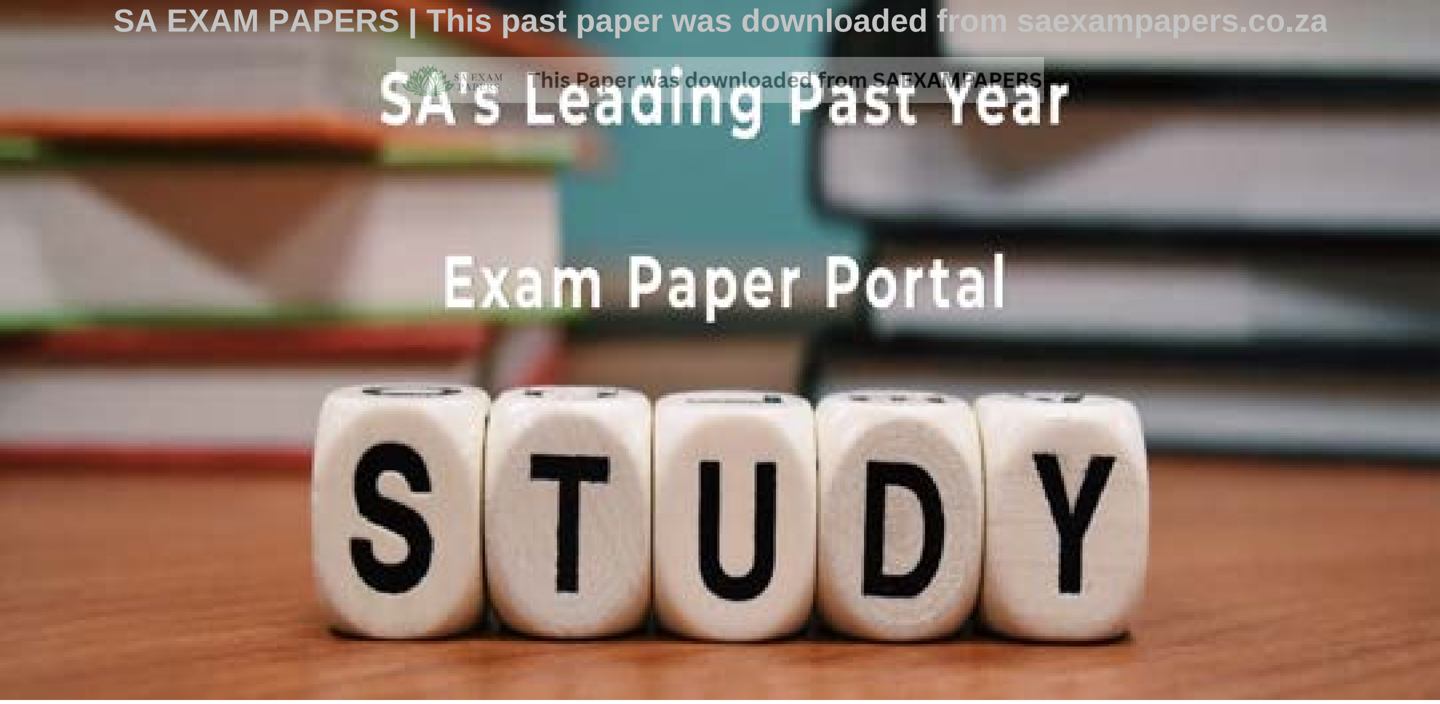
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Exam Paper Portal
STUDY

GAUTENG PROVINCE
EDUCATION
REPUBLIC OF SOUTH AFRICA

JUNE EXAMINATION
GRADE 12

2025

PHYSICAL SCIENCES: CHEMISTRY

(PAPER 2)

PHYSICAL SCIENCES P2

C2842E

TIME: 3 hours

MARKS: 150

16 pages + 2 data sheets

X05

INSTRUCTIONS AND INFORMATION

1. This question paper consists of SEVEN questions. Answer ALL the questions in the ANSWER BOOK.
2. Start EACH question on a NEW page in the ANSWER BOOK.
3. Number the answers correctly according to the numbering system used in the question paper.
4. Leave ONE line open between two subquestions, e.g., between QUESTION 2.1 and QUESTION 2.2.
5. You may use a non-programmable calculator.
6. You may use appropriate mathematical instruments.
7. Show ALL formulae and substitutions in ALL calculations.
8. Round-off your FINAL numerical answers to a minimum of TWO decimal places.
9. Give brief discussions, et cetera where required.
10. You are advised to use the attached DATA SHEETS.
11. Write neatly and legibly.

QUESTION 1: MULTIPLE-CHOICE QUESTIONS

Various 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 numbers (1.1 to 1.10) in the ANSWER BOOK, e.g. 1.11 D.

1.1 Which of the following represents a SATURATED hydrocarbon?

A C_2H_4
B C_3H_6
C C_3H_8
D C_4H_8 (2)

1.2 Which of the following pairs of reactants can be used to prepare the ester called ethyl propanoate in the laboratory?

A Ethane and propanoic acid
B Propanol and ethanoic acid
C Ethanol and propanoic acid
D Ethene and propanol (2)

1.3 Consider the reaction represented by the equation below:

$$CH_3CHCH_2 \quad + \quad HBr \quad \rightarrow \quad CH_3CHBrCH_3$$

What type of reaction is represented above?

A Halogenation
B Substitution
C Hydrogenation
D Hydrohalogenation (2)

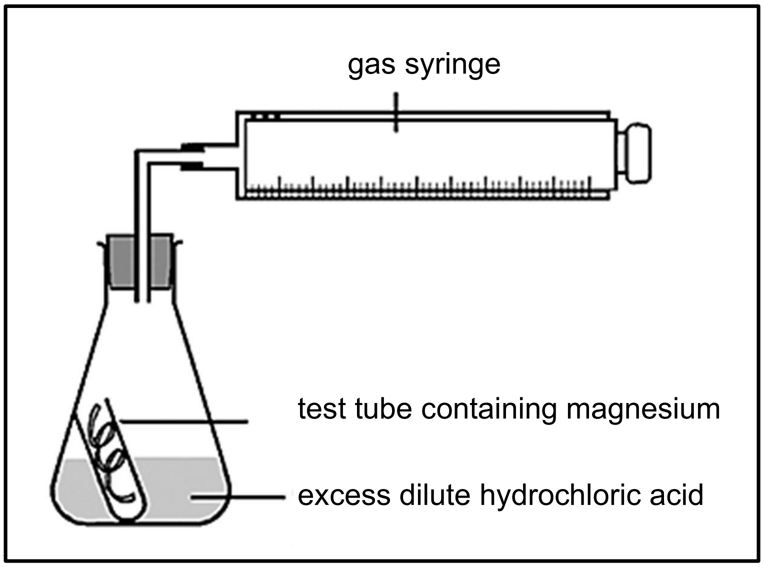
1.4 Consider the following compound:

$$CH_3CH(C\ell)CH_2C(CH_3)_3$$

The IUPAC name of this compound is:

A 2-chloro-4,4-dimethylpentane
B 2,2-dimethyl-4-chloropentane
C 4,4-dimethyl-2-chloropentane
D 4-chloro-2,2-dimethylpentane (2)

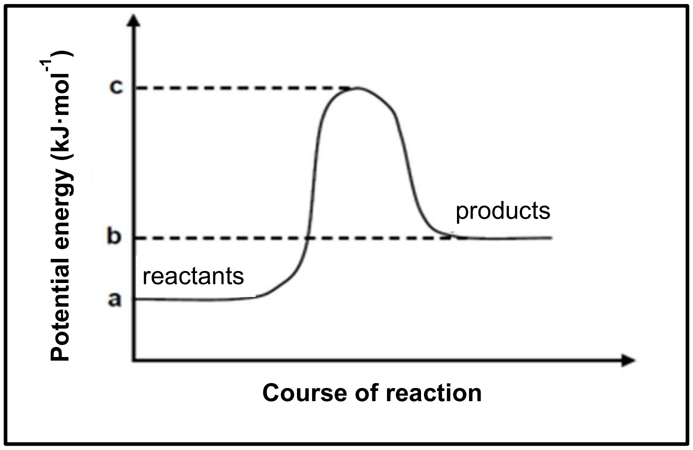
1.5 Two learners want to investigate the factors affecting the rate of reaction between magnesium (Mg) and hydrochloric acid (HCℓ). The concentration of the acid remains the same.



Which of the following changes to the experiment will produce the fastest rate of reaction?

A Powdered magnesium with hydrochloric acid at room temperature
B Powdered magnesium with hydrochloric acid at a higher temperature
C Magnesium ribbon with hydrochloric acid at a higher temperature
D Magnesium ribbon with hydrochloric acid at room temperature (2)

1.6 Consider the energy profile graph for a REVERSIBLE REACTION shown below.



The following statements are given:

(i) a – c represents the activation energy for the reverse reaction.
(ii) ∆H for the reverse reaction is a – b.
(iii) A catalyst lowers the activation energy for both forward and reverse reactions.

Identify the CORRECT statement(s).

A (ii) and (iii) only
B (iii) only
C (i), (ii) and (iii)
D (i) only (2)

1.7 The reaction of an acid-base indicator (In^-) represented as HIn(aq), with $H_2O(\ell)$ reaches equilibrium according to the following balanced equation:

$$HIn(aq) + H_2O(\ell) \rightleftharpoons H_3O^+(aq) + In^-(aq) \qquad \Delta H < 0$$

Red Yellow

At equilibrium, the colour of the solution is red.

Which of the following will change the colour of the solution from red to yellow?

A Increasing the concentration of H_3O^+ ions
B Increasing the temperature of the solution
C Adding a base
D Adding an acid (2)

1.8 The expression for the equilibrium constant (K_C) of a hypothetical reaction is given as follows:

$$K_C = \frac{[PQ_3]^2}{[Q_2]^3}$$

Which of the following equations for a reaction at equilibrium matches the above expression?

A $P_2(g) + 3Q_2(g) \rightleftharpoons 2PQ_3(aq)$

B $2PQ_3(\ell) \rightleftharpoons P_2(g) + 3Q_2(g)$

C $2PQ_3(aq) \rightleftharpoons P_2(g) + 3Q_2(g)$

D $P_2(s) + 3Q_2(g) \rightleftharpoons 2PQ_3(g)$ (2)

1.9 Which statement best describes the difference between the *endpoint* and the *equivalence point* in a titration?

A The endpoint occurs when the acid or base has completely reacted with each other, while the equivalence point is when the indicator changes colour.

B The equivalence point occurs when the acid or base has completely reacted with each other, while the endpoint is when the indicator changes colour.

C The endpoint and equivalence point occur at different times and have no connection in a titration.

D The equivalence point and endpoint are always exactly the same in every titration. (2)

1.10 A titration experiment was conducted using a sodium hydroxide (NaOH) standard solution of concentration 0,1 mol·dm^{-3} and hydrochloric acid (HCℓ) of unknown concentration.

In each titration, a volume of 20 cm^3 of NaOH was used.
The readings from the burette are given in the table below.

Titration	Volume of HCℓ (in cm^3)
1	26,66
2	26,50
3	26,60

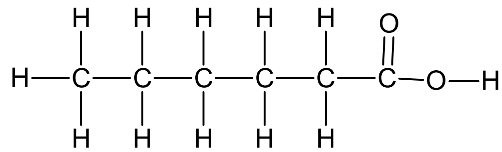
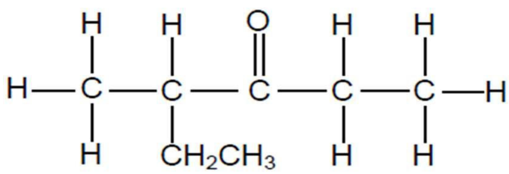
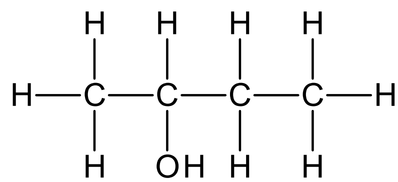
What is the concentration, in mol·dm^{-3}, of the HCℓ required to neutralise the NaOH?

A 0,0752
B 0,0750
C 0,0754
D 0,0755 (2)

[20]

QUESTION 2 (Start on a new page.)

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

A	C_5H_{12}	**B**	$C_4H_8O_2$
C	Ethyl butanoate	**D**	$CH_3CHCHCH_2CH_3$
E	Butan-1-ol	**F**	
G		**H**	

2.1 Consider compound **H.** Is this a PRIMARY, SECONDARY or TERTIARY alcohol? Explain the answer. (3)

2.2 Write down the letter that represents each of the following:

2.2.1 A ketone (1)

2.2.2 A MOLECULAR FORMULA of a hydrocarbon (1)

2.2.3 A reactant in the preparation of compound **C** (1)

2.3 Write down the STRUCTURAL formula of:

2.3.1 Compound **D** (2)

2.3.2 The FUNCTIONAL group of compound **F** (2)

2.3.3 The FUNCTIONAL isomer of compound **G** with a prefix of 4-methyl (2)

2.4 Write down the IUPAC name of:

2.4.1 Compound **D** (2)

2.4.2 Compound **G** (3)

2.5 Consider compounds **E** and **H**.

2.5.1 Identify the type of isomer. (1)

2.5.2 Define this type of isomer. (2)

2.6 Consider compound **C**.

2.6.1 To which homologous series does compound **C** belong? (1)

2.6.2 Give the NAME of the catalyst required in the preparation of compound **C**. (1)

2.6.3 Draw the STRUCTURAL FORMULA of compound **C**. (3)
[25]

QUESTION 3 (Start on a new page.)

The factors that affect the vapour pressure of different organic compounds are investigated. The table below shows the vapour pressure of five organic compounds, represented by the letters **A** – **E**.

	ORGANIC COMPOUND	**MOLECULAR MASS ($g \cdot mol^{-1}$)**	**VAPOUR PRESSURE (kPa) at 25 °C**
A	Propane	44	953,25
B	Butane	58	242,63
C	Ethyl methanoate	74	32,38
D	Alcohol	59	2,80
E	Propanoic acid	74	0,47

3.1 Define the term *vapour pressure.* (2)

3.2 Write down the homologous series to which compounds **A** and **B** belong. (1)

3.3 Explain the decrease in vapour pressure from compound **A** to compound **B**, as indicated in the table. (3)

3.4 Compounds **C** and **E** are functional isomers.

3.4.1 Define *molecular formula.* (2)

3.4.2 Which compound will have a higher boiling point? (1)

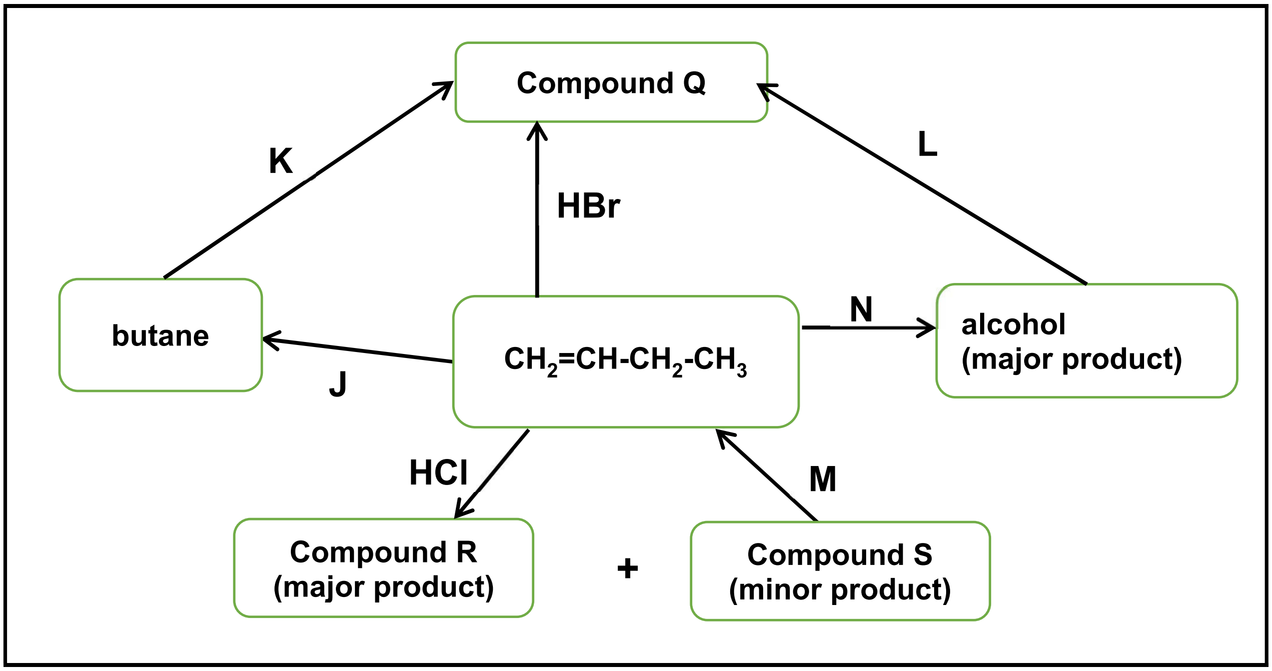
3.4.3 Explain the answer to QUESTION 3.4.2. (4)

3.5 The percentage composition of some of the elements in compound **D** is given as 61% carbon and 11,86% hydrogen. Determine, with calculations, the empirical formula of compound **D**. (4)

3.6 Write a balanced equation using molecular formulae for a complete combustion of compound **A**. (3)
[20]

QUESTION 4 (Start on a new page.)

The flow diagram below shows how an alkene can be used to prepare other organic compounds. The letters **J** to **N** represent various organic reactions.



4.1 Is an alkene a SATURATED or UNSATURATED hydrocarbon? Explain the answer. (3)

4.2 Write down the type of reaction represented by:

4.2.1 **J** (1)

4.2.2 **K** (1)

4.2.3 **M** (1)

4.3 Write down the STRUCTURAL FORMULA of compound **R**. (2)

4.4 For reaction **N**, write down:

4.4.1 The type of addition reaction (1)

4.4.2 Two reaction conditions (2)

4.4.3 The IUPAC name of the alcohol that forms (2)

4.5 Write down the IUPAC name of an isomer of butane. (2)

4.6 Use STRUCTURAL formulae to write down a balanced equation for reaction **L**. (5)

[20]

QUESTION 5 (Start on a new page.)

Three different experiments are performed using the reaction between magnesium carbonate and hydrochloric acid:

$$MgCO_3(s) + 2HC\ell(aq) \rightarrow MgC\ell_2(aq) + H_2O(\ell) + CO_2(g)$$

EXPERIMENT I

In this experiment, magnesium carbonate reacts with EXCESS hydrochloric acid in a closed container at 23 °C. The reaction is monitored by measuring the volume of carbon dioxide gas produced over time. The molar gas volume at 23 °C is 24 dm^3. The data collected is shown in the table below.

TIME (s)	VOLUME OF CO_2 (cm^3)
0	0
10	180
20	300
30	410
40	470
50	500
60	500

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

5.2 Use the collision theory to explain the effect on the reaction rate as time progresses. (4)

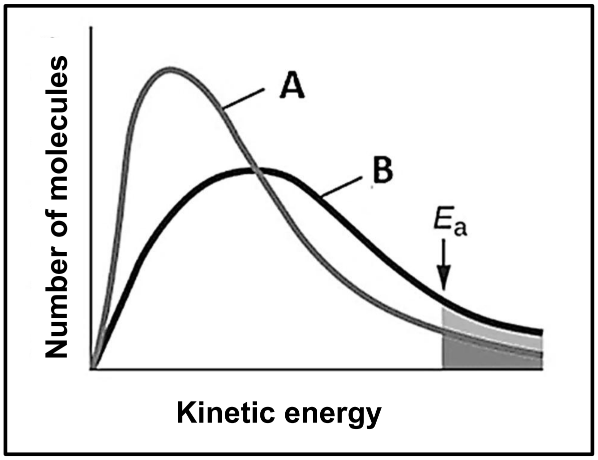
5.3 Calculate the reaction rate for the production of $CO_2(g)$ during the first 20 seconds, in $dm^3 \cdot s^{-1}$. (3)

5.4 Calculate the mass of $MgCO_3$ required for this experiment. (4)

EXPERIMENT II

5.5 Experiment I is repeated, but this time at 30 °C.

The following Maxwell-Boltzmann distribution curve was produced.



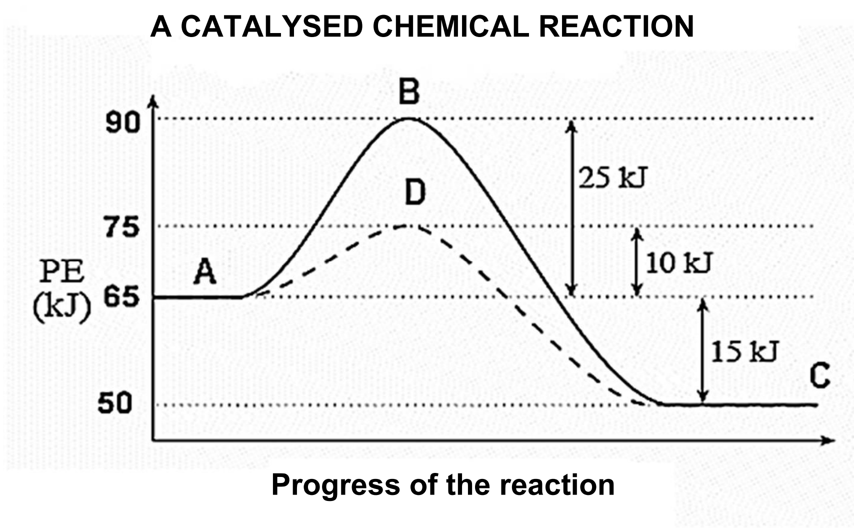
5.5.1 Which graph, **A** or **B**, best represents Experiment **II**? (1)

5.5.2 Explain the answer to QUESTION 5.5.1. (2)

5.5.3 If a catalyst was added, would the line representing the activation energy (E_a) be drawn to the LEFT or the RIGHT of the current line? (1)

EXPERIMENT III

5.6 Experiment I is repeated, but a catalyst is added, and the following graph is obtained.



5.6.1 Is the reaction EXOTHERMIC or ENDOTHERMIC? (1)

5.6.2 Which letter represents the activated complex? (1)

5.6.3 Give the value of the activation energy for the forward catalysed reaction. (1)

[20]

QUESTION 6 (Start on a new page.)

The reaction between carbon disulfide $CS_2(g)$ and chlorine gas $C\ell_2(g)$ reaches chemical equilibrium in a closed container at constant temperature. The products that form are carbon tetrachloride $CC\ell_4(g)$ and sulphur dichloride $S_2C\ell_2(g)$. The balanced equation for this reaction is given below:

$$CS_2(g) + 3C\ell_2(g) \rightleftharpoons CC\ell_4(g) + S_2C\ell_2(g) \qquad \Delta H < 0$$

Initially, an unknown quantity of $CS_2(g)$ and 5 moles of $C\ell_2$ are placed in a 2 dm^3 container and allowed to reach equilibrium. The equilibrium mixture contains 0,8 mol of $CC\ell_4$. The equilibrium constant, K_c, for this reaction is 0,36.

6.1 State Le Chatelier's principle. (2)

6.2 Calculate the initial number of moles of $CS_2(g)$ required. (8)

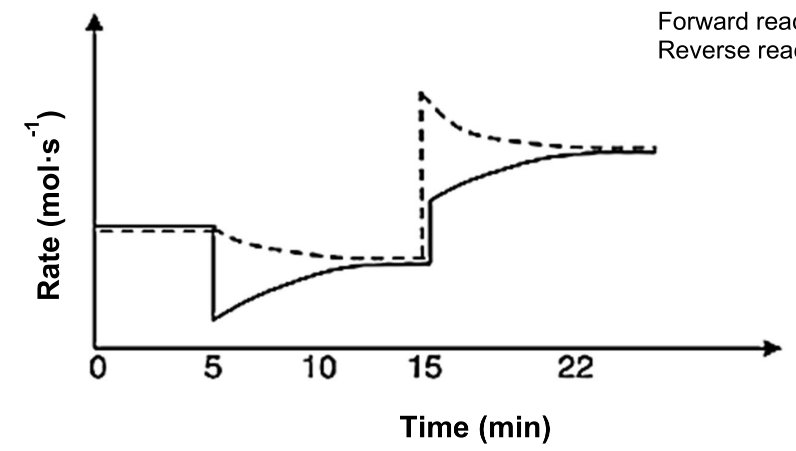
6.3 How will each of the following changes affect the yield of $S_2C\ell_2(g)$ at equilibrium?

Write INCREASE, DECREASE, or REMAIN THE SAME and give a reason in terms of the reaction which is favoured.

6.3.1 Carbon tetrachloride is removed from the system (2)

6.3.2 The volume of the container is increased (2)

6.4 The graph below shows the changes in the rate of the reaction after further changes were made to the equilibrium mixture above.



6.4.1 The equilibrium was disturbed at 5 minutes due to a change in the concentration of CS_2. Was this concentration INCREASED or DECREASED? (1)

6.4.2 At 15 minutes the temperature was changed. Use Le Chatelier's principle to determine whether the temperature has INCREASED or DECREASED. Explain the answer. (4)

6.4.3 At what time does the system reach equilibrium after the temperature change? (1)

[20]

QUESTION 7 (Start on a new page.)

Oxalic acid ($H_2C_2O_4$) is an organic diprotic acid commonly found in plants such as spinach. It is used in various industrial and laboratory applications, including cleaning, bleaching, and as a standard solution in acid-base titrations.

When oxalic acid ionises in water, it follows the steps given below:

STEP 1: $H_2C_2O_4(aq) + H_2O(\ell) \rightarrow HC_2O_4^-(aq) + H_3O^+(aq)$
STEP 2: $HC_2O_4^-(aq) + H_2O(\ell) \rightarrow C_2O_4^{2-}(aq) + H_3O^+(aq)$

7.1 Define a *weak acid*. (2)

7.2 Identify the acid-base conjugate pair in STEP 1. (2)

7.3 Give a reason why oxalic acid is referred to as a diprotic acid. (1)

7.4 The oxalate ion ($HC_2O_4^-$) can act as an ampholyte. Give a reason for this statement. (1)

7.5 In a volumetric flask 2,25 g of oxalic acid is added to water to make up a standard solution to 250 cm^3.

7.5.1 Calculate the concentration of the oxalic acid solution. (3)

7.5.2 25 cm^3 of the oxalic acid solution is titrated against sodium hydroxide. The average volume of NaOH required for neutralisation is 28,60 cm^3.

$$H_2C_2O_4(aq) + 2NaOH(aq) \rightarrow Na_2C_2O_4(aq) + 2H_2O(\ell)$$

Calculate the concentration of the sodium hydroxide. (4)

7.5.3 Explain why phenolphthalein would be a suitable indicator for this reaction. (2)

7.6 The reaction between EXCESS magnesium hydroxide ($Mg(OH)_2$), a slightly soluble base, and nitric acid (HNO_3), occurs in aqueous solution, where it produces magnesium nitrate ($Mg(NO_3)_2$), a soluble salt and water, according to the following balanced equation below.

$$Mg(OH)_2(aq) + 2HNO_3(aq) \rightarrow Mg(NO_3)_2(aq) + 2H_2O(\ell).$$

0,05 dm^3 of the $Mg(OH)_2$ solution has a concentration 0,115 $mol{\cdot}dm^{-3}$ and is added to 0,025 dm^3 of a 0,095 $mol{\cdot}dm^{-3}$ HNO_3 solution.

Calculate the pH of the FINAL solution. (10)
[25]

TOTAL: 150

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 $c = \frac{m}{MV}$	$n = \frac{V}{V_M}$
$\frac{c_aV_a}{c_bV_b} = \frac{n_a}{n_b}$	$pH = -\log[H_3O^+]$
$K_w = [H_3O^+][OH^-] = 1 \times 10^{-14}$ 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 $E^\theta_{cell} = E^\theta_{oxidising\ agent} - E^\theta_{reducing\ agent}$ / $E^\theta_{sel} = E^\theta_{oksideermiddel} - E^\theta_{reduseermiddel}$	

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

KEY/*SLEUTEL*

- Atomic number/*Atoomgetal*: 29
- Symbol/*Simbool*: Cu
- Approximate relative atomic mass/*Benaderde relatiewe atoommassa*: 63,5
- Electronegativity/*Elektronegatiwiteit*: 1,9

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) 1 H 1																	2 He 4
(1,0) 3 Li 7	(1,5) 4 Be 9											(2,0) 5 B 11	(2,5) 6 C 12	(3,0) 7 N 14	(3,5) 8 O 16	(4,0) 9 F 19	10 Ne 20
(0,9) 11 Na 23	(1,2) 12 Mg 24											(1,5) 13 Aℓ 27	(1,8) 14 Si 28	(2,1) 15 P 31	(2,5) 16 S 32	(3,0) 17 Cℓ 35,5	18 Ar 40
(0,8) 19 K 39	(1,0) 20 Ca 40	(1,3) 21 Sc 45	(1,5) 22 Ti 48	(1,6) 23 V 51	(1,6) 24 Cr 52	(1,5) 25 Mn 55	(1,8) 26 Fe 56	(1,8) 27 Co 59	(1,8) 28 Ni 59	(1,9) 29 Cu 63,5	(1,6) 30 Zn 65	(1,6) 31 Ga 70	(1,8) 32 Ge 73	(2,0) 33 As 75	(2,4) 34 Se 79	(2,8) 35 Br 80	36 Kr 84
(0,8) 37 Rb 86	(1,0) 38 Sr 88	(1,2) 39 Y 89	(1,4) 40 Zr 91	41 Nb 92	(1,8) 42 Mo 96	(1,9) 43 Tc	(2,2) 44 Ru 101	(2,2) 45 Rh 103	(2,2) 46 Pd 106	(1,9) 47 Ag 108	(1,7) 48 Cd 112	(1,7) 49 In 115	(1,8) 50 Sn 119	(1,9) 51 Sb 122	(2,1) 52 Te 128	(2,5) 53 I 127	54 Xe 131
(0,7) 55 Cs 133	(0,9) 56 Ba 137	57 La 139	(1,6) 72 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) 81 Tℓ 204	(1,8) 82 Pb 207	(1,9) 83 Bi 209	(2,0) 84 Po	(2,5) 85 At	86 Rn
(0,7) 87 Fr	(0,9) 88 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