basic education

Department:
Basic Education
REPUBLIC OF SOUTH AFRICA

NATIONAL SENIOR CERTIFICATE

GRADE 10

PHYSICAL SCIENCES: CHEMISTRY (P2)

NOVEMBER 2015

MARKS: 150

TIME: 2 hours

This question paper consists of 15 pages and 2 data sheets.

INSTRUCTIONS AND INFORMATION

1. Write your name and class (for example 10A) in the appropriate spaces on the ANSWER BOOK.

2. This question paper consists of TEN 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.

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 only the letter (A–D) next to the question number (1.1–1.10) in the ANSWER BOOK, for example 1.11 E.

1.1 In which ONE of the following global systems are all living organisms found?

A Biosphere

B Lithosphere

C Atmosphere

D Hydrosphere (2)

1.2 During an experiment, a group of learners observe ice melting in a beaker.

Which ONE of the following best explains the learners' observation?

A The ice is releasing heat energy.

B The ice is undergoing a physical change.

C The ice is undergoing a chemical change.

D The ice is decomposing into the elements hydrogen and oxygen. (2)

1.3 Which ONE of the following is a mixture?

A Air

B A diamond

C Distilled water

D Sodium chloride (2)

1.4 The number of neutrons in an atom of $^{23}_{11}Na$ is …

A 1

B 11

C 12

D 23 (2)

1.5 When atom **X** of an element in Group 1 ionises to become $\mathbf{X^+}$, the …

A mass number of **X** increases.

B atomic number of **X** decreases.

C charge of the nucleus increases.

D number of occupied energy levels decreases. (2)

1.6 Each of the substances below is formed by attractive forces between two ions.

In which ONE of the substances do the constituent ions have the same electron configuration?

A KBr

B Na_2S

C $MgC\ell_2$

D $CaC\ell_2$ (2)

1.7 In which ONE of the following is the structure correctly linked to the given element?

	ELEMENT	**STRUCTURE**
A	Lithium	Covalent
B	Iodine	Molecular
C	Sulphur	Ionic
D	Carbon	Metallic

(2)

1.8 Which ONE of the following balanced equations represents a dissociation process?

A $K^+(aq) + C\ell^-(aq) \rightarrow KC\ell(s)$

B $NaC\ell(s) \rightarrow Na^+(aq) + C\ell^-(aq)$

C $Zn(s) + 2HC\ell(aq) \rightarrow ZnC\ell_2(aq) + H_2(g)$

D $NaC\ell(aq) + AgNO_3(aq) \rightarrow NaNO_3(aq) + AgC\ell(s)$ (2)

1.9 Which ONE of the following represents 1 mole of a substance?

A 16 g oxygen gas

B 2 g hydrogen gas

C 22,4 dm^3 copper

D 22,4 cm^3 nitrogen gas (2)

1.10 The empirical formula of a certain carbon compound is CH_2O.

Which ONE of the following can be the molecular formula of this compound?

A C_2H_6O

B C_3H_6O

C $C_2H_4O_2$

D $C_2H_6O_2$ (2)

[20]

QUESTION 2 (Start on a new page.)

Grade 10 learners were given the substances in the table below.

brass	sand	oxygen gas	sugar	carbon dioxide
copper	pure air	salt solution	table salt	magnesium oxide

2.1 From the above table, write down:

2.1.1 An element (1)

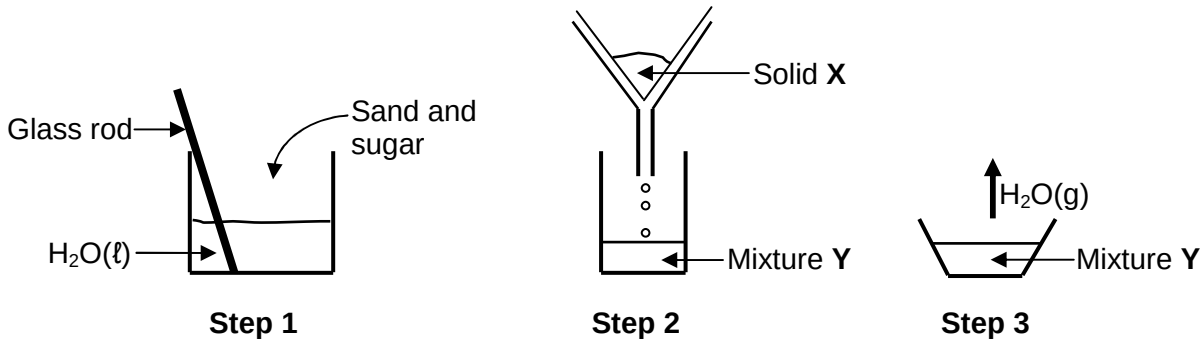
2.1.2 A homogeneous mixture (1)

2.1.3 A diatomic gas (1)

2.1.4 A compound which is a solid at 25 °C (1)

2.1.5 A heterogeneous mixture (1)

2.2 The learners perform an experiment to separate a mixture of sand and sugar. The experiment is done in three steps, as shown in the diagrams below.



Step 1 **Step 2** **Step 3**

2.2.1 Write down the name of:

(a) The process illustrated in **step 2** (1)

(b) The process illustrated in **step 3** (1)

(c) Solid **X** (1)

(d) Mixture **Y** (1)

2.2.2 Is **step 3** a CHEMICAL or PHYSICAL process? Give a reason for the answer. (2)
[11]

QUESTION 3 (Start on a new page.)

3.1 The table below shows the boiling and melting points of substances **A** to **D**.

SUBSTANCE	BOILING POINT (°C)	MELTING POINT (°C)
A	78	–117
B	444	133
C	–188	–220
D	184	90

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

3.1.2 From the above table, write down the LETTER (A–D) that represents the substance which is a:

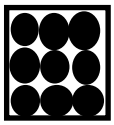
(a) Liquid at 100 °C (1)

(b) Solid at 100 °C (1)

(c) Gas at 25 °C (1)

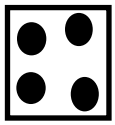
3.1.3 Which ONE of the following diagrams represents the PARTICLE ARRANGEMENT of substance **A** at –120 °C? Write down only I, II or III.

I



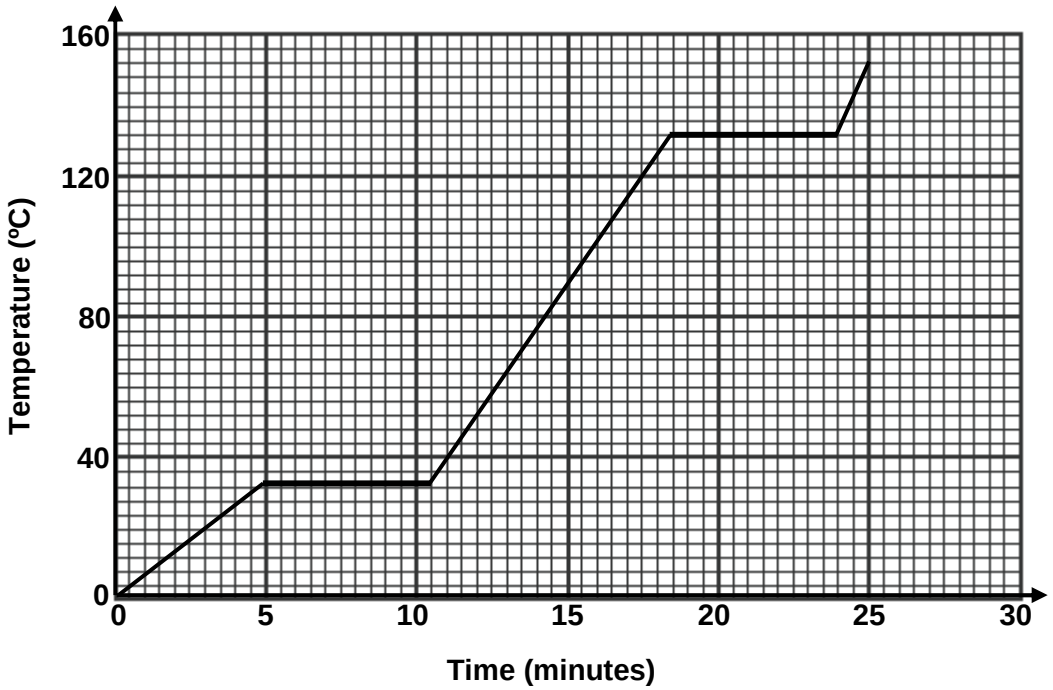
II

III



(1)

3.2 The heating curve of a substance is shown below.



3.2.1 Write down the physical state of the substance at t = 15 minutes. (1)

3.2.2 What is the boiling point of the substance? (1)

3.2.3 How will the average kinetic energy of the particles of the substance be affected between:

(Write down only INCREASES, DECREASES or REMAINS THE SAME.)

(a) t = 0 minutes and t = 5 minutes (1)

(b) t = 5 minutes and t = 10 minutes (1)

3.2.4 Refer to the kinetic molecular theory to fully explain the answer to QUESTION 3.2.3(b). (3)
[13]

QUESTION 4 (Start on a new page.)

Chlorine is a non-metallic element with an atomic number of 17 and can exist as isotopes.

4.1 Define the term:

4.1.1 Atomic number (2)

4.1.2 Isotope (2)

4.2 Natural chlorine consists of Cℓ-35 and Cℓ-37.

4.2.1 Write down the sp-notation for Cℓ-37. (2)

4.2.2 The relative atomic mass of chlorine is 35,5. Calculate the percentage of Cℓ-35 in natural chlorine. (3)

4.3 Chlorine gas ($C\ell_2$) consists of molecules.

Write down the:

4.3.1 Number of valence electrons in a chlorine atom (1)

4.3.2 Type of bonding in chlorine molecules (1)

4.3.3 Lewis structure for the chlorine molecule (2)

4.4 Calcium reacts with chlorine to form calcium chloride.

4.4.1 Draw the Aufbau diagram for a calcium ion. (3)

4.4.2 Write down the chemical symbols of the particles found in the calcium chloride crystal (lattice). (2)
[18]

QUESTION 5 (Start on a new page.)

5.1 The first ionisation energy and the electron affinity of the period 3 elements are shown in the table below.

ELEMENT	FIRST IONISATION ENERGY ($kJ \cdot mol^{-1}$)	ELECTRON AFFINITY ($kJ \cdot mol^{-1}$)
Sodium	496	53
Magnesium	738	0
Aluminium	578	44
Silicon	786	134
Phosphorous	1 012	72
Sulphur	1 000	200
Chlorine	1 251	349
Argon	1 521	0

5.1.1 Explain the difference between *ionisation energy* and *electron affinity*. (2)

5.1.2 Give a reason for the trend in the first ionisation energy as shown in the table. (1)

5.1.3 How will the SECOND ionisation energy of sodium compare to that of magnesium? Write down only HIGHER THAN, LOWER THAN or EQUAL TO. Explain the answer. (3)

5.1.4 Calculate the energy that will be needed to ionise 46 g of Na(g). (3)

5.1.5 Which ONE of the above elements has the greatest tendency to from negative ions? Refer to the data in the table to give a reason for the answer. (2)

5.2 Study the substances (A–E) in the table below and answer the questions that follow.

	SUBSTANCE
A	Sulphur powder
B	Sodium chloride crystals
C	Copper wire
D	CO_2(s) [dry ice]
E	A diamond

5.2.1 Write down the LETTER(S) that represent(s):

(a) A substance with a giant atomic lattice (1)

(b) A substance with a lattice consisting of positive ions and delocalised valence electrons (1)

(c) TWO substances with intermolecular forces between particles (2)

5.2.2 Use Lewis structures to show the formation of substance **B**. (4)

5.2.3 Substance **D** undergoes SUBLIMATION. Represent this change with a chemical equation. (2)
[21]

QUESTION 6 (Start on a new page.)

Magnesium ribbon burns in oxygen with a bright white flame to produce a white solid, magnesium oxide.

6.1 Name the type of chemical bonding in:

6.1.1 Magnesium ribbon (1)

6.1.2 Magnesium oxide (1)

6.2 Is the reaction between magnesium ribbon and oxygen a PHYSICAL or CHEMICAL change? Give a reason for the answer. (2)

6.3 Write down a balanced equation for the reaction between magnesium and oxygen. (3)

6.4 Use the law of conservation of mass to show that mass is conserved during the reaction in QUESTION 6.3. (4)
[11]

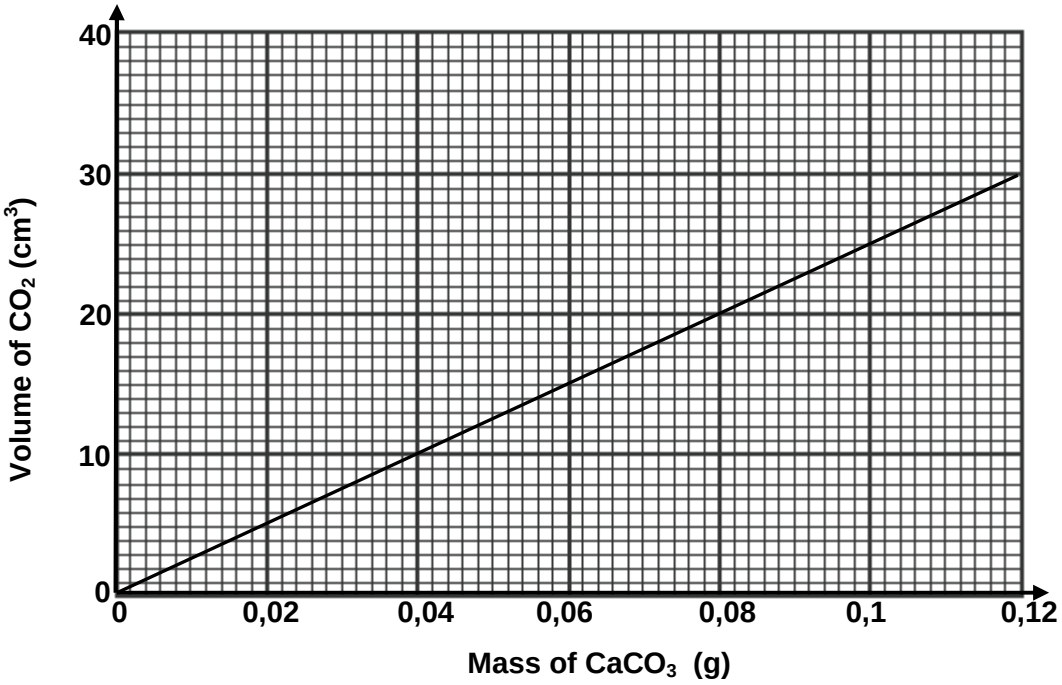
QUESTION 7 (Start on a new page.)

Calcium carbonate, $CaCO_3$, reacts with dilute hydrochloric acid, HCℓ, according to the following balanced equation:

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

7.1 The above reaction is an example of an acid-base reaction. Define the term *acid-base reaction*. (2)

The graph below shows the relationship between the volume of carbon dioxide gas, $CO_2(g)$ formed and the mass of PURE calcium carbonate.



7.2 From the graph, determine the volume of $CO_2(g)$ produced when 0,072 g of PURE $CaCO_3(s)$ reacts. (1)

7.3 A certain antacid tablet, with a mass of 0,25 g, contains mainly calcium carbonate which reacts with dilute hydrochloric acid in the stomach to produce carbon dioxide gas.

The concentration of hydrochloric acid in the stomach is 0,1 $mol \cdot dm^{-3}$.

7.3.1 Define the term *concentration of a solution.* (2)

7.3.2 It is found that 25 cm^3 of $CO_2(g)$ is formed when one antacid tablet completely reacts.

Use the information in the graph and calculate the percentage $CaCO_3(s)$ in one antacid tablet. (3)

7.3.3 Calculate the volume of hydrochloric acid that will be neutralised by ONE antacid tablet. (5)

[13]

QUESTION 8 (Start on a new page.)

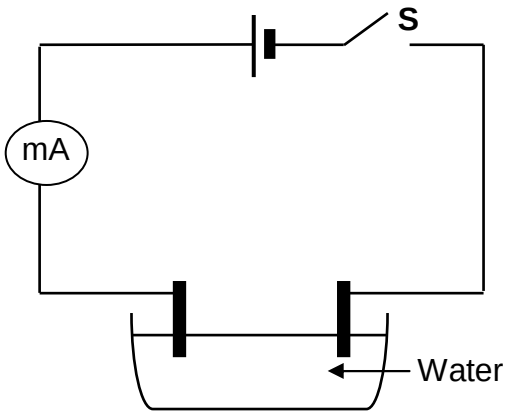
8.1 Many chemical reactions take place in aqueous solutions. Define the term *aqueous solution.* (1)

8.2 Ionic solids dissociate when dissolved in water.

8.2.1 Define the term *dissociation.* (2)

8.2.2 Write down a balanced equation for the dissociation of ammonium carbonate, $(NH_4)_2CO_3$, in water. (3)

8.3 The experimental setup below is used to compare the electrical conductivity of a calcium chloride solution, $CaC\ell_2(aq)$, and a sodium chloride solution, $NaC\ell(aq)$. The concentration of each solution is 0,5 $mol \cdot dm^{-3}$.



The $CaC\ell_2(aq)$ is added drop by drop to water and the ammeter reading is recorded after the addition of each drop. The procedure is then repeated with the $NaC\ell(aq)$. The results are shown in the table below.

NUMBER OF DROPS OF SOLUTION	AMMETER READING (mA)	
	$CaC\ell_2(aq)$	$NaC\ell(aq)$
0	0,18	0,18
1	0,55	0,34
2	0,92	0,55
3	1,29	0,74
4	1,47	0,92
5	1,84	1,1
6	2,21	1,29
7	2,39	1,47

8.3.1 Identify the:

(a) Dependent variable (1)

(b) Independent variable (1)

8.3.2 From the results, deduce the relationship between the ion concentration in a solution and its conductivity. (1)

8.3.3 Use balanced chemical equations to explain why $CaC\ell_2(aq)$ is a stronger electrolyte than $NaC\ell(aq)$. (4)

8.4 Indicate the type of reaction represented by each of the following equations. Write down only PRECIPITATION, REDOX or GAS FORMING.

8.4.1 $Zn(s) + CuSO_4(aq) \rightarrow Cu(s) + ZnSO_4(aq)$ (1)

8.4.2 $Zn(s) + 2HC\ell(aq) \rightarrow ZnC\ell_2(aq) + H_2(g)$ (1)

8.4.3 $Na_2CO_3(aq) + BaC\ell_2(aq) \rightarrow 2NaC\ell(aq) + BaCO_3(s)$ (1)

8.5 Write down a balanced chemical equation for the following word equation:

Nitric acid + copper → copper(II) nitrate + water + nitrogen dioxide (3)

[19]

QUESTION 9 (Start on a new page.)

9.1 Hydrogen, $H_2(g)$, and nitrogen, $N_2(g)$, react to form ammonia, $NH_3(g)$. The reaction that takes place is represented by the following equation:

$$N_2(g) + 3H_2(g) \rightarrow 2NH_3(g)$$

9.1.1 Define the term *1 mole.* (2)

9.1.2 How many moles of ammonia will be produced from 1 mole of hydrogen gas? (1)

9.1.3 Initially 10 cm^3 of nitrogen and 24 cm^3 of hydrogen are mixed in a container. The temperature and pressure remain constant.

Calculate the volume of gas that will remain in the container after the reaction is completed. (4)

In another experiment, 80 g of hydrogen gas reacts with nitrogen gas to form ammonia.

Calculate the:

9.1.4 Number of moles of hydrogen gas reacted (2)

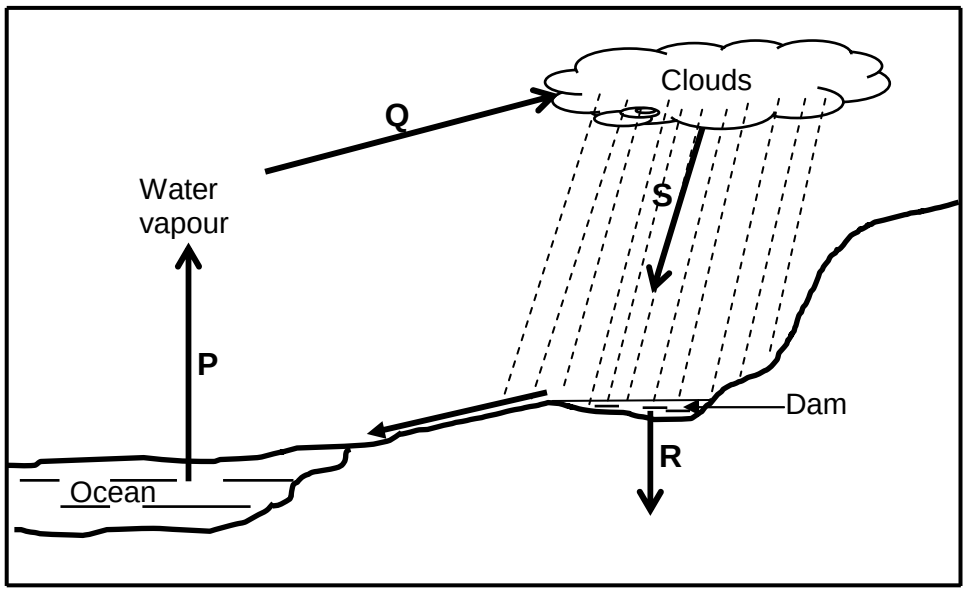
9.1.5 Volume of the nitrogen gas used at STP (2)

9.2 When 207 g of lead, Pb, combines with oxygen, 239 g of a certain oxide of lead is formed. Use a calculation to determine the formula of this oxide of lead. (5)

[16]

QUESTION 10 (Start on a new page.)

The water cycle in the diagram below links the hydrosphere to the other global systems. The letters **P**, **Q**, **R** and **S** indicate some of the processes which take place in the water cycle.



10.1 Briefly explain the term *hydrosphere*. (1)

10.2 Name the processes labelled:

10.2.1 **P** (1)

10.2.2 **Q** (1)

10.2.3 **R** (1)

10.2.4 **S** (1)

10.3 Write down ONE advantage of process **R**. (1)

10.4 The building of dams has several advantages for humans and the environment. State TWO of these advantages. (2)
[8]

TOTAL: 150

DATA FOR PHYSICAL SCIENCES GRADE 10
PAPER 2 (CHEMISTRY)

GEGEWENS VIR FISIESE WETENSKAPPE GRAAD 10
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

TABLE 2: FORMULAE/*TABEL 2: FORMULES*

$n = \frac{m}{M}$	$n = \frac{N}{N_A}$
$c = \frac{n}{V}$ OR $c = \frac{m}{MV}$	$n = \frac{V}{V_m}$

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**

KEY/*SLEUTEL*