^0C is 25g/100g of water **(1 mark)**
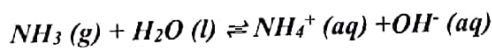
$84 - 25$ ½
$= 59$ ½

1

c) Calculate the molarity of the solution at 50^0C **(1 mark)**

(R.F.M of W=174.5)

Moles of W in $100cm^3 = \dfrac{25}{174.5} = 0.14327$ ½

Molarity $= \dfrac{0.14327 \times 1000}{100} = 1.4327\ M$ ½

1

16. Given the equation for the reaction below

$NH_3\ (g) + H_2O\ (l) \rightleftharpoons NH_4^+\ (aq) + OH^-\ (aq)$

a. State the Bronsted-Lowry definition of a base **(1 mark)**

Proton acceptor ✓1

1

b. Identify the base in the backward reaction **(1 mark)**
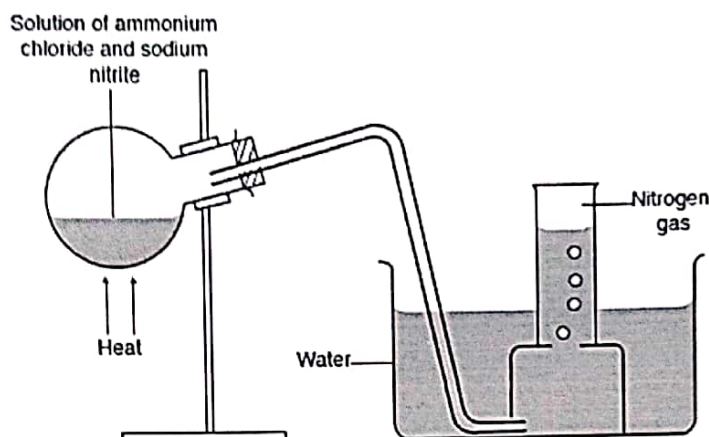
OH^- ✓1

1

17. Magnesium and aluminium are both metals. In terms of structure and bonding, how does the melting point of their respective chlorides compare? **(3 marks)**
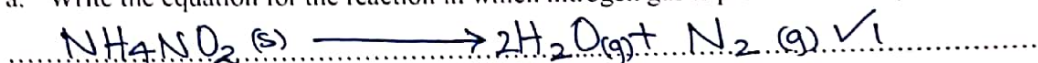
Chloride of Mg has higher MPt. than chloride of Al ✓1
$MgCl_2$ has strong ionic bonds in a giant ionic structure ½ ✓½
$AlCl_3$ is molecular ½ with covalent bonds. It therefore has weak van der waals forces between molecules.

3.

9½

18. The setup below shows laboratory preparation of nitrogen gas.

Solution of ammonium chloride and sodium nitrite

Heat

Water

Nitrogen gas

a. Write the equation for the reaction in which nitrogen gas is produced **(1 mark)**

$$NH_4NO_2(s) \longrightarrow 2H_2O(g) + N_2(g) \checkmark_1$$

b. What property makes nitrogen gas to be collected as shown above **(1 mark)**

– Slightly Soluble in water $\checkmark_1$
– Does not react with water $\checkmark_1$
Any 1 ×1

c. Nitrogen gas is used in storage of semen under artificial insemination. Explain. **(1 mark)**

It has a low freezing Point $\checkmark$

19. The structure below represents two cleansing agents Q and P.

Q- $RCOO^-Na^+$

P- $ROSO_3^-Na^+$

a. Give one advantage and one disadvantage of using agent Q **(2marks)**
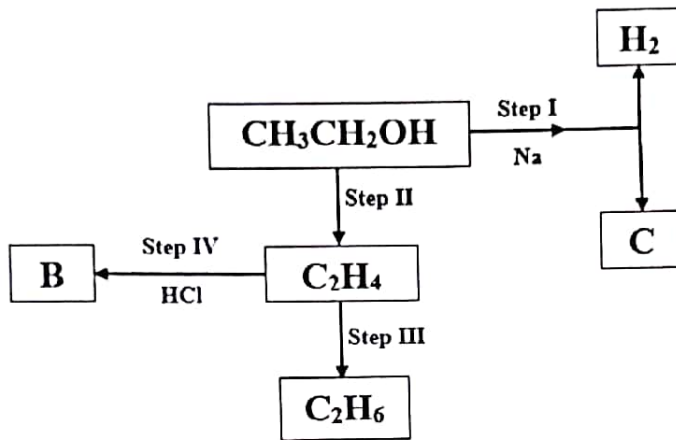
Advantage

Forms Scum with hard water. $\checkmark_1$

Disadvantage

Less expensive $\checkmark_1$
does not Pollute the environment $\checkmark_1$

Any 1×1

20. The flow chart below shows some of the chemical properties of organic compounds starting with ethanol. Use it to answer the questions that follow.
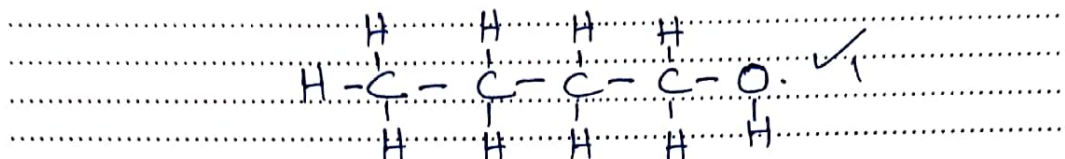

i. Name the type of reaction in; **(1 mark)**

   a) Step II   Dehydration ✓½

   b) Step IV   Addition ½

ii. Write the equation for the reaction in step I   **(1 mark)**

   $2CH_3CH_2OH + 2Na \longrightarrow 2CH_3CH_2ONa + H_2$ ✓1

iii. Give the structural formula and IUPAC name of compound B   **(1 mark)**

   Structural formula

   H—C—C—Cl   ✓1

   IUPAC name   chloro ethane ✓½   **(½ mark)**

iv. State the **major** industrial application of the reaction in step III   **(1 mark)**
   Manufacture of Margarine ‖ Conversion of oils into fats ✓1

21. The general formula for a homologous series of a group organic compounds is $C_nH_{2n+1}OH$.   n = 1, 2, 3...

   I. Give the name of the structural formula of the fourth member of the series C_4H_9OH.
      and

   i. Name   **(1 mark)**
      Butanol ✓1

CamScanner

ii. Structural formula **(1 mark)**

$$H-\underset{\underset{H}{|}}{\overset{\overset{H}{|}}{C}}-\underset{\underset{H}{|}}{\overset{\overset{H}{|}}{C}}-\underset{\underset{H}{|}}{\overset{\overset{H}{|}}{C}}-\underset{\underset{H}{|}}{\overset{\overset{H}{|}}{C}}-\overset{\overset{H}{}}{O}.$$

II. Write the equation for the reaction between the molecule in (I) above and Propanoic acid **(1 mark)**

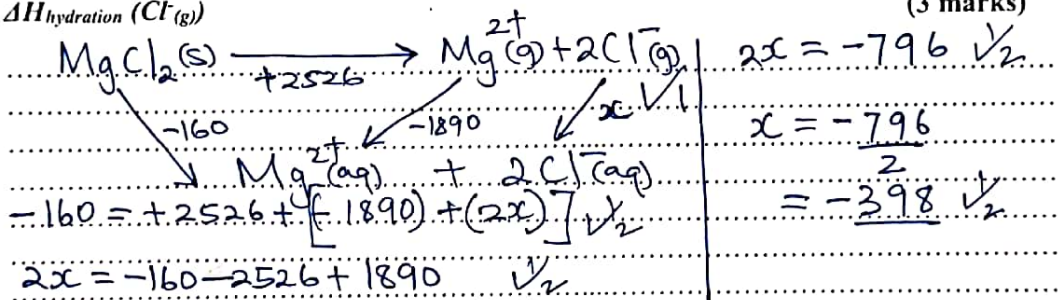$CH_3(CH_2)_3OH + CH_3CH_2COOH \longrightarrow CH_3CH_2COOCH_2(CH_2)_2CH_3 + H_2O$

22. I. The table below lists data relevant to the formation of $MgCl_2$ solution.

Enthalpy change	Value (kJ/mol)
$\Delta H_{solution}(MgCl_{2(s)})$	-160
$\Delta H_{lattice}(MgCl_{2(s)})$	-2526
$\Delta H_{hydration}(Mg^{2+}_{(g)})$	-1890

Using the information provided, calculate the molar heat of hydration of chloride ions, $\Delta H_{hydration}$ $(Cl^-_{(g)})$ **(3 marks)**

$MgCl_{2(s)} \xrightarrow{+2526} Mg^{2+}_{(g)} + 2Cl^-_{(g)}$ $2x = -796$

$\quad\searrow -160 \qquad \swarrow -1890 \qquad \downarrow x$ $x = \dfrac{-796}{2}$

$\qquad Mg^{2+}_{(aq)} + 2Cl^-_{(aq)}$ $= -398$

$-160 = +2526 + (-1890) + (2x)$

$2x = -160 - 2526 + 1890$

3.

II. Given that enthalpy of hydration of $Ca^{2+}_{(g)}$ is **-1562 kJ/mol**, suggest a reason why the enthalpy change of hydration of $Mg^{2+}_{(g)}$ as shown in the table above is higher than the enthalpy change of hydration of $Ca^{2+}_{(g)}$ **(1 mark)**

Mg^{2+} is smaller than Ca^{2+} and therefore attracts water molecules more readily during hydration

23. Petrol is a mixture of hydrocarbons. One of the hydrocarbons in petrol is octane, C_8H_{18}.
   a. Name the two products formed when octane is burnt in excess air. **(1 mark)**

   Water
   carbon (IV) oxide

b. More petrol can be made by cracking less useful petroleum fractions
   i. Define the term *cracking*. **(1 mark)**

   Breaking of long chain hydrocarbons into more useful short chain hydrocarbons. ✓₁

   ii. Write the equation for the cracking of dodecane, $C_{12}H_{26}$ to form ethene and one other hydrocarbon **(1 mark)**

   $C_{12}H_{26} \longrightarrow C_2H_4 + C_{10}H_{22}$ ✓₁

   iii. Give the name of the hydrocarbons homologous series to which ethene belongs **(1 mark)**

   Alkene ✓₁

24. A powder is suspected to be containing sulphite ions. Given, 2M nitric acid, dilute barium nitrate solution, Acidified potassium manganate (VII) reagents and other necessary laboratory apparatus, describe how one can confirm the presence of the ions. **(3 marks)** ½

   Place the solid in a boiling tube and add water, then shake to dissolve. Divide into two portions of 2cm³. To first portion, add dilute $Ba(NO_3)_2$ followed by HNO_3 ½. If forms white precipitate ½ that dissolves ½ in acid. To second portion, add drops of $H^+/KMnO_4$ ½. The colour changes from purple ½ to colourless. ½

   3.

25. Ethanoic acid reacts with ethanol to form a product that has a pleasant smell called an ester and water. When the reaction is at an equilibrium, a few drops of concentrated sulphuric acid were added, followed by warming.
   a. What is the effect of adding concentrated sulphuric acid on;
      i. The position of the equilibrium of the mixture? **(1 mark)**

      No effect ½. As a Catalyst there is no effect on equilibrium position ½

      ii. The yield of the ester **(1 mark)**
      No effect ½.
      Catalyst don't affect amount of products ½

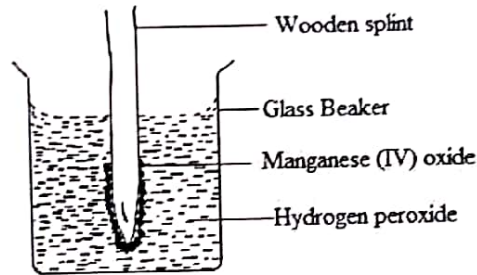   b. The forward reaction in the equilibrium is referred to as esterification. What is the name of the reverse reaction? **(1 mark)**

      Acidic hydrolysis ✓₁

c. Explain the effect of rise in temperature on the yield of products of a reaction with a molar enthalpy change of **-92kJ/mol.** (Exothermic) **(2 marks)**

The yield lowers||reduces ✓1

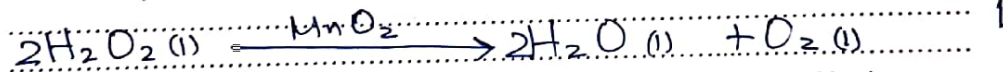Increase in temperature does not favour exothermic reactions ✓1   2

26. A wet wooden splint was dipped in manganese (IV) oxide powder and then soaked in hydrogen peroxide solution as shown below.
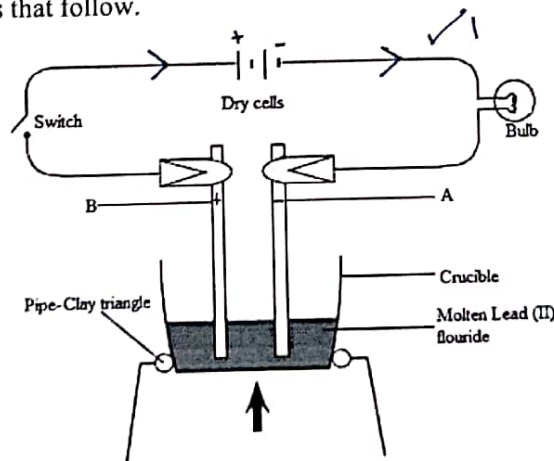

- Wooden splint
- Glass Beaker
- Manganese (IV) oxide
- Hydrogen peroxide

i. State and explain the observation that was made **(2 marks)**

Effervescence||bubbles ✓1

There is Production of oxygen gas ✓1   2

ii. Write the equation for the reaction that occurred **(1 mark)**

$$2H_2O_{2(l)} \xrightarrow{MnO_2} 2H_2O_{(l)} + O_{2(l)}$$ 1

27. The setup below shows the process of electrolysis of molten lead (II) fluoride. Use it to answer the questions that follow.

- Switch
- Dry cells
- Bulb
- B
- A
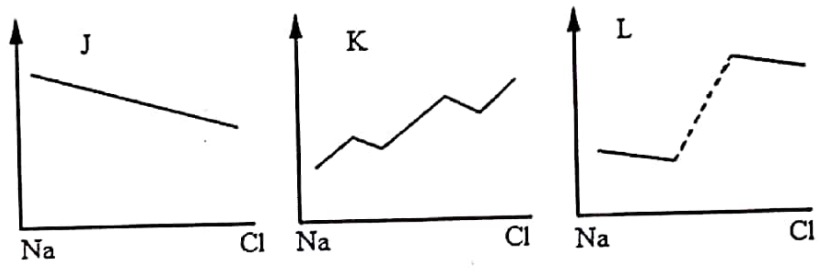- Pipe-Clay triangle
- Crucible
- Molten Lead (II) flouride

a. Identify the electrodes labelled A and B **(1 mark)**
   A. Cathode ✓½
   B. Anode ✓½
b. Indicate the direction of flow of electrons on the diagram on diagram · **(1 mark)**
c. State and explain the observation made on electrode B **(2 marks)**
   Pale yellow ✓ gas is evolved
   Flouride ions lose electrons to form F_2 gas ✓₁   2
   Accept: $2F_{(aq)}^- \longrightarrow F_2{(g)} + 2e$
d. Give any one application of electrolysis **(1 mark)**
   – Extraction of metals ✓₁   – Electroplating ✓₁   1
   – Manufacture of pure chemicals ✓₁   (Any 1 ×1)

28. The graphs J, K and L below shows the general trend in the properties of period 3 elements (Na to Cl). Use them to answer the questions that follow.

Select a graph that represents the variation in;
a. Ionic radius. L ✓½   **(½ mark)** ½

b. Atomic radius. Explain. **(1½ marks)**
   J ✓½
   There is a reduction in atomic size radius to due ✓½
   Increasing effective nuclear force as the protons increase.   1½

29. Aluminium objects do not need protection from corrosion while Iron objects must be protected from corrosion. Explain. **(2 marks)**
   – Aluminium once coated by a thin oxide layer
   There is no need for protection since the layer is
   inert ✓ preventing further corrosion.   2
   – Iron needs protection since the porous oxide (rust)
   layer allows continued corrosion. ✓₁

8