



KWAZULU-NATAL PROVINCE

EDUCATION
REPUBLIC OF SOUTH AFRICA



**NATIONAL
SENIOR CERTIFICATE**

GRADE 12

PHYSICAL SCIENCES P2 (CHEMISTRY)

JUNE EXAMINATION

2025

Stanmorephysics.com

MARKS : 150

TIME : 3 Hours

This question paper consists of 16 pages and 4 data sheets.



INSTRUCTIONS AND INFORMATION

1. Write your name in the appropriate spaces on the ANSWER BOOK.
2. This question paper consists of SEVEN questions. Answer ALL the questions in the ANSWER BOOK.
3. Start EACH question on a NEW page in the ANSWER BOOK.
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 2.2.
6. You may use a non-programmable calculator.
7. You may use appropriate mathematical instruments.
8. Show ALL formulae and substitutions in ALL calculations.
9. Round off your final numerical answers to a minimum of TWO decimal places.
10. Give brief motivations, discussions et cetera where required.
11. You are advised to use the attached DATA SHEETS.
12. Write neatly and legibly.



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 ANSWER BOOK, for example 1.11 E.

1.1 Which ONE of the following is a CORRECT EMPIRICAL FORMULA for ethyl butanoate?

- A CHO
- B CH₂O
- C C₃H₆O
- D C₆H₁₁O₂

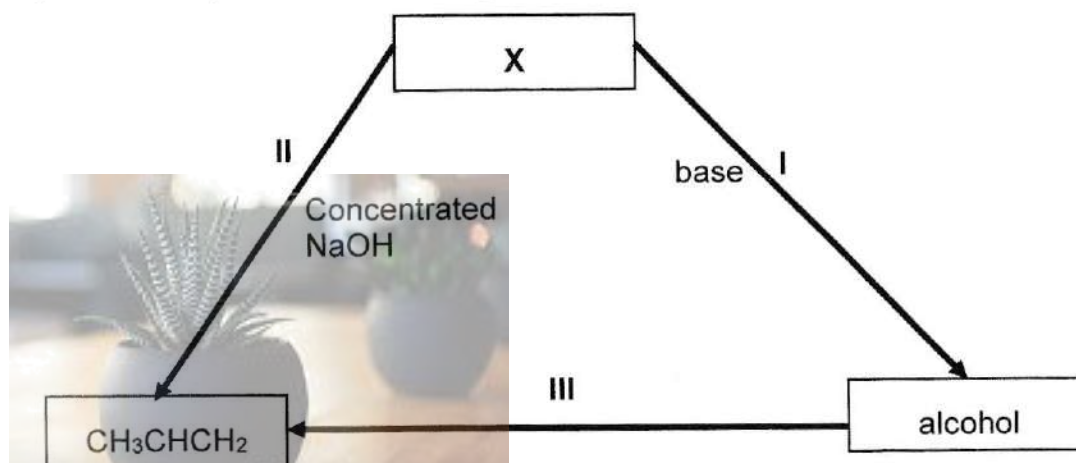
(2)

1.2 Which ONE of the following compounds has the LOWEST vapour pressure?

- A CH₃CH₂CH₂CH₂CH₃
- B CH₃COCH₂CH₃
- C CH₃CH₂COOH
- D CH₃CH₂OOCH

(2)

1.3 In the flow diagram below, X represents an organic compound. The numbers I, II and III represent different organic reactions.

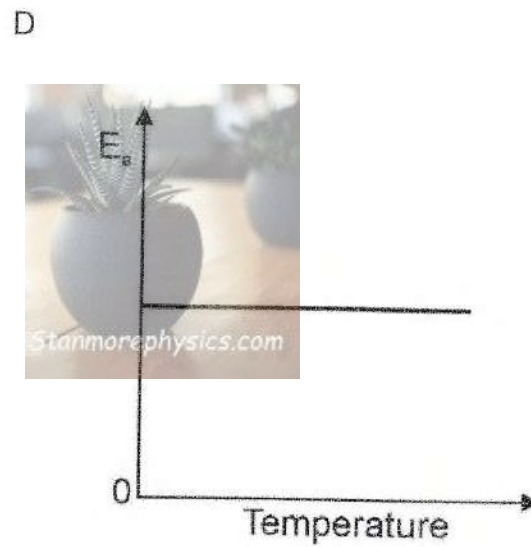
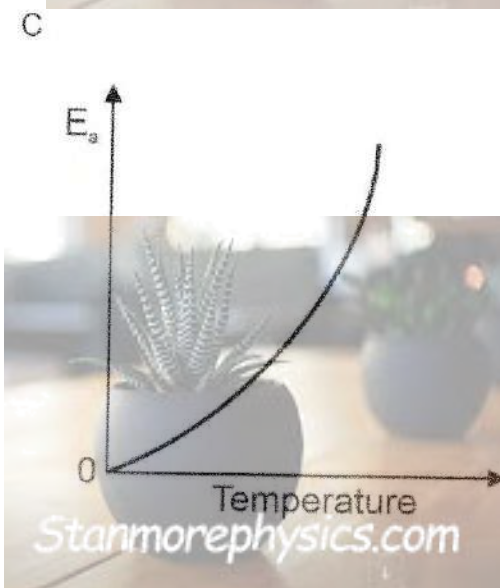
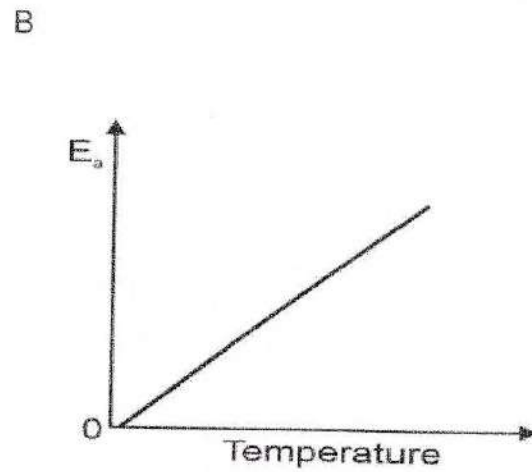
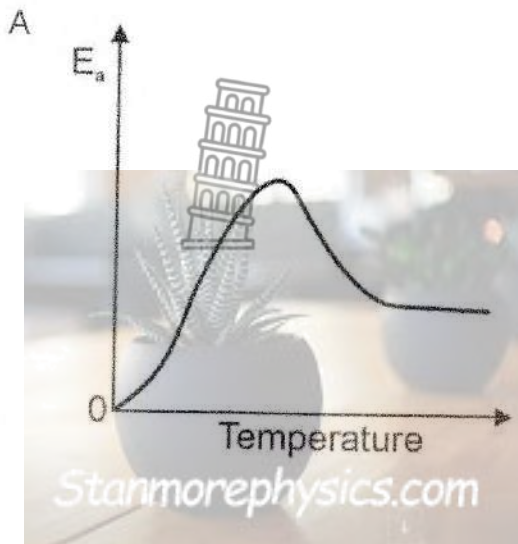


Which reaction(s) can be classified as HYDROLYSIS?

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

(2)

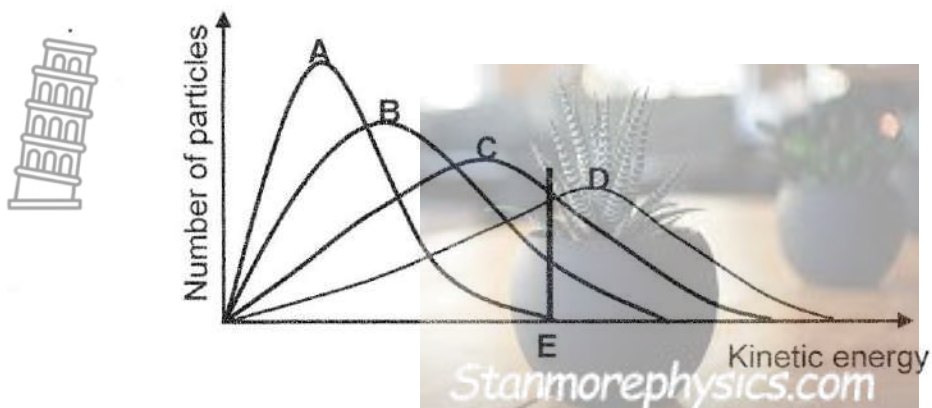
- 1.4 Which one of the following graphs shows the relationship between the activation energy (E_a) for a reaction and temperature?



(2)



- 1.5 The Maxwell-Boltzmann energy distribution curves below show the number of particles as a function of their kinetic energy for a reaction at four different temperatures, represented by 1, 2, 3, 4.



The time taken for the reaction to reach completion at the four different temperatures is recorded as follows:

Temperature	Time to reach completion(s)
1	28
2	37
3	56
4	63

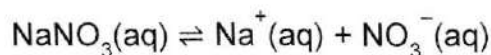
Which ONE of these curves represents the reaction at temperature 4?

- A A.
B B.
C C.
D D.

(2)



1.6 Consider the following reaction that reaches equilibrium in a beaker:



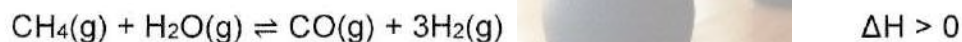
A few drops of concentrated nitric acid are added to the beaker without significantly changing the volume or the temperature of the mixture in the beaker.

Which ONE of the following combinations correctly identifies the DISTURBANCE ON THE SYSTEM and the SYSTEM'S RESPONSE to the disturbance?

	DISTURBANCE ON THE SYSTEM	SYSTEM'S RESPONSE
A	$[\text{Na}^+]$ decreases	Reverse reaction is favoured
B	$[\text{Na}^+]$ increases	Forward reaction is favoured
C	$[\text{NO}_3^-]$ decreases	Forward reaction is favoured
D	$[\text{NO}_3^-]$ increases	Reverse reaction is favoured

(2)

1.7 The reaction represented below reaches equilibrium in a closed container.



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

- A Add a catalyst
- B Decrease pressure by increasing the volume
- C Increase pressure by decreasing the volume
- D Decrease the temperature

(2)



- 1.8 A hypothetical chemical reaction in a closed container is represented by the following chemical equation:



1 mol of P was placed in an empty 1 dm³ container at a certain temperature. The container was sealed and P was allowed to decompose. At equilibrium x mol of P had decomposed. K_c for this reaction is:

A $\frac{2x}{1-x}$

B $\frac{2x}{(1-x)^2}$

C $\frac{4x^2}{1-x}$

D $\frac{4x^2}{(1-x)^2}$

(2)

- 1.9 The salt hydrolysis of equal concentrations of the following solutions are compared: sodium chloride, sodium oxalate, ammonium chloride

Which ONE of the following combinations is correct about the resulting solutions?

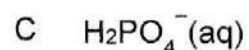
	ACIDIC	ALKALINE
A	Sodium chloride	Sodium oxalate
B	Sodium oxalate	Ammonium chloride
C	Sodium oxalate	Sodium chloride
D	Ammonium chloride	Sodium oxalate

(2)

- 1.10 Consider the reaction represented by the equation below:



Which ONE of the following is the strongest base in the above reaction?



(2)

[20]

QUESTION 2 (Start on a new page.)

The letters **A** to **F** in the table below represent six organic compounds.

A			
B $C_4H_{10}O$	C $CH_3CH_2COCH_2CH_3$	D	$CH_3COO(CH_2)_2CH_3$
E			
F	5-ethyl-2,6-dimethylhept-3-yne		

- 2.1 Write down the LETTER that represents EACH of the following:
- 2.1.1 A compound that has a carbonyl group bonded to two carbon atoms. (1)
- 2.1.2 A saturated hydrocarbon. (1)
- 2.2 Define the term *secondary alcohol*. (2)
- 2.3 Write down the letter that COULD REPRESENT a secondary alcohol. (2)
- 2.4 Write down the IUPAC name of compound:
- 2.4.1 **D** (3)
- 2.4.2 **E** (3)



- 2.5 For compound **F**, write down the:
- 2.5.1 name of the homologous series to which it belongs. (1)
- 2.5.2 STRUCTURAL formula. (3)
- 2.6 Define the term *positional isomer*. (2)
- 2.7 Write down the STRUCTURAL FORMULAE of the POSITIONAL ISOMERS of compound **B**. (4)
- [22]

QUESTION 3 (Start on a new page.)

Learners use organic compounds P and R, indicated in the table below, to investigate ONE of the factors which influences boiling points of organic compounds.

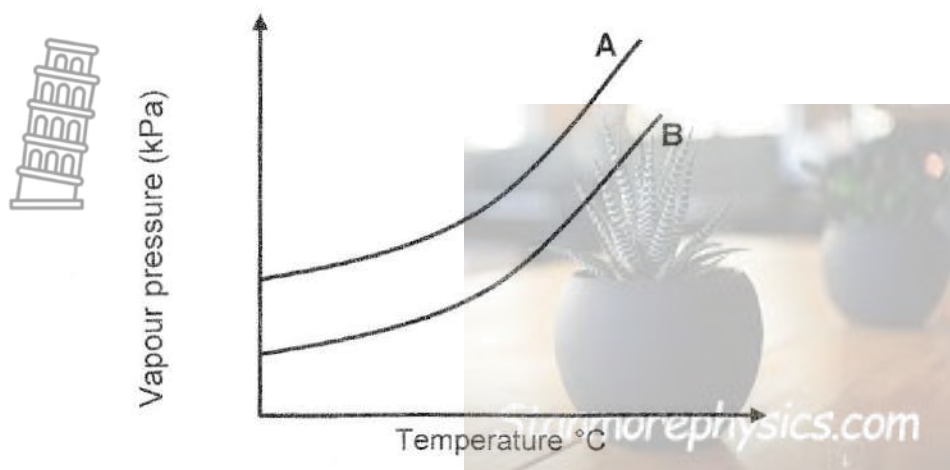
COMPOUND	FORMULA
P	$\text{CH}_3\text{CH}_2\text{COOH}$
R	$\text{CH}_3\text{CH}_2\text{CH}_2\text{CH}_2\text{OH}$

They use equal volumes of compounds P and R and heat them separately in a water bath. The temperature at which each compound boils is measured and recorded.

- 3.1 Define the term *boiling point*. (2)
- 3.2 Besides the conditions used to determine boiling points, give a reason why this is a fair comparison? (1)
- 3.3 Write down the name of the independent variable for this investigation. (1)
- 3.4 The boiling point of compound R is 97 °C.
- 3.4.1 Will the boiling point of compound P be HIGHER THAN, EQUAL TO or LOWER THAN 97 °C. (1)
- 3.4.2 Fully explain the answer to question 3.4.1 (4)



- 3.5 The graph below represents the relationship between vapour pressure and temperature for compound **P** and **R**. Take atmospheric pressure to be 100 kPa.



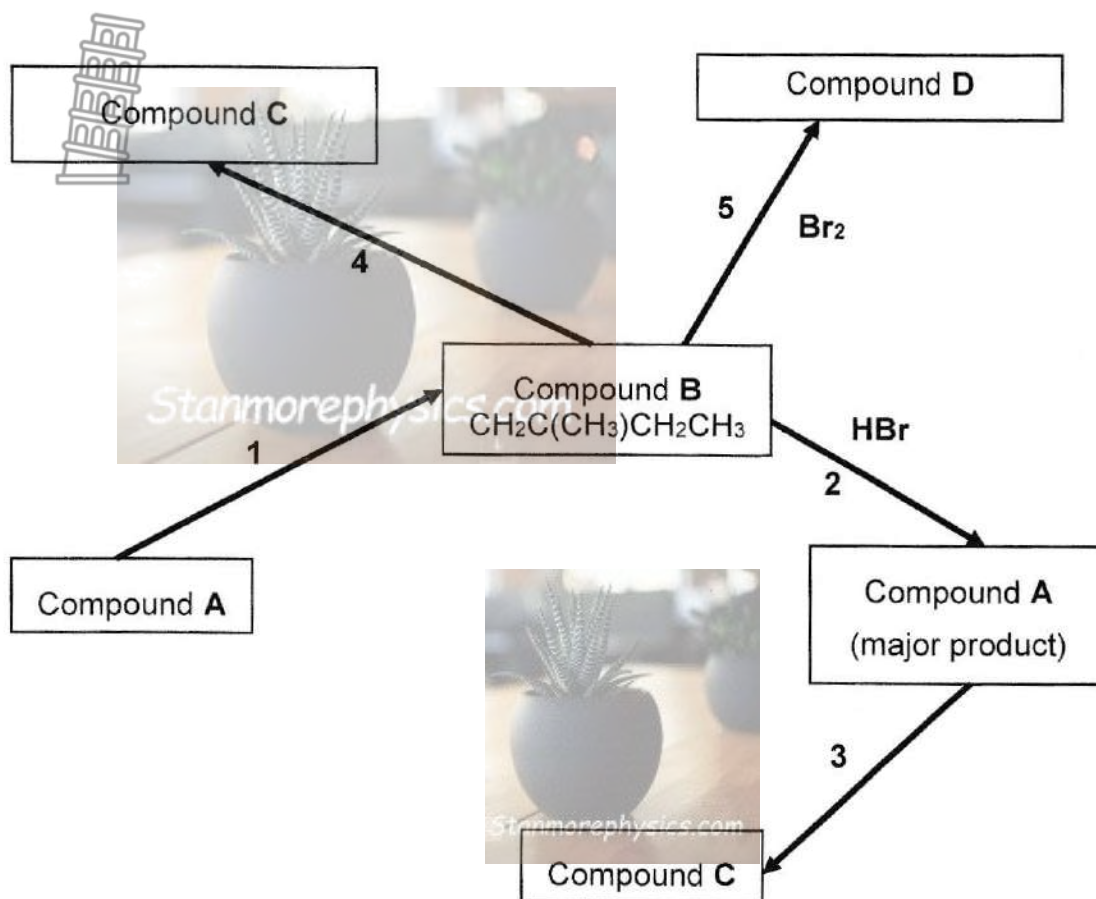
- 3.5.1 Which curve A or B represents the graph for compound **P**? (1)
- 3.5.2 Explain the answer to question 3.5.1 (3)
- 3.6 The investigation is repeated using twice the volumes of compounds **P** and **R** while keeping ALL other conditions unchanged. How will this change affect the boiling points. (Choose from INCREASES, DECREASES or REMAINS THE SAME) (1)
- 3.7 The learners NOW repeat the above investigation but using compound **S** which is a CHAIN ISOMER of compound **R**. (1)
- 3.7.1 Will the boiling point of compound **S** be HIGHER THAN, EQUAL TO or LOWER THAN 97 °C. (1)
- 3.7.2 Fully explain the answer to question 3.7.1 (4)

[19]

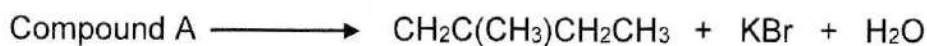


QUESTION 4 (Start on a new page.)

In the flow diagram below, **1**, **2**, **3**, **4** and **5** represent organic reactions. **A**, **B**, **C**, and **D** represent organic compounds.



4.1 Reaction 1 is represented in the equation below:



Reaction 1 takes place in the presence of a base.

Write down the:

4.1.1 Name or formula of the base used in reaction 1. (1)

4.1.2 TWO names for reaction 1. (2)

4.1.3 Structural formula for compound A. (3)

4.2 Reaction 2 is an addition reaction.

4.2.1 Write down the TYPE of addition in reaction 2. (1)

4.2.2 Explain why NO water must be present in reaction 2. (2)

- 4.3 Compound **C**, which is characterised by a HYDROXYL GROUP is produced in both reactions **3** and **4** using the SAME inorganic reactant.
- 4.3.1 Write down the NAME or FORMULA of the inorganic reactant used in BOTH reactions. (1)
- 4.3.2 Which reaction **3** or **4** represents an ADDITION reaction? (1)
- 4.3.3 Which reaction **3** or **4** represents a SUBSTITUTION reaction? (1)
- 4.3.4 Write down the balanced equation for reaction **3**, using MOLECULAR formulae. (3)
- 4.4 Reaction **5**, is an addition reaction.
- 4.4.1 What will be a VISIBLE OBSERVATION when this reaction occurs? (1)
- 4.4.2 Write down the IUPAC name of compound **D**. (2)
- 4.5 When compound **B** undergoes hydrogenation in the presence of a platinum catalyst, a SATURATED HYDROCARBON is formed.
- Write a balanced equation, using molecular formulae, to illustrate the complete combustion of the SATURATED HYDROCARBON formed. (4)
- [22]

QUESTION 5 (Start on a new page.)

The reaction between pure calcium carbonate, $\text{CaCO}_3(\text{s})$, and EXCESS hydrochloric acid, $\text{HCl}(\text{aq})$, is used to investigate the factors that affect the rate of a reaction.

The balanced equation for the reaction is:



The concentration of the $\text{HCl}(\text{aq})$ stays constant for the duration of the reaction.

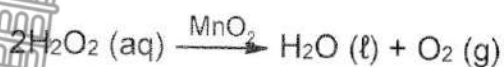
The volume of $\text{CO}_2(\text{g})$ released, was collected and measured in equal time intervals as shown in the table below:

Time (s)	0	30	60	90	120	150	180
Volume of CO_2 (cm^3)	0	18	24	28	31	33	

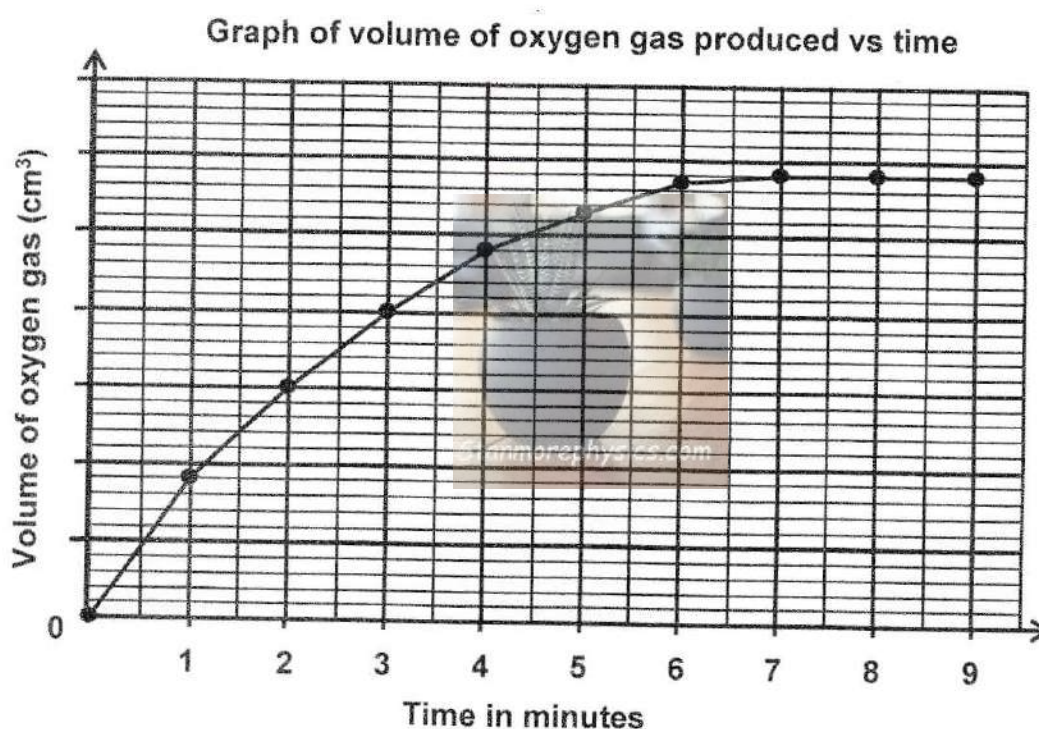
- 5.1 Define the term *reaction rate*. (2)
- 5.2 Is the reaction between calcium carbonate, $\text{CaCO}_3(\text{s})$, and hydrochloric acid, $\text{HCl}(\text{aq})$, EXOTHERMIC or ENDOTHERMIC? (1)
- 5.3 Draw an energy profile for an EXOTHERMIC REACTION. Indicate the following: (5)
- Energy of reactants
 - Energy of products
 - Heat of reaction
 - Activation energy

- 5.4 Why is there a noticeably BIGGEST CHANGE in volume of CO_2 in the table for the first 60 s? Use the collision theory to explain the answer. (4)

In another reaction manganese dioxide (MnO_2) catalyses the decomposition of a hydrogen peroxide solution ($\text{H}_2\text{O}_2(\text{aq})$) into water and oxygen.



0,1 g of manganese dioxide (MnO_2) was added to 200 cm^3 of a $0,2 \text{ mol}\cdot\text{dm}^{-3}$ solution of hydrogen peroxide ($\text{H}_2\text{O}_2(\text{aq})$). The oxygen gas produced was collected at standard temperature and pressure using a gas syringe. The readings were plotted to give the following graph:



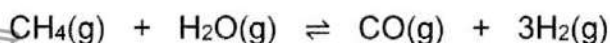
- 5.5 Explain, fully, how a catalyst increases the volume of oxygen produced per second. (3)
- 5.6 For the time interval $t = 0$ to $t = 7$ minutes, the average reaction rate for the formation of $\text{O}_2(\text{g})$ is $16,572 \text{ cm}^3\cdot\text{min}^{-1}$. Perform the relevant calculation/s to determine whether the above reaction reached completion at 7 minutes. (8)

[23]



QUESTION 6 (Start on a new page.)

- 6.1 One of the industrial preparations of hydrogen gas is represented by the equation below:

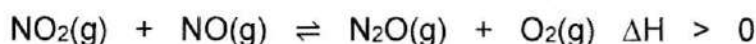


The reaction reaches equilibrium at 1000 °C in a closed container.

- 6.1.1 State Le Chatelier's Principle. (2)

- 6.1.2 How will a decrease in pressure at 1000 °C (by increasing the volume) affect the number of moles of $\text{H}_2(\text{g})$ at equilibrium? Write down, INCREASE, DECREASE or NO EFFECT. Use Le Chatelier's Principle to explain the answer. (4)

- 6.2 Consider the balanced equation for a reaction that takes place in a sealed 2 dm³ container.



The k_c value for the above reaction AT A PARTICULAR TEMPERATURE is 3,93. When the reaction reaches equilibrium AT THIS PARTICULAR TEMPERATURE, there are 0,58 moles of $\text{NO}(\text{g})$, 0,36 moles of $\text{N}_2\text{O}(\text{g})$ and 0,76 moles of $\text{O}_2(\text{g})$ present in the container.

One of the conditions that influences equilibrium is NOW changed and the reaction is allowed to re-establish equilibrium. When the NEW equilibrium is established the concentration of $\text{NO}_2(\text{g})$ is 0,12 mol·dm⁻³.

- 6.2.1 Which reaction was favoured, FORWARD or REVERSE when the above condition that influences equilibrium was changed. Support the answer with a relevant calculation. (5)

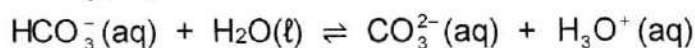
- 6.2.2 Name the condition that influences equilibrium that was changed. Support the answer with a relevant calculation. (8)

- 6.2.3 Was the condition named in question 6.2.2 INCREASED or DECREASED? Use Le Chatelier's Principle to explain the answer. (3)

[22]

QUESTION 7 (Start on a new page.)

- 7.1 The following reaction represents of ONE possible reaction of hydrogen carbonate ion, HCO_3^- (aq) and water:



7.1.1 Define the term *ampholyte*. (2)

7.1.2 Write down the formulae of TWO substances shown in the above equation that are ampholytes. (2)

7.1.3 Write down the OTHER possible reaction of the hydrogen carbonate ion, HCO_3^- (aq) and water. (2)

- 7.2 12 cm³ of sodium hydroxide, NaOH(aq) of concentration 0,10 mol.dm⁻³ is mixed with 48 cm³ of barium hydroxide, Ba(OH)₂(aq) of concentration 0,04375 mol.dm⁻³ in a flask. The resulting solution is homogenised by swirling the flask.

7.2.1 Both sodium hydroxide and barium hydroxide are described as strong bases. Define the term *strong base*. (2)

An aqueous solution of sulphuric acid, H₂SO₄(aq), of concentration 0,05 mol.dm⁻³, is used to exactly neutralise the resulting solution in the flask.

The table below shows 3 indicators with their corresponding pH ranges.

Name of Indicator	pH range
methyl orange	3,10 – 4,40
bromothymol blue	6,00 – 7,60
phenolphthalein	8,30 – 10,00

7.2.2 Write down the name of the indicator from the above table which would be most suitable to indicate when the resulting solution in the flask has been exactly neutralised. (2)

7.2.3 The pH of the aqueous solution of sulphuric acid, H₂SO₄(aq) is 1. Perform the necessary calculation to prove that the aqueous solution of sulphuric acid, H₂SO₄(aq) is a strong acid. (4)

7.2.4 Calculate the volume of an aqueous solution of sulphuric acid, H₂SO₄(aq), of concentration 0,05 mol.dm⁻³ that will exactly neutralise the resulting solution in the flask. Sulphuric acid is a strong acid. (8)

[22]
[150]

**DATA FOR PHYSICAL SCIENCES GRADE 12
PAPER 2 (CHEMISTRY)**

**GEGEWENS VIR FISIESTE WETENSKAPPE GRAAD 12
VRAESTEL 2 (CHEMIE)**



TABLE 1: PHYSICAL CONSTANTS/TABEL 1: FISIESTE KONSTANTES

NAME/NAAM	SYMBOL/SIMBOOL	VALUE/WAARDE
Standard pressure <i>Standaarddruk</i>	p^θ	$1,013 \times 10^5 \text{ Pa}$
Molar gas volume at STP <i>Molêre gasvolume by STD</i>	V_m	$22,4 \text{ dm}^3 \cdot \text{mol}^{-1}$
Standard temperature <i>Standaardtemperatuur</i>	T^θ	273 K
Charge on electron <i>Lading op elektron</i>	e	$-1,6 \times 10^{-19} \text{ C}$
Avogadro's constant <i>Avogadro-konstante</i>	N_A	$6,02 \times 10^{23} \text{ mol}^{-1}$

TABLE 2: FORMULAE/TABEL 2: FORMULES

$n = \frac{m}{M}$	$n = \frac{N}{N_A}$
$c = \frac{n}{V}$ or/of $c = \frac{m}{MV}$	$n = \frac{V}{V_m}$
$\frac{c_a v_a}{c_b v_b} = \frac{n_a}{n_b}$	$\text{pH} = -\log[\text{H}_3\text{O}^+]$
$K_w = [\text{H}_3\text{O}^+][\text{OH}^-] = 1 \times 10^{-14} \text{ at/by } 298 \text{ K}$	
$E_{\text{cell}}^\theta = E_{\text{cathode}}^\theta - E_{\text{anode}}^\theta / E_{\text{sel}}^\theta = E_{\text{katode}}^\theta - E_{\text{anode}}^\theta$	
or/of $E_{\text{cell}}^\theta = E_{\text{reduction}}^\theta - E_{\text{oxidation}}^\theta / E_{\text{sel}}^\theta = E_{\text{reduksie}}^\theta - E_{\text{oksidasie}}^\theta$	
or/of $E_{\text{cell}}^\theta = E_{\text{oxidising agent}}^\theta - E_{\text{reducing agent}}^\theta / E_{\text{sel}}^\theta = E_{\text{oksideermiddel}}^\theta - E_{\text{reduseermiddel}}^\theta$	
$I = \frac{Q}{\Delta t}$	$n = \frac{Q}{e}$ where n is the number of electrons/ <i>waar n die aantal elektrone is</i>

TABLE 4A: STANDARD REDUCTION POTENTIALS
TABEL 4A: STANDAARD-REDUKSIEPOTENSIALE

Half-reactions/Halfreaksies	E^{θ} (V)
$F_2(g) + 2e^- \rightleftharpoons 2F^-$	+ 2,87
$Co^{3+} + e^- \rightleftharpoons Co^{2+}$	+ 1,81
$H_2O_2 + 2H^+ + 2e^- \rightleftharpoons 2H_2O$	+1,77
$MnO_4^- + 8H^+ + 5e^- \rightleftharpoons Mn^{2+} + 4H_2O$	+ 1,51
$Cl_2(g) + 2e^- \rightleftharpoons 2Cl^-$	+ 1,36
$Cr_2O_7^{2-} + 14H^+ + 6e^- \rightleftharpoons 2Cr^{3+} + 7H_2O$	+ 1,33
$O_2(g) + 4H^+ + 4e^- \rightleftharpoons 2H_2O$	+ 1,23
$MnO_2 + 4H^+ + 2e^- \rightleftharpoons Mn^{2+} + 2H_2O$	+ 1,23
$Pt^{2+} + 2e^- \rightleftharpoons Pt$	+ 1,20
$Br_2(l) + 2e^- \rightleftharpoons 2Br^-$	+ 1,07
$NO_3^- + 4H^+ + 3e^- \rightleftharpoons NO(g) + 2H_2O$	+ 0,96
$Hg^{2+} + 2e^- \rightleftharpoons Hg(l)$	+ 0,85
$Ag^+ + e^- \rightleftharpoons Ag$	+ 0,80
$NO_3^- + 2H^+ + e^- \rightleftharpoons NO_2(g) + H_2O$	+ 0,80
$Fe^{3+} + e^- \rightleftharpoons Fe^{2+}$	+ 0,77
$O_2(g) + 2H^+ + 2e^- \rightleftharpoons H_2O_2$	+ 0,68
$I_2 + 2e^- \rightleftharpoons 2I^-$	+ 0,54
$Cu^+ + e^- \rightleftharpoons Cu$	+ 0,52
$SO_2 + 4H^+ + 4e^- \rightleftharpoons S + 2H_2O$	+ 0,45
$2H_2O + O_2 + 4e^- \rightleftharpoons 4OH^-$	+ 0,40
$Cu^{2+} + 2e^- \rightleftharpoons Cu$	+ 0,34
$SO_4^{2-} + 4H^+ + 2e^- \rightleftharpoons SO_2(g) + 2H_2O$	+ 0,17
$Cu^{2+} + e^- \rightleftharpoons Cu^+$	+ 0,16
$Sn^{4+} + 2e^- \rightleftharpoons Sn^{2+}$	+ 0,15
$S + 2H^+ + 2e^- \rightleftharpoons H_2S(g)$	+ 0,14
$2H^+ + 2e^- \rightleftharpoons H_2(g)$	0,00
$Fe^{3+} + 3e^- \rightleftharpoons Fe$	- 0,06
$Pb^{2+} + 2e^- \rightleftharpoons Pb$	- 0,13
$Sn^{2+} + 2e^- \rightleftharpoons Sn$	- 0,14
$Ni^{2+} + 2e^- \rightleftharpoons Ni$	- 0,27
$Co^{2+} + 2e^- \rightleftharpoons Co$	- 0,28
$Cd^{2+} + 2e^- \rightleftharpoons Cd$	- 0,40
$Cr^{3+} + e^- \rightleftharpoons Cr^{2+}$	- 0,41
$Fe^{2+} + 2e^- \rightleftharpoons Fe$	- 0,44
$Cr^{3+} + 3e^- \rightleftharpoons Cr$	- 0,74
$Zn^{2+} + 2e^- \rightleftharpoons Zn$	- 0,76
$2H_2O + 2e^- \rightleftharpoons H_2(g) + 2OH^-$	- 0,83
$Cr^{2+} + 2e^- \rightleftharpoons Cr$	- 0,91
$Mn^{2+} + 2e^- \rightleftharpoons Mn$	- 1,18
$Al^{3+} + 3e^- \rightleftharpoons Al$	- 1,66
$Mg^{2+} + 2e^- \rightleftharpoons Mg$	- 2,36
$Na^+ + e^- \rightleftharpoons Na$	- 2,71
$Ca^{2+} + 2e^- \rightleftharpoons Ca$	- 2,87
$Sr^{2+} + 2e^- \rightleftharpoons Sr$	- 2,89
$Ba^{2+} + 2e^- \rightleftharpoons Ba$	- 2,90
$Cs^+ + e^- \rightleftharpoons Cs$	- 2,92
$K^+ + e^- \rightleftharpoons K$	- 2,93
$Li^+ + e^- \rightleftharpoons Li$	- 3,05

Increasing oxidising ability/Toenemende oksiderende vermoë

Increasing reducing ability/Toenemende reducerende vermoë

TABLE 4B: STANDARD REDUCTION POTENTIALS
TABEL 4B: STANDAARD-REDUKSIEPOTENSIALE



Increasing oxidising ability/Toenemende oksiderende vermoë

Half-reactions/Halfreaksies	E^θ (V)
$\text{Li}^+ + e^- \rightleftharpoons \text{Li}$	-3,05
$\text{K}^+ + e^- \rightleftharpoons \text{K}$	-2,93
$\text{Cs}^+ + e^- \rightleftharpoons \text{Cs}$	-2,92
$\text{Ba}^{2+} + 2e^- \rightleftharpoons \text{Ba}$	-2,90
$\text{Sr}^{2+} + 2e^- \rightleftharpoons \text{Sr}$	-2,89
$\text{Ca}^{2+} + 2e^- \rightleftharpoons \text{Ca}$	-2,87
$\text{Na}^+ + e^- \rightleftharpoons \text{Na}$	-2,71
$\text{Mg}^{2+} + 2e^- \rightleftharpoons \text{Mg}$	-2,36
$\text{Al}^{3+} + 3e^- \rightleftharpoons \text{Al}$	-1,66
$\text{Mn}^{2+} + 2e^- \rightleftharpoons \text{Mn}$	-1,18
$\text{Cr}^{2+} + 2e^- \rightleftharpoons \text{Cr}$	-0,91
$2\text{H}_2\text{O} + 2e^- \rightleftharpoons \text{H}_2(\text{g}) + 2\text{OH}^-$	-0,83
$\text{Zn}^{2+} + 2e^- \rightleftharpoons \text{Zn}$	-0,76
$\text{Cr}^{3+} + 3e^- \rightleftharpoons \text{Cr}$	-0,74
$\text{Fe}^{2+} + 2e^- \rightleftharpoons \text{Fe}$	-0,44
$\text{Cr}^{3+} + e^- \rightleftharpoons \text{Cr}^{2+}$	-0,41
$\text{Cd}^{2+} + 2e^- \rightleftharpoons \text{Cd}$	-0,40
$\text{Co}^{2+} + 2e^- \rightleftharpoons \text{Co}$	-0,28
$\text{Ni}^{2+} + 2e^- \rightleftharpoons \text{Ni}$	-0,27
$\text{Sn}^{2+} + 2e^- \rightleftharpoons \text{Sn}$	-0,14
$\text{Pb}^{2+} + 2e^- \rightleftharpoons \text{Pb}$	-0,13
$\text{Fe}^{3+} + 3e^- \rightleftharpoons \text{Fe}$	-0,06
$2\text{H}^+ + 2e^- \rightleftharpoons \text{H}_2(\text{g})$	0,00
$\text{S} + 2\text{H}^+ + 2e^- \rightleftharpoons \text{H}_2\text{S}(\text{g})$	+0,14
$\text{Sn}^{4+} + 2e^- \rightleftharpoons \text{Sn}^{2+}$	+0,15
$\text{Cu}^{2+} + e^- \rightleftharpoons \text{Cu}^+$	+0,16
$\text{SO}_4^{2-} + 4\text{H}^+ + 2e^- \rightleftharpoons \text{SO}_2(\text{g}) + 2\text{H}_2\text{O}$	+0,17
$\text{Cu}^{2+} + 2e^- \rightleftharpoons \text{Cu}$	+0,34
$2\text{H}_2\text{O} + \text{O}_2 + 4e^- \rightleftharpoons 4\text{OH}^-$	+0,40
$\text{SO}_2 + 4\text{H}^+ + 4e^- \rightleftharpoons \text{S} + 2\text{H}_2\text{O}$	+0,45
$\text{Cu}^+ + e^- \rightleftharpoons \text{Cu}$	+0,52
$\text{I}_2 + 2e^- \rightleftharpoons 2\text{I}^-$	+0,54
$\text{O}_2(\text{g}) + 2\text{H}^+ + 2e^- \rightleftharpoons \text{H}_2\text{O}_2$	+0,68
$\text{Fe}^{3+} + e^- \rightleftharpoons \text{Fe}^{2+}$	+0,77
$\text{NO}_3^- + 2\text{H}^+ + e^- \rightleftharpoons \text{NO}_2(\text{g}) + \text{H}_2\text{O}$	+0,80
$\text{Ag}^+ + e^- \rightleftharpoons \text{Ag}$	+0,80
$\text{Hg}^{2+} + 2e^- \rightleftharpoons \text{Hg}(\ell)$	+0,85
$\text{NO}_3^- + 4\text{H}^+ + 3e^- \rightleftharpoons \text{NO}(\text{g}) + 2\text{H}_2\text{O}$	+0,96
$\text{Br}_2(\ell) + 2e^- \rightleftharpoons 2\text{Br}^-$	+1,07
$\text{Pt}^{2+} + 2e^- \rightleftharpoons \text{Pt}$	+1,20
$\text{MnO}_2 + 4\text{H}^+ + 2e^- \rightleftharpoons \text{Mn}^{2+} + 2\text{H}_2\text{O}$	+1,23
$\text{O}_2(\text{g}) + 4\text{H}^+ + 4e^- \rightleftharpoons 2\text{H}_2\text{O}$	+1,23
$\text{Cr}_2\text{O}_7^{2-} + 14\text{H}^+ + 6e^- \rightleftharpoons 2\text{Cr}^{3+} + 7\text{H}_2\text{O}$	+1,33
$\text{Cl}_2(\text{g}) + 2e^- \rightleftharpoons 2\text{Cl}^-$	+1,36
$\text{MnO}_4^- + 8\text{H}^+ + 5e^- \rightleftharpoons \text{Mn}^{2+} + 4\text{H}_2\text{O}$	+1,51
$\text{H}_2\text{O}_2 + 2\text{H}^+ + 2e^- \rightleftharpoons 2\text{H}_2\text{O}$	+1,77
$\text{Co}^{3+} + e^- \rightleftharpoons \text{Co}^{2+}$	+1,81
$\text{F}_2(\text{g}) + 2e^- \rightleftharpoons 2\text{F}^-$	+2,87

Increasing reducing ability/Toenemende reduserende vermoë

FINAL



KWAZULU-NATAL PROVINCE

EDUCATION
REPUBLIC OF SOUTH AFRICA

GRADE 12

**NATIONAL
SENIOR CERTIFICATE**

PHYSICAL SCIENCES P2 (CHEMISTRY)

JUNE 2025 EXAMINATION

MEMORANDUM

MARKS: 150

This memorandum consists of 13 pages.

QUESTION 1

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

[20]

QUESTION 2

- 2.1.1 C ✓ (1)
- 2.1.2 A ✓ (1)

2.2 The alcohol for which the functional group/OH/hydroxyl is attached to a carbon that is bonded to 2 other carbon atoms.

Marking criteria:

If any one of the underlined key words/phrases in the correct context is omitted, deduct 1 mark.
The underlined phrase must be in the correct context.

(2)

2.3 B ✓✓ (2)

2.4.1 propyl ethanoate ✓✓✓

Marking criteria:

- correct homologous series ✓
- alkyl group 3 carbon atoms ✓
- alkanoate 2 carbon atoms ✓

(3)

2.4.2 1 – chloro – 2,4,5 - trimethylhexane ✓✓✓

Marking criteria:

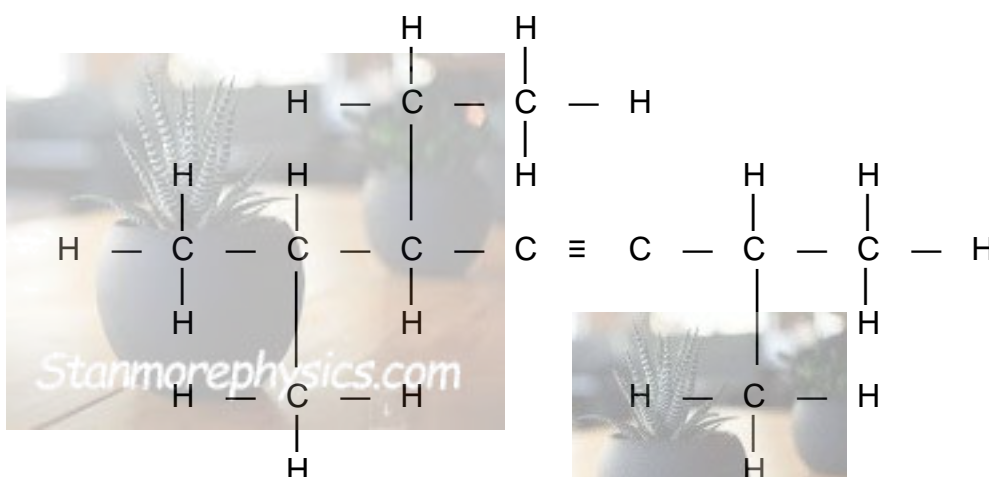
- correct stem i.e. hexane ✓
- substituents correctly identified i.e. chloro, trimethyl ✓
- IUPAC name completely correct including numbering, sequence and hyphen ✓

(3)

2.5.1 alkynes ✓

(1)

2.5.2



Marking criteria:

- Triple bond on 3rd carbon atom ✓
- 2 methyl groups and ethyl group shown ✓
- Whole structure correctly drawn with the substituents on the correct C atoms ✓

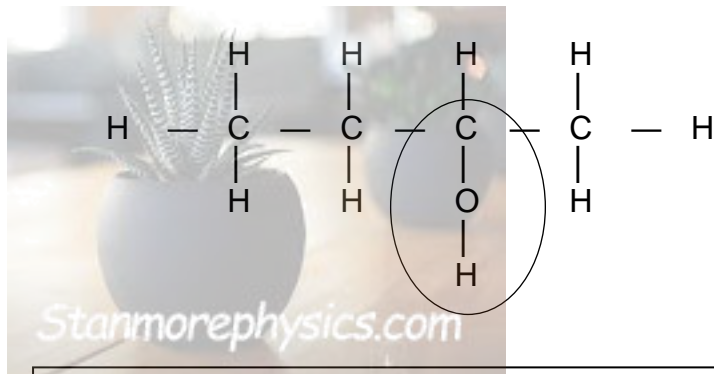
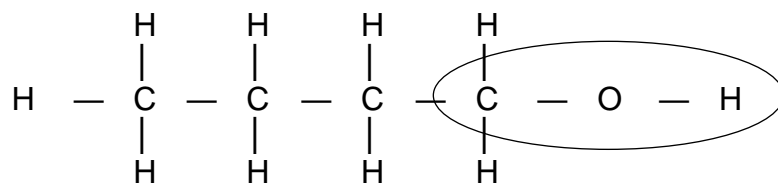
(3)

2.6

Same molecular formula, but different positions of the side chain, substituents or functional groups on the parent chain ✓✓ **(2 or 0)**

(2)

2.
7



Marking criteria:

- Both compounds have the hydroxyl/OH functional group correctly drawn ✓
- Functional group shown on first carbon for the one compound. ✓
- Functional group shown on second carbon for the other compound. ✓
- Whole structure correctly drawn for both compounds ✓ (If -OH is used $\frac{3}{4}$ max)

QUESTION 3

3.1 The **temperature** at which the vapour pressure of a substance equals atmospheric pressure. ✓✓

Marking criteria:

If any one of the underlined key words/phrases in the **correct context** is omitted, deduct 1 mark.

(2)

3.2 The molecular mass for both compounds is the same. ✓

(1)

3.3 Homologous series/functional group ✓

(1)

3.4.1 HIGHER THAN ✓

(1)

- 3.4.2
- Both compounds have hydrogen bonds, (London forces and dipole – dipole forces) ✓
 - Compound P has 2 sites for hydrogen bonding while compound R has only 1 site for hydrogen bonding ✓
 - The intermolecular forces between molecules of P are stronger than the intermolecular forces between molecules of compound R ✓
 - More energy is required to overcome the intermolecular forces between molecules of P ✓

Marking criteria:

- Identify type of intermolecular forces. ✓
- Compare number of sites for hydrogen bonding. ✓
- Compare the strength of the intermolecular forces. ✓
- Compare the energy required to overcome the intermolecular forces. ✓

(4)

3.5.1 B ✓

(1)

- 3.5.2
- Graph B represents a lower vapour pressure. ✓
 - The lower the vapour pressure the higher the boiling point. ✓
 - P has a higher boiling point. ✓

Marking criteria:

- Identify graph B as lower pressure. ✓
- State the relationship between vapour pressure and boiling point. ✓
- State that P has a higher boiling point. ✓

(3)

3.6 REMAINS THE SAME ✓

(1)

3.7.1 LOWER THAN 97 °C ✓

(1)

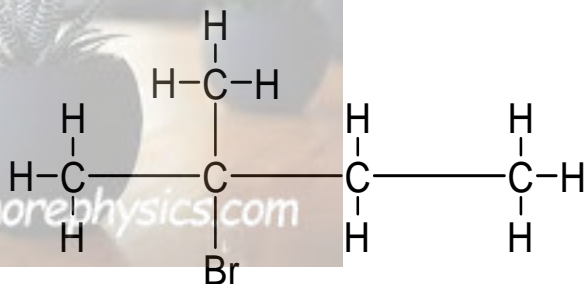
3.7.2	<ul style="list-style-type: none"> • Both compounds R and S have London forces/Dispersion forces and Hydrogen Bonding. ✓ • However, S has a smaller surface area than R, over which the intermolecular forces act. ✓ • The intermolecular forces between molecules of S are weaker. ✓ • Less energy will be required to overcome the intermolecular forces between molecules of S. ✓ 	
OR		
	<ul style="list-style-type: none"> • Both compounds R and S have London forces/Dispersion forces and Hydrogen Bonding. ✓ • However, R has a larger surface area than S, over which the intermolecular forces act. ✓ • The intermolecular forces between molecules of R are stronger. ✓ • More energy will be required to overcome the intermolecular forces between molecules of R. ✓ 	(4)

QUESTION 4

4.1.1 Potassium hydroxide/KOH ✓ (1)

4.1.2 Elimination ✓
Dehydrohalogenation ✓ (2)

4.1.3

**Marking criteria:**

- Br on 2nd carbon atom ✓
- Four carbons in longest chain ✓
- One methyl substituent on C2 ✓

4.2.1 hydrohalogenation ✓ (1)

4.2.2 The presence of water will result in a hydration reaction/formation of an alcohol ✓ ✓ (2)

4.3.1 Water/H₂O ✓ (1)

4.3.2 Reaction 4 ✓ (1)

4.3.3 Reaction 3 ✓ (1)

4.3.4 $\text{C}_5\text{H}_{11}\text{Br} + \text{H}_2\text{O} \rightarrow \text{C}_5\text{H}_{12}\text{O} + \text{HBr}$ **Marking criteria:**

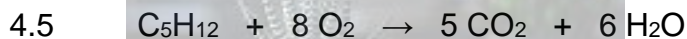
- Both reactants correct ✓
- Both products correct ✓
- Balancing ✓

4.4.1 The (reddish – brown) colour of Br₂ disappears immediately ✓ (1)

4.4.2 1,2 – dibromo – 2 - methylbutane ✓ ✓

Marking criteria:

- correct stem i.e. butane, substituents correctly identified i.e. dibromo, methyl ✓
- IUPAC name completely correct including numbering, sequence and hyphen ✓



Marking criteria:

- Reactant C_5H_{12} ✓
- Reactant O_2 ✓
- Both products correct ✓
- Balancing ✓

(4)
[22]

QUESTION 5

- 5.1
- Change in concentration ✓ of products/reactants per (unit) time. ✓
 - Change in amount/number of moles/volume/mass ✓ of products/reactants per (unit) time. ✓

Marking criteria:

If any one of the underlined key words/phrases in the **correct context** is omitted, deduct 1 mark.

OR

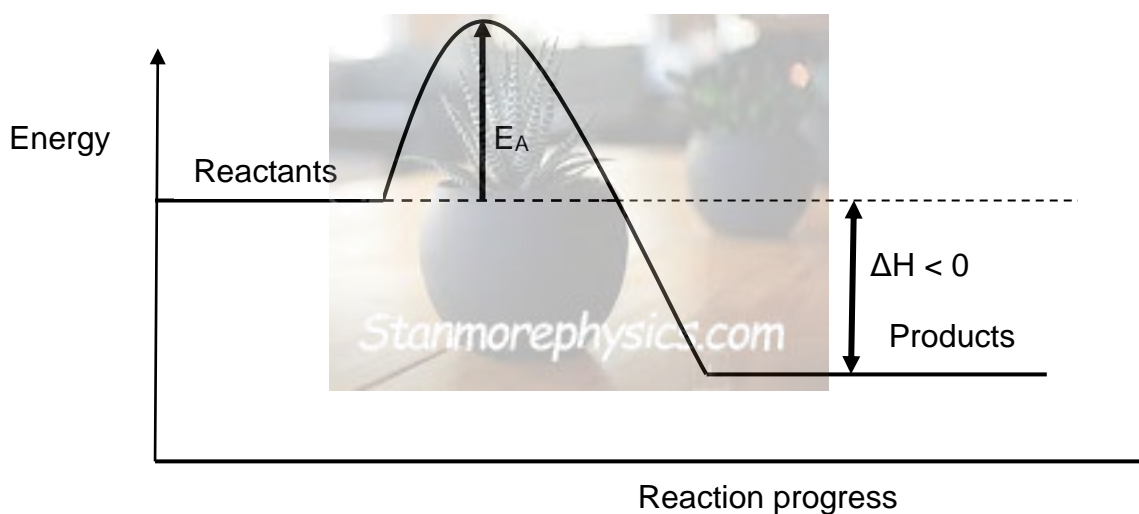
- Amount/number of moles/volume/mass of products formed/reactants used per (unit) time. ✓✓ **(2 or 0)**
- Rate of change in concentration/amount/number of moles/volume/ mass. ✓✓ **(2 or 0)**

(2)

- 5.2 Exothermic ✓

(1)

5.3

**Marking Criteria**

- Energy of reactants correctly shown ✓
- Energy of products correctly shown ✓
- Activation energy shown ✓
- Heat of reaction correctly indicated ✓
- Diagram correctly labeled ✓

5.4

- Reaction rate is higher in the first 60 s ✓ because there are more reactants in the reaction vessel (than when the reaction has proceeded for some time). ✓
- More effective collisions per unit time/second/ Frequency of effective collisions is higher. ✓
- More molecules have enough/sufficient kinetic energy for an effective collision/ More molecules have kinetic energy/ E_k equal to or greater than the activation energy. ✓

(4)

5.5

- Provides an alternate pathway of lower activation. ✓
- More molecules have sufficient energy/energy equal to or greater than the activation. ✓
- More effective collisions per unit time. ✓

(3)

5.6

Marking criteria

- Correct Equation ✓
- Substitute correctly into equation ✓
- $V(O_2) = 116,004 \text{ cm}^3$ ✓
- Correct substitution into $n = \frac{V}{V_m}$ to calculate $n(O_2)$ produced ✓
- Correct ratio: $H_2O_2 : O_2 = 1 : 2$ ✓
- Calculate $n(H_2O_2)$ initial ✓
- Calculate $n(H_2O_2)$ final ✓
- Conclusion: H_2O_2 NOT completely used up ✓

$$\text{rate} = \frac{\text{change in volume of } O_2(g)}{\Delta t} \checkmark$$

$$16,572 = \frac{y - 0}{7 - 0} \checkmark$$

$$y = 116,004 \text{ cm}^3 \checkmark$$

$$n = \frac{V}{V_m}$$

$$= \frac{0,116}{22,4} \checkmark$$

$$= 0,01 \text{ mol}$$

$$n(H_2O_2)_{\text{reacted}}$$

$$= 2 n(O_2) \checkmark$$

$$= 2(0,01) \checkmark$$

$$= 0,02 \text{ mol}$$

$$n(H_2O_2)_{\text{initial}}$$

$$= cV$$

$$= (0,2)(0,2) \checkmark$$

$$= 0,04 \text{ mol}$$

$$n(H_2O_2)_{\text{excess}}$$

$$= 0,04 - 0,02 \checkmark$$

$$= 0,02 \text{ mol}$$

- Reaction has not reached completion.
- 0,02 mol of H_2O_2 has not decomposed. ✓

(8)
[23]

QUESTION 6

6.1.1

Marking criteria:

If any one of the underlined key words/phrases in the correct context is omitted, deduct 1 mark.

The underlined phrase must be in the correct context.

When the equilibrium in a closed system is disturbed, the system will re-instate a new equilibrium by favouring the reaction that will oppose the disturbance. ✓✓

(2)

6.1.2 INCREASE. ✓

According to Le Chatliers Principle when the pressure decreases, the reaction that leads to an increase in the number of moles will be favoured. ✓

The forward reaction produces a greater number of moles than the reverse reaction. ✓

In this case the forward reaction is favoured/equilibrium position shifts to the right. ✓

(4)

6.2.1

Marking criteria:

- REVERSE ✓
- Kc expression ✓
- Correct Substitution of Kc, [NO], [N₂O], [O₂] ✓
- Calculating the [NO₂] ✓
- Comparing the calculated value of [NO₂] with the new value. ✓

REVERSE ✓

$$K_c = \frac{[N_2O][O_2]}{[NO_2][NO]} \quad \checkmark$$

$$3,93 = \frac{(0,18)(0,38)}{[NO_2][0,29]} \quad \checkmark$$

$$[NO_2] = 0,060 \text{ mol.dm}^{-3} \quad \checkmark$$

The concentration of NO₂ has increased from 0,06 mol.dm⁻³ to 0,12 mol.dm⁻³ ✓ (5)

6.2.2

Marking criteria:

- Initial concentrations of all substances ✓
- Concentration of NO₂ at equilibrium ✓
- Using the correct mol ratio ✓
- Calculating the concentration at equilibrium of all three substances ✓
- Correct substitution of equilibrium concentrations into K_c expression ✓
- K_c = 0,91 ✓
- Identifying that the condition changed is temperature. ✓
- K_c value changed. ✓

Temperature ✓

	NO ₂	NO	N ₂ O	O ₂	
Initial concentration (mol.dm ⁻³)	0,06	0,29	0,18	0,38	✓
Change (mol.dm ⁻³)	0,06	0,06	0,06	0,06	✓
Equilibrium concentration (mol.dm ⁻³)	0,12 ✓	0,35	0,12	0,32 ✓	✓

$$\begin{aligned}
 K_c &= \frac{[N_2O][O_2]}{[NO_2][NO]} \\
 &= \frac{(0,12)(0,32)}{[0,12][0,35]} \quad \checkmark \\
 &= 0,91 \quad \checkmark
 \end{aligned}$$



K_c value has changed (decreased). ✓

(8)

6.2.3 Decreased. ✓

Reverse reaction was favoured. ✓

According to Le Chatelier's Principle a decrease in temperature favours the exothermic reaction. ✓

(3)

[22]

QUESTION 7

7.1.1 A substance that can act as an acid or as a base. ✓✓ **(2 or 0)**

(2)

7.1.2 HCO₃⁻ ✓

H₂O ✓

(2)

7.1.3 HCO₃⁻(aq) + H₂O(l) ⇌ H₂CO₃(aq) ✓ + OH⁻(aq) ✓

(2)

7.2.1 Strong base dissociates completely ✓ in water to form a high concentration of OH⁻/hydroxide ions. ✓

Marking criteria:

If any one of the underlined key words/phrases in the correct context is omitted, deduct 1 mark.

(2)

7.2.2 bromothymol blue ✓✓

(2)

7.2.3

Marking criteria:

- Formula: $\text{pH} = -\log[\text{H}_3\text{O}^+]$
- Correct substitution ✓
- Ratio of $[\text{H}_3\text{O}^+]$ to $[\text{H}_2\text{SO}_4] = 2:1$ ✓
- H_2SO_4 undergoes complete ionisation. ✓

$$\begin{aligned} \text{pH} &= -\log[\text{H}_3\text{O}^+] && \checkmark \\ 1 &= -\log[\text{H}_3\text{O}^+] && \checkmark \\ [\text{H}_3\text{O}^+] &= 0,1 \text{ mol}\cdot\text{dm}^{-3} \end{aligned}$$

$$\begin{aligned} [\text{H}_2\text{SO}_4] &= \frac{1}{2}[\text{H}_3\text{O}^+] && \checkmark \\ &= \frac{1}{2}(0,1) && \checkmark \\ &= 0,05 \text{ mol}\cdot\text{dm}^{-3} \end{aligned}$$

All the H_2SO_4 is ionised to $[\text{H}_3\text{O}^+]$



(4)

7.2.4

Marking criteria:

- Equation $n = cV$ ✓
- Substitute for c and V in $n = cV$ to calculate $n(\text{OH}^-)$ from NaOH ✓
- Substitute for c and V in $n = cV$ to calculate $n(\text{OH}^-)$ from $\text{Ba}(\text{OH})_2$ ✓
- Add above values to obtain total $n(\text{OH}^-)$ ✓
- Use correct ratio to calculate $n(\text{H}_2\text{SO}_4)$ ✓
- Substitute $c(\text{H}_2\text{SO}_4)$ ✓ and $n(\text{H}_2\text{SO}_4)$ ✓
- Final answer: $0,054 \text{ dm}^3$ ✓

$$\begin{aligned} n(\text{OH}^-) \text{ from NaOH} &= cV && \checkmark \\ &= (0,1) \frac{12}{1000} && \checkmark \\ &= 1,2 \times 10^{-3} \text{ mols} \end{aligned}$$

$$\begin{aligned} n(\text{OH}^-) \text{ from Ba(OH)}_2 &= 2cV && \checkmark \\ &= 2(0,04375) \frac{12}{1000} && \checkmark \\ &= 4,2 \times 10^{-3} \text{ mols} \end{aligned}$$

$$n(\text{OH}^-)_{\text{Total}} = 1,2 \times 10^{-3} + 4,2 \times 10^{-3} \checkmark \text{ (for addition)}$$

$$= 5,4 \times 10^{-3} \text{ mols}$$

$$\begin{aligned} n(\text{H}_2\text{SO}_4) : n(\text{OH}^-)_{\text{Total}} &= 1:2 \quad \checkmark \text{ for ratio} \\ n(\text{H}_2\text{SO}_4) &= \frac{1}{2}(5,4 \times 10^{-3}) \\ &= 2,7 \times 10^{-3} \text{ mols} \end{aligned}$$

$$c(\text{H}_2\text{SO}_4) = \frac{n}{V}$$

$$0,05 = \frac{2,7 \times 10^{-3}}{V} \quad \checkmark$$

$$V = 0,054 \text{ dm}^3 \quad \checkmark$$

(8)

**TOTAL: [22]
150**