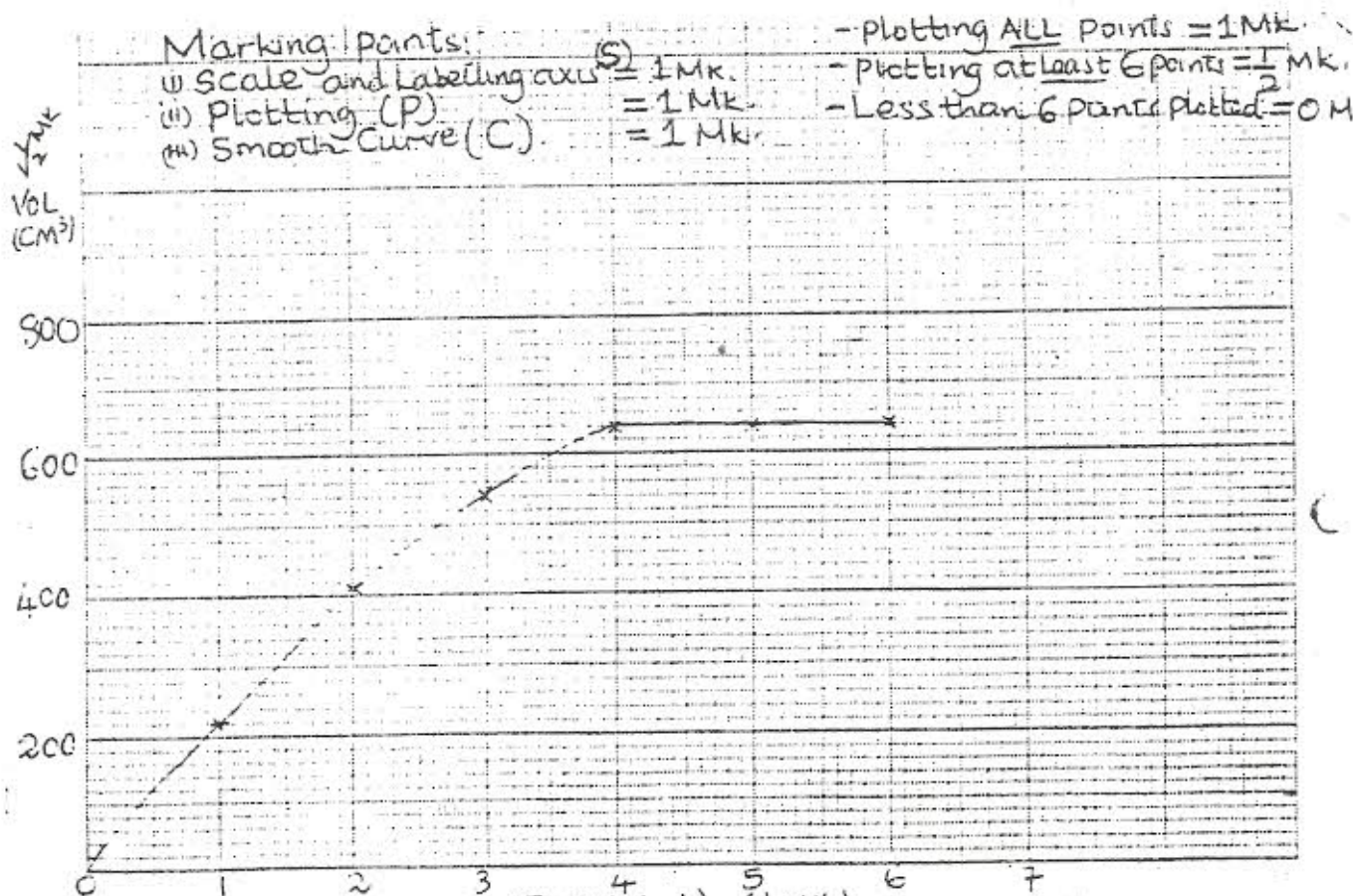# CHEMISTRY PAPER 233/2 MARKING SCHEME
2001

1. In an experiment to study the rate of reaction between duralumin (an alloy of aluminium, magnesium, copper) and hydrochloric acid, 0.5g of alloy were reacted with excess 4M hydrochloric acid. The data in the table below was recorded. Use it to answer the questions that follow.

Time (minutes)	Total volume of gas (cm³)
0	0
1	220
2	410
3	540
4	620
5	640
6	640
7	640

a) i) On the grid provided, plot a graph of total volume of gas produced (vertical axis against time) (3 marks)

Marking points:
(i) Scale and Labelling axis = 1Mk.
(ii) Plotting (P) = 1Mk.
(iii) Smooth Curve (C) = 1Mk.

- Plotting ALL Points = 1Mk.
- Plotting at least 6 points = ½ Mk.
- Less than 6 points plotted = 0 M

(ii) From the graph, determine the volume of gas produced at the end of 2½ minutes. (1 mark)

480cm³ (± 5.0cm³).

(Read value from Candidates graph)

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ii) From the graph, determine the volume of gas produced at the end of 2½ minutes

$485cm^3$ (±5 i.e. $480 \leftrightarrow 490cm^3$)
(NB read value from the candidate's graph)

b) Determine the rate of reaction between the 3rd and 4th minute

$$\frac{620 - 540}{1} = 80cm^3/min$$

$$\frac{620 - 540}{60} \neq 1.33cm^3/Sec$$

c) Give a reason why some solid remained at the end of the experiment
- Solid is due to presence of copper which had not reacted
- It did not react because it is below hydrogen in the reaction series

d) Given that 2.5cm3 of the total volume of the gas was from the reason between magnesium and aqueous hydrochloric acid, calculate the percentage mass of aluminium present in 0.5g of the alloy
(Al = 27.0 and Molar gas volume = 24,000cm^3 at 298K)

Volume of gas to (H_2) = 640 – 2.5
= 637.5cm^3

Moles of H_2g = $\frac{637.5}{24,000}$ = 0.0266
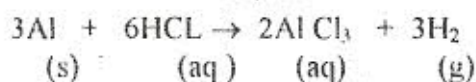
$3Al + 6HCL \rightarrow 2AlCl_3 + 3H_2$
(s)   (aq)   (aq)   (g)   **OR**   Mole ratio   Al : H2
                                                              2 : 3

Mole of Al = $\frac{637.5}{24,000} \times \frac{2}{3}$ Mass of Al = $\frac{637.5}{24,000} \times \frac{2}{3} 27$

Percentage mass of Al = $\frac{0.478}{0.5}$ = 95.6%   (95.55% - 95.64)

e) State two properties of duralumin that make it more suitable than pure aluminium in aeroplane construction
- Stronger than pure Aluminium // higher tensil strength
- Harder than pure Aluminium // tougher //
- More durable //more resistance to corrosion/rusting

2. a) In which homologous series do the following compounds belong?
   i)   CH$_3$CCH
       Alkyne

   ii)   CH3CH$_2$COOH
       Carboxylic acid //Alkanoic acid

b) Raw rubber is heated with sulphur in the manufacture of natural rubber

  i)   **What name is given to the process?**
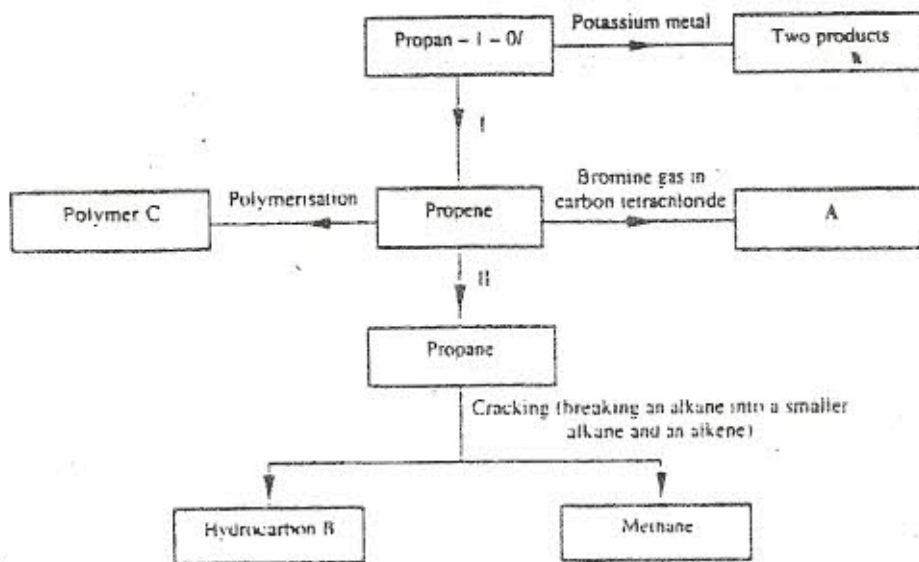   Vulcanisation

  ii)   **Why is the process necessary**
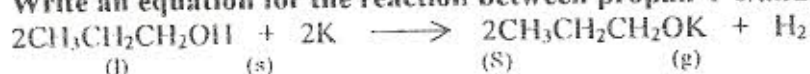   To harden rubber// make it tougher//stronger

c) Study the scheme given below and answer the question

c) Study the scheme given below and answer the questions that follow

  i)   **Write an equation for the reaction between propan-1-ol and potassium metal**

$$2CH_3CH_2CH_2OH_{(l)} + 2K_{(s)} \longrightarrow 2CH_3CH_2CH_2OK_{(S)} + H_{2(g)}$$

$$// 2C_2H_5OH_{(l)} + 2K_{(s)} \quad 2C_2H_5OK_{(S)} + H_{2(g)}$$

  ii)   **Name process I and II**
         I   –   Dehydration
         II –   Hydrogenation

  iii) **Identify the products A and B**
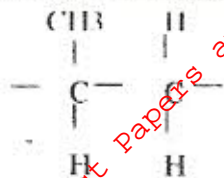   A   –   1, 2 - Dipromopropane
         B   –   Ethene/ CH_2CH_2//C_2H_4

  iv)   **Name ONE catalyst used in process II**
        Nickel // Ni // Palladium // Platinum // Platimin // pt

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v) Draw the structural formula of the repeating unit in the polymer C

$$-\overset{\displaystyle CH_3}{\underset{\displaystyle H}{\overset{\displaystyle |}{\underset{\displaystyle |}{C}}}}-\overset{\displaystyle H}{\underset{\displaystyle H}{\overset{\displaystyle |}{\underset{\displaystyle |}{C}}}}-$$

d) State **TWO** industrial uses of methane
   - Fuel//source of fuel
   - Production of hydrogen gas
   - Production of   i) CCl_4
                      ii) Chloroform(trichloromethane)
                      iii) A ltylne
   iv) Methanol

3. a) Study the standard electrode potentials for the half-cells given below and answer the questions that follow. (The letters do not represent the actual symbols of the elements).

 | | | E^0 volts |
   |---|---|---|
   | $N^+_{(aq)} + e^- \rightleftharpoons N_{(s)}$; | | -2.92 |
   | $J^+_{(aq)} + e^- \rightleftharpoons J_{(s)}$; | | +0.52 |
   | $K^+_{(aq)} + e^- \rightleftharpoons \frac{1}{2}K_{2(s)}$; | | 0.00 |
   | $\frac{1}{2}G_{2(g)} + e^- \rightleftharpoons G^-_{(aq)}$; | | +1.36 |
   | $M^{2+}_{(aq)} + 2e^- \rightleftharpoons M_{(s)}$; | | 0.44 |

   i) Identify the strongest oxidising agent. Give a reason for your answer
      G_2 or G.
      It has the highest positive electrode potential **OR** It has the highest reduction potential

   ii) Which two half cells would produce the highest potential difference when combined?

   $$\frac{1}{2}G + e^- \longrightarrow G^- \qquad -2.92 + 1.36$$

   $$N^+_{(aq)} + e^- \longrightarrow N_{(s)} \qquad \text{N and G or } G_2$$
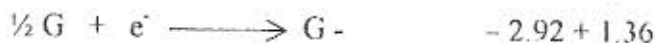
   iii) Explain whether the reaction represented below can take place
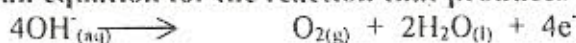 $$2N^+_{(aq)} + M_{(s)} \longrightarrow 2N_{(s)} + M^{2+}_{(aq)}$$
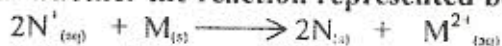
   Can't take place from left to right; M is below N in reactivity series; it cannot displace N from its solution
   E^0 Cell $= -2.92 + 0.44 = 2.48$

b) 100cm² of 2M sulphuric acid was electrolysed using the set up represented by the diagram below
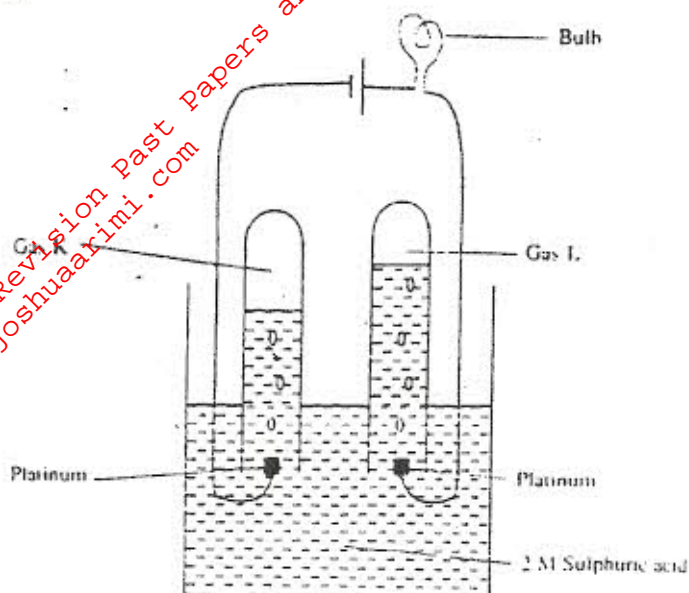
i) Write an equation for the reaction that produces gas L

$$4OH^-_{(aq)} \longrightarrow O_{2(g)} + 2H_2O_{(l)} + 4e^-$$

ii) Describe how gas K can be identified

Insert a burning splint in a gas jar of gas K; the gas burns with a pop sound to show that it is hydrogen.

iii) Explain the difference in
   a) the volumes of gases produced at the electrodes
      Hydrogen – Monovalent
      Oxygen – divalent
      Same amount of electricity liberates twice as much hydrogen as oxygen. The volume of $H_{2(g)}$ is twice $O_{2(g)}$ because to produce 1 mole of $H_{2(g)}$ 2 moles of electrons a required and to produce 1 mole of $O_{2(g)}$ – 4 mole of electrons are given out.

   b) brightness of the bulb if 100cm³ of 2M ethanoic acid was used in place of sulphuric acid.
      Bulb is brighter with sulphuric (H_2SO_4); H_2SO_4 is stronger acid hence its degree of ionization is higher.
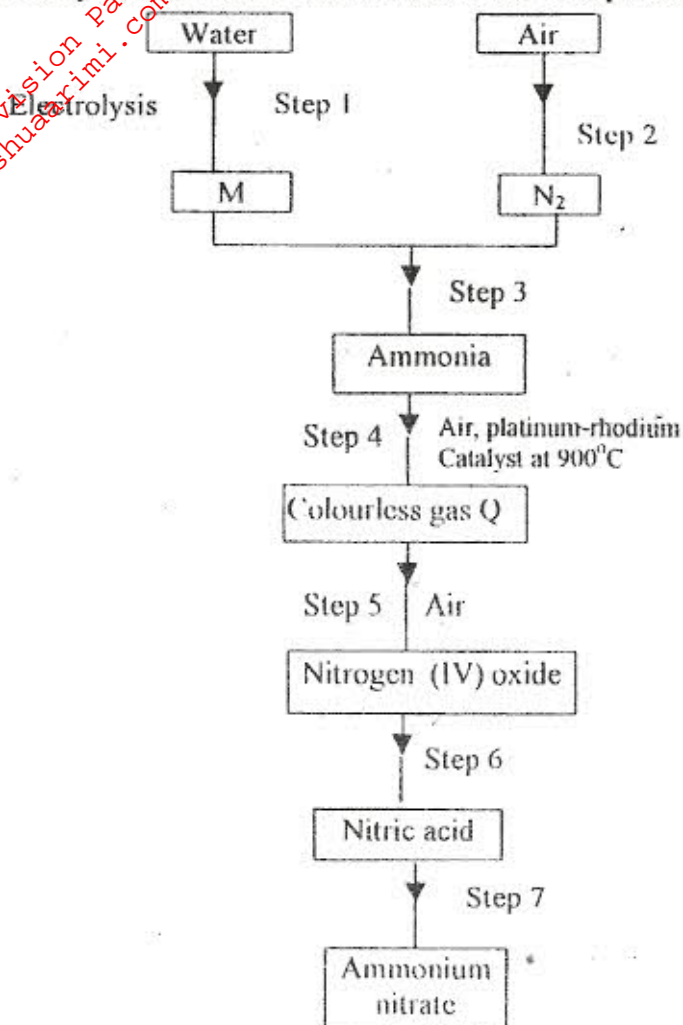
4. a) Fractional distillation of liquid air usually produces nitrogen and oxygen as the major products
   i) Name ONE substance that is used to remove carbon dioxide from the air before it is changed into liquid
      KOH/NaOH/Castric potash/Castric soda

ii) **Describe how nitrogen gas is obtained from the liquid air**
    (Boiling points Nitrogen = -196⁰C, Oxygen = -183⁰C)
    Liquid air warmed, to temperature below −196⁰C
    N_2 comes out first, because it has lower boiling point

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

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   ┌─────────┐              ┌─────────┐
   │  Water  │              │   Air   │
   └────┬────┘              └────┬────┘
Electrolysis │  Step 1            │  Step 2
   ┌────▼────┐              ┌────▼────┐
   │    M    │              │   N₂    │
   └────┬────┘              └────┬────┘
                                 │
                          Step 3 │
                          ┌──────▼──────┐
                          │   Ammonia   │
                          └──────┬──────┘
                  Step 4 │   Air, platinum-rhodium
                         │   Catalyst at 900⁰C
                  ┌──────▼───────────┐
                  │  Colourless gas Q │
                  └──────┬───────────┘
                  Step 5 │  Air
                  ┌──────▼───────────┐
                  │ Nitrogen (IV) oxide│
                  └──────┬───────────┘
                  Step 6 │
                  ┌──────▼──────┐
                  │  Nitric acid │
                  └──────┬──────┘
                  Step 7 │
                  ┌──────▼──────┐
                  │  Ammonium    │
                  │  nitrate     │
                  └─────────────┘
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(i) **Name element M**
     Hydrogen (H_2)

(ii) **Why is it necessary to use excess air in step 4?**
      Ammonia converted to gas Q

(iii) **Identify gas Q**
       Nitric oxide// $NO_{(g)}$ // Nitrogen monoxide// Nitrogen II Oxide

(iv) **Write an equation for the reaction in step 7**
      $NH_{3(g)} + HNO_{3(aq)} \longrightarrow NH_4NO_{(aq)}$

(v) **Give ONE use of ammonium nitrate**
Fertilizers// Manufacture of explosive

c) **State and explain the observations that would be made if a sample of sulphur is heated with concentrated nitric acid**
Brown fumes produced, HNO_3 reduced to NO_2
Yellow colour disappears // yellow sulphur dissolves
Brown gas // Sulphur disappears
Sulphur is oxidized to H_2SO_4 // SO_2 // H_2SO

5. a) **Give the name of one reagent which when reacted with concentrated hydrocholoric acid produces chroline gas**
Potassium permanganate KM_nO_4. M_nO_2 Manganese IV Oxide,
Lead IV Oxide PbO_2. // $CaOCl_2$

b) **A student set out to prepare iron (III) chloride using the apparatus shown in the diagram below**
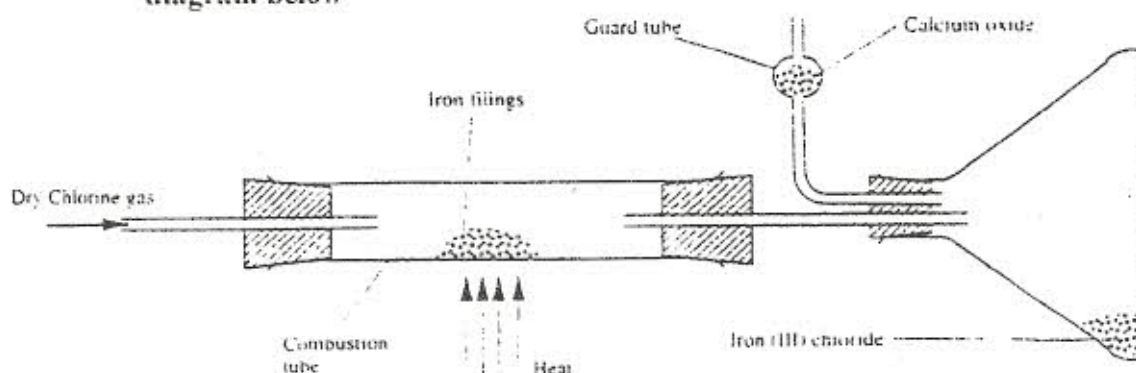
i) **Explain Why**
a) **It is necessary to pass chlorine gas through the apparatus before heating begins?**
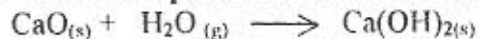To remove all the oxygen which would form Iron III Oxide instead of Iron III chloride

b) **Calcium oxide would be preferred to calcium chloride in the guard tube**
CaO can absorb both Cl_2 and moisture, calcium chloride can only absorb moisture

ii) **What property of iron (III) chloride makes it possible to be collected as shown in the diagram**
It sublimes or changes directly from solid to gas

iii) **Write an equation for one chemical reaction that took place in the guard tube**
$CaO_{(s)} + H_2O_{(g)} \longrightarrow Ca(OH)_{2(s)}$

$CaO_{(s)} + Cl_{(g)} \longrightarrow CaOCl_{2(s)}$

$Ca(OH)_2 + Cl_{2(g)} \longrightarrow CaOCl \bullet H_2O_{(s)}$

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iv) The total mass of iron (III) chloride formed was found to be 0.5g. Calculate the volume of chlorine gas that reacted with iron.
(Fe = 56.0, Cl = 35.5 and Molar gas volume at 298K is 24,000cm³)

$2Fe_{(s)} + 3Cl_{2(g)} \longrightarrow 2FeCl_{3(s)}$ $2Fe_{(s)} + 3Cl_{(g)} \longrightarrow 2FeCl3_{(s)}$
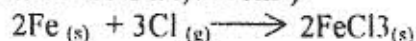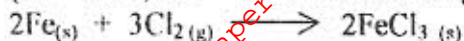
or // Fe: Cl₂ 3×24000 ----------- 325
                                                                    x ----------- 0.5
RFM of FeCl₃ = 162.5

Mole of FeCl₃ = $\dfrac{0.5}{162.5}$ = 0.003   **OR** $x = \dfrac{3 \times 24000 \times 0.5}{325}$

Mole of Cl₂ = $\dfrac{3}{2} \times 0.003$ = 0.0045   = 110.79cm³

Vol of Cl2 = 0.0045 × 24000 = 110.8cm³ (110.76 – 11cm²)

c) When hydrogen sulphide gas was passed through a solution of iron (III) chloride the following observations were made:

   i)   the colour of the solution changed from reddish-brown to green and
   ii) a yellow solid was deposited
        Explain these observations

   Fe^{3+} reduced to Fe^{2+}; H₂S oxidised to Sulphur Iron III to Iron II; Sulphur is deposited
   Iron III to Iron II Sulphur is deposited

d) State and explain the observations that would be made is a moist blue litmus paper was placed in a gas jar full of Chlorine gas
    Turns red, then white – because chlorine is acid and is a bleaching acid

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

Element	Electronic configuration	Ionisation energy kJmol⁻¹
P	2.1	519
Q	2.8.1	494
R	2.8.8.1	418

   i)   What is the general name given to the group in which elements P,Q and R belong?
        Alkali metals (reject alkaline metals)

   ii) What is meant by ionisation energy
        Energy required to remove an electron from an atom

   iii) Explain why element P has the highest ionisation energy
        P has the smallest atomic radius therefore the outer most electron is most strongly attracted to the nucleus, hence more energy is required to remove it.

iv) When a piece of element Q is placed on water, it melts and a hissing sound is produced as it moves on the surface of the water. Explain these observations

Melts, because of the heat produced during the reaction

Hissing sound because of production of H_2

Floats, because its less dense than water

Moves on the surface due to its propelled by escaping hydrogen

v) Write an equation for the reaction between element Q and water

$$2Q_{(s)} + 2H_2O_{(l)} \longrightarrow 2QOH_{(aq)} + H2_{(g)} \quad // \quad 2Na_{(s)} + 2H2O_{(l)} \longrightarrow 2NaOH_{(aq)} + H_{2(g)}$$

(b) Distinguish between a strong and a weak base. Give an example of each

- A strong base produced a high concentration of OH^- ions when dissolved in water e.g. NaOH // KOH // LiOH // Na_2O or K_2O, Wood ash,
- Weak base is partially ionised in water hence it produce a low concentration of OH^- ions e.g. $Ca(OH)_2$ // NH_4OH // CaO // $Mg(OH)$ // NH_3

  OR

- Strong base has more OH^- ions or PH of 12-14
- Weak base has few OH^- ions or PH of 8-11

(c) Neutralisation is one of the methods of preparing salts

i) What is meant by neutralisation

Reaction between 1 mole of H^+ and 1 mole of OH^- to form 1 mole of H_2O

$$H^+_{(aq)} + OH^-_{(aq)} \longrightarrow H_2O_{(l)}$$

ii) Describe how you would prepare crystals of sodium nitrate starting with 200cm3 of 2M sodium hydroxide

- Add 200cm³ of 2M HNO_3 to the 200cm³ of 2M NaOH
- Heat evaporation to concentrate the mixture
- Allow the mixture to cool for crystals to appear
- Filter/decant to obtain crystals

iii) Write an equation for the reaction that takes place when a solid sample of sodium nitrate is heated

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

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