LIMPOPO
PROVINCIAL GOVERNMENT
REPUBLIC OF SOUTH AFRICA

DEPARTMENT OF
EDUCATION

NATIONAL
SENIOR CERTIFICATE

GRADE 12

PHYSICAL SCIENCES
CONTROL TEST
13 MARCH 2024

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MARKS: 100

TIME: 2 HOURS

THIS QUESTION PAPER CONSISTS OF 12 PAGES AND 2 DATA SHEETS

INSTRUCTIONS AND INFORMATION

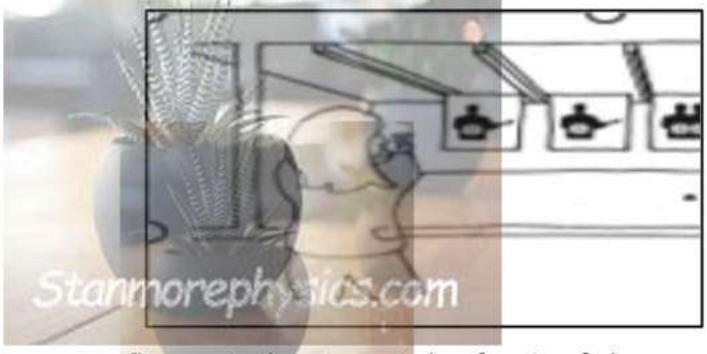
1. Write your name and other information in the appropriate spaces on the ANSWER SHEET/BOOK.
2. This question paper consists of SEVEN questions. Answer ALL questions in the ANSWER SHEET/BOOK.
3. Number the answers correctly according to the numbering system used in this question paper.
4. Leave one line between two sub-questions, for example between QUESTION 2.1 and QUESTION 2.2.
5. You may use a non-programmable pocket calculator.
6. You are advised to use the attached DATA SHEETS.
7. Show ALL formulae and substitutions in ALL calculations.
8. Round off your FINAL numerical answers to a minimum of TWO decimal places where applicable.
9. Give brief motivations, discussions, et cetera where required.
10. Write neatly and legibly.

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QUESTION 1

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 SHEET/BOOK.

1.1 The diagram below shows a woman at a shooting range.



The woman fires at the target in front of her and immediately involuntarily sways backwards due to the shot taken. Which Physics law can be used to explain why the woman sways backwards after taking a shot?

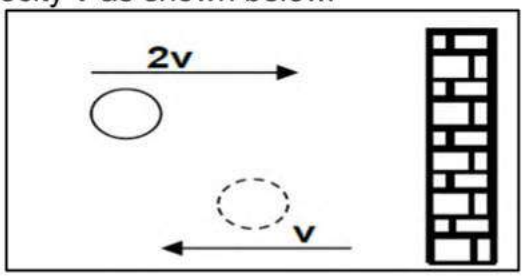
A Newton's law of universal gravitation

B Newton's second law of motion

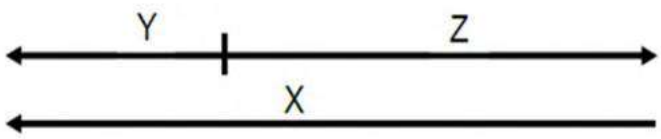
C Newton's third law of motion

D Newton's first law of motion (2)

1.2 A 10 *g* tennis ball travelling at velocity **2v** to the right strikes the wall and bounces with velocity **v** as shown below.



The vector diagram (not drawn to scale) representing the initial, final and change in momentum of the ball is indicated below with letters **X**, **Y** and **Z**.



Which of the vectors **X**, **Y** and **Z** represents the final momentum of the tennis ball?

A X
B Y
C Z
D Both X and Y (2)

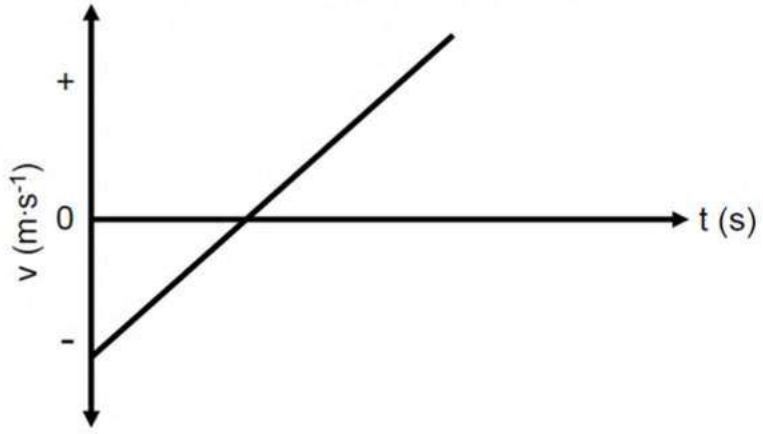
1.3 A bus with mass *5m* collides head-on with a car of mass *m*. The bus experiences a change in momentum of **x** kg·m·s^{-1} east due to the collision with the car. What is the change in momentum experienced by the car due to the collision with the bus?

A **x** kg·m·s^{-1}, east
B **x** kg·m·s^{-1}, west
C 5**x** kg·m·s^{-1}, east
D 5**x** kg·m·s^{-1}, west (2)

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1.4 A velocity versus time graph describing the motion of a projectile is drawn below. Refer to the graph to answer QUESTION 1.4 and 1.5.

Graph of velocity versus time



Which ONE of the following combinations is TRUE for the direction of the initial motion and gravitational acceleration of this projectile?

	INITIAL MOTION OF THE PROJECTILE	GRAVITATIONAL ACCELERATION (m·s^{-2})
A	Upwards	-9,8
B	Downwards	-9,8
C	Upwards	+9,8
D	Downwards	+9,8

(2)

1.5 Which physical quantity can be calculated using the area under the graph?

A Speed

B Velocity

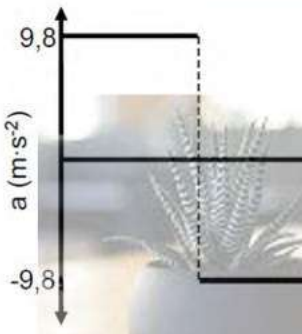
C Distance

D Displacement (2)

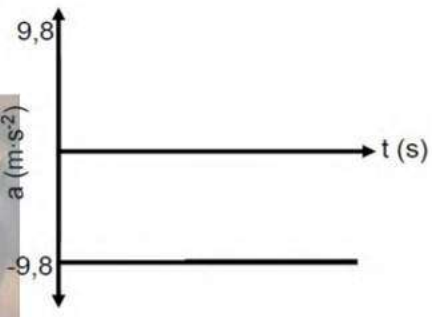
1.6 A ball is thrown towards the floor with velocity ***v*** from the top of a high building. The contact time of the ball with the ground is negligible. Ignore the effects of air resistance.

Which ONE of the following acceleration versus time graphs correctly represents the motion of the ball from the time it is thrown until it reaches a maximum height after it bounced off the floor? UPWARDS IS TAKEN AS POSITIVE.

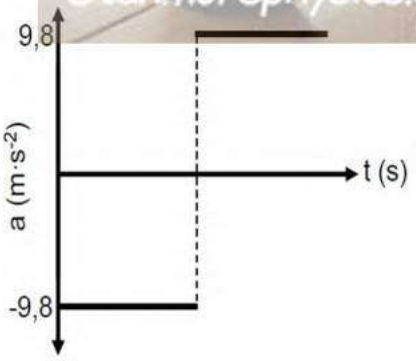
A



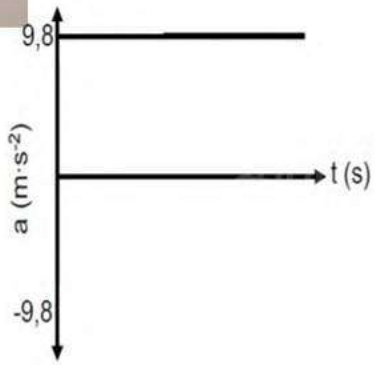
B



C



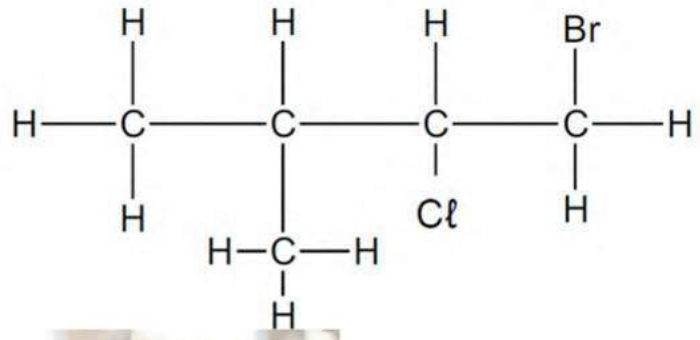
D



(2)

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1.7 The following is the structural formula for an organic molecule.



Which ONE of the following is the correct IUPAC name of this organic molecule?

A 1-bromo-2-chloro-3-methylbutane

B 4-bromo-3-chloro-2-methylbutane

C 2-methyl-3-chloro-4-bromobutane

D 2-methyl-4-bromo-3-chlorobutane (2)

1.8 Which ONE of the following combinations correctly indicates the STRONGEST intermolecular forces found in ethanol, ethanoic acid and ethyl ethanoate respectively?

	ETHANOL	ETHANOIC ACID	ETHYL ETHANOATE
A	Hydrogen bonds	Dipole-dipole forces	Hydrogen bonds
B	Hydrogen bonds	Hydrogen bonds	Dipole-dipole forces
C	Hydrogen bonds	Hydrogen bonds	Hydrogen bonds
D	Dipole-dipole forces	Hydrogen bonds	Dipole-dipole forces

(2)

1.9 The MELTING POINT of a compound is the ….

A Minimum temperature at which it boils.

B Maximum temperature at which it boils.

C Temperature at which its vapour pressure equals atmospheric pressure.

D Temperature at which the solid and liquid phases of a substance are at equilibrium.

(2)

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

Butane → methane + **Y**

Which ONE of the following represents **Y**?

A $CHCCH_3$

B CH_2CHCH_3

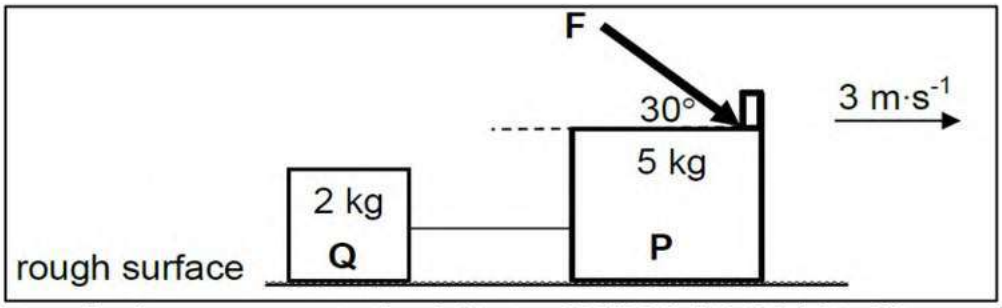
C $CH_3CH_2CH_3$

D $CH_3CHCHCH_3$ (2)

[20]

QUESTION 2

Two blocks, **P** and **Q**, resting on a rough horizontal surface, are connected by a light inextensible string. The blocks have masses 5 kg and 2 kg respectively. A constant force **F**, acting at an angle of 30° to the horizontal, is applied to the 5 kg block, as shown below:



The two blocks now move to the *right* at a CONSTANT SPEED of 3 $m \cdot s^{-1}$.

2.1 State Newton's First Law of Motion in words. (2)

2.2 Draw a labelled free-body diagram for block **P**. (5)

Block **P** and **Q** experience constant frictional forces of 2,5 N and 1 N respectively.

2.3 Calculate the magnitude of force **F**. (6)

The string connecting **P** and **Q** suddenly breaks while force **F** is still being applied.

2.4 Is the direction of the acceleration of block **Q** now towards the LEFT, or RIGHT? Explain your answer. (3)

2.5 How will the net force acting on block **P** be affected. Choose from INCREASES, DECREASES or REMAINS THE SAME. (1)

[17]

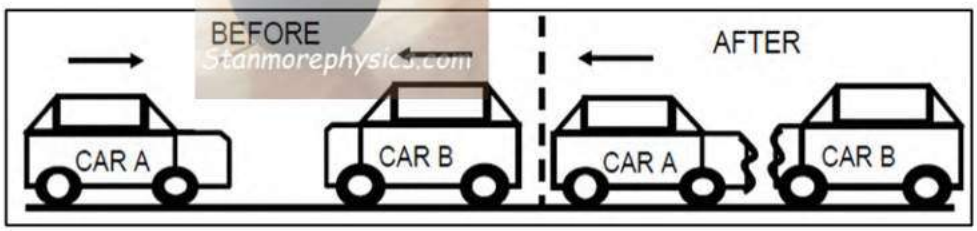
QUESTION 3

3.1 During a snooker game, two balls **X** and **Y** collide elastically. Ball **X** has a mass of 1,56 kg and travels at 3 $m \cdot s^{-1}$ in a straight line. Ball **Y** with an UNKNOWN mass was stationary before ball **X** hit it. After collision, ball **X** becomes stationery and ball **Y** moves forward at 2 $m \cdot s^{-1}$ in a straight line.

3.1.1 Explain what is meant by the term *elastic collision*. (2)

3.1.2 Calculate the mass of ball **Y** by making use of energy principles. (4)

3.2 Car **A** fitted with crumple zones collides head-on with car **B** without the crumple zones. Car **A** of mass 1 350 kg moves eastwards at 20 $m \cdot s^{-1}$ before colliding with car **B** of mass 1 500 kg moving at 10 $m \cdot s^{-1}$ westward. Immediately after the collision, car **A** moves backwards at 5 $m \cdot s^{-1}$.



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Friction can be ignored.

3.2.1 Nthabeleng, a Physical Sciences grade 12 learner at the scene, argues that "car **A**'s driver will be less injured compared to car **B**'s driver because car **A** is fitted with crumple zones". Is Nthabeleng correct? Choose from YES or NO. (1)

3.2.2 Explain the answer to QUESTION 3.2.1 (3)

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

3.2.4 Calculate the velocity of car **B** after the collision. (4)

[16]

QUESTION 4

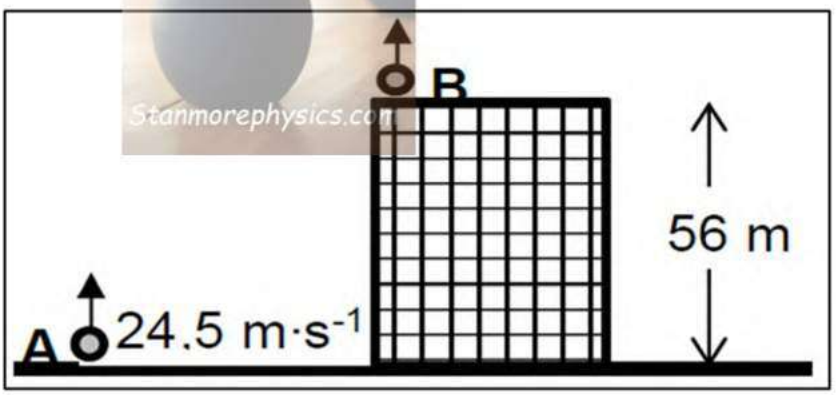
Ball **A** is projected vertically upwards from the GROUND, near a tall building, with a speed of 24,5 $m \cdot s^{-1}$. Ignore the effects of air friction.

4.1 Explain what is meant by the term *projectile*. (2)

4.2 Calculate the TOTAL time that ball **A** is in the air. (4)

4.3 Calculate the distance travelled by ball **A** during the LAST second of its fall. (4)

4.4 ONE SECOND after ball **A** is projected upwards, ball **B** is also projected vertically upwards, but from the ROOF of the building. The roof is 56 m above the ground. Both balls reach the ground at the SAME instant. Ignore the effects of air friction.



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4.4.1 Calculate the speed at which ball **B** is projected upwards from the roof. (3)

4.4.2 Calculate the speed at which ball **B** reaches the ground. (3)

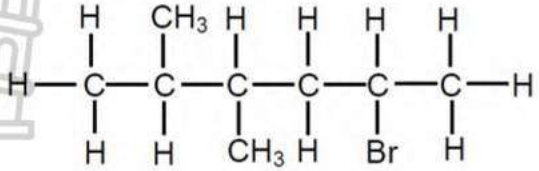
4.5 Sketch velocity-time graphs for the motion of both balls on the same set of axes. Clearly label the graphs for **A** and **B**. Indicate the following on the graphs:

- Time taken by both balls **A** and **B** to reach the ground.
- Time taken by ball **A** to reach its maximum height. (4)

[20]

QUESTION 5

The letters **A** to **E** in the table below represent five organic compounds.

A		**B**	C_3H_8O
C		**D**	Pentan-2-one
E	4-methylpent-2-yne		

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

5.1 For compound **D**, write down the:

5.1.1 Homologous series to which it belongs. (1)

5.1.2 IUPAC name of a FUNCTIONAL ISOMER. (2)

5.2 Write down the:

5.2.1 IUPAC name of compound **A.** (3)

5.2.2 STRUCTURAL FORMULA of compound **E.** (2)

5.3 Compound **B** is a primary alcohol.

5.3.1 Write down the meaning of the term *primary alcohol*. (2)

Compound **B** reacts with another organic compound **X** to form compound **C**.

Write down the:

5.3.2 Type of reaction that takes place. (1)

5.3.3 IUPAC name of compound **X.** (1)

[12]

QUESTION 6

The melting points and boiling points of four straight-chain ALKANES are shown in the table below:

COMPOUND	MELTING POINT (^{O}C)	BOILING POINT (^{O}C)
Pentane	-130	36,1
Hexane	-94	69
Heptane	-90,6	98,4
Octane	-57	125

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6.1. Write down the predominant phase of the following alkanes at -100 ^{o}C. Choose from GAS, LIQUID or SOLID.

6.1.1 Pentane (1)

6.1.2 Octane (1)

6.2 Hexane is now compared to 2,2-dimethylbutane.

6.2.1 Define term *boiling point*. (2)

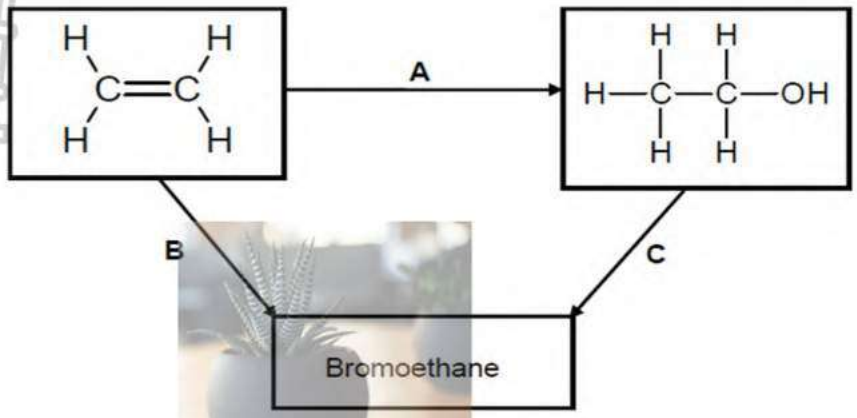
6.2.2 Is the boiling point of 2,2-dimethylbutane HIGHER THAN, LOWER THAN or EQUAL TO that of hexane? (1)

6.2.3 Fully explain the answer to QUESTION 6.2.2 (3)

[8]

QUESTION 7

Use the flow diagram below to answer the questions that follow.



7.1 Write the NAME of the TYPE of reaction represented by the following letters:

7.1.1 A (1)

7.1.2 B (1)

7.2 Apart from the alkene, another reactant and a catalyst are needed in reaction **A**. Write down the NAME or FORMULA of the:

7.2.1 Other reactant (1)

7.2.2 Catalyst (1)

7.3 Use STRUCTURAL FORMUAE to write down a balanced chemical equation for reaction **B**. (3)

[07]

TOTAL: 100 MARKS

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DATA FOR PHYSICAL SCIENCES GRADE 12 TERM ONE

TABLE ONE: PHYSICAL CONSTANTS

NAME	SYMBOL	VALUE
Acceleration due to gravity	g	9,8 m·s^{-2}
Gravitational constant	G	6,63 x 10^{-11} N·m^2·kg^{-2}
Radius of Earth	R_E	6,38 x 10^6 m
Mass of Earth	M_E	5,98 x 10^{24} kg

TABLE 2: FORMULAE

MOTION

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

FORCE

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

WORK, ENERGY AND POWER

$W = F\Delta x\cos\theta$	$U = mgh$ or $E_p = mgh$
$K = \frac{1}{2}mv^2$ or $E_k = \frac{1}{2}mv^2$	$W_{net} = \Delta K$ or $W_{net} = \Delta E_k$
$W_{nc} = \Delta K + \Delta U$ or $W_{nc} = \Delta E_k + \Delta E_p$	$P = \frac{W}{\Delta t}$
$P_{ave} = Fv_{ave}$	

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TABLE 3: PERIODIC TABLE OF ELEMENTS

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	10 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	18 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	36 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	54 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	86 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*

Atomic number
Atoomgetal

29
1,9 Cu
63,5

Electronegativity
Elektronegatiwiteit

Symbol
Simbool

Approximate relative atomic mass
Benaderde relatiewe atoommassa

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