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**ST. MARY'S DSG, KLOOF  
PHYSICAL SCIENCES  
TRIALS PAPER 2: CHEMISTRY**

**GRADE 12  
August 2021**

**TIME: 3 hours + 10 mins reading  
MARKS: 200**

**Examiners and Moderators: Mrs K. Bolton, Mrs G. Main and Mrs T. Kirsten**

**Read the Following Instructions Carefully:**

1. This paper consists of:
  - A question paper of 16 pages
  - A separate yellow answer sheet
  - A green data sheet
  - An answer booklet
2. Read the questions carefully. Answer **ALL** questions.
3. Write your NAME (not your examination number) on your question paper, so you can get your own paper back after Trials.
4. Number your answers exactly as the questions are numbered. **Answer each new question on a new page in your answer booklet.**
5. Please hand in the yellow answer sheet inside your answer booklet.
6. Write legibly and present your work neatly.
7. All working should be shown and units **MUST** be given with answers. Work to two significant figures. **Make sure your calculator is in the correct mode.**
8. Consult the data sheet where necessary.

**Acknowledgements:**

Beaulieu College Chemistry Prelim 2020; Victorian Certificate of Education 2020

St. Mary's Waverley Chemistry Prelims 2020; DBE June 2021; St. Anne's College Chemistry Trials 2020

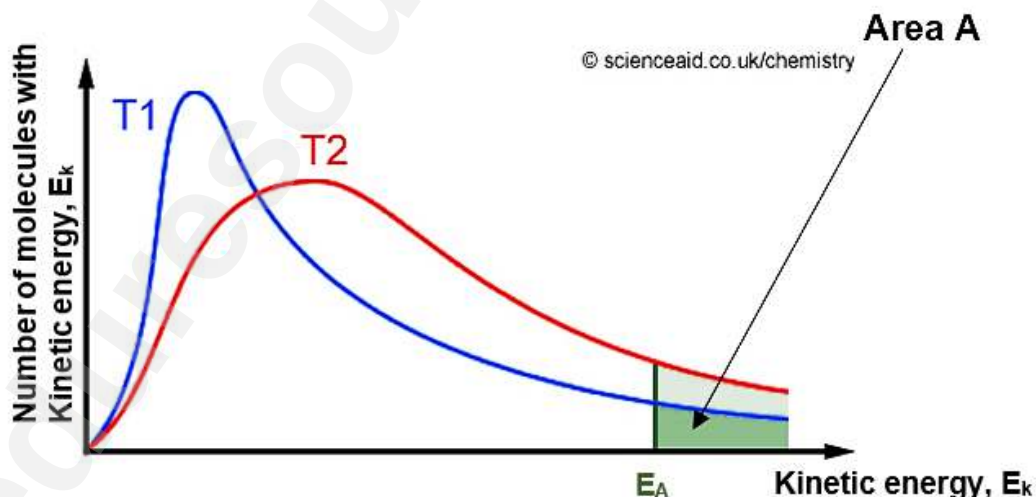
**QUESTION 1**      **MULTIPLE CHOICE**

Answer these questions on the multiple-choice **Answer Sheet** provided. Make a cross (X) in the box corresponding to the letter which you consider to be the most correct.

- 1.1  $\text{CHCl}_3$  and  $\text{Br}_2$  are both liquids at room temperature due to the existence of dipoles. Which dipoles are present in the respective liquids?

|   | $\text{CHCl}_3$                       | $\text{Br}_2$                         |
|---|---------------------------------------|---------------------------------------|
| A | Induced dipoles only                  | Induced dipoles only                  |
| B | Induced dipoles only                  | Induced dipoles and permanent dipoles |
| C | Induced dipoles and permanent dipoles | Induced dipoles and permanent dipoles |
| D | Induced dipoles and permanent dipoles | Induced dipoles only                  |

- 1.2 The diagram below shows the Maxwell-Boltzmann distribution curves for the particles of a sample of a liquid at two different temperatures,  $T_1$  and  $T_2$  :



Which one of the following statements about this graph is INCORRECT?

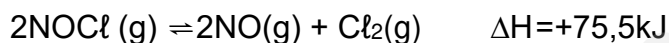
- A The temperature  $T_1$  of the liquid < the temperature  $T_2$  of the liquid
- B The darkly shaded area, Area A, represents the number of particles with enough energy to react at  $T_1$ .
- C The average kinetic energy at  $T_1$  is greater than the average kinetic energy at  $T_2$ .
- D The rate of the reaction at  $T_1$  < the rate of the reaction at  $T_2$ .

1.3 50 cm<sup>3</sup> of a 0,1 mol.dm<sup>-3</sup> solution of sulfuric acid is poured on to 5 g granulated zinc which is inside a glass beaker at room temperature.

Which of the following factors will NOT increase the initial rate of the reaction?

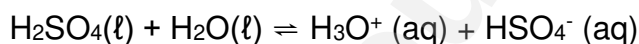
- A Using 100 cm<sup>3</sup> of a 0,1 mol.dm<sup>-3</sup> solution of sulfuric acid at room temperature
- B Using 30 cm<sup>3</sup> of a 0,2 mol.dm<sup>-3</sup> sulfuric acid at room temperature
- C Increasing the temperature of the acid solution to 50 °C
- D Grinding the granulated zinc into powder

1.4 Which statements are CORRECT when temperature increases in this reaction at equilibrium?



|   | Position of equilibrium | Equilibrium constant, K <sub>c</sub> |
|---|-------------------------|--------------------------------------|
| A | Shifts left             | Unchanged                            |
| B | Shifts right            | Decreases                            |
| C | Shifts right            | Unchanged                            |
| D | Shifts right            | Increases                            |

1.5 Sulfuric acid ionises in water according to the following equations:



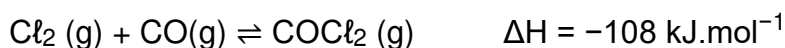
Consider the following statements regarding the ionisation above:

- I: H<sub>2</sub>O (ℓ) acts as a base in both reactions
- II: HSO<sub>4</sub><sup>-</sup> (aq) acts as an ampholyte
- III: SO<sub>4</sub><sup>2-</sup> (aq) is the conjugate base of H<sub>2</sub>SO<sub>4</sub>

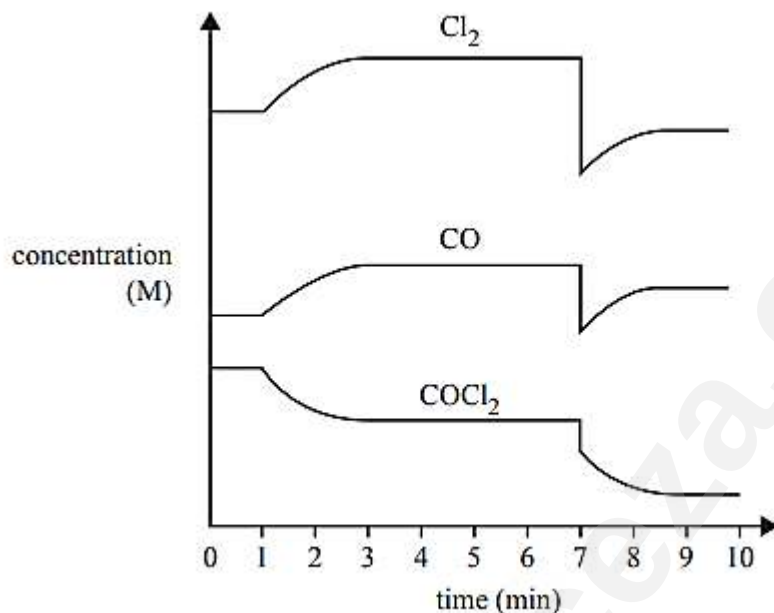
Which of the statements above is/are TRUE?

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

- 1.6 The following equation represents the reaction between chlorine gas,  $\text{Cl}_2$ , and carbon monoxide gas,  $\text{CO}$ .



The concentration–time graph below represents changes to the system



Which of the following identifies the changes to the system that took place at 1 minute and at 7 minutes?

|   | 1 minute                | 7 minutes          |
|---|-------------------------|--------------------|
| A | Increase in temperature | Increase in volume |
| B | Decrease in temperature | Decrease in volume |
| C | Increase in temperature | Decrease in volume |
| D | Decrease in temperature | Increase in volume |

- 1.7 The cell notation of a GALVANIC CELL is given as:



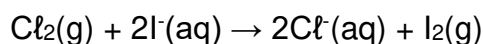
A bulb connected across the two electrodes glows brightly. After some time the brightness of the bulb decreases. This is because ...

- A the concentration of  $\text{Ni}^{2+}$  decreases.
- B the concentration of  $\text{Ag}^{+}$  decreases.
- C the silver electrode is used up.
- D the nickel electrode is used up.

1.8 Which one of the statements about the extraction of aluminium from alumina is **false**?

- A Aluminium is formed at the negative electrode through the process of reduction.
- B Carbon dioxide is a by-product of the extraction process.
- C Oxide ions are reduced at the graphite electrodes.
- D Alumina dissolves in molten cryolite reducing the energy cost of running the smelter.

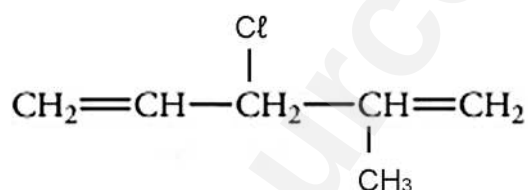
1.9 Consider the following redox reaction:



Which one of the statements regarding this reaction is TRUE?

- A Iodide ions are oxidised
- B Chloride ions are reduced
- C Iodine acts as a reducing agent
- D Chlorine acts as a reducing agent

1.10 Choose the most correct IUPAC name for the molecule shown below:

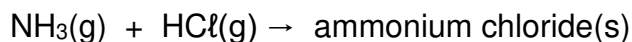


- A 3-chloro-4-methylpenta -1,4-diene
- B 2-methyl-3-chloro-1,4 pentene
- C 3-chloro-2-methylpenta-1,4-diene
- D 2-methyl-3 chloropenta-1,4-diene

[2x10=20]

**QUESTION 2**

Consider the following reaction:

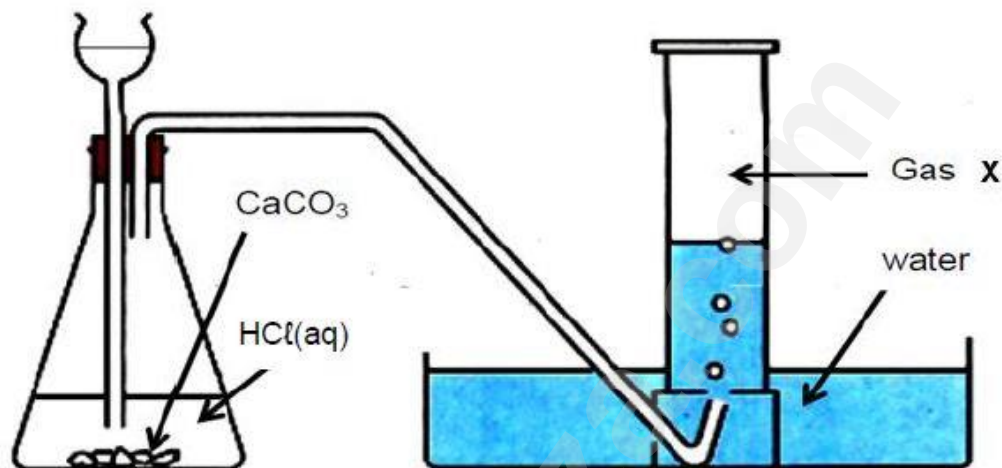


- 2.1 Define *intramolecular bond*. (2)
- 2.2 With regard to  $\text{NH}_3$  and  $\text{HCl}$ , name the SPECIFIC type of intramolecular bond which exists in both of them. (2)
- 2.3.1 Define *electronegativity*. (2)
- 2.3.2 The electronegativity of both N and Cl is 3,0, yet the compounds they form with H, ( $\text{NH}_3$  and  $\text{HCl}$ ), have significantly different boiling points. The boiling point of  $\text{NH}_3$  is 113,5 °C, whilst the boiling point of  $\text{HCl}$  is -85 °C. Explain this significant difference. (4)
- 2.4 Write down the formula of ammonium chloride. (2)
- 2.5 The boiling point of ammonium chloride is 520 °C. With reference to the **structure** of ammonium chloride and its **interparticle forces**, explain why this is so high. (4)
- 2.6 Under which conditions would ammonium chloride be able to conduct electricity? Explain your answer. (3)

**[19]**

**QUESTION 3**

A group of Grade 12 learners uses the reaction between calcium carbonate and hydrochloric acid to investigate one of the factors that influence reaction rate. They use the apparatus shown below.



The reaction that takes place is represented by the following chemical equation:



- 3.1 Two experiments are conducted by using the apparatus shown above.  
The conditions for each experiment are given in the table below.

| Experiment | Mass of $\text{CaCO}_3$ (g) | State of division of $\text{CaCO}_3$ | Concentration of $\text{HCl}$ ( $\text{mol}\cdot\text{dm}^{-3}$ ) | Temperature of $\text{HCl}$ ( $^{\circ}\text{C}$ ) |
|------------|-----------------------------|--------------------------------------|-------------------------------------------------------------------|----------------------------------------------------|
| 1          | 4                           | lumps                                | 0,2                                                               | 40                                                 |
| 2          | 4                           | lumps                                | 0,4                                                               | 40                                                 |

- 3.1.1 Define, in words, the term *reaction rate* in terms of THIS investigation. (2)
- 3.1.2 From the table above, write down the independent variable for this investigation. (1)
- 3.1.3 Give a reason why the learners must use equal masses and the same state of division of  $\text{CaCO}_3(\text{s})$ . (1)

- 3.2 The learners observe that the reaction rate is HIGHER in experiment 2 than in experiment 1.
- 3.2.1 Use the collision theory to explain this observation. (3)
- 3.2.2 Refer to experiment 2 and calculate the volume of hydrochloric acid (in  $\text{cm}^3$ ) that reacts with  $\text{CaCO}_3(\text{s})$ . Assume that  $\text{CaCO}_3$  is the LIMITING REAGENT. (5)
- 3.3 Sketch a POTENTIAL ENERGY versus REACTION COORDINATE graph for this reaction.

Label the axes and indicate the following on the graph:

- (a) Heat of reaction  
(b) Activation energy  
(c) Activated complex (4)
- [16]**

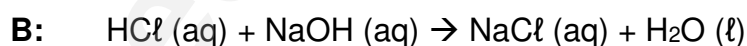
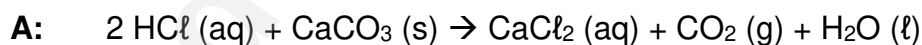
#### **QUESTION 4**

Learners prepare a solution of known concentration by dissolving 2 g of pure sodium hydroxide crystals,  $\text{NaOH}$ , in water in a  $250 \text{ cm}^3$  volumetric flask.

- 4.1 Write down the term for the underlined phrase. (1)
- 4.2 Write down the reaction equation for the dissociation of  $\text{NaOH}$ . (3)
- 4.3 Calculate the concentration of the sodium hydroxide solution. (4)
- 4.4 Calculate the concentration of hydronium ions in the sodium hydroxide solution at  $25^\circ\text{C}$ . (3)

The learners now react 1,5 g of pure  $\text{CaCO}_3$  with  $50 \text{ cm}^3$  dilute  $\text{HCl}$  of unknown concentration.

The EXCESS  $\text{HCl}$  is neutralised with  $25 \text{ cm}^3$  of the  $\text{NaOH}$  solution that they prepared. The balanced equations for the reactions are:



- 4.5  $\text{HCl}$  is a dilute, strong acid. Explain the difference between a dilute and a strong acid. (3)

- 4.6 Refer to the table of indicators below and state which indicator would be most suitable for the titration reaction **B**. (1)

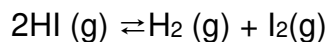
| Indicator        | Colour change<br>Acid to Base | pH range |
|------------------|-------------------------------|----------|
| Methyl orange    | Red to yellow                 | 3,1-4,4  |
| Bromothymol blue | Yellow to blue                | 6,0-7,6  |
| Phenolphthalein  | Colourless to pink            | 8,3-10,0 |

- 4.7 Define *neutralisation/equivalence point*. (2)
- 4.8 Calculate the number of moles of EXCESS  $\text{HCl}$  (aq). (4)
- 4.9 Calculate the initial concentration of the dilute  $\text{HCl}$  (aq). (6)
- 4.10 Consider the salt  $\text{CaCl}_2$  formed in Reaction **A**.
- 4.10.1 Define *hydrolysis* of a salt. (2)
- 4.10.2 Explain whether a solution of  $\text{CaCl}_2$  would be acidic, basic or neutral. Include any relevant hydrolysis equations in your answer. (5)

**[34]**

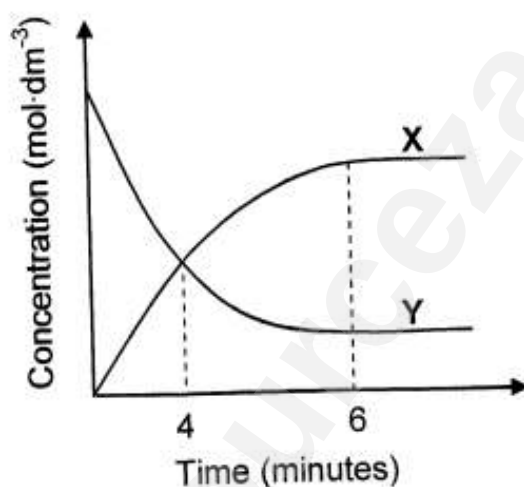
**QUESTION 5**

Pure hydrogen iodide gas, HI (g), of concentration  $1 \text{ mol} \cdot \text{dm}^{-3}$ , is sealed in a  $0,5 \text{ dm}^3$  container at temperature **T**. The reaction reaches equilibrium according to the following balanced equation:



5.1 Explain what is meant by a dynamic chemical equilibrium. (2)

The graph below shows how the concentrations of the reactant and products vary with time during the reaction.



5.2.1 Which ONE of the curves, X or Y, represents the changes in the concentration of the products? Give a reason for the answer. (2)

5.2.2 How does the **rate** of the forward reaction compare to that of the reverse reaction at  $t = 4$  minutes? Choose from HIGHER THAN, LOWER THAN or EQUAL TO. (1)

5.3 The equilibrium constant  $K_c$  for the reaction is 0,04 at temperature **T**.

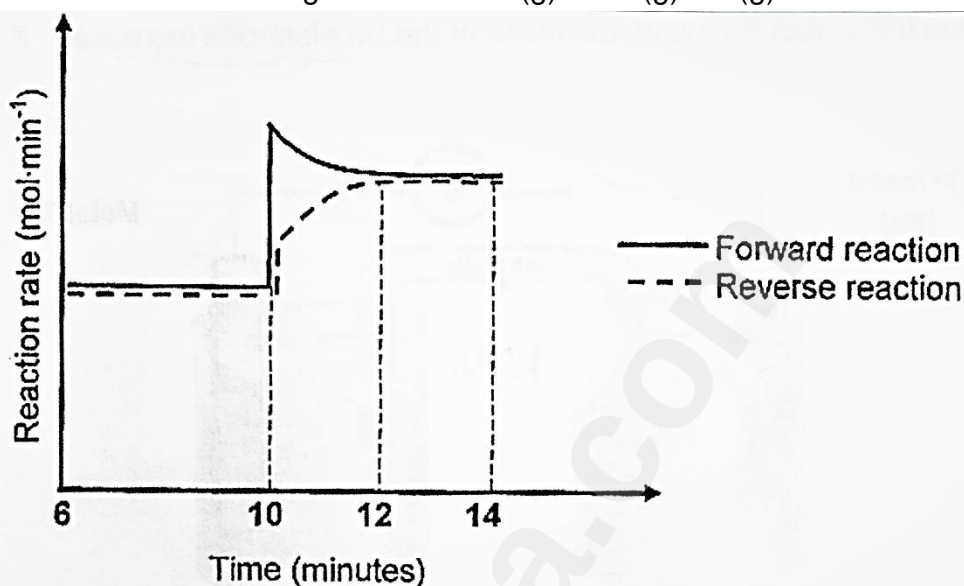
5.3.1 What does the magnitude of the equilibrium constant for this reaction indicate? (2)

5.3.2 Explain the effect of high pressure on the amount of hydrogen and iodine formed. (2)

5.3.3 Write the expression for the equilibrium constant for this reaction. (2)

5.3.4 Using a **concentration** RICE table, calculate the concentration of iodine ( $\text{I}_2$ ), at time  $t = 6$  minutes. (6)

- 5.4 The graph below shows how the rates of the forward and reverse reactions change with time for the following reaction:  $2\text{HI}(\text{g}) \rightleftharpoons \text{H}_2(\text{g}) + \text{I}_2(\text{g})$ .



The temperature of the container is increased at  $t = 10$  minutes.

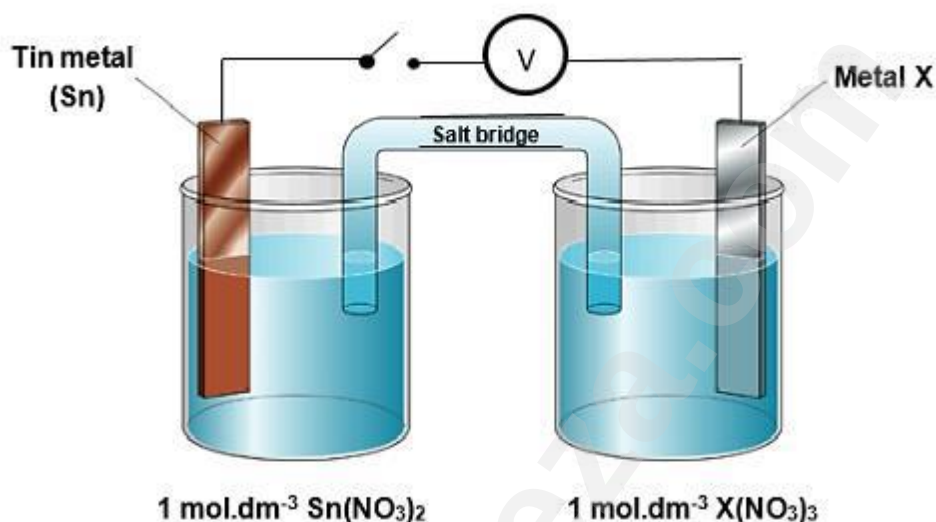
- 5.4.1 Compare the RATES of the forward and reverse reaction at time  $t = 10$  minutes. (2)
- 5.4.2 Using *Le Chateliers Principle*, explain whether the forward reaction is exothermic or endothermic. (4)
- 5.4.3 The graph above has been reproduced on your answer sheet. Draw the rates graph for the following changes:
- 5.4.3.1 At **14 minutes** more  $\text{H}_2$  is added to the system. (2)
- 5.4.3.2 At **18 minutes** a catalyst is added. (2)

[27]

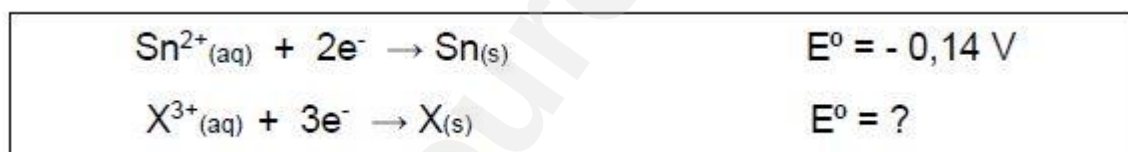
**QUESTION 6**

An electrochemical cell is constructed with an open switch, as shown in the diagram.

- A strip of tin (Sn) and a strip of unknown metal, X are used as electrodes.
- When the switch is closed, the mass of the Sn electrode increases.



The half reactions involved in this cell are as follows:



- 6.1 Name the energy conversion that takes place in this cell. (2)
- 6.2 Which electrode (Sn or X) is the cathode? Justify your answer. (2)
- 6.3 Define the term *anode*. (2)
- 6.4 State the direction of electron flow in the external circuit when the switch is closed. State only from **X to Sn** or from **Sn to X**. (1)
- 6.5 If the standard cell potential for this cell is +0,60 V, calculate the standard electrode potential for the half cell labelled X. (3)
- 6.6 Identify metal X. (1)
- 6.7 Write down the cell notation with standard conditions for this cell. (4)
- 6.8 Write down the balanced net-ionic equation for the overall chemical reaction occurring in this cell. (3)
- 6.9 Suggest a suitable electrolyte for use in the salt bridge. (1)
- 6.10 Explain how the salt bridge maintains neutrality at the **cathode**. (3)

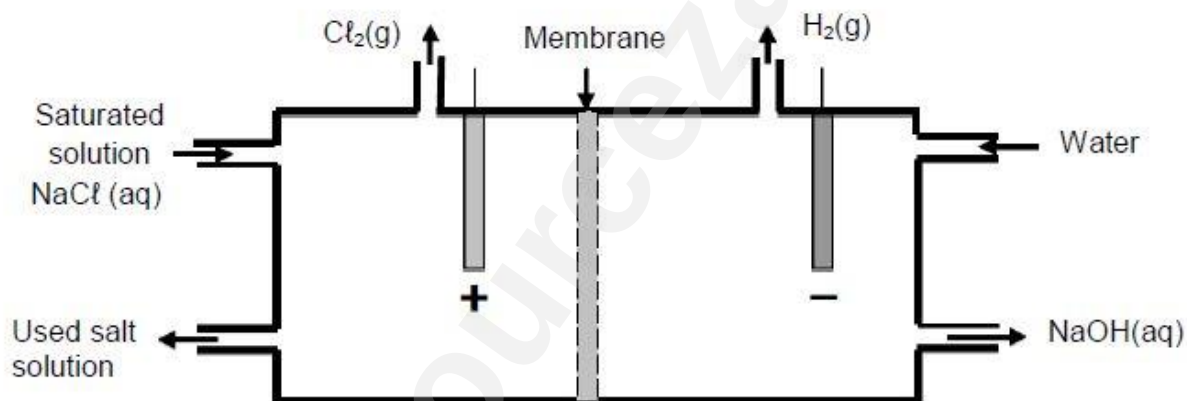
- 6.11 The salt bridge is replaced by one which is narrower and longer than the one shown in the diagram. With the cell operating under standard conditions, state how each of the following will be affected by this change. Write down: **INCREASES, DECREASES OR REMAINS THE SAME.**

- 6.11.1 The emf (1)  
6.11.2 The internal resistance (1)  
6.11.3 The current delivered (1)

[25]

### QUESTION SEVEN

- 7.1 Chlorine gas is produced in industry by the electrolysis of a saturated solution of aqueous sodium chloride ( $\text{NaCl(aq)}$ ). Other products of this process are hydrogen gas and sodium hydroxide. The diagram below illustrates a 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 main function of the membrane in the membrane cell. (2)  
7.1.3 Write down the half-reaction that takes place at the cathode. (2)  
7.1.4 Use the relative strengths of the oxidising agents present to explain why sodium metal is NOT produced at the cathode in the membrane cell. (3)

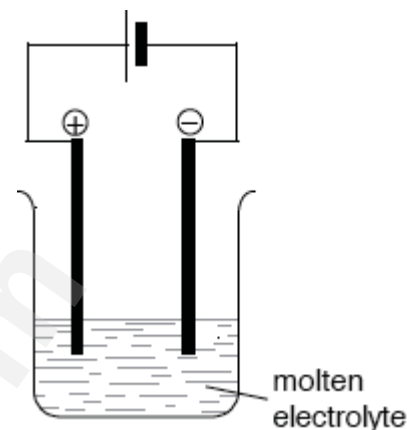
7.2 In the electrolysis of a molten GROUP II/2 metal chloride 2,50 A of constant current is passed through a cell for 1,28 hours.

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

7.2.2 Use the information provided below to determine the **identity** of the group II/2 metal.

- Mass of cathode before application of current: 25,720 g
- Mass of cathode after application of current: 30,949 g

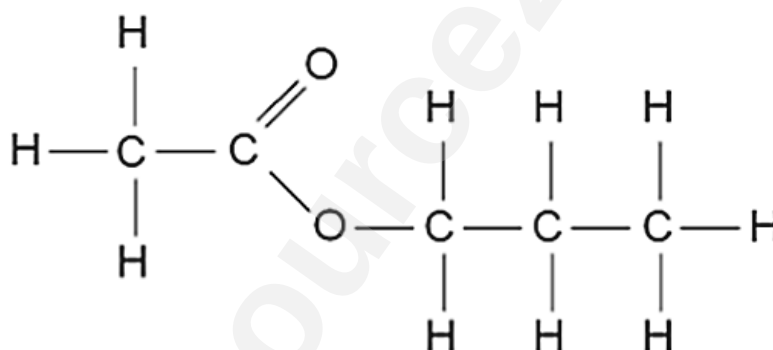
(5)



[16]

### QUESTION 8

The following compound (Z) is produced in a condensation reaction.



8.1 NAME the homologous series to which compound Z belongs. (1)

8.2 Give the IUPAC name of compound Z. (2)

8.3.1 Define *structural isomers*. (2)

8.3.2 Give the IUPAC name of the **functional isomer** of compound Z. (2)

8.4.1 Define a *functional group*. (2)

8.4.2 Give the NAME of the functional group of the isomer named in q 8.3.2 (2)

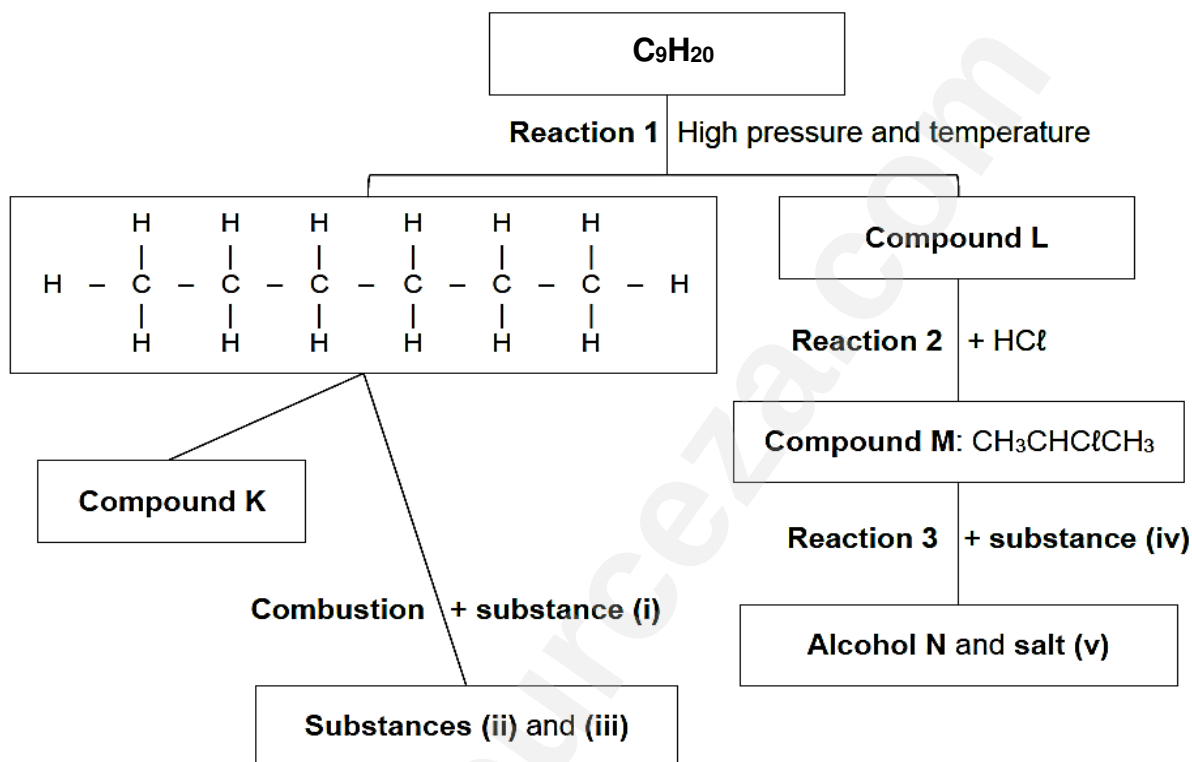
8.5 One of the reaction conditions for the formation of compound Z is heating. Describe a safe way to do this in a laboratory and state why it is necessary. (2)

8.6 What other reaction condition must be met for the formation of compound Z, and why is this necessary? (3)

[16]

**QUESTION 9**

A long chain hydrocarbon containing 9 carbons undergoes **Reaction 1** to produce hexane and **compound L**. Further reactions of each substance are shown in the diagram below.



- 9.1 For **Reaction 1**, identify both the
- 9.1.1 GENERAL type of reaction and
- 9.1.2 SPECIFIC type of reaction that has occurred. (2)
- 9.2 Write the balanced combustion reaction for hexane hence identifying substances (i)–(iii). Use molecular formulae. (Phase labels not required) (3)
- 9.3 **Compound K** is a structural isomer of hexane.
- 9.3.1 Give the IUPAC name for a possible isomer of hexane. (3)
- 9.3.2 What specific type of isomerism is shown by these two isomers? (1)
- 9.4 Give the IUPAC name for **Compound L**. (1)
- 9.5 Refer to **Reaction 2**.
- 9.5.1 Identify the SPECIFIC type of reaction that took place. (1)
- 9.5.2 What specific condition must be met for this reaction to take place? (1)

- 9.6 Refer to **Reaction 3** which produces an alcohol and a salt.
- 9.6.1 Identify the GENERAL type of reaction that took place. (1)
- 9.6.2 Draw the structural formula for **alcohol N**. (3)
- 9.6.3 Identify substance (iv) and salt (v). (2)
- 9.6.4 State the conditions required for this reaction to occur. (2)
- 9.7 Consider **Compounds L, M and N**.
- 9.7.1 Identify the type of intermolecular forces present in each of the compounds. (3)
- 9.7.2 Rank these compounds in *increasing order* of boiling points. (2)
- 9.7.3 Explain your choice of compound with the highest boiling point by referring to relative strengths of intermolecular forces. (2)
- [27]