HILLCREST HIGH SCHOOL
PHYSICAL SCIENCE
GRADE 12
PAPER 2 - Chemistry

JUNE 2022
TIME: 2 HRS

Total 100

Instructions

1. Answer ALL the questions.
2. This question paper consists of TWO sections:
3. SECTION A (10)
   SECTION B (90)

   Answer SECTIONS A and B in the ANSWER BOOK.
4. 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 and a periodic table 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)

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) on your ANSWER BOOK.

1.1 Which of the following organic compounds has the molecular formula $C_5H_{10}O_2$?

A ethyl propanoate

B butyl ethanoate

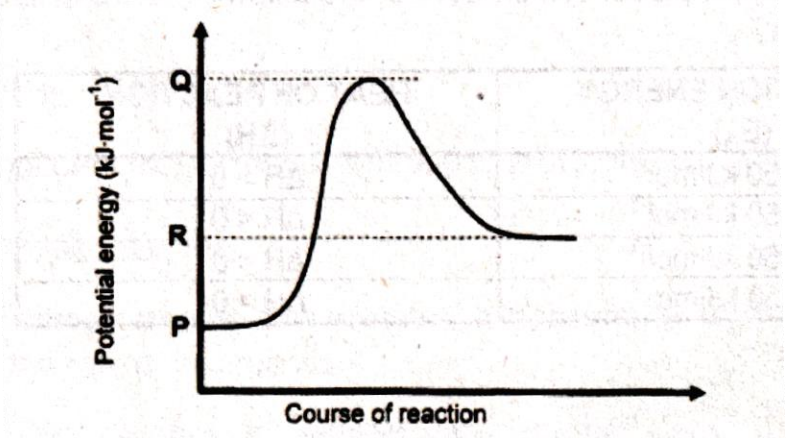
C propyl methanoate

D methyl ethanoate

1.2 Esters are formed by a reaction between two organic compounds, **X** and **Y**, each with a different functional group. The functional groups of these compounds are:

	Compound X	**Compound Y**
A	Hydroxyl group	Carbonyl group
B	Hydroxide group	Carboxyl group
C	Hydroxyl group	Carboxyl group
D	Hydroxide group	Carbonyl group

1.3 Consider the potential energy graph for the reaction shown below:



The activation energy for the reverse reaction in terms of **P**, **Q** and **R** is:

A Q

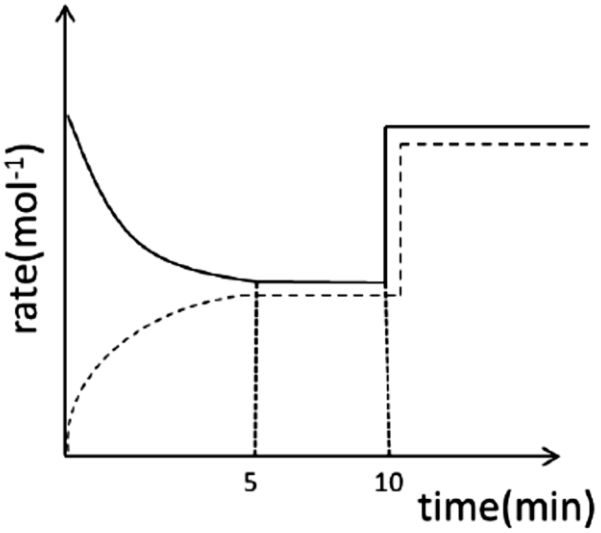
B R – P

C Q – R

D Q – P

1.4 The graph below represents the change in the Rate of Reaction vs Time for the reversible reaction that took place when hydrogen gas and iodine gas were sealed in a container. Equilibrium was first established after 5 minutes. The equation for the reaction is shown below:

$$H_2(g) + I_2(g) \leftrightarrows 2HI(g) \qquad \Delta H < 0$$



What change in the conditions was made at 10 minutes to change the rate of the reaction as indicated on the graph?

A A catalyst was added.

B The temperature was increased.

C The temperature was decreased.

D The external pressure on the reaction mixture was decreased.

1.5 Which of the four solutions below is a dilute, weak acid solution?

A 0,1 mol.dm^{-3} HCℓ solution

B 5 mol.dm^{-3} CH_3COOH solution

C 0,5 mol.dm^{-3} oxalic acid solution

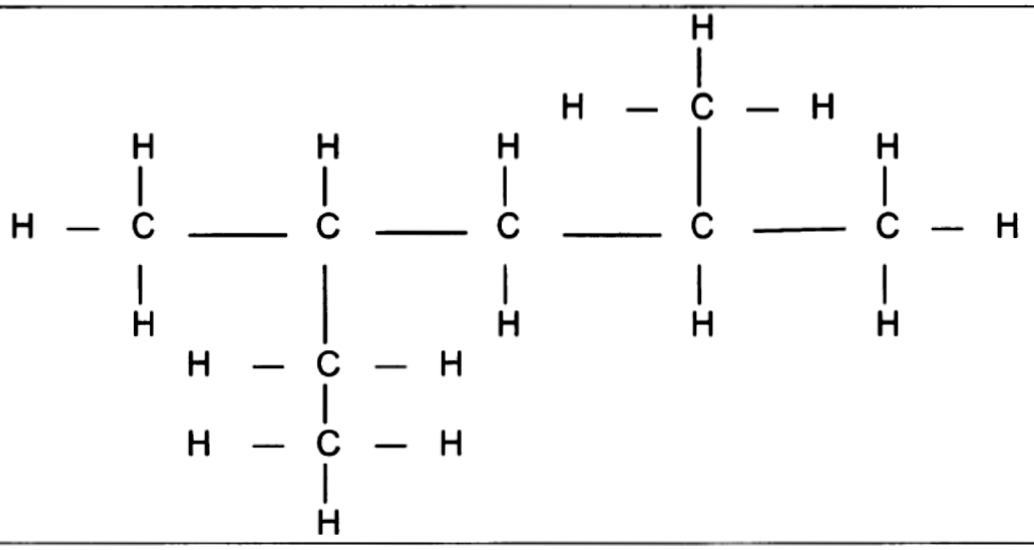
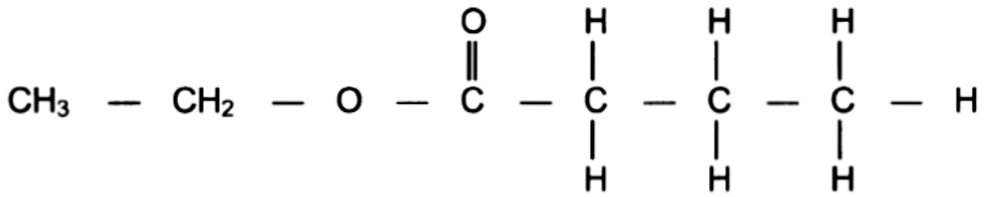
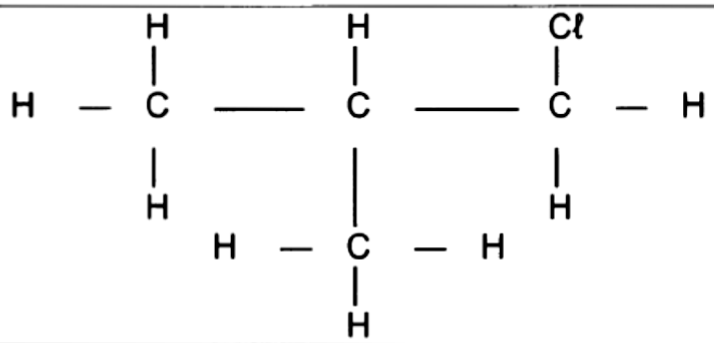
D 0,1 mol.dm^{-3} NaOH solution

[5x2 = 10]

SECTION B

Question 2

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

A					
B					
C					
D	C_4H_8O	**E**	$CH_3CH(CH_3)CH(CH_3)CH_2CCCH_3$	**F**	$CH_3(CH_2)_3CH_2OH$

Use the table above to answer the following questions:

2.1 Write down the:

2.1.1 IUPAC name of compound **A**. (2)

2.1.2 IUPAC name of compound **B**. (2)

2.1.3 Write down the general formula of the homologous series to which compound **C** belongs. (1)

2.2 Compound **E** is a hydrocarbon. Is compound **E** a SATURATED or UNSATURATED compound? Give a reason for your answer. (2)

2.3 Write down the IUPAC name of a POSITIONAL ISOMER of compound **F**. (2)

2.4 **D** is the molecular formula of TWO functional isomers.

2.4.1 Define the term *functional isomer*. (2)

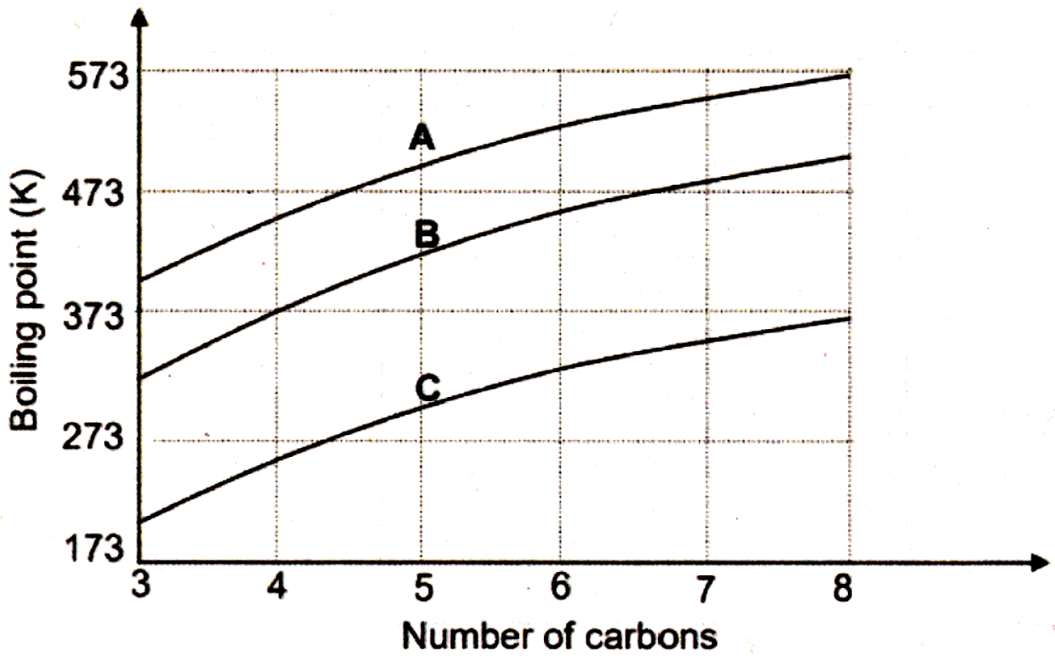
2.4.2 Draw the STRUCTURAL FORMULA of ONE of the functional isomers of **D**. (2)

2.4.3 Write down the name of the OTHER functional isomer of **D**.
(Hint: this is NOT the same compound drawn in QUESTION 2.4.2.) (2)

[15]

Question 3

The relationship between boiling point and the number of carbon atoms in straight chain molecules of aldehydes, alkanes and primary alcohols was investigated. Curves **A**, **B** and **C** were obtained.



3.1 Define the term *boiling point*. (2)

3.2 Write down the STRUCTURAL FORMULA of the functional group of the aldehydes. (1)

3.3 The graph shows that the boiling points increase as the number of carbon atoms increases. Explain this trend. (3)

3.4 Identify the curve (**A**, **B** or **C**) that represents the following:

3.4.1 Compounds with London forces only. (1)

3.4.2 The aldehydes. Explain this answer. (4)

3.5 Use the information in the graph and write down the IUPAC name of the compound with a boiling point of 373K. (1)

3.6 Write down the IUPAC name of the compound containing five carbon atoms which has the lowest vapour pressure at a given temperature. (2)

[14]

QUESTION 4

4.1 A straight chain hydrocarbon C_xH_y, undergoes the following exothermic reaction:

$$\mathbf{2\ C_xH_y\ +\ 25\ O_{2\,(g)}\ \rightarrow\ 16\ CO_{2\,(g)}\ +\ 18\ H_2O_{\,(g)}}$$

4.1.1 NAME the type of reaction occurring above. (1)

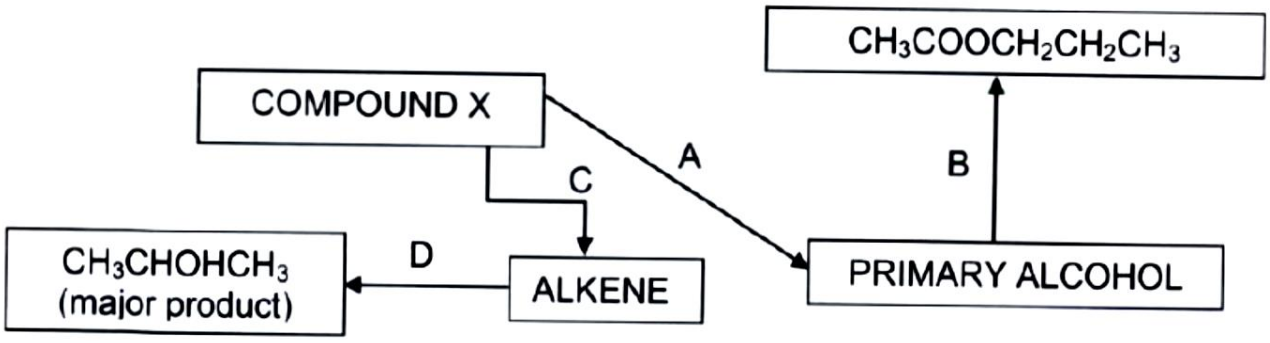
4.1.2 Determine the MOLECULAR FORMULA of compound C_xH_y. (2)

The reaction above takes place in a closed container at a constant temperature higher than 100ºC and at a constant pressure.

4.1.3 Calculate the TOTAL VOLUME of gas formed in the container when 50 cm^3 of C_xH_y reacts completely with oxygen. (3)

4.2 The flow diagram below shows how COMPOUND X can be used to prepare other organic compounds. The letters **A**, **B**, **C** and **D** represent different organic reactions.

Compound X is a HALOALKANE.



Use the information in the flow diagram to answer the following questions:

4.2.1 Write down the type of reaction represented by:

4.2.1.1 **A** (1)

4.2.1.2 **B** (1)

4.2.1.3 **C** (1)

4.2.1.4 **D** (1)

4.2.2 Consider reaction **C**. Write down:

4.2.2.1 TWO reaction conditions for this reaction. (2)

4.2.2.2 IUPAC name of the alkene formed. (1)

4.2.3 Write down the name or formula of the inorganic reactant for reaction **A**. (1)

4.2.4 Reaction **B** involves the reaction of an organic compound with a PRIMARY ALCOHOL.

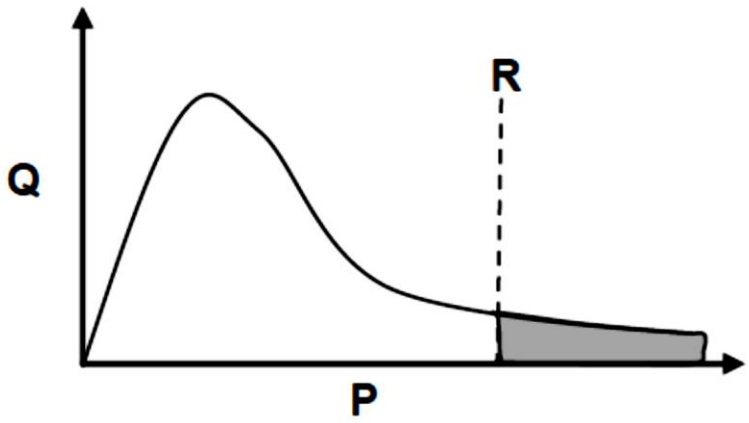
4.2.4.1 Define the term *primary alcohol*. (2)

4.2.4.2 Write down the STRUCTURAL FORMULA of the organic compound that reacts with the primary alcohol in reaction B. (2)

[18]

QUESTION 5

5.1 Study the Maxwell-Boltzmann distribution curve for a certain reaction below:



5.1.1 Give the axis label represented by **Q.** (1)

Line **R** represents the <u>minimum energy required for the reaction to take place</u>.

5.1.2 Write down the term for the underlined phrase. (1)

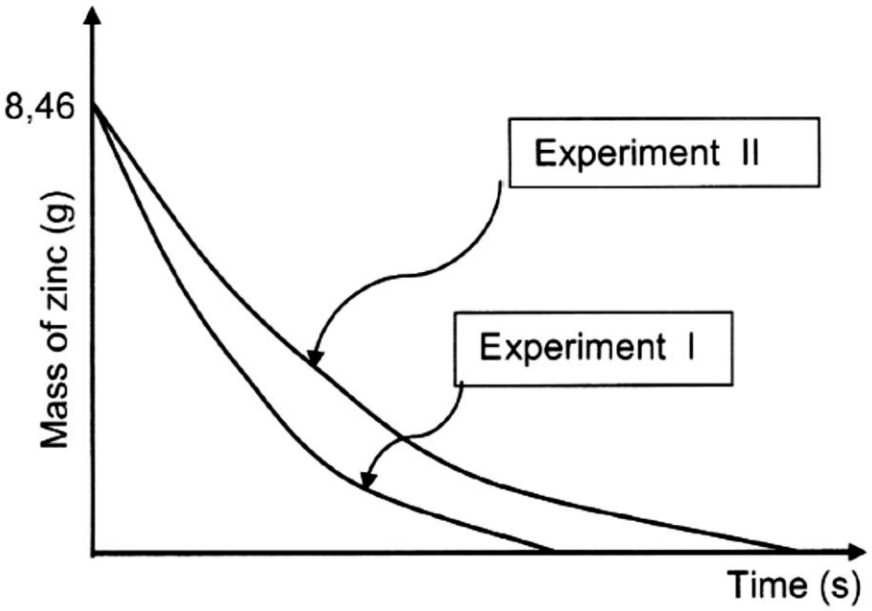
5.1.3 How will the shaded area on the graph be affected when a catalyst is added? Choose from INCREASE, DECREASE or REMAIN THE SAME. (1)

5.2 A group of learners use the reaction of zinc granules and sulphuric acid to investigate the effect of concentration on reaction rate. The balanced equation for the reaction is:

$$\mathbf{Zn(s) + H_2SO_4(aq) \rightarrow ZnSO_4(aq) + H_2(g)}$$

Two experiments, **I** and **II**, were conducted using 8,46 g of zinc. The concentration of sulphuric acid was different for each experiment.

The sketch graph below shows the mass of zinc remaining in the flasks as the reactions proceeded.



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

5.2.2 Which reactant was in excess? (1)

5.2.3 In experiment **I**, 1,8816 dm^3 of hydrogen gas was collected at STP in the first minute of the reaction.

Calculate:

5.2.3.1 the mass of zinc remaining in the flask after one minute. (5)

5.2.3.2 the rate of reaction (**in $g.s^{-1}$**) at one minute. (2)

5.2.4 Which experiment, **I** or **II**, used a higher concentration of sulphuric acid? (1)

5.2.5 Explain, with reference to the Collision Theory, the effect of concentration on reaction rate. (3)

[17]

Question 6

Steam reacts with hot carbon at 1 000ºC according to the following balanced equation:

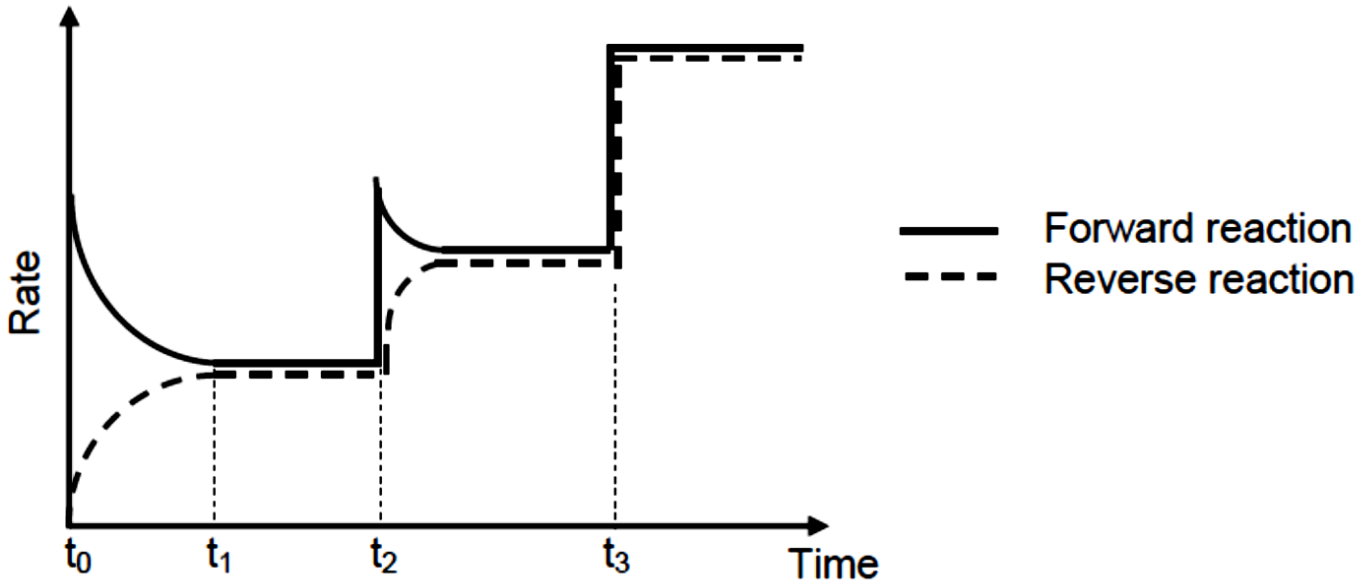
$$2\ H_2O(g) + C(s) \rightleftarrows CO_2(g) + 2\ H_2(g)$$

Initially, 36 g of steam and a certain amount of 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 mol.

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

6.2 Calculate the equilibrium constant, K_c, for the reaction at 1 000ºC. (8)

6.3 The graph below shows how the rates of the forward and reverse reactions change with time.



6.3.1 Give a reason why the rate of the forward reaction decreases between t_0 and t_1. (1)

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

The temperature was adjusted at time t_2.

6.3.3 Was the temperature INCREASED or DECREASED? (1)

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

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

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Question 7

7.1 When oxalic acid $(COOH)_2$ crystals are added to water it ionises according to the following balanced equation:

$$\mathbf{(COOH)_2(s) + 2H_2O(\ell) \leftrightarrows (COO)_2^{2-}(aq) + 2\ H_3O^+(aq)}$$

7.1.1 Why is oxalic acid considered to be a weak acid? (2)

7.1.2 Some sodium oxalate crystals, $Na_2(COO)_2$, are now added to the solution above.
How will the pH of the solution be affected?
Choose from INCREASES, DECREASES or REMAINS THE SAME. (1)

7.2 Learners add 50 cm^3 of hydrochloric acid solution of concentration 0,1 $mol.dm^{-3}$ to 25 cm^3 of sodium hydroxide solution of concentration '**x**' $mol.dm^{-3}$. The equation for this reaction is given below.

$$\mathbf{HC\ell(aq) + NaOH(aq) \rightarrow NaC\ell(aq) + H_2O(\ell)}$$

The concentration of the hydronium ions, $[H_3O^+]$, in the resulting 75 cm^3 solution is found to be 0,0461 $mol.dm^{-3}$ after the reaction is complete.

Calculate the concentration '**x**' of the sodium hydroxide solution. (7)

[10]

Total 100

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* $E^{\theta}_{cell} = E^{\theta}_{oxidising\ agent} - E^{\theta}_{reducing\ agent}$ / $E^{\theta}_{sel} = E^{\theta}_{oksideermiddel} - E^{\theta}_{reduseermiddel}$	

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

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																	**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	**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	**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	**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	**Xe** 131
0,7 **Cs** 133	0,9 **Ba** 137	**La** 139	1,6 **Hf** 179	**Ta** 181	**W** 184	**Re** 186	**Os** 190	**Ir** 192	**Pt** 195	**Au** 197	**Hg** 201	1,8 **Tℓ** 204	1,8 **Pb** 207	1,9 **Bi** 209	2,0 **Po**	2,5 **At**	**Rn**
0,7 **Fr**	0,9 **Ra** 226	**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**