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PHYSICAL SCIENCE: PAPER II

Time: 3 hours

200 marks

Examiner: Mrs F Paterson

Moderators: Mrs H Bezuidenhout
Ms I Botha

Name: _____ Grade: _____

PLEASE READ THE FOLLOWING INSTRUCTIONS CAREFULLY

1. This question paper consists of **16** pages.
2. Please check that your question paper is complete.
3. All **TEN** questions in this paper must be answered.
4. Question 1 consists of 10 multiple-choice questions. There is only one correct answer to each question. These questions are answered on the inside front cover of your Answer Book. The letter that corresponds with your choice of the correct answer must be marked with a cross as shown in the example below:

A	B	C	D
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Here the answer C has been marked.

5. **START EACH QUESTION ON A NEW PAGE.**
6. Number the answers correctly according to the numbering system used in this question paper.
7. Use the data and formulae whenever necessary.
8. Express ALL final answers correct to TWO decimal places, while still maintaining **ACCURACY**.
9. An approved calculator (non-programmable, non-graphical) may be used.
10. Show all the necessary steps in calculations.
11. It is in your own interest to write legibly and to set your work out neatly.
12. You may NOT use Tippex.
13. You may not borrow **ANYTHING** during the examination.

QUESTION 1: MULTIPLE-CHOICE QUESTIONS

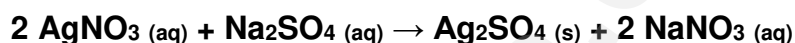
Four options are provided as possible answers to the following questions. Each question has only ONE correct answer.

1.1 The chemical formula for DINITROGEN TETROXIDE is:

- A. NO
- B. N₂O₄
- C. N₄O₂
- D. N₂O₅

(2)

1.2 17 g of AgNO₃ in solution are added to 15 g Na₂SO₄ in solution. AgNO₃ and Na₂SO₄ react according to the following balanced reaction equation:



Assuming the reaction runs to completion, which of the following correctly shows the excess reagent and the mass of this excess reagent left over after the reaction has completed?

	REAGENT IN EXCESS	MASS OF EXCESS REAGENT LEFT (g)
A	Na ₂ SO ₄	7,9
B	Na ₂ SO ₄	0,8
C	AgNO ₃	3
D	AgNO ₃	15,6

(2)

1.3 A test tube contains 4 g of zinc powder covered with 20 cm³ of a 0,1 mol·dm⁻³ hydrochloric acid solution. A second test tube contains 8 g of zinc pellets covered with 25 cm³ of a 0,5 mol·dm⁻³ nitric acid solution. What would be a possible reason that would cause the reaction in the second test tube to take place at a faster rate?

- A. The volume of the acid in the second test tube is greater
- B. The nitric acid has a higher concentration
- C. The zinc pellets have a greater mass
- D. The surface area of the zinc pellets is greater than that of the powder

(2)

- 1.4 Consider the following statements with respect to a chemical reaction in a state of dynamic chemical equilibrium:
- I. The concentrations of the reactants and products are identical provided the reaction occurs in a closed system
 - II. The rates of the forward and reverse reactions are identical provided the reaction occurs in a closed system
 - III. The amounts of reactant and product remains unchanged provided the reaction occurs in a closed system.

Which of the statement (s) above is/are true?

- A. I only
- B. II only
- C. III only
- D. II and III

(2)

- 1.5 The following reactions have reached equilibrium in a closed container. In which of the reactions will an increase in pressure favor the YIELD OF PRODUCTS?

- A. $2 \text{NO (g)} + \text{Cl}_2 \text{(g)} \rightleftharpoons 2 \text{NOCl (g)}$
- B. $\text{CO (g)} + \text{H}_2\text{O (g)} \rightleftharpoons \text{CO}_2 \text{(g)} + \text{H}_2 \text{(g)}$
- C. $2 \text{SO}_3 \text{(g)} \rightleftharpoons 2 \text{SO}_2 \text{(g)} + \text{O}_2 \text{(g)}$
- D. $\text{PCl}_5 \text{(g)} \rightleftharpoons \text{PCl}_3 \text{(g)} + \text{Cl}_2 \text{(g)}$

(2)

- 1.6 Which indicator would be best suited for the titration of potassium hydroxide against an oxalic acid solution?

	INDICATOR	pH RANGE
A	Methyl Orange	3,1 – 4,4
B	Bromocresol purple	5,2 – 6,8
C	Bromothymol blue	6,0 – 7,6
D	Phenolphthalein	8,3 – 10,0

(2)

- 1.7 A decrease in the oxidation number of an atom during a chemical reaction is known as.....

- A. redox
- B. reduction.
- C. oxidation.
- D. electrolysis.

(2)

- 1.8 A strong base is defined as one which....

- A. Neutralizes a strong acid
- B. Dissociates almost completely in an aqueous solution
- C. Is a metal hydroxide
- D. Has a pH between 8 and 10

(2)

1.9 Which ONE of the following isomers has the lowest boiling point?

- A. $\text{CH}_3\text{CH}_2\text{CH}_2\text{CH}_2\text{CH}_2\text{CH}_3$
- B. $\text{CH}_3\text{CH}_2\text{C}(\text{CH}_3)_2\text{CH}_3$
- C. $\text{CH}_3\text{CH}(\text{CH}_3)\text{CH}_2\text{CH}_2\text{CH}_3$
- D. $\text{CH}_3\text{CH}_2\text{CH}(\text{CH}_3)\text{CH}_2\text{CH}_3$

(2)

1.10 The following equation represents the cracking of a hydrocarbon at high temperature and pressure.



Which product in the above reaction is SATURATED?

- A. C_6H_{14}
- B. C_3H_6
- C. C_4H_8
- D. C_2H_4

(2)

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QUESTION 2 [START ON A NEW PAGE]

- 2.1 Define the term *ionic bond*. (2)
- 2.2 Give the FORMULA of a substance which exhibits an ionic bond. (1)
- 2.3 Name the **specific** type of **intramolecular bonds** found in:
- 2.3.1 Hydrogen fluoride (2)
- 2.3.2 Fluorine (2)
- 2.4 Name the **specific** type of **intermolecular forces** found between molecules of:
- 2.4.1 Hydrogen fluoride (2)
- 2.4.2 Fluorine (2)
- 2.5 Explain why the boiling point of hydrogen fluoride (19,5 °C) is higher than the boiling point of fluorine (-188 °C). (2)
- 2.6 Silicon dioxide has a very high melting point of **1610 °C**. With reference to the structure and relevant bonds, explain why silicon dioxide has such a high melting point. (4)
- 2.7 A student is required to make a **250 cm³** of a standard solution of **0,2 mol.dm⁻³** sodium sulphate, Na₂SO₄.
- 2.7.1 Define *standard solution*. (2)
- 2.7.2 Calculate the mass of Na₂SO₄ required. (4)
- 2.7.3 Describe in point form how a standard solution is prepared. (5)

[28]

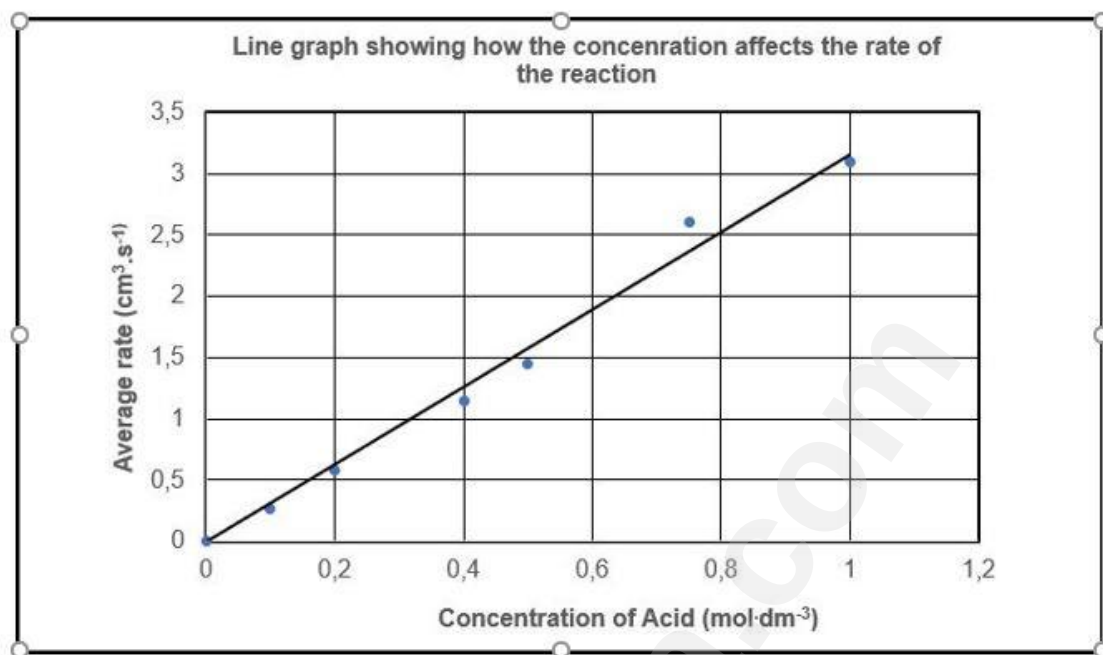
QUESTION 3**[START ON A NEW PAGE]**

- 3.1 In an investigation a solution of an acid is reacted with calcium carbonate (CaCO_3) and the time taken for the volume of the gas to reach 50 cm^3 was recorded. The experiment was repeated three times and the data was captured in the table shown below:

ACID SOLUTION	TIME (s)
A	34
B	22
C	33

- 3.1.1 Why was the experiment repeated? (1)
- 3.1.2 Identify and explain with good reasoning if any of the results appear irregular. (2)
- 3.1.3 Calculate the average time taken for the 50 cm^3 of gas to be produced. Ignore any irregular values that you may have stated in QUESTION 3.1.2. (2)
- 3.1.4 Calculate the average rate ($\text{cm}^3 \cdot \text{s}^{-1}$) in of the reaction. (3)
- 3.2 Solutions of varying concentrations of the acid were reacted with calcium carbonate. The volume of gas given off during the reaction was measured. The data was captured in a table and then plotted on a graph (as shown below).

CONCENTRATION OF ACID ($\text{mol} \cdot \text{dm}^{-3}$)	AVERAGE RATE ($\text{cm}^3 \cdot \text{s}^{-1}$)
1	3,1
0,75	2,6
0,5	1,45
0,4	1,15
0,2	0,58
0,1	0,27

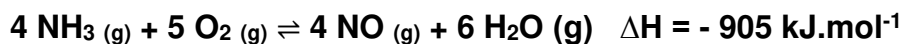


- 3.2.1 Write down a possible hypothesis for this investigation. (2)
- 3.2.2 Name the INDEPENDENT variable. (1)
- 3.2.3 Name ONE CONSTANT variable. (1)
- 3.2.4 Which point on the graph does not fit in with the trend? (2)
- 3.2.5 Write down a CONCLUSION for the investigation. (2)

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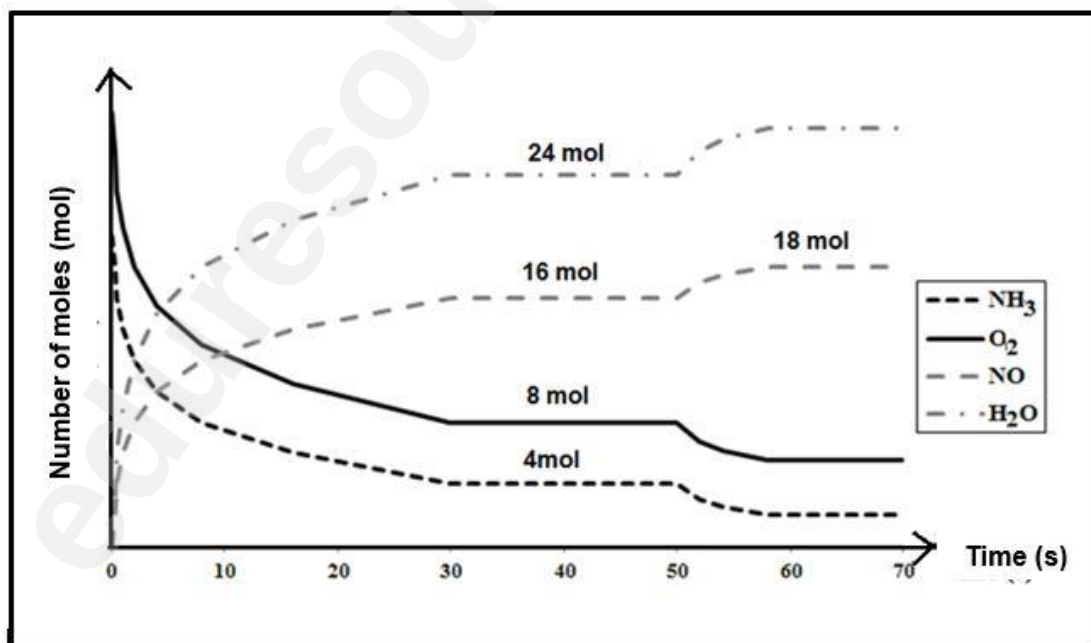
QUESTION 4 [START ON A NEW PAGE]

The first step in the industrial process to manufacture nitric acid involves the catalytic oxidation of ammonia. The yield of nitrogen monoxide depends on the temperature and pressure of the reaction. The equation of the reaction in the first step is given below.



- 4.1 Is this an EXO- or ENDOTHERMIC reaction? (1)
- 4.2 State *Le Chatelier's Principle*. (3)
- 4.3 State the pressure (HIGH or LOW) that would be required to produce a high yield of nitrogen monoxide? Explain your answer in terms of *Le Chatelier's Principle*. (4)
- 4.4 In the reaction above ammonia and oxygen were added to a 2 dm³ vessel and allowed to react and reach equilibrium. A change to the conditions of the reaction vessel was then made, after which the system was allowed to reach equilibrium for the second time.

The graph below represents the moles of the reactants and products for this reaction. Study the graph and then answer the questions given below:



- 4.4.1 Determine, from the graph, the time interval, during which the reaction was in equilibrium for the first time. (2)
- 4.4.2 State and explain the change in condition that was made at 50 seconds, which resulted in the disturbance of the equilibrium. (5)
- 4.4.3 Write down the expression for the equilibrium constant (K_c) for this reaction. (2)

- 4.4.4 Calculate the K_c value for this reaction at the temperature of the system when equilibrium is re-established for the second time after 50 s. (6)
- 4.4.5 How would adding 5 mol of water to the system at equilibrium affect the equilibrium constant (K_c)? (2)
- 4.4.6 Explain your answer to question **4.4.5**. (2)

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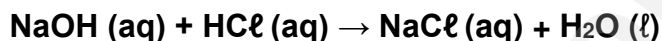
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QUESTION 5

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- 5.1 A learner conducts a titration using a solution of sodium hydroxide to determine the concentration of a hydrochloric acid solution. He finds that **16 cm³** of a **0,25 mol·dm⁻³** NaOH solution neutralises **25 cm³** of the HCl solution with unknown concentration.

The balanced equation of the chemical reaction between sodium chloride and hydrochloric acid is:

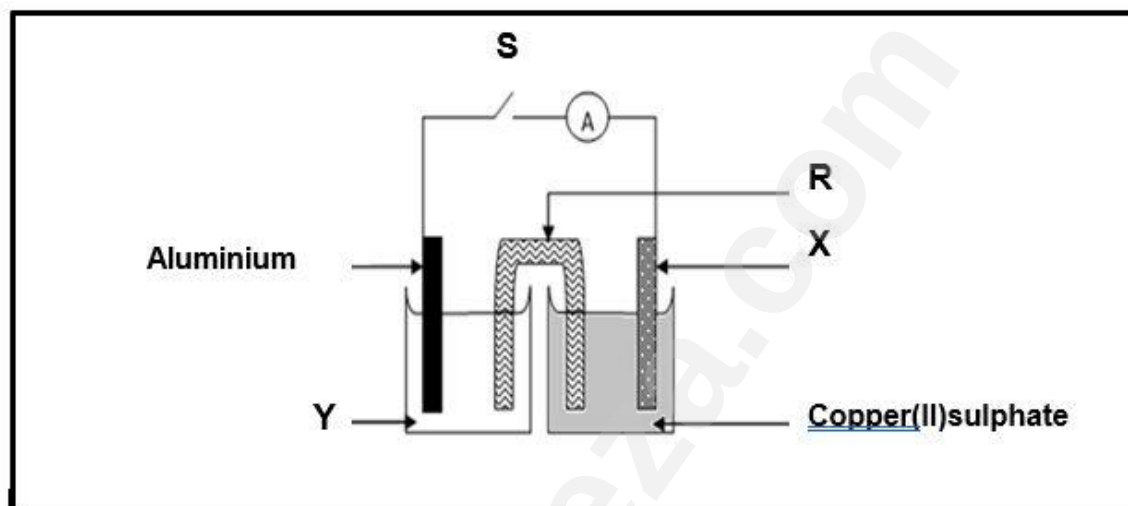


- 5.1.1 What is the MASS of sodium hydroxide needed to prepare **250 cm³** of a **0,25 mol·dm⁻³** sodium hydroxide solution? (5)
- 5.1.2 Calculate the CONCENTRATION of the HCl solution. (5)
- 5.1.3 When only ONE drop of the hydrochloric acid solution still had to be added to reach the equivalence point of the titration, the concentration of the OH⁻ in the mixture was **1,23 x 10⁻⁴ mol·dm⁻³**. Calculate the hydronium ion concentration of the solution at this specific point. (3)
- 5.2 An aqueous solution of ammonia (NH₃) is investigated.
- 5.2.1 State whether the pH of this solution will be GREATER THAN 7, EQUAL TO 7 or LESS THAN 7. (1)
- 5.2.2 Give a reason for your answer in QUESTION 5.2.1. (1)
- 5.2.3 Write down a balanced equation to explain your answer to QUESTION 5.2.2. (3)
- 5.2.4 If a few crystals of ammonium chloride (NH₄Cl) are added to the ammonia solution, will the pH of the solution INCREASE, DECREASE or REMAIN THE SAME? (2)
- 5.2.5 Give a reason for your answer to QUESTION 5.2.4. (2)

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QUESTION 6 [START ON A NEW PAGE]

An electrochemical cell is constructed consisting of an aluminium electrode dipped into a solution containing a suitable electrolyte and an unknown electrode **X** dipped in a solution of copper(II)sulphate. Study the diagram below and answer the questions which follow:



- 6.1 Define the term *electrolyte*. (2)
- 6.2 When the switch, **S**, is closed, it is found that after some time the aluminium electrode corrodes. State whether the aluminium electrode is the CATHODE or ANODE. Justify your answer. (2)
- 6.3 Write the chemical FORMULA for a suitable electrolyte **Y**. (2)
- 6.4 Name the metal out of which electrode **X** is made. Explain your answer. (3)
- 6.5 The emf of the above cell, under standard conditions is **2,0 V**. (2)
- 6.5.1 Write down the standard conditions. (2)
- 6.5.2 State or calculate the standard electrode potential of electrode **X**. (2)
- 6.6 If the cell has been delivering a current for about **45 minutes** state what will happen in each one of the following cases. State only INCREASE, DECREASE or REMAINS UNCHANGED. (2)
- 6.6.1 The mass of the anode (2)
- 6.6.2 The blue colour of the CuSO_4 solution (2)
- 6.6.3 The emf of the cell (2)

6.7 While the cell is operating at its full potential a few drops of a colourless liquid is added to the electrolyte in the aluminium half-cell. A white aluminium precipitate form. The voltmeter reading changes. State whether the voltmeter reading INCREASES or DECREASES. Explain your answer fully. (4)

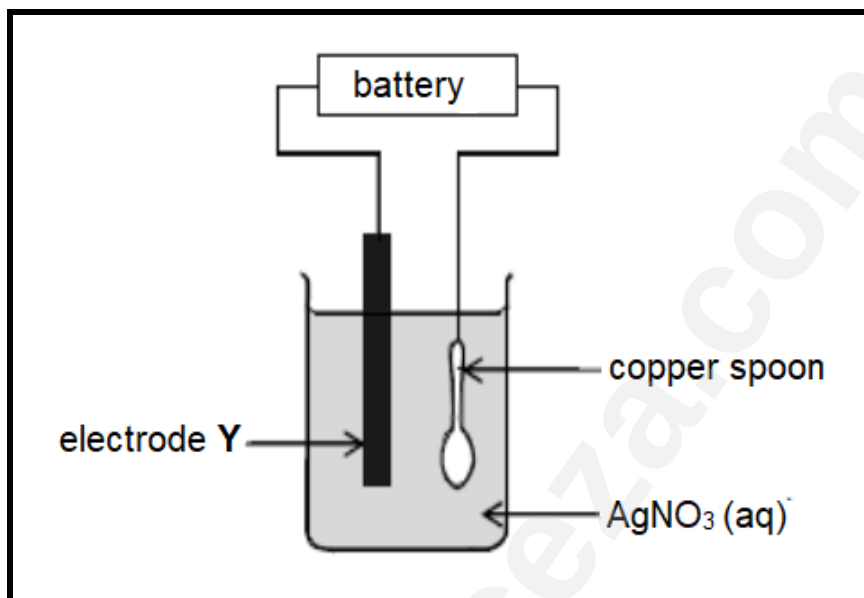
6.8 Describe and explain how electrodes with a larger surface area will influence the voltage (emf) and current delivered by the cell. (3)

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QUESTION 7

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The diagram below shows an electrochemical cell that can be used to coat a copper spoon with silver.



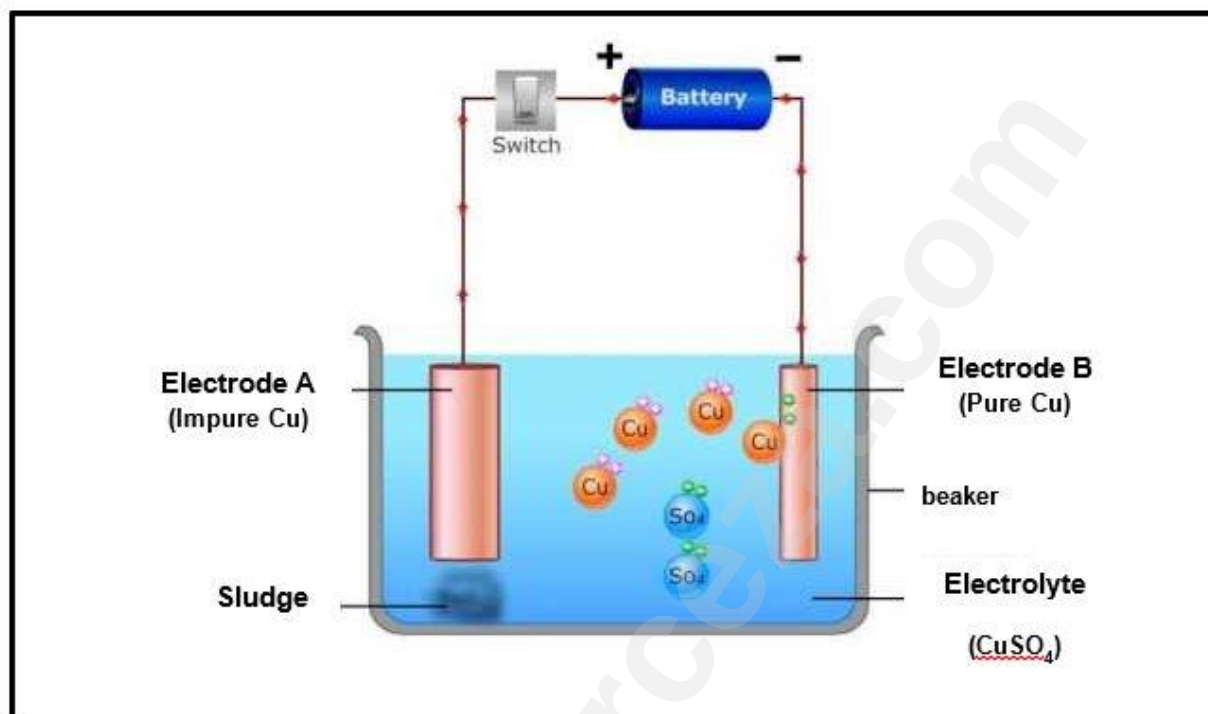
- 7.1 Define the term *oxidation* in terms of electron transfer. (2)
- 7.2 Which electrode, the SPOON or Y, is the CATHODE? (2)
- 7.3 Write down a half-reaction that explains the change that occurs on the surface of the copper spoon during electrolysis. (2)
- 7.4 Write down the metal that electrode Y is made of. (2)
- 7.5 Give a reason why the CONCENTRATION of the $\text{AgNO}_3(\text{aq})$ remains CONSTANT during electrolysis. (2)

[10]

QUESTION 8

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The diagram below shows an electrochemical cell used for the purification of copper. Study the diagram and answer the questions that follow.

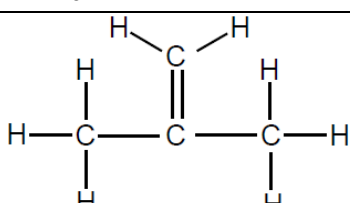


- 8.1 State the type of energy conversion that takes place in the above cell (2)
- 8.2 Write down the half reaction that takes place at electrode **A**. (2)
- 8.3 Explain why the colour of the electrolyte (CuSO_4) will NOT change during this process. (3)
- 8.4 Due to the small amounts of zinc impurities in the impure copper, the electrolyte becomes contaminated with Zn^{2+} ions. Explain why the Zn^{2+} ions do not contaminate the pure copper obtained during this process. (3)

[10]

QUESTION 9 [START ON A NEW PAGE]

The letters **A** to **D** in the table below represent four organic compounds.

A	$\text{CH}_3\text{CH}_2\text{CH}_2\text{COOH}$	B	Ethanol
C	Ethyl propanoate	D	Hexane
E	$\text{CH}_3\text{CH}_2\text{CH}_2\text{CH}_2\text{COOH}$	F	2,2-dimethylbutane
G		H	$\text{CH}_3\text{CH}_2\text{CH}_2\text{CH}_2\text{CH}_2\text{COOH}$

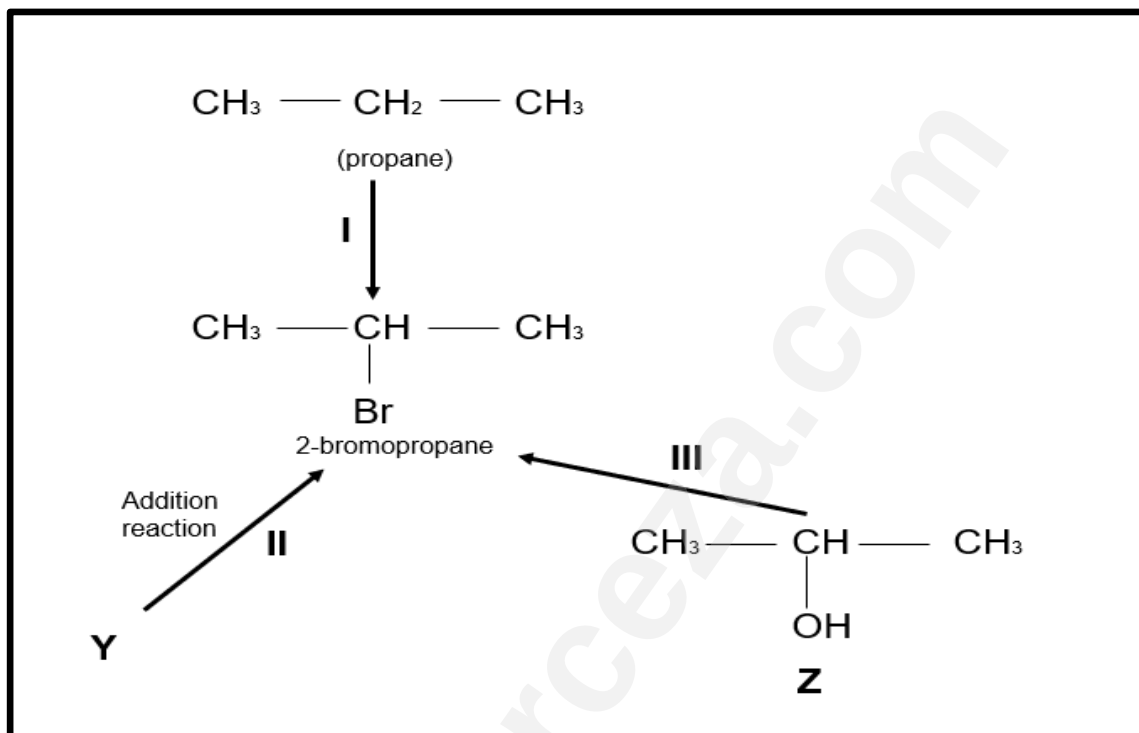
- 9.1 Consider compound **C**.
- 9.1.1 Name the homologous series to which this compound belongs. (1)
- 9.1.2 Name the TYPE of reaction to which this compound is a product. (1)
- 9.1.3 Write down the reaction conditions for the reaction in QUESTION 9.1.2. (2)
- 9.1.4 Use structural formulae and write the balanced chemical equation for the formation of compound **C**. (4)
- 9.1.5 Write down the LETTER (in the table) of a functional isomer of compound **C**. (2)
- 9.2 Consider compound **G**.
- 9.2.1 Write down the IUPAC name of compound **G**. (2)
- 9.2.2 Is this compound saturated or unsaturated? Give a reason for the answer. (2)
- 9.3 Write down the letters of the two compounds (in the table) that are chain isomers. (2)
- 9.4 Consider compounds **A**, **E** and **H**.
- 9.4.1 Define *boiling point*. (2)
- 9.4.2 Which one of these compounds has the LOWEST boiling point. (2)
- 9.4.3 Explain your answer in terms of intermolecular forces, relative strength of the forces and energy. (5)
- 9.5 Compare the boiling points of compounds **D** and **F**. (3)

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QUESTION 10

[START ON A NEW PAGE]

2-bromopropane is used as a reactant in the synthesis of many other organic compounds. It may be synthesised in three different ways:



- 10.1 NAME of the reaction represented by I. (1)
- 10.2 State the reaction condition for reaction I. (1)
- 10.3 Using molecular formulae write a balanced reaction equation for the complete combustion of propane. (4)
- 10.4 Write the structural formula for compound Y. (2)
- 10.5 Besides Y, what other reactant is needed for reaction II? Write down the NAME or FORMULA. (1)
- 10.6 Give the NAME of the reaction represented by reaction II. (1)
- 10.7 Identify the type of reaction represented by III. (1)
- 10.8 Give the IUPAC NAME for compound Z. (2)

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