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**TOTAL
MARKS**

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**HILTON COLLEGE
GRADE 12 TRIAL EXAMINATION
PHYSICAL SCIENCE: PAPER II**

Time: 3 hours

200 marks

Examiner: Mr NC Robert**Moderator:** MJ van Wyk**Laundry number:**

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PLEASE READ THE FOLLOWING INSTRUCTIONS CAREFULLY

1. This question paper consists of 30 pages and a green DATA SHEET of 3 pages (i–iii). Please make sure that your question paper is complete.
2. Read the questions carefully.
3. **Answer ALL the questions on the question paper and hand it in at the end of the examination. Remember to write your laundry number in the space provided above.**
4. Unless instructed otherwise, you do NOT have to give state symbols (phase indicators) when asked to write a balanced chemical equation
5. Use the data and formulae whenever necessary.
6. Show all the necessary steps in all calculations.
7. Units need not be included in the working of calculations, but appropriate units should be shown in the answer.
8. Where appropriate, take your answers to two decimal places.
9. It is in your interest to write legibly and to present your work neatly.
10. Two blank pages (pages 24 and 25 are included at the end of the exam paper. If you run out of space for an answer, use these pages. If you use this extra space, make sure that you indicate this clearly at the question to ensure that your answer is marked in full.

	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Total
Mark									
Marker Initial									
Moderated Mark									
Moderator Initial									
Question Total	20	18	28	26	32	13	23	40	200

QUESTION 1

Answer these questions on the multiple-choice answer grid below. Make a clear cross (X) in the box corresponding to the letter that you consider to be correct. Every question has only one correct answer.

A	B	☒	D
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Here the option C has been marked as an example.

1.1	A	B	C	D
1.2	A	B	C	D
1.3	A	B	C	D
1.4	A	B	C	D
1.5	A	B	C	D
1.6	A	B	C	D
1.7	A	B	C	D
1.8	A	B	C	D
1.9	A	B	C	D
1.10	A	B	C	D

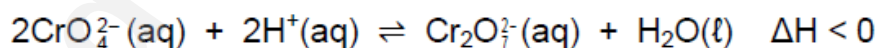
- 1.1 An unknown metal M forms the compound $M_2(SO_4)_3$. Which formula represents another compound where M has the same valency?

- A $M(NO_3)_2$
- B MPO_4
- C M_2O
- D M_3N_4

- 1.2 Which one of the following contains $6,02 \times 10^{23}$ atoms?
- A 18 g of Ar gas
 - B $5,6 \text{ dm}^3$ of NH_3 gas at STP
 - C 32 g of O_2 gas
 - D $22,4 \text{ dm}^3$ of CO gas at STP
- 1.3 Which one of the following statements best describes ALL intramolecular bonds?
- A Any one of ionic, covalent, or hydrogen bonds.
 - B An equal sharing of electrons within molecules.
 - C A bond which occurs between atoms within molecules.
 - D A bond which occurs between molecules, ions or atoms of a noble gas.
- 1.4 Which ONE of the following statements is TRUE for the given reaction?



- A A catalyst will not affect the rate of the reaction.
 - B An increase in pressure will favour the reverse reaction.
 - C The activation energy of the forward reaction is greater than the activation energy of the reverse reaction.
 - D The rate of the forward reaction increases when the temperature increases.
- 1.5 Consider the equilibrium represented by the balanced equation below:



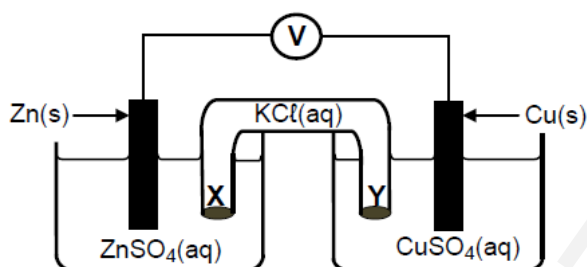
Which ONE of the following changes to the equilibrium will favour the forward reaction?

	TEMPERATURE	pH
A	Decrease	Increase
B	Decrease	Decrease
C	Increase	Increase
D	Increase	Decrease

1.6 Which one of the following is NOT a conjugate acid–base pair.

- A H_3O^+ and OH^-
- B NH_4^+ and NH_3
- C H_2S and HS^-
- D NH_3 and NH_2^-

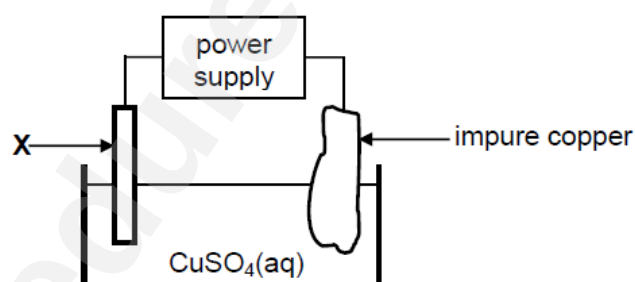
1.7 The diagram below represents a voltaic cell.



Which ONE of the following correctly describes the movement of ions in the cell?

	TYPE OF IONS	DIRECTION OF MOVEMENT
A	$\text{Cl}^-(\text{aq})$	Y to X
B	$\text{SO}_4^{2-}(\text{aq})$	X to Y
C	$\text{Cu}^{2+}(\text{aq})$	Y to X
D	$\text{K}^+(\text{aq})$	Y to X

1.8 The diagram below represents a cell that is used for the refining of copper.



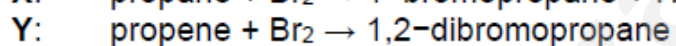
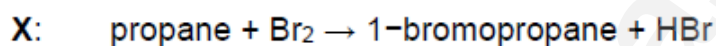
Which ONE of the following statements is TRUE?

- A X is made of platinum.
- B The mass of X increases.
- C X is the electrode where oxidation takes place.
- D X is connected to the positive terminal of the power supply.

- 1.9 Which ONE of the following combinations correctly indicates the **STRONGEST** intermolecular forces found in ethanoic acid and methyl propanoate respectively?

	ETHANOIC ACID	METHYL PROPANOATE
A	Hydrogen bonds	Hydrogen bonds
B	Dipole-dipole forces	London forces
C	Hydrogen bonds	London forces
D	Hydrogen bonds	Dipole-dipole forces

- 1.10 Consider the two reactions, X and Y, below:



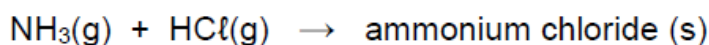
Identify the reaction that has the **LOWER** activation energy and the reaction that has the **LOWER** reaction rate under identical external conditions?

	LOWER activation energy	LOWER reaction rate
A	X	X
B	X	Y
C	Y	X
D	Y	Y

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QUESTION 2

Consider the following reaction, in which gaseous ammonia and hydrogen chloride react to produce the ionic solid ammonium chloride.



- 2.1 Define *covalent bond*. (2)

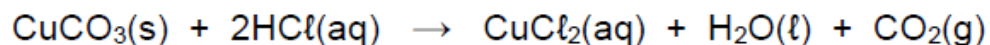
- 2.2 With regard to NH_3 and HCl , name the SPECIFIC type of intramolecular bond which exists in both of them. Fully explain how this bond is formed. (3)

- 2.3 Write the chemical formula for ammonium chloride. (1)

- 2.4 The boiling point of ammonium chloride is 520°C . With reference to the **structure** of ammonium chloride and the **forces** between its particles, explain why this is so high. (4)

QUESTION 3

3 g of impure copper (II) carbonate reacts with an excess of hydrochloric acid. The balanced chemical equation for the reaction that takes place is:



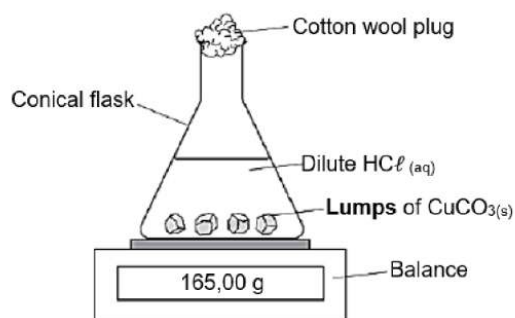
270 cm³ of carbon dioxide gas was collected at STP.

3.1 Define the *mole*. (2)

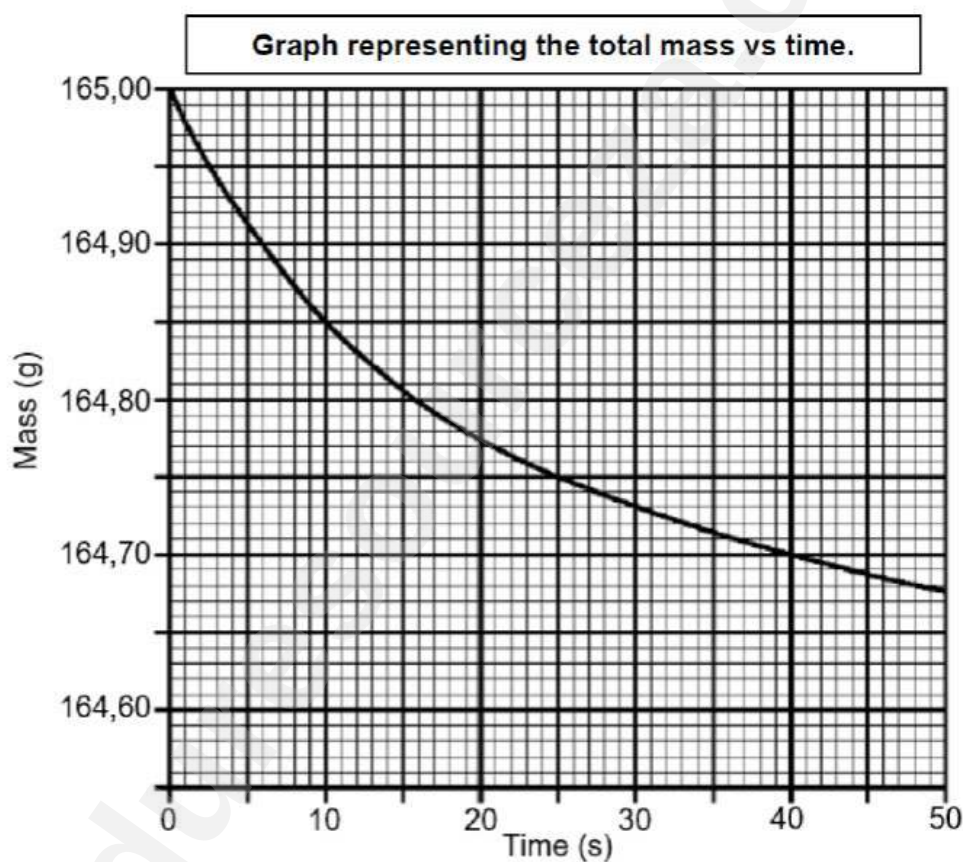
3.2 Determine the amount (in moles) of carbon dioxide produced. (3)

3.3 Determine the percentage purity of the copper (II) carbonate. (5)

To determine the rate of this reaction of copper (II) carbonate (**lumps**) with an excess of **hydrochloric acid**, we used the apparatus shown below:



The graph shows their results for the first 50 seconds.



- 3.4 Has the reaction gone to completion after 50 s? Explain by referring to the graph. (2)

3.5 Define the *rate of the reaction*. (2)

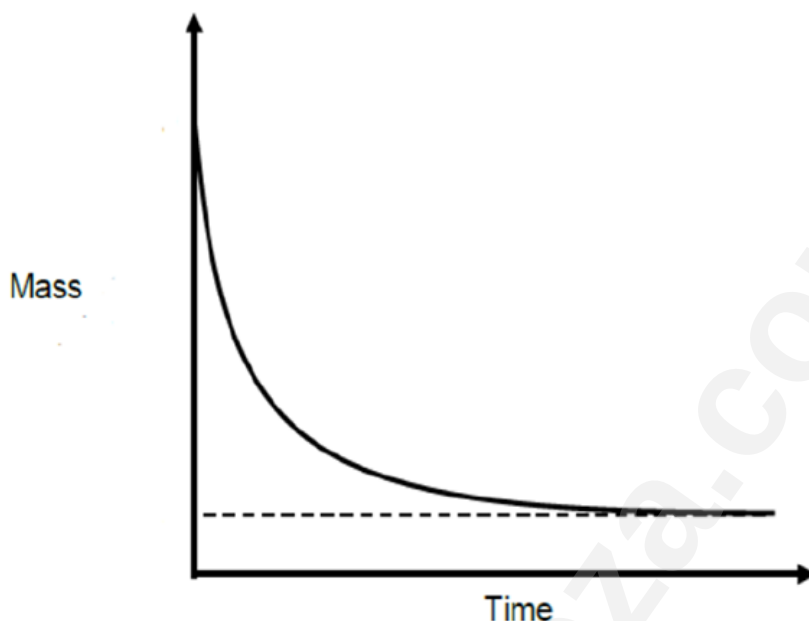
3.6 Calculate the average rate of the reaction in g.s^{-1} :

3.6.1) during the first 10 s. (2)

3.6.2) between 20s and 40s. (2)

3.7 Explain the difference in your answers for questions 3.6.1 and 3.6.2 above. (2)

- 3.8 A sketch graph for the above experiment which copper (II) carbonate lumps was used is shown below:



Draw two more curves on the sketch graph above for the following reaction conditions.

Label the lines clearly as **A** and **B**.

3.8.1) **A:** 2 g of **powdered** copper (II) carbonate is used. (2)

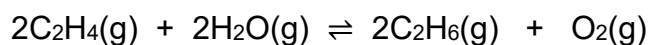
3.8.2) **B:** The concentration of the acid was halved. (2)

- 3.9 Use the **collision theory** to explain the effect of **halving** the concentration of the acid, on the **rate of the reaction**. (4)

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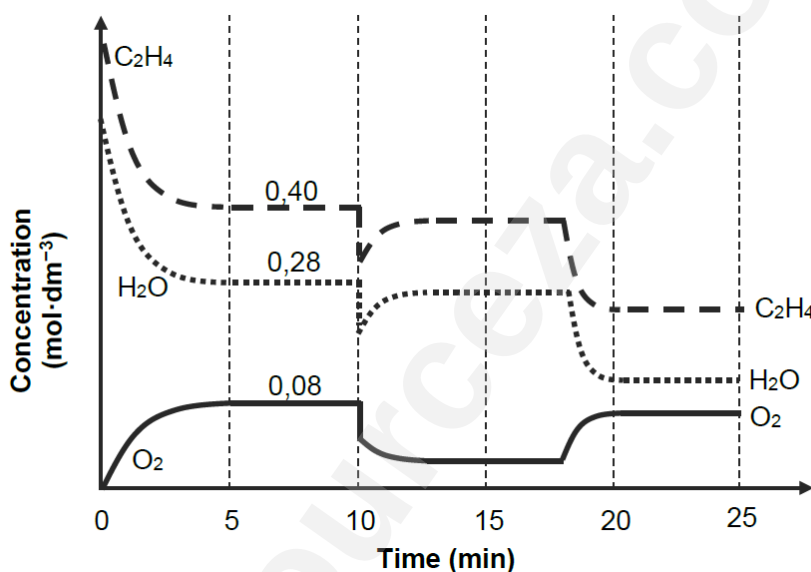
QUESTION 4

- 4.1 Consider the reversible reaction of ethene with steam in the ABSENCE of an acid, as shown below:



The reaction was done in a **3 dm³** closed container. The temperature was kept constant at T_1 for the first 18 minutes.

The graph below (NOT to scale) shows the changes in concentration of C_2H_4 , H_2O and O_2 as a function of time.



- 4.1.1 The equilibrium constant at temperature T_1 is 0,025. Calculate the equilibrium amount (in **moles**) of **C_2H_6** at 7 minutes. (6)

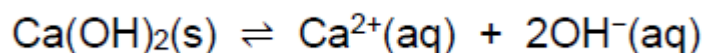
4.1.2 Describe fully the change made to the system at 10 minutes. (2)

4.1.3 State *Le Châtelier's principle*. (2)

4.1.4 At 18 min, the temperature was INCREASED to T_2 . With reference to **Le Châtelier's principle** and the graph, fully explain whether the forward reaction is endothermic or exothermic. (5)

4.1.5 At 35 minutes, argon (an inert gas) is added to the container. What effect does this have on the amount of C_2H_6 at equilibrium? State only INCREASES, DECREASES, or NO EFFECT. (2)

- 4.2 A **saturated** solution of calcium hydroxide has solid calcium hydroxide in equilibrium with its aqueous ions.



- 4.2.1 What is the effect on the concentration of hydroxide ions if more solid calcium hydroxide is added? State only INCREASES, DECREASES, or NO EFFECT. (2)

- 4.2.2 Explain the concept of the *pH scale*. (2)

- 4.2.3 A few drops of a concentrated CaCl_2 solution are added to the equilibrium mixture at 25 °C. Explain fully how this will affect the pH of the solution. [HINT: Make use of Le Chatelier's principle] (5)

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QUESTION 5

5.1 In an aqueous solution, hydrogen sulfide (H_2S) acts as an acid. Saturated aqueous hydrogen sulfide has a K_a value of $8,9 \times 10^{-8}$ at $25^\circ C$.

5.1.1 Define the term *acid*. (2)

5.1.2 **Fully** explain whether hydrogen sulfide is a strong or weak acid. (3)

The K_a expression for the aqueous solution of hydrogen sulphide is:

$$K_a = \frac{[HS^-][H_3O^+]}{[H_2S]}$$

5.1.3 Write the ionisation equation for hydrogen sulfide in an aqueous solution. (4)

5.1.4 Calculate the hydronium ion concentration in saturated aqueous hydrogen sulfide at $25^\circ C$ if the hydroxide ion concentration is $1,06 \times 10^{-10} \text{ mol.dm}^{-3}$. (4)

- 5.1.5 Calculate the concentration of the saturated aqueous hydrogen sulfide solution. (3)

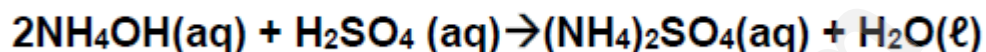
- 5.2 The pH values of solutions of three organic acids of the same concentration were measured.

ACID	pH
X	5
Y	2
Z	3

- 5.2.1 Arrange the solutions of the 3 acids in decreasing order of electrical conductivity. Fully explain the arrangement. (3)

- 5.3 An experiment was carried out to determine the concentration of aqueous ammonia by titrating it with a $0,150 \text{ mol}\cdot\text{dm}^{-3}$ sulfuric acid solution. It was found that 25 cm^3 of the aqueous ammonia required $20,1 \text{ cm}^3$ of the sulfuric acid solution for neutralisation.

The balanced equation for the reaction is below:



- 5.3.1 Calculate the concentration of the aqueous ammonia. (5)

Three acid-base indicators are listed in the table below.

Indicator	Colour in lower pH	Colour in higher pH	pH range
Methyl orange	Red	Yellow	3,1–4,4
Bromothymol blue	Yellow	Blue	6,0–7,6
Phenolphthalein	Colourless	Pink	8,3–10

5.3.2 Identify one indicator that could be used for this experiment to show the end point. (1)

5.3.3 Define *hydrolysis of a salt*. (2)

5.3.4 Using a suitable equation, that is directly related to the definition of hydrolysis, explain whether the solution at the end point will be acidic or basic. In other words, explain whether the salt $(\text{NH}_4)_2\text{SO}_4$ is acidic or basic in an aqueous solution. (5)

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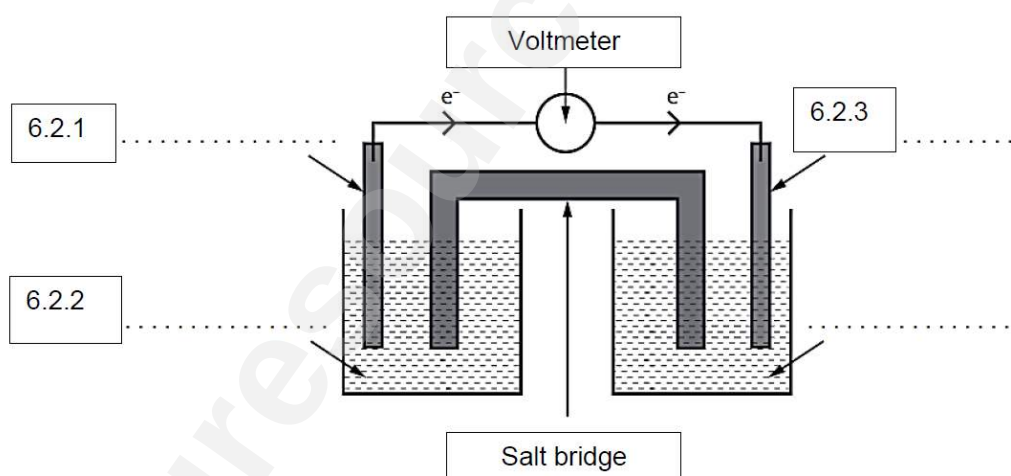
QUESTION 6

A student decides to build a galvanic cell, which is producing a current, consisting of:

- an aluminium electrode, Al(s)
- a tin electrode, Sn(s)
- a solution of aluminium nitrate, $\text{Al(NO}_3)_3 \text{ (aq)}$
- a solution of tin(II) nitrate, $\text{Sn(NO}_3)_2 \text{ (aq)}$

6.1 Define *oxidation*. (1)

6.2 Label the parts numbered 6.2.1- 6.2.3 in the diagram below. Use labels from the **bulleted list above**. Electron flow is represented on the diagram. (3)



6.2.1 _____

6.2.2 _____

6.2.3 _____

6.3 Write down the cell notation for this galvanic cell. Standard conditions and phase indicators are **not** required. (3)

6.4 Calculate the initial emf of this galvanic cell. (2)

6.5 What are the TWO functions of the salt bridge? (2)

6.6 What is the effect of increasing the concentration of the solution in the salt bridge on: (State only INCREASES, DECREASES, or NO EFFECT.) (2)

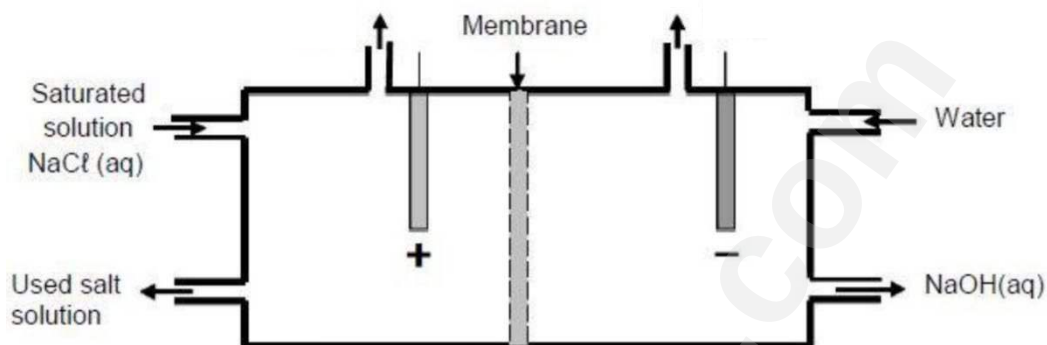
6.6.1 the maximum current the cell can provide?

6.6.2 the initial emf of the cell?

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QUESTION 7

- 7.1 Chlorine gas is produced in industry by the electrolysis of a saturated solution of aqueous sodium chloride (NaCl(aq)). Other products of this process are hydrogen gas and sodium hydroxide. The diagram below illustrates this membrane cell that can be used in this process.



- 7.1.1 Give another name for a saturated solution of sodium chloride. (1)
- _____
- 7.1.2 State the energy conversion that takes place in this cell. (2)
- _____
- 7.1.3 State the main function of the membrane in this cell referring to both the cations and anions present. (2)
- _____
- _____
- 7.1.4 What metal acts as the anode and what gas is produced at the anode? (2)
- _____
- _____
- 7.1.5 Write down the half-reaction that occurs at the cathode in this cell. (2)
- _____

- 7.1.6 Use the relative strengths of the oxidising agents present to explain why sodium metal is NOT produced at the cathode in this cell. (3)

- 7.1.7 Two other types of cells are used in this process, the diaphragm cell and the mercury cell.

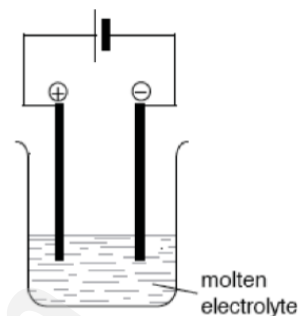
- A) Which cell has is the cheapest to run? (1)

- B) Which cell has the disadvantage of producing a low concentration of NaOH? (1)

- C) In which cell is asbestos a health hazard? (1)

- D) Which cell produces very pure products but has high running costs? (1)

- 7.2 In the electrolysis of a molten GROUP 2 metal chloride, 2,50 A of constant current is passed through a cell for 1,28 hours.



- 7.2.1 Calculate the amount of charge that passed through the cell for 1,28 hours. (3)

- 7.2.2 If the mass of the cathode increases by 5,253 g after the current has been applied, determine the identity of the GROUP 2 metal. (4)

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QUESTION 8

8.1 Consider each of the following pairs of structural isomers:

- A *2-methylpentane* and B *3-methylpentane*.
- C *1-chlorobutane* and D *1-chloro-2-methylpropane*
- E *Propanoic acid* and F *ethyl methanoate*

8.1.1 Compounds A and B are classified as saturated hydrocarbons.
Define a *saturated compound*. (2)

8.1.2 **Name the:**

A) Homologous series to which Compound D belongs: (1)

B) Functional group of Compound E. (1)

C) Two reactants used to prepare Compound F. (2)

8.1.3 Draw/write the

A) Structural formula of Compound E. (2)

- B) Condensed structural formula of Compound D. (2)

- C) Molecular formula of Compound B. (2)

- 8.1.4 Define the term *structural isomers*. (2)

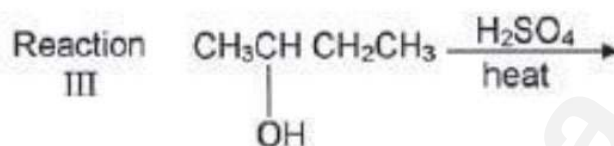
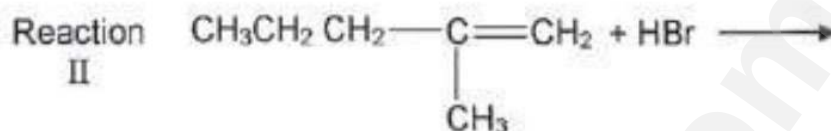
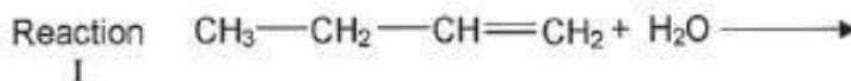
- 8.1.5 Identify the specific type of structural isomer illustrated by:

- A) Compounds A and B (1)

- B) Compounds E and F (1)

- 8.1.6 Explain which compound, C or D has a higher boiling point. (3)

- 8.2 Most organic compounds can undergo certain reactions to produce a variety of organic compounds. Some incomplete reaction equations are shown below:



- 8.2.1 Name the GENERAL type of reaction represented by Reaction III. (1)

- 8.2.2 Both Reactions I and II are examples of addition reactions.
Name the SPECIFIC type of addition reaction that is represented by each reaction. (2)

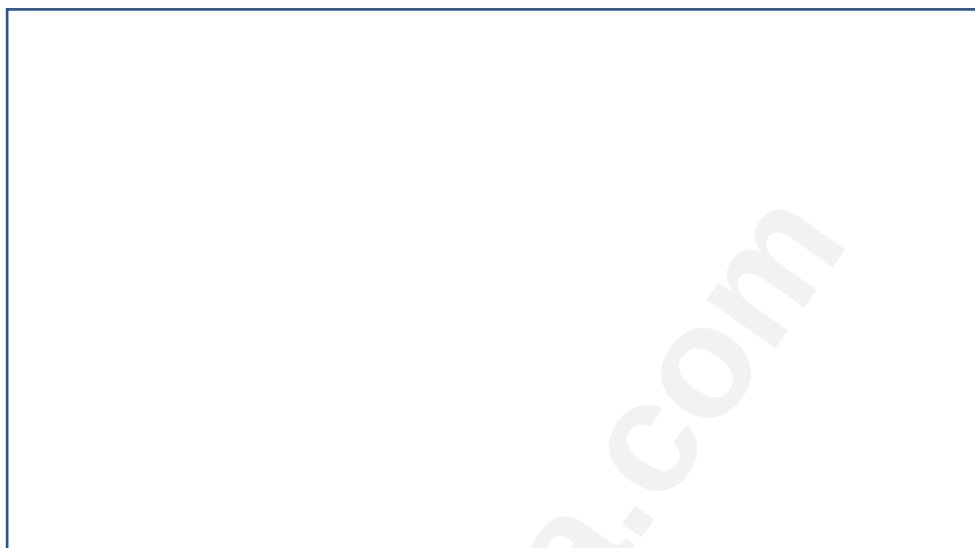
Reaction I: _____

Reaction II: _____

- 8.2.3 Write down the IUPAC name of the product formed in Reaction I. (2)

- 8.2.4 Reaction I only takes place in the presence of a catalyst. Write down the formula of the catalyst used in Reaction I. (1)

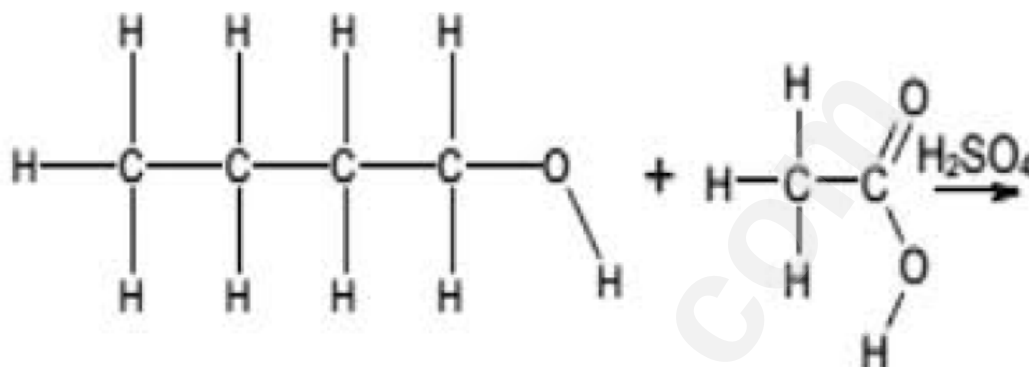
8.2.5 Draw the structural formula of the product in Reaction II. (3)



8.2.6 To which homologous series does the organic product formed in Reaction III belong? (1)

8.2.7 Write down the balanced **molecular** equation of the combustion reaction for the **reactant** in Reaction III. (4)

- 8.3 Consider the following organic reaction, between an alcohol and carboxylic acid. [Note that H_2SO_4 is shown above the arrow.] Answer the questions that follow:



- 8.3.1 What are the two reasons H_2SO_4 is used in this reaction. (2)

- 8.3.2 Draw the structural formula and give the IUPAC name of the organic product formed in this reaction. (5)

[40]

ADDITIONAL SPACE (ALL questions)

REMEMBER TO CLEARLY INDICATE AT THE QUESTION THAT YOU USED THE ADDITIONAL SPACE TO ENSURE THAT ALL ANSWERS ARE MARKED

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