KWAZULU-NATAL PROVINCE

EDUCATION
REPUBLIC OF SOUTH AFRICA

NATIONAL SENIOR CERTIFICATE

GRADE 12

PHYSICAL SCIENCES P2 (CHEMISTRY)

JUNE EXAMINATION

2025

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MARKS : 150

TIME : 3 Hours

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

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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.

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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 CH_2O

C C_3H_6O

D $C_6H_{11}O_2$ (2)

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

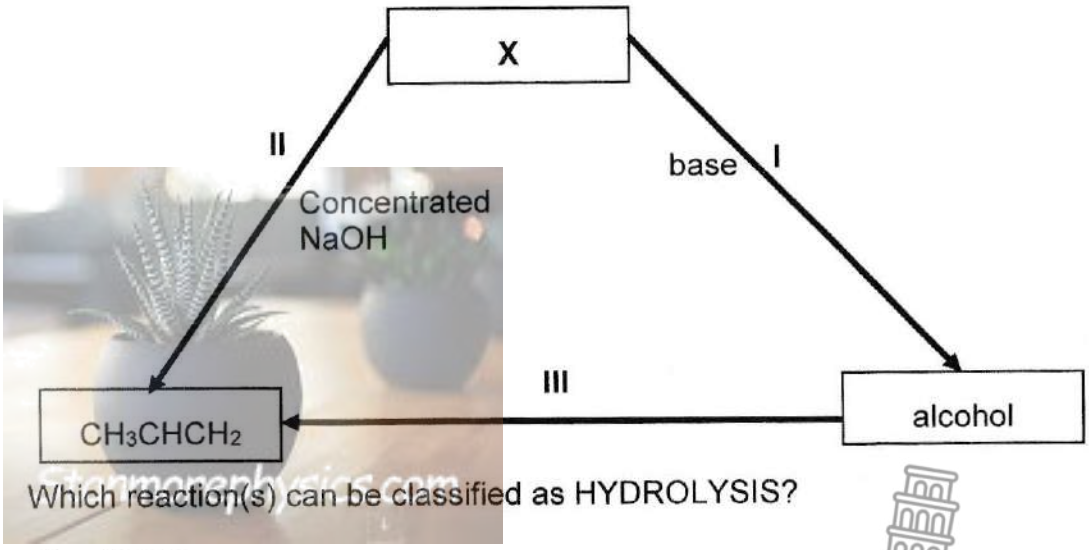
A $CH_3CH_2CH_2CH_2CH_3$

B $CH_3COCH_2CH_3$

C CH_3CH_2COOH

D CH_3CH_2OOCH (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

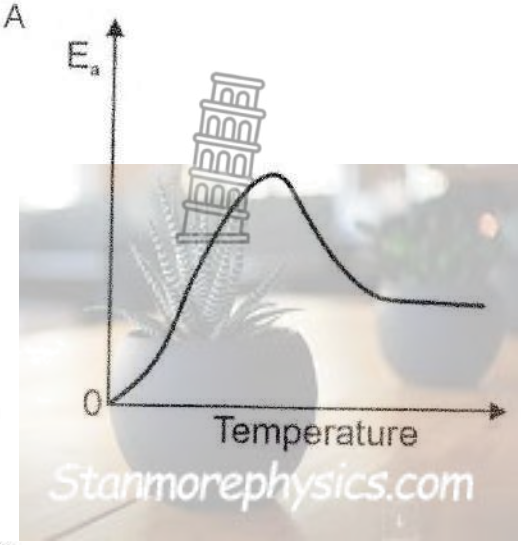
C II and III only

D I, II and III (2)

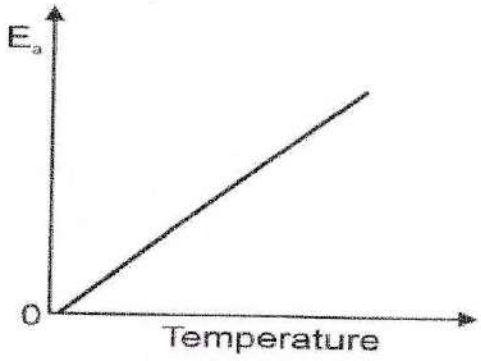
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1.4 Which one of the following graphs shows the relationship between the activation energy (Ea) for a reaction and temperature?

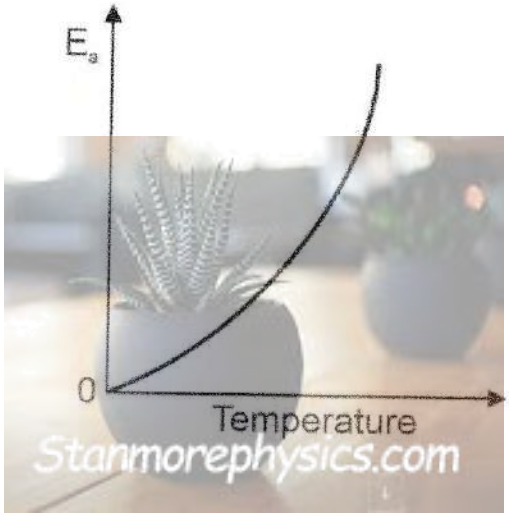
A



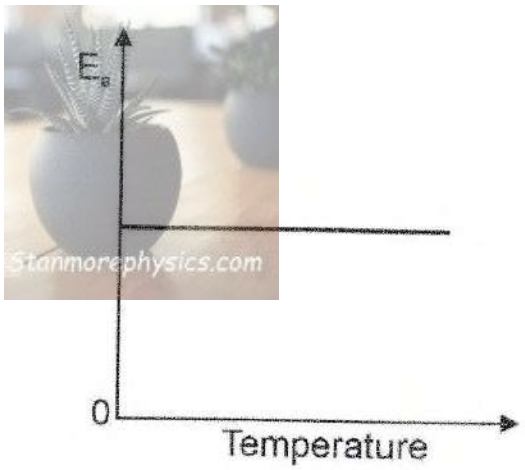
B



C



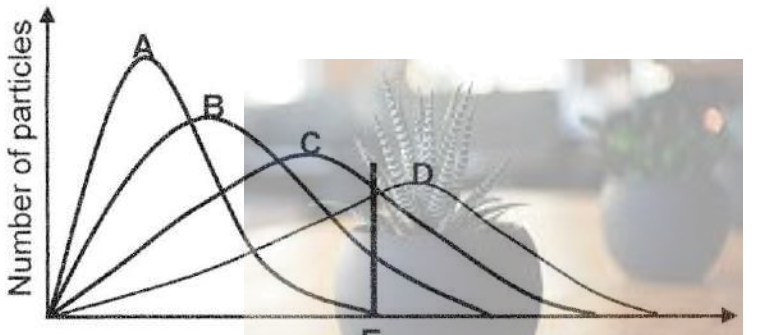
D



(2)

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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.



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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

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

A A.

B B.

C C.

D D. (2)

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

$$NaNO_3(aq) \rightleftharpoons Na^+(aq) + NO_3^-(aq)$$

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	$[Na^+]$ decreases	Reverse reaction is favoured
B	$[Na^+]$increases	Forward reaction is favoured
C	$[NO_3^-]$ decreases	Forward reaction is favoured
D	$[NO_3^-]$ increases	Reverse reaction is favoured

(2)

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

$$CH_4(g) + H_2O(g) \rightleftharpoons CO(g) + 3H_2(g) \qquad \Delta H > 0$$

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)

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

$$P(g) + \rightleftharpoons 2Q(g)$$

1 mol of P was placed in an empty 1 dm^3 container at a certain temperature. The container was sealed and P was allowed to decompose. At equilibrium x mol of P had decomposed. Kc 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:

$$H_3PO_4(aq) + HCO_3^-(aq) \rightleftharpoons H_2PO_4^-(aq) + H_2CO_3(aq) \quad Ka > 1$$

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

A $H_3PO_4(aq)$

B $HCO_3^-(aq)$

C $H_2PO_4^-(aq)$

D $H_2CO_3(aq)$

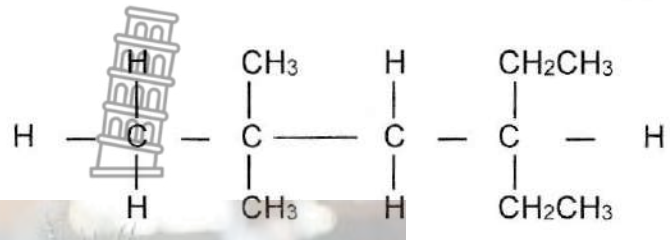
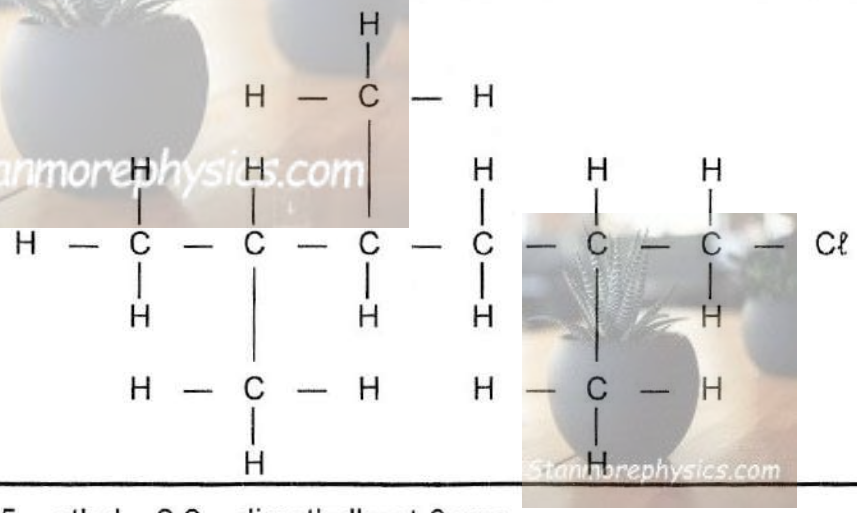
(2)

[20]

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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)

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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	CH_3CH_2COOH
R	$CH_3CH_2CH_2CH_2OH$

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)

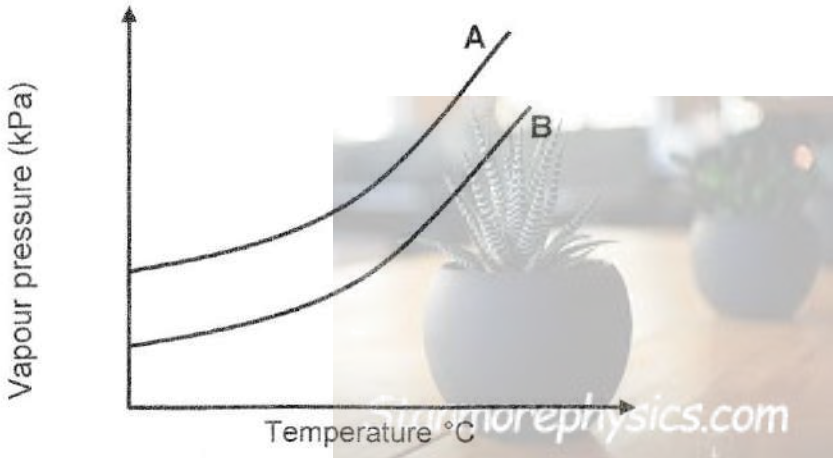
3.4 The boiling point of compound R is 97 °C.

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)

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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.

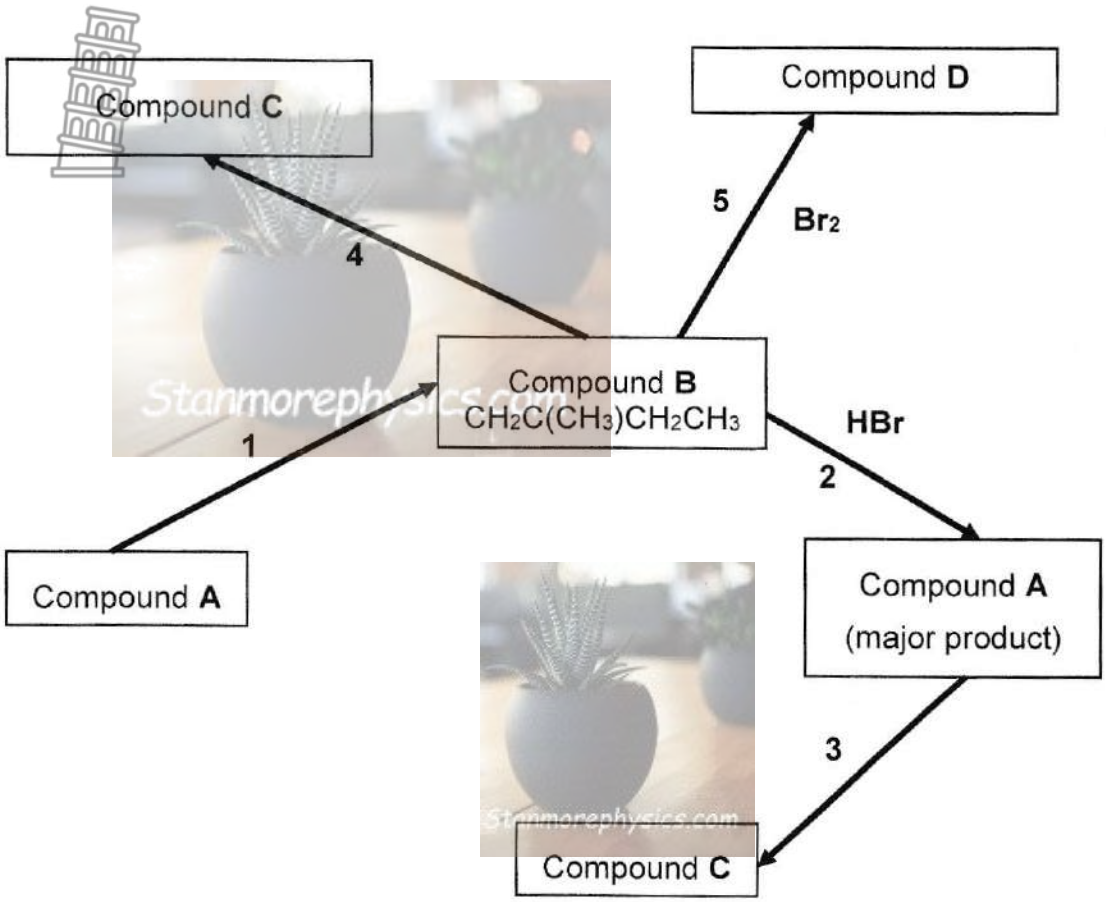
3.7.1 Will the boiling point of compound S be HIGHER THAN, EQUAL TO or LOWER THAN 97 °C. (1)

3.7.2 Fully explain the answer to question 3.7.1 (4)
[19]

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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:

$$\text{Compound A} \longrightarrow CH_2C(CH_3)CH_2CH_3 + KBr + H_2O$$

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)

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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]

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QUESTION 5 (Start on a new page.)

The reaction between pure calcium carbonate, $CaCO_3(s)$, and EXCESS hydrochloric acid, $HC\ell(aq)$, is used to investigate the factors that affect the rate of a reaction.

The balanced equation for the reaction is:

$$CaCO_3(s) + 2HC\ell(aq) \rightarrow CaC\ell_2(aq) + CO_2(g) + H_2O(\ell)$$

The concentration of the $HC\ell(aq)$ stays constant for the duration of the reaction.

The volume of $CO_2(g)$ 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	5	18	24	28	31	33

5.1 Define the term *reaction rate*. (2)

5.2 Is the reaction between calcium carbonate, $CaCO_3(s)$, and hydrochloric acid, $HC\ell(aq)$, EXOTHERMIC or ENDOTHERMIC? (1)

5.3 Draw an energy profile for an EXOTHERMIC REACTION. Indicate the following:

- Energy of reactants
- Energy of products
- Heat of reaction
- Activation energy (5)

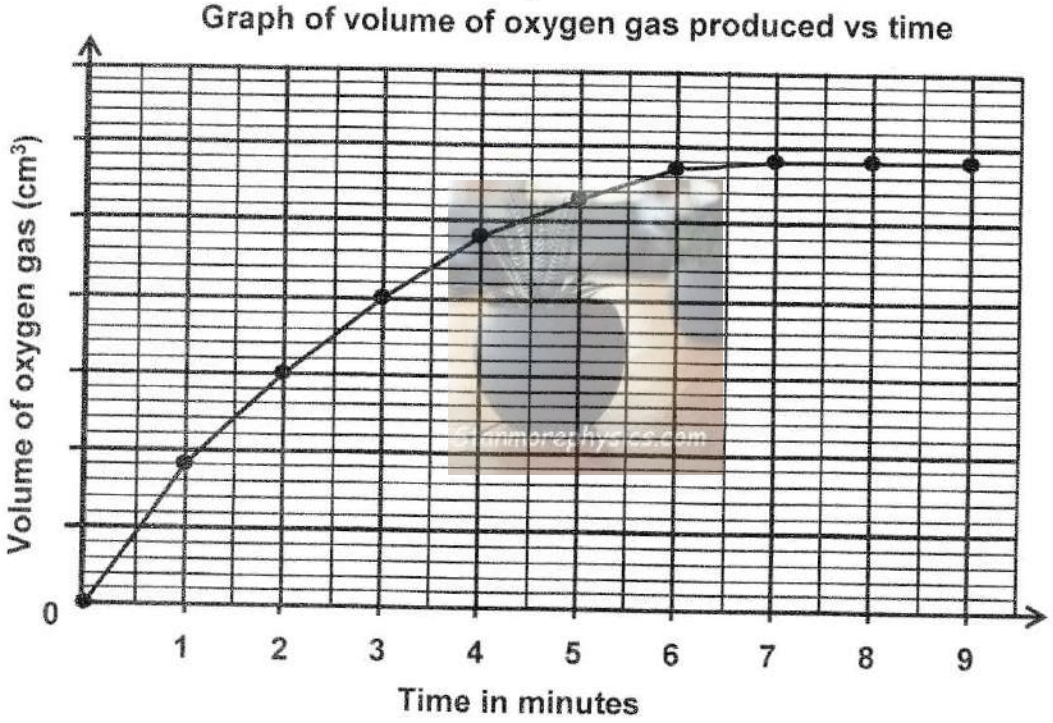
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5.4 Why is there a noticeably BIGGEST CHANGE in volume of CO_2 in the table for the first 60 s? Use the collision theory to explain the answer. (4)

In another reaction manganese dioxide (MnO_2) catalyses the decomposition of a hydrogen peroxide solution ($H_2O_2(aq)$) into water and oxygen.

$$2H_2O_2\,(aq) \xrightarrow{MnO_2} H_2O\,(\ell) + O_2\,(g)$$

0,1 g of manganese dioxide (MnO_2) was added to 200 cm^3 of a 0,2 $mol.dm^{-3}$ solution of hydrogen peroxide ($H_2O_2(aq)$). 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 $O_2(g)$ is 16,572 $cm^3.min^{-1}$.
Perform the relevant calculation/s to determine whether the above reaction reached completion at 7 minutes. (8)
[23]

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QUESTION 6 (Start on a new page.)

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

$$CH_4(g) + H_2O(g) \rightleftharpoons CO(g) + 3H_2(g)$$

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 $H_2(g)$ 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 dm^3 container.

$$NO_2(g) + NO(g) \rightleftharpoons N_2O(g) + O_2(g) \quad \Delta H > 0$$

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 NO(g), 0,36 moles of $N_2O(g)$ and 0,76 moles of $O_2(g)$ 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 $NO_2(g)$ 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? (3)
Use Le Chatelier's Principle to explain the answer.

[22]

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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:

$$HCO_3^-(aq) + H_2O(\ell) \rightleftharpoons CO_3^{2-}(aq) + H_3O^+(aq)$$

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 cm^3 of sodium hydroxide, NaOH(aq) of concentration 0,10 $mol.dm^{-3}$ is mixed with 48 cm^3 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, $H_2SO_4(aq)$, 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, $H_2SO_4(aq)$ is 1.
Perform the necessary calculation to prove that the aqueous solution of sulphuric acid, $H_2SO_4(aq)$ is a strong acid. (4)

7.2.4 Calculate the volume of an aqueous solution of sulphuric acid, $H_2SO_4(aq)$, 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]

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DATA FOR PHYSICAL SCIENCES GRADE 12
PAPER 2 (CHEMISTRY)

GEGEWENS VIR FISIESE WETENSKAPPE GRAAD 12
VRAESTEL 2 (CHEMIE)

TABLE 1: PHYSICAL CONSTANTS/*TABEL 1: FISIESE KONSTANTES*

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

TABLE 2: FORMULAE/*TABEL 2: FORMULES*

$n = \frac{m}{M}$	$n = \frac{N}{N_A}$
$c = \frac{n}{V}$ or/*of* $c = \frac{m}{MV}$	$n = \frac{V}{V_m}$
$\frac{c_a v_a}{c_b v_b} = \frac{n_a}{n_b}$	$pH = -\log[H_3O^+]$
$K_w = [H_3O^+][OH^-] = 1 \times 10^{-14}$ at/*by* 298 K	
$E^{\theta}_{cell} = E^{\theta}_{cathode} - E^{\theta}_{anode}$ / $E^{\theta}_{sel} = E^{\theta}_{katode} - E^{\theta}_{anode}$ or/*of* $E^{\theta}_{cell} = E^{\theta}_{reduction} - E^{\theta}_{oxidation}$ / $E^{\theta}_{sel} = E^{\theta}_{reduksie} - E^{\theta}_{oksidasie}$ or/*of* $E^{\theta}_{cell} = E^{\theta}_{oxidisingagent} - E^{\theta}_{reducingagent}$ / $E^{\theta}_{sel} = E^{\theta}_{oksideermiddel} - E^{\theta}_{reduseermiddel}$	
$I = \frac{Q}{\Delta t}$	$n = \frac{Q}{e}$ where n is the number of electrons/ *waar n die aantal elektrone is*

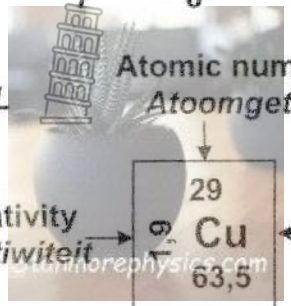
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TABLE 3: THE PERIODIC TABLE OF ELEMENTS
TABEL 3: DIE PERIODIEKE TABEL VAN ELEMENTE

1 (I)	2 (II)	3	4	5	6	7	8	9	10	11	12	13 (III)	14 (IV)	15 (V)	16 (VI)	17 (VII)	18 (VIII)
2,1 H 1																	2 He 4
1,0 Li 7	1,5 Be 9											2,0 B 11	2,5 C 12	3,0 N 14	3,5 O 16	4,0 F 19	10 Ne 20
0,9 Na 23	1,2 Mg 24											1,5 Aℓ 27	1,8 Si 28	2,1 P 31	2,5 S 32	3,0 Cℓ 35,5	18 Ar 40
0,8 K 39	1,0 Ca 40	1,3 Sc 45	1,5 Ti 48	1,6 V 51	1,6 Cr 52	1,5 Mn 55	1,8 Fe 56	1,8 Co 59	1,8 Ni 59	1,9 Cu 63,5	1,6 Zn 65	1,6 Ga 70	1,8 Ge 73	2,0 As 75	2,4 Se 79	2,8 Br 80	36 Kr 84
0,8 Rb 86	1,0 Sr 88	1,2 Y 89	1,4 Zr 91	Nb 92	1,8 Mo 96	1,9 Tc	2,2 Ru 101	2,2 Rh 103	2,2 Pd 106	1,9 Ag 108	1,7 Cd 112	1,7 In 115	1,8 Sn 119	1,9 Sb 122	2,1 Te 128	2,5 I 127	54 Xe 131
0,7 Cs 133	0,9 Ba 137	57 La 139	1,6 Hf 179	73 Ta 181	74 W 184	75 Re 186	76 Os 190	77 Ir 192	78 Pt 195	79 Au 197	80 Hg 201	1,8 Tℓ 204	1,8 Pb 207	1,9 Bi 209	2,0 Po	2,5 At	86 Rn
0,7 Fr	0,9 Ra 226	89 Ac															

58 Ce 140	59 Pr 141	60 Nd 144	61 Pm	62 Sm 150	63 Eu 152	64 Gd 157	65 Tb 159	66 Dy 163	67 Ho 165	68 Er 167	69 Tm 169	70 Yb 173	71 Lu 175
90 Th 232	91 Pa	92 U 238	93 Np	94 Pu	95 Am	96 Cm	97 Bk	98 Cf	99 Es	100 Fm	101 Md	102 No	103 Lr

KEY/*SLEUTEL*



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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
$C\ell_2(g) + 2e^-$	$\rightleftharpoons$	$2C\ell^-$	+ 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
$Br_2(\ell) + 2e^-$	$\rightleftharpoons$	$2Br^-$	+ 1,07
$NO_3^- + 4H^+ + 3e^-$	$\rightleftharpoons$	$NO(g) + 2H_2O$	+ 0,96
$Hg^{2+} + 2e^-$	$\rightleftharpoons$	$Hg(\ell)$	+ 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
$A\ell^{3+} + 3e^-$	$\rightleftharpoons$	$A\ell$	– 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

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

Half-reactions/*Halfreaksies*			E^{θ} (V)
$Li^+ + e^-$	$\rightleftharpoons$	Li	− 3,05
$K^+ + e^-$	$\rightleftharpoons$	K	− 2,93
$Cs^+ + e^-$	$\rightleftharpoons$	Cs	− 2,92
$Ba^{2+} + 2e^-$	$\rightleftharpoons$	Ba	− 2,90
$Sr^{2+} + 2e^-$	$\rightleftharpoons$	Sr	− 2,89
$Ca^{2+} + 2e^-$	$\rightleftharpoons$	Ca	− 2,87
$Na^+ + e^-$	$\rightleftharpoons$	Na	− 2,71
$Mg^{2+} + 2e^-$	$\rightleftharpoons$	Mg	− 2,36
$A\ell^{3+} + 3e^-$	$\rightleftharpoons$	$A\ell$	− 1,66
$Mn^{2+} + 2e^-$	$\rightleftharpoons$	Mn	− 1,18
$Cr^{2+} + 2e^-$	$\rightleftharpoons$	Cr	− 0,91
$2H_2O + 2e^-$	$\rightleftharpoons$	$H_2(g) + 2OH^-$	− 0,83
$Zn^{2+} + 2e^-$	$\rightleftharpoons$	Zn	− 0,76
$Cr^{3+} + 3e^-$	$\rightleftharpoons$	Cr	− 0,74
$Fe^{2+} + 2e^-$	$\rightleftharpoons$	Fe	− 0,44
$Cr^{3+} + e^-$	$\rightleftharpoons$	Cr^{2+}	− 0,41
$Cd^{2+} + 2e^-$	$\rightleftharpoons$	Cd	− 0,40
$Co^{2+} + 2e^-$	$\rightleftharpoons$	Co	− 0,28
$Ni^{2+} + 2e^-$	$\rightleftharpoons$	Ni	− 0,27
$Sn^{2+} + 2e^-$	$\rightleftharpoons$	Sn	− 0,14
$Pb^{2+} + 2e^-$	$\rightleftharpoons$	Pb	− 0,13
$Fe^{3+} + 3e^-$	$\rightleftharpoons$	Fe	− 0,06
$2H^+ + 2e^-$	**$\rightleftharpoons$**	**$H_2(g)$**	**0,00**
$S + 2H^+ + 2e^-$	$\rightleftharpoons$	$H_2S(g)$	+ 0,14
$Sn^{4+} + 2e^-$	$\rightleftharpoons$	Sn^{2+}	+ 0,15
$Cu^{2+} + e^-$	$\rightleftharpoons$	Cu^+	+ 0,16
$SO_4^{2-} + 4H^+ + 2e^-$	$\rightleftharpoons$	$SO_2(g) + 2H_2O$	+ 0,17
$Cu^{2+} + 2e^-$	$\rightleftharpoons$	Cu	+ 0,34
$2H_2O + O_2 + 4e^-$	$\rightleftharpoons$	$4OH^-$	+ 0,40
$SO_2 + 4H^+ + 4e^-$	$\rightleftharpoons$	$S + 2H_2O$	+ 0,45
$Cu^+ + e^-$	$\rightleftharpoons$	Cu	+ 0,52
$I_2 + 2e^-$	$\rightleftharpoons$	$2I^-$	+ 0,54
$O_2(g) + 2H^+ + 2e^-$	$\rightleftharpoons$	H_2O_2	+ 0,68
$Fe^{3+} + e^-$	$\rightleftharpoons$	Fe^{2+}	+ 0,77
$NO_3^- + 2H^+ + e^-$	$\rightleftharpoons$	$NO_2(g) + H_2O$	+ 0,80
$Ag^+ + e^-$	$\rightleftharpoons$	Ag	+ 0,80
$Hg^{2+} + 2e^-$	$\rightleftharpoons$	$Hg(\ell)$	+ 0,85
$NO_3^- + 4H^+ + 3e^-$	$\rightleftharpoons$	$NO(g) + 2H_2O$	+ 0,96
$Br_2(\ell) + 2e^-$	$\rightleftharpoons$	$2Br^-$	+ 1,07
$Pt^{2+} + 2e^-$	$\rightleftharpoons$	Pt	+ 1,20
$MnO_2 + 4H^+ + 2e^-$	$\rightleftharpoons$	$Mn^{2+} + 2H_2O$	+ 1,23
$O_2(g) + 4H^+ + 4e^-$	$\rightleftharpoons$	$2H_2O$	+ 1,23
$Cr_2O_7^{2-} + 14H^+ + 6e^-$	$\rightleftharpoons$	$2Cr^{3+} + 7H_2O$	+ 1,33
$C\ell_2(g) + 2e^-$	$\rightleftharpoons$	$2C\ell^-$	+ 1,36
$MnO_4^- + 8H^+ + 5e^-$	$\rightleftharpoons$	$Mn^{2+} + 4H_2O$	+ 1,51
$H_2O_2 + 2H^+ + 2e^-$	$\rightleftharpoons$	$2H_2O$	+1,77
$Co^{3+} + e^-$	$\rightleftharpoons$	Co^{2+}	+ 1,81
$F_2(g) + 2e^-$	$\rightleftharpoons$	$2F^-$	+ 2,87

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