Province of the
EASTERN CAPE
EDUCATION

NATIONAL SENIOR CERTIFICATE

GRADE 12

JUNE 2023

TECHNICAL SCIENCES: CHEMISTRY P2

MARKS: **75**

TIME: **1½ hours**

This question paper consists of 14 pages, including 2 data sheets.

INSTRUCTIONS AND INFORMATION

1. Write your FULL NAME and SURNAME in the appropriate spaces in the ANSWER BOOK.
2. Answer ALL the questions.
3. Start each question on a NEW page in the ANSWER BOOK.
4. You may use a non-programmable calculator.
5. You may use appropriate mathematical instruments.
6. Number the answers according to the numbering system used in this question paper.
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 et cetera where required.
10. You are advised to use the attached DATA SHEETS.
11. Write neatly and legibly.

QUESTION 1: MULTIPLE-CHOICE QUESTIONS

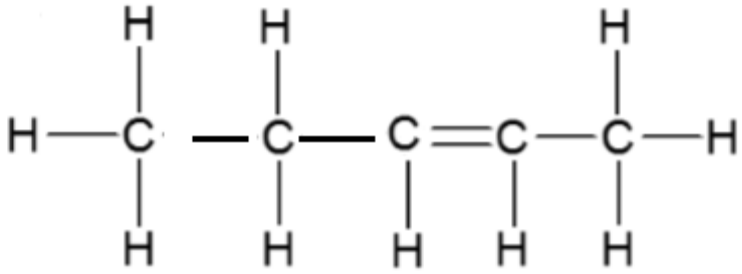
Various options are provided as possible answers to the following questions. Choose the answer and write only the letter (A–D) next to the question numbers (1.1 to 1.5) in the ANSWER BOOK, for example 1.6 E.

1.1 Which ONE of the following combinations is correct about the name of the functional group and homologous series?

	Name of the functional group	Homologous series
A	Carboxyl group	Ketone
B	Formyl group	Carboxylic acid
C	Carboxyl group	Aldehyde
D	Hydroxyl group	Alcohol

(2)

1.2 Consider the structural formula of the compound below and identify its correct IUPAC name and the type of hydrocarbon:



A Pent-3-ene; saturated

B Pent-2-ene; unsaturated

C 2-Pentane; unsaturated

D Pent-2-ene; saturated (2)

1.3 Study the organic reaction below and answer the following question.

$$CH_4 + O_2 \longrightarrow CO_2 + \mathbf{Y}$$

The substance that **Y** represents is …, and it is an … compound.

A water; organic

B water; inorganic

C carbon; organic

D methane; inorganic (2)

1.4 Which of the following set of answers is the correct arrangement of semiconductors?

	Valence electrons	**Arrangement of covalent bonds**	**Element**	**Material**
A	4	tetrahedral	carbon	diamond
B	4	hexagonal	diamond	carbon
C	5	tetrahedral	arsenic	phosphorous
D	5	pentagonal	germanium	silicon

(2)

1.5 Extrinsic and intrinsic semiconductors:

(i) In doping, an impurity is added to a semiconductor to improve the conductivity of the semiconductor
(ii) In doping, a catalyst is added to a semiconductor to improve the conductivity of the semiconductor
(iii) A few protons gain enough thermal energy to cross the energy gap (from the valence band) to the conduction band
(iv) Semiconductors are doped with a trivalent impurity
(v) A few electrons gain enough thermal energy to cross the energy gap (from the valence band) to the conduction band

Which ONE of the following combinations below is CORRECT?

A (i) and (ii)

B (ii) and (iii)

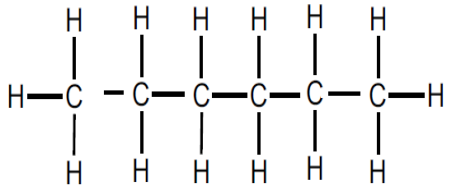
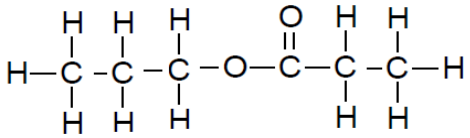
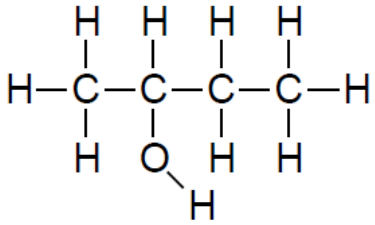
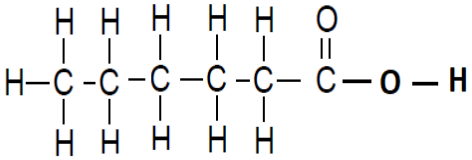
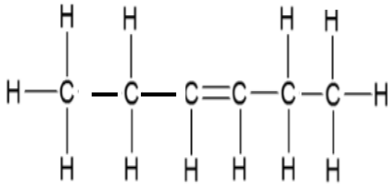
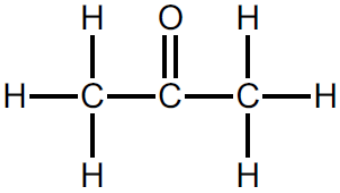
C (i) and (iv)

D (iii) and (iv) (2)

[10]

QUESTION 2 (Start on a NEW page.)

Consider the organic compounds represented by the letters **A** to **G** below and answer the questions that follow.

A	Hex-2-ene	**E**	2-methylpropan-2-ol
B		**F**	
C		**G**	
D		**H**	

2.1 Define the term *hydrocarbon*. (2)

2.2 Write down the letter(s) that represents the following:

2.2.1 A secondary alcohol (1)

2.2.2 A saturated hydrocarbon (1)

2.2.3 Functional isomers (2)

2.2.4 Hydrocarbons (1)

2.2.5 Positional isomers (2)

2.3 Write down the IUPAC name of the following:

2.3.1 **D** (1)

2.3.2 **H** (1)

2.3.3 **F** (2)

2.4 Write down the:

2.4.1 STRUCTURAL formula of compound **A** (2)

2.4.2 STRUCTURAL formula for the functional group of compound **D** (1)

2.4.3 MOLECULAR formula of compound **B** (1)

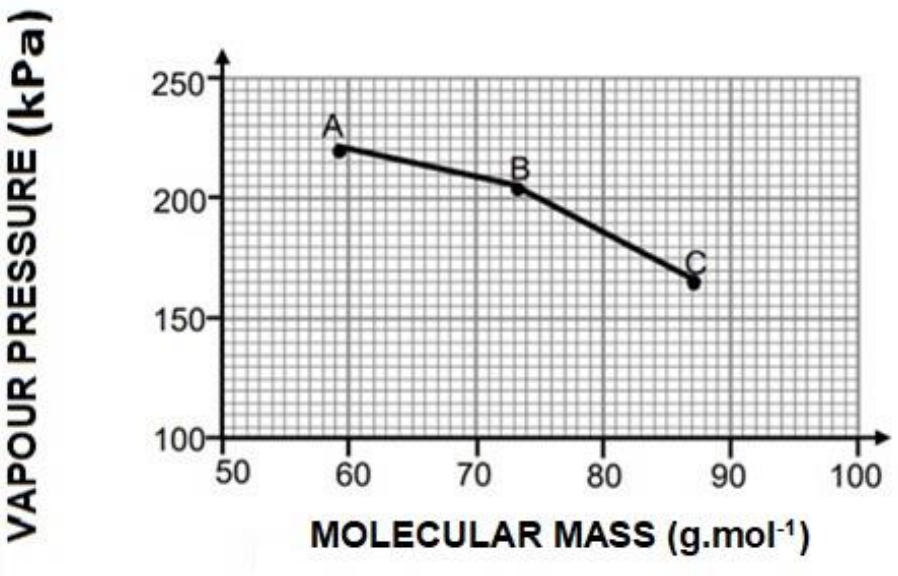
2.4.4 The name of a ketone (1)

2.4.5 STRUCTURAL formula of compound **E** (2)

[20]

QUESTION 3 (Start on a NEW page.)

Students were observing the vapour pressure of three (3) organic compounds from a homologous series with a general formula $\mathbf{C_nH_{2n+2}}$, represented by **A**, **B** and **C**. The number of carbon atoms of these organic compounds ranges between 3 carbon atoms and 5 carbon atoms. Their results were graphed as follows:



3.1 Define the term *homologous series*. (2)

3.2 What trend can be deduced from the graph? (2)

3.3 Identify the type of intermolecular forces that exist between the molecules of these organic compounds. (1)

3.4 Write down the names of the compounds in the graph represented by the following letters:

3.4.1 **A** (1)

3.4.2 **B** (1)

3.4.3 **C** (1)

3.5 Explain the difference in the vapour pressure of compounds **B** and **C**. Refer to the MOLECULAR MASSES, STRENGTH OF INTERMOLECULAR FORCES and THE ENERGY NEEDED. (4)

3.6 Which compound will have the …? (Write only **A**, **B** or **C**.)

3.6.1 highest viscosity (1)

3.6.2 lowest melting point (1)

3.6.3 highest boiling point (1)

[15]

QUESTION 4 (Start on a NEW page.)

The table below shows the boiling points of four organic compounds, represented by the letters **A** to **D**, of comparable molecular mass.

Compound		Molecular mass	Boiling point (°C)
A	Butane	58	0
B	Propanone	58	49
C	Propan-1-ol	60	97
D	Ethanoic acid	60	118

4.1 Which compound can be used as a fuel in gas burners? (1)

4.2 Explain your answer to QUESTION 4.1. (2)

4.3 How will the boiling point of 2-methylpropane compare to that of compound **A**?

Write HIGHER THAN, LOWER THAN or EQUAL TO.

Refer to MOLECULAR STRUCTURES, INTERMOLECULAR FORCES and the ENERGY needed to explain the answer. (4)

4.4 What is the relationship between compound **A** and 2-methyl propane? Explain. (2)

4.5 Consider the vapour pressure of compounds **B** and **C**. These compounds have different vapour pressure.

4.5.1 Give a reason for this difference in vapour pressure by referring to the intermolecular forces present in EACH of these compounds. (4)

Which ONE of compounds **B** or **C** has the:

4.5.2 Highest vapour pressure (1)

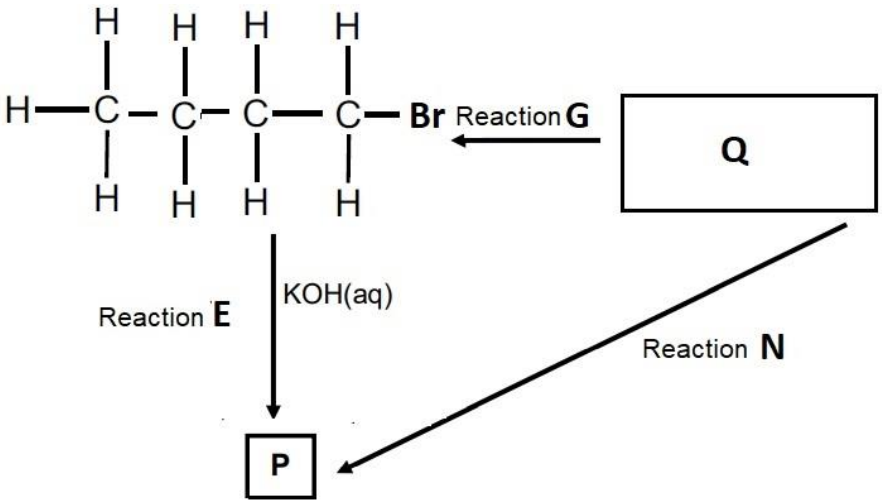
4.5.3 Highest melting point (1)

4.5.4 Lowest viscosity (1)

[16]

QUESTION 5 (Start on a NEW page.)

Consider the flow diagram below and answer the questions that follow.



5.1 Write down the type of reaction represented by the following:

5.1.1 **G** (1)

5.1.2 **E** (1)

5.1.3 **N** (1)

5.2 For Reaction **E**, write the following down:

5.2.1 The homologous series to which compound **P** belongs (1)

5.2.2 ONE reaction condition (1)

5.2.3 The balanced chemical equation using STRUCTURAL FORMULAE (3)

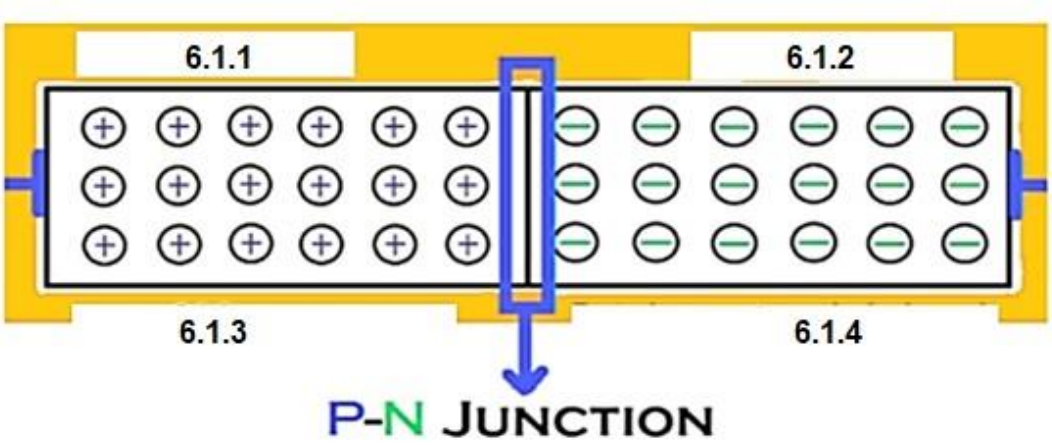
5.3 Write down the structural formula for compound **Q**. (2)

[10]

QUESTION 6 (Start on a NEW page.)

A p-n junction is formed when a p-doped semiconductor is connected to an n-doped semiconductor.

6.1 Label the following diagram of a p-n junction.



[4]

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*
Avogadro se konstante Avogadro's constant	N_A	$6{,}02 \times 10^{23}\ mol^{-1}$
Molêre gaskonstante Molar gas constant	R	$8{,}31\ J{\cdot}K^{-1}{\cdot}mol^{-1}$
Standaarddruk Standard pressure	p^{θ}	$1{,}013 \times 10^{5}$ Pa
Molêre gasvolume teen STD Molar gas volume at STP	V_m	$22{,}4\ dm^3{\cdot}mol^{-1}$
Standaardtemperatuur Standard temperature	T^{θ}	273 K

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 $c = \frac{m}{MV}$ $\frac{c_a V_a}{c_b V_b} = \frac{n_a}{n_b}$	pH= -log[H_3O^+] K_w = [H_3O^+][OH^-] = 1x10^{-14} at /by 298K
$E^{\theta}_{cell} = E^{\theta}_{cathode} - E^{\theta}_{anode}$ / $E^{\theta}_{sel} = E^{\theta}_{katode} - E^{\theta}_{anode}$ $E^{\theta}_{cell} = E^{\theta}_{reduction} - E^{\theta}_{oxidation}$ / $E^{\theta}_{sel} = E^{\theta}_{reduksie} - E^{\theta}_{oksidasie}$ $E^{\theta}_{cell} = E^{\theta}_{oxidising\ agent} - E^{\theta}_{reducing\ agent}$ / $E^{\theta}_{sel} = E^{\theta}_{oksideermiddel} - E^{\theta}_{reduseermiddel}$		

TABLE 3: THE PERIODIC TABLE OF ELEMENTS/*TABEL 3: 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*

Atoomgetal
Atomic number

Elektronegatiwiteit
Electronegativity

29
1,9 Cu

Simbool
Symbol

Benaderde relatiewe atoommassa
Approximate relative atomic mass

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

Increasing oxidising ability/*Toenemende oksiderende vermoë* ↓

Increasing reducing ability/*Toenemende reduserende vermoë* ↑