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EXAMINATION

GRADE 12

**PHYSICAL SCIENCES
(PAPER 2: CHEMISTRY)**

JUNE 2025

MARKS: 150

TIME: 3 HOURS

This paper consists of 16 pages and two information sheets.

INSTRUCTIONS AND INFORMATION

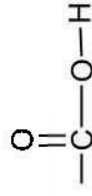
1. Write your name and other information in the appropriate spaces on the ANSWER BOOK.
2. This question paper consists of eight questions. Answer ALL questions in the ANSWER BOOK.
3. Start EACH question on a NEW page in the ANSWER BOOK.
4. Number the answers correctly according to the numbering system used in this question paper.
5. Leave one line between two sub-questions, for example between QUESTION 2.1 and QUESTION 2.2.
6. You may use a non-programmable pocket calculator.
7. You may use appropriate mathematical instruments.
8. You are advised to use the attached DATA SHEETS.
9. Show ALL formulae and substitutions in ALL calculations.
10. Round off your FINAL numerical answers to a minimum of TWO decimal places where applicable.
11. Give brief motivations, discussions, et cetera where required.
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 down only the letter A, B, C or D next to the question number (1.1–1.10) in your ANSWER BOOK.

- 1.1 Which ONE of the following is the correct name of the functional group of the alkynes?
- A Formyl group
 - B Carbonyl group
 - C Carbon-carbon triple bond
 - D Carbon-carbon double bond
- (2)

- 1.2 Consider the structural formula of the functional group below.



Which ONE of the following homologous series can be functional isomers of the homologous series having the above functional group?

- A Esters
 - B Ketones
 - C Aldehydes
 - D Carboxylic acids
- (2)

- 1.3 Which ONE of the following decreases as the relative molecular masses of the straight chain alkanes increases?

- A Melting point
 - B Boiling point
 - C Vapour pressure
 - D Strength of intermolecular forces
- (2)

- 1.4 Compound **Q** reacts with $\text{C}_3\text{H}_7\text{Cl}$ according to the following balanced chemical equation.



What type of a reaction is **represented** above?

- A Dehydrohalogenation
- B Hydrohalogenation
- C Hydration
- D Hydrolysis (2)

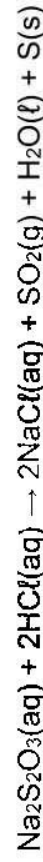
- 1.5 The **NAME** of the catalyst used in esterification reaction is ... acid.

- A carbonic
- B sulphuric
- C phosphoric
- D hydrochloric (2)

- 1.6 Which **ONE** of the following best describes the effect of temperature on the reaction rate?

- A Hydrogen peroxide decomposes faster in the presence of manganese (IV) oxide.
- B 5 g sodium reacts faster with the same volume oxygen than 5 g of copper.
- C 10 g of calcium carbonate reacts faster with $0,4 \text{ mol}\cdot\text{dm}^{-3}$ hydrochloric acid than $0,04 \text{ mol}\cdot\text{dm}^{-3}$ of hydrochloric acid.
- D 10 g of sodium reacts slower with 100 ml water at 50°C than at 100°C . (2)

- 1.7 Learners use the reaction between sodium thiosulphate and hydrochloric acid to determine the reaction rate according to the balanced chemical equation below.



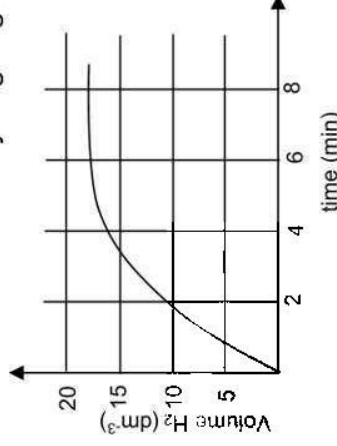
Which method will lead to the MOST inaccurate practical results?

- A Measuring the rate at which the mass of the reaction mixture decrease.
 - B Measuring the rate of change in concentration of hydrochloric acid.
 - C Measuring the rate at which the precipitate is formed.
 - D Measuring the rate at which the gas is formed.
- (2)

- 1.8 The experiment was conducted by reacting a certain mass of zinc with an excess hydrochloric acid. The balance equation for the reaction is:

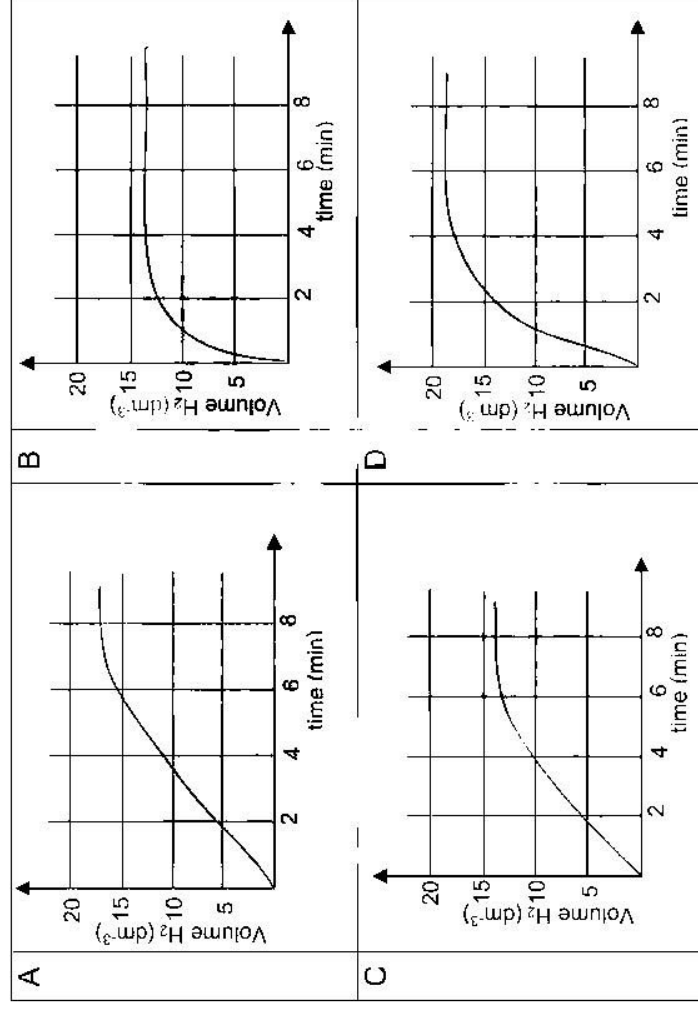


The graph below shows the results of the hydrogen gas produced per unit time.



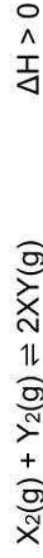
The experiment was **repeated** with the same amount of zinc reacting with same the volume of HCl with twice the concentration.

Which ONE of the graphs below represents the results of the second experiment?



(2)

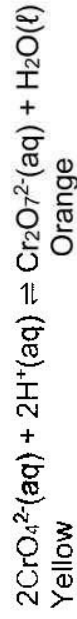
- 1.9 A hypothetical reaction below reaches equilibrium in a closed container according to the following balanced chemical equation.



The YIELD of XY can be increased by:

- A Increasing the pressure
- B Heating the container
- C Addition of a catalyst
- D Removing $X_2(g)$ (2)

- 1.10 The balanced chemical reaction below reaches equilibrium in a closed container.



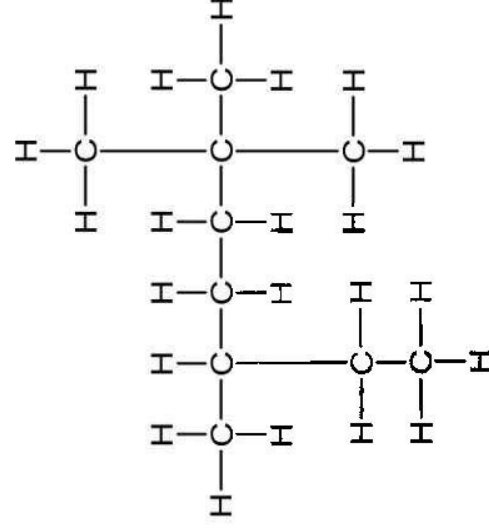
Which ONE of the following is correct when you add concentrated HCl to the mixture?

- A Concentration of $Cr_2O_7^{2-}$ decreases.
- B Concentration of $2CrO_4^{2-}$ increases.
- C Reverse reaction is favoured.
- D The solution turns orange. (2)

[20]

QUESTION 2

2.1 Consider the structural formula of the hydrocarbon below.



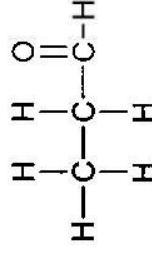
2.1.1 Define the term *hydrocarbon*. (2)

2.1.2 Write down the general formula of the homologous series of the above compound. (1)

2.1.3 Give the IUPAC name of the compound. (3)

2.2 An unknown compound **X** is a functional isomer of compound **A** below.

A



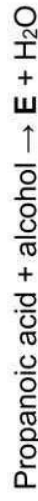
Write down the:

2.2.1 Name of the homologous series of compound **A** (1)

2.2.2 Condensed structural formula of compound **X** (2)

2.2.3 IUPAC name of compound **X** (2)

- 2.3 Propanoic acid reacts with alcohol in the presence of concentrated acid to produce organic compound **E** as shown by the incomplete equation below.



The percentage composition of compound **E** is as follows

COMPOUND E		
Carbon	Hydrogen	Oxygen
58,82%	9,81%	31,37%

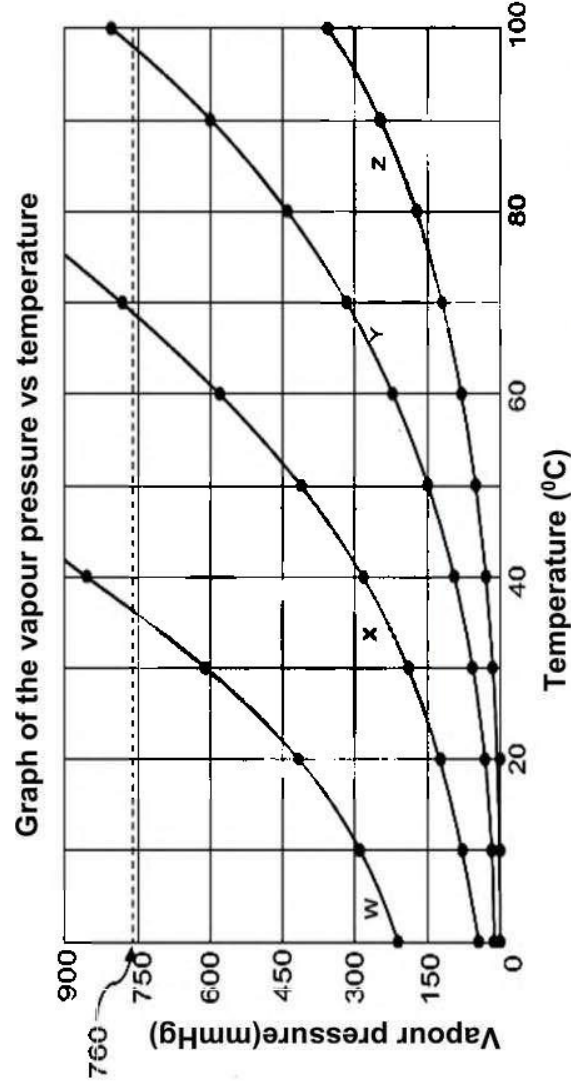
The molecular mass of compound **E** is EQUAL to its empirical formula mass.

- 2.3.1 Define the term *empirical formula*. (2)
- 2.3.2 Determine by calculation, the molecular formula of compound **E**. (5)
- 2.3.3 Write down the molecular formula of the alcohol. (2)

[20]

QUESTION 3

A group of learners investigate the relationship between the strength of the intermolecular forces and the vapour pressure of four UNBRANCHED organic compounds W, X, Y and Z. The compounds have the SAME NUMBER of carbon atoms but belong to different homologous series. Their results are represented in the graph below. 760 mmHg is equal to 1atm.



- 3.1 Define the term *vapour pressure*. (2)
- 3.2 Formulate the investigative question for this investigation. (2)
- 3.3 Use the graph to determine the boiling point of **X**. (2)
- 3.4 Which ONE of the compounds **W** or **Y** has the strongest intermolecular forces? Explain the answer by referring to the vapour pressure and boiling point. (3)
- 3.5 Compound **Z** has two sites for hydrogen bonding. Write down the NAME of its functional group. (2)
- 3.6 Compound **X** is an aldehyde and **Y** is an alcohol. Refer to the TYPE of intermolecular forces to fully explain the difference in vapour pressure between compound **X** and **Y**. (4)
- 3.7 Compound **Y** is butan-2-ol. (2)
 - 3.7.1 Draw the structural formula of its CHAIN isomer. (2)
 - 3.7.2 Identify the structure drawn in 3.7.1 as a primary, secondary or tertiary alcohol? Explain the answer. (2)

[19]

QUESTION 4

Four reactions of organic compounds are given in the table below.

Reaction 1	Butane + Br ₂ → 2-bromobutane + P
Reaction 2	Pentane + O ₂ → CO ₂ (g) + H ₂ O(l)
Reaction 3	Hexane → 3C ₂ H ₄ + Q
Reaction 4	2-bromobutane + NaOH → R (major product) + NaBr(aq) + H ₂ O(l)

4.1 Consider **REACTION 1**:

- 4.1.1 Is butane a **SATURATED** or **UNSATURATED** compound?
Give a **reason** for the answer. (2)
- 4.1.2 Write down the **NAME** of the inorganic product **P**. (1)
- 4.1.3 Write down a **complete** balanced equation using **STRUCTURAL** formulae. (4)

4.2 Consider **REACTION 2**:

Write down the:

- 4.2.1 **NAME** of the chemical reaction that takes place. (1)
- 4.2.2 Balanced chemical equation using **MOLECULAR** formulae. (3)

4.3 Consider **REACTION 3**:

- 4.3.1 Except high temperature, write down **ONE** other reaction condition for this chemical reaction. (1)
- 4.3.2 Using **CONDENSED STRUCTURAL** formulae, write a complete chemical equation. (3)
- 4.3.3 The product C₂H₄ then reacts with an unknown substance in the presence of nickel as a catalyst. Identify the type of reaction that takes and hence write down the molecular formula of product formed. (2)

4.4 Consider **REACTION 4**:

- 4.4.1 Identify the type of reaction that takes place. (1)
- 4.4.2 Is the NaOH that reacted diluted or concentrated. (1)
- 4.4.3 Draw a **STRUCTURAL** formula of compound **R**. (2)

[21]

QUESTION 5

In the experiments to investigate factors that influence the reaction rate, 5 g of Mg reacts with excess hydrochloric acid.

The balanced chemical equation for the reaction is given below.



The same mass of Mg was used in all the experiments. Reaction condition for each experiment is summarised below.

EXPERIMENT	CONCENTRATION OF ACID ($\text{mol}\cdot\text{dm}^{-3}$)	STATE OF DIVISION OF Mg	VOLUME OF HCl (cm^3)
A	0,6	granules	500
B	0,6	powder	500
C	0,9	granules	500

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

5.2 Will it be a fair comparison to compare reaction rate of experiment **B** and **C**? Explain the answer. (2)

5.3 Experiment **A** and **B** are compared.
Write down the following:

5.3.1 Dependant variable. (1)

5.3.2 Controlled variable. (1)

5.4 Use the collision theory and explain which experiment **A** or **C** will have a higher reaction rate. (5)

5.5 Calculate the number of moles of unreacted HCl in experiment **C**. (6)

- 5.6 In another experiment **D**, 500 cm³ excess HCl with a concentration of 0,6 mol·dm⁻³ reacts with 5 g of Ca powder.
The balanced equation for the reaction is represented below:



Experiment **D** is now compared with experiment **B**.

- 5.6.1 Identify the limiting reagent in experiment **D**.
Explain the answer. (2)
- 5.6.2 Write down the independent variable for these investigations. (1)
- 5.6.3 Which **ONE** of the reactions will produce more hydrogen gas?
Write down only **B** or **D**. (1)
- 5.6.4 Explain the answer in QUESTION 5.6.3. (2)
- 5.7 Which metal between **Mg** and **Ca** reacts faster with HCl?
Write down **Mg** or **Ca**. (1)
- 5.8 Explain the answer in QUESTION 5.7 above. (1)

[25]

QUESTION 6

Carbon reacts with carbon dioxide in a closed system at room temperature. The reaction reaches equilibrium according to the balanced chemical equation below.



- 6.1 State *Le Chatelier* principle. (2)
- 6.2 Carbon dioxide is added to the system at room temperature.
How will the following be affected?
- 6.2.1 The rate of the forward reaction. (1)
- 6.2.2 The yield of the CO. (1)
- 6.2.3 Explain the answer to QUESTION 6.2.2. (2)
- 6.3 At equilibrium, the pressure of the system is increased by decreasing the volume of the container at the same temperature.
How will this affect the:
- 6.3.1 Amount of CO₂? Explain the answer (3)
- 6.3.2 K_C value? (1)

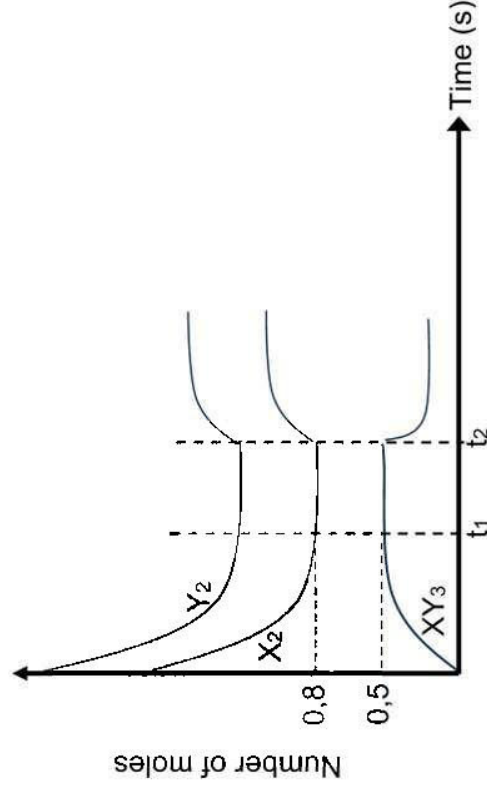
[10]

QUESTION 7

Consider the hypothetical reaction below that takes place in a 2 dm³ closed container. The balanced chemical equation for the reaction is as follows.



The graph of the number of moles versus time for the reaction is shown below.



7.1 Define the following:

7.1.1 closed system

7.1.2 Chemical equilibrium

7.2 What is represented by the horizontal lines between t_1 and t_2 ?

7.3 The K_c value between t_1 and t_2 is 0,2197. Calculate the concentration of Y_2 gas between t_1 and t_2 .

7.4 Calculate the volume of Y_2 injected in the system at STP.

7.5 The size of the container is kept constant. Identify the disturbance at t_2 . Explain the answer.

(2)

(2)

(1)

(5)

(6)

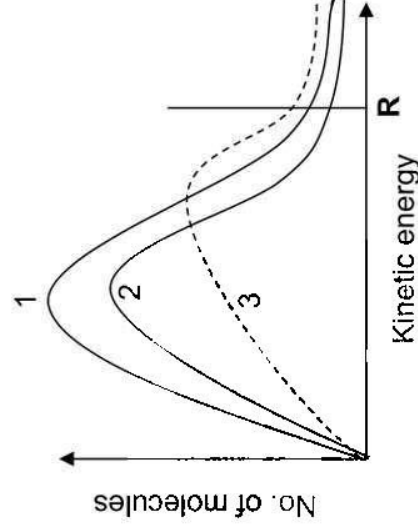
(4)

[20]

QUESTION 8

- 8.1 Three energy distribution curves 1, 2 and 3 for oxygen gas under different conditions are shown in the graph below:

Curve 2 represents 1 mol of oxygen gas at 70 °C



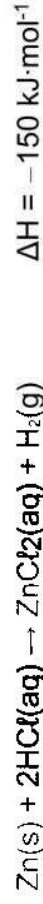
- 8.1.1 What does the line **R** represents? (1)

- 8.1.2 How will the addition of a suitable catalyst influence the position of **R**? Explain. (2)

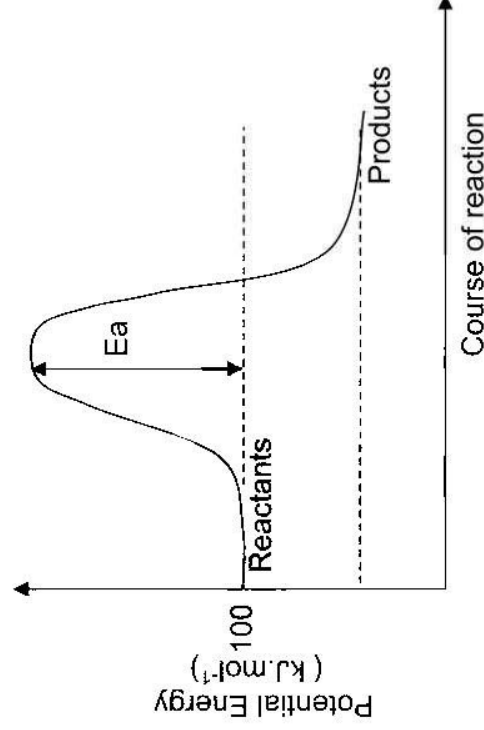
- 8.1.3 Which curve best represents each of the following conditions?

- (a) 1 mol of oxygen gas at 90 °C (1)
 (b) 2 mol of oxygen gas at 70 °C (1)

- 8.2 Consider the balanced chemical equation below:



The potential energy diagram for the reaction is drawn below.



- 8.2.1 Is the reaction exothermic or endothermic?
Explain the answer. (2)
- 8.2.2 How will the heat of the reaction (ΔH) change if the concentration of hydrochloric acid is decreased? Choose from INCREASES, DECREASES OR REMAINS THE SAME (1)
- 8.2.3 Calculate the energy of the product. (3)
- 8.2.4 Calculate the energy of the activated complex if the activation energy for the forward reaction is $90 \text{ kJ}\cdot\text{mol}^{-1}$. (2)
- 8.2.5 Re-draw the potential energy diagram in the ANSWER BOOK, and on the same set of axes use dotted lines to indicate the effect of adding a catalyst on this reaction. (2)

[15]

GRAND 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 <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		
$E_{\text{cell}}^\theta = E_{\text{oxidising agent}}^\theta - E_{\text{reducing agent}}^\theta$ / $E_{\text{sel}}^\theta = E_{\text{oksideermiddel}}^\theta - E_{\text{reduseermiddel}}^\theta$		

TABLE 3: THE PERIODIC TABLE OF ELEMENTS

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)
KEY/SLEUTEL Atomic number <i>Atoomgetal</i> Electronegativity <i>Elektronegatiwiteit</i> Symbol <i>Simbool</i> Approximate relative atomic mass <i>Benaderde relatiewe atoommassa</i>																	
1 H 1,008	4 He 4,003											5 B 10,811	6 C 12,011	7 N 14,007	8 O 15,999	9 F 18,998	10 Ne 20,180
3 Li 6,941	12 Mg 24,305											13 Al 26,982	14 Si 28,086	15 P 30,974	16 S 32,065	17 Cl 35,453	18 Ar 39,948
11 Na 22,990	20 Ca 40,078	21 Sc 44,956	22 Ti 47,867	23 V 50,942	24 Cr 51,996	25 Mn 54,938	26 Fe 55,845	27 Co 58,933	28 Ni 58,693	29 Cu 63,546	30 Zn 65,380	31 Ga 69,723	32 Ge 72,630	33 As 74,922	34 Se 78,960	35 Br 79,904	36 Kr 83,798
37 Rb 85,468	38 Sr 87,62	39 Y 88,906	40 Zr 91,224	41 Nb 92,906	42 Mo 95,94	43 Tc 98,906	44 Ru 101,07	45 Rh 102,91	46 Pd 106,42	47 Ag 107,87	48 Cd 112,41	49 In 114,82	50 Sn 118,71	51 Sb 121,76	52 Te 127,60	53 I 126,91	54 Xe 131,29
55 Cs 132,91	56 Ba 137,33	57 La 138,91	72 Hf 178,49	73 Ta 180,95	74 W 183,84	75 Re 186,21	76 Os 190,23	77 Ir 192,22	78 Pt 195,08	79 Au 196,97	80 Hg 200,59	81 Tl 204,38	82 Pb 207,2	83 Bi 208,98	84 Po 209	85 At 210	86 Rn 222
87 Fr 223	88 Ra 226	89 Ac															
			58 Ce 140,12	59 Pr 140,91	60 Nd 144,24	61 Pm	62 Sm 150,36	63 Eu 151,96	64 Gd 157,25	65 Tb 158,93	66 Dy 162,50	67 Ho 164,93	68 Er 167,26	69 Tm 168,93	70 Yb 173,05	71 Lu 174,97	
			90 Th 232,04	91 Pa 231,04	92 U 238,03	93 Np	94 Pu 244	95 Am	96 Cm	97 Bk	98 Cf	99 Es	100 Fm	101 Md	102 No	103 Lr	