education

MPUMALANGA PROVINCE

REPUBLIC OF SOUTH AFRICA

NATIONAL SENIOR CERTIFICATE

GRADE 12

PHYSICAL SCIENCES: CHEMISTRY P2

SEPTEMBER 2025

MARKS: 150

TIME: 3 HOURS

This question paper consists of 17 pages and 4 data sheets.

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INSTRUCTIONS AND INFORMATION

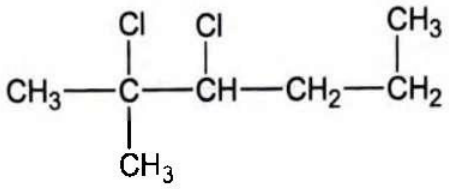
1. Write your name in the appropriate space on the FOLIO PAPER.
2. This question paper consists of NINE questions. Answer ALL the questions in the FOLIO PAPER.
3. Start EACH question on a NEW page in the FOLIO PAPER.
4. Number the answers correctly according to the numbering system used in this question paper.
5. Leave ONE line between two sub questions, for example between QUESTION 2.1 and QUESTION 2.2.
6. You may use a non-programmable calculator.
7. You may use appropriate mathematical instruments.
8. You are advised to use the attached DATA SHEETS.
9. Show ALL formulae and substitutions in ALL calculations.
10. Round off your final numerical answers to a MINIMUM of TWO decimal places.
11. Give brief motivations, discussions, et cetera where required.
12. Write neatly and legibly.

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QUESTION 1 : MULTIPLE-CHOICE QUESTIONS

Four options are provided as possible answers to the following questions. Each question has only ONE correct answer. Choose the answer and write only the letter (A – D) next to the question number (1.1 – 1.10) in the FOLIO PAPER, for example, 1.11 E.

1.1 Study the structural formula of the organic compound below.



The IUPAC name of this organic compound is...

A 2,3-dichloro-2,5-dimethylpentane

B 3,4-dichloro-1,4-dimethylpentane

C 2,3-dichloro-2-methylhexane

D 4,5-dichloro-4-methylhexane (2)

1.2 Consider the reaction represented by the equation below:

$$C_3H_7Br + H_2O \rightarrow C_3H_8O + HBr$$

This reaction is ...

A hydration.

B hydrolysis.

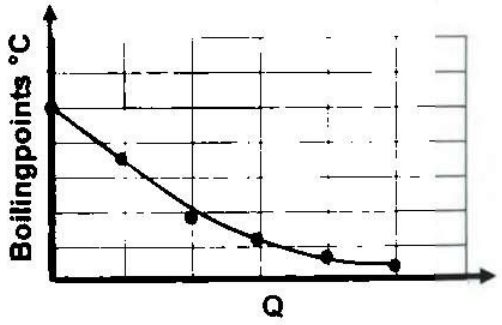
C dehydration.

D hydrohalogenation. (2)

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1.3 The graph below shows boiling points of alkanes with the same molecular mass plotted against a quantity **Q**.

Graph of boiling point versus quantity Q



Which ONE of the following is most likely represented by **Q**?

A Chain length

B Increase in strength of intermolecular forces

C Increase in surface area of chain isomers

D Number of methyl side chains in chain isomers (2)

1.4 The equation below represents a hypothetical reaction.

$$A(g) + B(g) \rightleftharpoons C(g) \qquad \Delta H = -50 \text{ kJ·mol}^{-1}$$

The activation energy for the REVERSE reaction is 110 kJ·mol^{-1}.

Which ONE of the following is the activation energy (in kJ·mol^{-1}) for the FORWARD reaction?

A 50

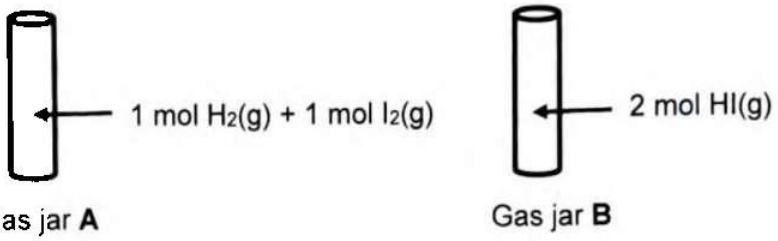
B 60

C 110

D 160 (2)

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1.5 Two identical sealed gas jars, **A** and **B**, initially contain gases as shown below.



Gas jar **A** Gas jar **B**

The reaction below reaches equilibrium at 500 °C according to the following balanced equation:

$$H_2(g) + I_2(g) \rightleftharpoons 2HI(g)$$

Which ONE of the following **statements** is TRUE at equilibrium?

A **B** will contain 1 mole **of $I_2(g)$**.

B **A** will contain a larger **amount of $I_2(g)$** than **B**.

C **A** and **B** will contain the same amount of HI(g).

D **B** will contain a larger amount of HI(g) than **A**. (2)

1.6 Which ONE of the following salts, when dissolved in water, will NOT change the pH of the water?

A Na_2CO_3

B $(COO)_2Na_2$

C $NH_4C\ell$

D $NaC\ell$ (2)

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1.7 Which ONE of the following shows the PRODUCTS for the reaction of oxalic acid with sodium hydroxide?

A $(COO)_2Na_2(aq) + H_2O(\ell) + CO_2(g)$

B $(COO)_2Na_2(aq) + H_2O(\ell)$

C $CH_3COONa(aq) + H_2O(\ell)$

D $CH_3COONa(aq) + H_2O(\ell) + CO_2(g)$ (2)

1.8 Which ONE of the following statements is CORRECT for an ELECTROLYTIC CELL?

A The anode is the positive electrode

B The cathode is the **positive electrode**.

C Oxidation takes place **at the catho**de.

D Reduction takes place **at the ano**de. (2)

1.9 An electrochemical cell was set up using a $Hg(\ell)|Hg^{2+}(aq)$ half-cell and another half-cell under standard conditions.

Which ONE of the following half-cells, when connected to the $Hg(\ell)|Hg^{2+}(aq)$ half-cell, will result in the HIGHEST cell potential?

A $A\ell(s)|A\ell^{3+}(aq)$

B $Zn(s)|Zn^{2+}(aq)$

C $Co(s)|Co^{2+}(aq)$

D $Pt(s)|H_2(g)|H^+(aq)$ (2)

1.10 Which ONE of the following redox reactions is SPONTANEOUS under standard conditions?

A $Br_2 + 2C\ell^- \rightarrow 2Br^- + C\ell_2$

B $2Fe^{3+} + 2I^- \rightarrow 2Fe^{2+} + I_2$

C $Ni^{2+} + H_2 \rightarrow Ni + 2H^+$

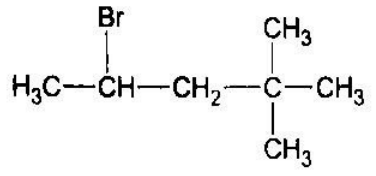
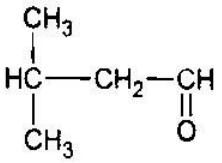
D $Cu + Pb^{2+} \rightarrow Cu^{2+} + Pb$ (2)

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QUESTION 2 (Start on a new page)

The letters **A** to **F** in the table below represent SIX organic compounds. Use the table to answer the questions that follow.

A		**B**	3-ethyl-2,4-dimethylpent-2-ene
C		**D**	$(CH_3)_2C(OH)CH_2CH_3$
E	$CH_3CH_2CO_2CH_2CH_3$	**F**	Pentan-2-one

2.1 Define the term *Homologous* ***series***. (2)

2.2 Write down the LETTER(S) that represent(s) the following:

2.2.1 Haloalkane (1)

2.2.2 A compound with a formyl group. (1)

2.3 Write down the:

2.3.1 IUPAC name of compound **A** (3)

2.3.2 STRUCTURAL FORMULA of compound **B** (3)

2.3.3 The STRUCTURAL FORMULA of the functional group of compound **F**. (1)

2.3.4 IUPAC name of the CHAIN isomer of compound **C**. (2)

2.4 Is compound **D** a PRIMARY, SECONDARY, or TERTIARY alcohol? (1)

2.5 Consider compound **E** and write down the ...

2.5.1 IUPAC name. (2)

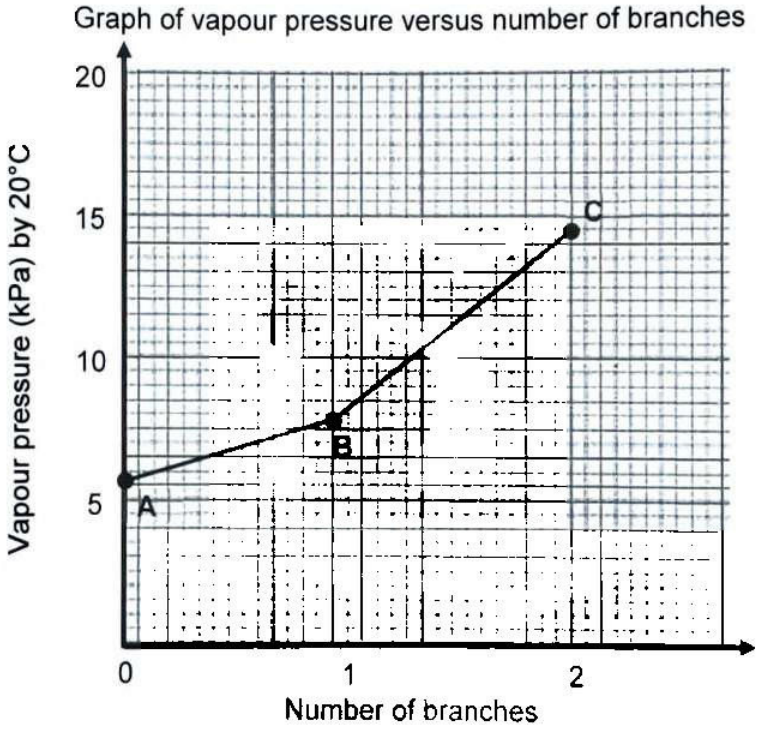
2.5.2 STRUCTURAL FORMULA of the FUNCTIONAL isomer of this compound. (2)

[18]

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QUESTION 3 (Start on a new page)

3.1 There are three chain isomers with molecular formula, C_5H_{12}. In a practical investigation, vapor pressure data for the three chain isomers **A**, **B**, and **C** were collected and presented on the graph as shown below.



3.1.1 Use the graph to determine the vapour pressure of compound **C**. (1)

3.1.2 Write down the IUPAC name of compound **B**. (2)

3.1.3 Which ONE of the three compounds (**A**, **B** or **C**) has the highest boiling point? (1)

3.1.4 Explain the difference in the vapour pressure of compounds **A**, **B** and **C**. In the explanation, refer to the STRUCTURE of the molecule, the STRENGTH of INTERMOLECULAR FORCE(S) and the ENERGY required. (3)

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3.2 Another experiment was conducted to determine the melting point of organic compounds from three different homologous series, represented by letters **D** to **F**, under the same conditions. The three compounds used were Ethanoic acid, Propan-1-ol and Propanal. The results are shown in the table below.

COMPOUND	MELTING POINT
D	-126°C
E	16,6°C
F	-113,8°C

3.2.1 Define the term *melting point*. (2)

3.2.2 Which compound is a solid at 0°C? Write down only **D**, **E** or **F**. (1)

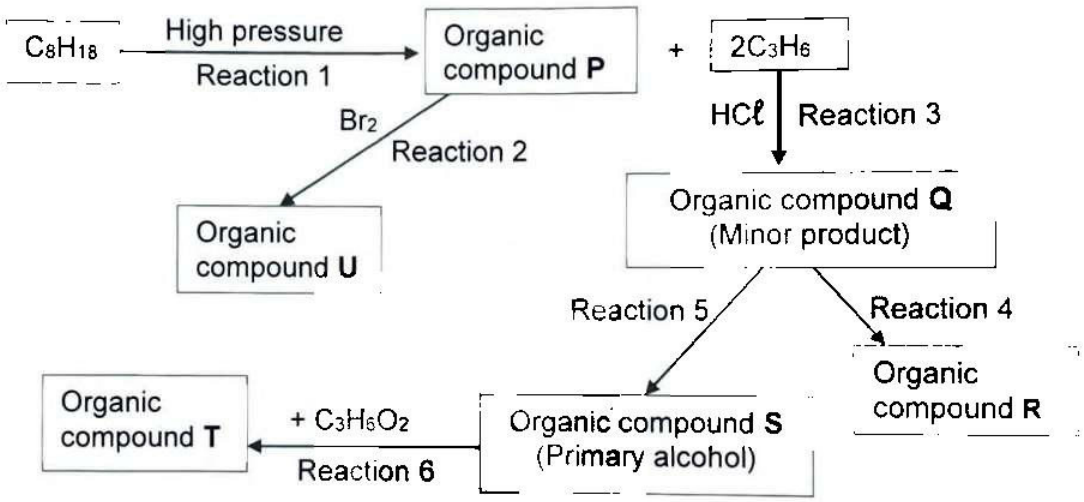
3.2.3 Write down the MELTING POINT of Propan-1-ol? (1)

3.2.4 Explain the difference in melting points between compounds **D** and **E**. (3)
[14]

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QUESTION 4 (Start on a new page)

Study the flow diagram below representing different organic reactions and answer the questions that follow.



4.1 Write down the type of reaction represented by:

4.1.1 Reaction 2 (1)

4.1.2 Reaction 3 (1)

4.2 For reaction **1**, write down the:

4.2.1 EMPIRICAL formula of compound **P**. (1)

4.2.2 IUPAC name of organic compound **P**. (1)

4.3 Reaction **4** is an ELIMINATION reaction, write down:

4.3.1 TWO reaction conditions (2)

4.3.2 The IUPAC NAME of organic compound **R**. (2)

4.4 For reaction **5**, write down the NAME or FORMULA of the inorganic product that is formed. (1)

4.5 In reaction **6**, organic compound **S** reacts with $C_3H_6O_2$ in the presence of sulphuric acid. Write down the:

4.5.1 Balanced equation using STRUCTURAL FORMULAE. (5)

4.5.2 Function of the sulphuric acid (H_2SO_4) in this reaction. (1)

[15]

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QUESTION 5 (Start on a new page)

A group of learners used the reaction between zinc and EXCESS dilute hydrochloric acid (HCℓ) to investigate the factors that affect the rate of a chemical reaction. The balanced equation for the reaction is:

$$Zn(s) + 2HC\ell \rightarrow ZnC\ell_2(aq) + H_2(g) \qquad \Delta H < 0$$

The same volume of HCℓ and the same mass of Zn were used.

Experiment	Temperature (°C)	Volume HCℓ (cm^3)	Concentration of HCℓ ($mol \cdot dm^{-3}$)	State of division of Zn
A	25	50	0,75	Granules
B	35	50	0,75	Granules
C	25	50	0,75	Powder

5.1 Define the term *reaction rate*. (2)

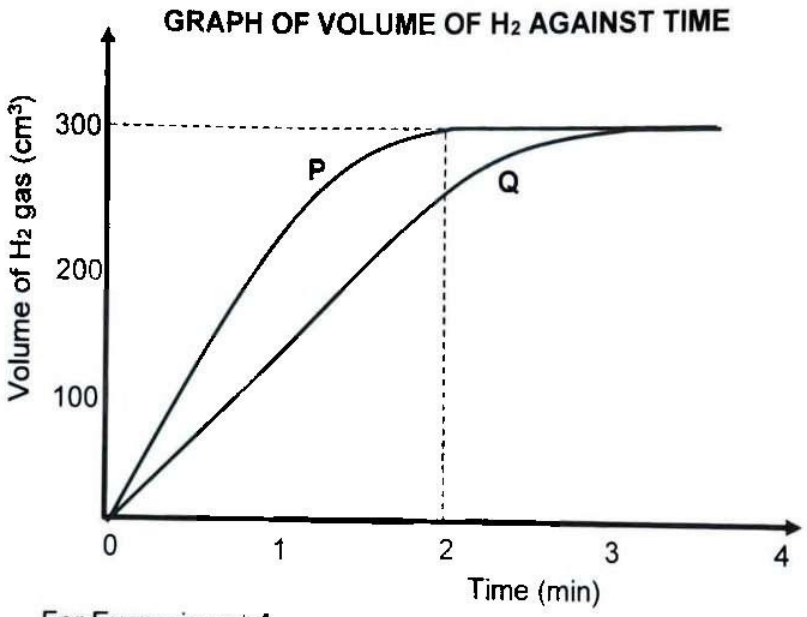
5.2 Is net energy ABSORBED or RELEASED during the reaction? Give a reason for the answer. (2)

5.3 How does the rate of the reaction in Experiment **A** compare to that of Experiment **B**? Write down only HIGER, LOWER or EQUAL TO. (1)

5.4 Explain the answer to Question 5.3 by using the COLLISION THEORY. (3)

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5.5 The volume of H_2 gas formed versus time for the reaction in Experiments **A** and **C** is shown below.



For Exaperiment **A**

5.5.1 Which curve represents the experiment? Write down only **P** or **Q**. (1)

5.5.2 Calculate the average rate of the reaction (in $dm^3.s^{-1}$) in the time 0 to 2 minutes. (3)

5.5.3 Calculate the mass of hydrochloric acid remaining upon completion of this reaction.

Assume that the MOLAR GAS VOLUME at 25 °C is 24 $dm^3.mol^{-1}$. (6)
[18]

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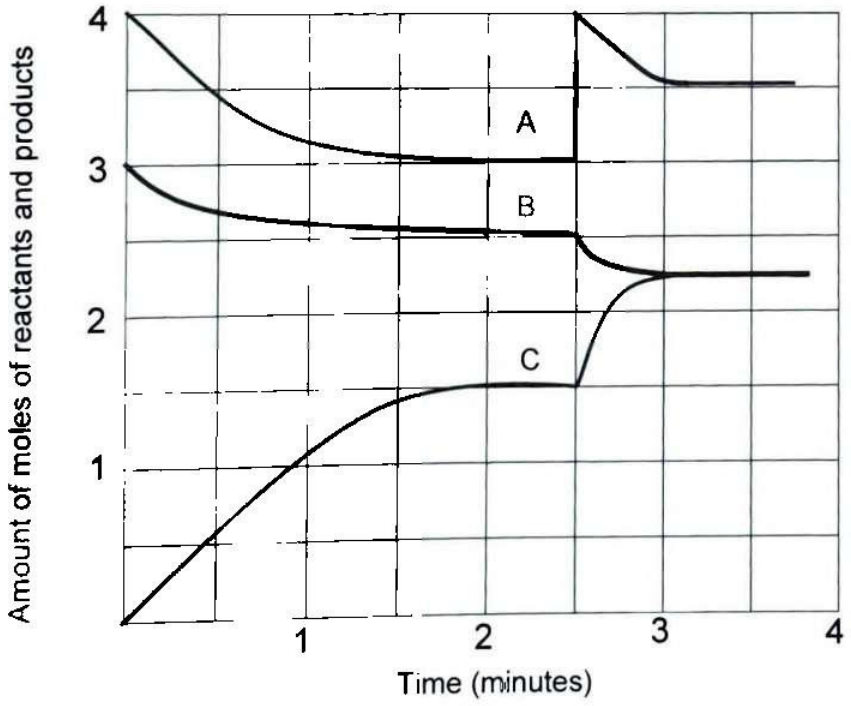
QUESTION 6 (Start on a new page)

The equation below represents a hypothetical reaction that takes place in a closed container at 350°C. The letters **x**, **y** and **z** represent the number of moles in the balanced equation.

$$\mathbf{x}A(g) + \mathbf{y}B(g) \rightleftharpoons \mathbf{z}C(g)$$

6.1 Define the term *chemical equilibrium*. (2)

The graph below shows the change in the number of moles of reactants and products versus time during the reaction.



6.2 After how many minutes did the system reach equilibrium for the first time? (1)

6.3 Using the information on the graph, write down the value of:

6.3.1 **x** (1)

6.3.2 **y** (1)

6.3.3 **z** (1)

6.4 Calculate the equilibrium constant, K_c for this reaction at 350°C if the volume of the container is 4 dm^3. (7)

6.5 Name the change made at 2,5 minutes. (1)

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6.6 Explain the effect of the change on the position of the equilibrium in QUESTION 6.5 using Le Chatelier's principle. (3)

6.7 When the temperature increases the K_c value increases for this reaction. Is the reverse reaction EXOTHERMIC or ENDOTHERMIC? Explain the answer. (3)
[20]

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QUESTION 7 (Start on a new page)

7.1 Barium hydroxide ($Ba(OH)_2$) is regarded as a strong base.

7.1.1 Define a *strong base*. (2)

7.1.2 Calculate the pH of a solution of a barium hydroxide solution, $Ba(OH)_2(aq)$, with a concentration of 0,1 $mol \cdot dm^{-3}$ (4)

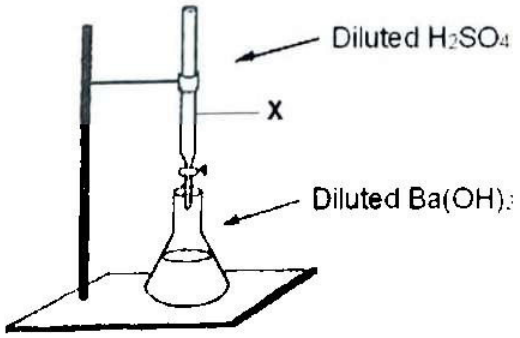
7.2 A standard solution of oxalic acid, $(COOH)_2$ (aq), with concentration 0,2 $mol \cdot dm^{-3}$ is prepared by dissolving a certain amount of oxalic acid crystals, $(COOH)_2 \cdot 2H_2O$, in water. The flask is then filled with distilled water up to the 250 cm^3 mark.

Calculate the mass of oxalic acid needed to prepare the standard solution. (5)

7.3 The apparatus in the diagram below are used for the titration of a dilute base ($Ba(OH)_2$) with a dilute acid (H_2SO_4).

Balanced equation:

$$H_2SO_4\,(aq) + Ba(OH)_2(aq) \rightarrow BaSO_4(s) + 2H_2O(\ell)$$



7.3.1 Name the apparatus labelled **X**. (1)

7.3.2 During the reaction, 50 cm^3 of the dilute base ($Ba(OH)_2$) reacts completely with 30 cm^3 of the dilute acid. Calculate the mass of barium sulphate that will form during the reaction if the concentration of the dilute base ($Ba(OH)_2$) is 0,1 $mol \cdot dm^{-3}$. (4)

7.4 Write down a balanced equation for the hydrolysis of CH_3COONa. (3)

[19]

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QUESTION 8 (Start on a new page)

Consider the galvanic cell, represented by the cell notation below.

$$Pt(s) \mid H_2(g) \mid H^+(aq) \parallel Ni^{2+}(aq) \mid Ni(s) \qquad \text{at } 25\ ^\circ C$$

This cell was set up to determine the standard electrode potential of the $Ni^{2+} \mid Ni$ half-cell.

8.1 Consider the standard hydrogen electrode used in this cell.

8.1.1 Besides the temperature of 25 °C, state the standard condition associated with the gaseous H_2 in the above cell. (1)

8.1.2 Which terminal of the voltmeter should be connected to the standard hydrogen electrode? State only POSITIVE or NEGATIVE. (1)

8.1.3 Calculate the initial reading on the voltmeter. (4)

8.2 The voltmeter is replaced with a resistor, resulting in an average current of 2,25 A being drawn from the cell for 4 hours.

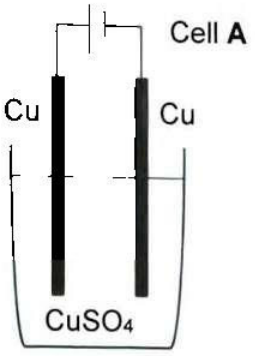
8.2.1 Write down the balanced chemical equation for the SPONTANEOUS reduction half-reaction that occurs. (2)

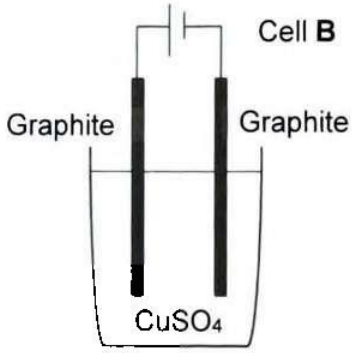
8.2.2 Calculate the change in mass of the nickel electrode. (7)
[15]

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QUESTION 9 (Start on a new page)

In both cells shown below, a concentrated aqueous solution of copper(II) sulphate is electrolysed using pure electrodes.





9.1 In Cell **A**, copper electrodes **are used**.

9.1.1 Write down the NAME the **substance(s)** that is/are reduced. (1)

9.1.2 As the reaction proceeds, **what** will happen to the concentration of the electrolyte? Write down, INCREASES, DECREASES, or STAYS THE SAME. (1)

9.2 In Cell **B**, graphite electrodes are used.

9.2.1 Write down the reduction half reaction. (2)

9.2.2 As the reaction proceeds, what will happen to the concentration of the electrolyte? Choose from, INCREASES, DECREASES, or STAYS THE SAME. (1)

9.3 Chlorine is produced industrially by the electrolysis of a concentrated sodium chloride solution, NaCℓ(aq).

The balanced equation for the net (overall) cell reaction is as follows:

$$2NaCℓ(aq) + 2H_2O(ℓ) \rightarrow H_2(g) + 2NaOH(aq) + Cℓ_2(g)$$

For the above reaction, write down the:

9.3.1 Half-reaction that takes place at the cathode (2)

9.3.2 NAME or FORMULA of the oxidising agent (1)

9.3.3 Refer to the Table of Standard Reduction Potentials to explain why sodium ions are not reduced during this process. (3)

[11]

TOTAAL [150]

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