

1. An atom of element A has mass number 39 and 19 protons.

(a) Write the electron arrangement of the atom. (1 mark)

2.8.8.1 ✓ / 2, 8, 8, 1 } 2-8-8-1 01

(b) State the period and group to which element A belongs.

Group I / one ✓ / accept 1 1/2 (1/2 mark)

Period 4 / four ✓ / accept IV 1/2 (1/2 mark)

(c) State whether the element is a metal or a non-metal. (1 mark)

Metal ✓ 01

2. Describe how an increase in concentration increases the rate of a reaction. (2 marks)

As the concentration increases, the number of reacting particles per unit volume increases, thus effective collisions. This leads to increase in rate of reaction.

3. The flow chart in Figure 1 represents some stages in the extraction of copper metal. Study it and answer the questions that follow.

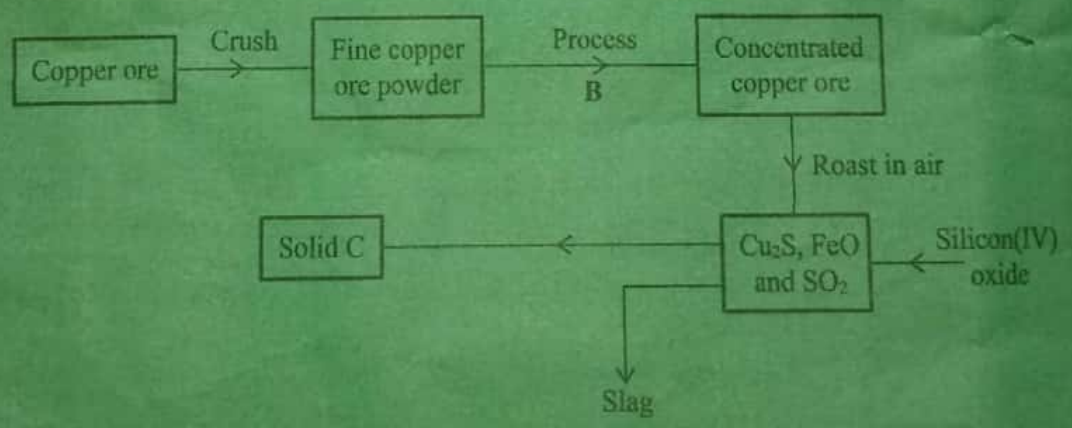


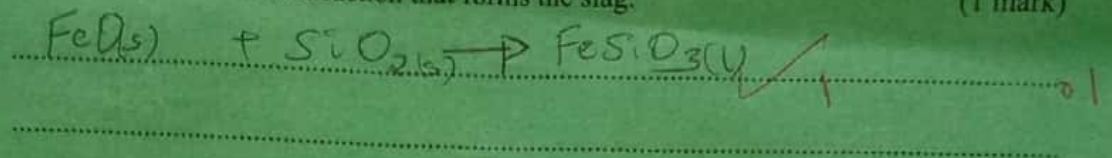
Figure 1

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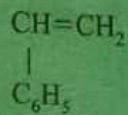
(a) Identify:

- (i) the copper ore Copper pyrites /  $CuFeS_2$  (1 mark) 01
- (ii) process B froth floatation (½ mark) ½
- (iii) solid C Copper(I) sulphide ( $Cu_2S$ ) (½ mark) ½

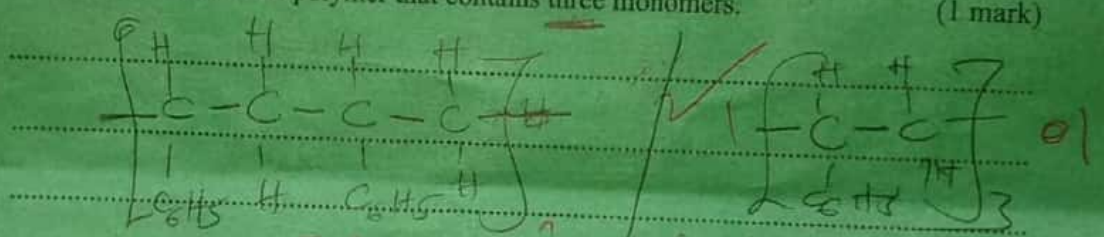
(b) Write an equation for the reaction that forms the slag. (1 mark)



4. A monomer has the following structure.



(a) Draw the structure of its polymer that contains three monomers. (1 mark)



(b) A sample of the polymer formed from the monomer has a molecular mass of 4992. Determine the number of monomers that formed the polymer (C=12; H=1.0). (2 marks)

RFM of Monomer =  $(8 \times 12) + 8 = 96 + 8 = 104$  01

RFM of polymer = 4992

Consequently  
number of monomers =  $\frac{4992}{104} = 48$  02

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5. Hydrogen gas can be prepared by passing steam over heated magnesium ribbon as shown in Figure 2.

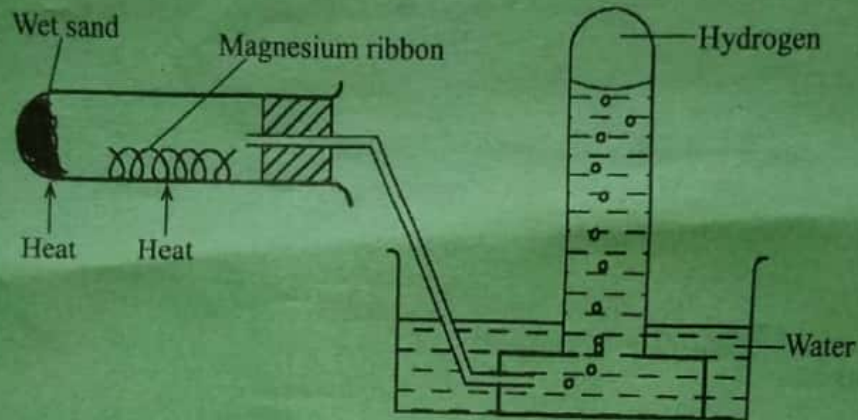
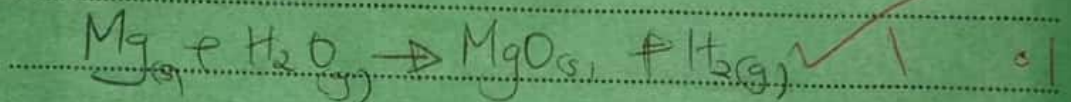


Figure 2

- (a) Write an equation for the reaction that produces hydrogen gas. (1 mark)



- (b) Explain why the delivery tube must be removed from beneath the water before heating is stopped. (1 mark)

To prevent suck-back of water which would break the boiling tube.

- (c) Explain why sodium metal is not suitable for this experiment. (1 mark)

Sodium is very reactive and reacts explosively with steam.

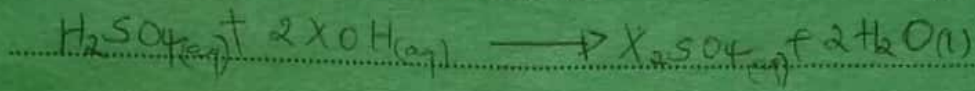
6. A farmer intended to plant cabbages in his farm. He first tested the pH of the soil and found it to be 3.0. If cabbages do well in alkaline soils, explain the advice that would be given to the farmer in order to realise a high yield. (2 marks)

Add calcium oxide to raise the soil pH. Calcium oxide is a basic oxide hence dissolves in water in the soil to form alkaline solution that reacts with acidic soil and raises soil pH.

7. A solution contains 40.3 g of substance XOH per litre. 25.0 cm<sup>3</sup> of this solution required 30.0 cm<sup>3</sup> of 0.3 M sulphuric(VI) acid for complete neutralisation.

(a) Calculate the number of moles of XOH that reacted.

(½ mark)



$$\text{moles of H}_2\text{SO}_4 = \frac{30 \times 0.3}{1000} = 0.009 \text{ moles}$$

$$\text{moles of XOH} = (2 \times 0.009) = 0.018 \text{ moles}$$

(b) Determine the relative atomic mass of X.

(1½ marks)

$$\text{molarity of XOH} = \frac{0.018 \times 1000}{25} = 0.72 \text{ M}$$

$$\text{RFM} = \frac{\text{mass per litre}}{\text{molarity}} = \frac{40.3}{0.72} = 55.972$$

$$2 \times 16 + 1 = 56$$

$$x = 39$$

8. Table 1 shows the properties of two chlorides, D and E.

Table 1

Chlorides	Melting points (°C)	Electrical conductivity (liquid)
D	1074	Good
E	203	Poor

(a) State the type of bond present in:

(i) D ionic / electrovalent (1 mark)

(ii) E covalent / van der Waals forces (1 mark)

- (b) Explain in terms of structure and bonding, the difference in electrical conductivity of the chlorides D and E. (1 mark)

D giant ionic when in molten state the ions are mobile hence conducts electric current. E is giant molecular and therefore does not have mobile ions.

9. Sulphur(IV) oxide is prepared in the laboratory using the set-up in Figure 3. Study it and answer the questions that follow.

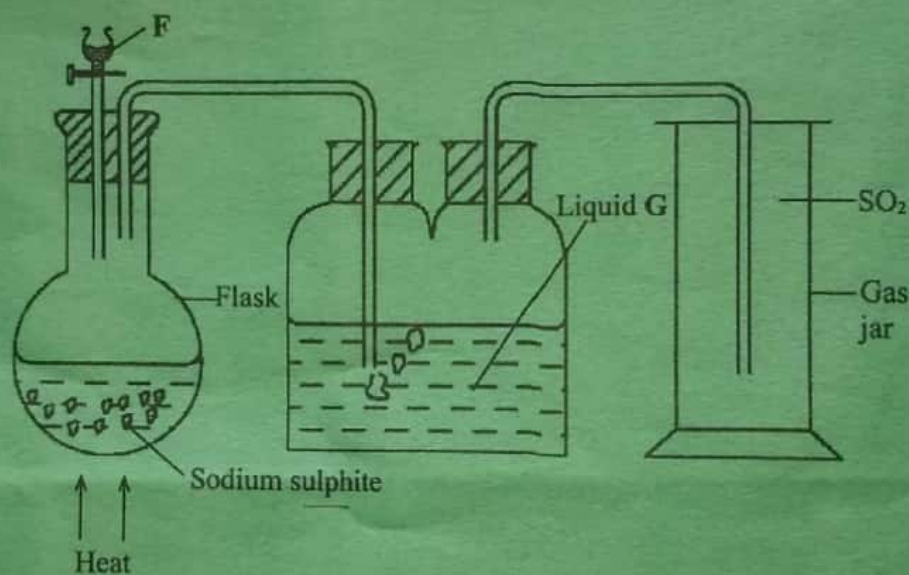
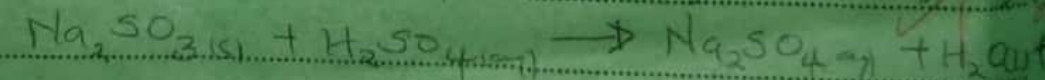
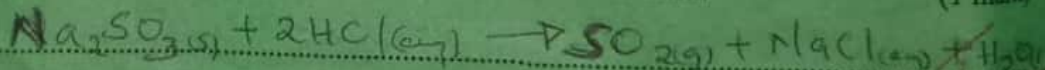


Figure 3

- (a) Identify substance F. (1 mark)

HCl / Dilute hydrochloric acid / Dilute HCl acid

- (b) Write an equation for the reaction that takes place in the flask. (1 mark)



- (c) State the purpose of liquid G. (1 mark)

To dry the gas

10. The graph in Figure 4 was obtained when a certain substance was heated and its temperature recorded at regular intervals.

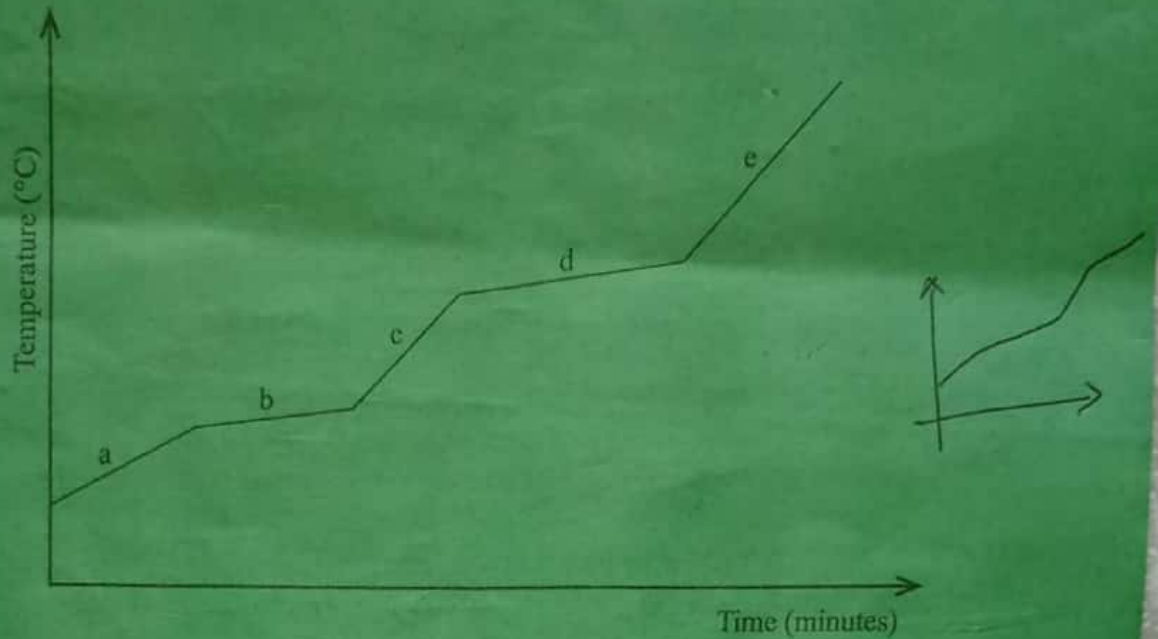


Figure 4

- (a) State the purity of the substance. (1 mark)

Impure ✓

- (b) Explain the answer in (a). (1 mark)

The substance does not have a sharp M.P or B.P. ✓

- II. Ethene is prepared in the laboratory by dehydration of ethanol.

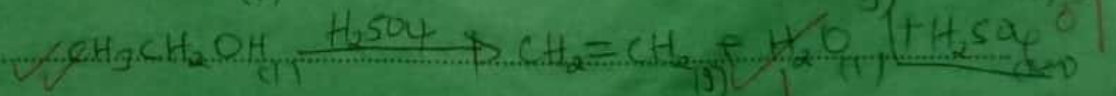
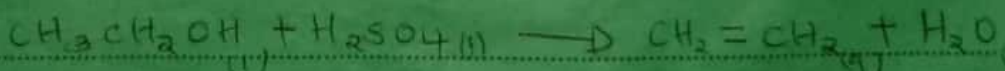
- (a) Name a suitable dehydrating agent used in this process. (1 mark)

Concentrated sulphuric (VI) acid ✓  
 Ref: H<sub>2</sub>SO<sub>4</sub>(aq)

- (b) State the condition necessary for the reaction to occur. (1 mark)

Temperature 160°C - 180°C ✓  
 Ref: Dilute H<sub>2</sub>SO<sub>4</sub> / Al<sub>2</sub>O<sub>3</sub> / Phosphoric acid

- (c) Write an equation for the dehydration process. (1 mark)



12. A boiling tube filled with chlorine water was inverted in a trough containing the same solution and the set-up left in sunlight for about 2 hours.

(a) State the observations made in the boiling tube. (1 mark)

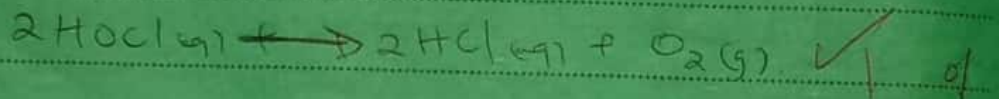
The colour of the solution changed from yellow to colourless.   
 - colourless gas collected.   
 // level of water drops in the tube

(b) Explain the observations made in (a). (1 mark)

Colourless gas collected.   
 The sunlight decomposed chlorine (l) acid to oxygen & hydrochloric acid.

Accept only Hypochlorous decomposed

(c) Write an equation for the reaction that occurred in the boiling tube. (1 mark)



13. 5g of calcium carbonate was strongly heated to a constant mass. Calculate the mass of the solid residue formed (Ca = 40.0; C = 12.0; O = 16.0). (2 marks)

$\text{CaCO}_3 \rightarrow \text{CaO} + \text{CO}_2$    
 mass = 2.8g   
 No of moles of  $\text{CaCO}_3 = \frac{5}{100} = 0.05$  moles   
 moles of  $\text{CaO} = 0.05$  moles   
 mass of  $\text{CaO} = 0.05 \times 56 = 2.8$ g

14. During laboratory preparation of oxygen, manganese(IV) oxide is added to reagent H.

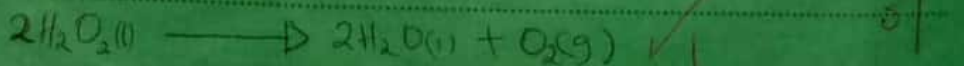
(a) Name reagent H. (1 mark)

Hydrogen peroxide  $\text{H}_2\text{O}_2$

(b) State the role of manganese(IV) oxide in this experiment. (1 mark)

to speed up the production of oxygen gas (catalyst)

(c) Write the equation for the reaction that takes place. (1 mark)



15. Figure 5 shows an apparatus used to separate a mixture of water and hexene.

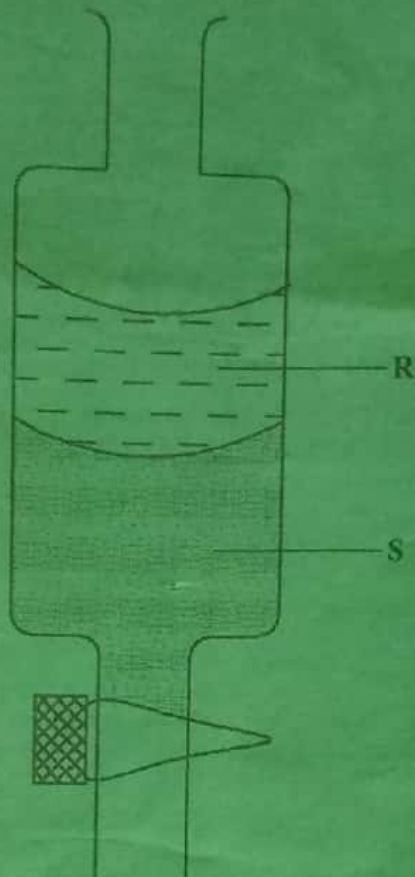


Figure 5

- (a) Name the apparatus in Figure 5. (1 mark)  
 Separating funnel // Dropping funnel 01
- (b) State the principle by which the mixture of the two liquids is separated. (1 mark)  
 Immiscibility // Different densities 01
- (c) Identify the liquids, R and S if the density of hexene is  $0.66 \text{ g/cm}^3$ .
- (i) R Hexene // Hexane (½ mark)
- (ii) S Water // Water (½ mark)



16. (a) Complete the following table.

(2 marks)

Solution	pH	Nature of solution
H	1.0	strong acid
I	7.0	Neutral
J	4.0 - 5.9	Weak acid
K	13.0	strong base

(b) Explain why a solution of ammonia in methylbenzene has no effects on red litmus paper while in aqueous ammonia red litmus paper turns blue. (1 mark)

In methylbenzene it is a molecular liquid does not dissociate, while it ionizes in water to form ions.

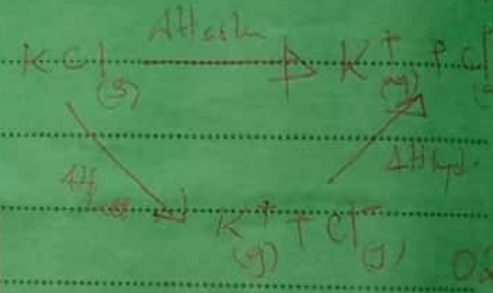
17. The heat of solution and hydration energy of potassium chloride is  $-17.2 \text{ kJ}$  and  $-689 \text{ kJ}$  respectively. Calculate the lattice energy of potassium chloride. (2 marks)

$$\Delta H_{\text{soln}} = \Delta H_{\text{lat}} + \Delta H_{\text{hyd}}$$

$$-17.2 \text{ kJ} = \Delta H_{\text{lat}} - 689 \text{ kJ}$$

$$\Delta H_{\text{lat}} = -17.2 + 689 \text{ kJ}$$

$$\Delta H_{\text{lat}} = +671.8 \text{ kJ}$$



18. Use the information in Table 2 to answer the questions that follow.

Table 2

Bond	Bond energy (kJ mol <sup>-1</sup> )
C-H	412
Cl-Cl	242
C-Cl	338
H-Cl	431

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- (a) State what is meant by heat of reaction. (1 mark)

The amount of heat energy evolved or absorbed during a chemical reaction between molar quantities of reactants.

- (b) Calculate the heat change when one mole of methane reacts completely with excess chlorine in the presence of UV light. (2 marks)



Bond breaking

$$4 \times 412$$

$$4 \times 242 = 968$$

$$\text{total} = +2616$$

Bond formation

$$4 \times -338$$

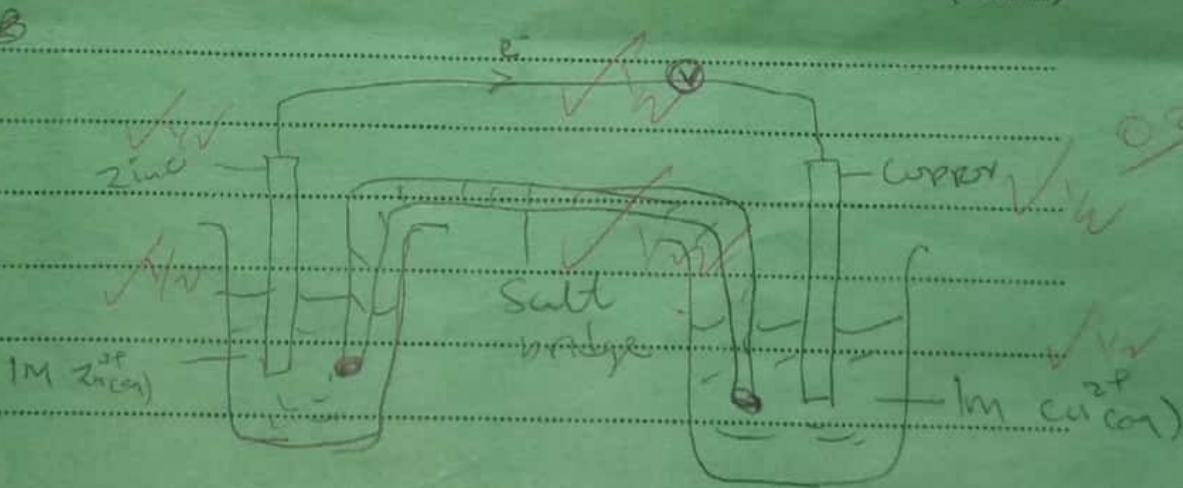
$$4 \times -431$$

$$\text{total} = -5076$$

$$\Delta H = +2616 + -5076$$

$$= -2460 \text{ J mol}^{-1}$$

19. Given that the  $E^\circ$  of  $\text{Cu(s)}/\text{Cu}^{2+}(\text{aq})$  is  $+0.34\text{V}$  and that of  $\text{Zn(s)}/\text{Zn}^{2+}(\text{aq})$  is  $-0.76\text{V}$ , draw a labelled diagram of zinc and copper electrochemical cell. (3 marks)

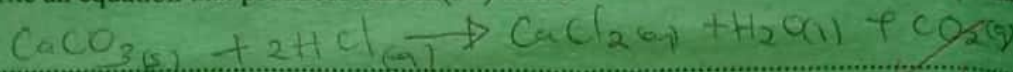


20. During laboratory preparation of carbon(IV) oxide gas, dilute hydrochloric acid was added to substance L in a conical flask.

(a) Identify substance L. (1 mark)

calcium carbonate ( $\text{CaCO}_3$ ) Marble chips

(b) Write an equation that produces carbon(IV) oxide. (1 mark)



(c) State the observations made when the gas produced was bubbled through calcium hydroxide solution for a long time. (1 mark)

white ppte formed dissolves in excess to form a colourless solution

21. Study the information in Table 3 and use it to answer the questions that follow.

Table 3

Elements	Na	Mg	Al	Si	P	S	Cl
Atomic numbers	11	12	13	14	15	16	17
Atomic radii (nm)	0.157	0.136	0.125	0.117	0.110	0.104	0.099

(a) Explain the trend in atomic radii from sodium to chlorine. (1 mark)

Atomic radii decreases across the period. Across the period the number of protons increasing the nuclear attraction for the electrons contributing to decrease in atomic radii.

(b) Explain how the chloride of aluminium differs from those of other metals in the period. (2 marks)

$\text{AlCl}_3$  is molecular. It differs from other metal chlorides because it exists as a dimer, two molecules of  $\text{AlCl}_3$  per through co-ordinate bonds while the other metal chlorides are ionic.

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$\text{AlCl}_3$  hydrolyses other do not hydrolyse  
 $\text{AlCl}_3$  sublimes while other metal chlorides do not  
 $\text{AlCl}_3$  is a Lewis acid

22. The diagram in Figure 6 shows radiations emitted by a radioactive sample.

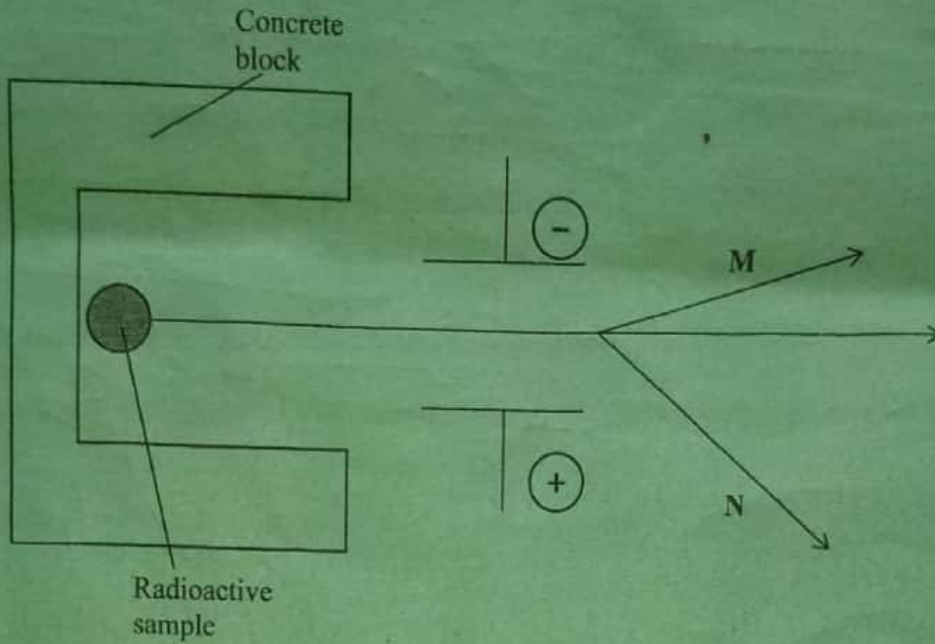


Figure 6

(a) Identify radiations:

(i) M ..... Alpha /  $\alpha$  ..... (1 mark)

(ii) N ..... Beta /  $\beta$  ..... (1 mark)

(b) Explain what would happen when a sheet of paper is placed in the path of the two radiations. (1 mark)

The alpha ( $\alpha$ ) particles will be stopped while  
( $\beta$ ) beta particles will penetrate the sheet of paper.

23.  $^{16}_8X$  and  $^{18}_8X$  are isotopes of element X. They occur naturally in the ratio of 9:1 respectively. Calculate the relative atomic mass of element X. (2 marks)

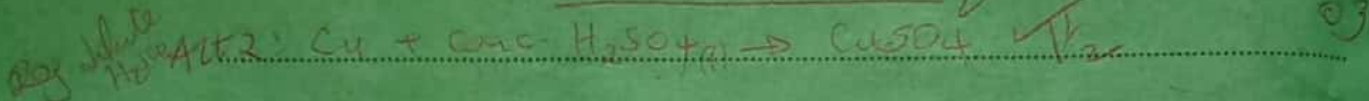
$$RAM = \left(\frac{9}{10} \times 16\right) + \left(\frac{1}{10} \times 18\right)$$

$$= 14.4 + 1.8$$

$$= 16.2$$

24. Starting with copper turnings, describe how a sample of copper(II) sulphate crystals can be prepared in the laboratory. (3 marks)

Ans 1 Heat copper turnings in air to form copper(II) oxide. Add dilute sulphuric(VI) acid. Filter to obtain copper(II) sulphate solution. Heat the solution to saturation and allow to cool for crystals to form. Dry between filter papers.



25. Chemical tests were carried out on separate samples of water drawn from the same source. The observations made were recorded as shown in Table 4.

Table 4

Test	Observation
(i) Addition of aqueous calcium chloride	No white precipitate
(ii) Addition of dilute sulphuric(VI) acid	No effervescence, colourless solution
(iii) Addition of a few drops of acidified barium nitrate	No white precipitate
(iv) Addition of aqueous ammonia	White precipitate dissolves

State the inferences made in reactions:

- (i)  $Pb^{2+}, Ag^+, SO_4^{2-}, CO_3^{2-}$  absent (1 mark)
- (ii)  $CO_3^{2-}, SO_4^{2-}, HCO_3^-$  absent (1 mark)
- (iii)  $SO_4^{2-}, S_2O_3^{2-}$  absent (1 mark)

26. 140 cm<sup>3</sup> of nitrogen gas diffuses through a membrane in 70 seconds. How long will it take 200 cm<sup>3</sup> of carbon(IV) oxide gas to diffuse through the same membrane under the same conditions of temperature and pressure. (3 marks)

Alt 1

Rate of diffusion  $N_2 = \frac{140}{70} = 2 \text{ cm}^3/\text{s}$

$$\frac{R_{N_2}}{R_{CO_2}} = \sqrt{\frac{M_{N_2}}{M_{CO_2}}} = 1.2575$$

$$R_{CO_2} = \frac{2}{1.2575} = 1.595$$

$$1.595 = \frac{200}{\text{Time}}$$

$$\text{Time} = \frac{200}{1.595} = 125.395 = 125.4 \text{ s}$$

Alt 2

140 cm<sup>3</sup> of  $N_2$  diffuses in 70 s

200 cm<sup>3</sup> of  $N_2$  diffuses in  $\frac{200}{140} \times 70 = 100 \text{ s}$

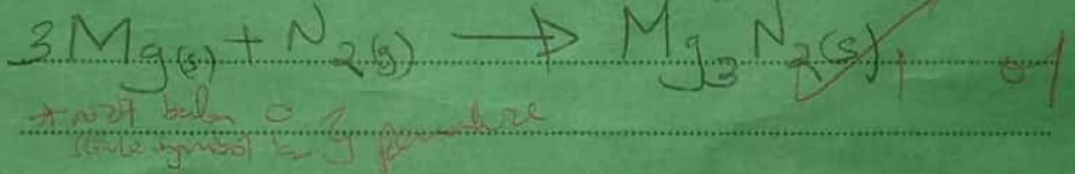
$$\frac{100}{R_{CO_2}} = \sqrt{\frac{M_{N_2}}{M_{CO_2}}}$$

$$100 = 0.7997 R_{CO_2}$$

$$R_{CO_2} = \frac{100}{0.7997} = 125.15$$

27. When burning magnesium ribbon is introduced into a gas jar full of nitrogen, it continues to burn producing a greenish yellow powder.

- (a) Write an equation for the reaction between nitrogen and magnesium. (1 mark)



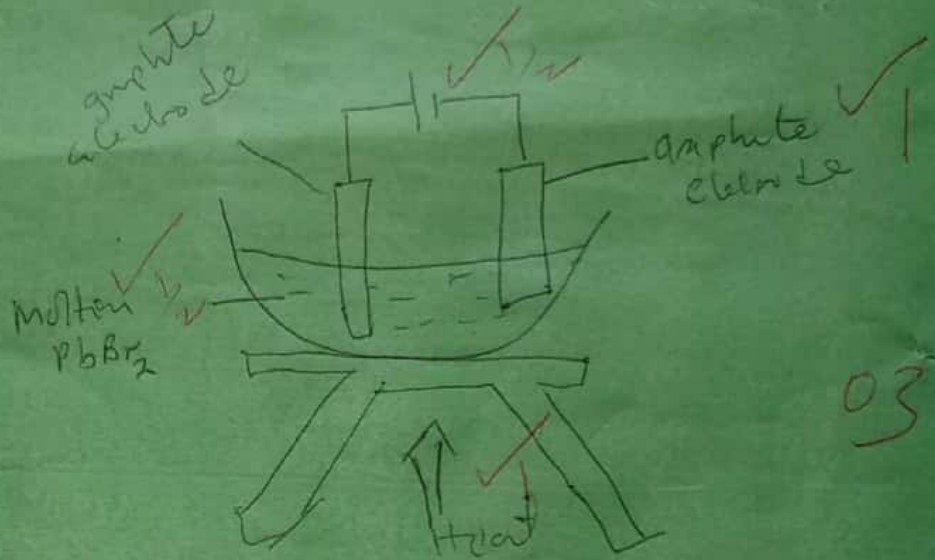
- (b) Explain why magnesium continues to burn in nitrogen but sulphur does not. (2 marks)

Burning Mg produces a lot of heat that is enough to break N-N triple bond hence it reacts with it while burning of sulphur produce little heat not enough to break N-N triple bond.

- (c) State one use of nitrogen. (1 mark)

- ✓ In refrigeration e.g. storage of some food
- ✓ Manufacture of ammonia: Haber process
- ✓ In light bulbs

28. Draw in the space provided a labelled diagram of the set-up of the apparatus that can be used to electrolyse molten lead(II) bromide. (3 marks)



29. Name an appropriate apparatus that is used to prepare standard solutions in the laboratory. (1 mark)

Volumetric flask

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