

Total Mark

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PHYSICAL SCIENCES PAPER II
GRADE 12 PRELIMINARY EXAMINATION
11 SEPTEMBER 2026
SESSION 1

EXAMINERS: N. Glanville, N. Govender and M Muller

MODERATOR: External

Time: 3 hours

Total Marks: 200 marks

Student Name: _____

Teacher: NGL / NGO

PLEASE READ THE FOLLOWING INSTRUCTIONS CAREFULLY

1. This question paper consists of 35 pages as well as a 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 **name** in the space provided and circle your teachers' initials.
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. Four blank pages (pages 7, 19, 30 and 33) are included in this examination paper and additional graph paper has been provided on page 34. If you run out of space for an answer, use these pages. Clearly indicate the number of your answer should you use this extra space.

	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Total
Student Mark									
Question Total	20	16	38	24	29	27	17	29	200

QUESTION 1

- 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.

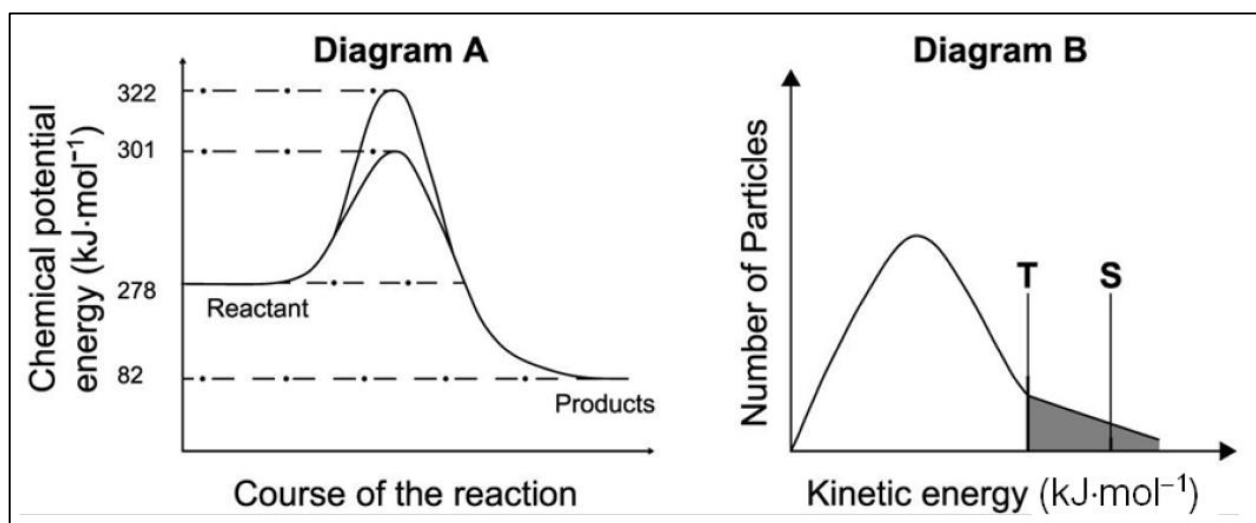
A	B	~~C~~	D
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Here the option C has been marked as an example.

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 Which one of the statements about carbon dioxide is correct? (2)
- A It conducts electricity when solid due to its delocalized electrons.
B It conducts electricity when molten due to mobile ions.
C It has a high melting point due to its giant structure with strong covalent bonds.
D It has a low boiling point due to the weak London forces between molecules.
- 1.2 Adding a catalyst to a reaction in equilibrium will speed up ... (2)
- A the forward reaction more than the reverse reaction and increase the yield.
B the forward and reverse reactions equally and increase the yield.
C the forward and reverse reactions equally and not affect the yield
D the forward reaction more than the reverse reaction and not affect the yield.

- 1.3 The diagrams below show A, the energy profile graph, and B, the Maxwell-Boltzmann distribution, for the same chemical reaction. The effect of a catalyst is indicated as it normally is.



The value represented by the letter T, in $\text{kJ}\cdot\text{mol}^{-1}$, is ... (2)

- A $322 - 278$
- B 322
- C 301
- D $301 - 278$

- 1.4 In which reaction is water acting as a Brønsted-Lowry acid? (2)

- A $\text{H}_2\text{O} + \text{HCl} \rightarrow \text{H}_3\text{O}^+ + \text{Cl}^-$
- B $\text{H}_2\text{O} + \text{NH}_3 \rightarrow \text{NH}_4^+ + \text{OH}^-$
- C $2\text{H}_2\text{O} + 2\text{K} \rightarrow \text{H}_2 + 2\text{KOH}$
- D $\text{H}_2\text{O} + \text{SO}_2 \rightarrow \text{H}_2\text{SO}_3$

1.5 The pH values of equal concentrations of the following salt solutions are compared. (2)

- KNO_3
- NH_4NO_3
- CH_3COOK

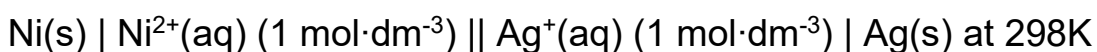
Identify the combination with the highest pH and the lowest pH.

	Highest pH	Lowest pH
A	CH_3COOK	NH_4NO_3
B	CH_3COOK	KNO_3
C	NH_4NO_3	CH_3COOK
D	KNO_3	CH_3COOK

1.6 During the electrolysis of aqueous KCl solution, using inert electrodes, gaseous hydrogen evolved at one electrode and gaseous chlorine at the other electrode. Which of the following responses best describes the reaction at the cathode? (2)

	Half reaction	Process
A	$2\text{H}_2\text{O} + 2\text{e}^- \rightarrow \text{H}_2 + 2\text{OH}^-$	Reduction
B	$2\text{Cl}^- \rightarrow \text{Cl}_2 + 2\text{e}^-$	Reduction
C	$2\text{H}_2\text{O} + 2\text{e}^- \rightarrow \text{H}_2 + 2\text{OH}^-$	Oxidation
D	$2\text{Cl}^- \rightarrow \text{Cl}_2 + 2\text{e}^-$	Oxidation

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 ... (2)

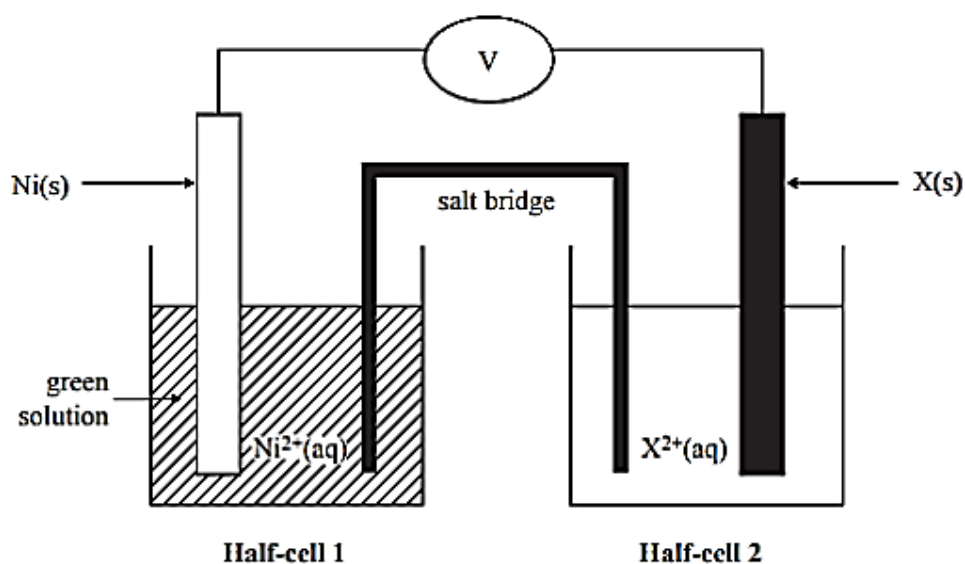
- A the concentration of Ni^{2+} decreases.
- B the silver electrode is used up.
- C the concentration of Ag^+ decreases.
- D the nickel electrode is used up.

1.8 At the start of the day, a student set up a galvanic cell using two electrodes: nickel, Ni, and metal X and their electrolyte solutions Ni^{2+} and X^{2+} . The colour of the Ni^{2+} solution is green. This set-up is shown in the diagram below.

Consider the following alternative metals that could be used to replace metal X:

1. zinc, Zn
2. lead, Pb
3. cadmium, Cd
4. copper, Cu

At the end of the day, the student checked the colour of the solution in Half-cell 1 and observed that the solution was a darker green colour. Which of the alternative metals could cause the colour of Half-cell 1 to become a darker green? (2)

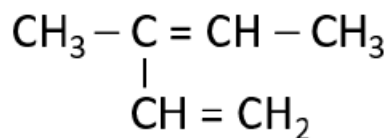


- A metals 1 or 3
B metals 2 or 4
C metals 1, 2 or 3
D metals 3 or 4

1.9 Which of the following options lists ONLY organic molecules? (2)

- A C_2H_4 ; CO_2 ; CH_4O
- B HCN ; C_2H_6 ; CH_2O_2
- C C_3H_8 ; $\text{C}_3\text{H}_7\text{Cl}$; $\text{C}_3\text{H}_5\text{OH}$
- D C ; C_4H_8 ; C_4H_{10}

1.10 Which is the correct IUPAC name for the following organic compound? (2)



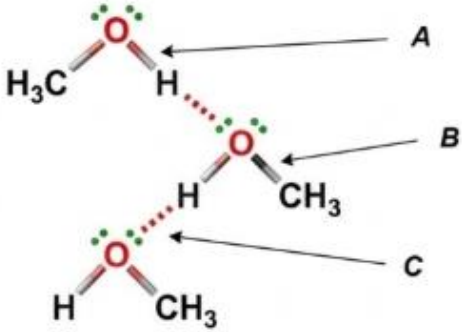
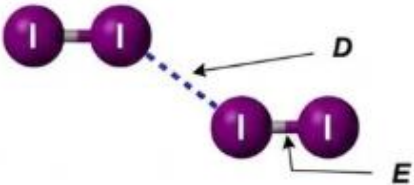
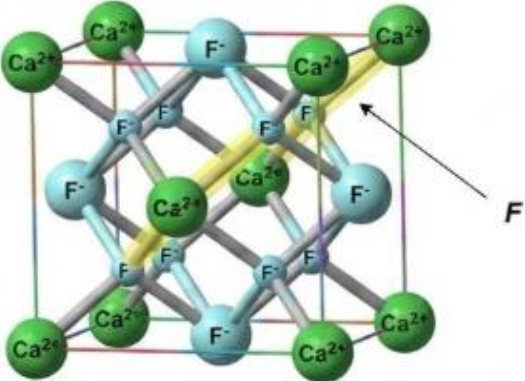
- A hexa-1,3-diene
- B 3-methylpent-2,4-diene
- C 3-methylpenta-1,3-diene
- D 2-ethylbuta-2,4-diene

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QUESTION 2

- 2.1 The table below shows a range of chemical compounds and their structures.
The labels **A** to **F** refer to either an intermolecular force or a chemical bond.

Name	Structure
methanol	
iodine	
calcium fluoride	

2.1.1 Define *electronegativity*.

(2)

2.1.2 State the main difference between an *intermolecular force* and a *chemical bond*. (2)

2.1.3 Referring to the table choose from the letters **A** to **F** to answer the following: (4)

- a) The most polar covalent bond.

- b) A hydrogen bond intermolecular force.

- c) A pure covalent bond.

- d) An ionic bond.

2.2 The boiling point of methanol is 64,7 °C, while the boiling point of iodine is significantly higher at 184,3 °C.

2.2.1 Explain the **origin** of the London intermolecular forces present in iodine. (4)

2.2.2 Referring to ALL intermolecular forces present in the two substances, explain why iodine has a higher boiling point than methanol. (4)

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QUESTION 3

3.1 50 cm³ of 0,4 mol·dm⁻³ phosphoric acid is added to 13,2 g of powdered BaCO₃. They react at **STP** to form a salt, X, as shown in the balanced chemical equation.



3.1.1 Write the chemical formula of the salt X. (1)

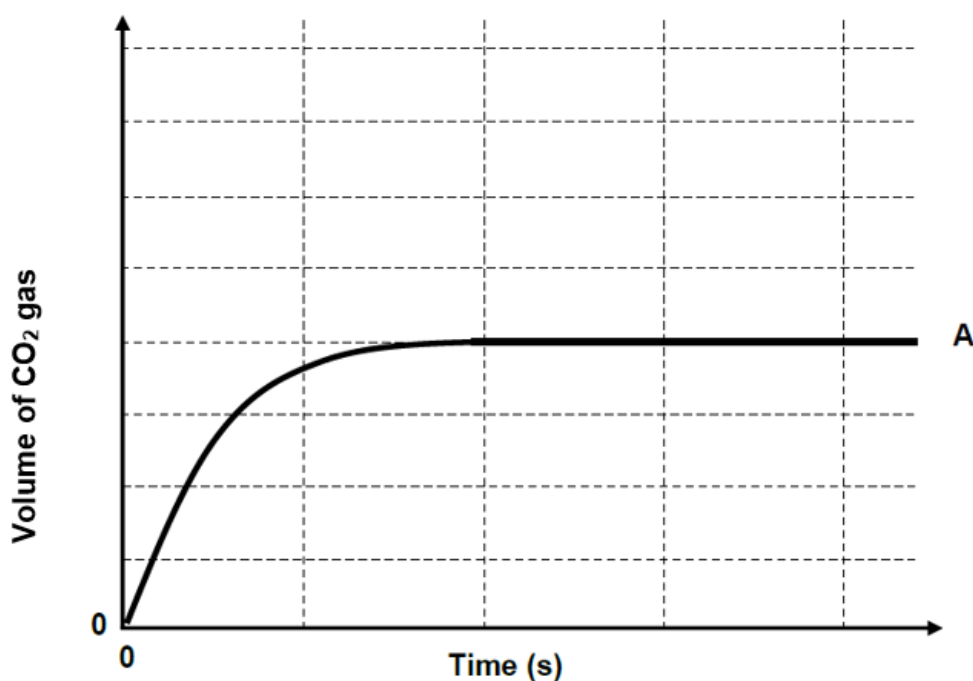
3.1.2 Calculate the number of moles in 50 cm³ of 0,4 mol·dm⁻³ phosphoric acid. (4)

3.1.3 **Phosphoric acid is the limiting reagent.** Calculate the number of moles of BaCO₃ that are in excess. (Give your answer to 3 decimal places). (5)

3.1.4 Calculate the volume of carbon dioxide gas produced in this reaction, if the yield is 83,2% (5)

3.1.5 Define *reaction rate*. (2)

The rate of this reaction is monitored by measuring the volume of carbon dioxide gas produced at set time intervals. The results for the conditions given **at the start of question 3 on page 11 are** shown in the sketch **labelled A on the next page**.



3.1.6 On the same set of axes shown for experiment A, sketch the graph for each of the following experiments:

- Using $0,6 \text{ mol} \cdot \text{dm}^{-3}$ phosphoric acid. All other conditions remain unchanged.
Label this as graph B. (2)
- Using the same mass of a single chunk of BaCO_3 . All other conditions remain unchanged. **Label this as graph C.** (2)

3.1.7 Use the collision theory to explain how decreasing the temperature would decrease the rate of this reaction. (4)

3.2 Solutions of $\text{Na}_2\text{S}_2\text{O}_3$ and hydrochloric acid react as follows:



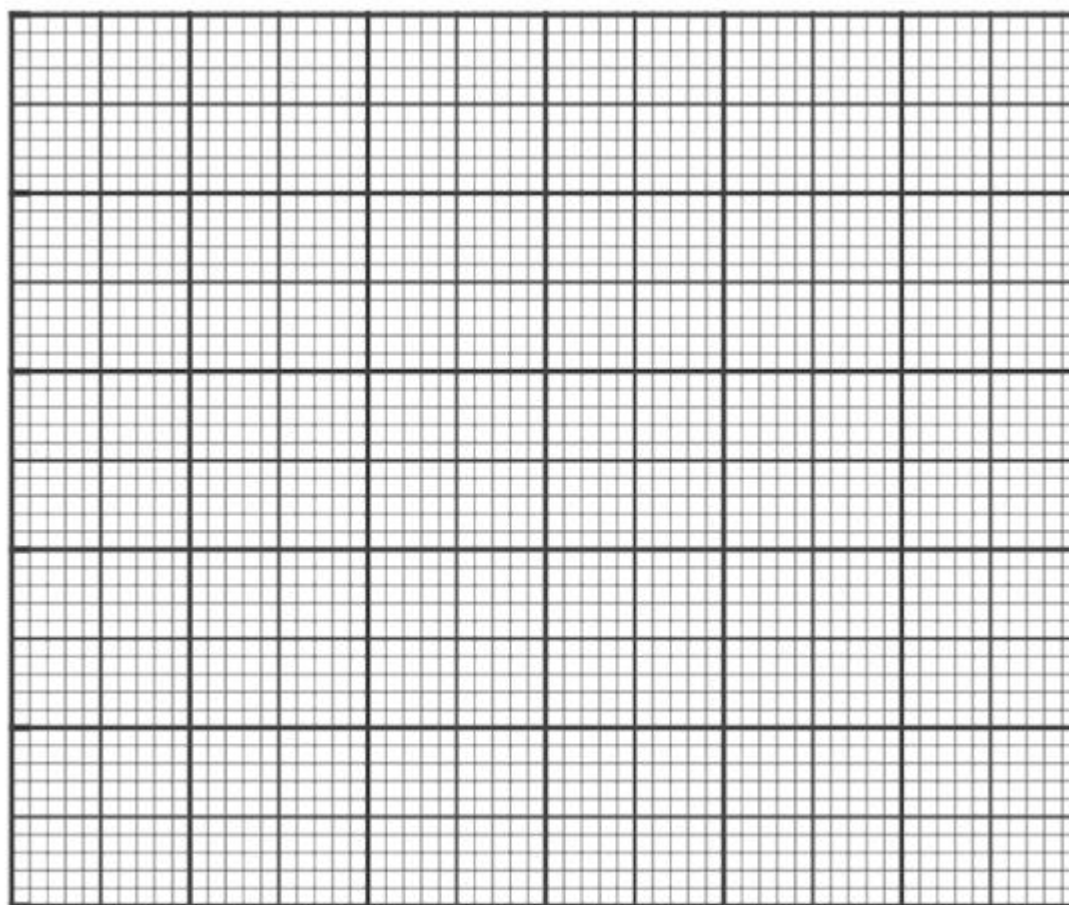
The effect of the concentration of $\text{Na}_2\text{S}_2\text{O}_3$ on the rate of reaction was investigated.

In each experiment, 5 cm^3 of **excess** hydrochloric acid was added to 50 cm^3 of the $\text{Na}_2\text{S}_2\text{O}_3$ solution in the flask.

The results are tabulated below.

Experiment	1	2	3	4	5
$[\text{Na}_2\text{S}_2\text{O}_3] (\text{mol}\cdot\text{dm}^{-3})$	0,03	0,04	0,06	0,08	0,10
Rate ($\times 10^{-3} \text{ s}^{-1}$)	3,1	3,7	5,9	8,1	9,5

3.2.1 Plot a graph of reaction rate versus concentration. Draw the line of best fit. *(An extra copy of the graph paper is provided on page 35, should you need it.)* (5)



$[\text{Na}_2\text{S}_2\text{O}_3] (\text{mol}\cdot\text{dm}^{-3})$

3.2.2 Use the graph to determine how long (in seconds) it would take for a $\text{Na}_2\text{S}_2\text{O}_3$ of concentration of $0,05 \text{ mol}\cdot\text{dm}^{-3}$ to react in this experiment. (3)

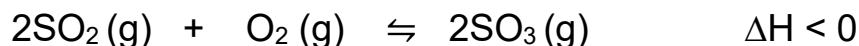
3.2.3 State in words, the relationship between the rate of the reaction and the concentration of the $\text{Na}_2\text{S}_2\text{O}_3$ solution. (2)

3.2.4 Use the collision theory to explain how increasing the concentration of the $\text{Na}_2\text{S}_2\text{O}_3$ solution affects the rate of this reaction. (3)

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QUESTION 4

The following equation represents the Contact process, a key reaction in the preparation of sulfuric acid:



The reaction is controlled in such a way that the temperature inside the container remains between 400 °C and 550 °C, and is not allowed to drop below 380 °C.

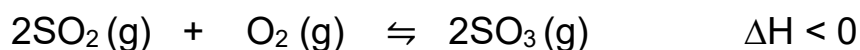
- 4.1 Explain the economical reasoning behind keeping the temperature of this reaction in the range 400 °C and 550 °C, and not allowing it to drop below 380 °C. (3)

- 4.2 50 mol of SO_2 was placed in a 200 dm³ reaction vessel with an unknown quantity of oxygen. Analysis of the equilibrium mixture at 400°C showed that 22 mol SO_3 was present. The K_c value at 400°C is 7,328.

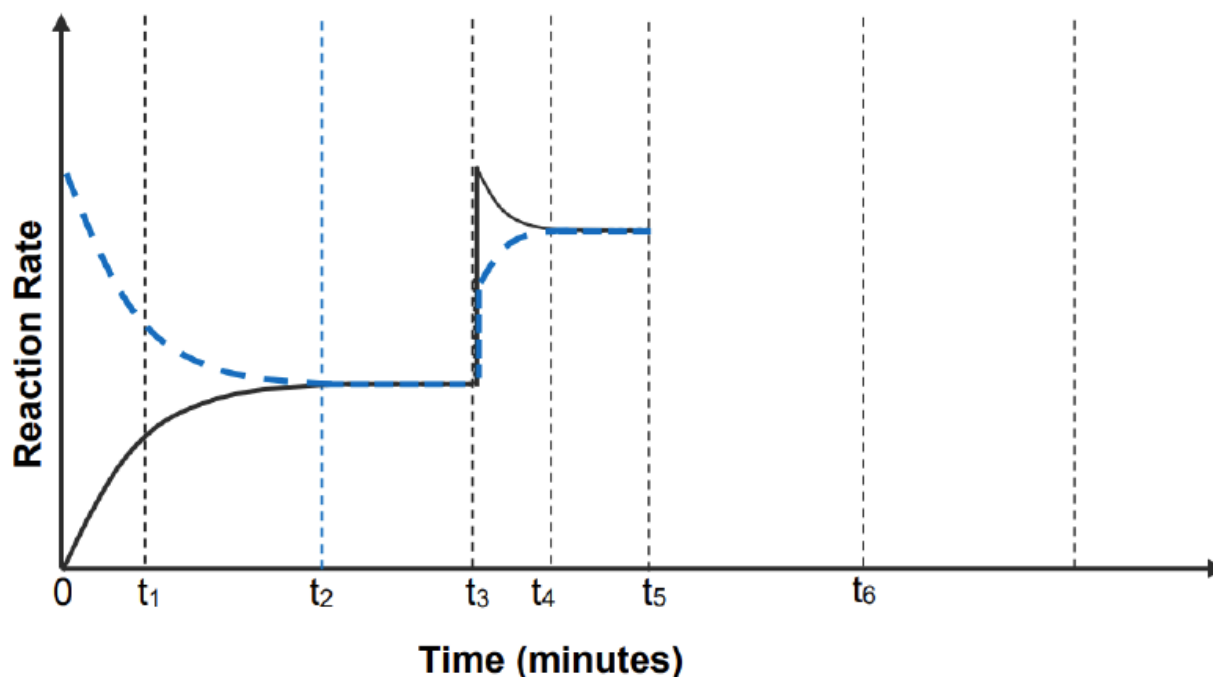
- 4.2.1 Write an expression for K_c for this reaction. (2)

- 4.2.2 Calculate the concentration of O_2 in the system at equilibrium (answer to 3 decimal places). (6)

- 4.3 The graph below represents the changes in the system when SO₂ was allowed to react with excess O₂. The blue dashed line represents the forward reaction rate.



Consider the following graph:



- 4.3.1 Write down the balanced chemical equation for the reaction represented by solid black line. (1)

- 4.3.2 Which has a higher initial reaction rate, the forward or reverse reaction? (1)

- 4.3.3 At which **time interval(s)** is the reaction at dynamic chemical equilibrium? (2)

- 4.3.4 **Circle** the correct word/s to complete the statement below.

Between t₄ and t₅, the concentrations of SO₂ and O₂ are... (1)

Equal to each other	Constant	Changing
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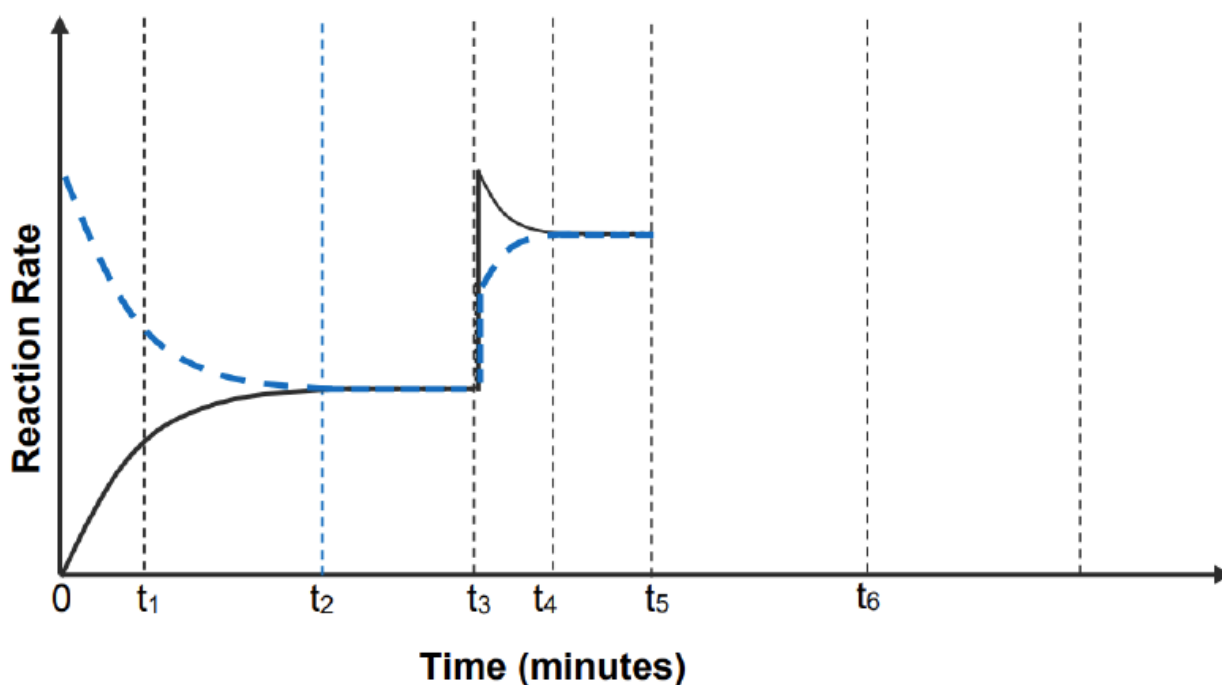
4.3.5 The system was subjected to a stress at t_3 .

- a) Identify this stress and explain your answer with reference to the graph and Le Chatelier's principle. (4)

- b) **Circle/Highlight** the effect, if any, on the K_c value due to the stress you explained in 4.3.5 a above. (1)

Increase	Decrease	Remain the same
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4.3.6 At t_5 , the volume of the container was increased at constant temperature, resulting in a decrease in the pressure. Complete the rate vs time graph on the axes below from t_5 until after equilibrium is re-established at t_6 . (3)



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QUESTION 5

5.1 A titration was performed between solutions of sulfuric acid, H_2SO_4 , and lithium hydroxide, LiOH .

5.1.1 Write a balanced chemical equation for the dissociation of lithium hydroxide. Phase symbols are not required. (2)

5.1.2 Write a balanced chemical equation for the reaction between sulfuric acid and lithium hydroxide. Phase symbols are not required. (3)

A standard solution of lithium hydroxide was prepared by dissolving exactly 7,2 g of LiOH to make up an aqueous solution of $0,25 \text{ dm}^3$ in a glass container.

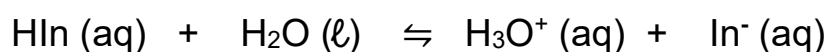
5.1.3 **Circle/highlight** the most appropriate glass container to make a standard solution in. (1)

Measuring cylinder	Burette	Conical flask	Volumetric flask
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5.1.4 Calculate the concentration of the standard solution. (3)

5.1.5 A pipette was used to transfer 20 cm³ of the lithium hydroxide solution to a conical flask. The average of three titrations showed that 23,17 cm³ was required to neutralise the lithium hydroxide. Calculate the concentration of the sulfuric acid solution. (4)

Indicators ionise in water according to the following equation. The indicator in its different forms has different colours.



The table below provides information about three different indicators.

Indicator	End-point pH range	Colour of molecular form of indicator	Colour of ionic form of indicator
Bromophenol blue	3,0 – 4,8	Yellow	Blue
Phenol red	6,8 – 8,2	Yellow	Red
Cresol purple	7,6 – 9,2	Yellow	Purple

5.1.6 Define *ionisation*. (2)

5.1.7 Using the information in the table above, **circle/highlight** the name of the indicator which would be suitable for this titration. (1)

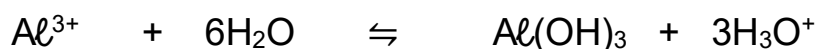
Bromophenol blue	Phenol red	Cresol purple
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When the indicator is placed into LiOH (aq) it results in a DECREASE in the concentration of hydronium ions in solution.

5.1.8 Explain why the concentration of hydronium ions DECREASES. (2)

5.1.9 Hence, state the colour of the solution when the indicator is placed into LiOH (aq). Explain your answer in terms of Le Châtelier's principle. Use bullet points in your answer. (4)

5.2 Some varieties of hydrangeas, also known as Christmas roses, can produce pink or blue blooms. An acidic pH results in pink blooms turning blue, while an alkaline pH results in blue blooms turning pink, and a neutral pH produces purple blooms. A solution of aluminium sulfate, a salt, is one of the substances recommended for changing colour. Aluminium ions hydrolyse water as shown in the balanced chemical equation:



<https://www.plantingtree.com/blogs/gardening/how-to-change-hydrangea-color>

5.2.1 Write the chemical formula of aluminium sulfate. (1)

5.2.2 Define the term *salt*. (2)

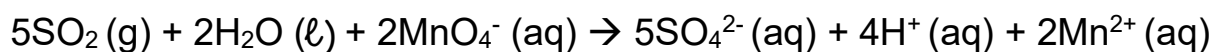
5.2.3 Identify the acid that was used to prepare the aluminium sulfate salt. (1)

5.2.4 Use the hydrolysis equation to explain what colour blooms the addition of aluminium sulfate to the soil would result in. (3)

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QUESTION 6

6.1 Consider the net cell equation for a galvanic cell below:



6.1.1 Define *oxidising agent*. (2)

6.1.2 Complete the table below by writing the appropriate formula of the chemical species that matches the description on the left. (4)

Description	Formula
Oxidised species	
Reduced species	
Species acting as oxidising agent	
Species acting as reducing agent	

6.1.3 Use the standard electrode potential table to calculate the emf of this galvanic cell at standard conditions. (3)

6.1.4 Why is an acid added to the electrolytes in the half cells? (2)

6.1.5 Platinum wire gauze is used as an electrode for both half-cells.

- a) Student **A** suggests that platinum is too expensive to use as an electrode in this galvanic cell and suggests that using an iron electrode would be cheaper and would still work efficiently. Explain why **student A** is not correct. (2)

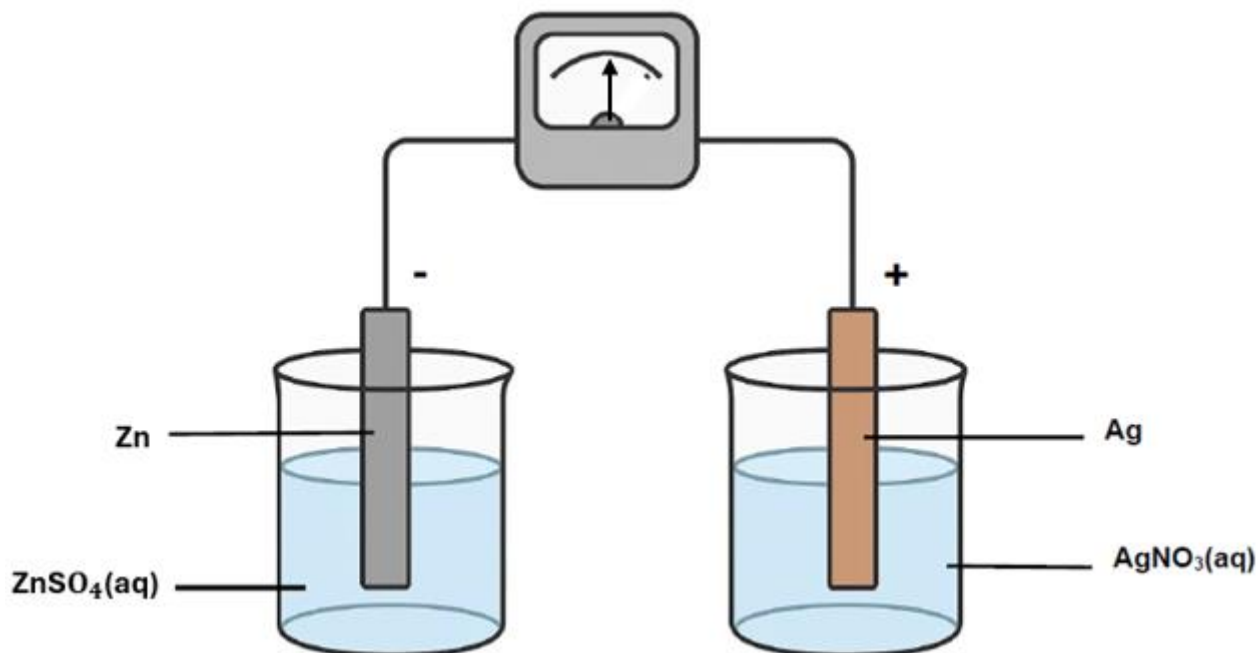
- b) The platinum gauze is replaced with a solid rod of platinum in the sulfur dioxide half-cell. Predict how this change would affect the current in the external circuit.

Circle the correct option. (1)

Increase	Decrease	No change
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- c) Explain your answer to question **6.1.5 b**. (2)

6.2 The silver-zinc galvanic cell is commonly used as a battery in watches. It is made up of a silver electrode in contact with a silver (I) nitrate solution and a zinc electrode in contact with a zinc (II) sulphate solution. The half-cells are connected under standard conditions.



6.2.1 Name the component that is missing from the diagram in this galvanic cell. (1)

6.2.2 Silver ions react with chloride ions to form a silver (I) chloride precipitate. How would using a potassium chloride electrolyte in the component named in question 6.2.1 affect the functioning of this cell? (3)

6.2.3 Write down the cell notation for this cell. Standard conditions do not have to be shown. (3)

6.2.4 Predict how the emf of this cell would change if distilled water were added to the electrolyte in the zinc half-cell. **Circle/highlight** the correct option below. (1)

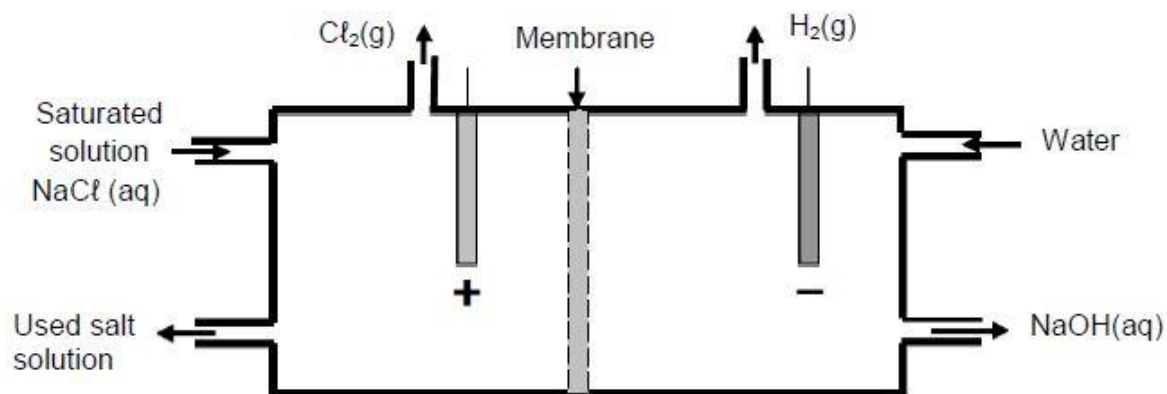
Increase	Decrease	No change
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6.2.5 Explain your answer to question **6.2.4**. (3)

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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 . Other products of this process are hydrogen gas and sodium hydroxide. The diagram below illustrates a cell that can be used in this process.



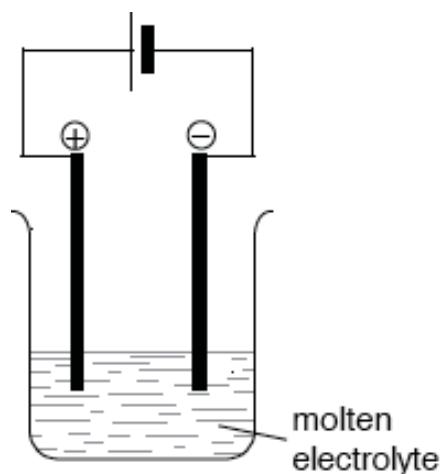
7.1.1 State the type of energy conversion that occurs in this cell. (1)

7.1.2 State the function of the membrane in this cell. (1)

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. (2)

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. (4)

7.2.2 Use the information provided below to determine the **identity** of the group 2 metal.
(Do not round off values in your working out)

- Mass of cathode before application of current: 25,720 g
- Mass of cathode after application of current: 33,915 g (7)

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QUESTION 8

Two organic compounds and their boiling points are given in the table below.

These two compounds are structural isomers of each other.

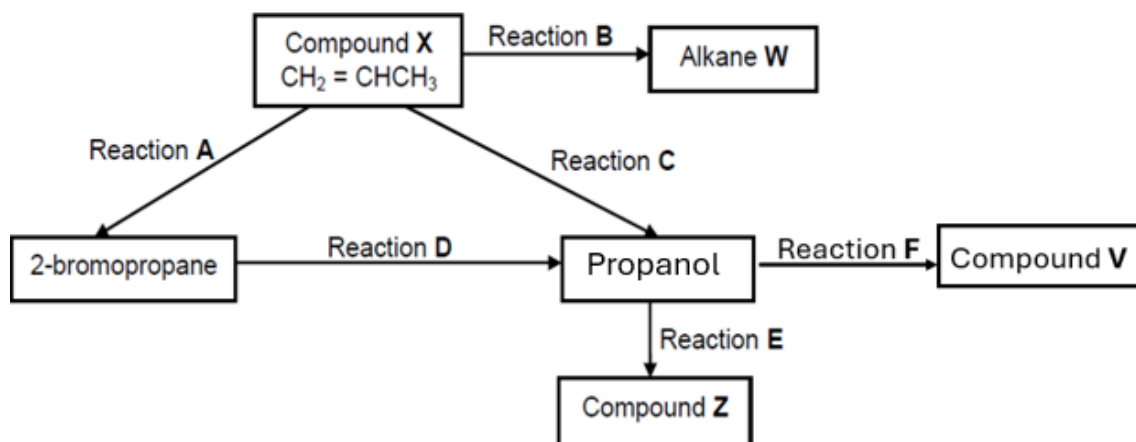
Compound	Boiling Point (°C)
Propyl ethanoate	102,0
Pentanoic Acid	186,0

8.1.1 Define *structural isomers*. (2)

8.1.2 What type of structural isomers are the compounds given in the table? (1)

8.1.3 Explain the difference in the boiling points of the compounds listed in the table. (4)

8.2 The flow diagram below shows how different organic compounds can be prepared using compound **X** as the starting material.



8.2.1 Define *saturated compound*. (2)

8.2.2 Is compound **X** saturated or unsaturated? (1)

8.2.3 Compound **X** reacts with hydrogen (H_2) during reaction **B** to form alkane **W**. Write down the SPECIFIC type of reaction that takes place. (1)

8.2.4 During reaction **A**, compound **X** is converted to 2-bromopropane. For this reaction, write down the:

a) Name or formula of the inorganic reactant needed. (1)

b) Condensed structural formula for 2-bromopropane. (1)

8.2.5 Compound **X** reacts with water during reaction **C** to form propanol. Using structural formulae, write down a balanced equation for the reaction. (3)

8.2.6 Consider reaction **D**. Write down the:

a) Reaction conditions. (2)

b) General type of reaction that takes place. (1)

8.2.7 Reaction **E** is an elimination reaction. For this reaction, write down the:

a) IUPAC name of compound **Z**. (1)

b) Specific type of elimination reaction that takes place. (1)

8.2.8 In reaction **F**, ethanoic acid is added to propanol.

a) Write down the type of reaction that reaction **F** is. (1)

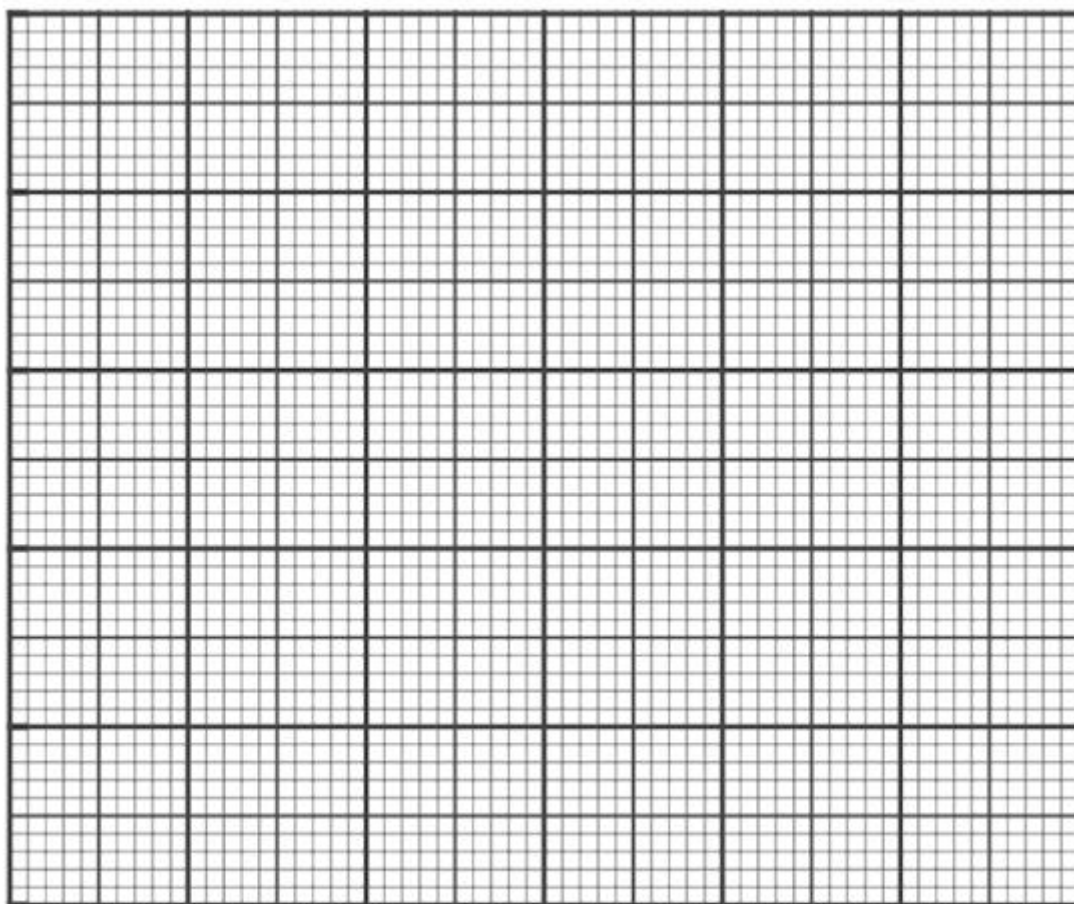
b) Write down the IUPAC name of compound **Z**. (2)

c) Using structural formula, write down the balanced equation for reaction **F**. (5)

[29]

Total Mark 200

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



$[\text{Na}_2\text{S}_2\text{O}_3] \text{ (mol}\cdot\text{dm}^{-3}\text{)}$