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SENIOR CERTIFICATE EXAMINATIONS/ NATIONAL SENIOR CERTIFICATE EXAMINATIONS

TECHNICAL SCIENCES P2

2021

MARKS: 150

TIME: 3 hours

This question paper consists of 16 pages and 4 data sheets.

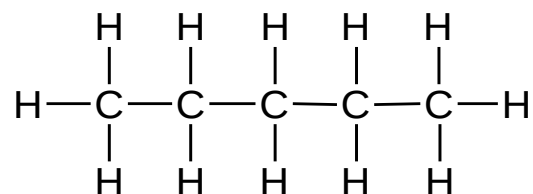
INSTRUCTIONS AND INFORMATION

1. Write your centre number and examination number in the appropriate spaces on the ANSWER BOOK.
2. This question paper consists of TEN 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 1.10) in the ANSWER BOOK, e.g. 1.11 D.

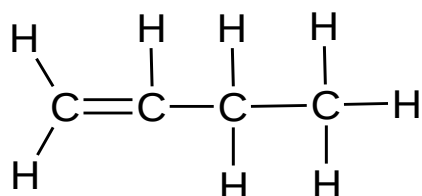
- 1.1 What is the IUPAC name of the organic molecule with the following structural formula:



- A Butane
B Methane
C Propane
D Pentane

(2)

- 1.2 A compound has the following structural formula:



This compound is a/an ...

- A alkene.
B alcohol.
C haloalkane.
D carboxylic acid.

(2)

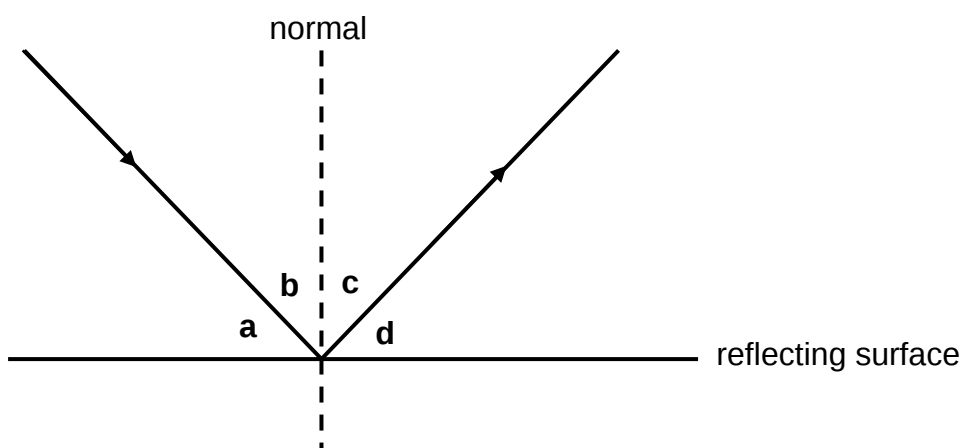
- 1.3 The vapour pressure of ethanol at 25 °C in a closed container will increase when ...
- A the ethanol is cooled to 4 °C.
 - B the ethanol is heated to 86 °C.
 - C water is added to the ethanol at 25 °C.
 - D carboxylic acid is added to the ethanol. (2)
- 1.4 When butane burns in excess oxygen, the products formed are ...
- A methane and water.
 - B carbon and hydrogen.
 - C carbon dioxide and water.
 - D carbon monoxide and hydrogen. (2)
- 1.5 Consider the statements below about a galvanic cell.
- (i) Reduction occurs at the cathode.
 - (ii) The type of reaction taking place is a redox reaction.
 - (iii) All electrochemical reactions involve the transfer of protons.
 - (iv) All galvanic cells involve the use of electricity to initiate non-spontaneous chemical reactions.
- Which ONE of the combinations below is INCORRECT?
- A (iv) only
 - B (i) and (iii)
 - C (iii) and (iv)
 - D (ii), (iii) and (iv) (2)
- 1.6 In the standard cell notation for a voltaic cell, the single vertical line ' | ' represents a ...
- A phase boundary.
 - B wire connection.
 - C gas electrode.
 - D salt bridge. (2)

1.7 Molten NaCl conducts electricity due to the presence of ...

- A atoms of Na and Cl.
- B free molecules.
- C free electrons.
- D free ions.

(2)

1.8 Consider the diagram below. The letters **a**, **b**, **c** and **d** represent angles as indicated. Which ONE of the following is TRUE when light rays are reflected from a surface?



- A $\angle a = \angle c$
- B $\angle b = \angle c$
- C $\angle b = \angle d$
- D $\angle a = \angle b$

(2)

1.9 The following devices use electromagnetic waves to function.

A



Counterfeit money detector

B



TV remote control

Which ONE of the combinations of properties of electromagnetic waves below is CORRECT?

	A	B
A	Long wavelength	Short wavelength
B	Low frequency	High frequency
C	Photons have high energy	Photons have low energy
D	Small amplitude	Large amplitude

(2)

1.10 Which ONE of the following forms of energy production is NOT environmentally friendly?

- A Hydroelectric energy
- B Nuclear energy
- C Solar energy
- D Wind energy

(2)
[20]

QUESTION 2 (Start on a new page.)

The questions below refer to the six organic compounds represented in TABLE 1 below.

TABLE 1

A	$\text{H}-\text{C}\equiv\text{C}-\text{H}$	B	$\begin{array}{c} \text{Br} \\ \\ \text{H}-\text{C}-\text{H} \\ \\ \text{Br} \end{array}$
C	$\begin{array}{c} \text{OH} \\ \\ \text{H}-\text{C}-\text{H} \\ \\ \text{H} \end{array}$	D	$\begin{array}{c} \text{OH} \\ \\ \text{O}=\text{C}-\text{H} \end{array}$
E	Methyl ethanoate	F	Ethanal

- 2.1 Define the term *homologous series*. (2)
- 2.2 Write down the LETTER of the compound belonging to the following homologous series:
- 2.2.1 Alcohols (1)
- 2.2.2 Carboxylic acids (1)
- 2.2.3 Alkynes (1)
- 2.2.4 Haloalkanes (1)
- 2.2.5 Esters (1)
- 2.3 Write down the NAME of the next member in the homologous series of compound **F**. (1)

2.4 Which of these compounds is used in the oxyacetylene flame during welding? (1)

2.5 Write down the structural formula of the FUNCTIONAL GROUP of the organic molecules represented by:

2.5.1 D (2)

2.5.2 F (2)

Consider the organic molecules in TABLE 2 below.

TABLE 2

G butane	H <pre> H H H H — C — C — C — H H H H — C — H H </pre>
I <pre> H H H H — C — C — C — Cl H H H </pre>	J 2-chloropropane

2.6 Differentiate between CHAIN and POSITIONAL isomers. (4)

2.7 Which of the organic molecules in TABLE 2 are:

2.7.1 Chain isomers (1)

2.7.2 Positional isomers (1)

2.8 Write down the IUPAC NAME of molecule:

2.8.1 H (2)

2.8.2 I (2)

2.9 Write down the structural formula of molecule **J**. (2)

[25]

QUESTION 3 (Start on a new page.)

3.1 Identify the type of intermolecular forces acting in:

3.1.1 Propane (1)

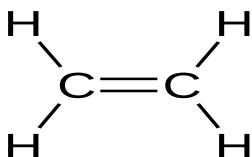
3.1.2 Propanal (2)

3.2 How does the strength of the intermolecular force influence the boiling point of organic molecules? (1)

3.3 3.3.1 Which one, ethanal or pentanal, will have the highest vapour pressure? (1)

3.3.2 Explain the answer to QUESTION 3.3.1. (4)

3.4 Below is the structural formula of a monomer.

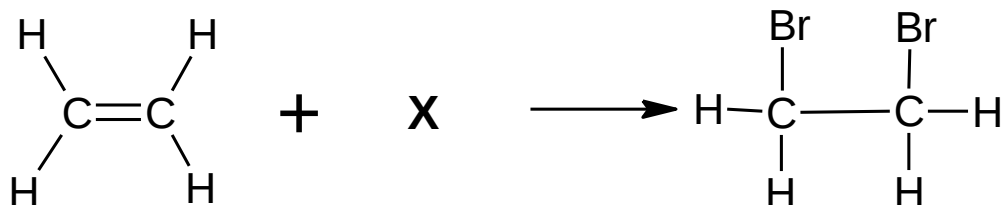


3.4.1 Define the term *monomer*. (2)

3.4.2 Write down the NAME of the polymer formed from the monomer given above. (1)
[12]

QUESTION 4 (Start on a new page.)

- 4.1 The equation below represents a reaction taking place in a sealed container. **X** represents an unknown reagent.



- 4.1.1 Write down the NAME or FORMULA of unknown reagent **X**. (1)
- 4.1.2 Write down the TYPE of reaction. Choose from ADDITION or SUBSTITUTION. (1)
- 4.1.3 Write down the NAME of the type of reaction in QUESTION 4.1.2. (1)
- 4.1.4 Write down the IUPAC name of the product formed. (2)
- 4.2 Refer to the following organic compounds:

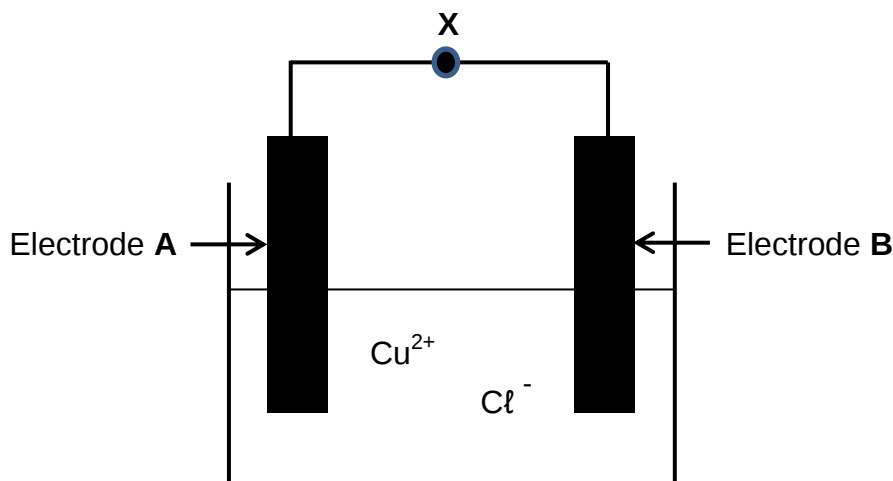
TABLE 3

A	B
2-chloropropane	$ \begin{array}{c} \text{H} \\ \\ \text{H}-\text{C}-\text{H} \\ \\ \text{H}-\text{C}-\text{C}-\text{C}-\text{H} \\ \quad \quad \\ \text{H} \quad \text{H} \quad \text{H} \end{array} $

- Which ONE of the compounds will be more likely to undergo an oxidation (combustion) reaction? Write down **A** or **B**. (1)
- 4.3 2-chloropropane undergoes a substitution reaction to form an alcohol.
- 4.3.1 Write down the TYPE of substitution reaction. (1)
- 4.3.2 Name ONE condition needed for this reaction. (1)
- [8]**

QUESTION 5 (Start on a new page.)

The diagram below represents an ELECTROLYTIC CELL used in the decomposition of copper (II) chloride solution. Symbol **X** represents a component of the electrolytic cell. When the cell is in operation, cations (positive ions) are attracted to electrode **A**.



- 5.1 Write down the NAME of component **X**. (1)
- 5.2 Give a reason why component **X** is important in the cell above. (2)
- 5.3 Redraw the diagram above in your ANSWER BOOK and label both the anode and cathode, as well as component **X**. Indicate component **X** with the CORRECT symbol. (3)
- 5.4 Write down the chemical formula of the electrolyte. (1)
- 5.5 Compare the anode and the cathode with regard to the following:
- 5.5.1 Type of half-reaction (2)
- 5.5.2 Polarity of the electrode (2)
- 5.6 Write down the half-reaction that takes place at the negative electrode. (2)
- 5.7 Write down the net cell reaction for the cell above. (3)
- [16]**

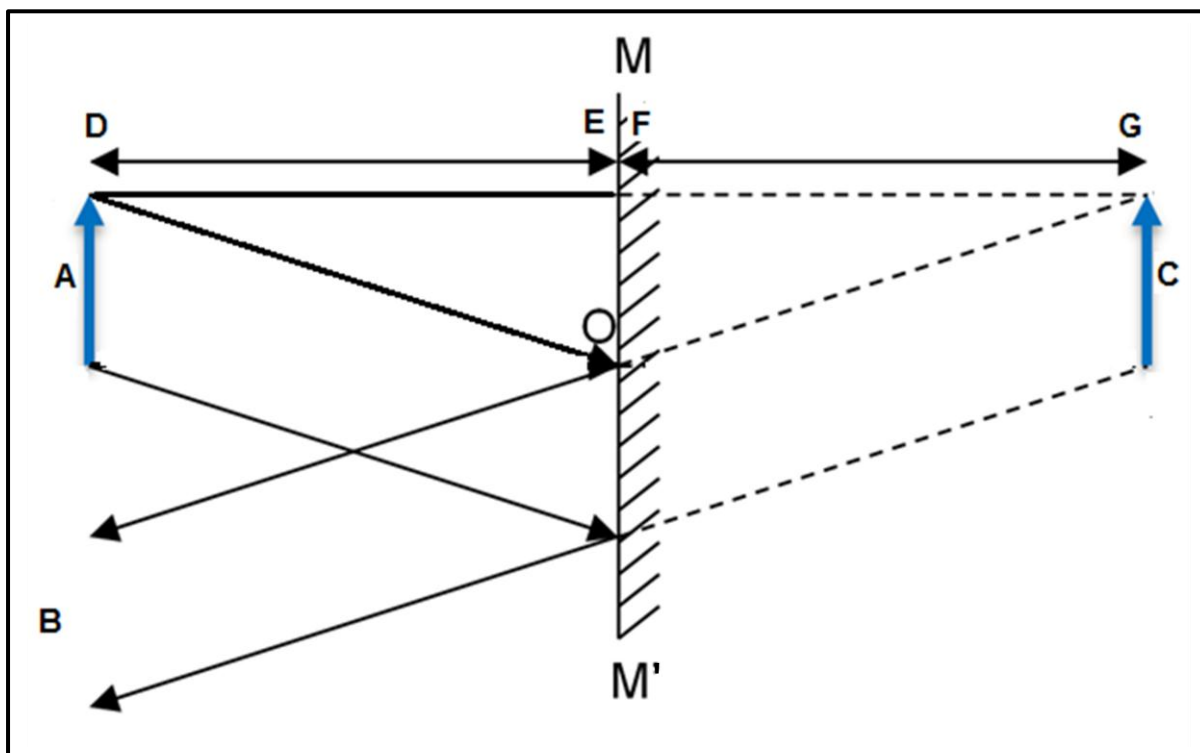
QUESTION 6 (Start on a new page.)

A spontaneous electrochemical cell is set up under standard conditions using Ni and Ag as electrodes.

- 6.1 Choose ONE word from the statement above that indicates that the cell is a galvanic cell. (1)
- 6.2 Define the following:
- 6.2.1 Galvanic cell (2)
- 6.2.2 Electrolyte (2)
- 6.3 What energy conversion will take place in the cell above? (2)
- 6.4 Which ONE of the electrodes is the cathode? (1)
- 6.5 Write down the half-reaction at the cathode. (2)
- 6.6 Calculate the emf of the cell under standard conditions. (4)
- 6.7 Write down the cell notation for the cell above. (3)
- 6.8 Worldwide interest in renewable energy technologies continues to see strong growth each year. The outlook remains positive, especially for alternative solar energy technology applications.
- 6.8.1 Name ONE alternate energy source, besides solar energy. (1)
- 6.8.2 Name THREE uses of a photovoltaic cell. (3)
- [21]**

QUESTION 7 (Start on a new page.)

- 7.1 Mirrors produce images with a number of distinguishable characteristics. The diagram below shows an object and its image as observed in mirror **MOM'**.



- 7.1.1 What type of a mirror is shown in the diagram above? (1)
- 7.1.2 Which phenomenon of light is demonstrated in the diagram? (1)
- 7.1.3 State the law of the phenomenon in QUESTION 7.1.2. (2)
- 7.1.4 Write down THREE properties of the image observed. (3)
- 7.2 Choose a word(s) from the list below that match(es) the letters **A**, **B** and **C** in the diagram above. Write only the word(s) next to the question numbers (7.2.1 to 7.2.3) in the ANSWER BOOK.

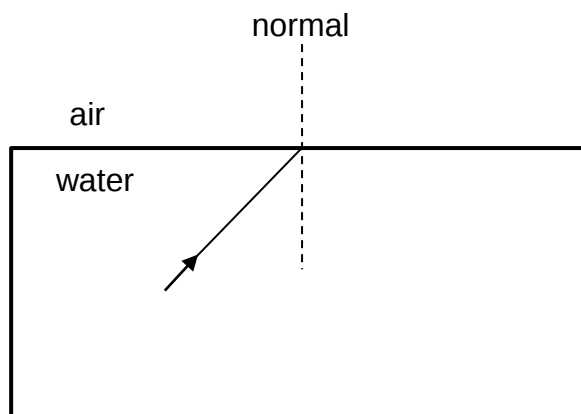
lens;	object;	mirror;	normal;	image;	eye of the observer
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- 7.2.1 A (1)
- 7.2.2 B (1)
- 7.2.3 C (1)
- 7.3 Consider the distances **DE** and **FG** in the diagram above.
- 7.3.1 What is the relationship between distances **DE** and **FG**? (1)
- 7.3.2 How will an increase in the size of object **A** influence distance **FG**? Choose from INCREASES, DECREASES or REMAINS THE SAME. (1)

[12]

QUESTION 8 (Start on a new page.)

- 8.1 In the diagram below, a ray of light moves from water into air, with an angle of incidence of 49° .



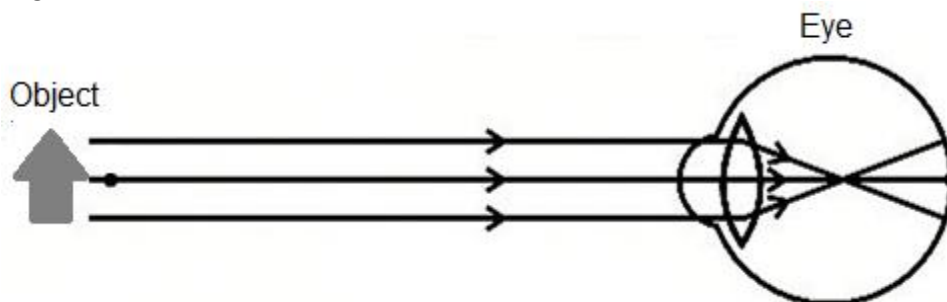
The critical angle for water/air is 49° .

- 8.1.1 What will be observed at the boundary of the two media when the incidence angle is equal to the critical angle? (1)
- 8.1.2 Redraw the diagram above in your ANSWER BOOK to indicate the path of the ray when the incident angle is increased to 65° . Label ALL rays and the magnitude of the angles. (3)
- 8.1.3 What is this phenomenon observed called? (1)
- 8.2 Dispersion is an observable property of light.
- 8.2.1 Define the term *dispersion*. (2)
- 8.2.2 Draw a labelled ray diagram of the dispersion of white light from air through a triangular prism. Indicate and name the colour that is refracted the MOST and the LEAST. (4)
- 8.2.3 How many OTHER colours are in the spectrum of white light, besides the two colours mentioned in QUESTION 8.2.2? (1)
- 8.2.4 Define the term *refraction*. (2)
- 8.2.5 Explain why white light spreads out into different colours when it passes through a triangular prism by referring to REFRACTION, WAVELENGTH and SPEED. (3)
- [17]**

QUESTION 9 (Start on a new page.)

9.1 Write down TWO differences between a *concave lens* and a *convex lens*. (4)

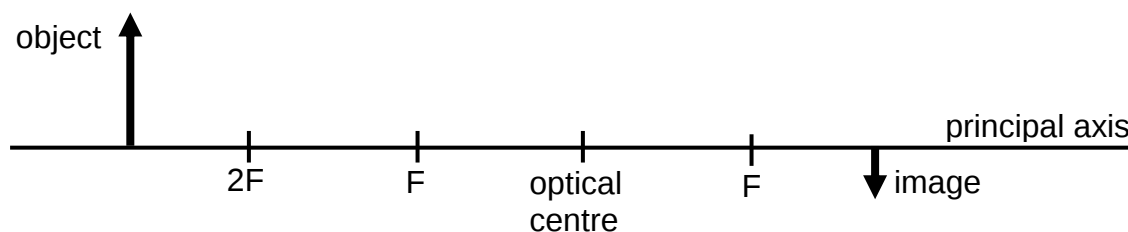
9.2 Some people's eyes are unable to focus on nearby objects, as indicated in the diagram below.



9.2.1 Write down the NAME of the eye condition as shown in the diagram above. (1)

9.2.2 Which type of lens can be used to correct the condition named in QUESTION 9.2.1? (1)

9.3 The diagram below shows the formation of an image when rays of light pass through an unknown lens. The object, the image, the optical centre and the principal axis are indicated.



Redraw the diagram in your ANSWER BOOK. Indicate ALL the rays and the CORRECT type of lens.

(5)
[11]

QUESTION 10 (Start on a new page.)

10.1 Define the term *electromagnetic waves*. (2)

10.2 The electromagnetic spectrum consists of the following electromagnetic waves: ultraviolet rays, microwaves, X-rays, gamma rays, radio waves, infrared rays.

Which electromagnetic wave has the:

10.2.1 Longest wavelength (1)

10.2.2 Highest frequency (1)

10.3 A photon of blue light has an energy of $1,75 \times 10^{-48}$ J.

Determine, by means of a calculation, whether a photon of light with a frequency of $7,50 \times 10^{14}$ Hz is a photon of GREEN light or of INDIGO light. (4)
[8]

TOTAL: 150

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

TABLE 1/TABEL 1: PHYSICAL CONSTANTS/FISIIESE KONSTANTES

NAME/NAAM	SYMBOL/SIMBOOL	VALUE/WAARDE
Standard pressure <i>Standaarddruk</i>	p^θ	$1,01 \times 10^5 \text{ Pa}$
Standard temperature <i>Standaardtemperatuur</i>	T^θ	$273 \text{ K}/0^\circ \text{C}$
Speed of light <i>Spoed 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	$E_{\text{cell}}^\theta = E_{\text{cathode}}^\theta - E_{\text{anode}}^\theta$ / $E_{\text{sel}}^\theta = E_{\text{katode}}^\theta - E_{\text{anode}}^\theta$ or/of $E_{\text{cell}}^\theta = E_{\text{reduction}}^\theta - E_{\text{oxidation}}^\theta$ / $E_{\text{sel}}^\theta = E_{\text{reduksie}}^\theta - E_{\text{oksidasie}}^\theta$ or/of $E_{\text{cell}}^\theta = E_{\text{oxidising agent}}^\theta - E_{\text{reducing agent}}^\theta$ / $E_{\text{sel}}^\theta = E_{\text{okseermiddel}}^\theta - E_{\text{reduseermiddel}}^\theta$
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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
$Cl_2(g) + 2e^- \rightleftharpoons 2Cl^-$		+ 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
$2H^+ + 2e^- \rightleftharpoons H_2(g)$		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
$Al^{3+} + 3e^- \rightleftharpoons Al$		- 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

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

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		

KEY/SLEUTEL

Atomic number
Atoomgetal

Electronegativity
Elektronegatiwiteit

Symbol
Simbool

Approximate relative atomic mass
Benaderde relatiewe atoommassa

29
Cu
63,5

KEY/SLEUTEL

Atomic number
*Atoomgetal*Electronegativity
*Elektronegatiwiteit*Symbol
*Simbool*Approximate relative atomic mass
Benaderde relatiewe atoommassa