GAUTENG PROVINCE
EDUCATION
REPUBLIC OF SOUTH AFRICA

PREPARATORY EXAMINATION

2022

11102

TECHNICAL SCIENCES

PAPER 2

TIME: 1½ hours

MARKS: 75

10 pages + 4 information sheets

11102E

X05

INSTRUCTIONS AND INFORMATION

1. This question paper consists of SIX questions. Answer ALL the questions in the ANSWER BOOK.
2. Start EACH question on a NEW page in the ANSWER BOOK.
3. Number the answers correctly according to the numbering system used in this question paper.
4. Leave ONE line between two sub-questions, e.g. between QUESTION 2.1 and QUESTION 2.2.
5. You may use a non-programmable calculator.
6. You are advised to use the attached DATA SHEETS.
7. Round-off your FINAL numerical answers to a minimum of TWO decimal places.
8. Give brief motivations, discussions, etc., where required.
9. Write neatly and legibly.

QUESTION 1: MULTIPLE-CHOICE QUESTIONS

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

1.1 Which of the following compounds represents the first member of the ketones?

A $HCHO$

B CH_3OH

C H_3COCH_3

D CH_3CH_2COOH (2)

1.2 Which of the following compounds is saturated?

A C_4H_{10}

B C_5H_{10}

C C_5H_9OH

D C_6H_{10} (2)

1.3 Consider the compound with molecular formula of $C_5H_{11}OH$. To which homologous series does this compound belong?

A Aldehydes

B Ketones

C Esters

D Alcohols (2)

1.4 Methyl ethanoate is prepared by the reaction between ...

A ethanoic acid and ethanol.

B ethanoic acid and methanol.

C methanoic acid and methanol.

D methanoic acid and ethanol. (2)

1.5 Which of the following definitions does NOT describe electrolysis?

A The dissolution of a substance using an electrical current

B The chemical process where electrical energy is converted to chemical energy

C The use of electrical energy to cause a chemical change

D The use of chemical energy to cause an electrical change (2)

1.6 Choose the correct comparison between an electrolytic cell and a galvanic cell.

A A galvanic cell is an electrochemical cell where electrical energy is converted into chemical energy and an electrolytic cell is where chemical energy is converted into electrical energy.

B An electrolytic cell is an electrochemical cell where electrical energy is converted into chemical energy and a galvanic cell is where chemical energy is converted into electrical energy.

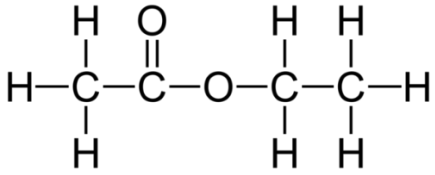
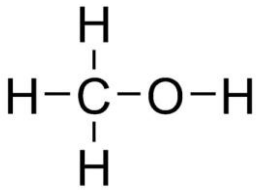
C A galvanic cell is a non-spontaneous cell, whereas an electrolytic cell is a spontaneous cell.

D Both cells are electrochemical cells that convert electrical energy into chemical energy. (2)

[12]

QUESTION 2 (Start on a new page.)

Letters **A** to **F** in the table below represent SIX organic molecules.

A	C_4H_8	**B**	Ethane
C	Bromine	**D**	Ethanoic acid
E		**F**	

2.1 Define a *functional group*. (2)

2.2 Give the IUPAC name of compound **E**. (2)

2.3 From the list above choose a substance that is used in the laboratory for the preparation of **E**. Write down ONLY the letter. (1)

2.4 Give the name or formula of the catalyst that is needed for the reaction referred to in QUESTION 2.3. (1)

2.5 Write down the structural formulae of THREE isomers of substance **A**. Write down the IUPAC name under each isomer. (6)

2.6 Write down the structural formula of compound **D**. (2)

2.7 Define an *unsaturated hydrocarbon*. (2)

2.8 Identify an unsaturated hydrocarbon from the table above. Write down ONLY the letter of the correct answer. (1)

[17]

QUESTION 3 (Start on a new page.)

Knowledge of the boiling points may be used to identify chemical compounds. The boiling points of four organic compounds, represented by the letters **A**, **B**, **C** and **D** are shown in the table below.

	Compound	**Boiling Point ˚C**
A	Propane	-42
B	Pentane	36
C	2-methylbutane	27,8
D	Pentan-1-ol	137

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

3.2 Between **A** and **B**, which has the higher vapour pressure? (1)

3.3 An unknown straight chain alkane has a boiling point of -0,5 °C. Use the information in the table above to identify this alkane and write down its IUPAC name. (2)

3.4 **B** and **C** are structural isomers.

3.41 Define the term *structural isomer*. (2)

3.4.2 Explain why **B** has a higher boiling point than **C**. Refer to chain length/ branch, intermolecular forces and energy in your explanation. (3)

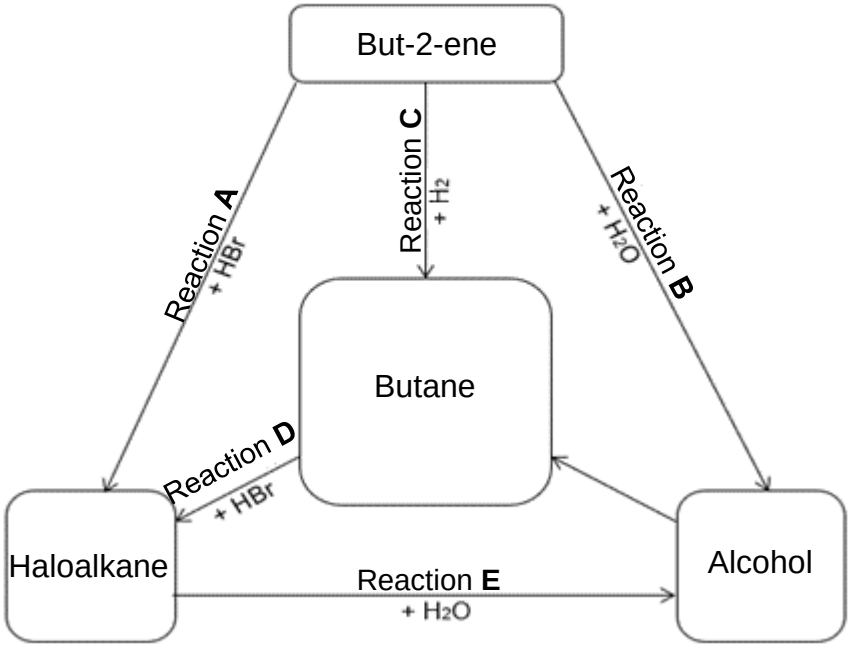
[10]

QUESTION 4 (Start on a new page.)

Pentane is one of the important hydrocarbons used in the synthesis of petroleum for vehicles.

4.1 Write down the balanced chemical reaction of the combustion of pentane in excess oxygen. (3)

4.2 The flow diagram below shows how pentane can be converted to several other organic compounds. Study the reactions (A to E) and answer the questions that follow.



4.2.1 Which reaction is a representation of hydrohalogenation? (1)

4.2.2 From the flow diagram above, write a balanced chemical equation for reaction **B** to show the formation of the major product. (3)

4.2.3 Write a suitable name given to reaction **C** in the flow diagram above. (1)

4.2.4 Which catalyst may be used in reaction **C** above? (1)

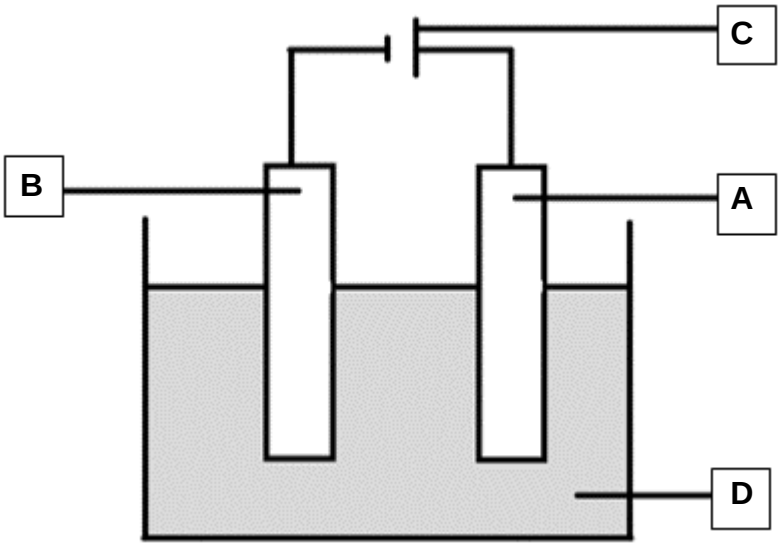
4.3 Reaction **E** results in the formation of alcohol as one of the products.

4.3.1 What are the TWO reaction conditions for reaction **E**? (2)

4.3.2 Write down the IUPAC name of the alcohol formed in the reaction **E** above. (1)
[12]

QUESTION 5 (Start on a new page.)

The electrochemical cell below is used to decompose copper(II)chloride.



Use the above diagram to answer the following questions.

5.1 What type of electrochemical cell is represented in the diagram above? (1)

5.2 Identify the following electrodes as anode or cathode:

5.2.1 Electrode **A** (1)

5.2.2 Electrode **B** (1)

5.3 What type of electrochemical cell does component **C** represent? (1)

5.4 To which electrode will the copper ions be attracted? (1)

5.5 Write down the oxidation half-reaction for the above electrochemical cell. (2)

5.6 Write down the reduction half-reaction for the above electrochemical cell. (2)

5.7 Write down the net balanced chemical equation for the reaction in the electrochemical cell above. (3)

5.8 State ONE precautionary measure that must be taken into consideration while the cell is in operation. (1)

5.9 What energy conversion takes place in this type of cell? (2)

5.10 Two Grade 12 learners want to use the cell to coat copper with a layer of gold. Name the TWO electrodes that the learners can use to replace the graphite electrodes in this cell. (2)

5.11 Give a suitable name for the process referred to in QUESTION 5.10 above. (1)

5.12 At which electrode (cathode or anode) will they connect gold as an electrode? (1)

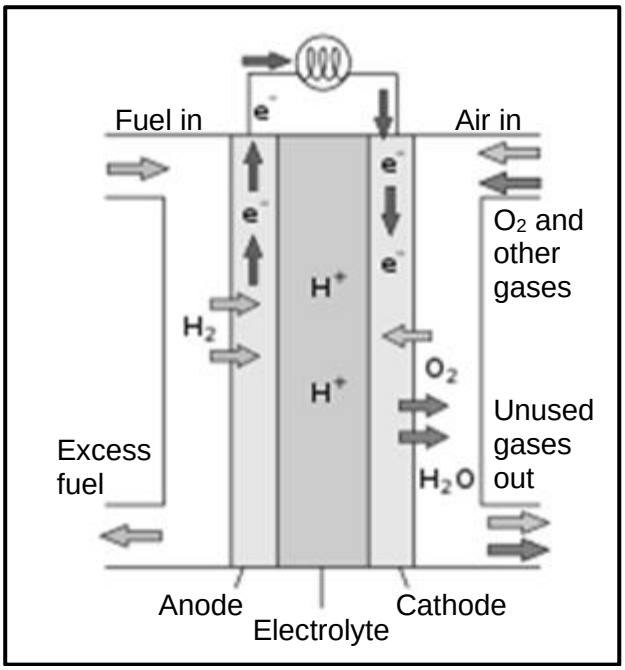
5.13 One of the observations is that the concentration of ions in the electrolyte used remains constant. Provide a suitable explanation for this observation. (1)

[20]

QUESTION 6 (Start on a new page.)

Fossil fuel is a non-renewable source of energy which is being exhausted. This means that new sources of energy must be developed, which is called alternative energy, for example, environmentally-friendly hydrogen fuel cells.

Use the following diagram of a hydrogen fuel cell to answer the questions that follow.



6.1 Name the TWO reactants used in the hydrogen fuel cell. (2)

6.2 Why is a catalyst used in this hydrogen fuel cell? (1)

6.3 Name ONE advantage of hydrogen fuel cells over batteries, gasoline and diesel engines. (1)
[4]

TOTAL: 75

END

DATA FOR TECHNICAL SCIENCES GRADE 12/
GEGEWENS VIR TEGNIESE WETENSKAPPE GRAAD 12
PAPER/*VRAESTEL* 2

TABLE/*TABEL* 1

PHYSICAL CONSTANTS/*FISIESE KONSTANTES*		
CONSTANT/*KONSTANTE*	**SYMBOL/*SIMBOOL***	**VALUE/*WAARDE***
Planck's constant *Planck se konstante*	h	$6,63 \times 10^{-34}$ J.s
Speed of light *Spoed van lig*	c	3×10^{8} m.s^{-1}

TABLE/*TABEL* 2

WAVES, SOUND AND LIGHT/*GOLWE, KLANK EN LIG*	
Speed/*Spoed*	$c = f\lambda$
Energy/*Energie*	$E = hf$ or/*of* $E = \frac{hc}{\lambda}$

TABLE/*TABEL* 3

ELECTROCHEMISTRY/*ELEKTROCHEMIE*	
Emf/*Emk*	$E^{\theta}_{cell} = E^{\theta}_{cathode} - E^{\theta}_{anode}$ / $E^{\theta}_{sel} = E^{\theta}_{katode} - E^{\theta}_{anode}$ or/*of* $E^{\theta}_{cell} = E^{\theta}_{reduction} - E^{\theta}_{oxidation}$ / $E^{\theta}_{sel} = E^{\theta}_{reduksie} - E^{\theta}_{oksidasie}$ or/*of* $E^{\theta}_{cell} = E^{\theta}_{oxidising\ agent} - E^{\theta}_{reducing\ agent}$ / $E^{\theta}_{sel} = E^{\theta}_{oksideermiddel} - E^{\theta}_{reduseermiddel}$

TABLE 4A: STANDARD REDUCTION POTENTIALS/
TABEL 4A: STANDAARD-REDUKSIEPOTENSIALE

Half-reactions/*Halfreaksies*	E^{θ} (V)
$F_2(g) + 2e^- \rightleftharpoons 2F^-$	+ 2,87
$Co^{3+} + e^- \rightleftharpoons Co^{2+}$	+ 1,81
$H_2O_2 + 2H^+ + 2e^- \rightleftharpoons 2H_2O$	+1,77
$MnO_4^- + 8H^+ + 5e^- \rightleftharpoons Mn^{2+} + 4H_2O$	+ 1,51
$C\ell_2(g) + 2e^- \rightleftharpoons 2C\ell^-$	+ 1,36
$Cr_2O_7^{2-} + 14H^+ + 6e^- \rightleftharpoons 2Cr^{3+} + 7H_2O$	+ 1,33
$O_2(g) + 4H^+ + 4e^- \rightleftharpoons 2H_2O$	+ 1,23
$MnO_2 + 4H^+ + 2e^- \rightleftharpoons Mn^{2+} + 2H_2O$	+ 1,23
$Pt^{2+} + 2e^- \rightleftharpoons Pt$	+ 1,20
$Br_2(\ell) + 2e^- \rightleftharpoons 2Br^-$	+ 1,07
$NO_3^- + 4H^+ + 3e^- \rightleftharpoons NO(g) + 2H_2O$	+ 0,96
$Hg^{2+} + 2e^- \rightleftharpoons Hg(\ell)$	+ 0,85
$Ag^+ + e^- \rightleftharpoons Ag$	+ 0,80
$NO_3^- + 2H^+ + e^- \rightleftharpoons NO_2(g) + H_2O$	+ 0,80
$Fe^{3+} + e^- \rightleftharpoons Fe^{2+}$	+ 0,77
$O_2(g) + 2H^+ + 2e^- \rightleftharpoons H_2O_2$	+ 0,68
$I_2 + 2e^- \rightleftharpoons 2I^-$	+ 0,54
$Cu^+ + e^- \rightleftharpoons Cu$	+ 0,52
$SO_2 + 4H^+ + 4e^- \rightleftharpoons S + 2H_2O$	+ 0,45
$2H_2O + O_2 + 4e^- \rightleftharpoons 4OH^-$	+ 0,40
$Cu^{2+} + 2e^- \rightleftharpoons Cu$	+ 0,34
$SO_4^{2-} + 4H^+ + 2e^- \rightleftharpoons SO_2(g) + 2H_2O$	+ 0,17
$Cu^{2+} + e^- \rightleftharpoons Cu^+$	+ 0,16
$Sn^{4+} + 2e^- \rightleftharpoons Sn^{2+}$	+ 0,15
$S + 2H^+ + 2e^- \rightleftharpoons H_2S(g)$	+ 0,14
$2H^+ + 2e^- \rightleftharpoons H_2(g)$	**0,00**
$Fe^{3+} + 3e^- \rightleftharpoons Fe$	– 0,06
$Pb^{2+} + 2e^- \rightleftharpoons Pb$	– 0,13
$Sn^{2+} + 2e^- \rightleftharpoons Sn$	– 0,14
$Ni^{2+} + 2e^- \rightleftharpoons Ni$	– 0,27
$Co^{2+} + 2e^- \rightleftharpoons Co$	– 0,28
$Cd^{2+} + 2e^- \rightleftharpoons Cd$	– 0,40
$Cr^{3+} + e^- \rightleftharpoons Cr^{2+}$	– 0,41
$Fe^{2+} + 2e^- \rightleftharpoons Fe$	– 0,44
$Cr^{3+} + 3e^- \rightleftharpoons Cr$	– 0,74
$Zn^{2+} + 2e^- \rightleftharpoons Zn$	– 0,76
$2H_2O + 2e^- \rightleftharpoons H_2(g) + 2OH^-$	– 0,83
$Cr^{2+} + 2e^- \rightleftharpoons Cr$	– 0,91
$Mn^{2+} + 2e^- \rightleftharpoons Mn$	– 1,18
$A\ell^{3+} + 3e^- \rightleftharpoons A\ell$	– 1,66
$Mg^{2+} + 2e^- \rightleftharpoons Mg$	– 2,36
$Na^+ + e^- \rightleftharpoons Na$	– 2,71
$Ca^{2+} + 2e^- \rightleftharpoons Ca$	– 2,87
$Sr^{2+} + 2e^- \rightleftharpoons Sr$	– 2,89
$Ba^{2+} + 2e^- \rightleftharpoons Ba$	– 2,90
$Cs^+ + e^- \rightleftharpoons Cs$	- 2,92
$K^+ + e^- \rightleftharpoons K$	– 2,93
$Li^+ + e^- \rightleftharpoons Li$	– 3,05

Increasing oxidising ability/*Toenemende oksiderende vermoë*

Increasing reducing ability/*Toenemende reduserende vermoë*

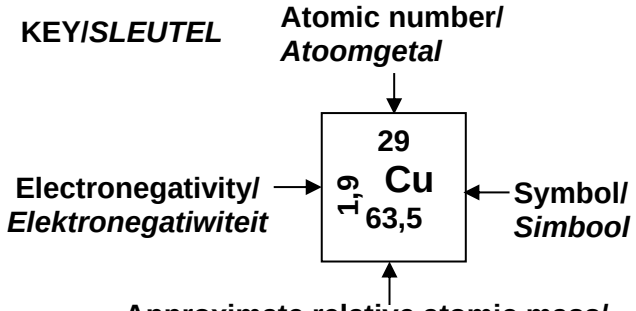
TABLE 4B: STANDARD REDUCTION POTENTIALS/ *TABEL 4B: STANDAARD-REDUKSIEPOTENSIALE*

Increasing oxidising ability/*Toenemende oksiderende vermoë* ↓

Half-reactions/*Halfreaksies*			E^{θ} (V)
$Li^+ + e^-$	⇌	Li	– 3,05
$K^+ + e^-$	⇌	K	– 2,93
$Cs^+ + e^-$	⇌	Cs	– 2,92
$Ba^{2+} + 2e^-$	⇌	Ba	– 2,90
$Sr^{2+} + 2e^-$	⇌	Sr	– 2,89
$Ca^{2+} + 2e^-$	⇌	Ca	– 2,87
$Na^+ + e^-$	⇌	Na	– 2,71
$Mg^{2+} + 2e^-$	⇌	Mg	– 2,36
$A\ell^{3+} + 3e^-$	⇌	$A\ell$	– 1,66
$Mn^{2+} + 2e^-$	⇌	Mn	– 1,18
$Cr^{2+} + 2e^-$	⇌	Cr	– 0,91
$2H_2O + 2e^-$	⇌	$H_2(g) + 2OH^-$	– 0,83
$Zn^{2+} + 2e^-$	⇌	Zn	– 0,76
$Cr^{3+} + 3e^-$	⇌	Cr	– 0,74
$Fe^{2+} + 2e^-$	⇌	Fe	– 0,44
$Cr^{3+} + e^-$	⇌	Cr^{2+}	– 0,41
$Cd^{2+} + 2e^-$	⇌	Cd	– 0,40
$Co^{2+} + 2e^-$	⇌	Co	– 0,28
$Ni^{2+} + 2e^-$	⇌	Ni	– 0,27
$Sn^{2+} + 2e^-$	⇌	Sn	– 0,14
$Pb^{2+} + 2e^-$	⇌	Pb	– 0,13
$Fe^{3+} + 3e^-$	⇌	Fe	– 0,06
$2H^+ + 2e^-$	**⇌**	**$H_2(g)$**	**0,00**
$S + 2H^+ + 2e^-$	⇌	$H_2S(g)$	+ 0,14
$Sn^{4+} + 2e^-$	⇌	Sn^{2+}	+ 0,15
$Cu^{2+} + e^-$	⇌	Cu^+	+ 0,16
$SO_4^{2-} + 4H^+ + 2e^-$	⇌	$SO_2(g) + 2H_2O$	+ 0,17
$Cu^{2+} + 2e^-$	⇌	Cu	+ 0,34
$2H_2O + O_2 + 4e^-$	⇌	$4OH^-$	+ 0,40
$SO_2 + 4H^+ + 4e^-$	⇌	$S + 2H_2O$	+ 0,45
$Cu^+ + e^-$	⇌	Cu	+ 0,52
$I_2 + 2e^-$	⇌	$2I^-$	+ 0,54
$O_2(g) + 2H^+ + 2e^-$	⇌	H_2O_2	+ 0,68
$Fe^{3+} + e^-$	⇌	Fe^{2+}	+ 0,77
$NO_3^- + 2H^+ + e^-$	⇌	$NO_2(g) + H_2O$	+ 0,80
$Ag^+ + e^-$	⇌	Ag	+ 0,80
$Hg^{2+} + 2e^-$	⇌	$Hg(\ell)$	+ 0,85
$NO_3^- + 4H^+ + 3e^-$	⇌	$NO(g) + 2H_2O$	+ 0,96
$Br_2(\ell) + 2e^-$	⇌	$2Br^-$	+ 1,07
$Pt^{2+} + 2e^-$	⇌	Pt	+ 1,20
$MnO_2 + 4H^+ + 2e^-$	⇌	$Mn^{2+} + 2H_2O$	+ 1,23
$O_2(g) + 4H^+ + 4e^-$	⇌	$2H_2O$	+ 1,23
$Cr_2O_7^{2-} + 14H^+ + 6e^-$	⇌	$2Cr^{3+} + 7H_2O$	+ 1,33
$C\ell_2(g) + 2e^-$	⇌	$2C\ell^-$	+ 1,36
$MnO_4^- + 8H^+ + 5e^-$	⇌	$Mn^{2+} + 4H_2O$	+ 1,51
$H_2O_2 + 2H^+ + 2e^-$	⇌	$2H_2O$	+1,77
$Co^{3+} + e^-$	⇌	Co^{2+}	+ 1,81
$F_2(g) + 2e^-$	⇌	$2F^-$	+ 2,87

Increasing reducing ability/*Toenemende reduserende vermoë* ↑

TABLE 5: THE PERIODIC TABLE OF ELEMENTS/*TABEL 5: 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**