

MARKING SCHEME

Name.....Adm.No.....

Index No...../..... Class.....

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

SUKELLEMO JOINT EXAM

(The Kenya Certificate of Secondary Education)

233/1

CHEMISTRY

Paper 1

(Theory)

DECEMBER 2020

Time 2 Hours

Instructions to Candidates

1. Write your name, admission number, class and index number in the spaces provided above.
 2. Sign and write the date of the examination in the spaces provided
 3. Answer all the questions in the spaces provided.
 4. All working must be clearly shown.
 5. Non-programmable silent electronic calculators and KNEC mathematical tables may be used.
5. This paper consists of 12 printed pages. Candidates should check the question paper to ascertain that all the pages are printed as indicated and that no questions are missing.

For Examiner's Use only

Questions	Maximum score	Candidates score
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1 - 28	80	
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1. Explain how a burette is suited to its function of accurate measurement of volume of liquids

✓ **It is narrow for small meniscus / It is long for smaller calibrations** (1 mark)

2. A mixture of two liquids **A** and **B** with densities of 2.34g/cm^3 and 1.30g/cm^3 respectively is to be separated.

(i) Describe how to efficiently obtain liquid **B** from the mixture. (2 marks)

✓ **Place the mixture in a separating funnel ($\frac{1}{2}$ mk) ;allow it to settle.Open the tap and carefully let out the lower liquid **A** into a container ($\frac{1}{2}$ mk). Discard the interphase. ($\frac{1}{2}$ mk) .Liquid **B** remains in the separating funnel ($\frac{1}{2}$ mk)**

(ii) Name the type of mixture consisting of liquids **A** and **B** (1 mark)

✓ **Immiscible liquids**

3. Nitrogen (I)oxide gas can be prepared in the laboratory using a mixture of ammonium chloride solution and sodium nitrate solution.

(a) The reaction occurs in two steps. State the two steps in the correct order. (2 marks)

✓ **Ammonium chloride and sodium nitrate solutions react to form ammonium nitrate and sodium chloride** (1 mark)

✓ **Ammonium nitrate solution undergoes thermal decomposition to form nitrogen (I) oxide and water** (1 mark)

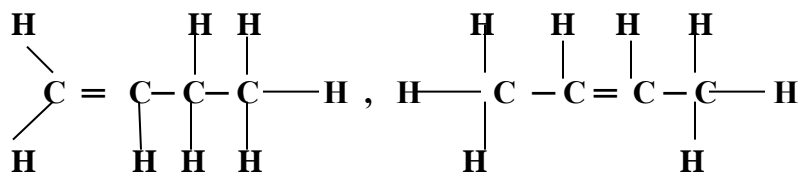
(b) State one use of nitrogen (I) oxide (1 mark)

✓ **Anaesthetic for dental surgery**

✓ **Produce flames for analytical work** (Any 1 x 1 mark)

✓ **An oxidizer in racing car engines**

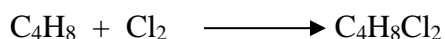
4.(a) Draw structural formulae of two positional isomers with molecular formula C_4H_8 .



(1 mark)

(1 mark)

(b) Study the equation below and answer the questions that follow.



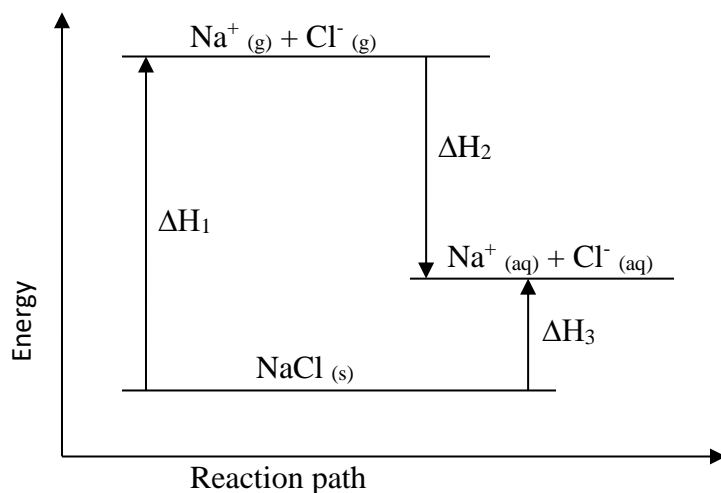
(i) State the condition under which this reaction occurs. (1 mark)

✓ **Room temperature** (1 mark)

(ii) Give the general name of this type of reaction. (1 mark)

✓ **Addition reaction** (1 mark)

5. The diagram below shows the energy changes that occur when sodium chloride dissolves in water. Study it and answer the questions that follow.



a) What do ΔH_1 , ΔH_2 and ΔH_3 represent? (1½ mark)

- ΔH_1 : Lattice energy (½ mk)
 ΔH_2 : Hydration energy (½ mk)
 ΔH_3 : Heat of solution (½ mk)

b) Given that the lattice energy of NaCl (s) is -776 kJmol^{-1} and hydration energies of $\text{Na}^+(\text{g})$ and $\text{Cl}^-(\text{g})$ are -407 kJmol^{-1} and -364 kJmol^{-1} respectively. Calculate the heat of solution (ΔH_{sol}) of 1 mole NaCl (s). (1½ mark)

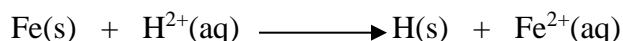
$$(\Delta H_{\text{sol}}) = \Delta H_1 + \Delta H_2$$

$$= 776 + (-407 - 364) \text{ (½ mk)} = + 5 \text{ kJmol}^{-1} \text{ (1 mk)}$$

6. The standard electrode potentials of a metal **H** and **Iron** are given below.



Is the reaction below possible? Show your working (2 marks)



$$\text{Emf} = -0.91 - (-0.44) = -0.47\text{V} \quad (1 \text{ mark})$$

The reaction is not possible (½ mk) since overall emf is negative (½ mk)

7. (a) Why is the percentage of carbon (IV) oxide in the atmosphere fairly constant? (1 mark)

- ✓ There is a balance between the processes that produce carbon (IV) oxide and processes that absorb it (1 mark)

(b) Calculate the volume of carbon(IV)oxide in $9,000 \text{ m}^3$ of air contained in a room. (2 marks)

$$9,000 \times 0.03/100 \quad (1 \text{ mark})$$

$$= 2.7 \text{ m}^3 \quad (1 \text{ mark})$$

8. State two applications of using impurities to lower the melting point of substances. (2 marks)

- ✓ Extraction of metals from their molten compounds/ores

✓ **Clearing of ice from roads in temperate countries**

9. a) Determine the percentage of nitrogen in ammonium nitrate fertilizer (N=14.0, H=1.0, O=16.0) (2 marks)

RMM of $\text{NH}_4\text{NO}_3 = 80$ (½ mk)

% N = $100 \times 28 / 80$ (1 mark) = 35 % (½ mk)

b) Give one negative effect of continuous use of nitrogenous fertilizers (1 mark)

- ✓ **Causes eutrophication/rapid growth of water plants (1 mark)**
- ✓ **Make soil acidic**

10. Study the table below and use it to answer the questions that follow. (The letters do not represent the actual symbols of the elements).

Element	S	P	Q	R	T
Atomic number	5	20	3	18	5
Atomic mass	10	40	7	40	11

(a) Select two letters that represent a pair of isotopes ? (1 mark)

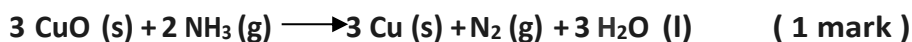
S and T (1 mark) Mark as a pair

(b) Give the number of neutrons in an atom of element T. (1 mark)

$11 - 5 = 6$ (1 mark)

11. Dry ammonia gas was passed over heated copper(II) oxide.

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



(b) Give the property of ammonia gas illustrated in the reaction above (1 mark)

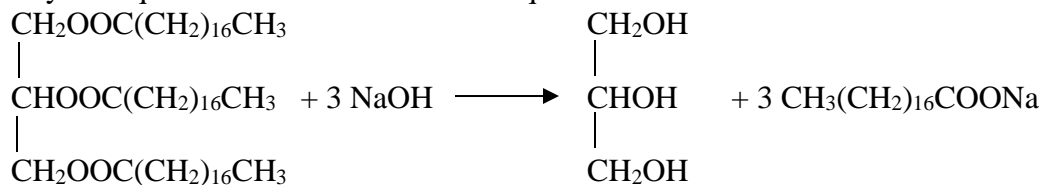
✓ **Reducing property (1 mark)**

(c) Write the formula of a gas that can be used in place of ammonia gas in the reaction above

CO / H₂

(1 mark)

12. Study the equation below and answer the questions that follow:

**X****Y****Z**

a) What type of reaction is this? (1 mark)

✓ **Hydrolysis** (1 mark)

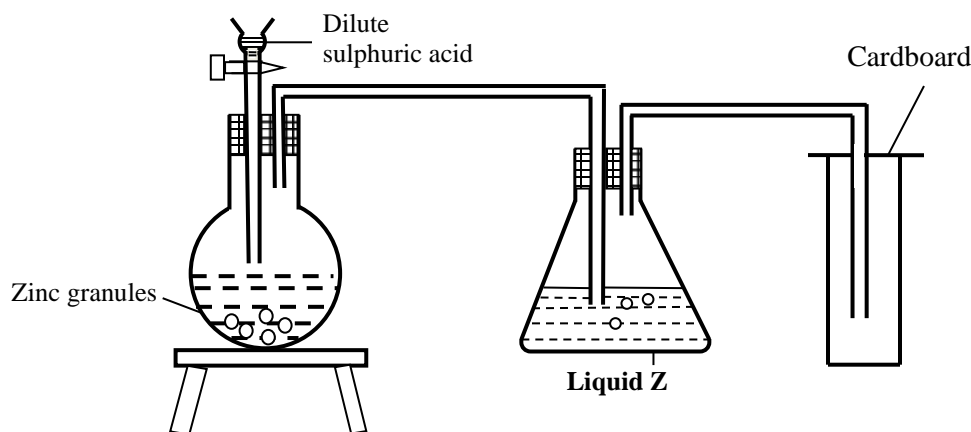
b) What class of organic compounds does **X** belong? (1 mark)

✓ **Esters** (1 mark)

c) Explain the role of sodium chloride in the manufacture of soap. (1 mark)

✓ **Precipitates /hardens soap (½ mk) by lowering its solubility glycerol (½ mk)**

13. The set up below was used to prepare dry hydrogen gas. Study it and answer the questions that follow.



(i) Identify one mistake in the set-up above. (1 mark)

✓ **The method of gas collection**

(ii) What is the role of Liquid **Z**? (1 mark)

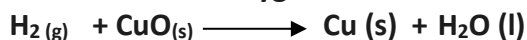
✓ **Absorbs moisture/water from hydrogen gas**

(iii) Using an equation give one chemical property of hydrogen gas (1 mark)

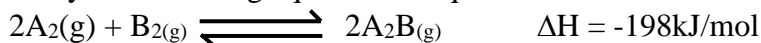
✓ **Burns in oxygen to form water**



✓ Removes oxygen from metals lower in the reactivity series



14. Study the following equilibrium equation.

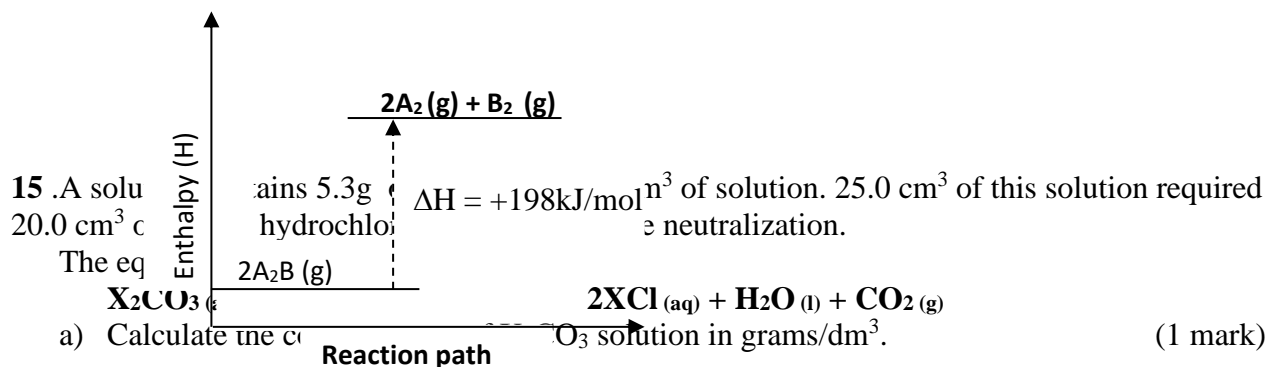


(a) Suggest two ways of increasing the yield of A_2B . (1 mark)

✓ Lowering temperature (1/2 mk)

✓ Increasing pressure (1/2 mk)

(b) Draw the energy level diagram for the backward reaction. (2 marks)



$$\begin{aligned} 5.3 \text{ g} &\longrightarrow 1000 \text{ cm}^3 \\ ? &\longrightarrow 1000 \text{ cm}^3 \\ ? &= \frac{5.3 \times 1000}{500} = 10.6 \text{ g/dm}^3 \quad (1/2 \text{ mk}) \end{aligned}$$

b) Find the molarity of X_2CO_3 solution. (1 mark)

$$\text{Moles of HCl} = \frac{20 \times 0.25}{1000} = 0.005 \quad (1/2 \text{ mk})$$

$$\text{Moles of } \text{X}_2\text{CO}_3 = \frac{0.005}{2} = 0.0025 \quad (1/2 \text{ mk})$$

$$\text{Molarity of } \text{X}_2\text{CO}_3 = \frac{0.0025 \times 1000}{25} = 0.1 \text{ M} \quad (1/2 \text{ mk})$$

c) Find the relative formula mass of X_2CO_3 hence calculate the relative atomic mass of X . (C = 12, O = 16) (2 marks)

$$\text{Formula mass} = \frac{10.6}{0.1} = 106 \quad (1/2 \text{ mk})$$

$$2X + 12 + 48 = 106 \quad (1/2 \text{ mk})$$

$$X = 23 \quad (1 \text{ mk})$$

16. (a) State Graham's law of diffusion. (1 mark)

At constant temperature and pressure, the rate of diffusion of a gas is inversely proportional to the square root of its density / molecular mass (1 mk)

(b) 100cm^3 of Carbon (IV) Oxide diffuses through a porous plate in 30 seconds. Calculate the time taken by 75cm^3 of Nitrogen (IV) Oxide to diffuse through the same plate under similar conditions. (C = 12, O = 16, N = 14) (2 marks)

$$75\text{cm}^3 \text{ of CO}_2 \text{ takes} = \frac{75 \times 30}{100} \text{ second } \checkmark^{1/2} = 22.5 \text{ s } \checkmark^{1/2}$$

$$\text{Rmm of CO}_2 = 12 + 2 \times 16 = 44 \checkmark^{1/2}$$

$$\text{Rmm of NO}_2 = 14 + 2 \times 16 = 46 \checkmark^{1/2}$$

$$\frac{T_{\text{NO}_2}}{T_{\text{CO}_2}} = \sqrt{\frac{M_{\text{NO}_2}}{M_{\text{CO}_2}}} \quad T_{\text{NO}_2} = 22.5 \sqrt{\frac{46}{44}} \text{ seconds } \checkmark^{1/2}$$

$$= 23.006\text{s } \checkmark^{1/2}$$

17. A student fetched water from a river in a limestone area. He used it for washing and realized that it did not lather easily. On boiling, the water lathered easily. When he added washing soda, it again lathered easily

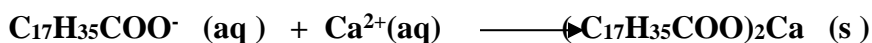
(i) Name two compounds that are most likely to be present in the water (1 mark)

✓ **Calcium hydrogen carbonate** $\checkmark^{1/2}$

✓ **Magnesium hydrogen carbonate** $\checkmark^{1/2}$

(ii) Given that the structure of soap is $\text{C}_{17}\text{H}_{35}\text{COONa}$.

Explain by means of ionic equation how the above compounds prevent lathering. (1 mark)



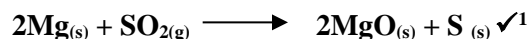
18. A student burnt magnesium ribbon in a gas jar full of sulphur (IV) oxide gas.

(i) State two observations made in the gas jar. (2 mark)

- **A yellow powder of sulphur was deposited** \checkmark^1

- **White solid of magnesium oxide is formed** \checkmark^1

(ii) Write an equation for the reaction that took place. (1 mark)



19. A radioactive isotope **M** decays by emitting two alpha and a beta particle to form ^{206}Y .

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a) What was the atomic number of **M** (1 mark)
Atomic number = 83 + 4 - 1 = 86 \checkmark^1

b) After 224 days $\frac{1}{16}$ of mass of **M** remained. Determine the half-life of **M**. (2 marks)

$$1 \xrightarrow{t_{1/2}} \frac{1}{2} \xrightarrow{t_{1/2}} \frac{1}{4} \xrightarrow{t_{1/2}} \frac{1}{8} \xrightarrow{t_{1/2}} \frac{1}{16} \quad \checkmark^{1/2}$$

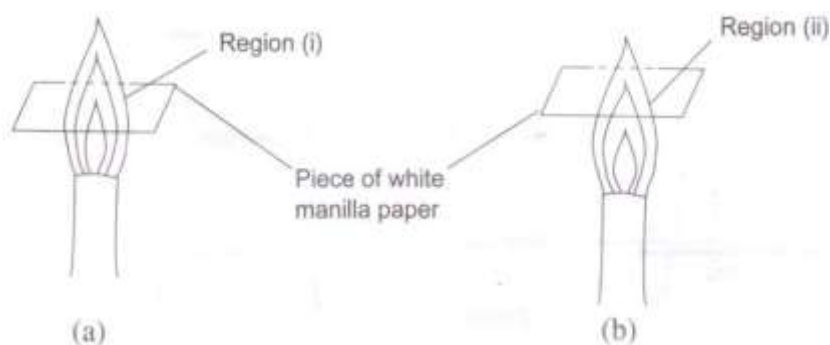
There are 4 $t_{1/2}$ $\checkmark^{1/2}$

$$4 t_{1/2} = 224 \quad \checkmark^{1/2}$$

$$t_{1/2} = 56 \text{ days} \quad \checkmark^{1/2}$$

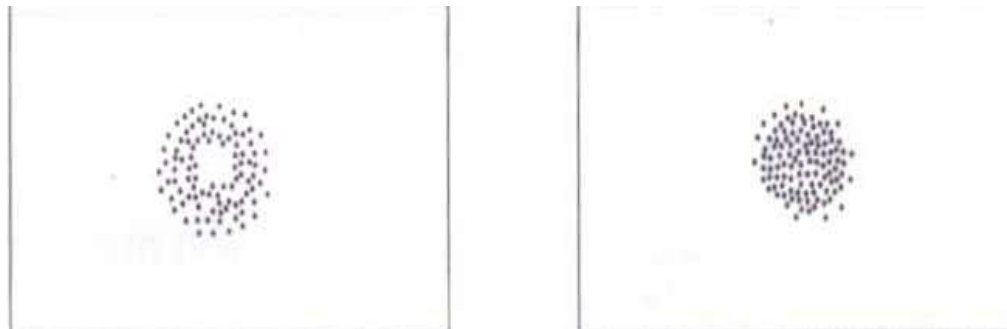
c) State one use of radioactivity in agriculture. (1 mark)
 \checkmark **Monitoring uptake of nutrients such as phosphates by plants (1 mark)**

20. (i) With the aid of a well labeled diagram, show that the almost colourless region of a non luminous flame consist of unburnt gases (1½ marks)



$\checkmark^{1/2}$

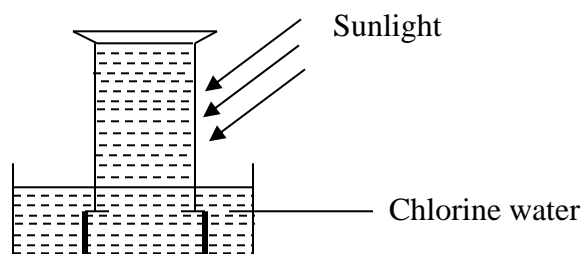
$\checkmark^{1/2}$



(ii) Highlight the steps followed when lighting a Bunsen burner. (1½ marks)

- ✓ Close the air-hole ✓^{1/2}
- ✓ Strike a match and place it on top of the chimney ✓^{1/2}
- ✓ Open the air-hole ✓^{1/2}

21. The diagram below shows an experiment involving chlorine water.



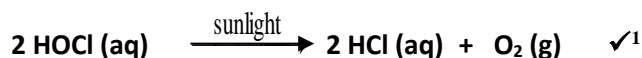
a) Chlorine water is a mixture of two acids. Explain using a chemical equation. (1 mark)



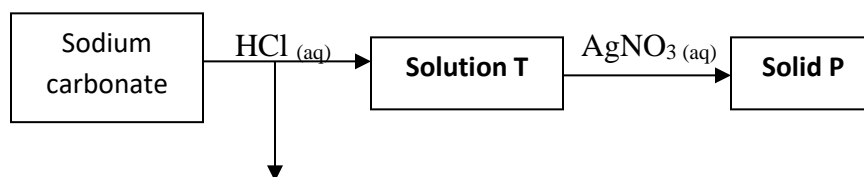
b) State and explain the observation that was made after 24 hours. (2 marks)

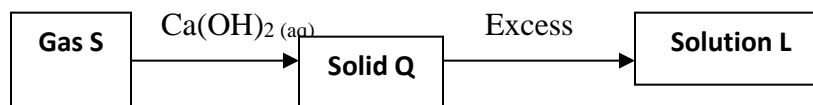
- ✓ **Yellow chlorine water turns colourless / Bubbles of a colourless gas** ✓¹ **Chloric(I) acid decomposes in sunlight to form hydrochloric acid and oxygen gas** ✓¹

c) Write an equation for the reaction that took place in (b) above. (1 mark)



22. Study the flow chart below and use it to answer the questions that follow.





a) Identify substances L, P, Q and S. (2 marks)

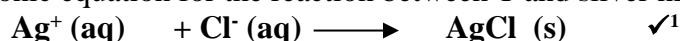
L - Calcium hydrogen carbonate / (CaHCO₃)₂ ✓^{1/2}

P - Silver chloride / AgCl ✓^{1/2}

Q - Calcium carbonate / CaCO₃ ✓^{1/2}

S - Carbon (IV) oxide ✓^{1/2}

b) Write an ionic equation for the reaction between T and silver nitrate solution. (1 mark)



23. a) Define solubility. (1 mark)

✓ **The maximum mass of a solute that can dissolve in 100g of water at a given temperature** ✓¹

b) In an experiment to determine the solubility of solid **W** in water at 40°C, the following results were obtained.

Mass of empty evaporating dish = 36.2g

Mass of evaporating dish + saturated solution = 52.4g.

Mass of evaporating dish + dry solid **W** = 40.4g

Use this data to calculate the solubility of **W** at 40°C. (2 marks)

Mass of saturated solution = 52.4 - 36.2 = 16.2 g ✓^{1/2}

Mass of solid W = 40.4 - 36.2 = 4.2g

Mass of water = 16.2 - 4.2 = 12g ✓^{1/2}

Solubility of solid W at 40°C = $\frac{4.2 \times 100}{12}$ = ✓^{1/2} 35g/100g of water ✓^{1/2}

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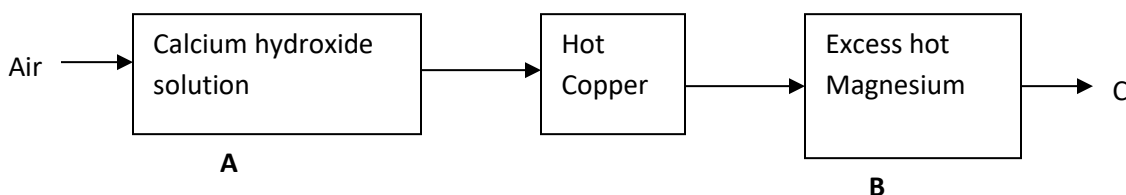
24. In terms of structure and bonding, explain why propane (RMM=44) is a gas at room temperature while ethanol (RMM=46) is a liquid at room temperature (2 marks)

✓ **The molecules of propane are held together by weak Van der Waals forces; ✓¹ whereas those of ethanol are held together by stronger hydrogen bonds ✓¹**

25. Explain why hard water flowing in lead pipes may be safer for drinking than soft water flowing in the same pipes. (2 marks)

- ✓ **Formation of insoluble calcium carbonate/magnesium carbonate** ✓¹ **in hard water pipes prevents the lead pipes from dissolving into the water to cause lead poisoning**

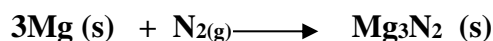
26. Air was passed through reagents as shown below.



i) State and explain the observations made when air is passed over hot copper. (2 marks)

The brown copper metal turns to black copper (II) oxide. ✓¹ **Copper is oxidized by oxygen to form copper (II)oxide** ✓¹

ii) Write the equation for the reaction taking place in chamber B (1 mark)



27. When sugar crystals were reacted with concentrated sulphuric (VI) acid, a black solid **A** was formed which when dried, burnt in excess air to form a colourless gas **B** only while when concentrated sulphuric (VI) acid is reacted with liquid **C** at a temperature of 170°C, a colourless gas **D** is formed which turns yellow bromine water to colourless and also turns colour of substance **E** from purple to colourless.

(i) Identify substances : (2 marks)

Gas **B** : **Carbon (IV) oxide** ✓^{1/2}

Liquid **C** : **Ethanol** ✓^{1/2}

Gas **D** : **Ethene** ✓^{1/2}

Substance E : **Acidified potassium manganate (VII)** ✓^{1/2}

(ii) Which property of concentrated sulphuric (VI) acid is being demonstrated by formation of the black solid (1 mark)

✓ **Dehydrating agent** ✓¹

28. Sodium is extracted from its ore by the electrolysis process.

a) Name the chief ore from which sodium is extracted from. (1 mark)

✓ **Rock salt** ✓¹

b) An ore is suspected to contain mainly sodium. Describe a method that can be used to confirm the presence of sodium in the ore. (2 marks)

Crush the ore, add water and stir. ✓^{1/2} Filter and dip a glass rod in the filtrate ✓^{1/2}. Remove the glass rod and heat in a non-luminous flame ✓^{1/2}. Yellow flame ✓^{1/2} confirms presence of sodium

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