education

Department of Education
FREE STATE PROVINCE

EXAMINATION

GRADE 12

PHYSICAL SCIENCES (PAPER 2: CHEMISTRY)

JUNE 2022

Stanmorephysics

MARKS: 150

TIME: 3 HOURS

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

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INSTRUCTIONS AND INFORMATION

1. Write your name and other information in the applicable spaces on the ANSWER BOOK.
2. This question paper consists of nine 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.

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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 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 compounds contains a formyl group?

A Propanol

B Propanal

C Propan-2-one

D Propanoic acid (2)

1.2 Which general formula represents haloalkanes?

A $C_nH_{n+1}X$

B $C_nH_{2n-1}X$

C $C_nH_{2n-2}X$

D $C_nH_{2n+1}X$ (2)

1.3 Which one of the following compounds is a hydrocarbon molecule?

A $CH_3(CH_2)_2CH_3$

B $CH_3COCH_2CH_3$

C $CH_3CH_2CH_2COOH$

D $CH_3CH(OH)CH_2CH_3$ (2)

1.4 Consider the IUPAC name below.

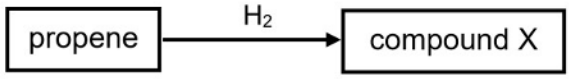
Propyl butanoate

Which two organic molecules were used to prepare the molecule above?

A	Butanol	Propanoic acid
B	Propane	Butanoic acid
C	Propanol	Butanoic acid
D	Butane	Propanoic acid

(2)

1.5 Consider the flow diagram below:



Which catalyst is most suitable for the reaction above?

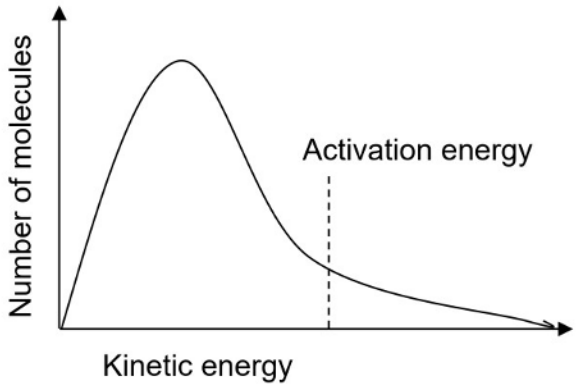
A H_2SO_4

B Pt

C H_3PO_4

D Zn (2)

1.6 The given graph represents a Maxwell-Boltzman curve. The activation energy for a certain reaction is indicated by the dotted line.



A change was made and it was found that the activation energy moved to the RIGHT. What is a possible explanation for this?

A The catalyst was removed.

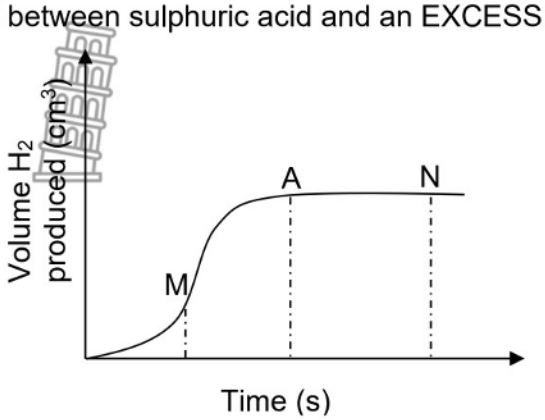
B The temperature was increased.

C The concentration was decreased.

D The volume of the reaction vessel was increased. (2)

USE THE FOLLOWING INFORMATION AND GRAPH TO ANSWER QUESTIONS 1.7 AND 1.8.

The graph shows how the total volume of hydrogen gas (H_2) produced by the reaction between sulphuric acid and an EXCESS of magnesium varied with time.



1.7 Which ONE of the statements about SECTION **AN** of the curve is correct?

A All the magnesium has reacted.

B No more hydrogen gas is produced.

C The rate of the reaction is at a maximum.

D The concentration of the acid is decreasing. (2)

1.8 Which ONE of the statements about SECTION **MA** of the curve is correct?

A A catalyst is introduced.

B The reaction is exothermic.

C The magnesium is in excess.

D The acid's concentration is decreasing. (2)

1.9 The following reaction reaches equilibrium in a closed container:

$$A_2X\,(aq) + B_2\,(g) \rightleftharpoons A_2\,(aq) + B_2X\,(s) \quad ; \quad \Delta H < 0$$

The pressure in the container is then decreased by releasing some of **B_2** from the container.

What effect does this have on the rate of the reverse reaction and the concentration of **A_2**?

	Rate of reverse reaction	**Concentration of A_2**
A	Increases	Increases
B	Decreases	Decreases
C	Decreases	Increases
D	Increases	Decreases

(2)

1.10 Consider the following equilibrium reaction:

$$C_2H_4\,(g) + H_2\,(g) \rightleftharpoons C_2H_6\,(g) \quad ; \quad \Delta H < 0$$

For this reaction the K_C value is **2×10^{-2}** at a certain temperature. To change the K_C value to **6×10^{-2}** ...

A the temperature must be increased.

B the temperature must be decreased.

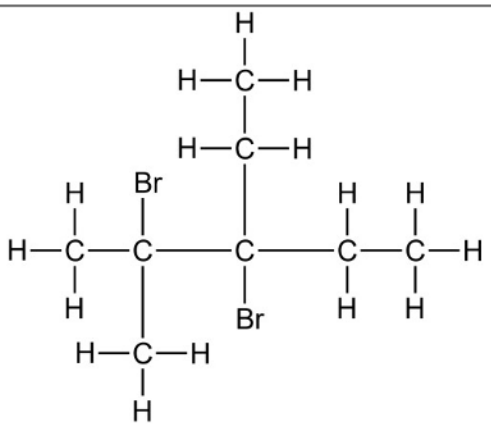
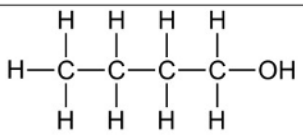
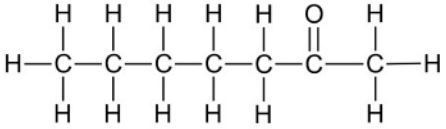
C the pressure must be increased.

D a catalyst must be added. (2)

[20]

QUESTION 2

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

A	Propanoic acid	**B**	Hexanal
C	Butane	**D**	
E		**F**	

2.1 Write down the letter(s) that represent(s) a:

2.1.1 Hydrocarbon (1)

2.1.2 Ketone (1)

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

2.3 Write down the IUPAC name of the FUNCTIONAL ISOMER of compound **A**. (2)

2.4 For compound **B**, write down the:

2.4.1 Homologous series to which it belongs. (1)

2.4.2 Structural formula (2)

2.4.3 General formula (1)

2.5 Write down the IUPAC name of compound **D**. (3)

2.6 A catalyst is needed during the reaction of compound **A** with compound **E**. Write down the following:

2.6.1 Name or formula of the catalyst (1)

2.6.2 Structural formula of the ORGANIC product that is formed. (2)

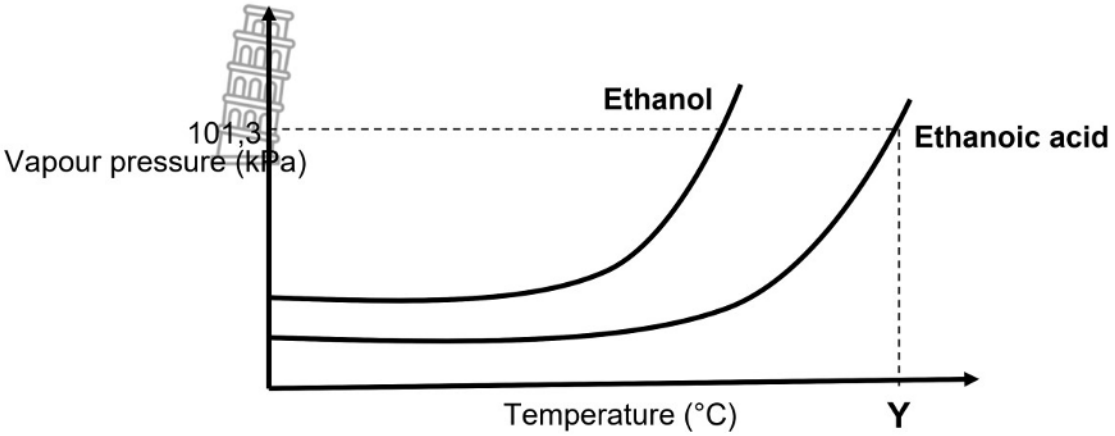
2.7 **220 g** of compound **C** reacts with EXCESS oxygen.

2.7.1 Write down the balanced chemical equation for the combustion of compound **C**. (3)

2.7.2 Calculate the mass of the carbon dioxide that is produced. (5)
[24]

QUESTION 3

The graph below, not drawn to scale, shows the VAPOUR PRESSURE of two organic compounds.



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

3.2 Write down the independent variable for this investigation. (1)

3.3 Which compound has the lowest boiling point? (1)

3.4 Fully explain the answer in question 3.3. (4)

3.5 Name and define the term for the temperature represented by **Y**. (3)

3.6 Redraw the graph above in your answer book. On the same set of axes, sketch the curve that will be obtained when ethanoic acid is replaced with propanone. Clearly label the two curves. (2)

3.7 The table below shows the IUPAC names of three alkanes.

Alkane	IUPAC name
A	2,2-dimethylpropane
B	2-methylbutane
C	pentane

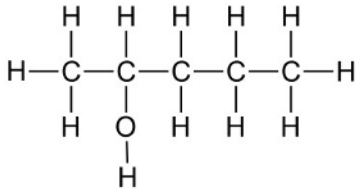
3.7.1 Is the vapour pressure of 2,2-dimethylpropane HIGHER THAN, LOWER THAN or EQUAL TO that of 2-methylbutane? Fully explain your answer. (4)

3.7.2 Arrange the above alkanes in order of DECREASING strength of intermolecular forces. (2)

[19]

QUESTION 4

Consider the following organic reactions **1** to **4** involving compounds **A** to **E**.

Reaction 1	**A** + Br–Br $\xrightarrow{\text{Heat}}$ **B** + H–Br
Reaction 2	**B** + $KOH_{(conc)}$ $\longrightarrow$ **C** + KBr + **D**
Reaction 3	**C** + H_2O $\longrightarrow$ 
Reaction 4	**A** $\longrightarrow$ C_3H_6 + **E**

4.1 Name the type of reaction represented by:

4.1.1 Reaction 1 (1)

4.1.2 Reaction 3 (1)

4.2 Consider **reaction 1**.

4.2.1 To which homologous series does compound **B** belong? (1)

4.2.2 Write down the IUPAC name of compound **A**. (2)

4.3 Consider **reaction 2**.

4.3.1 Name the TYPE of elimination reaction represented by this reaction. (1)

4.3.2 Write down one reaction condition needed. (1)

4.3.3 Write down the name of compound **D**. (1)

4.4 Consider **reaction 3**.

4.4.1 Is compound **C** SATURATED or UNSATURATED? Give a reason for your answer. (2)

4.4.2 Write down the IUPAC name of compound **C**. (2)

4.5 Consider **reaction 4**.

4.5.1 Name the type of reaction represented by reaction 4. (1)

4.5.2 Using CONDENSED STRUCTURAL FORMULAE, write down the balanced equation for this reaction. Indicate the reaction condition above the arrow. (4)

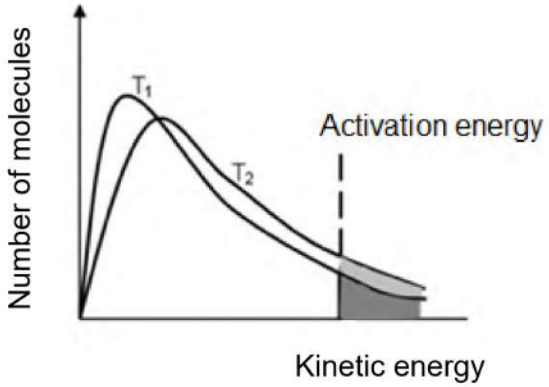
[17]

QUESTION 5

The collision theory can be used to explain how different factors affect the rate of a chemical reaction.

5.1 Name TWO conditions that determine whether a collision between two molecules, **A** and **B**, will lead to a chemical reaction. (2)

5.2 The following graphs show two identical reactions taking place at different temperatures.



5.2.1 In terms of the collision theory, explain why the rate of a chemical reaction increases with increasing temperature. (2)

5.2.2 Which graph represents the reaction taking place at a higher temperature? Write only T_1 or T_2. (1)

5.2.3 What is represented by the TOTAL area under each graph? (1)

5.2.4 What is represented by the SHADED area under both graphs? (2)

[8]

QUESTION 6

A group of learners use the reaction between zinc and sulphuric acid to investigate one of the factors that affects reaction rate. The equation below represents the reaction that takes place.

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

They add 6,5 g of zinc granules to excess DILUTE sulphuric acid and measure the **mass of zinc used per unit time**.

The learners then repeat the experiment using excess CONCENTRATED sulphuric acid.

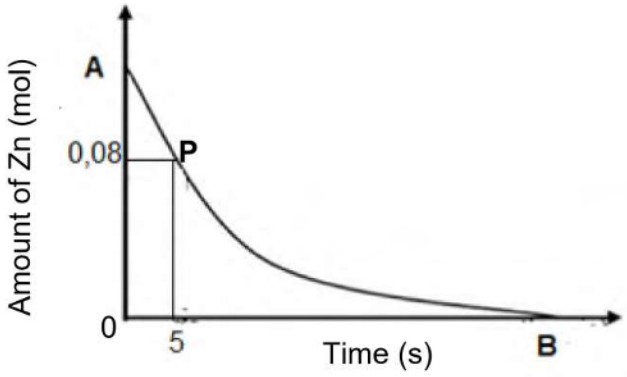
6.1 Define the term *reaction rate*. (2)

6.2 Which factor influencing reaction rate is investigated? (1)

6.3 Write down a hypothesis for this investigation. (2)

6.4 The learners must use the same mass of ZINC GRANULES in both experiments. Which variable is controlled by doing this? (1)

The results obtained for the reaction using DILUTE sulphuric acid are represented in the graph below.



6.5 Calculate the value of **A** on the y-axis. (3)

6.6 Calculate the value of **B** on the x-axis if the average rate of the reaction was 0,15 $g \cdot s^{-1}$ for the part of the graph represented by **PB**, where **P** is at t = 5 s. (5)

6.7 Copy the above graph into your ANSWER BOOK. ON THE SAME SET OF AXES, use a dotted line to draw the curve that will be obtained when concentrated sulphuric acid is used. (3)

[17]

QUESTION 7

Learners perform six experiments to study the factors which affect the rate of chemical reactions. They use the reaction between solid calcium carbonate ($CaCO_3$) and an excess hydrochloric acid solution ($HC\ell$), represented by the balanced equation below, in all the experiments.

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

An EXCESS HYDROCHLORIC ACID is used, and the calcium carbonate is COMPLETELY COVERED in all the experiments. The CO_2 is released into the atmosphere.

The conditions of the experiments are summarized in the table below:

	Mass of $CaCO_3$ (g)	**State of $CaCO_3$**	**Concentration of $HC\ell$ ($mol \cdot dm^{-3}$)**	**Temperature of $HC\ell$ (°C)**
Experiment 1	2	powder	0,2	25
Experiment 2	2	lumps	0,2	25
Experiment 3	2	lumps	0,2	25
Experiment 4	2	lumps	1,0	25
Experiment 5	4	powder	0,2	25
Experiment 6	4	powder	0,2	35

7.1 Can the reaction reach equilibrium after some time? Write YES or NO. Give a reason for your answer. (2)

7.2 Which factor influencing reaction rate is investigated using the conditions of experiments **1** and **2**? (1)

7.3 It was found that the reaction rate for experiments **2** and **3** are not the same. Give a possible reason for this observation. (1)

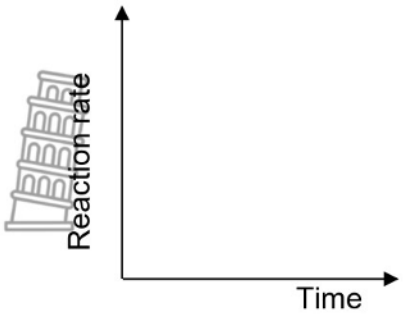
7.4 Compare experiments **3** and **4**. Write down the:

7.4.1 Independent variable (1)

7.4.2 Dependant variable (1)

7.4.3 One controlled variable (1)

7.5 The conditions of experiments **5** and **6** are now compared. Redraw the following set of axes in your answer book.

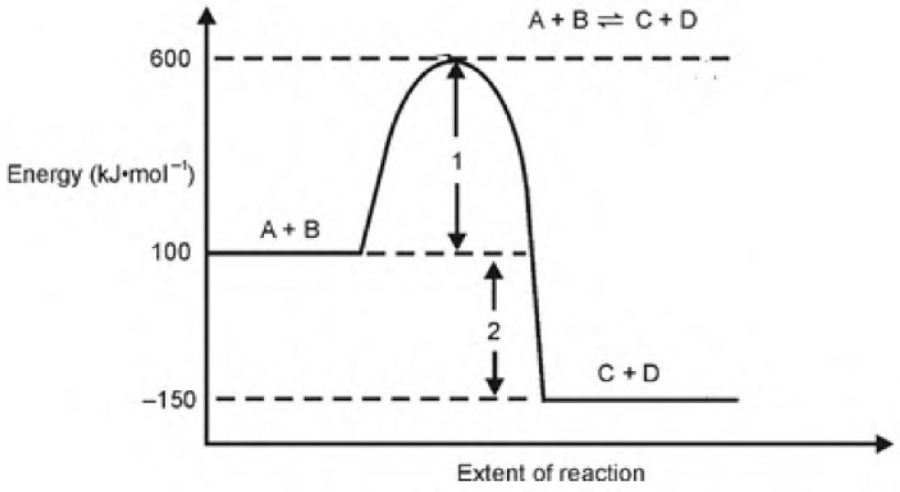


On the same set of axes, draw the expected graphs for experiments **5** and **6**; clearly showing their shapes and differences and label the two graphs. (3)

[10]

QUESTION 8

In the following energy diagram, the *x*-axis represents the extent of reaction. The *y*-axis represents the energy of the reactants or products.



8.1 Give the name for:

8.1.1 Label 1 (1)

8.1.2 Label 2 (1)

8.2 Is the reverse reaction ENDOTHERMIC or EXOTHERMIC? (1)

8.3 Calculate the activation energy for the reverse reaction shown on the diagram. (3)

8.4 How will an increase in the concentration of **A** and **B** influence the activation energy for the reverse reaction? Write only INCREASES, DECREASES or REMAINS THE SAME. (1)

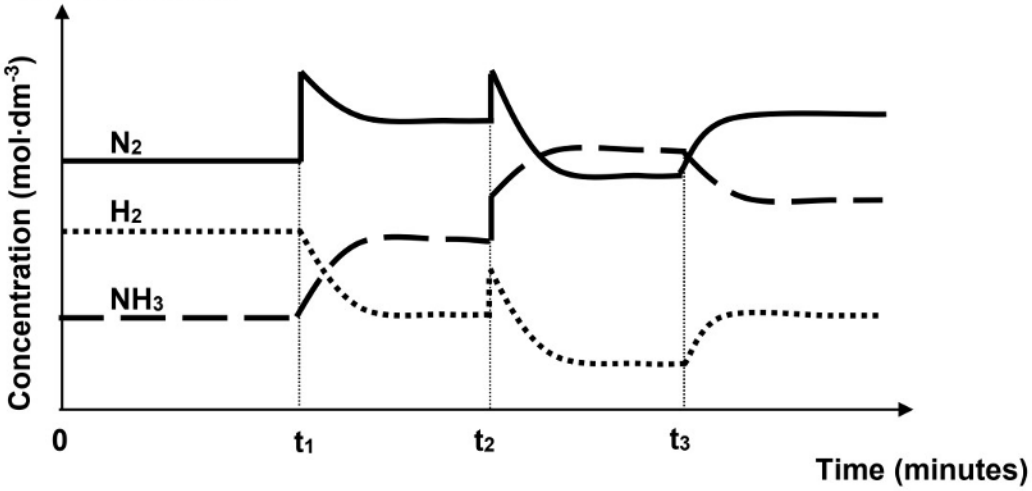
8.5 Calculate the heat of reaction (ΔH) for the reverse reaction. (3)
[10]

QUESTION 9

A laboratory produces ammonia at a temperature of 450 °C. The balanced equation below represents the reaction that takes place in a sealed container.

$$N_2(g) + 3H_2(g) \rightleftharpoons 2NH_3(g) \quad ; \quad \Delta H < 0$$

Adjustments are made to the TEMPERATURE, PRESSURE, CONCENTRATION and use of a CATALYST in the equilibrium mixture. The graphs below represent the results obtained.



9.1 Was the reaction at equilibrium at t = 0 s? Give a reason for your answer. (2)

9.2 Identify the changes made to the equilibrium mixture at each of the following times:

9.2.1 t_1 (2)

9.2.2 t_3 (2)

9.3 At t_2 a possible change in pressure took place.

9.3.1 Did the pressure INCREASE, DECREASE or REMAIN THE SAME? (1)

9.3.2 Give a reason for your answer in question 9.3.1. (2)

9.3.3 Refer to the principle of Le Chatelier and explain what would happen to the concentration of the NH_3 if the pressure was DECREASED. (3)

9.4 At which of the above time(s) did the change made to the reaction mixture lead to a higher yield of ammonia? Write down only **t_1** and/or **t_2** and/or **t_3**. (2)

A laboratory technician now injects 5 mol of N_2 and 5 mol of H_2 into a 5 dm^3 sealed, empty container. Equilibrium is reached at 450 °C. Upon analysis of the equilibrium mixture, it is found that the mass of NH_3 is 20,4 g.

9.5 Calculate the value of the equilibrium constant (K_c) at 450 °C. (9)

9.6 What would happen to the Kc value calculated in question 9.5 if 10 mol of N_2 and 10 mol of H_2 were used? (2)

[25]

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 *Standaarddruk*	p^{θ}	1,013 x 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 x 10^{-19} C
Avogadro's constant *Avogadro-konstante*	N_A	6,02 x 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 $c = \frac{m}{MV}$	$n = \frac{V}{V_m}$
$\frac{c_a V_a}{c_b V_b} = \frac{n_a}{n_b}$	$pH = -\log [H_3O^+]$
$K_w = [H_3O^+][OH^-] = 1x10^{-14}$ at/*by* 298 K	
$E^{\theta}_{cell} = E^{\theta}_{cathode} - E^{\theta}_{anode}$ OR $E^{\theta}_{cell} = E^{\theta}_{reduction} - E^{\theta}_{oxidation}$ OR $E^{\theta}_{cell} = E^{\theta}_{oxidising\ agent} - E^{\theta}_{redusing\ agent}$	$E^{\theta}_{sel} = E^{\theta}_{katode} - E^{\theta}_{anode}$ OF $E^{\theta}_{sel} = E^{\theta}_{reduksie} - E^{\theta}_{oksidasie}$ OR $E^{\theta}_{sel} = E^{\theta}_{oksideermiddel} - E^{\theta}_{reduseermiddel}$

THE PERIODIC TABLE OF ELEMENTS
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**															

Ce 140	**Pr** 141	**Nd** 144	**Pm**	**Sm** 150	**Eu** 152	**Gd** 157	**Tb** 159	**Dy** 163	**Ho** 165	**Er** 167	**Tm** 169	**Yb** 173	**Lu** 175
Th 232	**Pa**	**U** 238	**Np**	**Pu**	**Am**	**Cm**	**Bk**	**Cf**	**Es**	**Fm**	**Md**	**No**	**Lr**

KEY/*SLEUTEL*

Atomic number *Atoomgetal*

Electronegativity *Elektronegatiwiteit* → 29 / 1,9 **Cu** / 63,5 ← **Symbol** *Simbool*

Approximate relative atomic mass *Benaderde relatiewe atoommassa*



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