

Hillcrest High School

PHYSICAL SCIENCE P2

June 2025

Grade 12

MARKS: 100

TIME: 2 Hours

EXAMINER: Mrs J. Knox-Whitehead

MODERATOR: Ms N. Badenhorst

Instructions:

1. Answer ALL the questions.
2. This question paper consists of TWO sections:
3. SECTION A (10)
SECTION B (90)
4. Answer SECTIONS A and B in the ANSWER BOOK.
Non-programmable calculators may be used.
5. Appropriate mathematical instruments may be used.
6. Number the answers correctly according to the numbering system used in this question paper.
7. Data sheets are attached for your use.
8. Give brief motivations, discussions, et cetera where required.
9. Numbers must be rounded off to two decimal places

SECTION A**QUESTION 1: MULTIPLE CHOICE QUESTIONS**

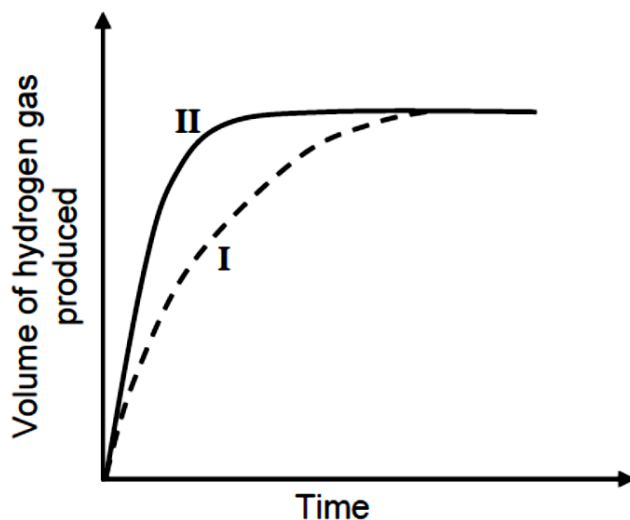
Four options are provided as possible answers to the following questions. Each question has only one correct answer. Write only the letter (A-D) next to the question number (1.1-1.5) in the answer book.

- 1.1 Consider the molecule C_3H_8O . The name of the homologous series that this compound belongs to is a/an...
- A ketone
 - B alcohol
 - C aldehyde
 - D carboxylic acid
- (2)
- 1.2 Which ONE of the following isomers has the HIGHEST vapour pressure?
- A $CH_3CH_2CH_2CH_2CH_2CH_3$
 - B $CH_3CH_2C(CH_3)_2CH_3$
 - C $CH_3CH(CH_3)CH_2CH_2CH_3$
 - D $CH_3CH_2CH(CH_3)CH_2CH_3$
- (2)
- 1.3 In which one of the following reactions at equilibrium will the YIELD of the product decrease when the VOLUME of the container is decreased at constant temperature?
- A $N_2O_4(g) \rightleftharpoons 2NO_2(g)$
 - B $H_2(g) + I_2(g) \rightleftharpoons 2HI(g)$
 - C $N_2(g) + 3H_2(g) \rightleftharpoons 2NH_3(g)$
 - D $2SO_2(g) + O_2(g) \rightleftharpoons 2SO_3(g)$
- (2)

- 1.4 A hydrochloric acid solution, $\text{HCl}(\text{aq})$, of concentration $1 \text{ mol}\cdot\text{dm}^{-3}$ is added to EXCESS POWDERED magnesium at $25 \text{ }^\circ\text{C}$.

Curve I below represents the volume of hydrogen gas produced during the reaction.

Curve II was obtained at different conditions using the SAME VOLUME of hydrochloric acid solution.

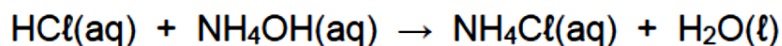


Which ONE of the following represents the conditions used to obtain curve II?

	STATE OF DIVISION OF Mg	CONCENTRATION OF ACID ($\text{mol}\cdot\text{dm}^{-3}$)	TEMPERATURE ($^\circ\text{C}$)
A	Ribbon	0,5	25
B	Ribbon	2	25
C	Powder	1	20
D	Powder	1	30

(2)

- 1.5 A hydrochloric acid solution is titrated against an ammonia solution. The balanced equation for the reaction is:



Which ONE of the following gives the pH of the solution at the end point and the reason for this pH?

	pH	REASON
A	3	$\text{H}_3\text{O}^+(\text{aq})$ is formed during the ionisation of HCl(aq) .
B	5	$\text{H}_3\text{O}^+(\text{aq})$ is formed during hydrolysis of $\text{NH}_4^+(\text{aq})$.
C	7	Neutralisation takes place at the end point.
D	9	$\text{OH}^-(\text{aq})$ is formed during hydrolysis of $\text{NH}_4^+(\text{aq})$.

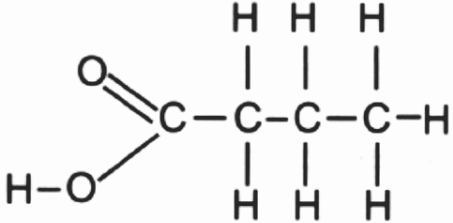
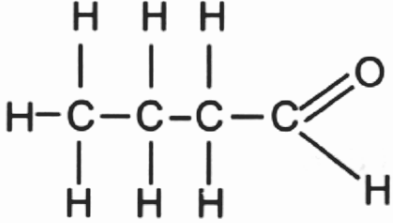
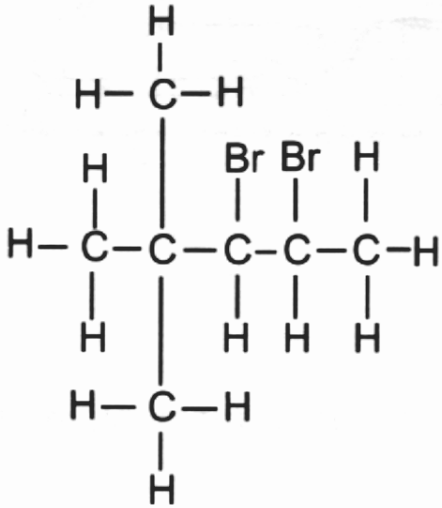
(2)

[2 x 5 = 10]

Section B

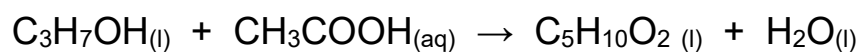
Question 2

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

A		B	
C	Pentan-2-one	D	$\text{CH}_3\text{CH}_2\text{COCH}_2\text{CH}_3$
E		F	Methyl propanoate

- 2.1 Define the term *homologous series*. (2)
- 2.2 Consider the organic compound **B**.
Write down the:
- 2.2.1 Homologous series to which this compound belongs. (1)
- 2.2.2 IUPAC name of the functional isomer of this compound. (2)
- 2.3
- 2.3.1 Write down the IUPAC name of compound **E**. (3)
- 2.3.2 DRAW the functional group of the homologous series to which compound **C** belongs. (1)

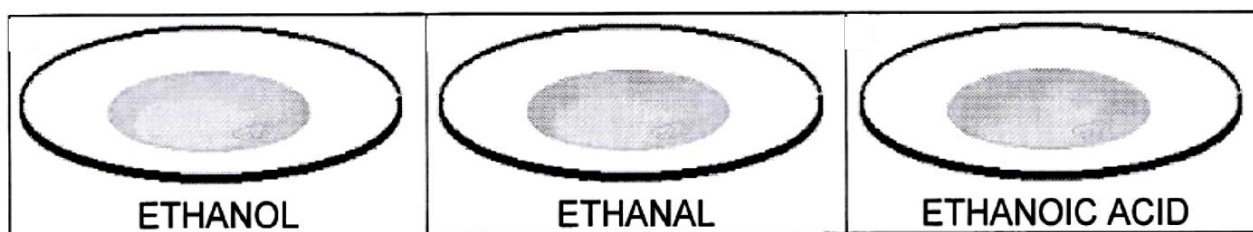
During a chemical reaction, 55g of propan-1-ol reacts with excess ethanoic acid to produce 89,78g of $C_5H_{10}O_2$. The balanced equation for the reaction is:



- 2.4 Identify the type of chemical reaction shown above. (1)
- 2.5 Write down the:
- 2.5.1 STRUCTURAL FORMULA of the organic product. (3)
- 2.5.2 IUPAC name of the organic product. (2)
- 2.6 Calculate the percentage yield for the above reaction. (5)
- [20]**

Question 3

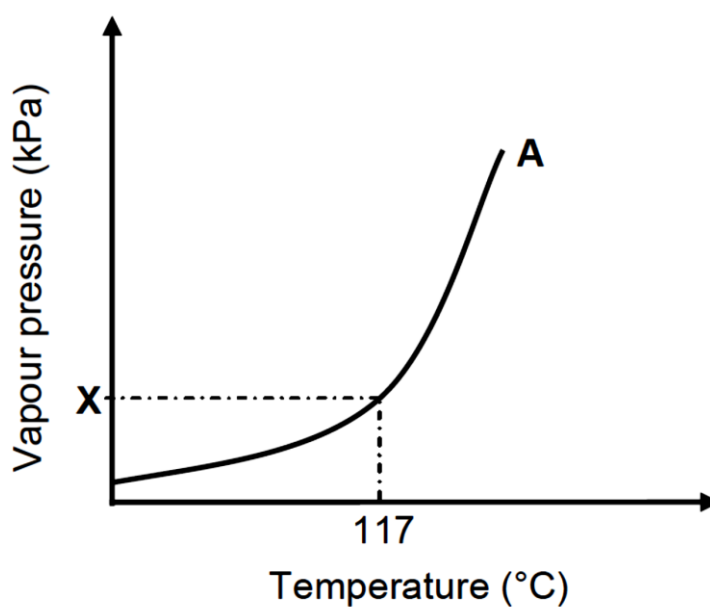
- 3.1 Learners investigate the evaporation of some organic compounds as shown in the diagram below. They place 5 ml of each liquid in a watch glass and observe the change in volume of the liquids.



- 3.1.1 Which one of the above liquids would have the largest volume after 10 minutes? (1)
- 3.1.2 Explain your answer to QUESTION 3.1.1, referring to intermolecular forces and volatility in your answer. (3)
- 3.2 Compounds **A**, **B** and **C** are used to investigate a factor which influences the boiling points of organic compounds. The results of the investigation are shown in the table below:

COMPOUND		BOILING POINT (°C)
A	Butan-1-ol	117
B	Butan-2-ol	100
C	2-methylpropan-2-ol	82

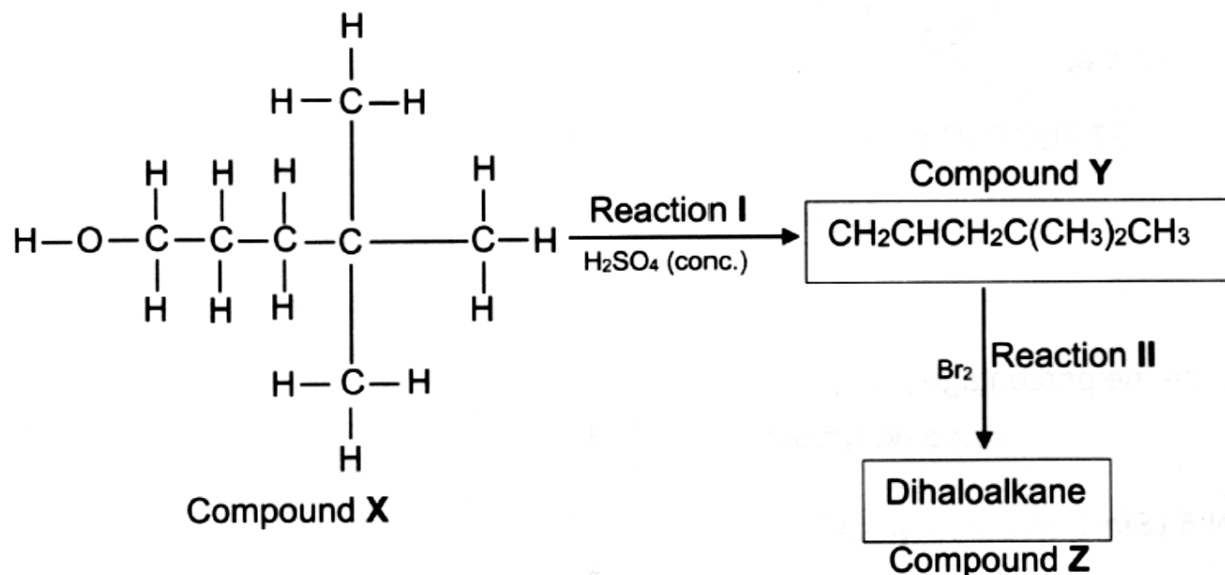
- 3.2.1 Is this a fair investigation? Choose from YES or NO and give a reason for this answer. (2)
- 3.2.2 Fully explain the difference in the boiling points of compounds **B** and **C**. (3)
- 3.2.3 Define the term *positional isomer*. (2)
- 3.2.4 From the compounds **A**, **B** and **C**, choose the letters that represent positional isomers. (1)
- 3.2.5 Study the graph below which has been drawn using values relating to compound **A** and write down the value of **X**. (1)



[13]

Question 4

An organic compound **Z** is produced from compound **X** using Reactions I and II as shown in the flow diagram below.



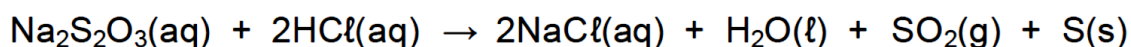
- 4.1 Study the details of Reaction I. Write down the:
- 4.1.1 Name of this organic reaction. (1)
- 4.1.2 Name or formula of the INORGANIC product also formed during the reaction. (1)
- 4.1.3 Purpose of the H_2SO_4 (conc.) used in this reaction. (1)
- 4.2 Is Compound Y SATURATED or UNSATURATED? Give a reason for your answer. (2)
- 4.3 Name the reaction represented by Reaction II. (1)
- 4.4 Using STRUCTURAL formulae, write down the balanced chemical equation for Reaction II. (3)

[9]

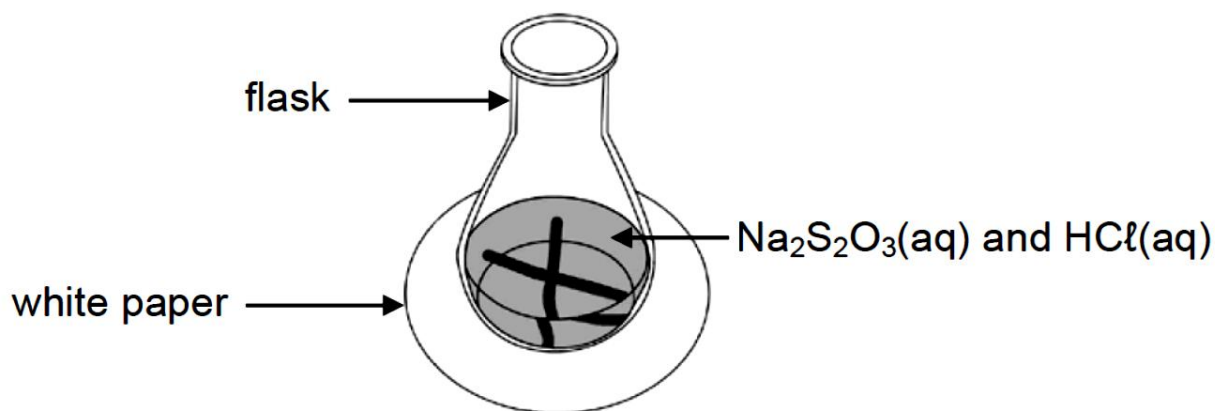
Question 5

ANSWER QUESTION 5.3 ON THE ATTACHED GRAPH PAPER AND HAND IT IN WITH YOUR ANSWER BOOKLET. MAKE SURE IT HAS YOUR NAME ON IT.

Learners use the reaction between sodium thiosulfate and hydrochloric acid to investigate one of the factors affecting reaction rate. The balanced equation for the reaction is:



The diagram below shows the experimental setup.



In the first experiment, 50 cm³ of the sodium thiosulfate solution was added to 100 cm³ of a 2 mol.dm⁻³ hydrochloric acid solution in a conical flask that was placed over a cross drawn on a sheet of white paper as shown above. The hydrochloric acid was in EXCESS. The time taken for the cross to become invisible was recorded.

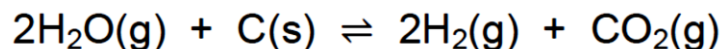
The experiment was repeated four times with different amounts of the sodium thiosulfate solution as shown in the table below. The results obtained are shown in the table:

EXPERIMENT	VOLUME OF Na ₂ S ₂ O ₃ (cm ³)	VOLUME OF H ₂ O (cm ³)	TIME (s)	AVERAGE RATE ($\frac{1}{\text{time}}$) (x 10 ⁻² s ⁻¹)
1	50	0	22,7	4,4
2	40	10	28,6	3,5
3	30	20	38,5	2,6
4	20	30	58,8	1,7
5	10	40	111,1	0,9

- 5.1 Define *reaction rate*. (2)
- 5.2 Study the table carefully to understand how the reaction mixture was prepared before the hydrochloric acid was added. How does the concentration of the sodium thiosulfate solution used in experiment **2** compare to that used in experiment **5**?
Choose from GREATER THAN, LESS THAN or EQUAL TO. (1)
- 5.3 Detach the GRAPH PAPER from the back of this question paper and draw on it a graph of average reaction rate versus volume of sodium thiosulfate used.
(WRITE YOUR NAME ON THE GRAPH PAPER AND HAND IT IN WITH THE ANSWER BOOKLET.) (3)
- 5.4 Use the graph to determine the volume of dilute sodium thiosulfate solution that needs to react in order for the cross to become invisible in 40 seconds.
DRAW DOTTED LINES ON YOUR GRAPH TO SHOW HOW YOU ARRIVED AT YOUR ANSWER. (3)
- 5.5 Use the Collision Theory to explain the effect of an increase in concentration on reaction rate. (3)
- 5.6 The mass of sulphur produced in experiment **1** is 1,62g. Calculate the mass of the sodium thiosulfate used in experiment **1**. (4)
- [16]**

Question 6

Steam, $\text{H}_2\text{O}(\text{g})$, reacts with hot carbon, $\text{C}(\text{s})$, at 1000°C according to the following balanced equation:

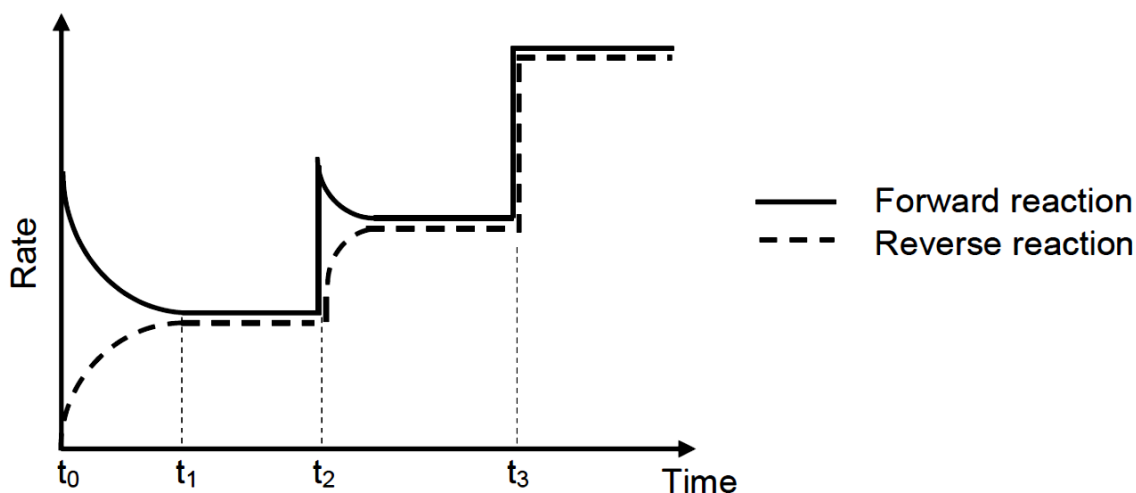


Initially, unknown amounts of steam and carbon were placed in a 2 dm^3 sealed container and allowed to react. At equilibrium it was found that the amount of carbon had changed by $0,225 \text{ mol}$.

6.1 Define the term *dynamic equilibrium*. (2)

6.2 Given that the equilibrium constant, K_c , for the reaction at 1000°C is $0,00948$, calculate the initial mass of steam placed in the container. (8)

6.3 The graph below shows how the rates of the forward and reverse reactions changed with time as various changes were made to the reaction vessel.



6.3.1 Give a reason for the decrease in the rate of the forward reaction between t_0 and t_1 . (1)

6.3.2 What change was made to the equilibrium mixture at t_3 ? (1)

At time t_2 , the temperature of the system was increased.

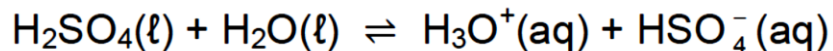
6.3.3 Is the forward reaction EXOTHERMIC or ENDOTHERMIC? (1)

6.3.4 Refer to Le Chatelier's principle to explain the answer to QUESTION 6.3.3. (2)

[15]

Question 7

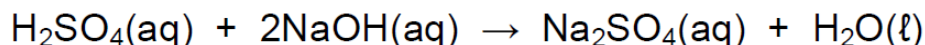
7.1 The balanced equation below represents the first step in the ionisation of sulfuric acid in water:



7.1.1 Write down the formulae of TWO ampholytes in the equation above. (2)

7.1.2 The K_a value for this reaction is $2,4 \times 10^6$. Explain how this relates to the properties of sulfuric acid. (2)

7.2 Learners use the reaction of a $0,15 \text{ mol}\cdot\text{dm}^{-3}$ sulfuric acid solution with a sodium hydroxide solution in **two** different experiments. The balanced equation for the reaction is:



7.2.1 Experiment 1: They use 24 cm^3 of $\text{H}_2\text{SO}_4(\text{aq})$ in a titration to neutralise 26 cm^3 of $\text{NaOH}(\text{aq})$.

Calculate the concentration of the $\text{NaOH}(\text{aq})$. (5)

7.2.2 Experiment 2: 30 cm^3 of the same $\text{H}_2\text{SO}_4(\text{aq})$ is added to 20 cm^3 of a $0,28 \text{ mol}\cdot\text{dm}^{-3}$ NaOH solution in a beaker.

Calculate the pH of the final solution. (8)

[17]

Total 100

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

**GEGEWENS VIR FISIESTE WETENSAPPE 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 $c = \frac{m}{MV}$	$n = \frac{V}{V_m}$
$\frac{c_a V_a}{c_b V_b} = \frac{n_a}{n_b}$	$\text{pH} = -\log[\text{H}_3\text{O}^+]$
$K_w = [\text{H}_3\text{O}^+][\text{OH}^-] = 1 \times 10^{-14}$ at/by 298 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 $E_{\text{cell}}^{\theta} = E_{\text{oxidising agent}}^{\theta} - E_{\text{reducing agent}}^{\theta} / E_{\text{sel}}^{\theta} = E_{\text{oksideermiddel}}^{\theta} - E_{\text{reduseermiddel}}^{\theta}$	

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

NSC – Grade 12

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18				
(I)	(II)											(III)	(IV)	(V)	(VI)	(VII)	(VIII)				
1 H	4 Be	21 Sc	22 Ti	23 V	24 Cr	25 Mn	26 Fe	27 Co	28 Ni	29 Cu	30 Zn	31 Ga	32 Ge	33 As	34 Se	35 Br	36 Kr				
3 Li	9 Be	20 Ca	39 K	40 Ca	41 Sc	42 Ti	43 V	44 Cr	45 Mn	46 Fe	47 Co	48 Ni	49 Cu	50 Zn	51 Ga	52 Ge	53 As	54 Se			
11 Na	12 Mg	19 K	37 Rb	38 Sr	39 Y	40 Zr	41 Nb	42 Mo	43 Tc	44 Ru	45 Rh	46 Pd	47 Ag	48 Cd	49 In	50 Sn	51 Sb	52 Te			
17 Cl	18 Ar	23 Na	35 Br	36 Kr	37 Rb	38 Sr	39 Y	40 Zr	41 Nb	42 Mo	43 Tc	44 Ru	45 Rh	46 Pd	47 Ag	48 Cd	49 In	50 Sn			
35 Br	36 Kr	55 Cs	86 Rn	87 Fr	88 Ra	89 Ac	90 Th	91 Pa	92 U	93 Np	94 Pu	95 Am	96 Cm	97 Bk	98 Cf	99 Es	100 Fm	101 Md	102 No	103 Lr	
53 I	54 Xe	85 At	131 Xe	132 Rn	133 Fr	134 Ra	135 Ac	136 Th	137 Pa	138 U	139 Np	140 Pu	141 Am	142 Cm	143 Bk	144 Cf	145 Es	146 Fm	147 Md	148 No	149 Lr
85 At	86 Rn	137 Fr	138 Ra	139 Ac	140 Th	141 Pa	142 U	143 Np	144 Pu	145 Am	146 Cm	147 Bk	148 Cf	149 Es	150 Fm	151 Md	152 No	153 Lr	154 Uu	155 Uub	156 Uut
103 Lr	104 Uu	151 Md	152 No	153 Lr	154 Uu	155 Uub	156 Uut	157 Uuq	158 Uur	159 Uus	160 Uuq	161 Uur	162 Uus	163 Uuq	164 Uur	165 Uus	166 Uuq	167 Uur	168 Uus	169 Uuq	170 Uur
175 Lu	176 Uub	231 Fr	232 Ra	233 Ac	234 Th	235 Pa	236 U	237 Np	238 Pu	239 Am	240 Cm	241 Bk	242 Cf	243 Es	244 Fm	245 Md	246 No	247 Lr	248 Uu	249 Uub	250 Uut

29 Cu	Electronegativity Elektronegatiwiteit	Symbol Simbool
29	Atomic number Atoomgetal	63,5

Approximate relative atomic mass Benaderde relatiewe atoommassa	29
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QUESTION 5.3: DETACH THIS PAGE AND SUBMIT WITH YOUR ANSWER BOOKLET.

