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(ii) magnesium. (1 mark)

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(b) Predict the atomic radius of calcium. (1 mark)

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**8.** Compound **D** with formula, $C_3H_4$, was reacted with excess hydrogen chloride gas.

(a) Give the name of compound **D**. (1 mark)

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(b) Draw **two** possible structures of the products formed. (2 marks)

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**9.** Study the setup in **Figure 2** and answer the questions that follow.

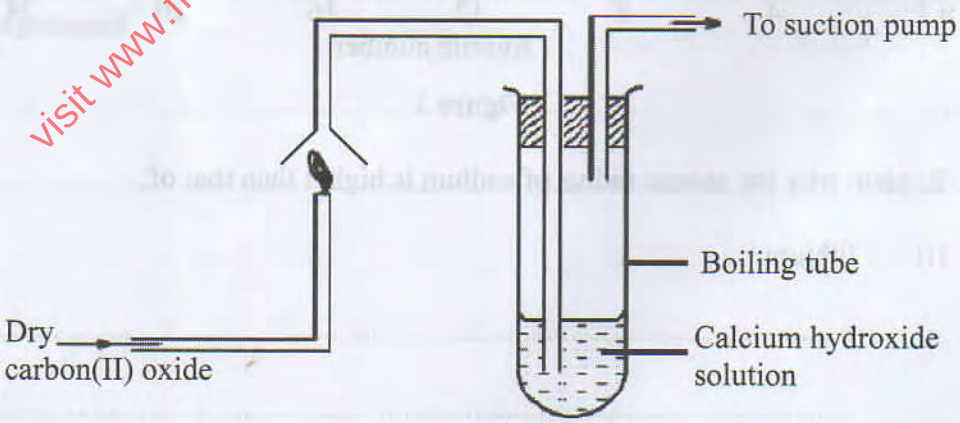


**Figure 2**

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**THE KENYA NATIONAL EXAMINATIONS COUNCIL**
**Kenya Certificate of Secondary Education**

**233/1** **Paper 1**

# CHEMISTRY – (Theory)

## Mar. 2022 – 2 hours

**Name** ..... **Index Number** .....

**Candidate's Signature** ..... **Date** .....

**Instructions to candidates**

(a) Write your name 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) **Non-programmable** silent electronic calculators and KNEC mathematical tables may be used.
(e) All working **must** be clearly shown where necessary.
(f) **This paper consists of 20 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**

| 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
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| 17 | 18 | 19 | 20 | 21 | 22 | 23 | 24 | 25 | 26 | 27 | Grand Total |
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**1.** (a) Draw a labelled diagram showing the atomic structure of $^{24}_{12}\mathbf{Mg}$. (2 marks)

(b) The atomic number of phosphorus is 15. Draw a dot (•) and cross (x) diagram for the compound formed when phosphorus reacts with chlorine, atomic number 17. (1 mark)

**2.** (a) State the condition under which a Bunsen burner produces a luminous flame. (1 mark)

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(b) Write an equation for the reaction that takes place in a luminous flame assuming the laboratory gas is butane. (1 mark)

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(c) One of the regions in the non-luminous flame is the unburnt gas region. Describe how the presence of this region can be shown using a wooden splint. (1 mark)

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3. (a) The elements sodium, magnesium and aluminium belong to group I, II and III respectively. Select the element with the highest electrical conductivity and give a reason. (1 mark)

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(b) Complete **Table 1** to show the products of electrolysis for concentrated sodium chloride and molten sodium chloride.

**Table 1**

| Compound | Anode | Cathode |
|---|---|---|
| Concentrated sodium chloride | | |
| Molten sodium chloride | | |

(2 marks)

4. A small piece of sodium metal was placed in a beaker containing pure water.

(a) State **two** observations made during the reaction. (1 mark)

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(b) State and explain another observation made when a drop of phenolphthalein is added to the mixture in the beaker. (1 mark)

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(c) Explain why it is **not** advisable to carry out this experiment using potassium metal. (1 mark)

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**5.** Describe how a pure sample of copper(II) nitrate crystals can be prepared using recycled copper wire. (3 marks)

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**6.** The following apparatus and chemicals are used to investigate the percentage of air used when iron rusts: iron filings, 100 ml measuring cylinder, trough and water.

(a) Draw a setup of the experiment. (2 marks)

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(b) Write an expression to show how the percentage of air used is calculated at the end of the experiment. (1 mark)

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7. **Figure 1** shows a graph of atomic radius of some group I and group II elements.

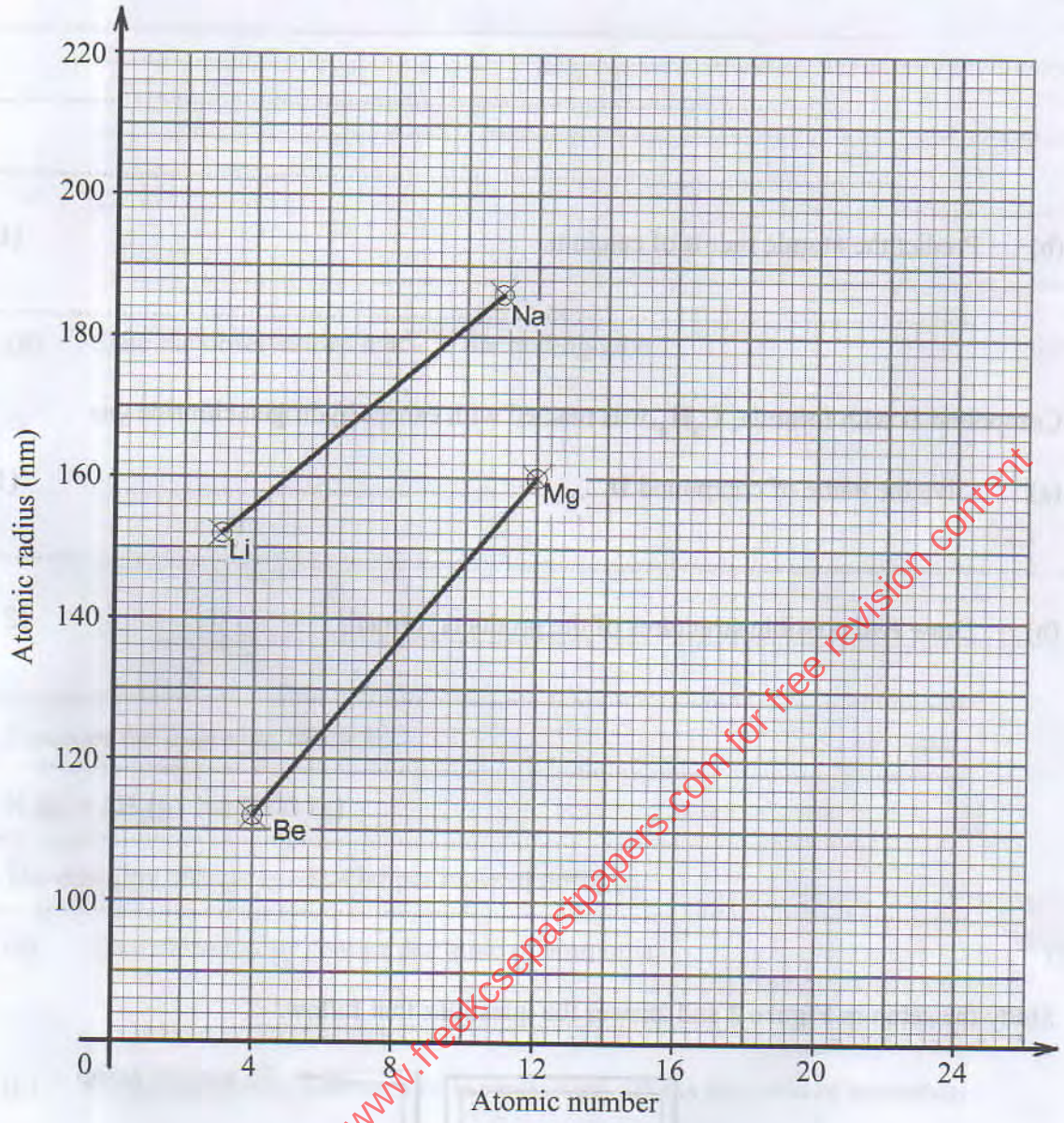


**Figure 1**

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(a) Explain why the atomic radius of sodium is higher than that of:

(i) lithium. (1 mark)

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(a) State the precaution that should be taken in carrying out the experiment. Give a reason. (1 mark)

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(b) State the observations made in the boiling tube. (2 marks)

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**10.** Consider the following reaction:

$N_2(g) + 3H_2(g) \rightleftharpoons 2NH_3(g)$

The enthalpy change is **–92.4 kJ** per mole of nitrogen.

(a) Give the enthalpy change per mole of ammonia. (1 mark)

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(b) State and explain how each of the following affects the yield of ammonia:

(i) Increase in temperature. (1 mark)

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(ii) Finely divided iron. (1 mark)

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**11.** Study the flow chart in **Figure 3** and answer the questions that follow.

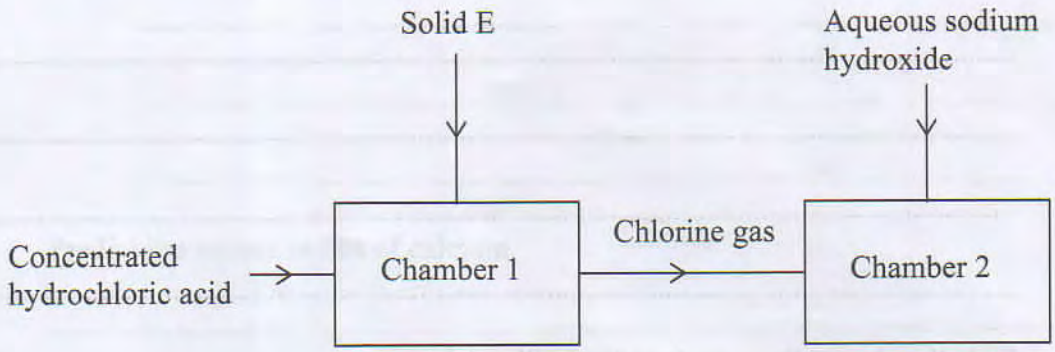


**Figure 3**

(a) Identify solid **E**. (1 mark)

.....

(b) Name the type of reaction that takes place in chamber **1**. (1 mark)

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(c) Write an equation for the reaction that takes place in chamber **2**. (1 mark)

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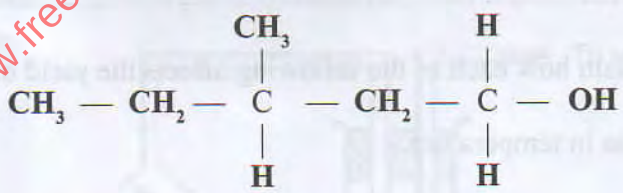
**12.** Compounds **H** and **J** have the following structures.



Compound **H**

Compound **J**

(a) Give the names of:

(i) Compound **H**. (1 mark)

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(ii) Compound **J**. (1 mark)

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(b) State the conditions necessary for **H** and **J** to react. (1 mark)

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**13.** Rhombic sulphur is **one** of the allotropes of sulphur.

(a) Draw the structure of rhombic sulphur. (1 mark)

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(b) Describe the observations made when rhombic sulphur is heated from room temperature until it boils. (1 mark)

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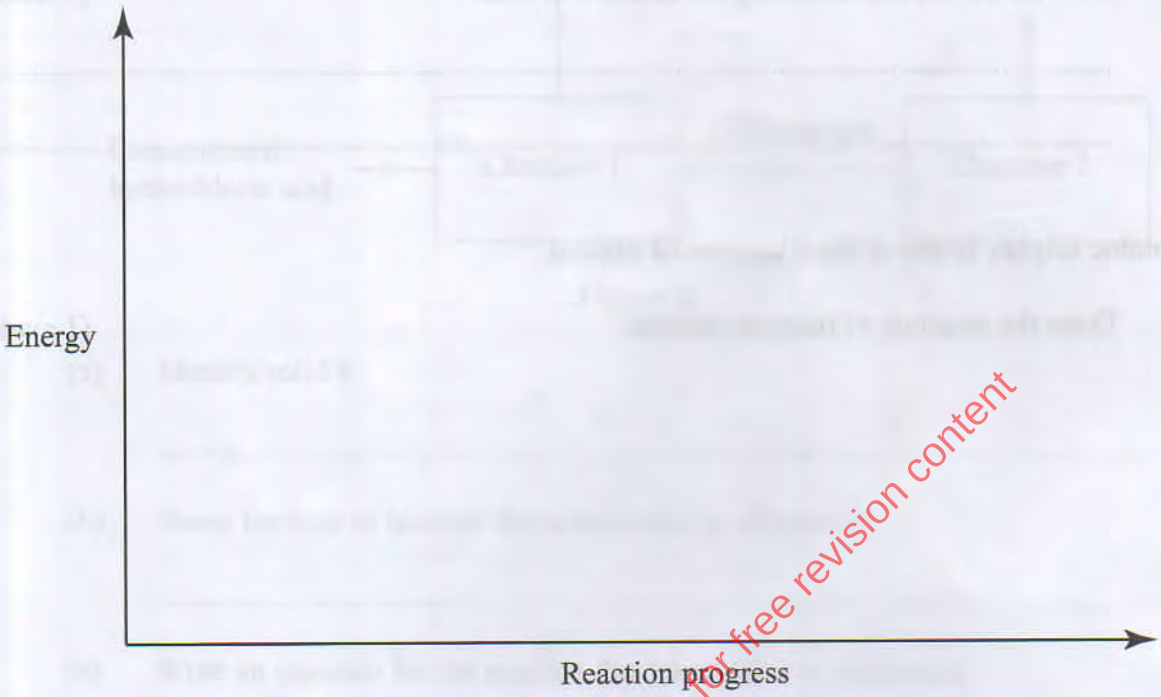
**14.** The molar enthalpy of solution for potassium sulphate ($K_2SO_4$) is **+23.8 kJ**.

(a) On the axes provided, draw a labelled energy level diagram for the dissolution process of potassium sulphate in water. (2 marks)




(b) Calculate the enthalpy change when 5.22 g of potassium sulphate is completely dissolved in water (K = 39.0; S = 32.0; O = 16.0). (1 mark)

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**15.** (a) State Gay–Lussac's law. (1 mark)

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(b) 180 $cm^3$ of nitrogen(II) oxide gas was reacted with 400 $cm^3$ of oxygen gas.

(i) Write an equation for the reaction. (1 mark)

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(ii) Calculate the total volume of the gases at the end of the reaction. (3 marks)

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**16.** Describe how the setup in **Figure 4** can be used to distinguish between 50.0 $cm^3$ of 0.2 M hydrochloric acid and 50.0 $cm^3$ of 0.2 M ethanoic acid using pieces of 6 m length of magnesium ribbon and a stop watch. (3 marks)

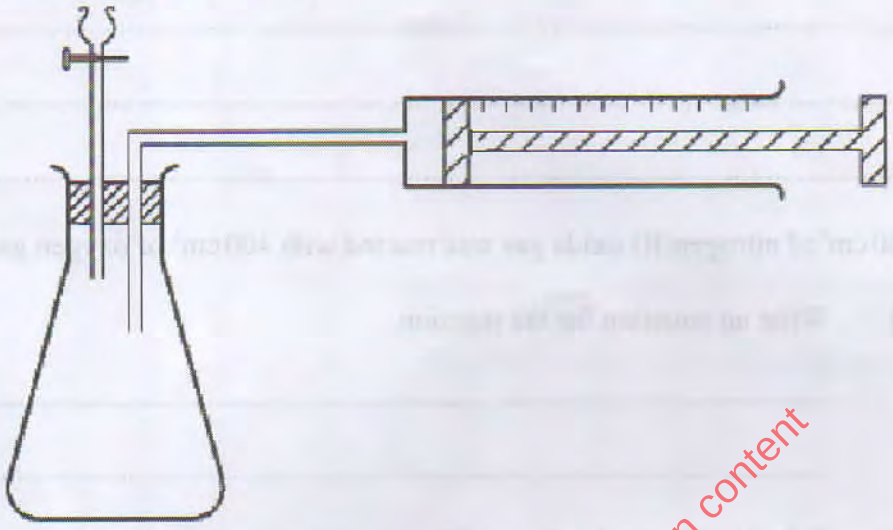

**Figure 4**

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17. Describe how dilute nitric(V) acid and blue litmus papers can be used to distinguish between solid samples of sodium carbonate and sodium sulphite. (3 marks)

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18. (a) Describe how propanone can be used to extract a pure sample of sunflower oil. (2 marks)

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(b) State why sodium hydroxide solution is **not** suitable for the extraction of sunflower oil. (1 mark)

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**19.** 31.5 $cm^3$ of concentrated nitric(V) acid was diluted to 500 $cm^3$. 10.0 $cm^3$ of the dilute acid required 25.0 $cm^3$ of 0.4 M sodium hydroxide for neutralisation.

(a) Calculate concentration of the:

(i) dilute acid. (1 mark)

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(ii) concentrated acid. (1 mark)

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(b) State the correct method for diluting the concentrated nitric(V) acid. (1 mark)

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**20.** **Figure 5** shows part of a radioactive decay series.

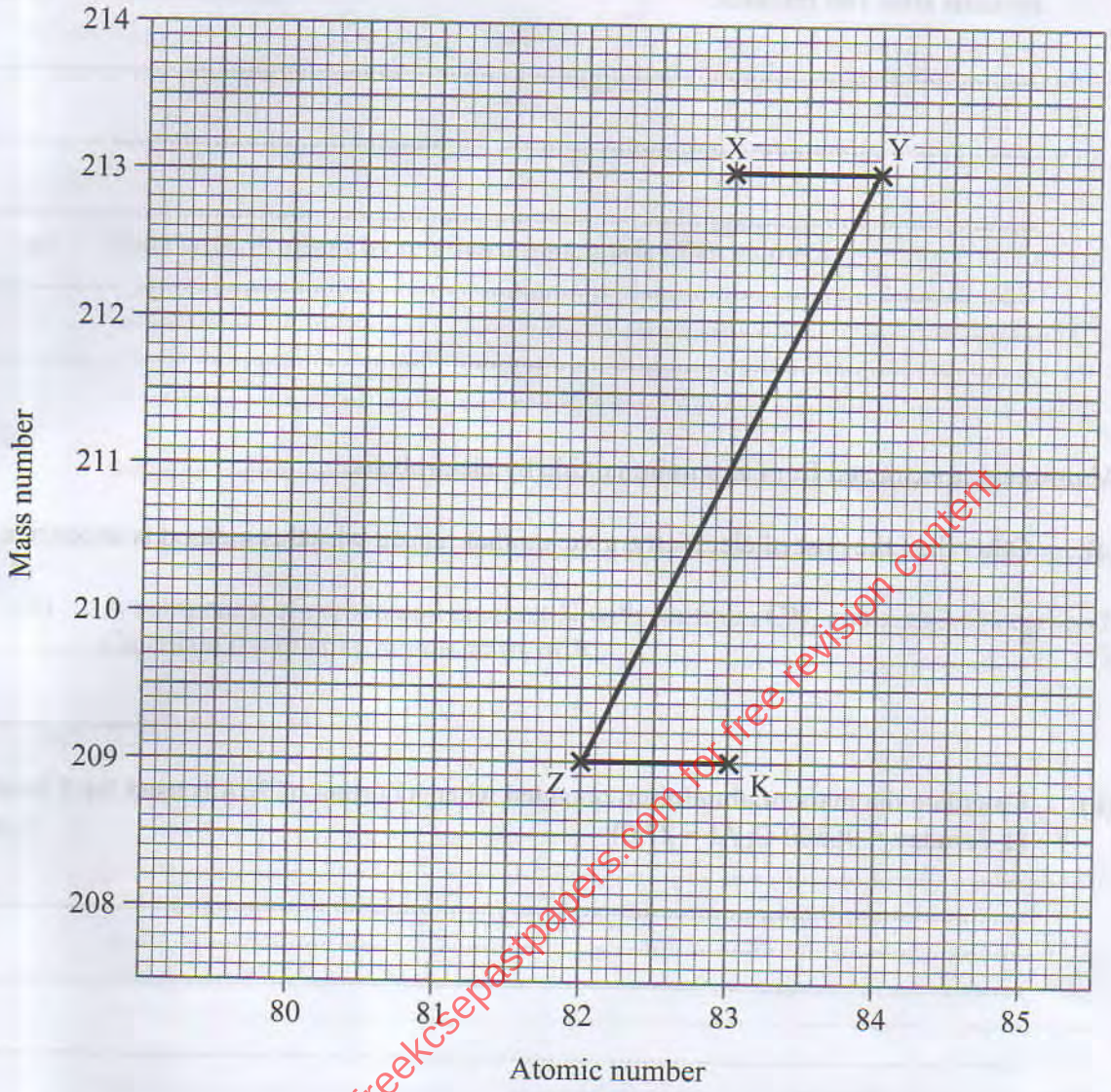


**Figure 5**

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(a) Write a nuclear equation for the formation of nuclide **K** from nuclide **X**. (1 mark)

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(b) The half-life of nuclide **X** is 47 minutes. Determine the percentage of nuclide **X** that remains after 188 minutes. (2 marks)

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**21.** Aluminium is extracted from aluminium oxide by electrolysis.

(a) Other than the cost of electricity, give another reason why this method is expensive. (1 mark)

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(b) Calculate the mass of aluminium obtained when a current of 20A is used for 5 hours. (1 Faraday = 96500 C; Al = 27.0) (2 marks)

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**22.** Explain each of the following observations:

(a) Articles made of copper turn green when left exposed in air over a long period of time. (1 mark)

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(b) Addition of aqueous ammonia to a solution containing copper(II) ions produces a deep blue solution. (1 mark)

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**23.** (a) State what is meant by relative atomic mass of an element. (1 mark)

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(b) A compound of carbon and element **X** with formula, $CX_4$ contains 3.6% carbon by mass. Calculate the relative atomic mass of **X**. (2 marks)

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**24.** Carbon(II) oxide can be prepared by dehydration of ethanedioic acid.

(a) Complete the following equation to show the reaction that takes place. (1 mark)

$H_2C_2O_4 \rightarrow$

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(b) Name another reagent that can be used to prepare carbon(II) oxide by dehydration. (1 mark)

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**25.** **Figure 6** shows an incomplete diagram of a setup for laboratory preparation of nitrogen gas.

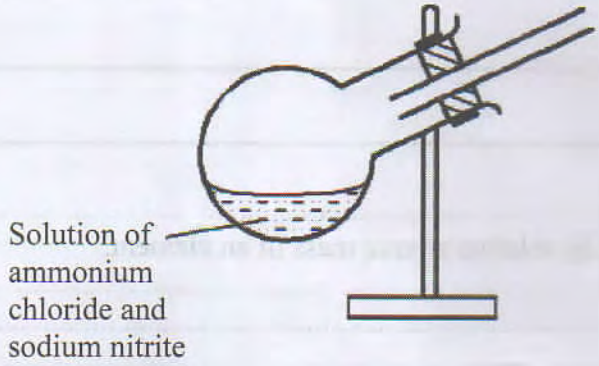


**Figure 6**

(a) Complete the setup in **Figure 6** to show how nitrogen gas can be collected. (2 marks)

(b) The nitrogen prepared using this setup is purer than that obtained from air. Give a reason. (1 mark)

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**26.** Hydrazine, $\mathbf{H-\underset{|}{N}-\underset{|}{N}-H}$ is used as a fuel in rockets. Using the bond energies in **Table 2**, calculate the enthalpy change for combustion of hydrazine.

$N_2H_4(l) + O_2(g) \rightarrow N_2(g) + 2H_2O(g)$

**Table 2**

| Bond | Bond Energy kJ/mol |
|---|---|
| N — H | 388 |
| N — N | 163 |
| O = O | 496 |
| N ≡ N | 944 |
| O — H | 463 |

(3 marks)

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27. (a) **Table 3** gives the standard reduction potentials of some group VII elements.

**Table 3**

| Reduction equations | E°/V |
|---|---|
| $Cl_2 + 2e \rightarrow 2Cl^-$ | +1.36 |
| $Br_2 + 2e \rightarrow 2Br^-$ | +1.07 |
| $I_2 + 2e \rightarrow 21^-$ | +0.54 |

State and explain the reactions that take place when aqueous bromine is added to a sample of sea water containing both chloride and iodide ions. (2 marks)

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(b) Give a reason why potassium iodide is added to table salt. (1 mark)

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