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**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

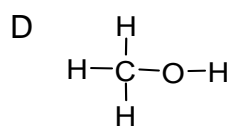
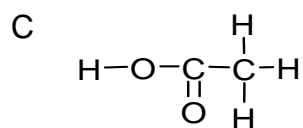
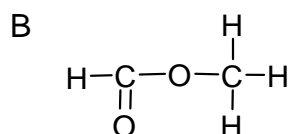
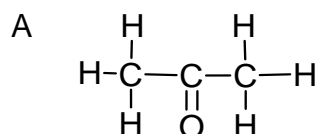
Various options are provided as possible answers to the following questions. Choose the answer and write only the letter (A–D) next to the question numbers (1.1 to 1.5) in the ANSWER BOOK, for example 1.6 D.

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



(2)

1.2 Which ONE of the following compounds represents a ketone?



(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

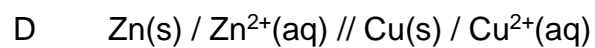
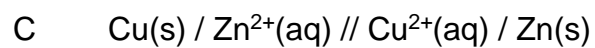
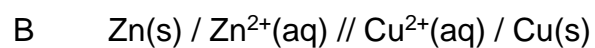
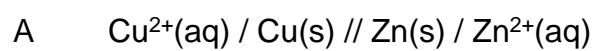
B propanoic acid, butan-1-ol, pentane

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:



(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 $ \begin{array}{ccccccc} & \text{H} & & \text{H} & & \text{H} & & \text{H} & & \text{O} \\ & & & & & & & & & // \\ \text{H} & - \text{C} & - & \text{C} & - & \text{C} & - & \text{C} & - & \text{C} \\ & & & & & & & & & \backslash \\ & \text{H} & & \text{H} & & \text{H} & & \text{H} & & \text{H} \end{array} $
C 3-Chloro-But-1-ene	D $ \begin{array}{ccccccc} & \text{H} & & \text{H} & & \text{O} & & & & \\ & & & & & & & & & \\ \text{H} & - \text{C} & - & \text{C} & - & \text{C} & - & \text{O} & - & \text{H} \\ & & & & & & & & & \\ & \text{H} & & \text{H} & & & & & & \end{array} $

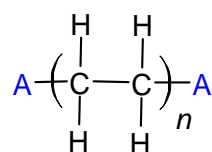
2.2.1 Define the term *isomers* in words. (2)

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.)

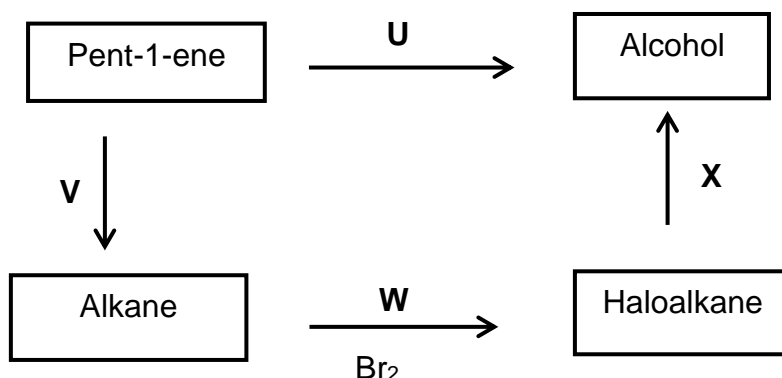
The table below shows the vapour pressure of various organic compounds at 25 °C.

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)

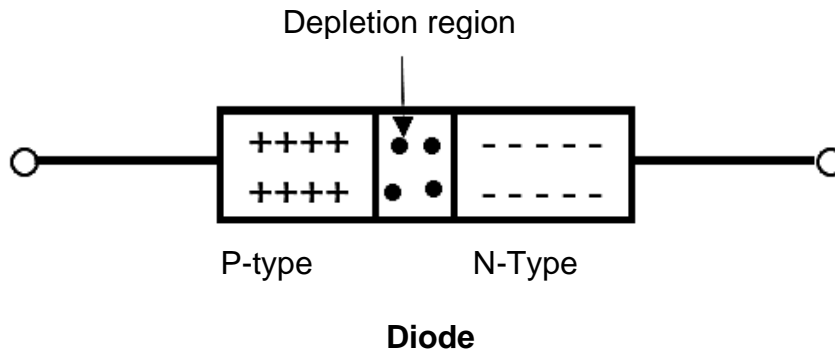
4.3 Fossil fuels are formed by the natural process of decomposition of organisms under heat and pressure. They contain a high percentage of carbon and include fuels such as coal, petrol and natural gases. Alkanes are the most important fossil fuels. The combustion of alkanes (also known as oxidation)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

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

[12]

QUESTION 5 (Start on a new page.)

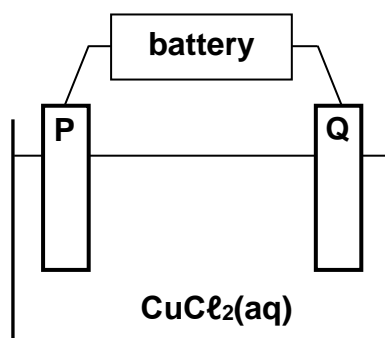
Semiconductor devices such as diodes are widely used in modern electronics.



- 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)

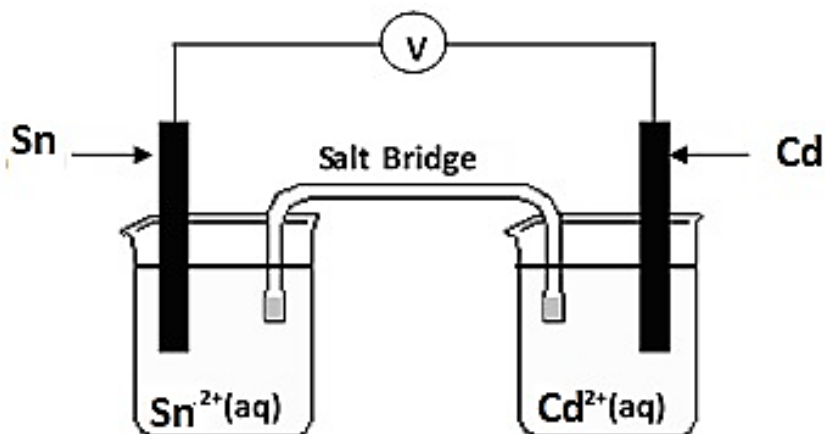
6.5.2 This cell can be used for the electroplating of a bracelet in the industry. Which electrode (**P** or **Q**) will be replaced with a bracelet during the electroplating process? (1)

[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: FISIIESE KONSTANTES

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

TABLE 2: FORMULAE/TABEL 2: FORMULES

$E^\theta_{\text{cell}} = E^\theta_{\text{cathode}} - E^\theta_{\text{anode}} / E^\theta_{\text{sel}} = E^\theta_{\text{katode}} - E^\theta_{\text{anode}}$
$E^\theta_{\text{cell}} = E^\theta_{\text{reduction}} - E^\theta_{\text{oxidation}} / E^\theta_{\text{sel}} = E^\theta_{\text{reduksie}} - E^\theta_{\text{oksidasie}}$
$E^\theta_{\text{cell}} = E^\theta_{\text{oxidising agent}} - E^\theta_{\text{reducing agent}} / E^\theta_{\text{sel}} = E^\theta_{\text{oksideermiddel}} - E^\theta_{\text{reduseermiddel}}$

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)
1 2,1 1 H																	2 He 4
3 1,0 7 Li	4 1,5 9 Be											5 2,0 11 B	6 2,5 12 C	7 3,0 14 N	8 3,5 16 O	9 4,0 19 F	10 Ne 20
11 0,9 23 Na	12 1,2 24 Mg											13 1,5 27 Al	14 1,8 28 Si	15 2,1 31 P	16 2,5 32 S	17 3,0 35,5 Cl	18 Ar 40
19 0,8 39 K	20 1,0 40 Ca	21 1,3 45 Sc	22 1,5 48 Ti	23 1,6 51 V	24 1,6 52 Cr	25 1,5 55 Mn	26 1,8 56 Fe	27 1,8 59 Co	28 1,8 59 Ni	29 1,9 63,5 Cu	30 1,6 65 Zn	31 1,6 70 Ga	32 1,8 73 Ge	33 2,0 75 As	34 2,4 79 Se	35 2,8 80 Br	36 Kr 84
37 0,8 86 Rb	38 1,0 88 Sr	39 1,2 89 Y	40 1,4 91 Zr	41 Nb 92	42 1,8 96 Mo	43 1,9 98 Tc	44 2,2 101 Ru	45 2,2 103 Rh	46 2,2 106 Pd	47 1,9 108 Ag	48 1,7 112 Cd	49 1,7 115 In	50 1,8 119 Sn	51 1,9 122 Sb	52 2,1 128 Te	53 2,5 127 I	54 Xe 131
55 0,7 133 Cs	56 0,9 137 Ba	57 La 139	72 1,6 179 Hf	73 Ta 181	74 W 184	75 Re 186	76 Os 190	77 Ir 192	78 Pt 195	79 Au 197	80 Hg 201	81 1,8 204 Tl	82 1,8 207 Pb	83 1,9 209 Bi	84 2,0 209 Po	85 2,5 210 At	86 Rn
87 0,7 Fr	88 0,9 226 Ra	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
$Cl_2(g) + 2e^-$	$\rightleftharpoons 2Cl^-$	+ 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

Half-reactions/Halfreaksies		E^θ (V)
$\text{Li}^+ + e^-$	\rightleftharpoons Li	- 3,05
$\text{K}^+ + e^-$	\rightleftharpoons K	- 2,93
$\text{Cs}^+ + e^-$	\rightleftharpoons Cs	- 2,92
$\text{Ba}^{2+} + 2e^-$	\rightleftharpoons Ba	- 2,90
$\text{Sr}^{2+} + 2e^-$	\rightleftharpoons Sr	- 2,89
$\text{Ca}^{2+} + 2e^-$	\rightleftharpoons Ca	- 2,87
$\text{Na}^+ + e^-$	\rightleftharpoons Na	- 2,71
$\text{Mg}^{2+} + 2e^-$	\rightleftharpoons Mg	- 2,36
$\text{Al}^{3+} + 3e^-$	\rightleftharpoons Al	- 1,66
$\text{Mn}^{2+} + 2e^-$	\rightleftharpoons Mn	- 1,18
$\text{Cr}^{2+} + 2e^-$	\rightleftharpoons Cr	- 0,91
$2\text{H}_2\text{O} + 2e^-$	\rightleftharpoons $\text{H}_2(\text{g}) + 2\text{OH}^-$	- 0,83
$\text{Zn}^{2+} + 2e^-$	\rightleftharpoons Zn	- 0,76
$\text{Cr}^{3+} + 3e^-$	\rightleftharpoons Cr	- 0,74
$\text{Fe}^{2+} + 2e^-$	\rightleftharpoons Fe	- 0,44
$\text{Cr}^{3+} + e^-$	\rightleftharpoons Cr^{2+}	- 0,41
$\text{Cd}^{2+} + 2e^-$	\rightleftharpoons Cd	- 0,40
$\text{Co}^{2+} + 2e^-$	\rightleftharpoons Co	- 0,28
$\text{Ni}^{2+} + 2e^-$	\rightleftharpoons Ni	- 0,27
$\text{Sn}^{2+} + 2e^-$	\rightleftharpoons Sn	- 0,14
$\text{Pb}^{2+} + 2e^-$	\rightleftharpoons Pb	- 0,13
$\text{Fe}^{3+} + 3e^-$	\rightleftharpoons Fe	- 0,06
$2\text{H}^+ + 2e^-$	\rightleftharpoons $\text{H}_2(\text{g})$	0,00
$\text{S} + 2\text{H}^+ + 2e^-$	\rightleftharpoons $\text{H}_2\text{S}(\text{g})$	+ 0,14
$\text{Sn}^{4+} + 2e^-$	\rightleftharpoons Sn^{2+}	+ 0,15
$\text{Cu}^{2+} + e^-$	\rightleftharpoons Cu^+	+ 0,16
$\text{SO}_4^{2-} + 4\text{H}^+ + 2e^-$	\rightleftharpoons $\text{SO}_2(\text{g}) + 2\text{H}_2\text{O}$	+ 0,17
$\text{Cu}^{2+} + 2e^-$	\rightleftharpoons Cu	+ 0,34
$2\text{H}_2\text{O} + \text{O}_2 + 4e^-$	\rightleftharpoons 4OH^-	+ 0,40
$\text{SO}_2 + 4\text{H}^+ + 4e^-$	\rightleftharpoons $\text{S} + 2\text{H}_2\text{O}$	+ 0,45
$\text{Cu}^+ + e^-$	\rightleftharpoons Cu	+ 0,52
$\text{I}_2 + 2e^-$	\rightleftharpoons 2I^-	+ 0,54
$\text{O}_2(\text{g}) + 2\text{H}^+ + 2e^-$	\rightleftharpoons H_2O_2	+ 0,68
$\text{Fe}^{3+} + e^-$	\rightleftharpoons Fe^{2+}	+ 0,77
$\text{NO}_3^- + 2\text{H}^+ + e^-$	\rightleftharpoons $\text{NO}_2(\text{g}) + \text{H}_2\text{O}$	+ 0,80
$\text{Ag}^+ + e^-$	\rightleftharpoons Ag	+ 0,80
$\text{Hg}^{2+} + 2e^-$	\rightleftharpoons $\text{Hg}(\ell)$	+ 0,85
$\text{NO}_3^- + 4\text{H}^+ + 3e^-$	\rightleftharpoons $\text{NO}(\text{g}) + 2\text{H}_2\text{O}$	+ 0,96
$\text{Br}_2(\ell) + 2e^-$	\rightleftharpoons 2Br^-	+ 1,07
$\text{Pt}^{2+} + 2e^-$	\rightleftharpoons Pt	+ 1,20
$\text{MnO}_2 + 4\text{H}^+ + 2e^-$	\rightleftharpoons $\text{Mn}^{2+} + 2\text{H}_2\text{O}$	+ 1,23
$\text{O}_2(\text{g}) + 4\text{H}^+ + 4e^-$	\rightleftharpoons $2\text{H}_2\text{O}$	+ 1,23
$\text{Cr}_2\text{O}_7^{2-} + 14\text{H}^+ + 6e^-$	\rightleftharpoons $2\text{Cr}^{3+} + 7\text{H}_2\text{O}$	+ 1,33
$\text{Cl}_2(\text{g}) + 2e^-$	\rightleftharpoons 2Cl^-	+ 1,36
$\text{MnO}_4^- + 8\text{H}^+ + 5e^-$	\rightleftharpoons $\text{Mn}^{2+} + 4\text{H}_2\text{O}$	+ 1,51
$\text{H}_2\text{O}_2 + 2\text{H}^+ + 2e^-$	\rightleftharpoons $2\text{H}_2\text{O}$	+ 1,77
$\text{Co}^{3+} + e^-$	\rightleftharpoons Co^{2+}	+ 1,81
$\text{F}_2(\text{g}) + 2e^-$	\rightleftharpoons 2F^-	+ 2,87

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Increasing reducing ability/Toenemende reduserende vermoë