



# basic education

Department:  
Basic Education  
**REPUBLIC OF SOUTH AFRICA**

**NATIONAL  
SENIOR CERTIFICATE**

**GRADE 12**

**TECHNICAL SCIENCES P2**

**NOVEMBER 2021**

**MARKS: 75**

**TIME: 1½ hours**

**This question paper consists of 9 pages and 4 data sheets.**

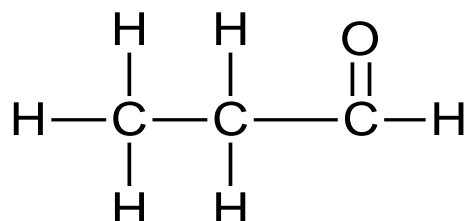
**INSTRUCTIONS AND INFORMATION**

1. Write your centre number and examination number in the appropriate spaces on the ANSWER BOOK.
2. This question paper consists of SIX 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, e.g. between QUESTION 2.1 and QUESTION 2.2.
6. You may use a non-programmable calculator.
7. You are advised to use the attached DATA SHEETS.
8. Round off your FINAL numerical answers to a minimum of TWO decimal places.
9. Give brief motivations, discussions, etc. where required.
10. 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 1.5) in the ANSWER BOOK, e.g. 1.6 D.

- 1.1 Consider the structural formula of a compound below and identify the type of homologous series to which the compound belongs:



- A Carboxylic acid  
 B Aldehyde  
 C Alcohol  
 D Ketone

(2)

- 1.2 Study the table below and answer the following question.

MOLECULAR NAME	BOILING POINT (°C)
Methane	- 164
Ethane	- 89
Propane	- 42
Butane	- 0,5

Which ONE of the above molecules has the LOWEST vapour pressure?

- A Methane  
 B Propane  
 C Ethane  
 D Butane

(2)

- 1.3 Which ONE of the following combinations is TRUE about the substance that is oxidised?

	ELECTRONS	OXIDATION NUMBER
A	Gain	Decreases
B	Loss	Decreases
C	Gain	Increases
D	Loss	Increases

(2)

1.4 An electrolyte conducts electricity because:

- (i) It is a solid and ions are free to move.
- (ii) It is molten and ions are not moving.
- (iii) It is a solution and ions are free to move.

Which ONE of the combinations below is CORRECT?

- A (ii) only
- B (i) and (ii)
- C (iii) only
- D (i), (ii) and (iii) (2)

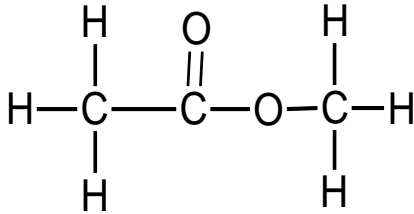
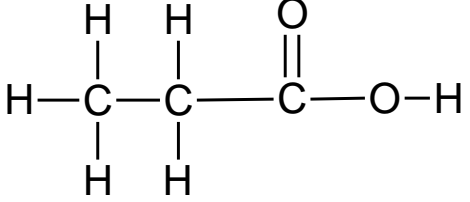
1.5 Which ONE of the following is CORRECT about the change in mass of electrodes in a galvanic cell? Assume that both electrodes are solid metals.

	<b>ANODE</b>	<b>CATHODE</b>
A	Decreases	Increases
B	Decreases	Decreases
C	Increases	Increases
D	Increases	Decreases

(2)  
**[10]**

**QUESTION 2 (Start on a new page.)**

Organic molecules from different homologous series are represented in TABLE 1 below.

<b>A</b> $\text{CH}_3\text{CH}_2\text{CH}_2\text{CH}_3$	<b>B</b> 
<b>C</b> $\text{CH}_3\text{CH}_2\text{CH}_2\text{CH}_2\text{Cl}$	<b>D</b> 
<b>E</b> Butan-1-ol	<b>F</b> 2-chloropropane

**TABLE 1**

- 2.1 Define the term *hydrocarbon*. (2)
- 2.2 Draw the structural formula of the compounds represented by the following letters:
- 2.2.1 **C** (2)
- 2.2.2 **E** (2)
- 2.3 Write down the IUPAC name of compound **B**. (2)
- 2.4 Write down the homologous series to which the following compounds belong:
- 2.4.1 **A** (1)
- 2.4.2 **B** (1)
- 2.5 Compounds **B** and **D** are structural isomers.
- 2.5.1 Define the term *structural isomer*. (2)
- 2.5.2 What type of structural isomer are compounds **B** and **D**? (1)

**[13]**

**QUESTION 3 (Start on a new page.)**

Consider the compounds represented in TABLE 2 below and answer the questions that follow.

<p><b>A</b></p> <pre>       H   H   H   H                     H — C — C — C — C — H                           H   H   H   H           </pre>	<p><b>B</b></p> <pre>       H   H   H                 H — C — C — C — H                       H       H                       H — C — H                       H           </pre>
<p><b>C</b></p> <pre>       H   H   H   H                     H — C — C — C — C — O — H                           H   H   H   H           </pre>	<p><b>D</b></p> <pre>       H   H   H   O                      H — C — C — C — C — O — H                       H   H   H           </pre>

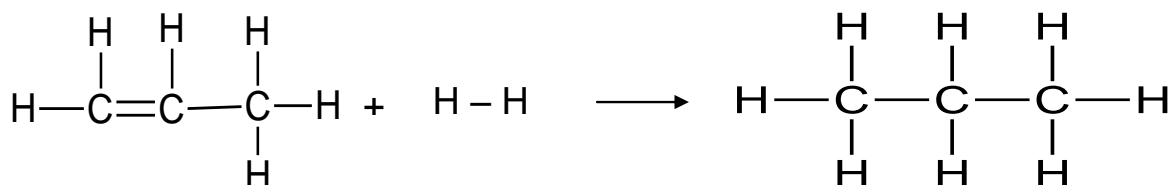
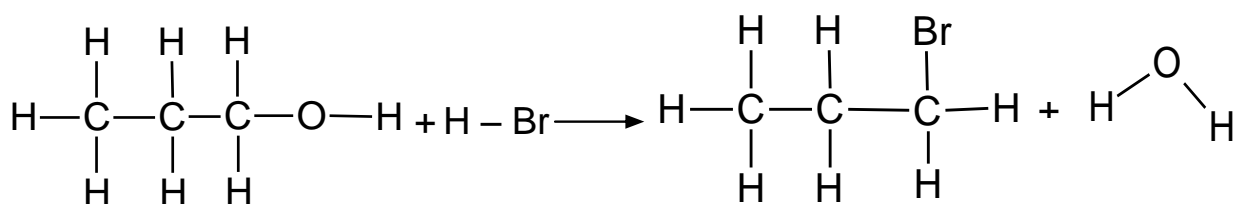
**TABLE 2**

- 3.1 Consider only compounds **A** and **B**.
- 3.1.1 What type of intermolecular forces exist between the molecules of these compounds? (1)
- 3.1.2 Which compound, **A** or **B**, has stronger intermolecular forces? (1)
- 3.1.3 Give a reason for the answer to QUESTION 3.1.2. (2)
- 3.2 The boiling point of compound **A** is compared to that of compound **C**.
- 3.2.1 Why is this a fair comparison? (2)
- 3.2.2 Which compound has a higher boiling point? (Write down only **A** or **C**.) (1)
- 3.2.3 Explain the answer to QUESTION 3.2.2. (3)
- 3.3 Arrange compounds **A**, **B**, **C** and **D** according to a decrease in vapour pressure. (2)

**[12]**

**QUESTION 4 (Start on a new page.)**

Consider the two reactions below and answer the questions that follow.

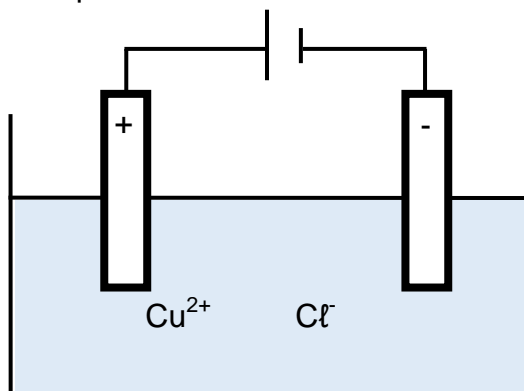
**Reaction 1****Reaction 2**

- 4.1 Write down the NAME of:
- 4.1.1 Reaction 1 (1)
- 4.1.2 Reaction 2 (1)
- 4.2 Write down the following:
- 4.2.1 The NAME or FORMULA of a catalyst used in reaction 1 (1)
- 4.2.2 ONE reaction condition for reaction 2 (1)
- 4.3 The product in reaction 1 (propane) can react with bromine or oxygen.
- 4.3.1 Write down a balanced chemical equation for the reaction of propane and bromine using STRUCTURAL FORMULAE. (4)
- 4.3.2 Write down the NAMES or FORMULAE of TWO products formed when propane reacts in excess oxygen. (2)
- 4.4 A semiconductor is a solid substance that has electrical conductivity between a conductor and an insulator. The conductivity of a semiconductor can be improved by adding an impurity.
- 4.4.1 Name the process that is used to improve the conductivity of a semiconductor. (1)
- 4.4.2 Define an *intrinsic semiconductor*. (2)
- 4.4.3 Distinguish between an *n-type semiconductor* and a *p-type semiconductor*. (4)

**[17]**

**QUESTION 5 (Start on a new page.)**

The diagram below represents an electrolytic cell used for the decomposition of copper(II)chloride. Graphite electrodes are used in this cell.



5.1 For the electrolyte used in the cell above, write down the NAME of a/an:

5.1.1 Cation (1)

5.1.2 Anion (1)

5.2 Which electrode represents the following?

5.2.1 An anode (1)

5.2.2 A cathode (1)

5.3 Define the term *oxidation*. (2)

5.4 Write down a balanced half-reaction that occurs at the positive electrode. (2)

5.5 Define the term *reducing agent*. (2)

5.6 Draw a diagram showing a cell that is used to electroplate a spoon with silver using a battery. Indicate:

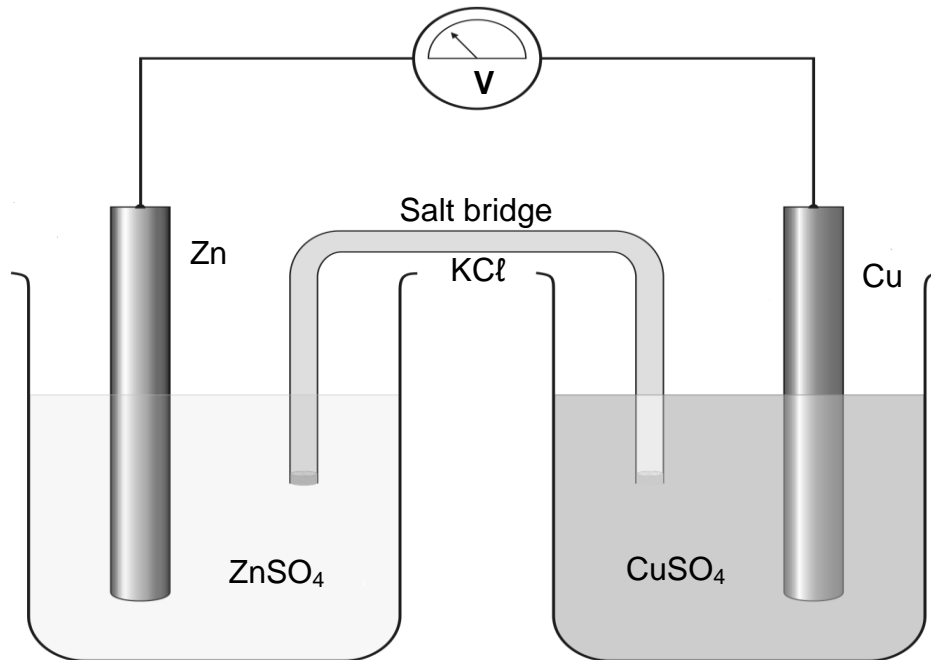
- The name of the electrolyte
- Anode and cathode in terms of a spoon and silver electrode
- A battery

(3)  
[13]



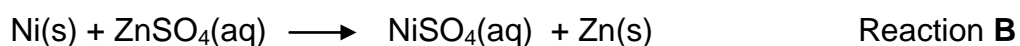
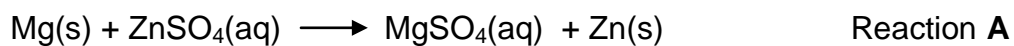
**QUESTION 6 (Start on a new page.)**

6.1 Learners performed an experiment to determine the electrode potential of a zinc-copper cell. They assembled the apparatus as shown in the diagram below. The experiment was performed under standard conditions.



- 6.1.1 Which type of cell is represented by the diagram above? (1)
- 6.1.2 Write down a balanced equation for the net ionic reaction of the above cell. (2)
- 6.1.3 Calculate the *emf* of the cell. (4)

6.2 Consider the two reactions below and answer the questions that follow.



- 6.2.1 Which ONE of the above reactions is spontaneous?  
Write down REACTION **A** or REACTION **B** only. (1)
- 6.2.2 Motivate the answer to QUESTION 6.2.1 by referring to the reducing ability of the reactants. (2)

**[10]**

**TOTAL: 75**

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

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

NAME/NAAM	SYMBOL/SIMBOOL	VALUE/WAARDE
Standard pressure <i>Standaarddruk</i>	$p^\ominus$	$1,01 \times 10^5 \text{ Pa}$
Standard temperature <i>Standaardtemperatuur</i>	$T^\ominus$	$273 \text{ K}/0 \text{ }^\circ\text{C}$
Speed of light <i>Spoe van lig</i>	$c$	$3 \times 10^8 \text{ m}\cdot\text{s}^{-1}$
Planck's constant <i>Planck se konstante</i>	$h$	$6,63 \times 10^{-34} \text{ J}\cdot\text{s}$

**TABLE 2/TABEL 2: WAVES, SOUND AND LIGHT/GOLWE, KLANK EN LIG**

$v = f \lambda$	$T = \frac{1}{f}$
$E = hf$ or/of $E = h \frac{c}{\lambda}$	

**TABLE 3/TABEL 3: FORMULAE/FORMULES**

Emf/Emk	$E_{\text{cell}}^\ominus = E_{\text{cathode}}^\ominus - E_{\text{anode}}^\ominus / E_{\text{sel}}^\ominus = E_{\text{katode}}^\ominus - E_{\text{anode}}^\ominus$ <p>or/of</p> $E_{\text{cell}}^\ominus = E_{\text{reduction}}^\ominus - E_{\text{oxidation}}^\ominus / E_{\text{sel}}^\ominus = E_{\text{reduksie}}^\ominus - E_{\text{oksidasie}}^\ominus$ <p>or/of</p> $E_{\text{cell}}^\ominus = E_{\text{oxidising agent}}^\ominus - E_{\text{reducing agent}}^\ominus / E_{\text{sel}}^\ominus = E_{\text{okseermiddel}}^\ominus - E_{\text{reduseermiddel}}^\ominus$
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**TABLE 4A: STANDARD REDUCTION POTENTIALS**  
**TABEL 4A: STANDAARD-REDUKSIEPOTENSIALE**

	$E^\theta$ (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
$Cl_2(g) + 2e^- \rightleftharpoons 2Cl^-$	+ 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
$Br_2(l) + 2e^- \rightleftharpoons 2Br^-$	+ 1,07
$NO_3^- + 4H^+ + 3e^- \rightleftharpoons NO(g) + 2H_2O$	+ 0,96
$Hg^{2+} + 2e^- \rightleftharpoons Hg(l)$	+ 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
<b><math>2H^+ + 2e^- \rightleftharpoons H_2(g)</math></b>	<b>0,00</b>
$Fe^{3+} + 3e^- \rightleftharpoons Fe$	- 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
$Al^{3+} + 3e^- \rightleftharpoons Al$	- 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**

	Half-reactions/ <i>Halfreaksies</i>	$E^\theta$ (V)
	$\text{Li}^+ + e^- \rightleftharpoons \text{Li}$	- 3,05
	$\text{K}^+ + e^- \rightleftharpoons \text{K}$	- 2,93
	$\text{Cs}^+ + e^- \rightleftharpoons \text{Cs}$	- 2,92
	$\text{Ba}^{2+} + 2e^- \rightleftharpoons \text{Ba}$	- 2,90
	$\text{Sr}^{2+} + 2e^- \rightleftharpoons \text{Sr}$	- 2,89
	$\text{Ca}^{2+} + 2e^- \rightleftharpoons \text{Ca}$	- 2,87
	$\text{Na}^+ + e^- \rightleftharpoons \text{Na}$	- 2,71
	$\text{Mg}^{2+} + 2e^- \rightleftharpoons \text{Mg}$	- 2,36
	$\text{Al}^{3+} + 3e^- \rightleftharpoons \text{Al}$	- 1,66
	$\text{Mn}^{2+} + 2e^- \rightleftharpoons \text{Mn}$	- 1,18
	$\text{Cr}^{2+} + 2e^- \rightleftharpoons \text{Cr}$	- 0,91
	$2\text{H}_2\text{O} + 2e^- \rightleftharpoons \text{H}_2(\text{g}) + 2\text{OH}^-$	- 0,83
	$\text{Zn}^{2+} + 2e^- \rightleftharpoons \text{Zn}$	- 0,76
	$\text{Cr}^{3+} + 3e^- \rightleftharpoons \text{Cr}$	- 0,74
	$\text{Fe}^{2+} + 2e^- \rightleftharpoons \text{Fe}$	- 0,44
	$\text{Cr}^{3+} + e^- \rightleftharpoons \text{Cr}^{2+}$	- 0,41
	$\text{Cd}^{2+} + 2e^- \rightleftharpoons \text{Cd}$	- 0,40
	$\text{Co}^{2+} + 2e^- \rightleftharpoons \text{Co}$	- 0,28
	$\text{Ni}^{2+} + 2e^- \rightleftharpoons \text{Ni}$	- 0,27
	$\text{Sn}^{2+} + 2e^- \rightleftharpoons \text{Sn}$	- 0,14
	$\text{Pb}^{2+} + 2e^- \rightleftharpoons \text{Pb}$	- 0,13
	$\text{Fe}^{3+} + 3e^- \rightleftharpoons \text{Fe}$	- 0,06
	<b><math>2\text{H}^+ + 2e^- \rightleftharpoons \text{H}_2(\text{g})</math></b>	<b>0,00</b>
	$\text{S} + 2\text{H}^+ + 2e^- \rightleftharpoons \text{H}_2\text{S}(\text{g})$	+ 0,14
	$\text{Sn}^{4+} + 2e^- \rightleftharpoons \text{Sn}^{2+}$	+ 0,15
	$\text{Cu}^{2+} + e^- \rightleftharpoons \text{Cu}^+$	+ 0,16
	$\text{SO}_4^{2-} + 4\text{H}^+ + 2e^- \rightleftharpoons \text{SO}_2(\text{g}) + 2\text{H}_2\text{O}$	+ 0,17
	$\text{Cu}^{2+} + 2e^- \rightleftharpoons \text{Cu}$	+ 0,34
	$2\text{H}_2\text{O} + \text{O}_2 + 4e^- \rightleftharpoons 4\text{OH}^-$	+ 0,40
	$\text{SO}_2 + 4\text{H}^+ + 4e^- \rightleftharpoons \text{S} + 2\text{H}_2\text{O}$	+ 0,45
	$\text{Cu}^+ + e^- \rightleftharpoons \text{Cu}$	+ 0,52
	$\text{I}_2 + 2e^- \rightleftharpoons 2\text{I}^-$	+ 0,54
	$\text{O}_2(\text{g}) + 2\text{H}^+ + 2e^- \rightleftharpoons \text{H}_2\text{O}_2$	+ 0,68
	$\text{Fe}^{3+} + e^- \rightleftharpoons \text{Fe}^{2+}$	+ 0,77
	$\text{NO}_3^- + 2\text{H}^+ + e^- \rightleftharpoons \text{NO}_2(\text{g}) + \text{H}_2\text{O}$	+ 0,80
	$\text{Ag}^+ + e^- \rightleftharpoons \text{Ag}$	+ 0,80
	$\text{Hg}^{2+} + 2e^- \rightleftharpoons \text{Hg}(\ell)$	+ 0,85
	$\text{NO}_3^- + 4\text{H}^+ + 3e^- \rightleftharpoons \text{NO}(\text{g}) + 2\text{H}_2\text{O}$	+ 0,96
	$\text{Br}_2(\ell) + 2e^- \rightleftharpoons 2\text{Br}^-$	+ 1,07
	$\text{Pt}^{2+} + 2e^- \rightleftharpoons \text{Pt}$	+ 1,20
	$\text{MnO}_2 + 4\text{H}^+ + 2e^- \rightleftharpoons \text{Mn}^{2+} + 2\text{H}_2\text{O}$	+ 1,23
	$\text{O}_2(\text{g}) + 4\text{H}^+ + 4e^- \rightleftharpoons 2\text{H}_2\text{O}$	+ 1,23
	$\text{Cr}_2\text{O}_7^{2-} + 14\text{H}^+ + 6e^- \rightleftharpoons 2\text{Cr}^{3+} + 7\text{H}_2\text{O}$	+ 1,33
	$\text{Cl}_2(\text{g}) + 2e^- \rightleftharpoons 2\text{Cl}^-$	+ 1,36
	$\text{MnO}_4^- + 8\text{H}^+ + 5e^- \rightleftharpoons \text{Mn}^{2+} + 4\text{H}_2\text{O}$	+ 1,51
	$\text{H}_2\text{O}_2 + 2\text{H}^+ + 2e^- \rightleftharpoons 2\text{H}_2\text{O}$	+ 1,77
	$\text{Co}^{3+} + e^- \rightleftharpoons \text{Co}^{2+}$	+ 1,81
	$\text{F}_2(\text{g}) + 2e^- \rightleftharpoons 2\text{F}^-$	+ 2,87

Increasing oxidising ability/*Toenemende oksiderende vermoë*

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 <b>H</b>																	2 <b>He</b>	
1,0 3 <b>Li</b>	1,5 4 <b>Be</b>											2,0 5 <b>B</b>	2,5 6 <b>C</b>	3,0 7 <b>N</b>	3,5 8 <b>O</b>	4,0 9 <b>F</b>	10 <b>Ne</b>	
0,9 11 <b>Na</b>	1,2 12 <b>Mg</b>											1,5 13 <b>Al</b>	1,8 14 <b>Si</b>	2,1 15 <b>P</b>	2,5 16 <b>S</b>	3,0 17 <b>Cl</b>	18 <b>Ar</b>	
0,8 19 <b>K</b>	1,0 20 <b>Ca</b>	1,3 21 <b>Sc</b>	1,5 22 <b>Ti</b>	1,6 23 <b>V</b>	1,6 24 <b>Cr</b>	1,5 25 <b>Mn</b>	1,8 26 <b>Fe</b>	1,8 27 <b>Co</b>	1,8 28 <b>Ni</b>	1,9 29 <b>Cu</b>	1,6 30 <b>Zn</b>	1,6 31 <b>Ga</b>	1,8 32 <b>Ge</b>	2,0 33 <b>As</b>	2,4 34 <b>Se</b>	2,8 35 <b>Br</b>	36 <b>Kr</b>	
0,8 37 <b>Rb</b>	1,0 38 <b>Sr</b>	1,2 39 <b>Y</b>	1,4 40 <b>Zr</b>		41 <b>Nb</b>	1,8 42 <b>Mo</b>	1,9 43 <b>Tc</b>	2,2 44 <b>Ru</b>	2,2 45 <b>Rh</b>	2,2 46 <b>Pd</b>	1,9 47 <b>Ag</b>	1,7 48 <b>Cd</b>	1,7 49 <b>In</b>	1,8 50 <b>Sn</b>	1,9 51 <b>Sb</b>	2,1 52 <b>Te</b>	2,5 53 <b>I</b>	54 <b>Xe</b>
0,7 55 <b>Cs</b>	0,9 56 <b>Ba</b>	57 <b>La</b>	1,6 72 <b>Hf</b>	73 <b>Ta</b>	74 <b>W</b>	75 <b>Re</b>	76 <b>Os</b>	77 <b>Ir</b>	78 <b>Pt</b>	79 <b>Au</b>	80 <b>Hg</b>	1,8 81 <b>Tl</b>	1,8 82 <b>Pb</b>	1,9 83 <b>Bi</b>	2,0 84 <b>Po</b>	2,5 85 <b>At</b>	86 <b>Rn</b>	
0,7 87 <b>Fr</b>	0,9 88 <b>Ra</b>	89 <b>Ac</b>																
			58 <b>Ce</b>	59 <b>Pr</b>	60 <b>Nd</b>	61 <b>Pm</b>	62 <b>Sm</b>	63 <b>Eu</b>	64 <b>Gd</b>	65 <b>Tb</b>	66 <b>Dy</b>	67 <b>Ho</b>	68 <b>Er</b>	69 <b>Tm</b>	70 <b>Yb</b>	71 <b>Lu</b>		
			90 <b>Th</b>	91 <b>Pa</b>	92 <b>U</b>	93 <b>Np</b>	94 <b>Pu</b>	95 <b>Am</b>	96 <b>Cm</b>	97 <b>Bk</b>	98 <b>Cf</b>	99 <b>Es</b>	100 <b>Fm</b>	101 <b>Md</b>	102 <b>No</b>	103 <b>Lr</b>		

**KEY/SLEUTEL**

Atomic number  
*Atoomgetal*

Electronegativity  
*Elektronegatiwiteit*

Symbol  
*Simbool*

Approximate relative atomic mass  
*Benaderde relatiewe atoommassa*

29 <b>Cu</b> 63,5
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