basic education

Department:
Basic Education
REPUBLIC OF SOUTH AFRICA

SENIOR CERTIFICATE EXAMINATIONS/ NATIONAL SENIOR CERTIFICATE EXAMINATIONS

TECHNICAL SCIENCES P2

2023

MARKS: 75

TIME: 1½ hours

This question paper consists of 9 pages and 4 data sheets.

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INSTRUCTIONS AND INFORMATION

1. Write your centre number and examination number in the appropriate spaces on the ANSWER BOOK.

2. This question paper consists of SIX questions. Answer ALL the questions in the ANSWER BOOK.

3. Start EACH question on a NEW page in the ANSWER BOOK.

4. Number the answers correctly according to the numbering system used in this question paper.

5. Leave ONE line between two subquestions, e.g. between QUESTION 2.1 and QUESTION 2.2.

6. You may use a non-programmable calculator.

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

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 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, e.g. 1.6 D.

1.1 Which ONE of the following homologous series has a CARBONYL GROUP as a functional group?

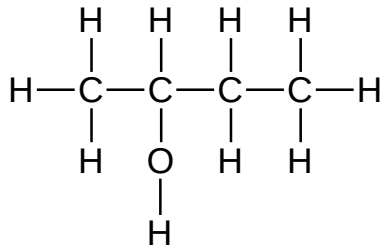
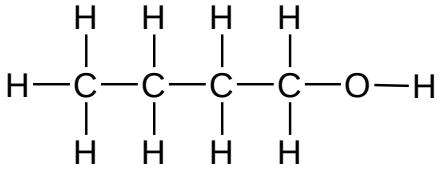
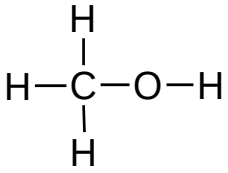
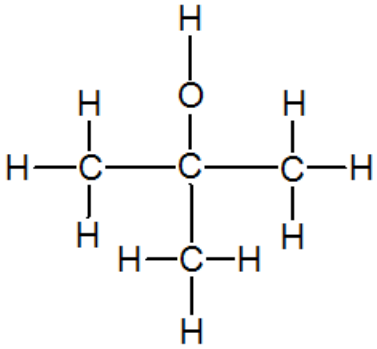
A Haloalkanes

B Aldehyde

C Alcohols

D Ketone (2)

1.2 Consider the structural formulae of the alcohols given below.

(i)		(ii)	
(iii)		(iv)	

Which ONE of the following combinations represents PRIMARY alcohols?

A (ii) and (iv)

B (i) and (iii)

C (ii) and (iii)

D (iii) and (iv) (2)

1.3 A liquid with high viscosity will flow …

A faster because it has a higher boiling point.

B faster because it has weak intermolecular forces.

C slowly because it has a low boiling point.

D slowly because it has strong intermolecular forces. (2)

1.4 An oxidising agent is a substance that …

A is oxidised.

B is reduced.

C retains the same number of electrons.

D retains the same oxidation number. (2)

1.5 Which ONE of the following is applicable to both an ELECTROLYTIC and a GALVANIC cell?

A The anode is positive.

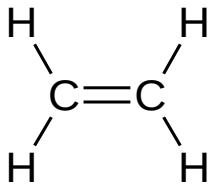
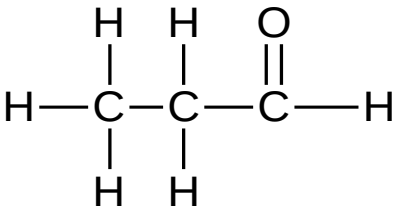
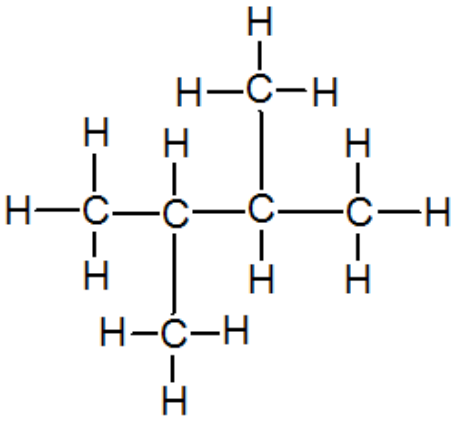
B The cathode is negative.

C Electron flow is from the cathode to the anode in the external circuit.

D Electron flow is from the anode to the cathode in the external circuit. (2)
[10]

QUESTION 2 (Start on a new page.)

Consider the table below containing organic molecules and answer the questions that follow.

A		**B**	
C	C_3H_4	**D**	Pentane
E		**F**	Ethanoic acid

2.1 Define the term *organic molecules.* (2)

2.2 Write down the NAME of the homologous series of the following:

2.2.1 **A** (1)

2.2.2 **C** (1)

2.3 Draw the structural formula of the compounds represented by the letters:

2.3.1 **D** (2)

2.3.2 **F** (2)

2.4 Write down the IUPAC name of compound **E**. (2)

2.5 For compound **B** write down the:

2.5.1 NAME of the functional group (1)

2.5.2 Molecular formula (1)

[12]

QUESTION 3 (Start on a new page.)

The table below indicates the vapour pressures of three organic compounds.

Compound	Name	Vapour Pressure (kPa)
A	Pentane	68,5
B	2-methylbutane	77
C	2,2-dimethylpropane	146

3.1 Define the term *vapour pressure*. (2)

3.2 Which compound, **A** or **B**, has the higher boiling point? (1)

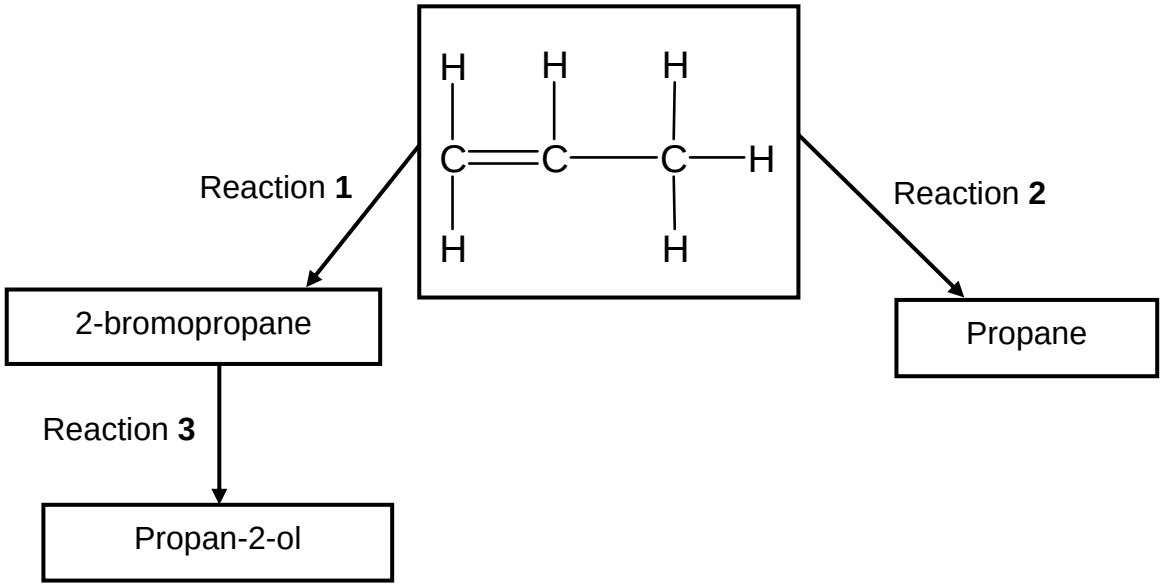
3.3 Explain the answer to QUESTION 3.2 by referring to the STRUCTURE, STRENGTH OF INTERMOLECULAR FORCES and ENERGY. (3)

3.4 What type of structural isomers are compounds **A**, **B** and **C**? (1)

3.5 Give a reason for the answer to QUESTION 3.4. (2)
[9]

QUESTION 4 (Start on a new page.)

Study the flow diagram involving organic reactions below and answer the questions that follow.



4.1 Write down the TYPE of ADDITION reaction represented by:

4.1.1 Reaction **1** (1)

4.1.2 Reaction **2** (1)

4.2 Use STRUCTURAL FORMULAE to write down a balanced chemical equation for Reaction **3**. (4)

4.3 Write down TWO reaction conditions for Reaction **1**. (2)

4.4 A blue-flamed gas (C_2H_2) used to cut and weld metals in the welding industry reacts with excess oxygen.

4.4.1 Write down the NAME of the reaction referred to in the statement above. (1)

4.4.2 Use MOLECULAR FORMULAE to write down a balanced equation for the reaction above. (3)

4.5 Define the following:

4.5.1 Polymerisation (2)

4.5.2 Macromolecule (2)

4.6 A p-n junction diode is formed when the n-type and the p-type materials are joined together by means of a special manufacturing process.

4.6.1 Define the term *doping.* (2)

4.6.2 Draw a symbol of a p-n junction diode and indicate the anode and cathode. (2)

[20]

QUESTION 5 (Start on a new page.)

Learners are provided with the following apparatus and a solution to assemble an electrochemical cell.

 Carbon rods	 Beaker
 Copper (II) chloride (aq)	 Cell
 Conducting wires	

5.1 What TYPE of an electrochemical cell can be assembled using ALL of the apparatus above and the solution? (1)

5.2 Write down TWO components in the list above to justify the answer to QUESTION 5.1. (2)

5.3 In assembling the electrochemical cell, one electrode was connected to the positive terminal and the other electrode to the negative terminal of the cell.

5.3.1 Which ONE of the electrodes will be the ANODE? Write down only ELECTRODE CONNECTED TO POSITIVE TERMINAL or ELECTRODE CONNECTED TO NEGATIVE TERMINAL. (1)

5.3.2 Write down the half-reaction taking place at the cathode. (2)

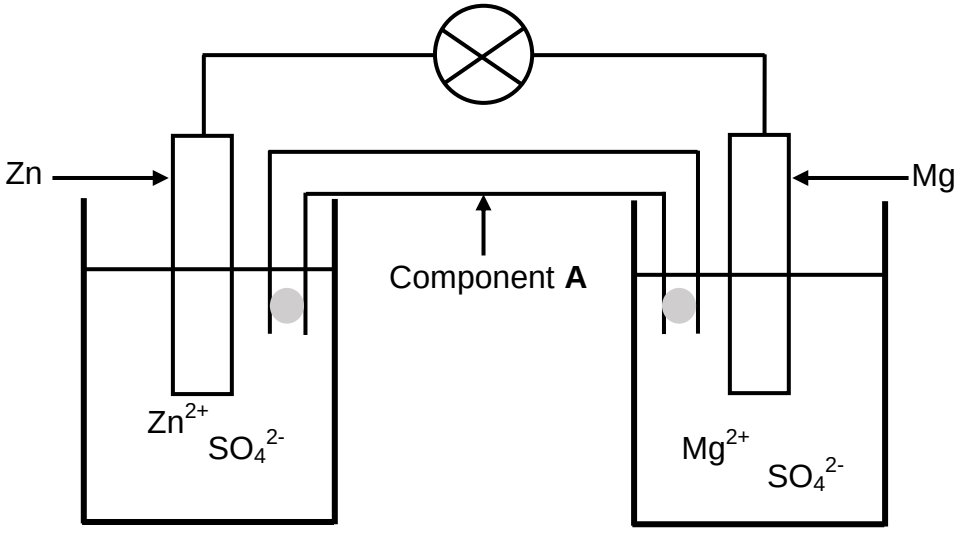
5.3.3 Write down the NAME or FORMULA of the product formed at the anode. (1)

5.4 Write down THREE examples of alternate energies. (3)

[10]

QUESTION 6 (Start on a new page.)

6.1 Learners performed an experiment to determine the electrode potential of an electrochemical cell under standard conditions. They assembled the apparatus, as shown in the diagram below.



6.1.1 State the energy conversion taking place in this cell. (2)

6.1.2 Write down a balanced net ionic reaction of the cell. (2)

6.1.3 In which direction will the SO_4^{2-} ions migrate through the salt bridge? Write down only FROM Zn TO Mg or FROM Mg TO Zn. (1)

6.1.4 Is the cell reaction spontaneous or non-spontaneous? (1)

6.1.5 Calculate the *emf* of the cell. (4)

6.2 Component **A** is removed.

6.2.1 Write down the NAME of component **A**. (1)

6.2.2 Will the light bulb glow? Write down YES or NO. (1)

6.2.3 Explain the answer to QUESTION 6.2.2. (2)
[14]

TOTAL: 75

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DATA FOR TECHNICAL SCIENCES GRADE 12
PAPER 2
GEGEWENS VIR TEGNIESE WETENSKAPPE GRAAD 12
VRAESTEL 2

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

NAME/*NAAM*	SYMBOL/*SIMBOOL*	VALUE/*WAARDE*
Standard pressure *Standaarddruk*	$p^{\ominus}$	$1{,}01 \times 10^5$ Pa
Standard temperature *Standaardtemperatuur*	$T^{\ominus}$	273 K/0 °C

TABLE 2/*TABEL 2*: FORMULAE/*FORMULES*

Emf/*Emk*	$E^{\theta}_{cell} = E^{\theta}_{cathode} - E^{\theta}_{anode}$ / $E^{\theta}_{sel} = E^{\theta}_{katode} - E^{\theta}_{anode}$ or/*of* $E^{\theta}_{cell} = E^{\theta}_{reduction} - E^{\theta}_{oxidation}$ / $E^{\theta}_{sel} = E^{\theta}_{reduksie} - E^{\theta}_{oksidasie}$ or/*of* $E^{\theta}_{cell} = E^{\theta}_{oxidising\ agent} - E^{\theta}_{reducing\ agent}$ / $E^{\theta}_{sel} = E^{\theta}_{oksideermiddel} - E^{\theta}_{reduseermiddel}$

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

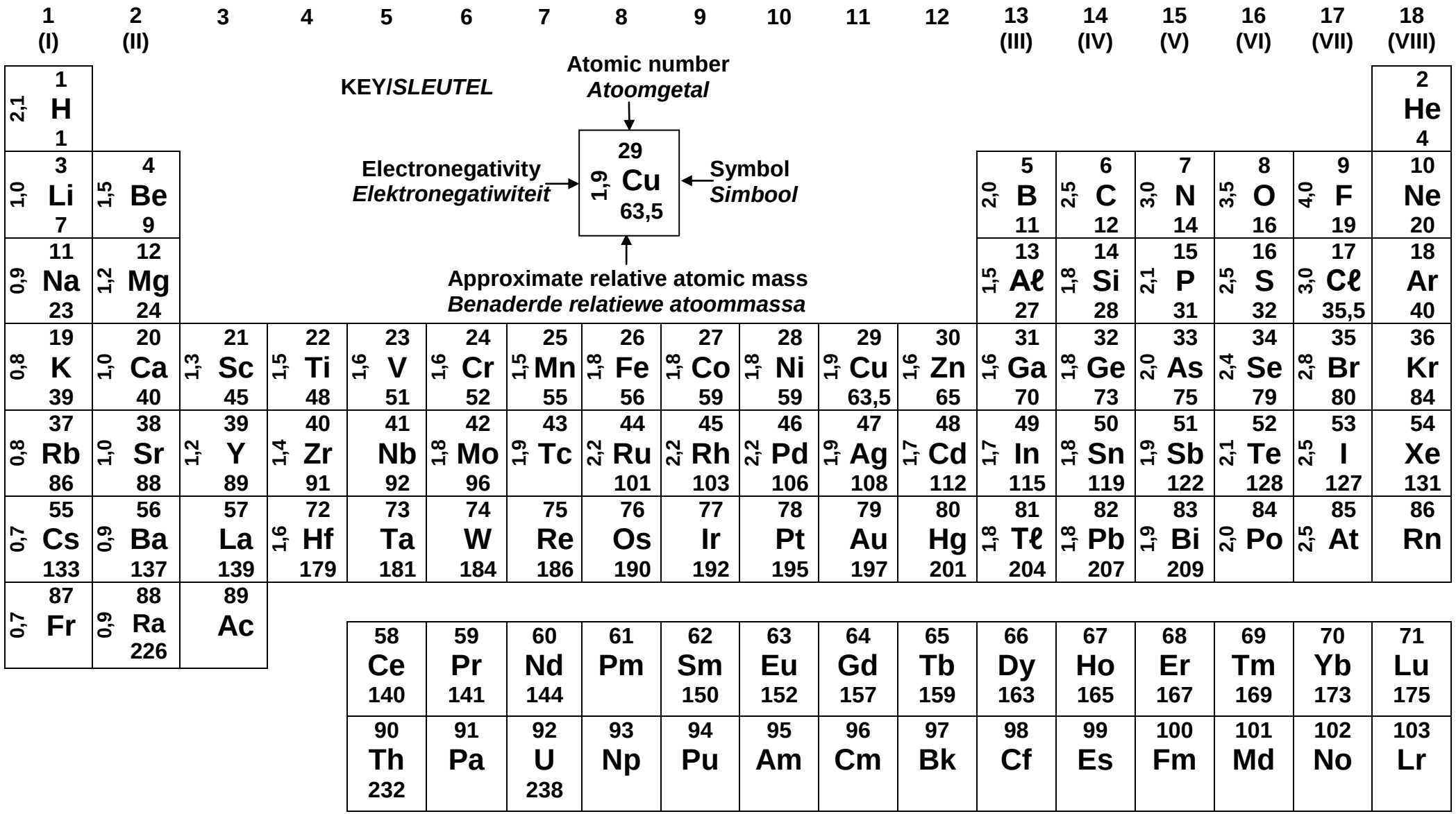

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TABLE 4A: STANDARD REDUCTION POTENTIALS
TABEL 4A: STANDAARD-REDUKSIEPOTENSIALE

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*

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TABLE 4B: STANDARD REDUCTION POTENTIALS
TABEL 4B: STANDAARD-REDUKSIEPOTENSIALE

Increasing oxidising ability/*Toenemende oksiderende vermoë* ↓

Increasing reducing ability/*Toenemende reduserende 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

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