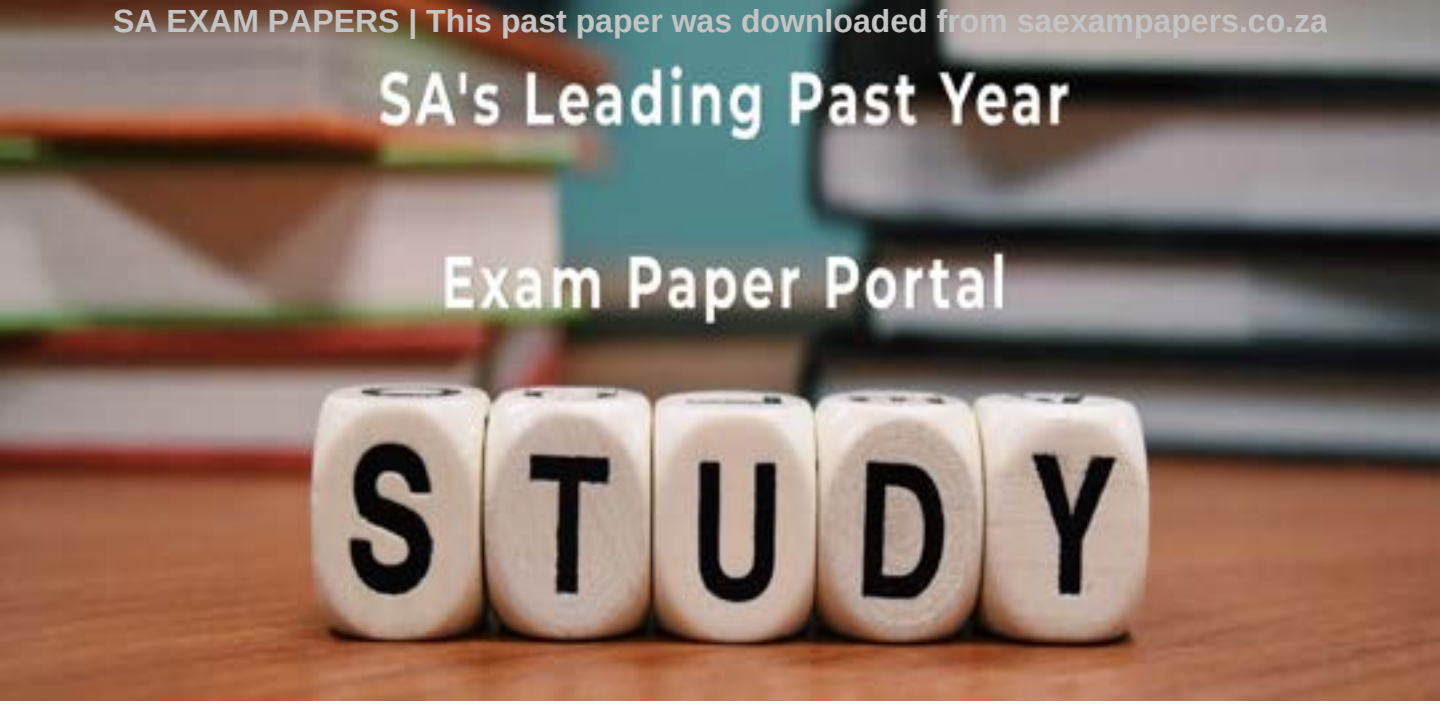


Province of the
EASTERN CAPE
EDUCATION

Iphondo leMpuma Kapa: Isebe leMfundo
Provinsie van die Oos Kaap: Department van Onderwys
Porafensie Ya Kapa Botjahabela: Lefapha la Thuto

NATIONAL SENIOR CERTIFICATE

GRADE 12

SEPTEMBER 2024

TECHNICAL SCIENCES P2

MARKS: **75**

TIME: **1½ hours**

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

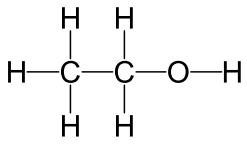
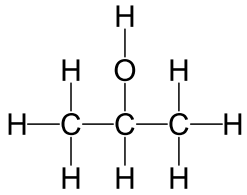
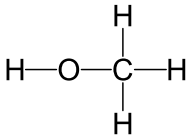
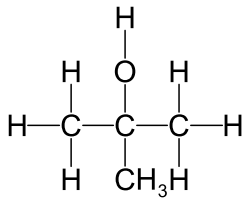
INSTRUCTIONS AND INFORMATION

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. You may use a non-programmable calculator.
5. LEAVE a line open between subsections, for example, between 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 given 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 is a secondary alcohol?

A		B	
C		D	

(2)

1.2 Alcohols have weaker intermolecular forces than carboxylic acids.

What is the possible reason for this?

A Alcohols have higher melting points than carboxylic acids.

B Alcohols have hydrogen bonds while carboxylic acids have dipole-dipole forces.

C Alcohols have only one site for hydrogen bonds and carboxylic acids have two.

D Alcohols have smaller molecular formula than carboxylic acids. (2)

1.3 Which ONE of the following compounds has the molecular formula $C_2H_4O_2$.

A Ethanol

B Methanoic acid

C Methyl methanoate

D Methyl ethanoate (2)

1.4 Consider the reaction represented by the following equation:

$$C\ell_{2(g)} + 2Fe^{2+}_{(aq)} \rightarrow 2C\ell^{-}_{(aq)} + 2Fe^{3+}_{(aq)}$$

The oxidising agent in this reaction is …

A $C\ell_2$

B Fe^{3+}

C $C\ell^-$

D Fe^{2+} (2)

1.5 Consider a galvanic cell represented by the following cell notation:

$$Zn_{(s)} / Zn^{2+}_{(aq)} // Cu^{2+}_{(aq)} / Cu_{(s)}$$

The single vertical lines represent a/an …

A anode.

B cathode.

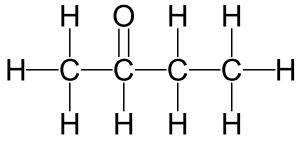
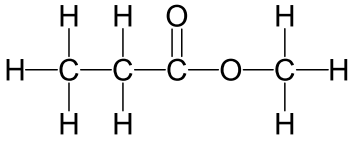
C salt bridge.

D phase boundary. (2)

[10]

QUESTION 2 (Start on a new page.)

The letters **A** to **F** in the table below represent six organic compounds.

A	$CH_3CH_2CH(CH_3)CH_2CH_3$	**B**	Butanoic acid
C	3-ethyl-2,2-dibromopentane	**D**	
E		**F**	But-2-ene

2.1 Write down the letter(s) that represent(s) the following:

2.1.1 Saturated hydrocarbon (1)

2.1.2 A ketone (1)

2.1.3 Two compounds which are functional isomers (1)

2.2 Write down the IUPAC name of compound **D** (2)

2.3 Write down the STRUCTURAL FORMULA of:

2.3.1 Compound **B** (2)

2.3.2 The CHAIN isomer of compound **A** (2)

2.4 Write down the:

2.4.1 General formula of the homologous series to which compound **F** belongs (1)

2.4.2 STRUCTURAL FORMULA of compound **C** (2)

[12]

QUESTION 3 (Start on a new page.)

The relationship between chain length and boiling point is investigated using three different organic compounds which belong to the same homologous series, and the results is given in the table below:

COMPOUND	NAME	BOILING POINT (°C)
A	Pent-1-yne	40,2
B	But-1-yne	8,08
C	Ethyne	-84

3.1 Define the term *boiling point.* (2)

3.2 Write down the NAME of the homologous series to which compounds **A**, **B** and **C** belong (1)

3.3 For this investigation, write down the:

3.3.1 Independent variable (1)

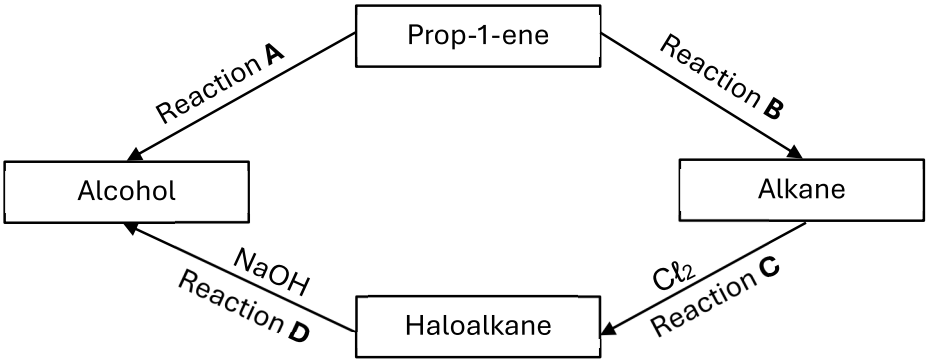
3.3.2 Controlled variable (1)

3.4 Explain the difference in boiling point of compound **A** to compound **C**, by referring to CHAIN LENGTH, INTERMOLECULAR FORCES and the ENERGY involved. (3)

3.5 Which compound will have the highest vapour pressure?
Give a reason for the answer. (2)
[10]

QUESTION 4 (Start on a new page.)

Prop-1-ene can be converted to other compounds by means of different organic reactions, represented by **A**, **B**, **C** and **D**, as shown in the flow diagram below.



4.1 Write down the type of reaction represented by:

4.1.1 **B** (1)

4.1.2 **C** (1)

4.2 Write down the:

4.2.1 NAME or FORMULA of the inorganic reactant used in reaction **B** (1)

4.2.2 IUPAC name of the haloalkane formed in reaction **C** (2)

4.2.3 FORMULA of the catalyst needed in reaction **B** (1)

4.3 During reaction **D**, the haloalkane reacts in the presence of a strong base to form an alcohol.

For reaction **D** write down:

4.3.1 The type of substitution reaction represented by **D**. (1)

4.3.2 A fully balanced chemical equation, using STRUCTURAL FORMULA. (3)

4.4 Rewrite the incomplete chemical equation for the complete combustion of butane shown below, in your ANSWERBOOK. Complete and balance the equation using MOLECULAR FORMULA.

$$C_4H_{10} + O_2 \rightarrow \_\_\_\_ + \_\_\_\_$$ (2)

[12]

QUESTION 5 (Start on a new page.)

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

5.1 Define the term *doping.* (2)

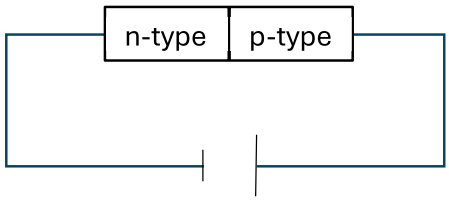
5.2 Besides silicon, provide an example of an intrinsic semiconductor. (1)

5.3 The conductivity of silicon is improved by the addition of small amounts of gallium.

5.3.1 What type of semi-conductor material is formed during this process? (1)

5.3.2 Give a reason for the answer in QUESTION 5.3.1. (1)

5.4 Consider the p-n junction diode connected to a power source, represented in the diagram below.

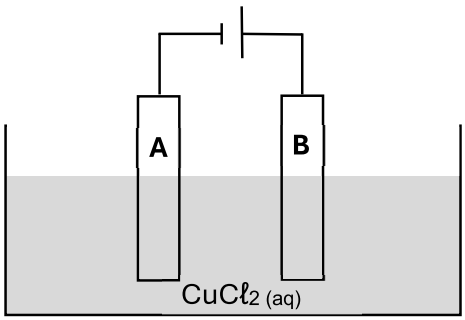


5.4.1 Is the diode above FORWARD BIAS or REVERSE BIAS? (1)

5.4.2 Give a reason to the answer in QUESTION 5.4.1. (1)
[7]

QUESTION 6 (Start on a new page.)

The electrochemical cell below makes use of carbon electrodes to decompose copper(II)chloride.



6.1 Define the term *electrolysis.* (2)

6.2 What type of cell is represented in the diagram above? (1)

6.3 Identify the following components from the diagram above.

6.3.1 **A** (1)

6.3.2 **B** (1)

6.4 What would be observed at component **B** when the reaction starts? (1)

6.5 Write down the oxidation half reaction of the above electrochemical cell. (2)

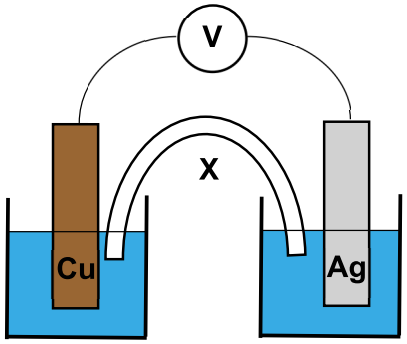
6.6 Define the term *reducing agent*. (2)

6.7 Write down the formula of the reducing agent in the above electrochemical cell. (1)

[11]

QUESTION 7 (Start on a new page.)

The cell in the diagram below has a copper electrode connected to a silver electrode and is set up under standard conditions.



7.1 Define the term *reduction* in words. (2)

7.2 Name component **X**. (1)

7.3 Write down the:

7.3.1 Energy conversion that takes place in this cell (1)

7.3.2 Reduction half-reaction of this cell (2)

7.3.3 Cell notation of this galvanic cell (3)

7.4 Calculate the initial emf of this cell under standard conditions. (4)

[13]

TOTAL: 75

NATIONAL SENIOR CERTIFICATE
NASIONALE SENIOR SERTIFIKAAT

DATA FOR TECHNICAL SCIENCES GRADE 12
PAPER 2

GEGEWENS VIR TEGNIESE WETENSKAPPE GRAAD 12
VRAESTEL 2

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}	0°C/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*

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
29
1,9 Cu
Elektronegatiwiteit / Electronegativity
Simbool / Symbol
Benaderde relatiewe atoommassa

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

Increasing oxidising ability/*Toenemende oksiderende vermoë* ↑

↓ Increasing reducing ability/*Toenemende reduserende vermoë*

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

TABLE 4B: STANDARD REDUCTION POTENTIALS/ *TABEL 4B: STANDAARD REDUKSIEPOTENSIALE*

Increasing oxidising ability/*Toenemende oksiderende vermoë* ↓

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
$A\ell^{3+} + 3e^-$	⇌	$A\ell$	− 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
$Hg^{2+} + 2e^-$	⇌	$Hg(\ell)$	+ 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 reducing ability/*Toenemende reduserende vermoë* ↑