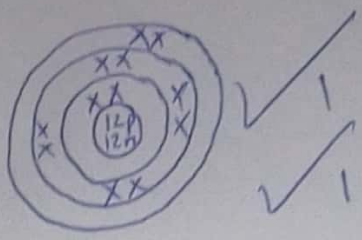
1. (a) Draw a labelled diagram showing the atomic structure of $^{24}_{12}Mg$. (2 marks)

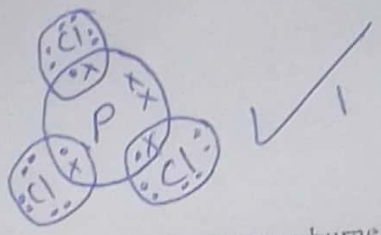
12 2.8.2



✓1 ✓1 (2)

(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)

2.8.5
2.8.7 PCl_3



✓1 (1)

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

when the air hole is closed ✓1 (1)

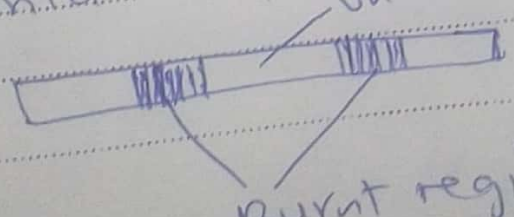
(b) Write an equation for the reaction that takes place in a luminous flame assuming the laboratory gas is butane. (1 mark)

$2C_4H_{10} + 9O_2 \rightarrow 8CO + 10H_2O$ ✓1✓1 (1)

(g) (g) (g)

(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)

Lower the wooden splint to the middle of the flame ✓1 (1)



06

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)

Aluminium ✓½
Aluminium has the highest number of delocalised electrons // Has 3 delocalised electrons ✓½

01

(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	Chlorine gas ✓½	Hydrogen gas ✓½
Molten sodium chloride	Chlorine gas ✓½	Sodium ✓½

02

(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)

- solid darts and melts ✓½
- Yellow flame is produce. ✓½

01

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

The solution turns pink ✓½ - NaOH formed is alkaline/basic in nature ✓½

01

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

K is very reactive hence explosive ✓1

1

06

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

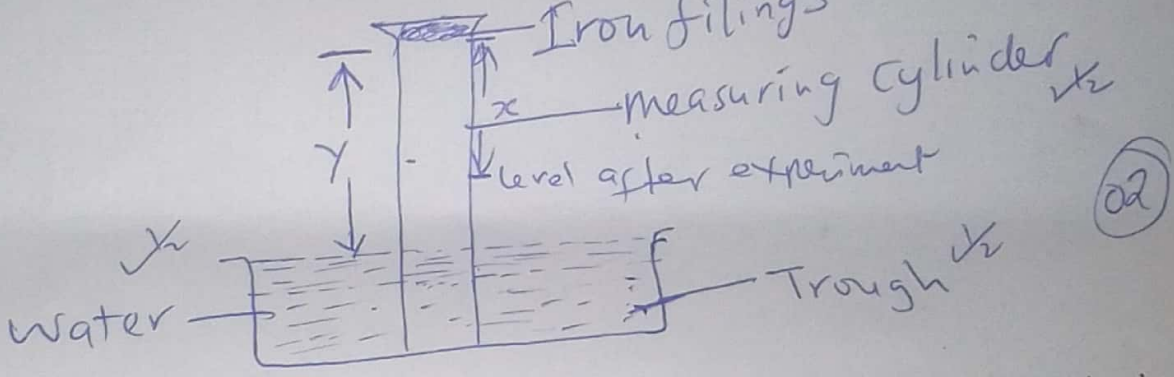
03

- Heat copper wire in presence of oxygen to produce copper(II) oxide. ½
- Add excess CuO to warm dilute HNO_3 ½ ½
- filter to obtain filtrate of $Cu(NO_3)_2$ and excess CuO as residue ½ ½
- Evaporate the filtrate to saturation ½ ½
- ~~Rinse and dry~~ cool to obtain crystals of $Cu(NO_3)_2$

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

(2 mar

(a) Draw a setup of the experiment.



02

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

$\frac{Y-X}{Y} \times 100$ ✓1

01

06

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

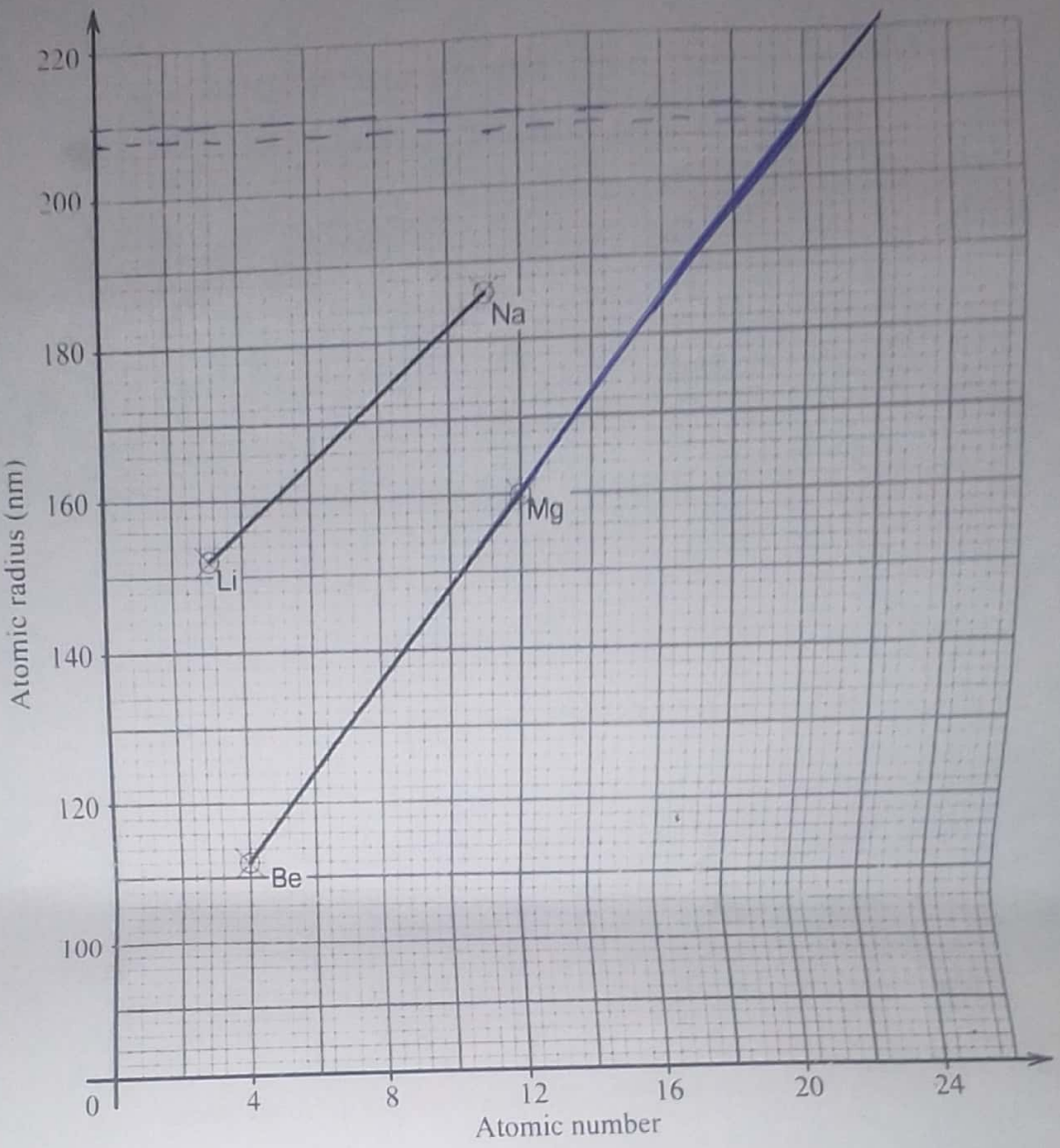


Figure 1

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

(i) lithium. (1 mark)

Sodium has more number of energy Levels than lithium (1)

(ii) magnesium (1 mark)

magnesium has more protons/nuclear charge than Na hence greater nuclear attraction making Mg smaller (1 mar

(b) Predict the atomic radius of calcium.

210nM ✓1 (1)

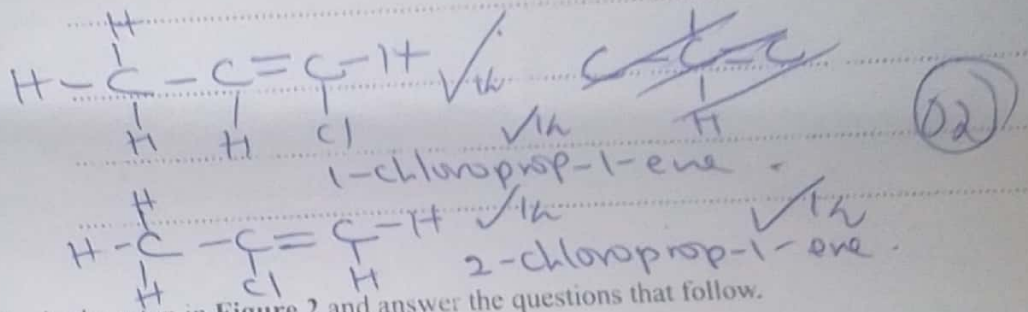
8. Compound **D** with formula, C_3H_4, was reacted with excess hydrogen chloride gas. (1 mar

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

propyne // prop-1-yne ✓1 (01)

(2 mar

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



(02)

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

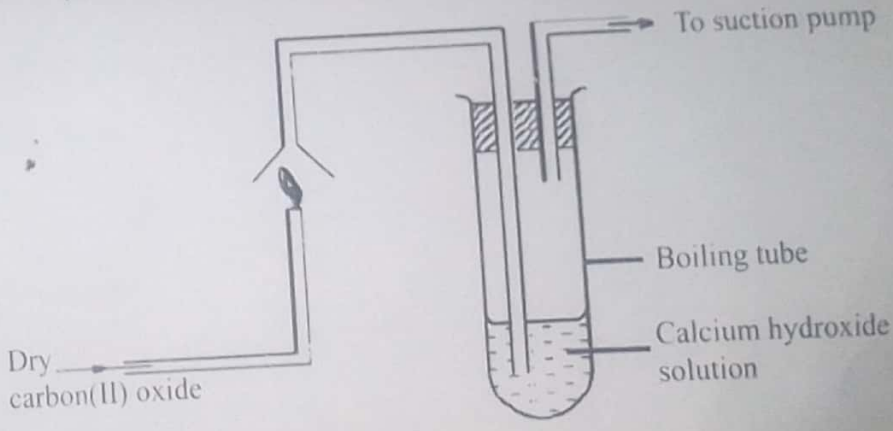


Figure 2

$CO + O_2 \rightarrow CO_2$.

05

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

Experiment should be done in ~~open air~~ ✓ 1/2
a fume chamber ✓ 1/2 (01)
CO is poisonous ✓ 1/2

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

white precipitate ✓1 is formed which further dissolves to form a colourless solution ✓1 in excess CO_2 gas (02)

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)

$\frac{+92.4}{2} = +46.2\ kJ\ mol^{-1}$ ✓1 (01)

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

(i) Increase in temperature. (1 mark) (01)

Lower ✓½ its yield since forward ✓½ reaction is exothermic thus breaks NH_3 to form N_2 and H_2.

(ii) Finely divided iron. (1 mark) (01)

No effect ✓½ on its yield; ✓½ catalyst do not affect equilibrium but only alter the rate of reaction.

06

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

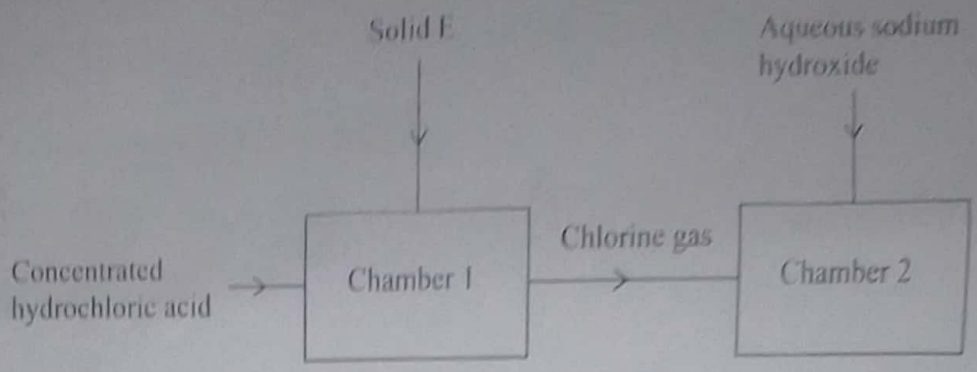


Figure 3

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

PbO_2 // MnO_2 // $KMnO_4$ ✓1

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

Redox reaction ✓1

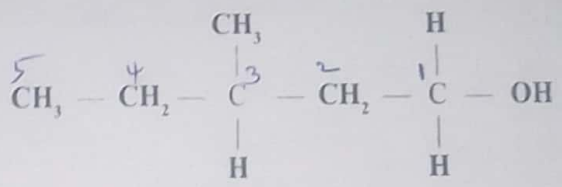
03

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

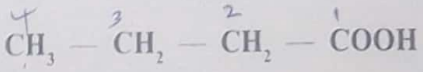
$NaOH + Cl_2 \longrightarrow NaCl + NaOCl$ ✓1

(aq) (g) (aq) (aq)

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



Compound **H**



Compound **J**

(a) Give the names of:

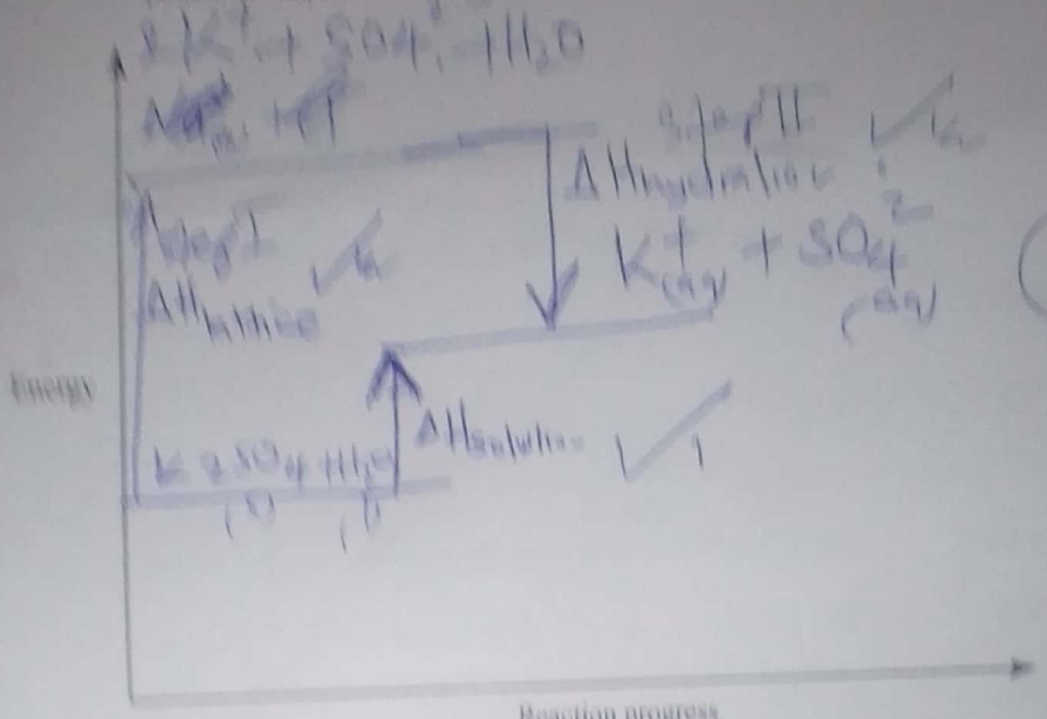
(i) Compound **H**. (1 mark)

3-methylpentanol ✓1

04

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)

(a) State Gay-Lussac's law. (1 mark)

when gases react they do so in volumes that bear a simple ratio to one another and to the volume of product if gaseous, temperature and pressure remaining constant ✓1 (01)

(b) 180 cm³ of nitrogen(II) oxide gas was reacted with 400 cm³ of oxygen gas.

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

$2NO + O_2 \rightarrow 2NO_2$ ✓1 (01)

180(g) 360(g) 180(g)

(90×2) 90 90×2

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

Unreacted oxygen = 400 − 90 = 310 ✓1

Product (NO_2) = 90×2 = 180 ✓1

Total volume = 310 + 180

= 490 cm^3 ✓1 (03)

05

16. Describe how the setup in **Figure 4** can be used to distinguish between 50.0cm³ of 0.2M hydrochloric acid and 50.0cm³ of 0.2M ethanoic acid using pieces of 6m length of magnesium ribbon and a stop watch. (3 marks)

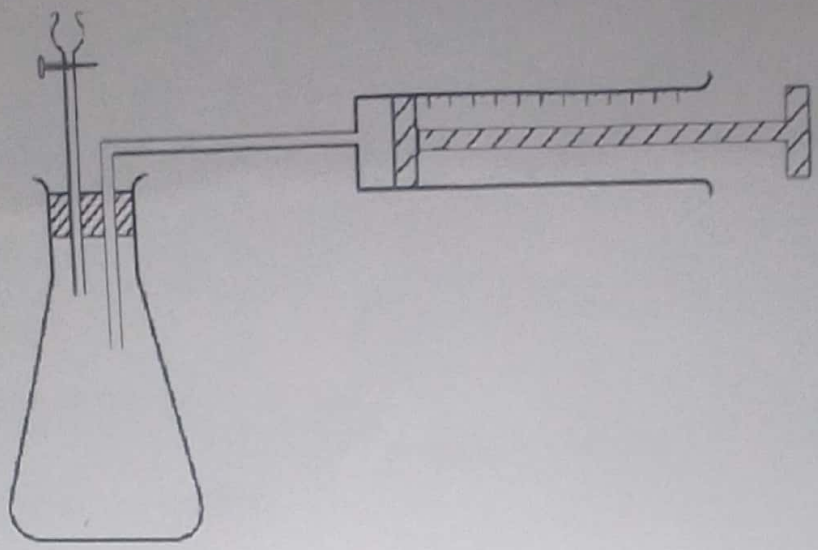


Figure 4

03

Using a stopwatch determine time taken for reaction to be complete in each case. ✓1
0.2M HCl takes the ~~shortest~~ shorter time for maximum volume of H_2 to be collected in the syringe since it has more H^+ to react with Mg to form H_2 and Mg^{2+} ✓1 on the other hand CH_3COOH being a weaker acid takes longer period of time for the reaction to be complete since it has less H^+ to react with Mg to form Mg^{2+} and H_2 gas. ✓1

03

03

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)

Add acid to each test tube; place litmus paper at mouth of test tube during effervescence; gas evolve using moist blue litmus paper

Na_2CO_3 will evolve gas that turns moist blue litmus paper red. while Na_2SO_3 will evolve gas that turns moist blue litmus paper red then white due to bleaching

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

- Crush sunflower then add propanone to dissolve the oil;
- Decant to obtain a mixture of oil and propanone in evaporating dish
- place the mixture in sunlight so that propanone evaporates and leaves oil

02

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

NaOH reacts with oil to produce a detergent (soap)

01

06

19. 31.5cm³ of concentrated nitric(V) acid was diluted to 500cm³. 10.0cm³ of the dilute acid required 25.0cm³ of 0.4 M sodium hydroxide for neutralisation.

(a) Calculate concentration of the:

(i) dilute acid. $NaOH_{(aq)} + HNO_{3(aq)} \rightarrow NaNO_{3(aq)} + H_2O_{(l)}$ (1 mark)

moles = $MV/1000 = \frac{25 \times 0.4}{1000} = \frac{10}{1000} = 0.01$ moles.

moles of NaOH

moles of $HNO_3 = 0.01$ moles

$M = \frac{1000 \times \text{moles}}{V}$

$= \frac{1000 \times 0.01}{10} = 1M$

$M_1V_1 = M_2V_2$ ✓ε (01)

$10M_1 = 0.4 \times 25$ ✓ε

$M_1 = \frac{0.4 \times 25}{10} = 1M$ ✓ε

(1 mark)

(ii) concentrated acid.

$M_1V_1 = M_2V_2$ ✓k

$31.5M_1 = 500 \times 1$ (01)

$M_1 = 500/31.5 = 15.87M$ ✓k

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

To 300cm³ of distilled water, add little by little concentrated HNO_3, ~~upto~~ upto volume of acid required, transfer to 500ml volumetric flask and top with water to zero mark ✓1 (01)

03

Figure 5 shows part of a radioactive decay series.

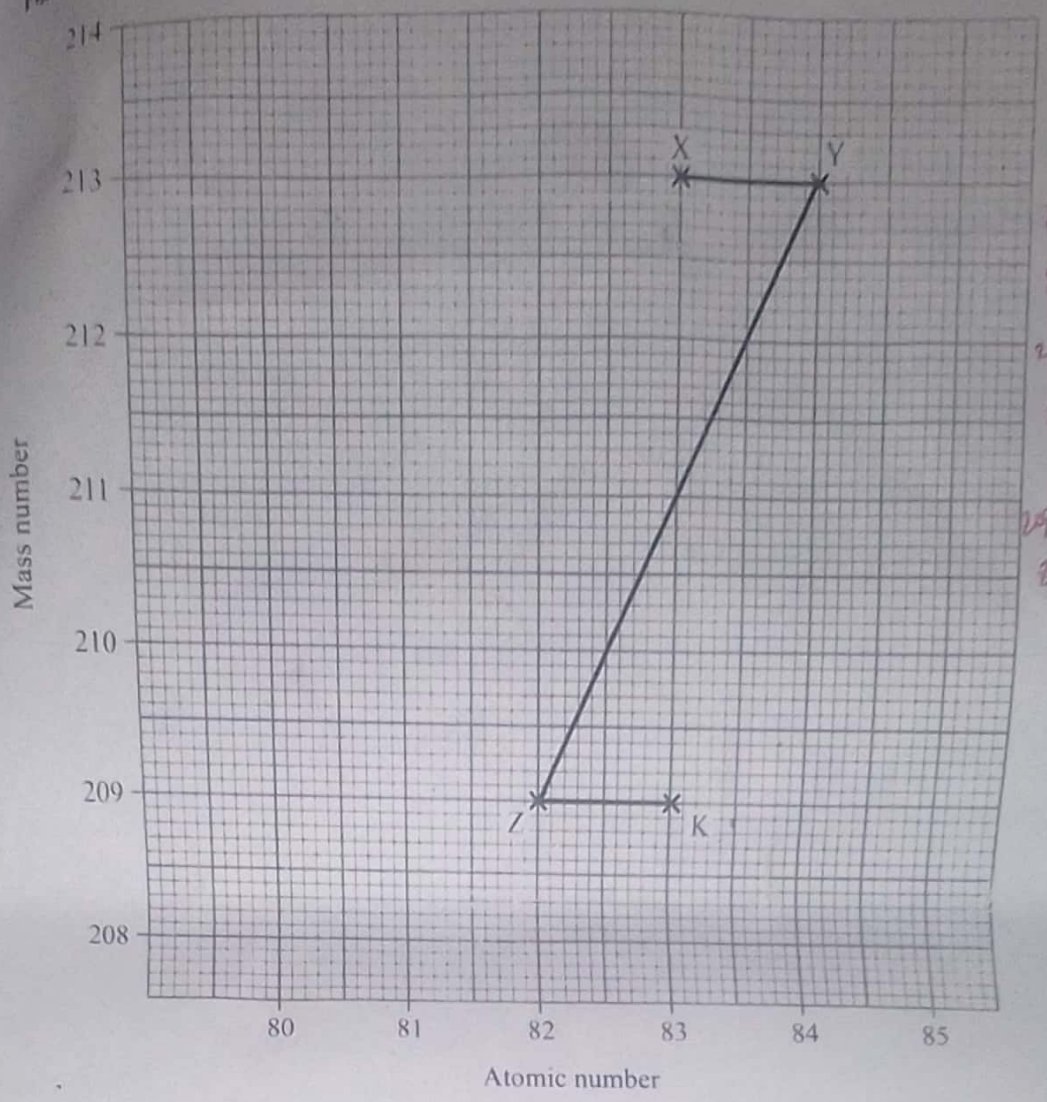


Figure 5

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

Turn over

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

$n = \frac{188}{47} = 4$ ✓½

$\frac{N}{N_0} = (\frac{1}{2})^n$

$= (\frac{1}{2})^4 = \frac{1}{4} \times \frac{1}{4} = \frac{1}{16}$ ✓½

$N/N_0 = \frac{1}{16} \times 100 = 6.25\%$ ✓½

02

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)

Carbon (graphite) reacts with oxygen hence need to be replaced after sometime ✓1

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

$Q = It$

$= 20 \times 5 \times 60 \times 60$ ✓1/2

$= 100 \times 3600 = 360,000C$

Al3+ $1mol = 3 \times 96500 = 289500C$ → 27g

$360,000C$ = ?

$\frac{360000 \times 27}{289500}$ ✓1/2 $= 33.575$ ✓1 g

Molar Mass = FeM

$m = \frac{Q \times molar\ mass}{eF}$

$= \frac{360,000 \times 27}{289500}$ ✓1

$= 33.575$ ✓1 g

02

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)

Articles are made of alloy containing Cu and Fe, Fe reacts with moisture to form Fe^{2+} which is green.

06

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

Cu^{2+} reacts to form a blue precipitate of $Cu(OH)_2$ which further reacts with aq NH_3 to produce tetramine copper(II) ions ✓1 (1)

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

Mass of atom of an element compared to C-12. ✓1 (1)

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)

	C	X
% mass	3.6	96.4
RAM	12	W
Moles	$\frac{3.6}{12}$ 0.3	$\frac{96.4}{W}$
Mole ratio	$\frac{0.3}{0.3}=1$	$\frac{96.4}{W}\div\frac{0.3}{0.3}=4$ ✓1

$\frac{96.4}{W}=4\times0.3$

$96.4=1.2W$ ✓½

$\frac{96.4}{1.2}=\frac{1.2W}{1.2}$

$W=\frac{964}{12}$ ✓½

$=80.33$ (02)

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)

$H_2C_2O_4 \rightarrow CO + CO_2 + H_2O$ ✓1

(s) (g) (g) (l) (1)

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

Methanoic acid ✓1 (1)

Turn over

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)

The one obtain from air contain argon

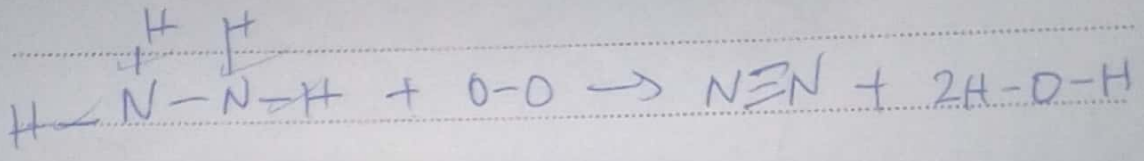
26. Hydrazine, $H-\underset{H}{\underset{|}{N}}-\underset{H}{\underset{|}{N}}-H$ is used as a fuel in rockets. Using the bond energies in **Table 2**, calculate the enthalpy change for combustion of hydrazine.

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

Table 2

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

(3 marks)



Bond breaking

$(4 N-H + N-N) + (O=O)$

$(4 \times 388) + (163) + (496)$

$1552 + 659$

$+2211$ ✓4

Bond formation

$N \equiv N + 2\,O-H$

$-944 + (2 \times -463)$

$-944 - 926$

-1870 ✓1

Enthalpy = Bond breaking + Bond formation

$= +2211 + (-1870)$ ✓1

$= +341\ KJmol^{-1}$ ✓1

03

03

Turn over

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
$I_2 + 2e \rightarrow 2I^-$	+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)

Brown liquid disappears/- diminishes a ✓½
grey deposits are formed. ✓½ (02)
Br_2 undergoes reduction ✓½ while I^-
undergoes oxidation ✓½ and no effect i- Cl^-
Since Cl^- has higher positive E°.

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

To provide Iodide ion necessary to
prevent goitre. ✓1 (01)

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03.