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Porafensie Ya Kapa Botjahabela: Lefapha la Thuto

# NATIONAL SENIOR CERTIFICATE

## GRADE 12

## SEPTEMBER 2026

# TECHNICAL SCIENCES P2 (CHEMISTRY)

**MARKS:** **75**

**TIME:** **1½ hours**

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

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## INSTRUCTIONS AND INFORMATION

1. Write your NAME and SURNAME in the appropriate spaces on the ANSWER BOOK.
2. This question paper consists of SEVEN 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 sub questions, for example between QUESTION 2.1 and QUESTION 2.2.
6. You may use a non-programmable calculator.
7. You may use appropriate mathematical instruments.
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, et cetera where required.
11. You are advised to use the attached DATA SHEETS.
12. Write neatly and legibly.

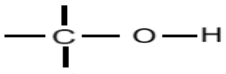
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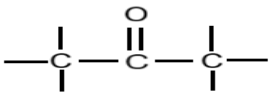
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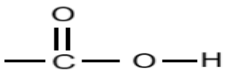
## QUESTION 1: MULTIPLE-CHOICE QUESTIONS

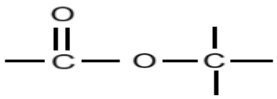
Various options are provided as possible answers to the following questions. Choose the answer and write only the correct letter (A–D) next to the question numbers (1.1 to 1.5) in the ANSWER BOOK, for example 1.6 A.

1.1 Which ONE of the following represents the functional group of a carboxylic acid?

A 

B 

C 

D 

(2)

1.2 Which ONE of the following organic compounds has the strongest intermolecular forces?

A Ethane

B Ethanoic acid

C Chloroethane

D Ethanol (2)

1.3 In an electrolytic cell anions migrate …

A to the positive electrode.

B to the negative electrode.

C from the negative to positive electrode.

D from the positive to negative electrode. (2)

1.4 In a galvanic cell ...

A the anode is positively charged.

B the cathode undergoes oxidation.

C the anode undergoes oxidation.

D the mass of the cathode decreases during the reaction. (2)

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1.5 Which impurity element can be added to silicon to produce a p-type semiconductor during doping?

A Phosphorous

B Boron

C Arsenic

D Antimony (2)

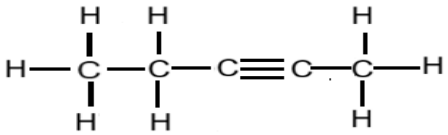
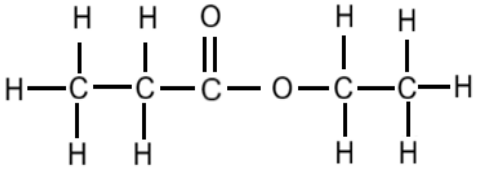
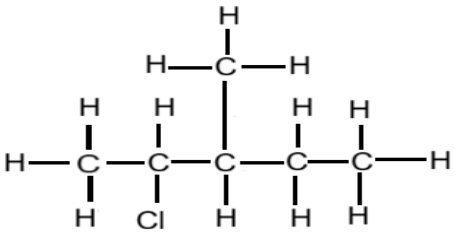
**[10]**



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**QUESTION 2 (Start on a new page.)**

The table below represents organic molecules from different homologous series.

| | | | |
|---|---|---|---|
| A | Butane | B | Polyethene |
| C |  | D | Hexanal |
| E |  | F |  |

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

2.2 Write down the letter that represents the following:

2.2.1 A saturated hydrocarbon (1)

2.2.2 An aldehyde (1)

2.2.3 A plastic (1)

2.3 Write down the GENERAL FORMULA to which compound **C** belongs. (1)

2.4 Write down the IUPAC name of:

2.4.1 Compound **E** (2)

2.4.2 Compound **F** (2)

2.5. Compound **A** has a chain isomer.

2.5.1 Draw the structural formula of the chain isomer of compound **A**. (2)

2.5.2 Give the IUPAC name of the compound drawn in QUESTION 2.5.1. (2)

**[14]**

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**QUESTION 3 (Start on a new page.)**

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

| | COMPOUND | VAPOUR PRESSURE AT 20°C (kPa) |
|---|---|---|
| **X** | Propanone | 24 |
| **Y** | Propanal | 29 |
| **Z** | Butane | 210 |

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

3.2 Which ONE of the compounds (**X**, **Y** or **Z**) has the:

3.2.1 Highest boiling point. Give a reason for your answer by referring to the vapour pressures in the table (2)

3.2.2 Weakest intermolecular forces (1)

3.3 Write down the name of the homologous series to which compound **X** belong. (1)

3.4 Explain the difference in vapour pressure of compound **X** and compound **Z** by referring to the TYPE OF INTERMOLECULAR FORCE, STRENGTH OF THE INTERMOLECULAR FORCES and the ENERGY NEEDED. (4)

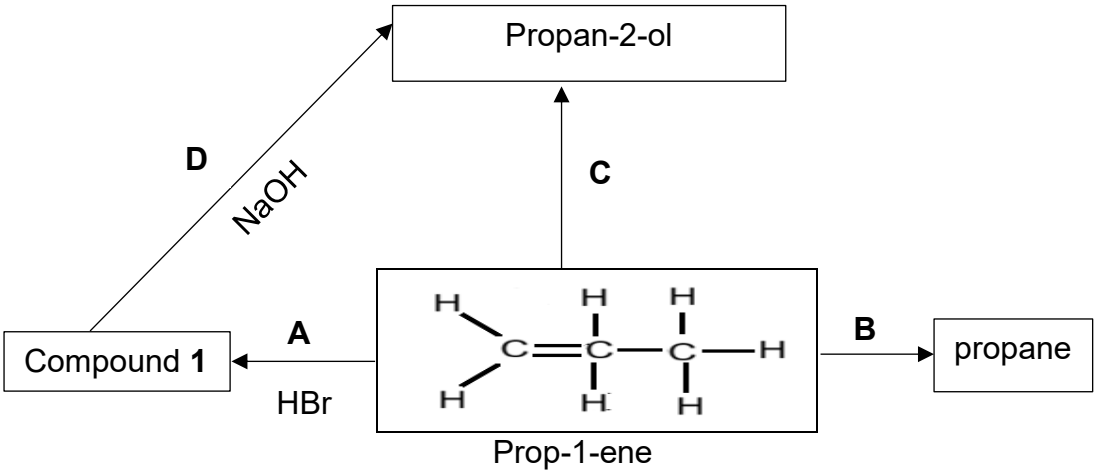
**[10]**

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**QUESTION 4 (Start on a new page.)**

The flow diagram shows how prop-1-ene can be converted to other organic compounds. Letters **A**, **B, C** and **D** represent different organic reactions.




4.1 Write down the name of the type of reaction represented by:

4.1.1 Reaction **B** (1)

4.1.2 Reaction **D** (1)

4.2 Consider reaction **C**.

4.2.1 Write down the molecular formula of the inorganic reactant used. (1)

4.2.2 Draw the structural formula of the product of reaction **C**. (2)

4.2.3 Write down the name of the functional group of the product formed. (1)

4.3 Write down the IUPAC name of compound **1**. (2)

4.4 Write down ONE reaction condition for reaction **A**. (1)

4.5 Propane burns in excess oxygen. Write down a balanced molecular equation to show the combustion reaction of propane. (3)

**[12]**

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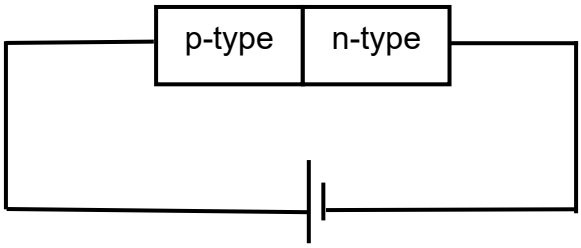
**QUESTION 5 (Start on a new page.)**

Impurities can be added to intrinsic semiconductors in a process called doping, creating P-type or N-type materials. When P-type and N-type materials are joined, they form a P-N junction diode.

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

5.2 Give ONE example of an intrinsic semiconductor other than silicon. (1)

5.3 Consider the diagram below that represents a P-N junction diode connected to a battery.



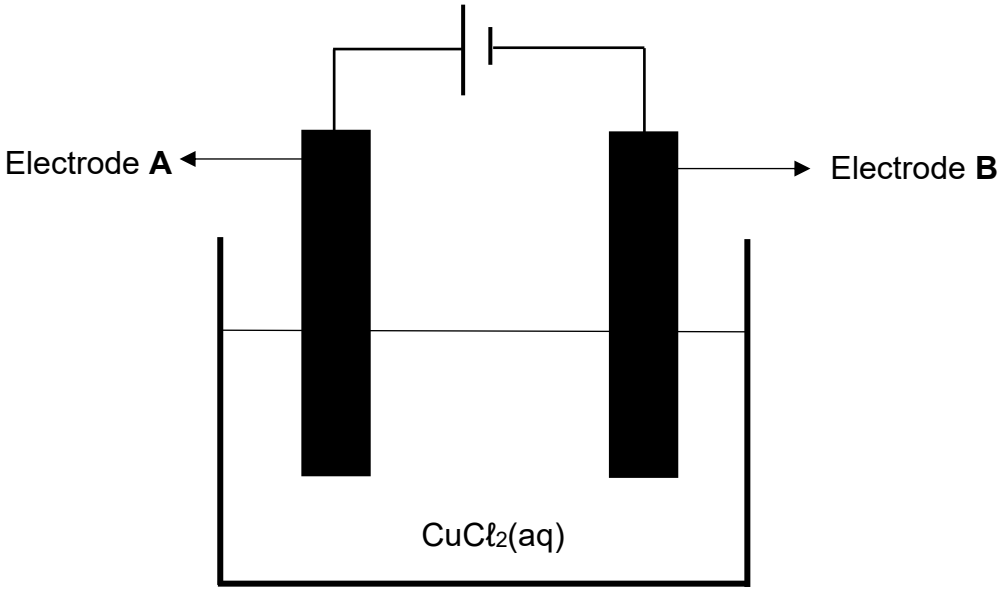

Is the diode above FORWARD BIASED or REVERSE BIASED?
Give a reason for your answer. (2)
**[5]**



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**QUESTION 6 (Start on a new page.)**

The simplified diagram below represents an electrolytic cell used for the decomposition of copper(II)chloride ($CuC\ell_2(aq)$). **A** and **B** are two carbon electrodes.




6.1 Define the term *electrolysis.* (2)

6.2 Explain why an external power source is required for this cell to operate. (2)

6.3 Write down the NAME or FORMULA of the reducing agent. Give a reason for your answer. (2)

6.4 What observation can be made at electrode **B** while the cell is functioning? (1)

6.5 Write down a half reaction to explain the observation in QUESTION 6.4. (2)

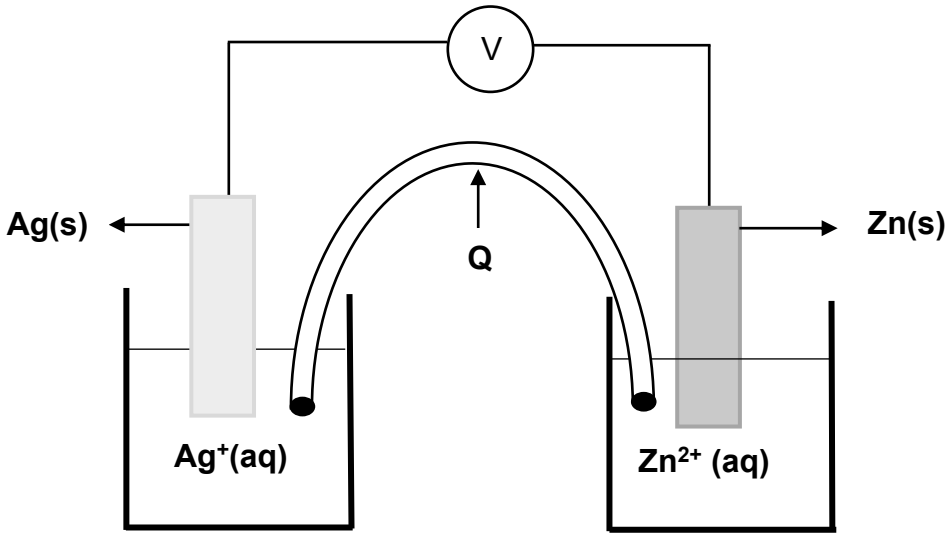
6.6 State ONE use of electrolytic cells in industry. (1)
**[10]**

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**QUESTION 7 (Start on a new page.)**

The diagram below represents a galvanic cell operating under standard conditions. The cell consists of a zinc (Zn) electrode immersed into a $Zn^{2+}(aq)$ solution connected to a silver (Ag) electrode immersed in an $Ag^{+}(aq)$ solution. The two half-cells are connected by component **Q**.




7.1 Define the term *galvanic cell*. (2)

7.2 Identify component **Q**. (1)

7.3 State ONE function of component **Q**. (1)

7.4 In which direction will the electrons in the external circuit flow? Choose from **Ag** to **Zn** or **Zn** to **Ag**. (1)

7.5 Write down the:

7.5.1 Half-reaction that takes place at the anode (2)

7.5.2 Cell notation for this cell (3)

7.6 The zinc (Zn) electrode is now replaced by an unknown metal electrode **X**. The cell is still operating under standard conditions, and the EMF of the cell is 2,46 V. Use a calculation to identify the unknown metal. (4)

**[14]**

**TOTAL: 75**

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# 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<br>*Standaarddruk* | $p^{\theta}$ | $1{,}013 \times 10^5$ Pa |
| Standard temperature<br>*Standaardtemperatuur* | $T^{\theta}$ | 0°C/273 K |

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

$E^{\theta}_{cell} = E^{\theta}_{cathode} - E^{\theta}_{anode}$ / $E^{\theta}_{sel} = E^{\theta}_{katode} - E^{\theta}_{anode}$

$E^{\theta}_{cell} = E^{\theta}_{reduction} - E^{\theta}_{oxidation}$ / $E^{\theta}_{sel} = E^{\theta}_{reduksie} - E^{\theta}_{oksidasie}$

$E^{\theta}_{cell} = E^{\theta}_{oxidising\ agent} - E^{\theta}_{reducing\ agent}$ / $E^{\theta}_{sel} = E^{\theta}_{oksideermiddel} - E^{\theta}_{reduseermiddel}$

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## 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

*Elektronegatiwiteit* / Electronegativity → 1,9 Cu ← *Simbool* / Symbol

Approximate relative atomic mass/
*Benaderde relatiewe atoommassa*

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

| Half-reactions/*Halfreaksies* | | | $E^{\theta}$ (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***

| **Half-reactions/*Halfreaksies*** | | | $E^{\theta}$ **(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 oxidising ability/*Toenemende oksiderende vermoë***

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