Province of the
EASTERN CAPE
EDUCATION

NATIONAL SENIOR CERTIFICATE

GRADE 12

SEPTEMBER 2022

TECHNICAL SCIENCES P2

MARKS: **75**

TIME: **1½ hours**

This question paper consists of 14 pages, including 4 data sheets.

INSTRUCTIONS AND INFORMATION

1. This question paper consists of SEVEN 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, for example between QUESTION 2.1 and QUESTION 2.2.

5. You may use a non-programmable calculator.

6. You may use appropriate mathematical instruments.

7. You are advised to use the attached DATA SHEETS.

8. Show ALL formulae and substitutions in ALL calculations.

9. Round off your FINAL numerical answers to a minimum of TWO decimal places.

10. Give brief motivations, discussions, etc. where required.

11. 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, for example 1.6 D.

1.1. Which ONE of the following general formulae represents alkynes?

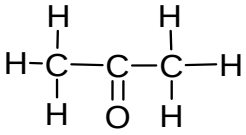
A C_nH_{2n-2}

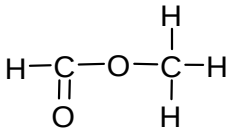
B C_nH_{2n-1}

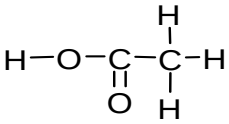
C C_nH_{2n}

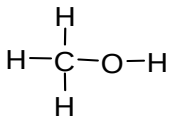
D C_nH_{2n+2} (2)

1.2 Which ONE of the following compounds represents a ketone?

A 

B 

C 

D 

(2)

1.3 Solar cells use p-n junction to convert sunlight directly into a(n) …

A magnetic field.

B electric field.

C magnetic flux.

D electric current. (2)

1.4 In which ONE of the following options are the three compounds listed in increasing order of vapour pressure?

A propanoic acid, pentane, butan-1-ol

B propanoic acid, butan-1-ol, pentane

C pentane, butan-1-ol, propanoic acid

D butan-1-ol, propanoic acid, pentane (2)

1.5 The cell notation for a standard Zn-Cu electrochemical cell is:

A $Cu^{2+}(aq) / Cu(s) // Zn(s) / Zn^{2+}(aq)$

B $Zn(s) / Zn^{2+}(aq) // Cu^{2+}(aq) / Cu(s)$

C $Cu(s) / Zn^{2+}(aq) // Cu^{2+}(aq) / Zn(s)$

D $Zn(s) / Zn^{2+}(aq) // Cu(s) / Cu^{2+}(aq)$ (2)

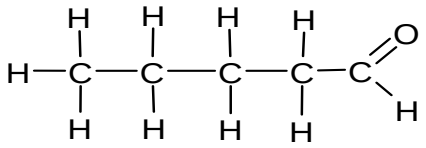
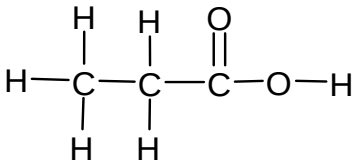
[10]

QUESTION 2 (Start on a new page.)

Organic chemistry is the chemistry of organic molecules divided into homologous series which are identified by the functional groups.

2.1 Define the term *hydrocarbons*. (2)

2.2 Consider the organic molecules listed below:

A hex-2-ene	**B** 
C 3-Chloro-But-1-ene	**D** 

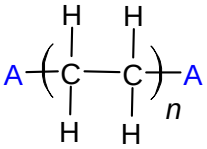
2.2.1 Define the term *isomers* in words. (2)

2.2.2 Draw the structural formula of a positional isomer of **A**. (2)

2.2.3 Write down the name of the homologous series to which **B** belongs. (1)

2.2.4 Give the IUPAC name for the chain isomer of compound **C**. (2)

2.3 The diagram below shows a monomer of the organic compound used for polyethylene. This is the industrial organic product used in the preparation of plastics.



Define the term *monomer* in words. (2)

[11]

QUESTION 3 (Start on a new page.)

The table below shows the vapour pressure of various organic compounds at 25 ˚C.

Compound	Molar mass ($g\ mol^{-1}$)	Vapour pressure ($x10^2$ Pa)
pentane	72	573,0
hexane	86	160,0
propan-1-ol	60	21,0
propan-2-ol	60	44,0
butan-1-ol	74	6,2
butan-2-ol	74	18,3
pentan-1-ol	88	2,2
pentan-2-ol	88	8,04
ethanoic acid	60	15,3
propanone	58	240,0

3.1 Write down the general formula of the homologous series to which pentane belongs. (1)

3.2 Draw the structural formula of propanone. (2)

3.3 Give the name of a **functional** isomer of propanone. (1)

3.4 Write down the name of the intermolecular forces involved in:

3.4.1 Alcohols (1)

3.4.2 Alkanes (1)

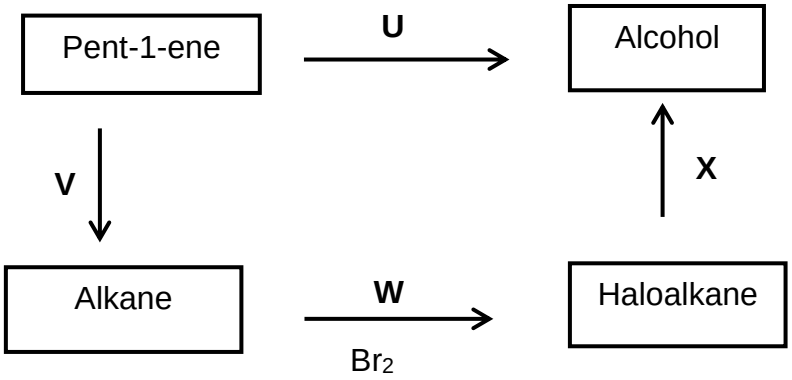
3.5 Refer to the table of organic compounds above to state and explain the relationship between vapour pressure and the strength of intermolecular forces. (2)

3.6 Which compound will have the higher boiling point:
Ethanoic acid or propan-1-ol?

Explain by referring to type of intermolecular forces and energy. (3)
[11]

QUESTION 4 (Start on a new page.)

Pent-1-ene can be converted to other compounds by means of different organic reactions represented by **U**, **V**, **W** and **X**, as shown below.



4.1 Write down the TYPE of the reaction represented by:

4.1.1 **U** (1)

4.1.2 **W** (1)

4.1.3 **V** (1)

4.2 During reaction **X**, the alkyl halide (haloalkane) reacts.

4.2.1 Give the NAME of a suitable base used. (1)

4.2.2 Name TWO reaction conditions for reaction **X**. (2)

4.2.3 Write down the balanced reaction using structural formulae for the reaction of Pent-1-ene with hydrogen bromide to form a haloalkane. (3)

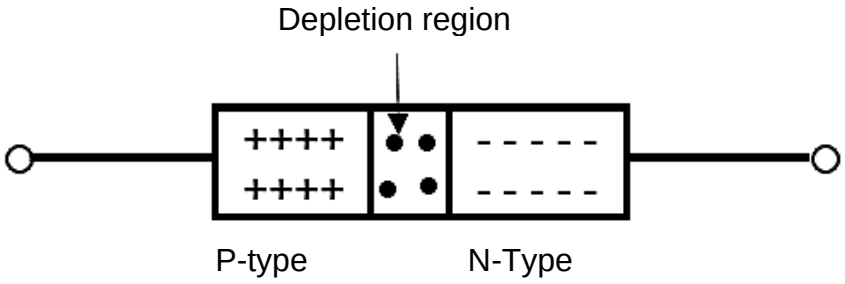
4.3 Fossil fuels are formed by the natural process of decomposition of organisms under heat and pressure. They contain a high percentage of carbon and include fuels such as coal, petrol and natural gases. Alkanes are the most important fossil fuels. The combustion of alkanes (also known as oxidation) is highly exothermic.

Write down a balanced reaction for the complete combustion of pentane. (3)

[12]

QUESTION 5 (Start on a new page.)

Semiconductor devices such as diodes are widely used in modern electronics.



Diode

5.1 Define the term *semiconductor* in words. (2)

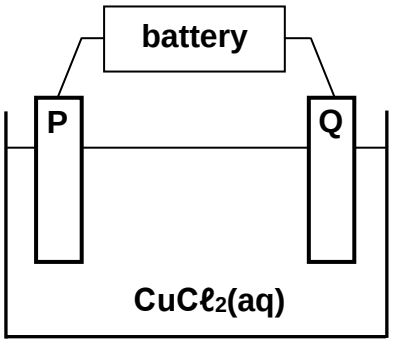
5.2 Phosphorus was added to silicon in small quantities. It was then found that the electrical conductivity of silicon improved.

5.2.1 Identify the described process in the above statement. (1)

5.2.2 What type of a semiconductor material (P-type or N-type) is formed during this process? Give a reason for your answer. (2)
[5]

QUESTION 6 (Start on a new page.)

In the electrolytic cell, represented below, two CARBON RODS are used as electrodes and a concentrated copper (II) chloride solution is used as an electrolyte.



When the cell is functioning, the following **observations** are made:

- A gas is released at electrode **P**
- Electrode **Q** is coated with a reddish-brown layer

6.1 Define the term *electrolyte.* (2)

6.2 Write down a half-reaction to explain the observation made at:

6.2.1 Electrode **P** (2)

6.2.2 Electrode **Q** (2)

6.3 Write down the energy conversion that is taking place in this cell. (1)

6.4 Which electrode, **P** or **Q**, is the cathode? Give a reason for your answer. (2)

6.5 The carbon rods in the above cell are now replaced with COPPER RODS. The following observations are made at electrode **P**:

- No gas is released
- Its surface appears rough and eroded

6.5.1 Refer to the RELATIVE STRENGTHS OF REDUCING AGENTS to explain this observation. (3)

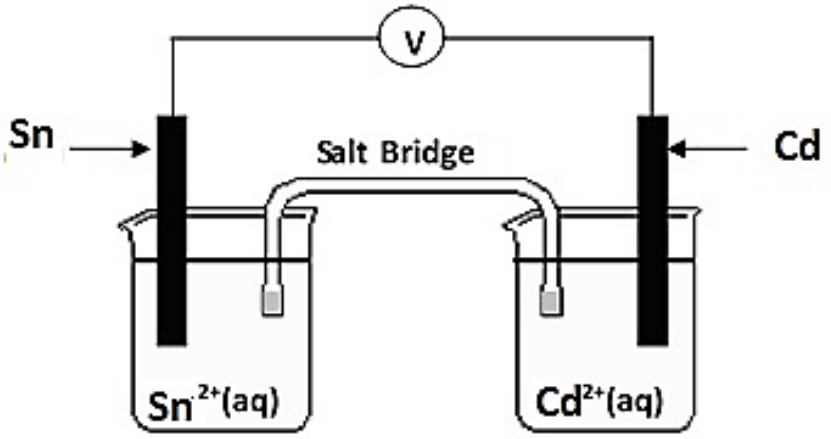
6.5.2 This cell can be used for the electroplating of a bracelet in the industry. Which electrode (**P** or **Q**) will be replaced with a bracelet during the electroplating process? (1)

[13]

QUESTION 7 (Start on a new page.)

The potential difference of a galvanic cell, measured experimentally by learners in a Technical Sciences laboratory, is COMPARED with its potential difference calculated at standard conditions.

They set up the galvanic cell shown below.



The voltmeter measures an initial reading of **0,19 V**.

7.1 Write down the energy conversion that takes place in this cell. (1)

7.2 State ONE function of the salt bridge. (1)

7.3 Write down the half-reaction that takes place at the anode. (2)

7.4 In which direction do electrons flow in the external circuit when this cell delivers a current?

Write down only **FROM Sn TO Cd** or **FROM Cd TO Sn**. (1)

7.5 Write down the balanced net (overall) cell reaction. (3)

7.6 Use the Table of STANDARD REDUCTION POTENTIALS to calculate the initial potential difference (emf) of the above cell at STANDARD CONDITIONS. (3)

7.7 From the results obtained, the learners concluded that the measured potential difference differs from the calculated potential difference.

Give TWO possible reasons for this difference in values. (2)
[13]

TOTAL: 75

NATIONAL SENIOR CERTIFICATE
NASIONALE SENIOR SERTIFIKAAT

DATA FOR TECHNICAL SCIENCES GRADE 12
PAPER 2 (CHEMISTRY)

GEGEWENS VIR TEGNIESE WETENSKAPPE GRAAD 12
VRAESTEL 2 (CHEMIE)

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

NAAM/*NAME*	SIMBOOL/*SYMBOL*	WAARDE/*VALUE*
Standard pressure *Standaarddruk*	p^{θ}	$1{,}013 \times 10^5$ Pa
Standard temperature *Standaardtemperatuur*	T^{θ}	273 K

TABLE 2: FORMULAE/*TABEL 2: FORMULES*

$E^{\theta}_{cell} = E^{\theta}_{cathode} - E^{\theta}_{anode}$ / $E^{\theta}_{sel} = E^{\theta}_{katode} - E^{\theta}_{anode}$

$E^{\theta}_{cell} = E^{\theta}_{reduction} - E^{\theta}_{oxidation}$ / $E^{\theta}_{sel} = E^{\theta}_{reduksie} - E^{\theta}_{oksidasie}$

$E^{\theta}_{cell} = E^{\theta}_{oxidising\ agent} - E^{\theta}_{reducing\ agent}$ / $E^{\theta}_{sel} = E^{\theta}_{oksideermiddel} - E^{\theta}_{reduseermiddel}$

TABLE 3: THE PERIODIC TABLE OF ELEMENTS/*TABEL 3: DIE PERIODIEKE TABEL VAN ELEMENTE*

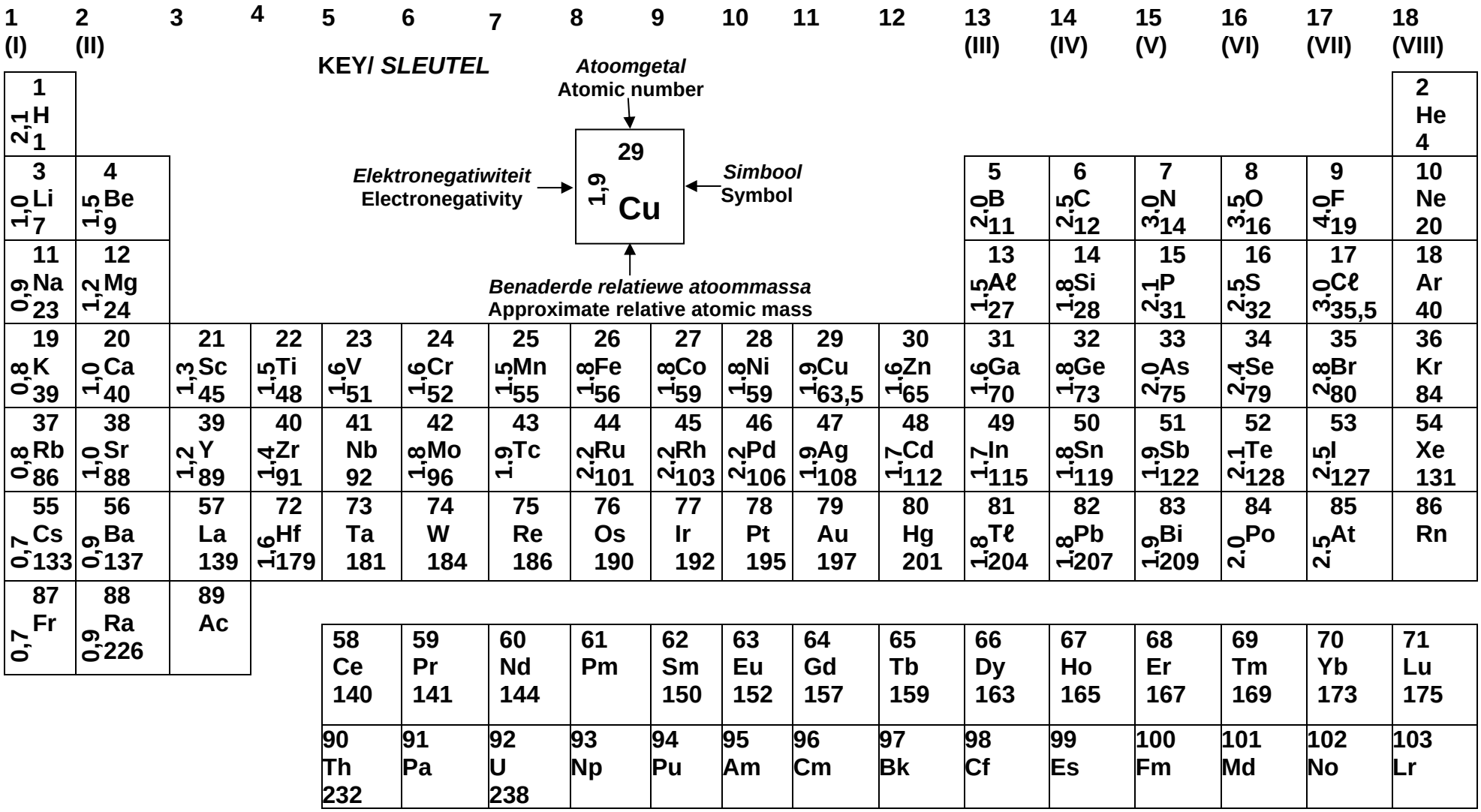


TABLE 4A: STANDARD REDUCTION POTENTIALS
TABEL 4A: STANDAARD REDUKSIEPOTENSIALE

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

Increasing reducing ability/*Toenemende reduserende vermoë* ↑