

KWAZULU-NATAL PROVINCE

EDUCATION
REPUBLIC OF SOUTH AFRICA

NATIONAL SENIOR CERTIFICATE

GRADE 12

PHYSICAL SCIENCES P2 (CHEMISTRY)

COMMON TEST

JUNE 2022

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MARKS: 100

TIME: 2 hours

This question paper consists of 10 pages and 2 data sheets.

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INSTRUCTIONS AND INFORMATION

1. Write your NAME and SURNAME in the appropriate spaces on the ANSWER BOOK.

2. This question paper consists of SEVEN questions. Answer ALL the 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 subquestions, for example between QUESTION 2.1 and QUESTION 2.2.

6. You may use a non-programmable 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.

11. Give brief motivations, discussions et cetera where required.

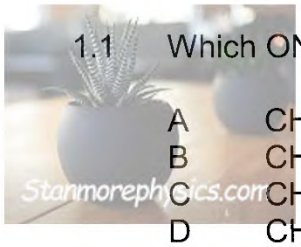
12. Write neatly and legibly.

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QUESTION 1: MULTIPLE-CHOICE QUESTIONS

Various options are provided as possible answers to the following questions.
Choose the correct answer and write only the letter (A-D) next to the question number (1.1 – 1.6) in the ANSWER BOOK, for example 1.7 D.



1.1 Which ONE of the following compounds is a KETONE?

A CH_3COCH_3
B CH_3CH_2CHO
C CH_3CH_2COOH
D $CH_3CH_2CH_2OH$ (2)

1.2 Which ONE of the following equations represents a SUBSTITUTION reaction?

A $CH_2CH_2 + HBr \rightarrow CH_3CH_2Br$
B $CH_2CH_2 + H_2O \rightarrow CH_3CH_2OH$
C $CH_3CH_2OH \rightarrow CH_2CH_2 + H_2O$
D $CH_3CH_2OH + HBr \rightarrow CH_3CH_2Br + H_2O$ (2)

1.3 Which ONE of the following compounds has mainly dipole-dipole forces between its molecules?

A Butane.
B Butanal.
C But-1-ene.
D But-1-yne. (2)

1.4 Consider the equation for a hypothetical reaction below:

$P(g) + Q(g) \rightarrow PQ(g)$

At 75 °C, the heat of reaction (ΔH), for this reaction is – 60 $kJ.mol^{-1}$.
At a temperature of 85 °C, the heat of reaction, in $kJ.mol^{-1}$, is:

A – 60
B + 60
C Less than - 60
D Greater than + 60 (2)

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1.5 The reaction represented by the balanced equation below reaches equilibrium in a closed container at 200 ^{0}C

$$C(s) + CO_2(g) \rightleftharpoons 2\,CO(g)$$

How will the number of moles of CO(g) at equilibrium and the value of Kc be affected when more C(s) is added to the container at 200 ^{0}C?

	NUMBER OF MOLES OF CO(g)	Kc
A	Increases	Increases
B	Increases	Remains the same
C	Remains the same	Increases
D	Remains the same	Remains the same

(2)

1.6 Solutions of acetic acid, $CH_3COOH(aq)$, and hydrochloric acid, $HC\ell(aq)$, each concentration 0,1 mol.dm^{-3} are compared.

How do the $H_3O^+(aq)$ concentration and the pH of acetic acid compare to that of hydrochloric acid?

	$[H_3O^+]$ of ACETIC ACID	pH of ACETIC ACID
A	Equal	Equal
B	Higher	Lower
C	Lower	Higher
D	Equal	Higher

(2)

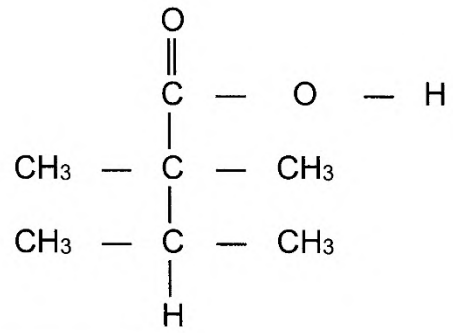
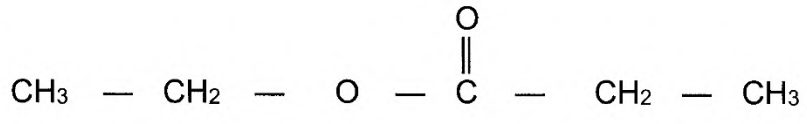
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QUESTION 2 (Start on a new page.)

Study the table below.

A	propyl butanoate	B	C_nH_{2n}
C	$C_5H_{12}O$	D	C_nH_{2n+2}
E			
F			
G	$CH_3CHCH_3CHCHC(CH_3)_3$		

Use the information in the table to answer the questions that follow.

2.1 C represents the molecular formula of a TERTIARY ALCOHOL:

2.1.1 Draw the structural formula for compound C. (2)

2.1.2 Give a reason why C is classified as a tertiary alcohol. (1)



2.2 Write down the IUPAC name for compound:

2.2.1 E. (2)

2.2.2 G. (3)

2.3 Write down the letter that represents the general formula of a saturated hydrocarbon. (2)

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

2.5 Write down the letters that represent compounds that are functional isomers of each other. (1)

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QUESTION 3 (Start on a new page.)

In an investigation the boiling points of two compounds are compared. The results of the investigation are recorded in the table below:

Compound	Molecular mass in $g.mol^{-1}$	Boiling Point (°C)
Propanoic acid	74	141
Ethyl methanoate	74	X

3.1 Define *boiling point*. (2)

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

3.3 Will the value X in the table be GREATER THAN, LESS THAN or EQUAL TO 141 °C? (1)

3.4 Fully explain the answer to question 3.3. (3)

Consider a STRAIGHT CHAIN hydrocarbon, R, with a molecular mass of $72\ g.mol^{-1}$

3.5 How does the vapour pressure of R compare with the vapour pressure of ethyl methanoate?

Choose from GREATER THAN, LESS THAN or EQUAL TO. (1)

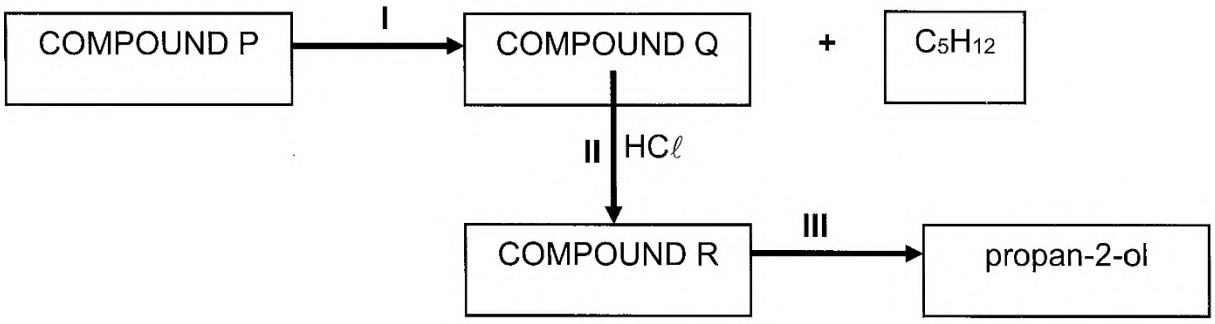
3.6 Draw the structural formula of a CHAIN ISOMER of compound R. (3)

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QUESTION 4 (Start on a new page.)

The flow diagram below shows how propan-2-ol can be produced from compound P.
I, II and III represent organic reactions.



4.1 Name the type of ELIMINATION reaction represented by reaction I. (1)

4.2 Draw the structural formula for compound R. (2)

4.3 Write down the IUPAC name of compound Q. (2)

4.4 What type of reaction is represented by reaction II? Choose from ADDITION, ELIMINATION or SUBSTITUTION. (1)

4.5 Write down the reaction conditions for reaction III. (2)

4.6 Write down the molecular formula of compound P. (2)

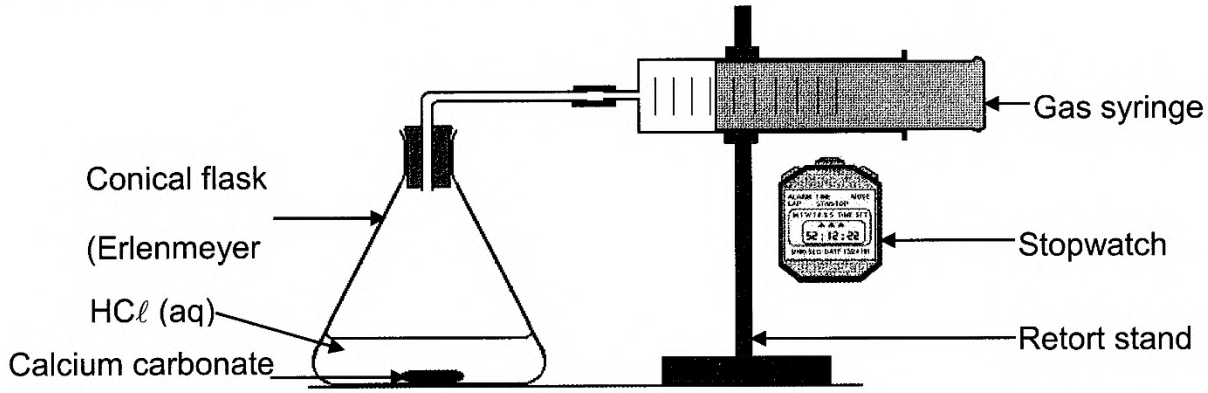
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QUESTION 5 (Start on a new page)

The apparatus shown below is used to investigate the rate at which carbon dioxide gas is produced when an unknown mass of granules of calcium carbonate ($CaCO_3$) reacts with EXCESS dilute hydrochloric acid ($HC\ell$).



The spontaneous reaction that takes place is represented by the following balanced equation:

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

The volume of carbon dioxide gas produced during the reaction was measured at 20 second intervals and recorded in the table below:

Time (seconds)	0	20	40	60	80	100	120
Volume $CO_2(g)$ (cm^3)	0	300	460	500	500	500	500

5.1 Define *reaction rate*, in words. (2)

5.2 How long, in seconds, did the reaction take to reach completion? (1)

5.3 Calculate the average rate in $cm^3.s^{-1}$ at which the $CO_2(g)$ is produced in the first 20 seconds. (3)

5.4 How does the average rate of the reaction, calculated in question 5.3 compare to the average rate of the reaction between 20 s and 40 s?

(Choose from GREATER THAN, LESS THAN or EQUAL TO).
Give a reason for the answer by using the data in the table. (2)

5.5 Calculate the mass of the calcium carbonate that was used in this investigation if the molar gas volume is 25,70 $dm^3 \cdot mol^{-1}$. (5)

5.6 The investigation is repeated under the same conditions but the calcium carbonate granules are replaced with an equal mass of calcium carbonate powder.



5.6.1 How will this change influence the rate of the reaction? Write down INCREASE, DECREASE or REMAINS THE SAME. (1)

5.6.2 Use the collision theory to explain the answer to question 5.6.1. (3)
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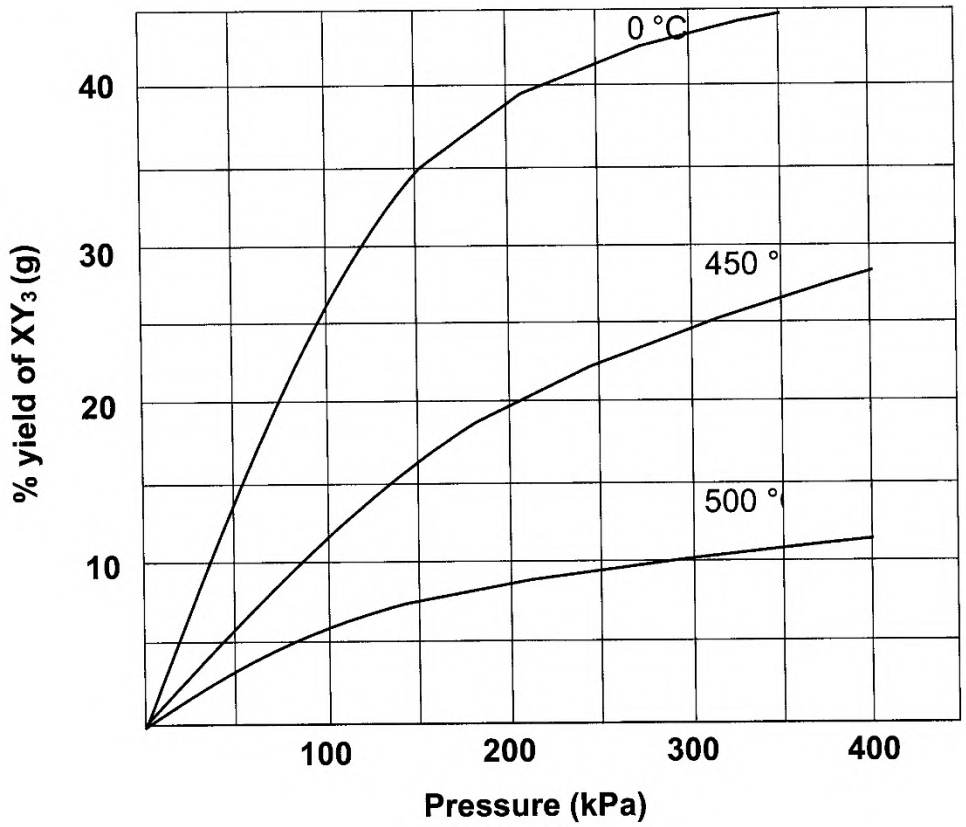
QUESTION 6 (Start on a new page)

6.1 The balanced equation below represents a hypothetical reaction that takes place in a sealed container.

$$X_2(g) + 3Y_2(g) \rightleftharpoons 2XY_3(g)$$

The graph below shows the percentage yield of $XY_3(g)$ at different temperatures and pressures.

GRAPH OF PERCENTAGE YIELD OF XY_3 (g) VERSUS PRESSURE



6.1.1 State *Le Chatelier's Principle.* (2)

6.1.2 Is the reaction between $X_2(g)$ and $Y_2(g)$ ENDOTHERMIC or EXOTHERMIC? (1)

6.1.3 Explain the answer to question 6.1.2. (3)

6.1.4 Describe the trend as illustrated by the graph between the percentage yield of $XY_3(g)$ and the pressure at a temperature of 500 °C. (1)

6.1.5 Use Le Chatelier's Principle to explain this trend. (2)

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6.2 Hydrogen gas, $H_2(g)$, of mass 3,50 g and iodine gas, $I_2(g)$, of mass 635 g were placed in a sealed container of volume 1,50 dm^3 and allowed to react. The reaction reached equilibrium at 300 °C. The balanced equation for the reaction that takes place is given below:



$$H_2(g) + I_2(g) \rightleftharpoons 2\,HI(g)$$

When equilibrium is reached, 1,45 moles of $I_2(g)$ is present.
Calculate the value of the Equilibrium Constant (Kc) at 300 °C for this reaction. (8)

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QUESTION 7 (Start on a new page.)

7.1 Consider the following reaction:

$$NH_3(g) + H_2O(\ell) \rightleftharpoons NH_4^+(aq) + OH^-(aq)$$

7.1.1 Define a *base* according to the Lowry-Bronsted theory. (1)

7.1.2 Is NH_4^+ the CONJUGATE ACID or CONJUGATE BASE of ammonia in the above reaction? (1)

7.1.3 Define *hydrolysis*. (2)

7.1.4 Write down a balanced equation to show the hydrolysis of the ammonium ions (NH_4^+). (2)

7.2 During a reaction, 25 cm^3 of an aqueous solution of strong base, barium hydroxide, $Ba(OH)_2$ with a pH of 13,6 was added to 40 cm^3 of an aqueous solution of sulphuric acid (H_2SO_4) of concentration 0,15 $mol.dm^{-3}$.
The following reaction takes place at 25 ^0C:

$$H_2SO_4(aq) + Ba(OH)_2(aq) \rightarrow BaSO_4(aq) + 2\,H_2O(\ell)$$

7.2.1 Calculate the concentration of the $Ba(OH)_2$ solution used in the reaction. (5)

7.2.2 Calculate the concentration of the hydronium ions (H_3O^+) in the final solution, assuming that the volumes are additive. (9)

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TOTAL MARKS: 100

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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*

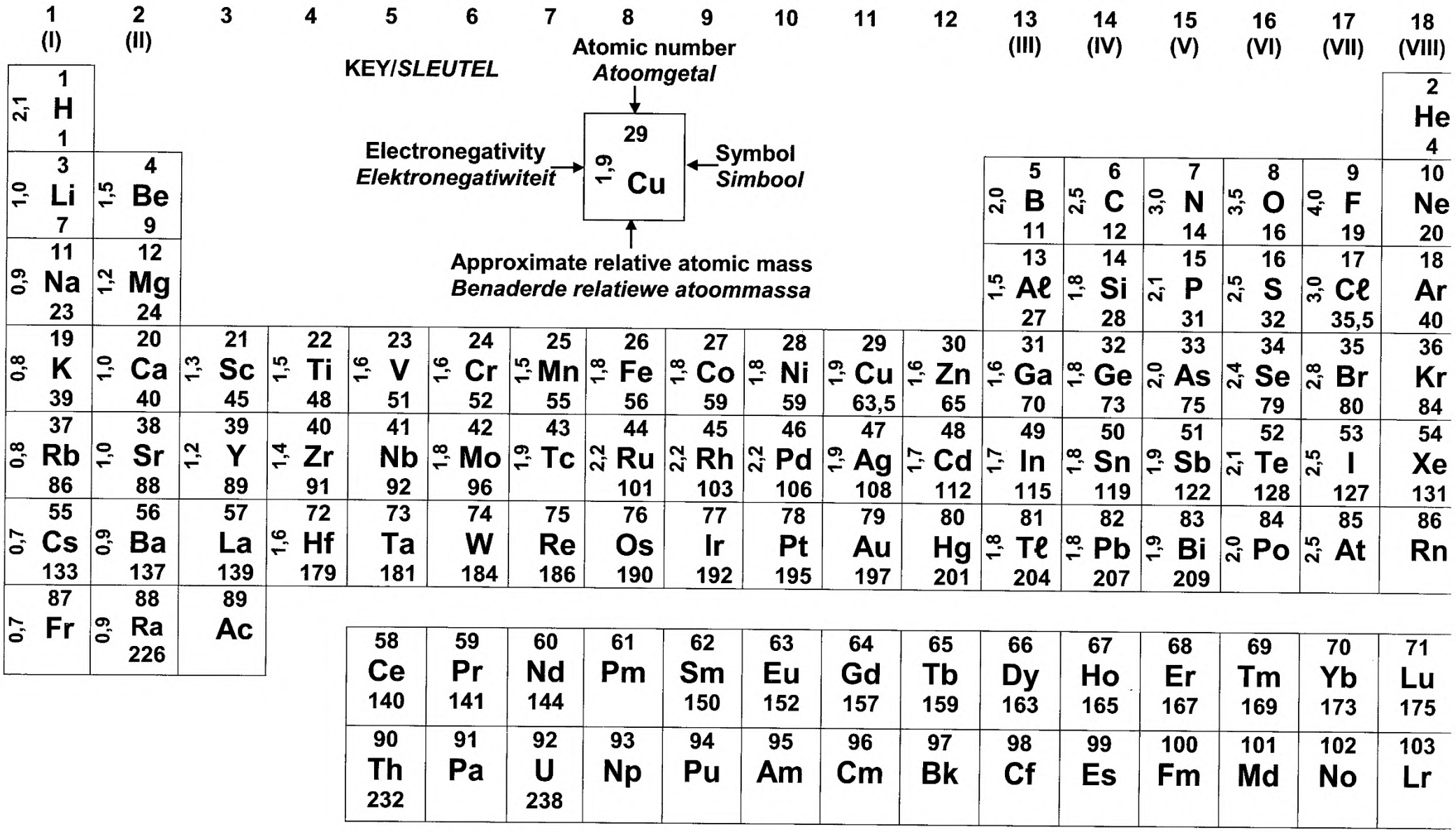
NAME/*NAAM*	SYMBOL/*SIMBOOL*	VALUE/*WAARDE*
Standard pressure *Standaarddruk*	p^{θ}	$1{,}013 \times 10^5$ Pa
Molar gas volume at STP *Molêre gasvolume by STD*	V_m	22,4 $dm^3 \cdot mol^{-1}$
Standard temperature *Standaardtemperatuur*	T^{θ}	273 K
Charge on electron *Lading op electron*	E	$-1{,}6 \times 10^{-19}$ 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	

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:RIODIC TABLE OF ELEMENTS
TABEL 3: DIE PERIODIEKE TABEL VAN ELEMENT



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