education

Department of Education
FREE STATE PROVINCE

EXAMINATION

GRADE 11

PHYSICAL SCIENCES

JUNE 2019

MARKS: 150

TIME: 3 HOURS

This paper consists of 12 pages, one a graph paper and two information sheets.

INSTRUCTIONS AND INFORMATION

1. Write your name and other information in the appropriate spaces on the ANSWER BOOK.

2. This question paper consists of TEN 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.

QUESTION 1: MULTIPLE-CHOICE QUESTION

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 pairs contains one VECTOR and one SCALAR?

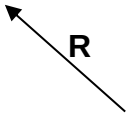
A Speed and distance

B Displacement and force

C Displacement and speed

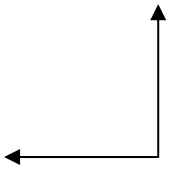
D Velocity and acceleration. (2)

1.2 Consider the resultant vector **R** represented below.

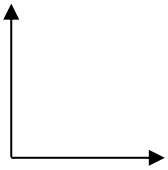


Which one of the following represents the COMPONENTS of **R**?

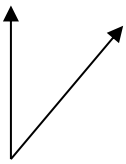
A



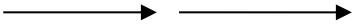
B



C

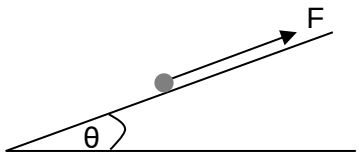


D



(2)

1.3 In the diagram below a steel ball is pulled up a rough, inclined plane at CONSTANT velocity by a force *F* that is parallel to the incline.



Which one of the following is correct if *w* and *f* represent the weight of the ball and the kinetic frictional force on the ball respectively?

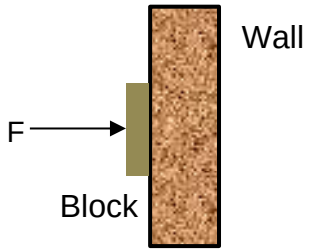
A $F = w_{//} + f$

B $F = w_{//} - f$

C $w_{//} = F + f$

D $f = F + w_{//}$ (2)

1.4 The diagram below shows a wooden block which is pressed hard against a wall by a horizontal force *F*.



Which one of the following represents an action-reaction force pair according to *Newton's third law of motion*?

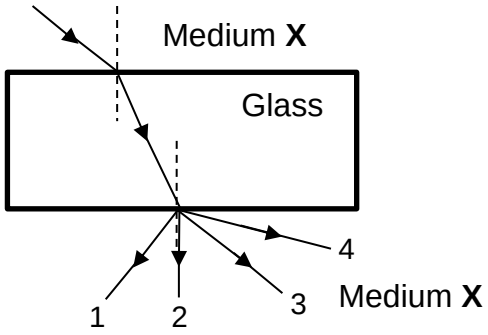
A The weight of the block and the force *F* on the block

B Force *F* on the block and the force of the block on the wall

C Force *F* on the block and the force of the wall on the block

D The force of the block on the wall and the force of the wall on the block. (2)

1.5 The diagram below represents a ray of light entering a rectangular glass block from medium **X** and emerges on the other side of the glass into medium **X**.



Which one of the following rays represents the correct *emergent* ray?

A 1

B 2

C 3

D 4 (2)

1.6 Which one of the following combinations will form a *dative covalent* bond?

A Cℓ and Cℓ

B $Cℓ^-$ and Na^+

C H_2O and $Cℓ^-$

D H_2O and H^+ (2)

1.7 What is the correct order of the bond length in the following molecules?

A HF > HCℓ > HBr

B HF < HCℓ < HBr

C HCℓ < HF < HBr

D HBr > HF > HCℓ (2)

1.8 Which one of the following molecules has no NET DIPOLE?

A $HC\ell$

B $CC\ell_4$

C H_2O

D $CH_3C\ell$ (2)

1.9 In which one of the following options are the *intermolecular forc*es arranged in order of INCREASING strength?

A Dipole-dipole forces; hydrogen bonds; London forces

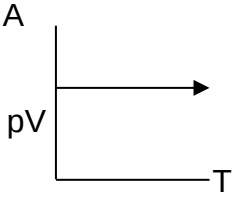
B London forces; hydrogen bonds; dipole-dipole forces

C Hydrogen bonds; London forces; dipole-dipole forces

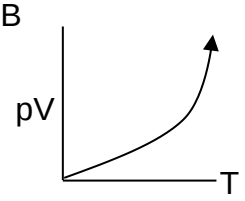
D London forces; dipole-dipole forces; hydrogen bonds (2)

1.10 Which one of the following graphs shows the correct relationship between *pV* and *T* for a mass of an ideal gas that is heated?

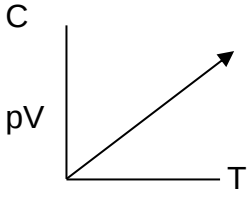
A



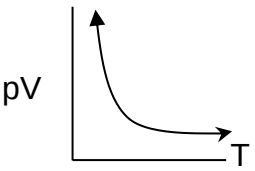
B



C



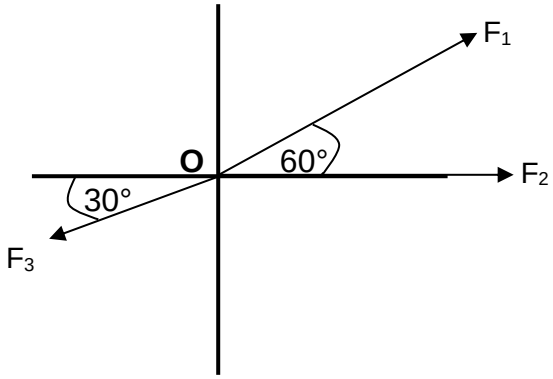
D



(2)
[20]

QUESTION 2

The diagram represents three forces that act at the same point **O** on the Cartesian plane. The magnitude of F_2 and F_3 are 20 N and 10 N respectively while the vertical and horizontal components of F_1 are 7 N and 4 N respectively.



2.1 Define the term *vector*. (2)

2.2 Calculate the following:

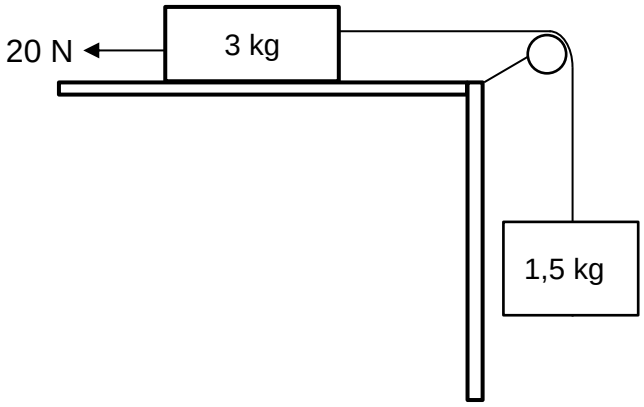
2.2.1 Magnitude of F_1 (2)

2.2.2 Vertical component of F_3 (2)

2.2.3 Magnitude of the resultant of F_1, F_2 and F_3 (5)
[11]

QUESTION 3

In the diagram a 3 kg block and a 1,5 kg block are connected by means of an inextensible rope that runs over a frictionless pulley. Ignore the masses of the rope and the pulley. A horizontal force of 20 N is applied to the 3 kg block and causes the block to accelerate to the left. Ignore the effect of the frictional force.



3.1 State *Newton's second* law of motion in words. (3)

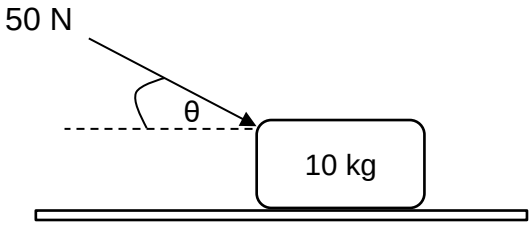
3.2 Draw a free-body diagram of ALL the forces acting on the 3 kg block. (4)

3.3 Calculate the magnitude of the:

3.3.1 Acceleration of the system (5)

3.3.2 Tension in the string (3)
[15]

QUESTION 4



A 10 kg cement block is pushed across a ROUGH, horizontal surface with a force of 50 N. The magnitude of the angle θ between the force and the horizontal is 30° and the block accelerates at 1,5 $m \cdot s^{-2}$.

4.1 Calculate the magnitude of the:

4.1.1 Normal force (4)

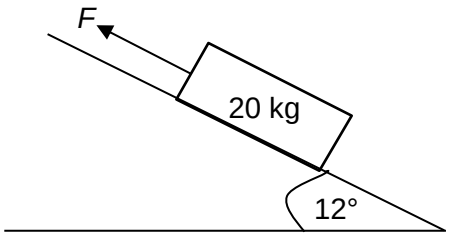
4.1.2 Frictional force (4)

4.2 How will the magnitude of the frictional force, calculated in question 4.1.2, change if angle θ decreases? Write down only INCREASES or DECREASES. (1)

4.3 Explain your answer to question 4.2. (3)

[12]

QUESTION 5



A constant force *F* of 99 N is applied to an object, mass 20 kg, on a rough, inclined plane. The inclined plane makes an angle of 12° with the horizontal and *F* is parallel to the inclined plane. The coefficient of kinetic friction is 0,3.

5.1 What kind of frictional force is acting on the object? (1)

5.2 Calculate the magnitude of the:

5.2.1 Component of the object's weight perpendicular to the inclined plane (2)

5.2.2 Acceleration of the object (5)

5.3 A small satellite, mass 250 kg, is in a circular orbit above the earth. The earth exerts a gravitational force of $2,4 \times 10^3$ N on the satellite to keep it in its orbit.

5.3.1 State *Newton's law of universal gravitation* in words. (3)

5.3.2 Calculate the height of the satellite above the surface of the earth if the average diameter of the earth is 12 800 km. (5)

[16]

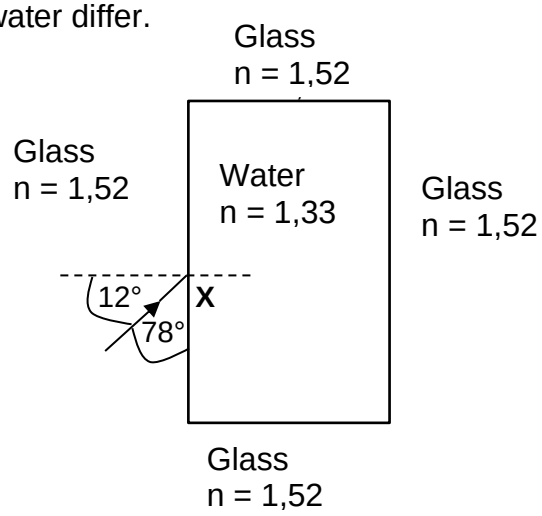
QUESTION 6

6.1 Define the following:

6.1.1 Refractive index (2)

6.1.2 Refraction (2)

6.2 In the diagram below a light ray strikes the interface between glass and water at **X**. The water has a rectangular shape. The optical densities of glass and water differ.



6.2.1 What is represented by the dotted line? (1)

6.2.2 Write down the magnitude of the *angle of incidence* at **X**. (1)

6.2.3 Redraw the diagram in your answer book and draw the path of the light ray as it moves from glass to water and then emerges from the water back into the glass. Label the following:

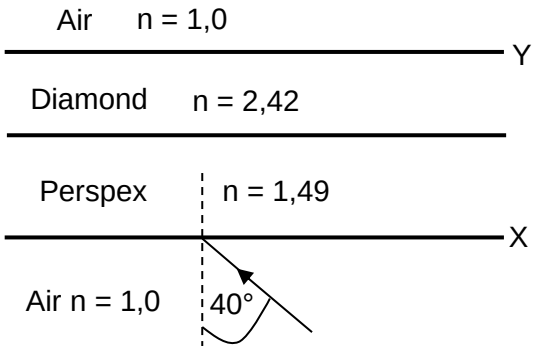
- Angle of refraction at **X**
- Emergent ray (4)

6.2.4 Use Snell's law to calculate the angle of refraction at **X**. (4)

[14]

QUESTION 7

7.1 In the diagram diamond is in contact with both air and Perspex. A ray of light enters the Perspex from air as indicated below.



7.1.1 Name the phenomenon that could possibly take place at the boundary between diamond and air, labelled **Y**, which is not possible at the boundary between air and Perspex, labelled **X**. (2)

7.1.2 Explain your answer to question 7.1.1. (2)

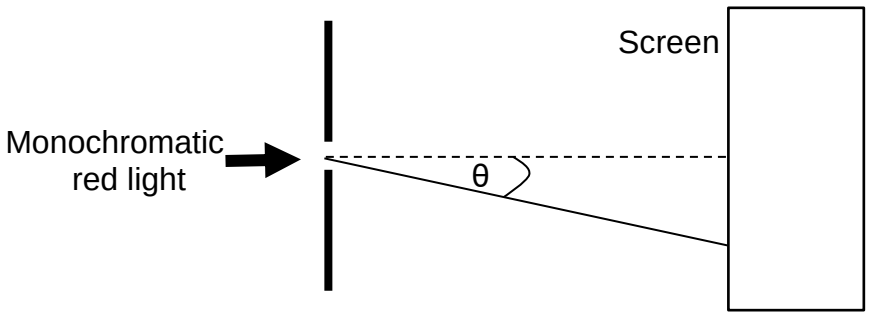
7.2 Calculate the following:

7.2.1 Speed of light in diamond (3)

7.2.2 Magnitude of the critical angle at **Y** (3)
[10]

QUESTION 8

Monochromatic red light is used to investigate diffraction. A screen is placed a certain distance from a single slit and a diffraction pattern is observed on the screen.



8.1 State *Huygens' principle* in words. (2)

8.2 Define *diffraction*. (2)

8.3 Draw the diffraction pattern that is observed; supply labels. (2)

8.4 How does each of the following changes influence the diffraction? Write down only MORE, LESS or THE SAME.

8.4.1 Red light is replaced with blue light. (2)

8.4.2 The width of the slit is increased. (2)
[10]

QUESTION 9

Consider the following molecules to answer the questions that follow.

F_2	H_2O	CH_4	$C\ell_2$	$PC\ell_5$	CO_2	PF_3

9.1 Write down the formulae of the following:

9.1.1 Two NON-POLAR molecules with bonding electrons that are EQUALLY shared by the atoms. (2)

9.1.2 Two NON-POLAR molecules with bonding electrons that are NOT EQUALLY shared by the atoms. (2)

9.2 Write down the molecular shapes of the following according to the VSEPR theory:

9.2.1 $PC\ell_5$ (2)

9.2.2 CO_2 (2)

9.3 Draw Lewis diagrams for the following molecules:

9.3.1 H_2O (2)

9.3.2 CH_4 (2)

9.4 The table below shows the boiling points of four compounds.

Compound	**Molar mass ($g \cdot mol^{-1}$)**	**Boiling point (°C)**
CH_4	16	-164
$HC\ell$	36,5	-85,05
H_2O	18	100
$NaC\ell$ (aq)	58,5	108,7

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

9.4.2 Identify the types of intermolecular forces in CH_4 and $HC\ell$. (2)

9.4.3 $NaC\ell$ (aq) has a higher boiling point than H_2O. Explain this phenomenon by referring to the STRENGTH OF THE INTERMOLECULAR FORCES and ENERGY. (4)

9.4.4 Which molecule in the table has the highest vapour pressure? (1)

9.4.5 Explain your answer to question 9.4.4. Refer to the TYPE and STRENGTH of THE INTERMOLECULAR FORCES. (2)

[23]

QUESTION 10

10.1 A fixed mass of oxygen gas (O_2) is used to verify one of the gas laws. The results are shown in the table below.

Pressure (kPa)	Volume (cm^3)
287	13
243	15
186	20
162	23

10.1.1 Use the ATTACHED GRAPH PAPER to draw a graph of pressure versus volume. (5)

10.1.2 What is the relationship between pressure and volume? Refer to the KINETIC MOLECULAR THEORY of gases to explain your answer. (3)

10.1.3 Write down TWO variables that must be kept constant during this experiment. (2)

10.1.4 Briefly explain how each of the variables you have mentioned in question 10.1.3 can be kept constant. (2)

10.1.5 Use your graph and write down the volume, in cm^3, of oxygen when the pressure is 180 kPa. (1)

10.2 Calculate the pressure exerted by 2 mol of helium gas at a volume of 0,02 cm^3 and a temperature of 30°C. (4)

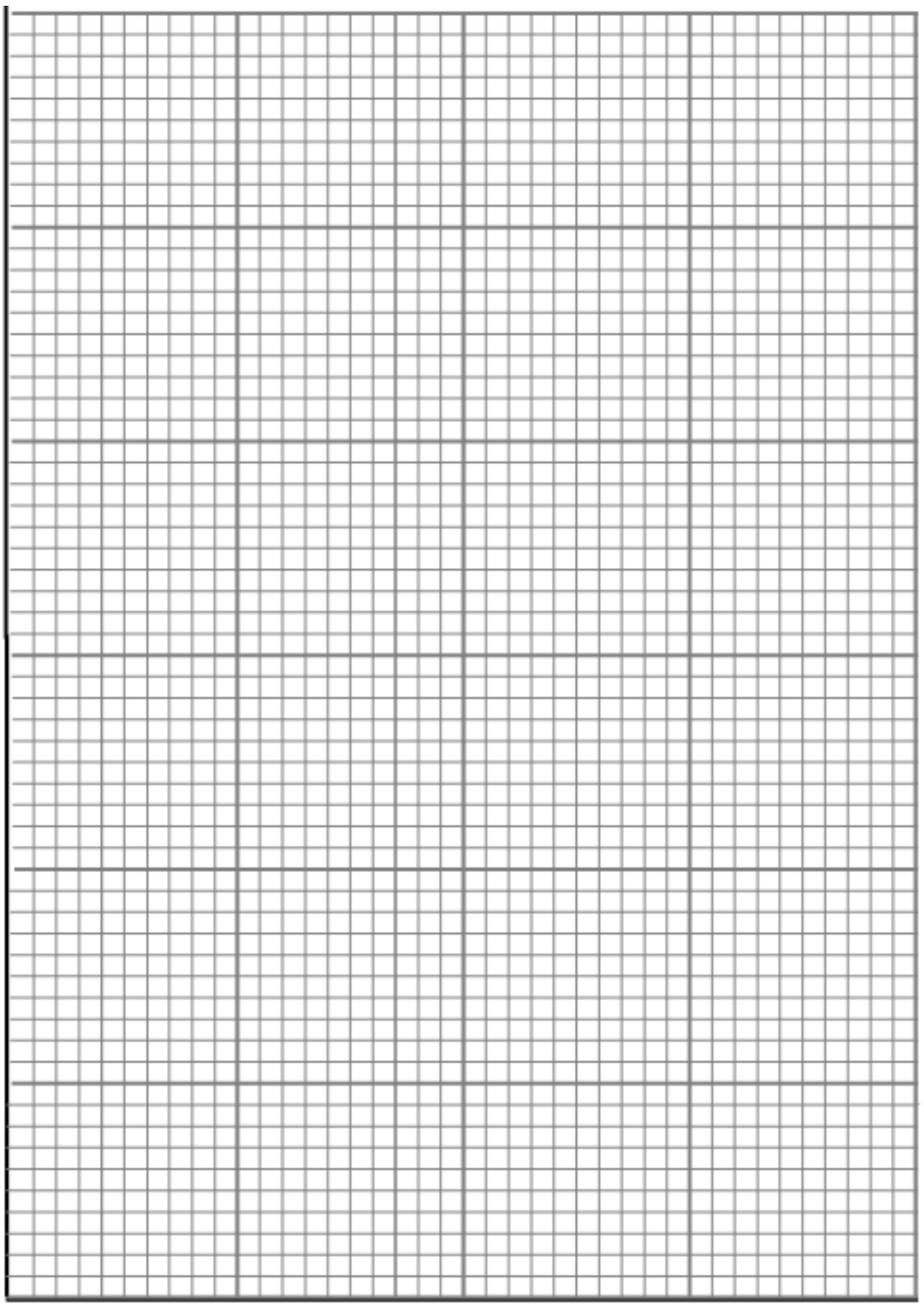
10.3 Write down two conditions under which a real gas deviates from the ideal gas behaviour. (2)
[19]

GRAND TOTAL: 150

GRAPH PAPER FOR QUESTION 10.1.1

NAME OF LEARNER: ..... GRADE: .....
Remember to hand in this graph paper with the rest of your answers.

p
(kPa)



V (cm^3)

DATA FOR PHYSICAL SCIENCES GRADE 11
GEGEWENS VIR FISIESE WETENSKAPPE GRAAD 11

TABLE 1: PHYSICAL CONSTANTS / *TABEL 1: FISIESE KONSTANTES*

NAME/NAAM	SYMBOL/SIMBOOL	VALUE/*WAARDE*
Acceleration due to gravity *Swaartekragversnelling*	g	9,8 $m \cdot s^{-2}$
Gravitational constant *Swaartekragkonstante*	G	6,67 x 10^{-11} $N \cdot m^2 \cdot kg^{-2}$
Speed of light in a vacuum *Spoed van lig in 'n vakuum*	c	3,0 x 10^8 $m \cdot s^{-1}$
Mass of Earth *Massa van Aarde*	M	5,98 x 10^{24} kg
Molar gas volume at STP *Molêre gasvolume by STD*	V_m	22,4 $dm^3 \cdot mol^{-1}$
Standard pressure *Standaarddruk*	p^θ	1,013 x 10^5 Pa
Standard temperature *Standaardtemperatuur*	T^θ	273 K
Molar gas constant *Molêre gaskonstante*	R	8,31 $J \cdot K^{-1} \cdot mol^{-1}$

TABLE 2: FORMULAE/*TABEL 2: FORMULES*

MOTION/BEWEGING

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

FORCE / *KRAG*

$F_{net} = ma$	$w = mg$
$F = \frac{Gm_1m_2}{r^2}$	$g = \frac{GM}{r^2}$
$f_k = \mu_k N$	$f_s^{(max)} = \mu_s N$

WAVES, SOUND AND LIGHT/*GOLWE, KLANK EN LIG*

$v = f\lambda$	$T = \frac{1}{f}$
$n_i \sin\theta_i = n_r \sin\theta_r$	$n = \frac{c}{v}$

GASES AND MOL/*GASSE EN MOL*

$\frac{p_1V_1}{T_1} = \frac{p_2V_2}{T_2}$	$pV = nRT$	
$n = \frac{m}{M}$	$n = \frac{N}{N_A}$	$n = \frac{V}{V_m}$

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 **1 H 1**																	**2 He 4**
1,0 **3 Li 7**	1,5 **4 Be 9**											2.0 **5 B 11**	2.5 **6 C 12**	3.0 **7 N 14**	3.5 **8 O 16**	4.0 **9 F 19**	**10 Ne 20**
0,9 **11 Na 23**	1,2 **12 Mg 24**											1.5 **13 Aℓ 27**	1.8 **14 Si 28**	2.1 **15 P 31**	2.5 **16 S 32**	3.0 **17 Cℓ 35,5**	**18 Ar 40**
0,8 **19 K 39**	1,0 **20 Ca 40**	1,3 **21 Sc 45**	1,5 **22 Ti 48**	1,6 **23 V 51**	1,6 **24 Cr 52**	1,5 **25 Mn 55**	1,8 **26 Fe 56**	1,8 **27 Co 59**	1,8 **28 Ni 59**	1,9 **29 Cu 63,5**	1,6 **30 Zn 65**	1.6 **31 Ga 70**	1.8 **32 Ge 73**	2.0 **33 As 75**	2.4 **34 Se 79**	2.8 **35 Br 80**	**36 Kr 84**
0,8 **37 Rb 86**	1,0 **38 Sr 88**	1,2 **39 Y 89**	1,4 **40 Zr 91**	**41 Nb 92**	1,8 **42 Mo 96**	1,9 **43 Tc**	2,2 **44 Ru 101**	2,2 **45 Rh 103**	2,2 **46 Pd 106**	1,9 **47 Ag 108**	1,7 **48 Cd 112**	1.7 **49 In 115**	1.8 **50 Sn 119**	1.9 **51 Sb 122**	2.1 **52 Te 128**	2.5 **53 I 127**	**54 Xe 131**
0,7 **55 Cs 133**	0,9 **56 Ba 137**	**57 La 139**	1,6 **72 Hf 179**	**73 Ta 181**	**74 W 184**	**75 Re 186**	**76 Os 190**	**77 Ir 192**	**78 Pt 195**	**79 Au 197**	**80 Hg 201**	1.8 **81 Tℓ 204**	1.8 **82 Pb 207**	1.9 **83 Bi 209**	2.0 **84 Po**	2.5 **85 At**	**86 Rn**
0,7 **87 Fr**	0,9 **88 Ra 226**	**89 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*