education

MPUMALANGA PROVINCE

REPUBLIC OF SOUTH AFRICA

NATIONAL SENIOR CERTIFICATE

GRADE 12

NKANGALA DISTRICT



PHYSICAL SCIENCES

17 MARCH 2023

MARKS: 100

TIME: 2 hours

This question paper consists of 13 pages and 3 data sheets.

INSTRUCTIONS AND INFORMATION

1. Write your name and class (for example 12 A) in the appropriate spaces on the FOLIO PAPER.
2. This question paper consists of 7 questions. Answer ALL the questions in the FOLIO PAPERS.
3. Start EACH question on a NEW page in the FOLIO PAPERS.
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 calculator.
7. You may use appropriate mathematical instruments.
8. You are advised to use the attached DATA SHEET.
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

Various options are provided as possible answers to the following questions. Each question has only ONE correct answer. Choose the correct answer and write only the letter (A–D) next to the question number (1.1–1.6) in the FOLIO PAPER, for example 1.11 E.

1.1 A ball is projected vertically upwards. Ignore air resistance.

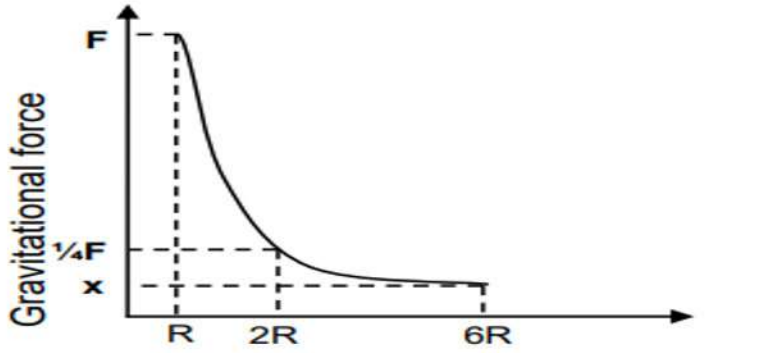
Which ONE of the following statements about the acceleration of the ball at its maximum height is CORRECT?

The acceleration is equal to …

A zero.
B g and is directed downwards.
C g and is directed upwards.
D g and is directed horizontally. (2)

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1.2 The graph below, not drawn to scale, shows the relationship between the gravitational force on a given mass and its distance from the centre of Earth.
The magnitude of the force on the mass at a distance R from the centre of Earth is F.



Which ONE of the following is the CORRECT representation of the magnitude of force x shown on the graph?

A 6F

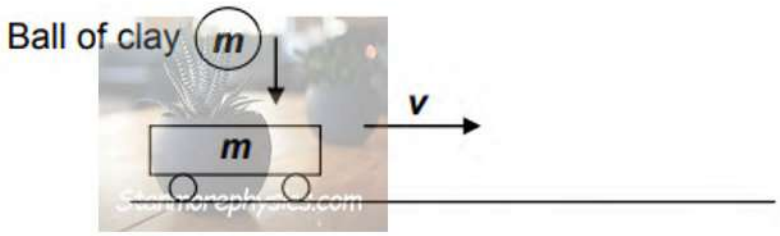
B 36F

C $\frac{1}{6}$F

D $\frac{1}{36}$F (2)

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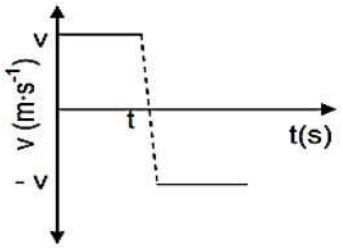
1.3 A trolley of mass *m* is moving at constant velocity *v* to the right on a frictionless horizontal surface. A ball of clay, also of mass *m*, dropped vertically, falls onto the trolley at time *t*, as shown in the diagram below.



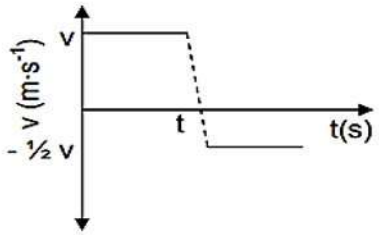
The ball of clay sticks to the trolley.

Which ONE of the velocity-time graphs below CORRECTLY represents the velocity of the trolley before and after time *t*?

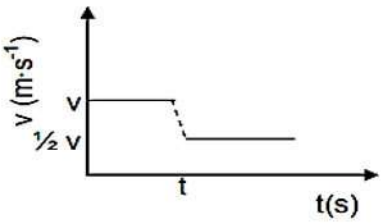
A



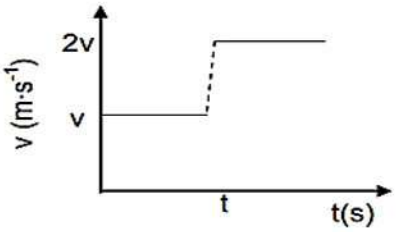
B



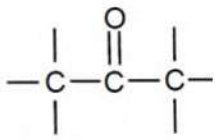
C



D



1.4 Study the structural formula of the functional group below.



The structure above is the functional group of …

A	Esters	B	Ketones
C	Aldehyde	D	Carboxylic acids

(2)

1.5 Which ONE of these compounds has the highest vapour pressure at room temperature?

A Propane
B Ethanol
C Ethanal
D Fluoroethane (2)

1.6 When butane is subjected to high temperatures and pressures, the following reaction takes place:

Octane → Pentane + Y

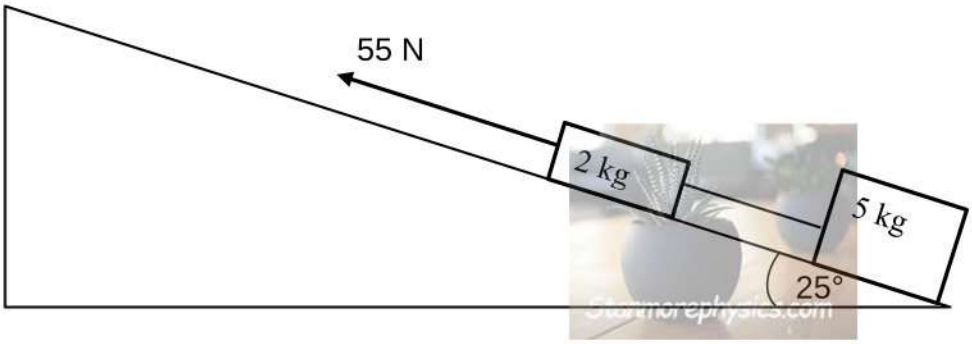
Which ONE of the following represents Y?

A $CHCCH_3$
B CH_2CHCH_3
C $CH_3CH_2CH_3$
C $CH_3CHCHCH_3$ (2)

[12]

QUESTION 2

A block of mass 2 kg is connected to another block of mass 5 kg by a light inextensible string. Both blocks are on an inclined plane of 25° to the horizontal. The 2 kg is pulled by a constant force of 55 N parallel to the plane as shown in the diagram below. The magnitude of the kinetic frictional force between the surface and the 5 kg block is 14,21 N. The coefficient of kinetic friction between the 2 kg block and the surface is 0,32.



2.1 Define the term ***normal force***. (2)

2.2 Draw a labelled free-body diagram showing ALL the forces acting on the 2 kg block as it moves up the inclined plane. (5)

2.3 Calculate the magnitude of the:

2.3.1 Kinetic frictional force between the 2 kg block and the surface. (3)

2.3.2 Tension in the string connecting the two blocks. (6)

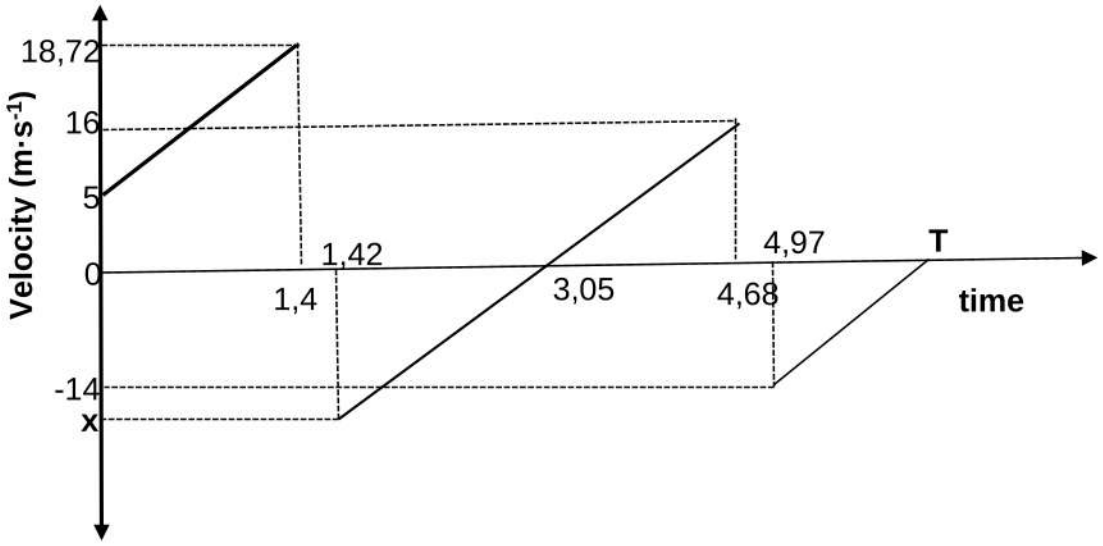
[16]

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QUESTION 3

A ball is thrown vertically downwards from the top of a building and bounces a few times as it hits the ground. The velocity-time graph below describes the motion of the ball from the time it is thrown, up to a certain time T. Take **downwards** as the positive direction and the ground as zero reference. The graph is NOT drawn to scale. The effects of air friction are ignored.

VELOCITY-TIME GRAPH



3.1 Define the term *free fall*. (2)

3.2 Calculate the height from which the ball is thrown. (3)

3.3 Calculate the time (T) shown on the graph. (3)

3.4 Write down the value of **x.** (1)

3.5 Calculate the maximum height reached by the ball after the first bounce. (3)

3.6 Sketch the position-time graph for the complete motion of the ball. Take GROUND as ZERO POSITION. Clearly show the following on the graph:

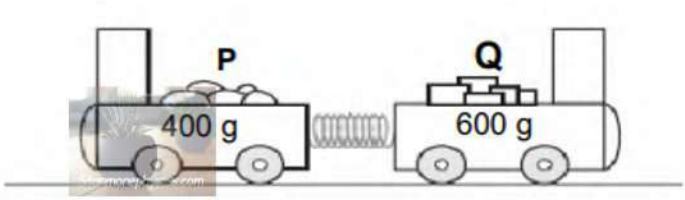
- The height from which the ball was thrown.
- The maximum height reached by the ball after the first bounce.
- The time T. (5)

[17]

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QUESTION 4

The diagram shows two trolleys, P and Q, held together by means of a compressed spring on a flat, frictionless horizontal track. The masses of P and Q are 400 g and 600 g respectively. When the trolleys are released, it takes 0,32 s for the spring to unwind to its natural length. Trolley Q then moves to the right at 4.5 $m \cdot s^{-1}$.



4.1 State the *principle of conservation of linear momentum* in words. (2)

4.2 Calculate the velocity of trolley P after the trolleys are released. (4)

4.3 Calculate the magnitude of the average force exerted by the spring on trolley Q. (4)

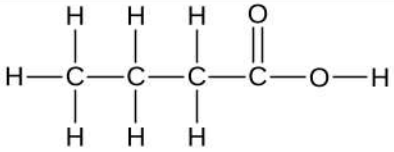
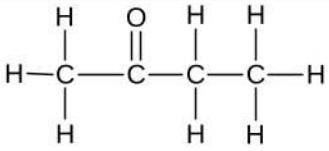
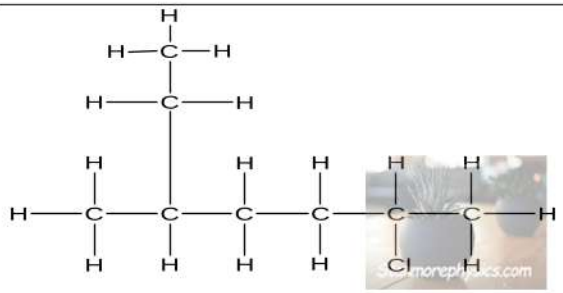
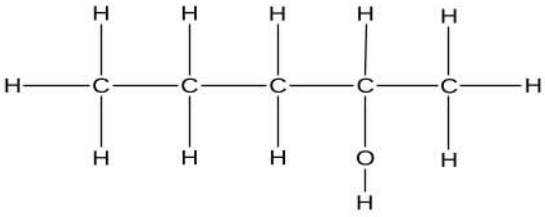
4.4 How does the magnitude of the force calculated in QUESTION 4.2 compare to the magnitude of the force exerted by the spring on trolley P? Write down only LARGER THAN, SMALLER THAN or THE SAME. (1)

[11]

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QUESTION 5

The letters **A** to **H** in the table below represent eight organic compounds.

A	$CH_3C(CH_3)_2CH_2CH_3$	B	$CH_3CHCHCH_2CH_3$
C		D	
E		F	
G	Methyl propanoate	H	Propanal

5.1 Is compound B SATURATED or UNSATURATED? Give reason for the answer. (2)

5.2 Write down the LETTER(S) that represents EACH of the following:

5.2.1 An aldehyde. (1)

5.2.2 A compound with the general formula C_nH_{2n}. (1)

5.2.3 Two compounds that are FUNCTIONAL isomers. (1)

5.2.4 A ketone. (1)

5.3 Write down the IUPAC name of:

5.3.1 Compound A . (3)

5.3.2 Compound E. (3)

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5.4 Write down the STRUCTURAL FORMULA of:

5.4.1 Compound G. (2)

5.4.2 Positional isomer of compound F. (2)

[16]

QUESTION 6

A laboratory technician is provided with three unmarked bottles containing an ALCOHOL, ALDEHYDE and ALKANE with similar molecular mass. She takes a sample from each bottle and labels them X, Y and Z. To identify each compound, she determines the boiling point under the same conditions. The results are in the table below.

SAMPLE	BOILING POINT
X	76 °C
Y	36 °C
Z	118 °C

(2)

6.1 Define the term *boiling point.*

6.2 Write down the letter that represent the compound with the lowest vapour pressure. (1)

6.3 Give a reason for the answer in QUESTION 6.2. (2)

6.4 Copy the letters X, Y and Z and write down the homologous series that is represent by each letter. (3)

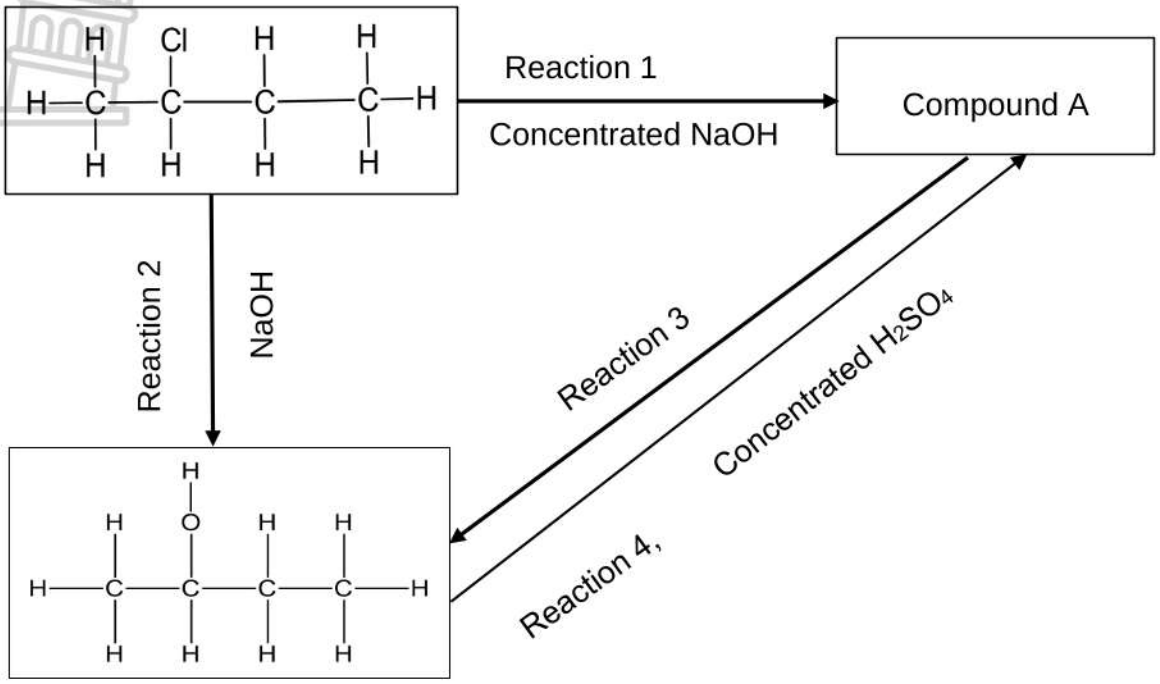
6.5 Refer to THE TYPE OF INTERMOLECULAR FORCES present in each compound and FULLY explain how you arrived at the answer given in QUESTION 6.4. (4)

[12]

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QUESTION 7

7.1 2-chlorobutane undergoes two different reactions, as shown in the diagram below.



Write down the type of reaction represented by:

7.1.1 Reaction 1. (1)

7.1.2 Reaction 2. (1)

7.1.3 Reaction 3. (1)

7.1.4 Reaction 4. (1)

For reaction 1 write down the:

7.1.5 IUPAC Name of organic compound A. (2)

7.1.6 Structural formula of organic compound A. (2)

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7.1.7 Reaction condition other than concentrated NaOH. (1)

For reaction 2 write down the:

7.1.8 Two reaction conditions. (2)

For reaction 4 write down the:

7.1.9 Function of H_2SO_4. (1)

7.2 Alkanes are used as a FUEL.

7.2.1 Write down the property of alkanes that is responsible for them to be used as a fuel. (1)

7.2.2 Using molecular formula write down the balanced combustion reaction of propane. (3)

[16]

GRAND TOTAL: 100

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4.2 Information sheets – Paper 1 (Physics)

TABLE 1: PHYSICAL CONSTANTS

NAME	SYMBOL	VALUE
Acceleration due to gravity	g	$9,8\ m\cdot s^{-2}$
Universal gravitational constant	G	$6,67 \times 10^{-11}\ N\cdot m^2\cdot kg^{-2}$
Radius of earth	R_E	$6,38 \times 10^{6}\ m$
Mass of earth	M_E	$5,98 \times 10^{24}\ kg$
Speed of light in a vacuum	c	$3,0 \times 10^{8}\ m\cdot s^{-1}$
Planck's constant	h	$6,63 \times 10^{-34}\ J\cdot s$
Coulomb's constant	k	$9,0 \times 10^{9}\ N\cdot m^2\cdot C^{-2}$
Charge on electron	e	$-1,6 \times 10^{-19}\ C$
Electron mass	m_e	$9,11 \times 10^{-31}\ kg$

TABLE 2: FORMULAE

MOTION

$v_f = v_i + a\Delta t$	$\Delta x = v_i\Delta t + \frac{1}{2}a\Delta t^2$ OR $\Delta y = v_i\Delta t + \frac{1}{2}a\Delta t^2$
$v_f^2 = v_i^2 + 2a\Delta x$ OR $v_f^2 = v_i^2 + 2a\Delta y$	$\Delta x = \left(\frac{v_f + v_i}{2}\right)\Delta t$ OR $\Delta y = \left(\frac{v_f + v_i}{2}\right)\Delta t$

FORCE

$F_{net} = ma$	$p = mv$
$F_{net}\Delta t = \Delta p$ $\Delta p = mv_f - mv_i$	$w = mg$
$F = \frac{Gm_1m_2}{r^2}$	$g = \frac{Gm}{r^2}$
$f_s^{max} = \mu_s N$	$f_k = \mu_k N$

WORK, ENERGY AND POWER

$W = F\Delta x\cos\theta$	$U = mgh$ or/*of* $E_P = mgh$
$K = \frac{1}{2}mv^2$ or/*of* $E_k = \frac{1}{2}mv^2$	$W_{net} = \Delta K$ or/*of* $W_{net} = \Delta E_k$ $\Delta K = K_f - K_i$ or/*of* $\Delta E_k = E_{kf} - E_{ki}$
$W_{nc} = \Delta K + \Delta U$ OR $W_{nc} = \Delta E_k + \Delta E_p$	
$P = \frac{W}{\Delta t}$	$P = Fv$

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4.3 Information sheets – Paper 2 (Chemistry)

TABLE 1: PHYSICAL CONSTANTS

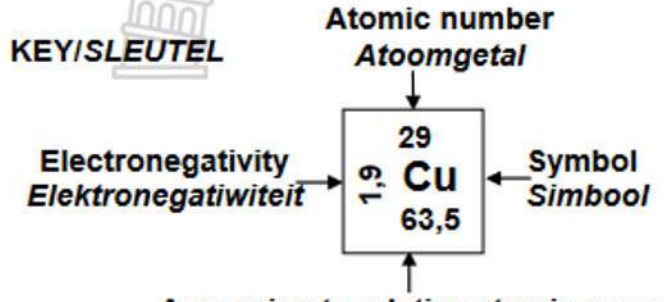
NAME	SYMBOL	VALUE
Standard pressure	p^θ	$1{,}013 \times 10^5$ Pa
Molar gas volume at STP	V_m	22,4 $dm^3 \cdot mol^{-1}$
Standard temperature	T^θ	273 K
Charge on electron	e	$-1{,}6 \times 10^{-19}$ C
Avogadro's constant	N_A	$6{,}02 \times 10^{23}$ mol^{-1}

TABLE 2: FORMULAE

$n = \frac{m}{M}$	$n = \frac{N}{N_A}$
$c = \frac{n}{V}$ OR $c = \frac{m}{MV}$	$n = \frac{V}{V_m}$
$\frac{c_a V_a}{c_b V_b} = \frac{n_a}{n_b}$	$pH = -\log[H_3O^+]$
$K_w = [H_3O^+][OH^-] = 1 \times 10^{-14}$ at 298 K	
$E^\theta_{cell} = E^\theta_{cathode} - E^\theta_{anode}$ $E^\theta_{cell} = E^\theta_{reduction} - E^\theta_{oxidation}$ $E^\theta_{cell} = E^\theta_{oxidisingagent} - E^\theta_{reducingagent}$	

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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																	2 **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**