



GRADE 12 PRELIMINARY EXAMINATION
PHYSICAL SCIENCES PAPER 2
5th September 2025

EXAMINER: Mrs. S. Govender

Time: 180 minutes

MODERATORS: Mr. M Pillay

Marks: 200 Marks

STUDENT NAME: _____

Teacher: _____

Read the Following Instructions Carefully

- 1. This question paper consists of: A question paper of 33 pages and a Data sheet of 2 pages
- 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 Name in the space provided.
- 4. Use the data and formulae whenever necessary.
- 5. Show all the necessary steps in calculations.
- 6. Where appropriate, give your answers to two decimal places.
- 7. It is in your interest to write legibly and to present your work neatly.
- 8. Two extra working-out pages are added to this examination paper (pages 32-33). If you run out of space for a question, use these extra working-out pages. Clearly indicate the number of questions, should you use this extra space.

Question number	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Total
Student Mark									
Question Total	20	21	24	25	27	32	16	35	200

QUESTION 1 MULTIPLE-CHOICE QUESTIONS

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

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

1.1	A	B	C	D	(2)
1.2	A	B	C	D	(2)
1.3	A	B	C	D	(2)
1.4	A	B	C	D	(2)
1.5	A	B	C	D	(2)
1.6	A	B	C	D	(2)
1.7	A	B	C	D	(2)
1.8	A	B	C	D	(2)
1.9	A	B	C	D	(2)
1.10	A	B	C	D	(2)

- 1.1 Hydrogen bonding is a type of intermolecular force that can exist between the molecules of certain compounds. Which one of the following statements below best describes the conditions under which hydrogen bonding is most likely to occur?

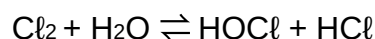
It occurs between...

- A small molecules which contain hydrogen atoms.
- B molecules in which hydrogen is bonded to small atoms with high electronegativity.
- C large molecules which contain both hydrogen and oxygen atoms.
- D molecules in which hydrogen is bonded to small atoms with low electronegativity.

- 1.2 The correct formula for magnesium dichromate is:
- A $\text{Mg}_2(\text{Cr}_2\text{O}_7)_2$
 - B $\text{Mg}_2(\text{Cr}_2\text{O}_7)_3$
 - C $\text{Mg Cr}_2\text{O}_7$
 - D $\text{Mg}_3(\text{Cr}_2\text{O}_7)_2$
- 1.3 Isobutyl formate is an organic ester. Its chemical formula is $\text{C}_5\text{H}_{10}\text{O}_2$. How many oxygen atoms are present in 2 moles of isobutyl formate?
- A $6,022 \times 10^{23}$
 - B $1,024 \times 10^{24}$
 - C $2,408 \times 10^{24}$
 - D $1,024 \times 10^5$
- 1.4 Which ONE of the following statements correctly describes the rate of reaction for the following reaction?
- $$\text{Mg(s)} + 2\text{HCl(aq)} \longrightarrow \text{MgCl}_2\text{(aq)} + \text{H}_2\text{(g)}$$
- A The time it takes to use up the reactants.
 - B The decrease in the concentration of magnesium per unit time.
 - C The time it takes for one of the reactants to be completely used up.
 - D The increase in the concentration of $\text{MgCl}_2\text{(aq)}$ per unit time.
- 1.5 Consider the reaction represented by the following balanced chemical equation:
- $$\text{H}_2\text{(g)} + \text{I}_2\text{(g)} \longrightarrow 2\text{HI(g)}$$
- The system is initially at equilibrium. The pressure increased by decreasing the volume of the container at constant pressure.
- How will the amount of HI(g) and the concentration of HI(g) change?

	Amount of HI(g)	Concentration of HI(g)
A	Remains the same	Remains the same
B	Decreases	Decreases
C	Remains the same	Increases
D	Remains the same	Decreases

- 1.6 Gaseous chlorine (Cl_2), used to disinfect the water in public swimming pools, reacts with water according to the following balanced equation:



The addition of chlorine changes the pH of water in swimming pools. Which of the following substances must be added to public pools periodically to increase the pH?

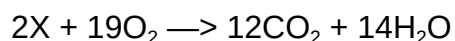
- A NH_4Cl
 - B Na_2CO_3
 - C KCl
 - D H_2SO_4
- 1.7 The organic compounds shown in the table below all have the same molar mass.

	Structural formula of compound	Boiling point ($^{\circ}\text{C}$)
X	<pre> H H H H - C - C - C - O - H H H H </pre>	97
Y	<pre> H O H - C - C \ H O - H </pre>	?
Z	<pre> O H - C / \ O C - H H </pre>	32

Which one of the following is likely to be the boiling point of compound Y?

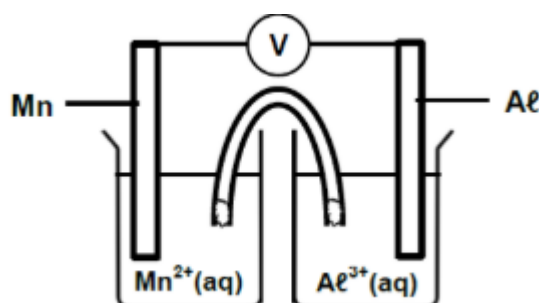
- A 24
- B 40
- C 90
- D 118

- 1.8 Compound X undergoes a combustion reaction according to the following equation:



What is the IUPAC name of compound X?

- A Hexane
 B Hex-2-ene
 C Propane
 D Hexanoic acid
- 1.9 A galvanic cell is set up as shown below, with ONE of the electrolyte solutions having a non-standard concentration. All other conditions are standard. The initial cell emf is found to be 0,55 V.



Which one of the following shows the correct **anode** for this cell and the non-standard **concentration** used in the corresponding electrolyte?

	Anode	Concentration of electrolyte
A	Al	Less than $1 \text{ mol} \cdot \text{dm}^{-3} \text{ Al}^{3+}(\text{aq})$
B	Al	More than $1 \text{ mol} \cdot \text{dm}^{-3} \text{ Al}^{3+}(\text{aq})$
C	Mn	Less than $1 \text{ mol} \cdot \text{dm}^{-3} \text{ Mn}^{2+}(\text{aq})$
D	Mn	More than $1 \text{ mol} \cdot \text{dm}^{-3} \text{ Mn}^{2+}(\text{aq})$

1.10 Consider the following reactions for a metal P:

(i) P reacts with a solution of silver nitrate resulting in a deposit of metallic silver.

(ii) P does not react with a solution of zinc sulphate.

Which ONE of the following correctly lists the metals, P; Ag and Zn in order of **DECREASING** strengths of reducing agents?

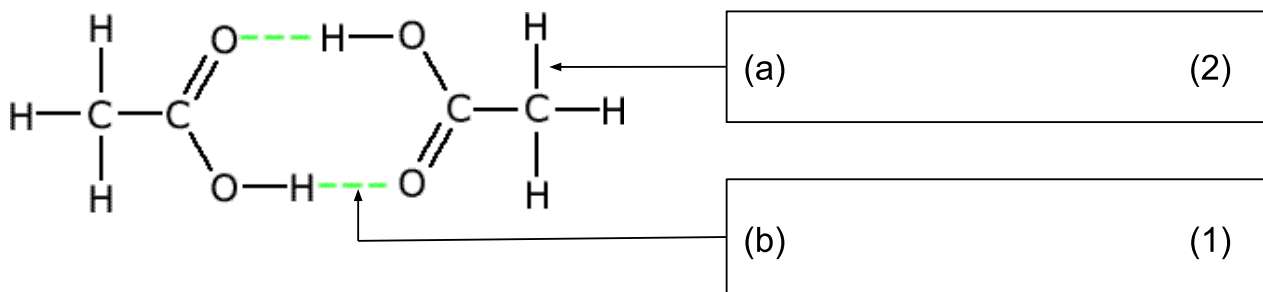
- A P; Ag; Zn
- B Zn; P; Ag
- C Ag; P; Zn
- D Ag; Zn; P

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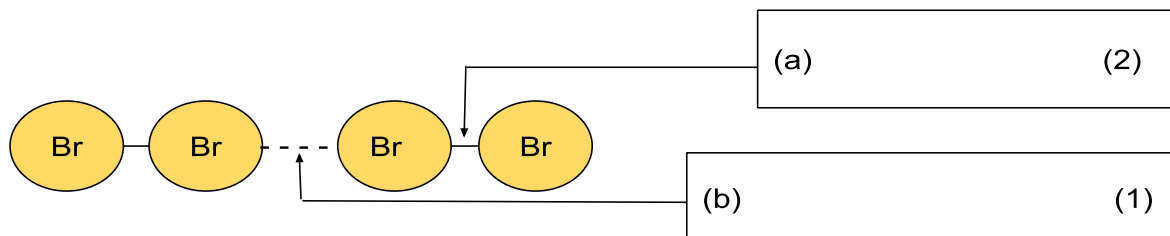
QUESTION 2

2.1 Supply the specific names for the **type of bonding** or **intermolecular force** indicated.

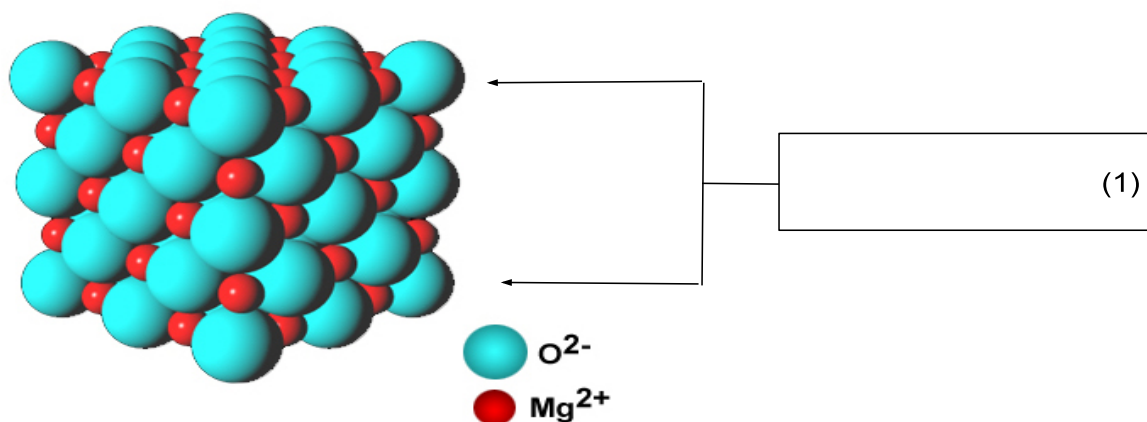
2.1.1 Ethanoic acid



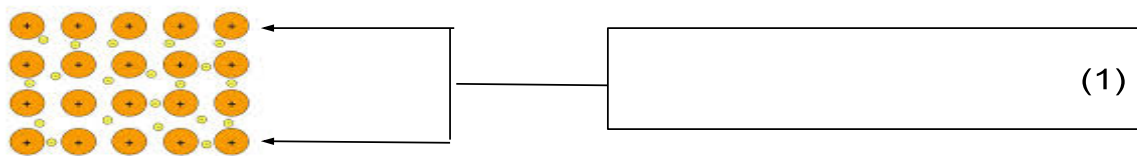
2.1.2 Bromine



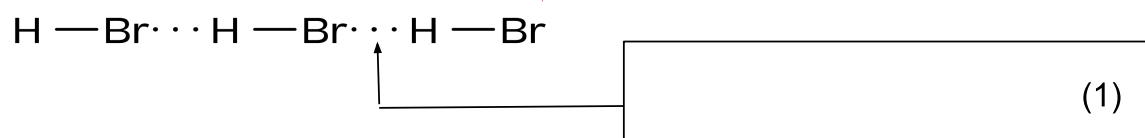
2.1.3 Magnesium oxide



2.1.4 Copper



2.1.5 Hydrogen bromide



2.2 Consider the distribution of electrons in Br_2 and HBr from Question 2.1.

2.2.1 In Br_2 , the electron cloud is unevenly distributed:

Circle the correct word: **PERMANENTLY** / **TEMPORARILY** (1)

2.2.2 In HBr , the electron cloud is unevenly distributed:

Circle the correct word: **PERMANENTLY** / **TEMPORARILY** (1)

2.3 Which one of the substances in Question 2.1 can conduct electricity **in both solid and molten form**?

Name the **charged particles** that move to allow conduction.

Substance: _____

Charged particles that can move: _____ (2)

2.4 At room temperature, bromine has a **higher boiling point** than nitrogen gas (N_2).

2.4.1 Name the force responsible for the higher boiling point of bromine. (1)

2.4.2 Explain why bromine has a higher boiling point than nitrogen gas, although both are non-polar. (4)

2.5 Explain the formation of the interatomic force in magnesium oxide. (3)

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QUESTION 3

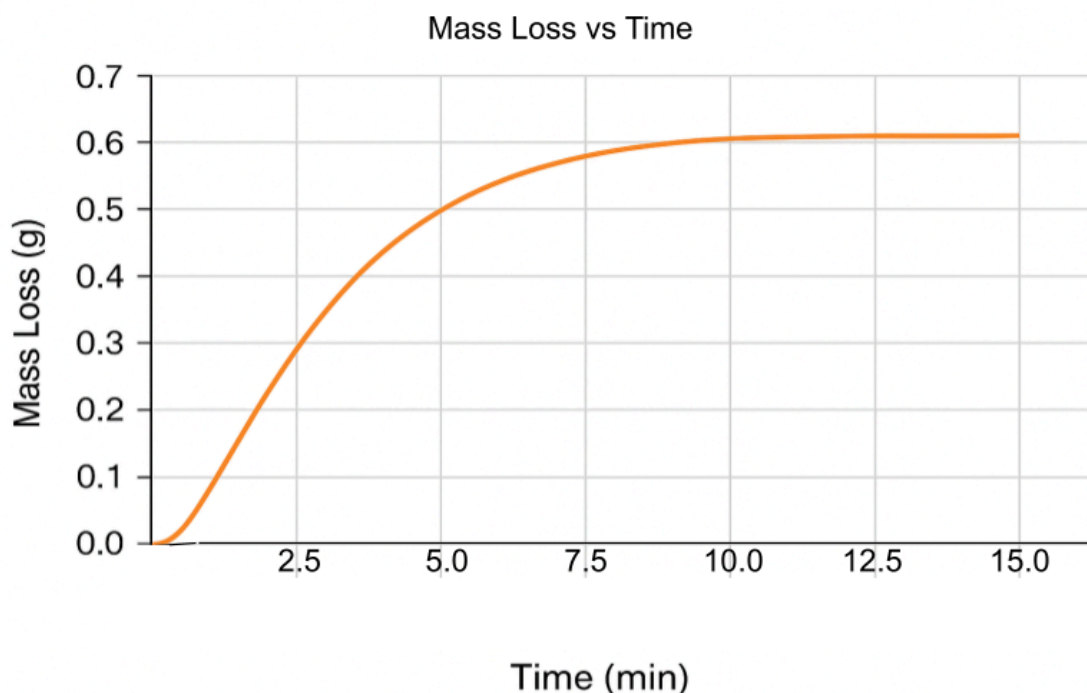
Sodium carbonate and hydrochloric acid react exothermically according to the following balanced equation:



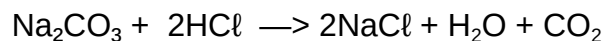
- 3.1 Define *heat of reaction* (ΔH). (2)

- 3.2 Explain why ΔH is **negative** for this reaction. (2)

- 3.3 A student places **2,12 g of sodium carbonate** in a conical flask on an electronic scale and quickly covers the opening with cotton wool to prevent splashing. They add **25 cm³ of 2,0 mol·dm⁻³ hydrochloric acid** to the flask. The loss in mass over time (due to CO₂ release) is recorded and plotted below:



- 3.4 Consider the amount of **Na₂CO₃** and **HCl** used and the chemical equation below:



- 3.4.1 Show by calculation that hydrochloric acid is present in excess. (5)

- 3.4.2 Calculate the total expected **mass of CO₂** released, assuming the reaction goes to completion.

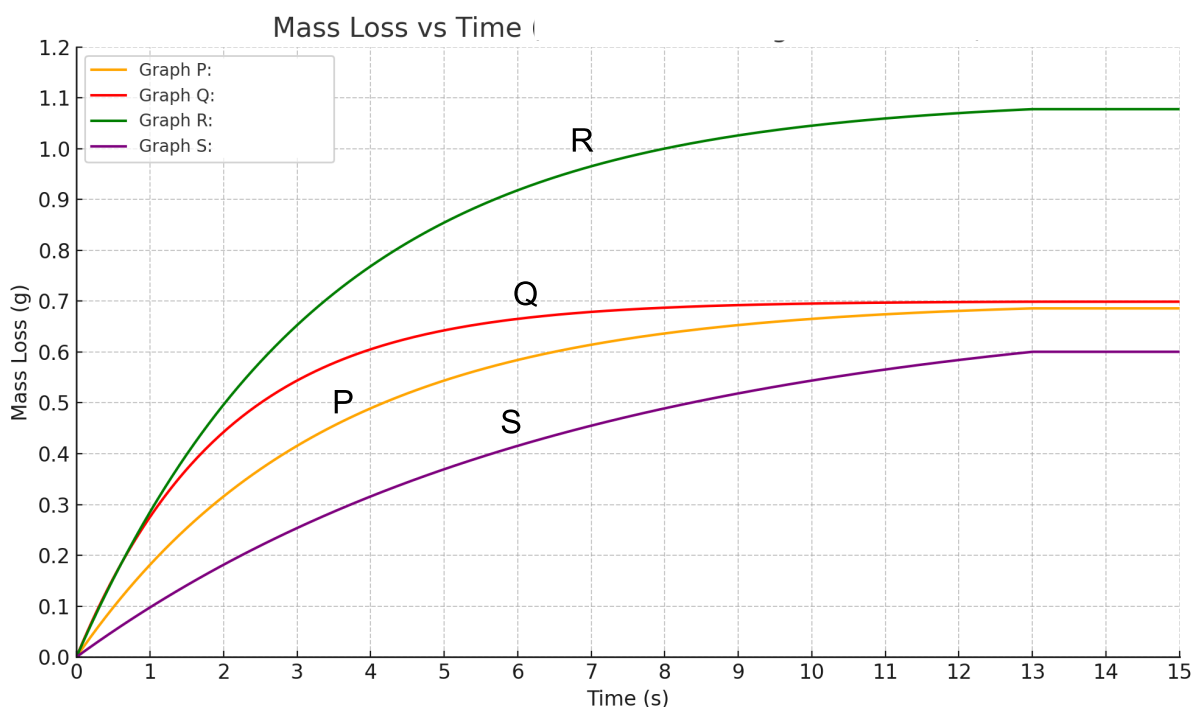
(Molar masses: Na₂CO₃ = 106 g·mol⁻¹; CO₂ = 44 g·mol⁻¹) (3)

- 3.5 Determine the **average rate of the reaction** (in g·min⁻¹) between **3 and 9 minutes**. Use the graph provided. Round your answer to **three decimal places**. (3)

3.6 The rate of reaction changes over time. Choose the correct words to describe the rate and identify the dominant factor influencing the rate in each interval: (6)

Stage	Time interval (min)	Rate description (increases / decreases / constant / zero)	Reason
I	0–5		
II	5–10		
III	13–15		

3.7 The experiment is repeated under different conditions. Each of the graphs below (**Q, R, S**) represents one variation to the original graph **P**.



Indicate which graph (**Q,R,S**) corresponds to the following conditions:

3.7.1 Hydrochloric acid is heated to 40°C before use. _____ (1)

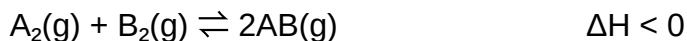
3.7.2 5,00 g of sodium carbonate is used instead of 2,12 g. _____ (1)

3.7.3 Hydrochloric acid concentration is halved. _____ (1)

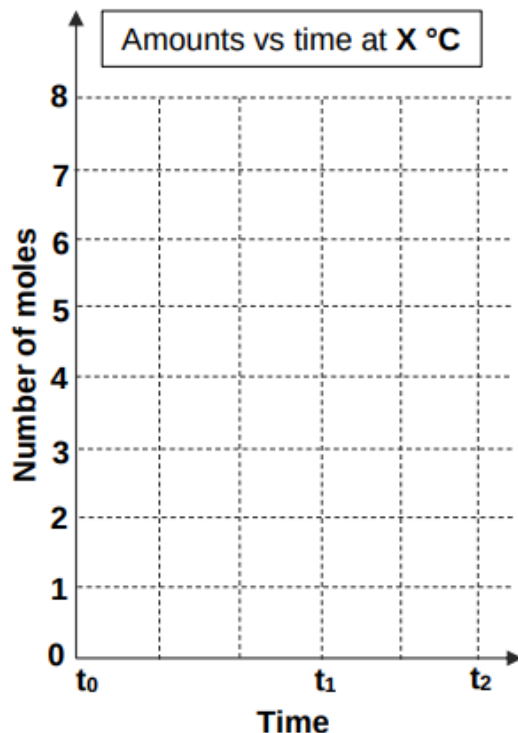
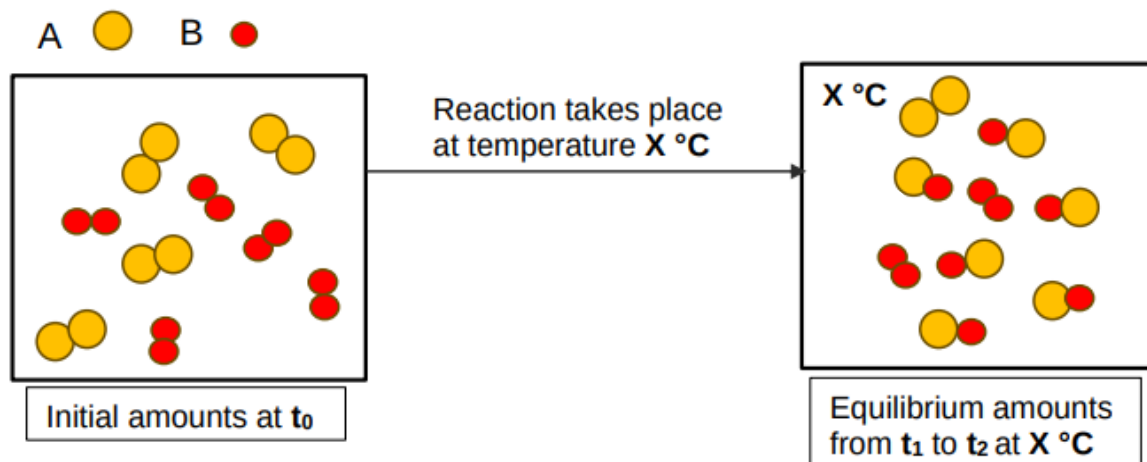
[24]

QUESTION 4

The following reversible reaction takes place in a **2 dm³** container.



The number of moles of each substance in the 2 dm³ container is represented below. Each molecule represents a mole of that substance. Starting with the **same initial amounts**, the reaction is carried out at **two different temperatures**. Equilibrium is established at time **t₁** and maintained until time **t₂**.



4.1 For the reaction occurring at **X °C**, plot the number of moles of A₂, B₂, and AB from **t₀** to **t₂** on the axes provided above. **Label** the three lines clearly. (5)

When the same reaction takes place at $Y^{\circ}\text{C}$, the equilibrium amounts in the 2 dm^3 container are as follows:

- 8 mol A_2
- 9 mol B_2
- 4 mol AB

4.2 Write down the K_c expression for the reaction. (2)

4.3 Calculate K_c at $X^{\circ}\text{C}$. (2)

4.4 Calculate K_c at $Y^{\circ}\text{C}$. (2)

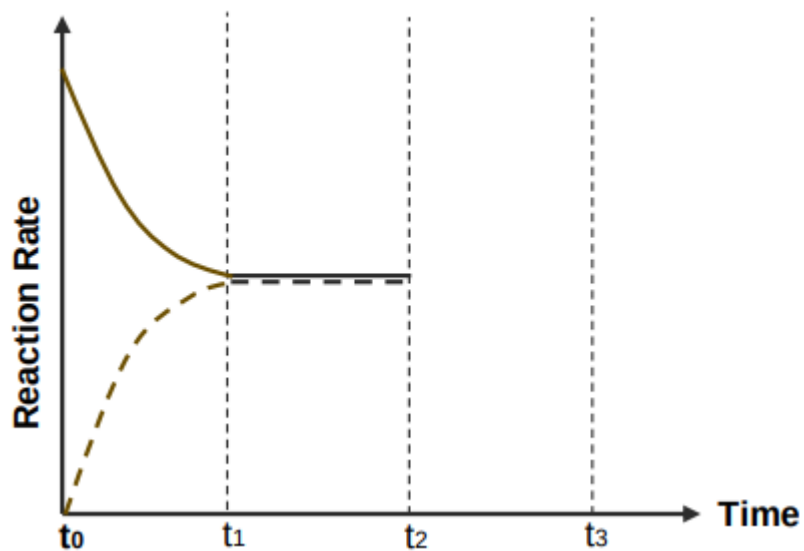
- 4.5 Which of **X °C** or **Y °C** is the lower temperature? Explain the answer by applying Le Châtelier's Principle. (5)

- 4.6 Consider the reaction taking place at **X °C**. At **t₂**, the volume of the container is increased at constant temperature. Explain the effect (if any) of the decrease in the volume on ...

- 4.6.1 the reaction rates (refer to the collision theory in your answer). (3)

- 4.6.2 the amounts of each substance in the container (refer to Le Châtelier's Principle in your answer). (3)

- 4.7 In another experiment involving the same reaction at $X^{\circ}\text{C}$, some $\text{B}_2(\text{g})$ is removed from the equilibrium mixture at t_2 . Equilibrium is reestablished before t_3 . On the axes below, show how the reaction rates will be affected between t_2 and t_3 . (3)



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QUESTION 5

The table below shows the properties of several diprotic acids.

Name	Molar mass ($\text{g}\cdot\text{mol}^{-1}$)	K_a at 25 °C
Fumaric acid	116,07	$3,3 \times 10^{-5}$
Malic acid	134,09	$3,5 \times 10^{-4}$
Oxalic acid	126,07	$5,6 \times 10^{-2}$
Glutaric acid	132,12	$6,8 \times 10^{-3}$

5.1 Define a *weak acid*. (2)

5.2 Which acid in the table is the **strongest**? Give a reason for your answer. (2)

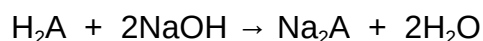
5.3 Malic acid is $\text{H}_2\text{C}_4\text{H}_4\text{O}_5$. The $\text{HC}_4\text{H}_4\text{O}_5^-$ ion is **amphiprotic**.

5.3.1 Define an *amphiprotic substance*. (2)

5.3.2 Write the formula of the **conjugate base** of $\text{HC}_4\text{H}_4\text{O}_5^-$. (1)

- 5.3.3 Sodium malate, $\text{Na}_2\text{C}_4\text{H}_4\text{O}_5$, is a salt. State whether it is **acidic, basic, or neutral**.
Write a relevant reaction equation. (3)

The Grade 12 learners were required to standardise a sodium hydroxide solution by titration with one of the diprotic acids in the table on page 18, which is represented as H_2A . The following balanced equation applies:



1,2 g of the unknown acid is dissolved in water and diluted to **250 cm³**.
A **25,0 cm³** volume is titrated with **0,100 mol·dm⁻³ NaOH**, and the average volume required to reach the endpoint is **22,8 cm³**.

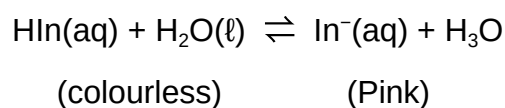
- 5.4 Define a *standard solution*. (2)

- 5.5 Calculate the **molar concentration** of the unknown acid solution.
Give your answer to **4 decimal places**. (4)

5.6 Using your answer and the data in the table above, **identify** the unknown acid by calculation. (4)

5.7 Differentiate between endpoint and equivalence point. (2)

5.8 Phenolphthalein is used in the titration. It follows this equilibrium:



5.8.1 What colour indicates the endpoint of the titration? (1)

5.8.2 Use Le Châtelier's Principle to explain this colour change. (4)

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QUESTION 6

Bromine water is a strong oxidising agent. When added to a solution of tin(II) chloride, a redox reaction occurs.

6.1 Define an *oxidising agent*. (2)

6.2 Give a reason why bromine (Br_2) is a strong oxidising agent. (2)

Bromine water is added to a solution of **tin(II) chloride** (SnCl_2).

(a) Identify the spectator ion in this reaction. (1)

(b) Write equations for:

(i) The reduction half-reaction (1)

(ii) The oxidation half-reaction (1)

(iii) The net ionic reaction (2)

- (c) Prove by calculation that this reaction is spontaneous at standard conditions.
Use the following standard reduction potentials:



(4)

- 6.3 Using the table of standard electrode potentials, refer to the relative strengths of the oxidising agents at standard conditions to explain:

- (a) Whether bromine will oxidise manganese to manganese(II). (2)

- (b) Whether bromine will further oxidise manganese(II) to permanganate (MnO_4^-). (2)

- 6.4 A standard hydrogen electrode is connected to a half-cell containing an acidified solution of iodate ions (IO_3^-) and iodide ions (I^-), also at standard conditions.

- 6.4.1 What metal should the electrode in the iodate/iodide half-cell be made of? (1)

- 6.4.2 What is the function of the standard hydrogen electrode? (2)

6.4.3 List the specific conditions required for the standard hydrogen electrode to function correctly. (3)

6.4.4 When this particular cell operates, state whether **OXIDATION** or **REDUCTION** will occur at the standard hydrogen electrode. Give a reason. (3)

6.4.5 Why does the electrolyte in the iodate/iodide half-cell need to be acidified? (1)

6.4.6 The aqueous electrolyte solutions used in this cell are as follows:

- Potassium iodate
- Potassium iodide
- Sulfuric acid
- Potassium nitrate for the salt bridge

(a) Write the chemical formulae of:

(i) Potassium iodate _____ (1)

(ii) Potassium iodide _____ (1)

- (b) One of the reasons potassium nitrate is used in the salt bridge is because it is highly soluble in water.

Explain the significance of this property with regard to the operation of the electrochemical cell.

(2)

- (c) The iodate half-cell uses sulfuric acid. The solution's pH changes as the cell operates.

Circle the correct answer:

The pH will

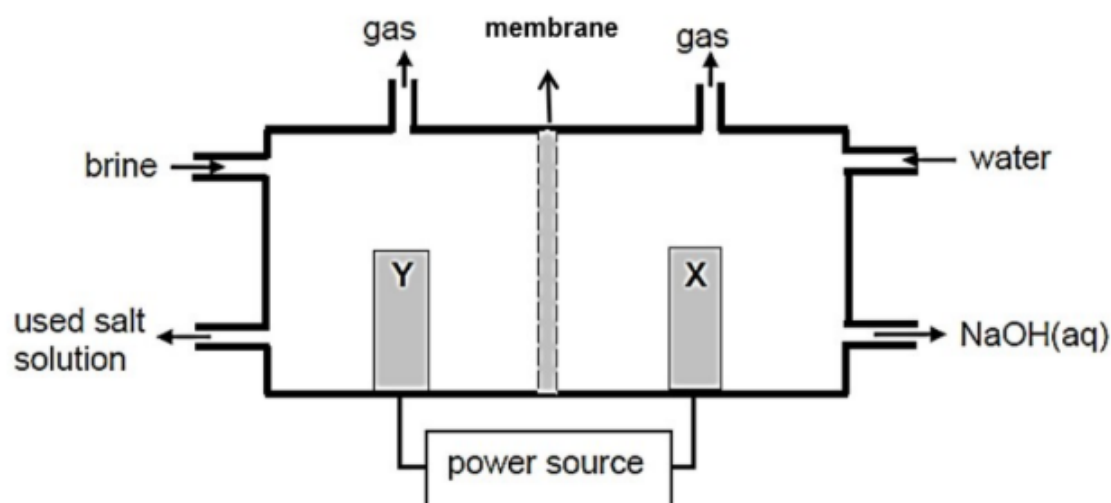
(i) **INCREASE** OR (ii) **DECREASE**

(1)

[32]

QUESTION 7

A simplified diagram of a cell used in the chlor-alkali industry is shown below:



7.1 Write down the chemical formula of brine. (1)

7.2 At which electrode, X or Y, is chlorine gas formed? _____ (1)

7.3 Write down the half-reaction taking place at the cathode. (2)

7.4 Write down the net overall equation for this reaction. (3)

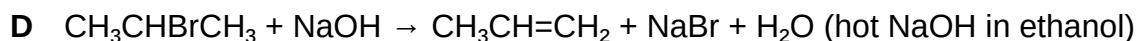
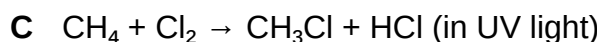
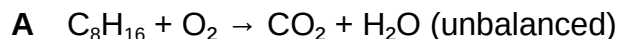
7.5 Explain why sodium metal is NOT produced at the cathode in the membrane cell. (2)

7.6 A current of 2000 A is passed through this cell for 1,5 minutes. Calculate the mass of chlorine gas produced during this time. (7)

[16]

QUESTION 8

Consider equations **A to E** below, each representing a different organic reaction:



8.1 Give the general reaction type for reactions **A** and **B**:

8.1.1 **A** _____ (1)

8.1.2 **B** _____ (1)

8.2 Give the specific reaction type for reactions **C**, **D**, and **E**:

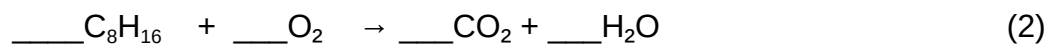
8.2.1 **C** _____ (1)

8.2.2 **D** _____ (1)

8.2.3 **E** _____ (1)

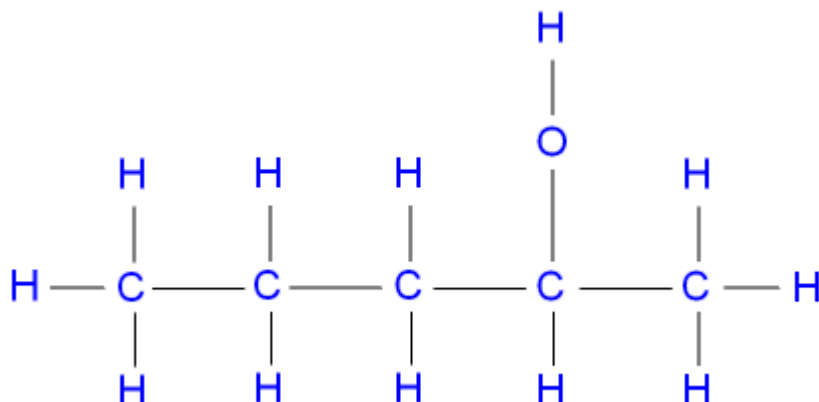
8.3 Consider reaction **A**:

8.3.1 Balance the following equation:



8.3.2 Define the term *structural isomers*. (2)

8.3.3 The compound below is one possible isomer for $\text{C}_5\text{H}_{12}\text{O}$



(a) Write the condensed structural formula of a positional isomer of the given compound. (2)

- (b) Draw a structural formula of the CHAIN isomer of the given compound. (2)

- (c) Give the IUPAC name of the isomer from Question 8.3.3 that is likely to have the **lowest** boiling point. (3)

8.4 Consider reaction **B**:

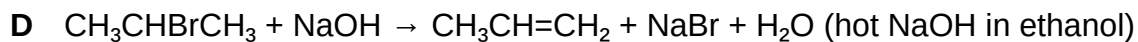
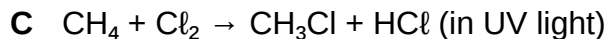


- 8.4.1 Name the **functional group** in the organic product. (1)

- 8.4.2 Identify a suitable catalyst for this reaction. (1)

- 8.4.3 Give the **IUPAC name** of the organic product. (2)

Consider reactions **C - E** :



8.5 Consider equation **C**.

8.5.1 Why is ultraviolet light necessary? (1)

8.5.2 Give the IUPAC name of the organic product of the reaction. (2)

8.6 Consider Equation **D**:

8.6.1 Give the IUPAC name of the organic reactant of the reaction. (2)

8.6.2 When the reactant is heated under reflux in dilute aqueous NaOH, a different organic product forms.

(a) Give the IUPAC name of this different organic product. (2)

(b) Name the specific type of reaction that occurs under these conditions. (1)

8.7 Consider Equation **E**:

8.7.1 Circle the correct option below and give an explanation: (3)
The organic **REACTANT** or **PRODUCT** is saturated because...

8.7.2 Name the reagent used in the standard laboratory test to distinguish between saturated and unsaturated compounds. (1)

8.7.3 Name the homologous series to which the product of reaction **E** belongs. (1)

8.7.4 Give the IUPAC name of the organic reactant. (2)

[35]

Remember to clearly indicate at the question that you used the additional space to ensure that all answers are marked. Otherwise, it will be considered rough work.

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ADDITIONAL PAGE (ALL QUESTIONS)

Remember to clearly indicate at the question that you used the additional space to ensure that all answers are marked. Otherwise, it will be considered rough work.

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