Province of the
EASTERN CAPE
EDUCATION

NATIONAL SENIOR CERTIFICATE

GRADE 12

SEPTEMBER 2023

TECHNICAL SCIENCES P2

MARKS: **75**

TIME: **1½ hours**

This question paper consists of 15 pages, including 4 data sheets.

INSTRUCTIONS AND INFORMATION

1. 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. You may use a non-programmable calculator.
5. Leave ONE line open between sub questions, i.e. QUESTION 2.1 and QUESTION 2.2.
6. You are advised to use the attached DATA SHEETS.
7. Show ALL formulae and substitutions in ALL calculations.
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 answers to the following questions. Choose the answer and write only the correct letter (A–D) next to the question numbers (1.1 to 1.5) in the ANSWER BOOK, for example 1.6 D.

1.1 $C_nH_{2n+1}OH$ is the GENERAL FORMULA for …

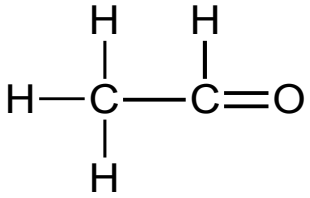
A alkanes.

B aldehydes.

C alcohols.

D alkenes. (2)

1.2 Consider the structural formula of an organic compound below.



Which ONE of the following is the correct IUPAC name of this compound?

A Ethanone

B Ethene

C Ethanol

D Ethanal (2)

1.3 Which ONE of the following is an unsaturated hydrocarbon?

A $CH_3CH_2CH_2OH$

B CH_2CHCH_3

C $CH_3CH_2(CH_2)_2CH_2CH_3$

D CH_3COOCH_3 (2)

1.4 Which ONE of the following redox reactions will occur spontaneously?

A $Cu(s) + 2H^+ \rightarrow Cu^{2+} + H_2(g)$

B $Mg(s) + 2H^+ \rightarrow Mg^{2+} + H_2(g)$

C $2Ag(s) + 2H^+ \rightarrow 2Ag^+ + H_2(g)$

D $Hg(\ell) + 2H^+ \rightarrow Hg^{2+} + H_2(g)$ (2)

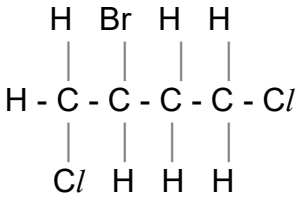
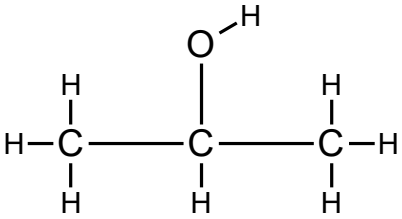
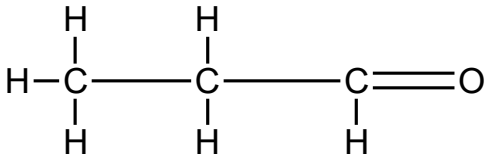
1.5 What will happen at the negative electrode of a voltaic (galvanic) cell and at the negative electrode of an electrolytic cell?

	Voltaic (galvanic) cell	**Electrolytic cell**
A	Oxidation	Reduction
B	Reduction	Oxidation
C	Oxidation	Oxidation
D	Reduction	Reduction

(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 their functional groups. The letters **A** to **H** in the table below represent eight organic compounds.

A	$CH_3CH_2CH(CH_3)CH_2OH$	**B**	$CH_3CH_2CH_2COOCH_2CH_3$
C		**D**	CH_2CH_2
E	Hexane	**F**	
G		**H**	$CH_3CH_2CO_2H$

2.1 Define the term *functional group.* (2)

2.2 Write down the:

2.2.1 Letter that represents a SECONDARY alcohol (1)

2.2.2 Name of the functional group of compound **H** (1)

2.2.3 Name of the homologous series to which compound **G** belongs (1)

2.2.4 IUPAC name of compound **C** (2)

2.2.5 NAME of the polymer formed from compound **D** (1)

2.2.6 Balanced equation, using MOLECULAR FORMULAE, for the combustion of compound **E** in excess oxygen (3)

2.2.7 IUPAC name of compound **A** (2)

2.2.8 General formula of the homologous series to which compound **B** belongs (1)

2.3. A few drops of fresh reddish-brown bromine water are added to compound **D** in a test tube.

2.3.1 Describe what will be observed in the test tube. (1)

2.3.2 Use structural formulae to write down a balanced equation for the reaction that takes place in the test tube. (4)

[19]

QUESTION 3 (Start on a new page.)

Two compounds **P** and **Q**, have the molecular formula $C_2H_4O_2$. (2)

3.1. What is meant by the term *structural isomers*?

3.2. Compound **P** has a lower vapour pressure than compound **Q**.

3.2.1 How will the boiling point of compound **P** compare to that of compound **Q**?

Only write HIGHER THAN, LOWER THAN, or EQUAL TO. (1)

3.2.2 Write down the NAME of compound **P**. (1)

3.2.3 To which class of organic compound does compound **Q** belong? (1)

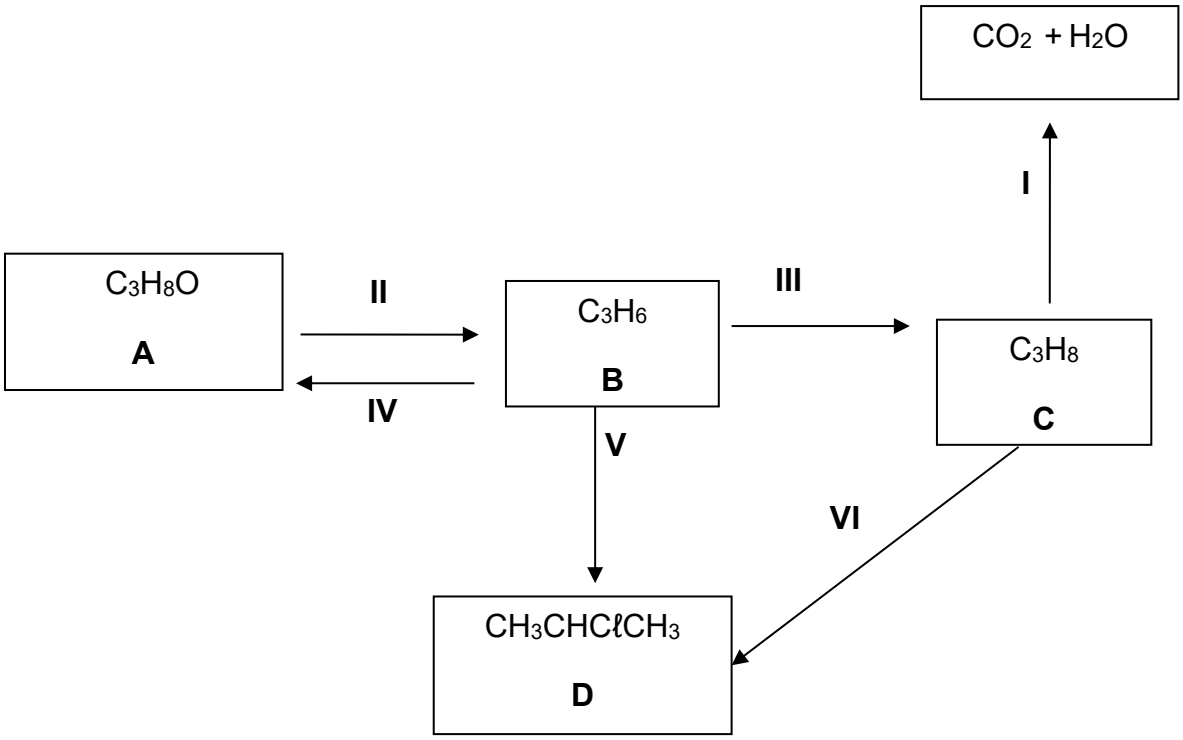
3.2.4 Write down the structural formula for compound **Q** and give its IUPAC name. (3)

3.2.5 Explain in terms of INTERMOLECULAR FORCES and ENERGY why compound **P** has a lower vapour pressure than compound **Q**. (3)

[11]

QUESTION 4 (Start on a new page.)

Consider the following sequence of organic reactions and answer the questions that follow. Reactions are labelled from **I** to **VI** while organic compounds are labelled from **A** to **D**.



4.1 Give the reagent needed for each of the following reactions:

4.1.1 Reaction **III** (1)

4.1.2 Reaction **V** (1)

4.2 Compound **A** is a major product of reaction **IV**.

4.2.1 Name the type of reaction that takes place. (1)

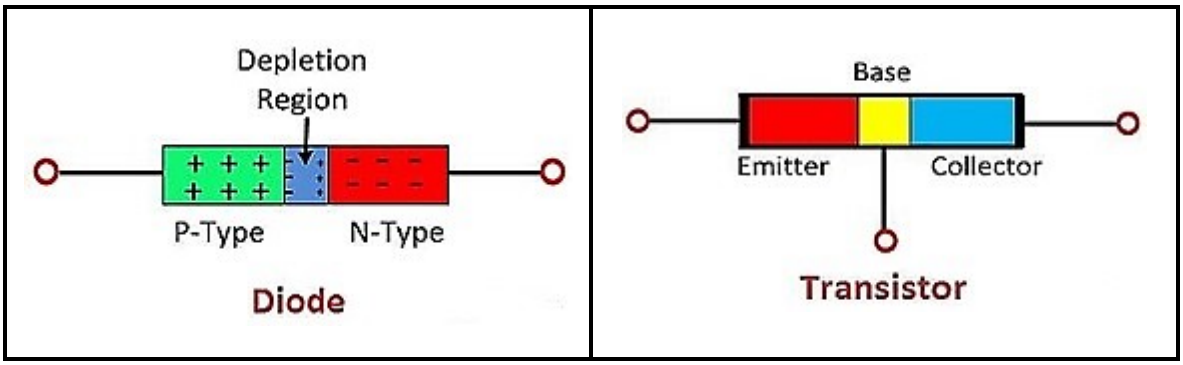
4.2.2 Write down the structural formula of compound **A**. (2)

4.3 Reaction **I** is a combustion reaction.

Write down the balanced chemical equation for this reaction. (2)
[7]

QUESTION 5 (Start on a new page.)

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



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

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

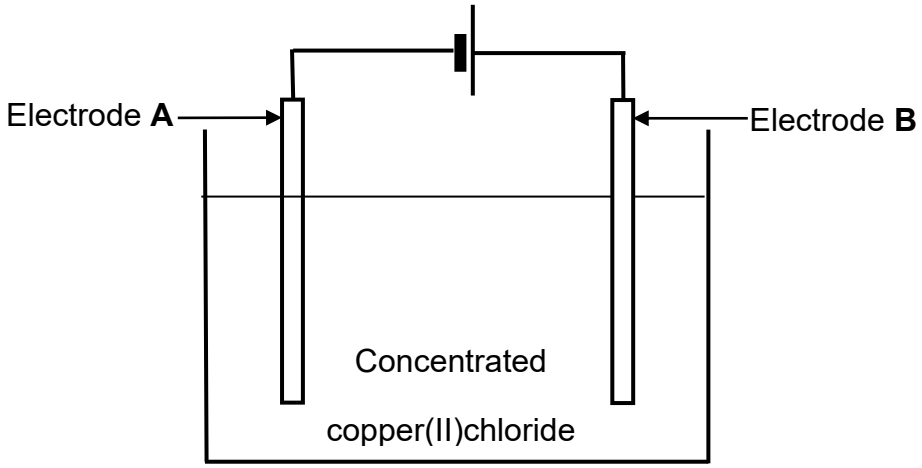
5.2.1 Name the process described in the above statements. (1)

5.2.2 What type of a semiconductor material is formed during this process? (1)

5.2.3 Give a reason for your answer in QUESTION 5.2.2. (1)
[5]

QUESTION 6 (Start on a new page.)

The diagram below represents an electrochemical cell used to decompose a concentrated copper(II)chloride solution using inactive electrodes.



6.1. Define the term *electrolysis* in words. (2)

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

6.3 At which electrode does reduction take place? Write down **A** or **B** only. (1)

6.4 Write down the:

6.4.1. NAME of the gas formed while the cell is functioning (1)

6.4.2. Half-reaction that takes place at electrode **A** (2)

6.4.3 NAME or FORMULA of the oxidising agent.
Give a reason for the answer (2)

6.4.4 NAME of a substance that can be used as electrodes in this cell (1)

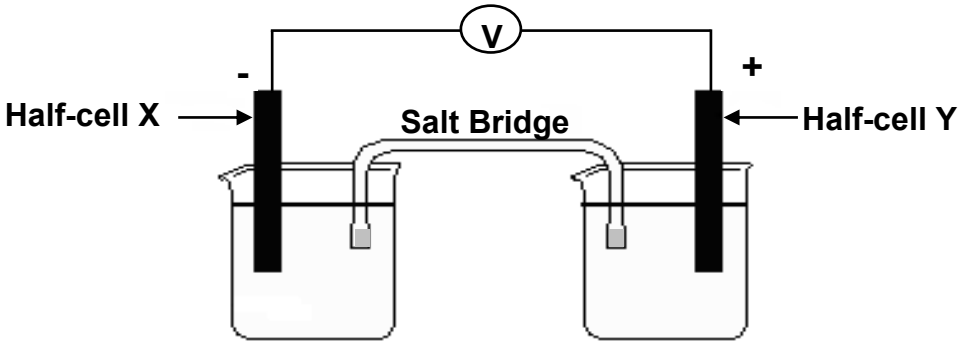
6.5. How does the concentration of the copper(II)chloride solution change as the reaction proceeds?

Write down INCREASES, DECREASES or NO CHANGE.

Give a reason for your answer. (2)
[12]

QUESTION 7 (Start on a new page.)

Learners use an electrochemical cell as shown in the diagram below in an investigation to compare the reducing abilities of different metals.



7.1 Name the type of electrochemical cell depicted in the diagram above. (1)

7.2 What will the voltmeter reading be if the salt bridge is removed? (2)

7.3 Name TWO standard conditions for this experiment. (2)

7.4 In their investigation, they use different combinations of half reactions as depicted in the table below, to compare the reducing abilities of Cu, Zn and Al. The cell potential for each combination of the half cells is recorded in the table below.

COMBINATION	Half-Cell X	Half-Cell Y	VOLTMETER READING (V)
1	Cu/Cu^{2+}	Al/Al^{3+}	-1,8
2	Al/Al^{3+}	Zn/Zn^{2+}	+0,8
3	Zn/Zn^{2+}	Cu/Cu^{2+}	+1,0

Write down a:

7.4.1 Possible reason why the voltmeter reading for a copper-aluminium cell is negative (2)

7.4.2 Suitable conclusion for this investigation (2)

7.5 Write down the NAME or SYMBOL of the:

7.5.1 Metal which is oxidised in COMBINATION 2 (1)

7.5.2 Reducing agent in COMBINATION 3 (1)
[11]

TOTAL: 75

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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
Molar gas volume at STP *Molêre gasvolume teen STD*	V_m	22,4 $dm^3 \cdot mol^{-1}$
Standard temperature *Standaardtemperatuur*	T^θ	273 K
Charge on electron *Lading op elektron*	e	$-1{,}6 \times 10^{-19}$ C
Avogadro's constant *Avogadro se konstante*	N_A	$6{,}02 \times 10^{23}$ mol^{-1}

TABLE 2: FORMULAE/*TABEL 2: FORMULES*

$n = \frac{m}{M}$ **OR/OF** $n = \frac{N}{N_A}$ **OR/OF** $n = \frac{V}{V_m}$	$c = \frac{n}{V}$ **OR/OF** $c = \frac{m}{MV}$ $\frac{c_a V_a}{c_b V_b} = \frac{n_a}{n_b} P$ $pV = nRT$	$pH = -\log[H_3O^+]$ $K_w = [H_3O^+][OH^-] = 1 \times 10^{-14}$ at /by 298K
$E^\theta_{cell} = E^\theta_{cathode} - E^\theta_{anode}$ / $E^\theta_{sel} = E^\theta_{katode} - E^\theta_{anode}$ $E^\theta_{cell} = E^\theta_{reduction} - E^\theta_{oxidation}$ / $E^\theta_{sel} = E^\theta_{reduksie} - E^\theta_{oksidasie}$ $E^\theta_{cell} = E^\theta_{oxidising\ agent} - E^\theta_{reducing\ agent}$ / $E^\theta_{sel} = E^\theta_{oksideermiddel} - E^\theta_{reduseermiddel}$		
$q = I\Delta t$ $n = \frac{Q}{e}$ **OR/OF** $n = \frac{Q}{q_e}$		

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

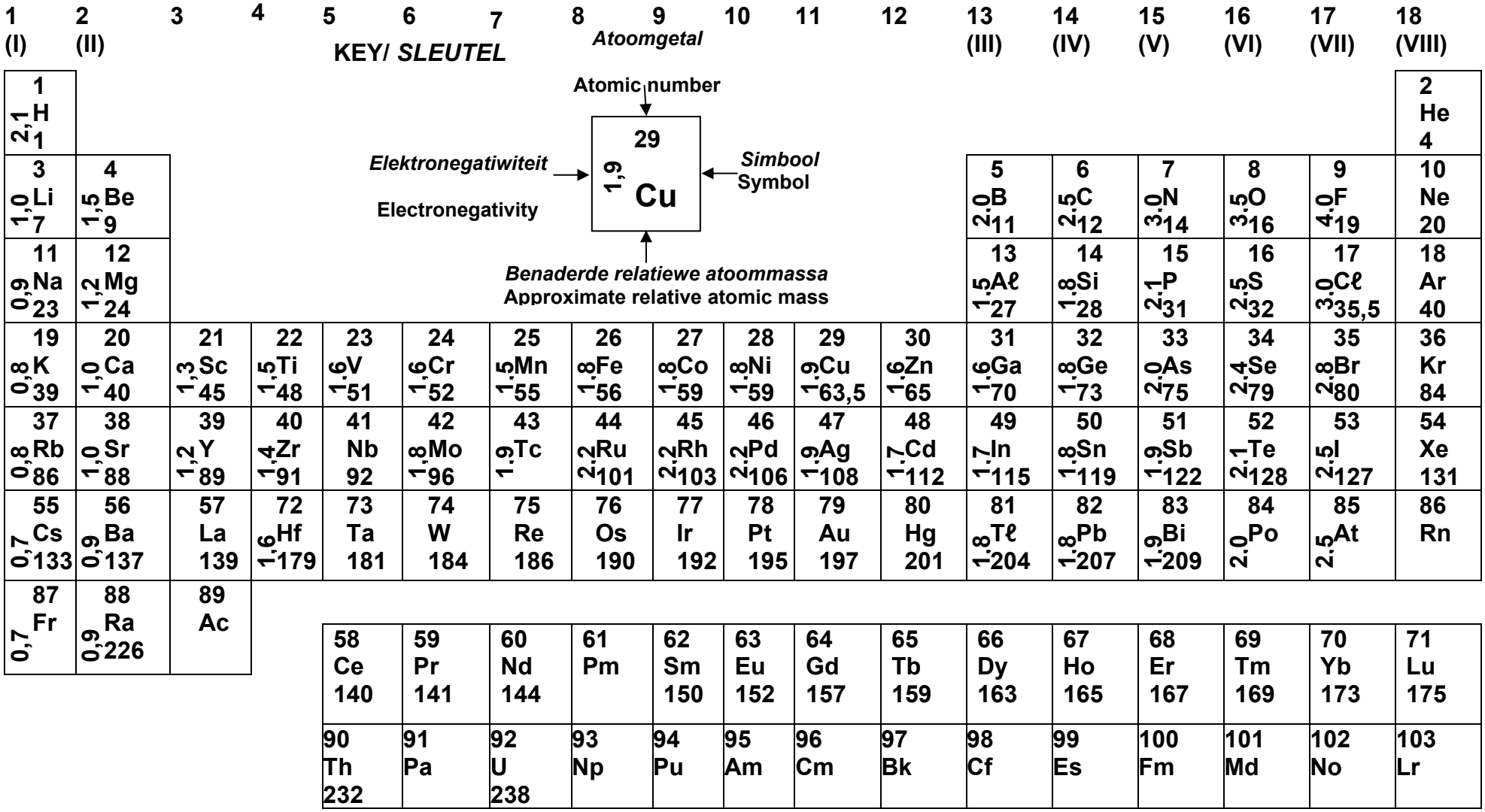

TABLE 4A: STANDARD REDUCTION POTENTIALS
TABEL 4A: STANDAARD REDUKSIEPOTENSIALE

Half-reactions/*Halfreaksies*			E^{θ}(V)
$F_2(g) + 2e^-$	$\rightleftharpoons$	$2F^-$	+ 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

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*