education
Department of Education
FREE STATE PROVINCE

PREPARATORY EXAMINATION

GRADE 12

PHYSICAL SCIENCES P2 (CHEMISTRY)

SEPTEMBER 2023

MARKS: 150

TIME: 3 HOURS

This question paper consists of 13 pages and 4 data sheets.

INSTRUCTIONS AND INFORMATION

1. Write your name and other applicable information in the appropriate spaces on the ANSWER BOOK.

2. The question paper consists of TEN 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, for example between QUESTION 3.1 and QUESTION 3.2.

6. You may use a non-programmable pocket 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 where necessary.

10. Give brief motivations, discussions, et cetera where required.

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

12. Write neatly and legibly.

QUESTION 1: MULTIPLE-CHOICE QUESTIONS

Various options are provided as possible answers to the following questions. Each question has only ONE correct answer. Choose the answer and write only the letter (A–D) next to the question numbers (1.1 to 1.10) in your ANSWER BOOK, for example, 1.11 E.

1.1 Which ONE of the following is a TERTIARY alcohol?

A Butan-1-ol

B Propan-2-ol

C 2-methylbutan-1-ol

D Methylpropan-2-ol (2)

1.2 Consider the following organic compounds:

(i) $CH_3CH(CH_3)CH(CH_3)CH_3$

(ii) $CH_3CH_2CH_2C(CH_3)CH_2$

(iii) $CH_3CH_2CH(CH_3)CH_2CH_3$

(iv) $CH_3CCCH(CH_3)_2$

Which of the above are chain isomers?

A (i) and (iv).

B (i) and (ii).

C (ii) and (iv).

D (i) and ((iii). (2)

1.3 Which homologous series is the formyl group the functional group of?

A Carboxylic acids

B Ketones

C Aldehydes

D Haloalkanes (2)

1.4 A piece of magnesium ribbon reacts with excess hydrochloric acid according to the following equation:

$$Mg(s) + 2HC\ell\,(aq) \rightarrow MgC\ell_2(aq) + H_2(g)$$

Which ONE of the following changes will NOT affect the reaction rate?

A Putting the reaction mixture in a hot water bath

B Using the same mass of powdered magnesium

C Increasing the volume of the hydrochloric acid

D Increasing the concentration of the hydrochloric acid (2)

1.5 Which ONE of the following statements is correct for a chemical reaction at equilibrium?

A The concentration of reactants and products remains constant.

B The concentration of reactants is equal to the concentration of products.

C The reaction has stopped.

D The number of moles of reactants is equal to the number of moles of products. (2)

1.6 Solid sulphur (S_8) reacts with oxygen (O_2) to produce sulphur dioxide …

$$S_8(s) + 8O_2(g) \rightleftharpoons 8SO_2(g)$$

What is the correct K_c expression for the equilibrium constant for the above reaction?

A $K_c = \frac{[SO_2]}{[S_8][O_2]}$

B $K_c = \frac{[SO_2]^8}{[O_2]^8}$

C $K_c = \frac{[S_8][O_2]}{[SO_2]}$

D $K_c = \frac{[SO_2]}{[O_2]}$ (2)

1.7 According to the Arrhenius theory, a base is …

A a proton donor.

B a proton acceptor.

C a substance that dissociates in water to form H^+.

D a substance that dissociates in water to form OH^-. (2)

1.8 Consider the reaction below:

$$H_3PO_4(aq) + HCO_3^-(aq) \rightleftharpoons H_2PO_4^-(aq) + H_2CO_3(aq)$$

Which ONE of the following are two acids in the above reaction?

A HCO_3^- and $H_2PO_4^-$

B H_3PO_4 and $H_2PO_3^-$

C H_3PO_4 and H_2CO_3

D HCO_3^- and H_2CO_3 (2)

1.9 A galvanic cell is constructed from cadmium and nickel. What is the correct cell notation for this cell?

A $Cd^{2+} | Cd || Ni^{2+} | Ni$

B $Ni | Ni^{2+} || Cd^{2+} | Cd$

C $Cd | Cd^{2+} || Ni^{2+} | Ni$

D $Ni^{2+} | Ni || Cd^{2+} | Cd$ (2)

1.10 Which ONE of the following half-reactions takes place at the CATHODE of an electrochemical cell used to electroplate an iron spoon with silver?

A $Ag^+ + e^- \rightarrow Ag$

B $Ag \rightarrow Ag^+ + e^-$

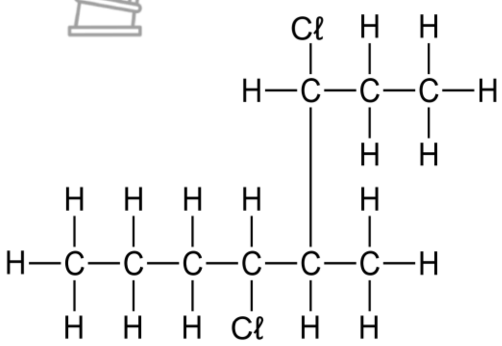
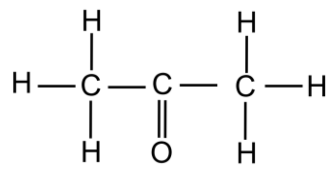
C $Fe^{2+} + 2e^- \rightarrow Fe$

D $Fe \rightarrow Fe^{2+} + 2e^-$ (2)

[20]

QUESTION 2 (Start on a new page.)

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

A	Butane	**B**	$CH_3CH_2CCCH_3$
C		**D**	
E	Butanoic acid		

2.1 Write down the letter(s) representing:

2.1.1 A compound with the general formula C_nH_{2n-2} (1)

2.1.2 A ketone (1)

2.1.3 A compound that can be used as fuel (1)

2.1.4 An unsaturated hydrocarbon (1)

2.2 For compound **E**, write down the:

2.2.1 NAME of the functional group (2)

2.2.2 Structural formula of its FUNCTIONAL ISOMER (2)

2.3 Write down the IUPAC name of:

2.3.1 Compound **C** (3)

2.3.2 Compound **D** (2)

2.4 Write down the IUPAC name of the functional isomer of **D**. (2)

2.5 Write down the structural formula of:

2.5.1 A CHAIN ISOMER of compound **A** (2)

2.5.2 Compound **E** (2)
[19]

QUESTION 3 (Start on a new page.)

3.1 The vapour pressures of two organic compounds at a specific temperature are compared.

	COMPOUND	**MOLAR MASS ($g \cdot mol^{-1}$)**
A	Butane	58
B	Methylpropane	58

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

3.1.2 Which ONE of the two compounds has the highest vapour pressure? Write down only **A** or **B**. (1)

3.1.3 Fully explain the answer to QUESTION 3.1.2 (3)

3.1.4 Give a reason why the above comparison can be considered fair. (1)

3.2 The compounds <u>propan-1-ol</u> and <u>propanone</u> are compared. Which compound has a higher boiling point? Fully explain the answer. (4)

3.3 The table below shows the results of an investigation regarding the melting points of organic molecules.

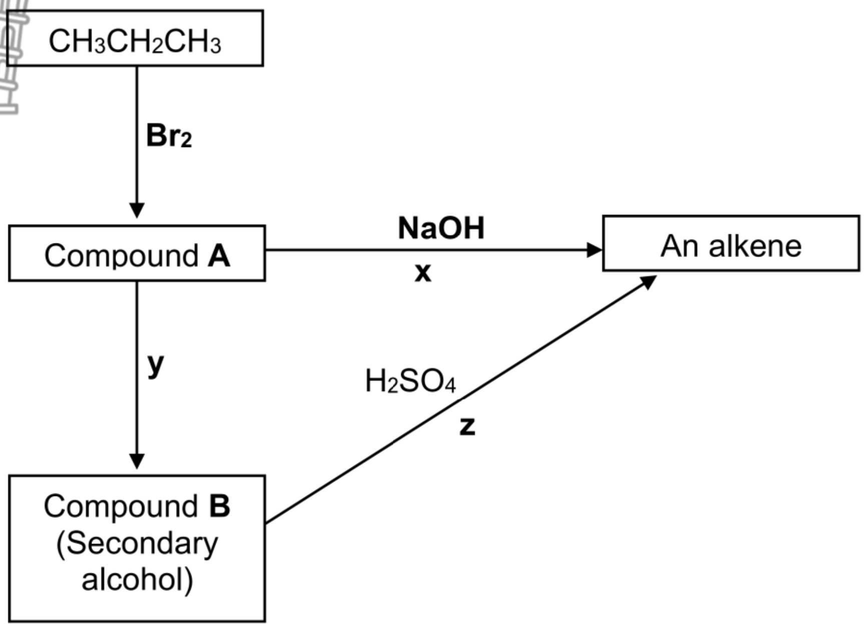
	Organic compound	**Boiling point (ºC)**
A	2,2-dimethylbutane	50
B	2,3-dimethylbutane	58
C	3-methylpentane	63

3.3.1 Write down the independent variable for this investigation. (1)

3.3.2 Explain the trend in boiling points of the above investigation. (3)
[15]

QUESTION 4 (Start on a new page.)

The flow diagram below shows the preparation of different organic compounds from $CH_3CH_2CH_3$. **x**, **y** and **z** represent organic reactions.



4.1 Write down the type of reaction represented by reaction:

4.1.1 **x** (1)

4.1.2 **y** (1)

4.1.3 **z** (1)

4.2 Reaction **x** takes place in the presence of a strong base. Write down the:

4.2.1 IUPAC name of compound **A** (2)

4.2.2 Balanced equation for the reaction **x**, using STRUCTURAL FORMULAE (4)

4.2.3 IUPAC name of the alkene produced (2)

4.3 State TWO differences in the reaction conditions for **x** and **y**. (2)

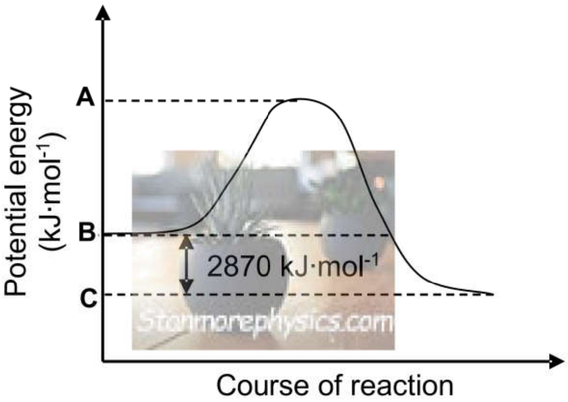
4.4 Compound **B** is a secondary alcohol. Define the term *secondary alcohol.* (2)
[15]

QUESTION 5 (Start on a new page.)

5.1 Glucose is metabolised in the human body through the following simplified equation.

$$C_6H_{12}O_6 + 6O_2 \rightarrow 6CO_2 + 6H_2O$$

The graph below shows the energy changes for the above reaction.



5.1.1 Is this reaction ENDOTHERMIC or EXOTHERMIC? Give a reason for the answer. (2)

5.1.2 Express the following in terms of the energy values **A**, **B** and **C** shown in the graph:

(a) The energy of the activated complex (1)

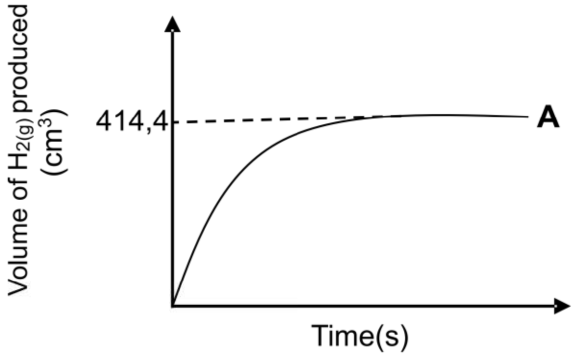
(b) The activation energy for the reverse reaction (2)

(c) ΔH for the forward reaction (2)

5.2 In an investigation of the rate of reaction, an EXCESS 200 cm^3 solution of HCℓ, concentration 0,5 $mol{\cdot}dm^{-3}$ reacts with zinc powder at STP. The following spontaneous reaction takes place:

$$Zn(s) + 2HC\ell\,(aq) \rightarrow ZnC\ell_2(aq) + H_2(g)$$

The volume of hydrogen gas produced is measured at regular time intervals and the following graph is drawn:



5.2.1 Define the term *concentration*. (2)

5.2.2 Write down the limiting reagent for the above reaction. (1)

5.2.3 Calculate the mass of the zinc used. (5)

5.2.4 The same mass of zinc granules is used instead of zinc powder.

(a) How will this affect the rate of reaction? Choose INCREASES, DECREASES or STAYS THE SAME. (1)

(b) Use the collision theory to explain the answer to QUESTION 5.2.4(a). (3)

5.2.5 A suitable catalyst is added to the reaction mixture.

Redraw the graph above in your ANSWER BOOK and label the given curve as **A**. On the same set of axes, sketch the curve that will be obtained if a catalyst is added. Label this as curve **B**. (2)

[21]

QUESTION 6 (Start on a new page.)

Hydrogen Iodide (HI) is allowed to decompose in a 5 dm^3 closed container at a temperature of 425 ºC, according to the following balanced equation:

$$2HI(g) \rightleftharpoons H_2(g) + I_2(g)$$

When the mixture reaches equilibrium at 425 ºC, it is found that 0,02 mol of H_2 is present in the container. The equilibrium constant for this reaction at 425 ºC is 0,016.

6.1 Define the term *closed system*. (2)

6.2 Calculate the initial number of moles of HI in the container. (8)

6.3 How will EACH of the following changes affect the amount of $H_2(g)$ produced? Write down only INCREASES, DECREASES or REMAINS THE SAME.

6.3.1 More $I_2(g)$ is added at 425 °C (1)

6.3.2 The pressure is increased (1)

6.4 At 325 °C, the equilibrium constant (K_c) for the reaction above is 0,014. Is the reaction EXOTHERMIC or ENDOTHERMIC? Fully explain the answer. (4)

[16]

QUESTION 7 (Start on a new page.)

7.1 Two grams (2g) of magnesium hydroxide is reacted with 30 cm^3 sulphuric acid solution of concentration 1,5 $mol{\cdot}dm^{-3}$, according to the following balanced equation:

$$H_2SO_4(aq) + Mg(OH)_2(aq) \rightarrow 2H_2O(\ell) + MgSO_4(aq)$$

7.1.1 Why is H_2SO_4 considered a STRONG ACID? (2)

7.1.2 Calculate the concentration of the final solution. (8)

7.2 A dilute $HC\ell$ solution has a concentration of 0,15 $mol{\cdot}dm^{-3}$. This dilute solution reacts with a concentrated solution of Na_2CO_3.

7.2.1 Define the term *dilute acid*. (2)

7.2.2 Calculate the pH of the $HC\ell$ solution. (3)

7.3 A solution is made by dissolving Na_2CO_3 (s) in water.

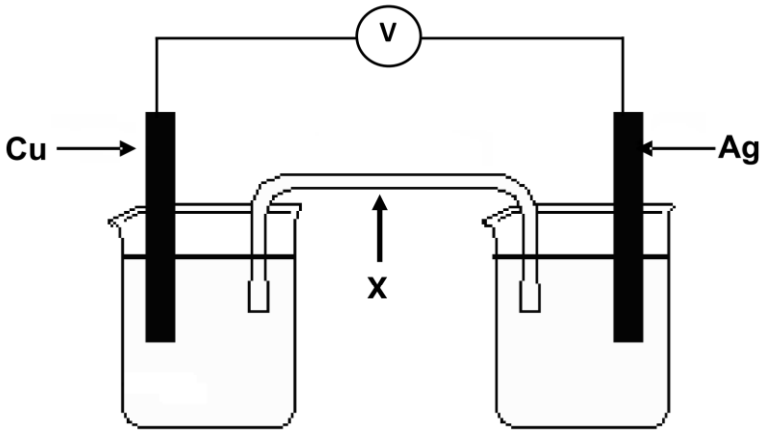
7.3.1 Is the solution of Na_2CO_3 ACIDIC or BASIC? (1)

7.3.2 Write down a balanced chemical equation that explains the answer to QUESTION 7.3.1. (3)

[19]

QUESTION 8 (Start on a new page.)

An electrochemical cell is set up under STANDARD CONDITIONS.



8.1 Write down ONE function of the part labelled **X**. (1)

8.2 Which electrode of the cell is the anode? Write down only **Cu** or **Ag**. (1)

8.3 Write down the name or formula of the electrolyte in:

8.3.1 The copper half-cell (1)

8.3.2 The silver half-cell (1)

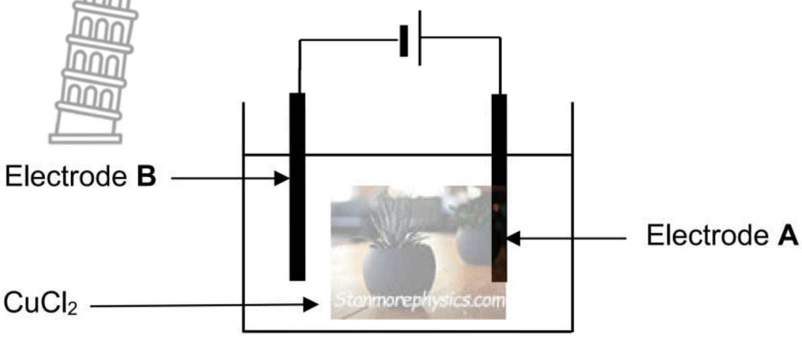
8.4 Write down the balanced net (overall) equation for the above cell. (3)

8.5 Calculate the emf of the cell. (4)

8.6 State the standard conditions under which this cell operates. (2)
[13]

QUESTION 9 (Start on a new page.)

The simplified diagram below represents an electrochemical cell used for the purification of copper.



9.1 State the energy conversion that takes place in this cell. (2)

9.2 Define the term *electrolyte*. (2)

9.3 Which electrode contains impure copper? Write down Electrode **A** OR Electrode **B**. (1)

9.4 Write down the half-reaction which takes place at electrode **B**. (2)

9.5 Is electrode **A** the ANODE or the CATHODE? (1)

9.6 The two electrodes are replaced with CARBON RODS.

9.6.1 Write down what will now be observed at electrode **A**. (2)

9.6.2 Write down a relevant half-reaction that explains the observation made in QUESTION 9.6.1. (2)

[12]

TOTAL: 150

DATA FOR PHYSICAL SCIENCES GRADE 12
PAPER 2 (CHEMISTRY)

GEGEWENS VIR FISIESE WETENSKAPPE GRAAD 12
VRAESTEL 2 (CHEMIE)

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

NAME / *NAAM*	SYMBOL / *SIMBOOL*	VALUE / *WAARDE*
Standard pressure *Standaarddruk*	p^{θ}	$1,013 \times 10^{5}$ Pa
Molar gas volume at STP *Molêre gasvolume by STD*	V_m	$22,4\ dm^{3}\cdot mol^{-1}$
Standard temperature *Standaardtemperatuur*	T^{θ}	273 K
Charge on electron *Lading op elektron*	e	$-1,6 \times 10^{-19}$ C
Avogadro's constant	N_A	$6,02 \times 10^{23}\ mol^{-1}$

TABLE 2: FORMULAE / *TABEL 2: FORMULES*

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

TABLE 3: THE PERIODIC OF ELEMENTS

KEY/*SLEUTEL*

Electronegativity / *Elektronegatiwiteit*	Atomic number / *Atoomgetal*	Symbol / *Simbool*	Approximate relative atomic mass / *Benaderde relatiewe atoommassa*
1,9	29	Cu	63,5

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

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
$\mathbf{2H^+ + 2e^-}$	$\rightleftharpoons$	$\mathbf{H_2(g)}$	**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

Increasing oxidising ability / *Toenemende oksiderende vermoë* ↓

Increasing reducing ability / *Toenemende reduserende vermoë* ↑

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