Province of the
EASTERN CAPE
EDUCATION

NATIONAL SENIOR CERTIFICATE

GRADE 12

SEPTEMBER 2023

TECHNICAL SCIENCES P2 (DEAF)

MARKS: **75**

TIME: **1½ hours**

This question paper has 15 pages, including 4 data sheets.

INSTRUCTIONS AND INFORMATION

1. This question paper has **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** the **same** as the numbers on the **question paper**.

4. **Use** a non-programmable **calculator**.

5. Leave **ONE line between two sub-questions**, e.g. between QUESTION 2.1 and QUESTION 2.2.

6. **Use** the **DATA SHEETS** at the **end** of the **question paper**.

7. **Show ALL formulae** and **substitutions** in **ALL calculations**.

8. **Round off** your **FINAL numerical answers** to **TWO decimal places**.

9. Give **short motivations**, **discussions**, etc. where required.

10. Write **neatly**.
    Your **work** must be **easy** to **read**.

QUESTION 1: MULTIPLE-CHOICE QUESTIONS

Choose the **answer**.
Write the **letter** (A–D) **next** to the **question numbers** (1.1 to 1.5), e.g. 1.6 D.

1.1 **$C_nH_{2n+1}OH$** is the **GENERAL FORMULA** for …

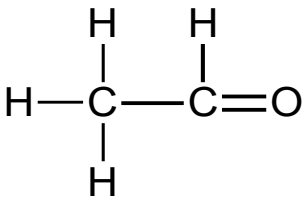
A alkanes.

B aldehydes.

C alcohols.

D alkenes. (2)

1.2 **Look** at the **structural formula** of an **organic compound**.



Which ONE is the **correct IUPAC name** of **this compound**?

A Ethanone

B Ethene

C Ethanol

D Ethanal (2)

1.3 **Which** ONE is **an unsaturated hydrocarbon**?

A $CH_3CH_2CH_2OH$

B CH_2CHCH_3

C $CH_3CH_2(CH_2)_2CH_2CH_3$

D CH_3COOCH_3 (2)

1.4 **Which** ONE of the **redox reactions** will **occur spontaneously**?

A $Cu(s) + 2H^+ \rightarrow Cu^{2+} + H_2(g)$

B $Mg(s) + 2H^+ \rightarrow Mg^{2+} + H_2(g)$

C $2Ag(s) + 2H^+ \rightarrow 2Ag^+ + H_2(g)$

D $Hg(\ell) + 2H^+ \rightarrow Hg^{2+} + H_2(g)$ (2)

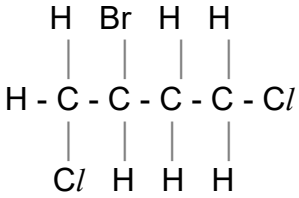
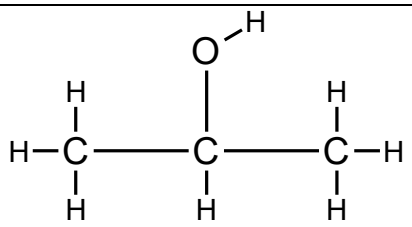
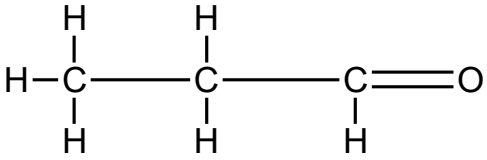
1.5 **What will happen** at the **negative electrode** of a **voltaic (galvanic) cell** and at the **negative electrode** of an **electrolytic cell**?

	Voltaic (galvanic) cell	**Electrolytic cell**
A	Oxidation	Reduction
B	Reduction	Oxidation
C	Oxidation	Oxidation
D	Reduction	Reduction

(2)
[10]

QUESTION 2 (Start on a new page.)

Organic chemistry is the **chemistry** of **organic molecules**.
It is **divided** into **homologous series** which are **identified** by their **functional groups**.
The letters **A** to **H** in the table **represent eight organic compounds**.

A	$CH_3CH_2CH(CH_3)CH_2OH$	**B**	$CH_3CH_2CH_2COOCH_2CH_3$
C		**D**	CH_2CH_2
E	Hexane	**F**	
G		**H**	$CH_3CH_2CO_2H$

2.1 **Define** the term ***functional group.*** (2)

2.2 **Write** down the:

2.2.1 **Letter** that **represents** a **SECONDARY alcohol** (1)

2.2.2 **Name** of the **functional group** of compound **H** (1)

2.2.3 **Name** of the **homologous series** to which **compound G** belongs (1)

2.2.4 **IUPAC name** of compound **C** (2)

2.2.5 **NAME** of the **polymer formed** from compound **D** (1)

2.2.6 **Balanced equation**, using **MOLECULAR FORMULAE**, for the **combustion** of compound **E** in **excess oxygen** (3)

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

2.2.8 **General formula** of the **homologous series** to which compound **B belongs** (1)

2.3. A few drops of fresh reddish-brown bromine water are added to compound **D** in a test tube.

2.3.1 Describe what will be observed in the test tube. (1)

2.3.2 Use structural formulae to write down a balanced equation for the reaction that takes place in the test tube. (4)

[19]

QUESTION 3 (Start on a new page.)

Two compounds **P** and **Q**, have the molecular formula $C_2H_4O_2$. (2)

3.1. **What** are ***structural isomers*?**

3.2. Compound **P** has a **lower vapour pressure than** compound **Q**.

3.2.1 **How** will the **boiling point** of compound **P compare** to that of compound **Q**?

Write **HIGHER THAN**, **LOWER THAN**, or **EQUAL TO**. (1)

3.2.2 **Write** down the **NAME** of compound **P**. (1)

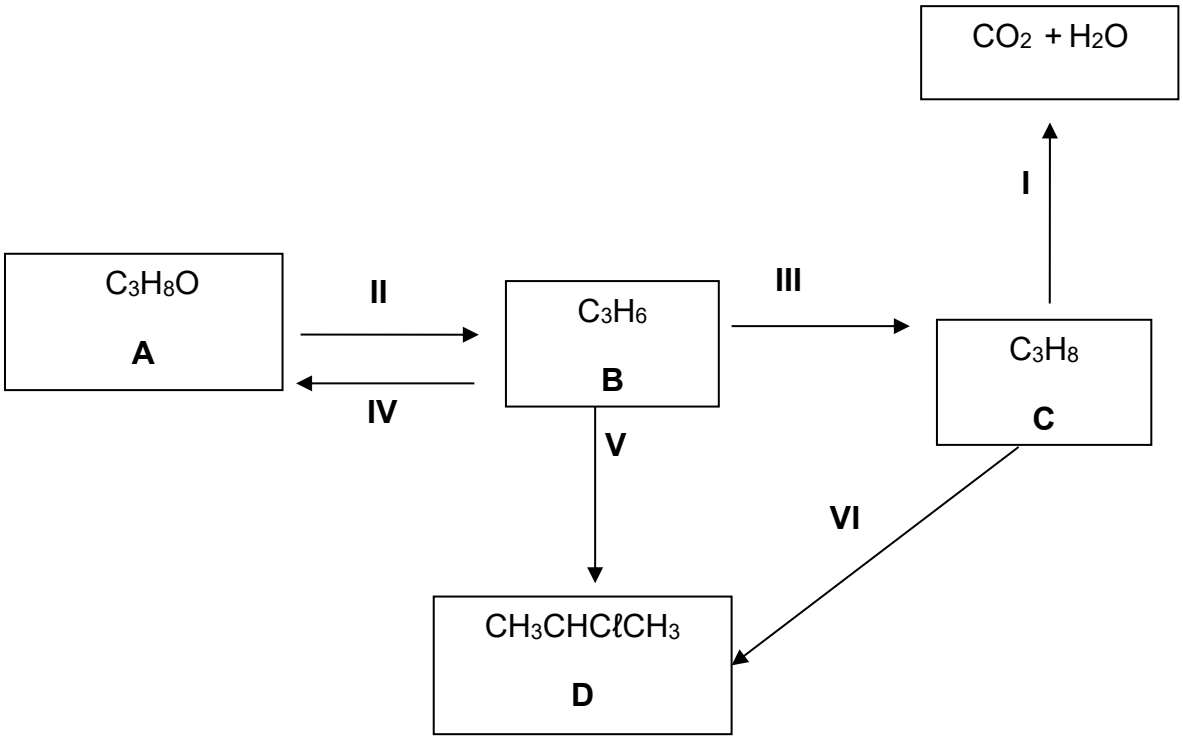
3.2.3 To **which class** of **organic compound** does compound **Q belong**? (1)

3.2.4 Write the **structural formula** for compound **Q** and **give** its **IUPAC name**. (3)

3.2.5 **Explain** in **terms** of **INTERMOLECULAR FORCES** and **ENERGY**.
Why does compound **P** has a **lower vapour pressure** than compound **Q**? (3)
[11]

QUESTION 4 (Start on a new page.)

Different organic reactions
Look at the **sequence**(arrangement) of **organic reactions**.
Answer the **questions**.
Reactions are **labelled** from **I** to **VI.**
Organic compounds are **labelled** from **A** to **D**.



4.1 **Give** the **reagent needed** for each of the **reactions**:

4.1.1 Reaction **III** (1)

4.1.2 Reaction **V** (1)

4.2 Compound **A** is a **major product** of reaction **IV**.

4.2.1 **Name** the **type** of **reaction** that **takes place**. (1)

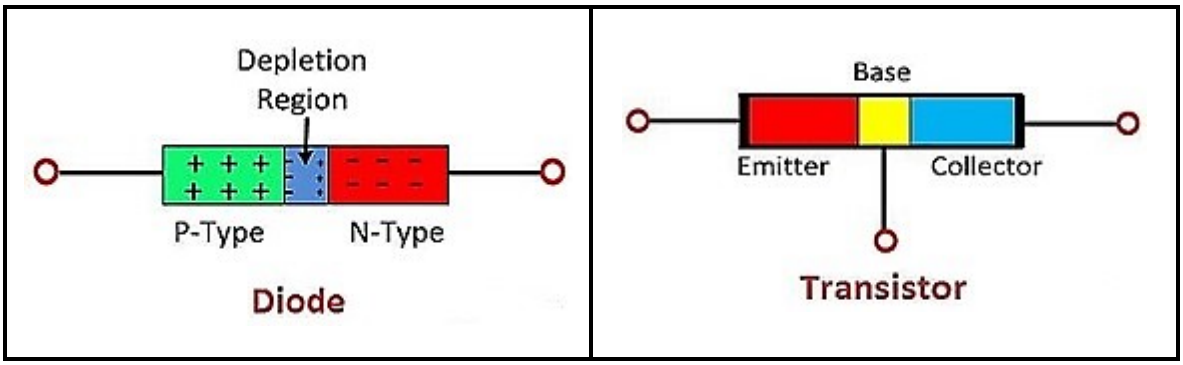
4.2.2 **Write** down the **structural formula** of compound **A**. (2)

4.3 Reaction **I** is a **combustion reaction**.

Write the **balanced chemical equation** for this **reaction**. (2)
[7]

QUESTION 5 (Start on a new page.)

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



5.1. **What** is a *semiconductor*? (2)

5.2. **Arsenic** was **added** to **silicon** in **small quantities**.
It **was** then **found** that the **electrical conductivity** of **silicon** has **improved**.

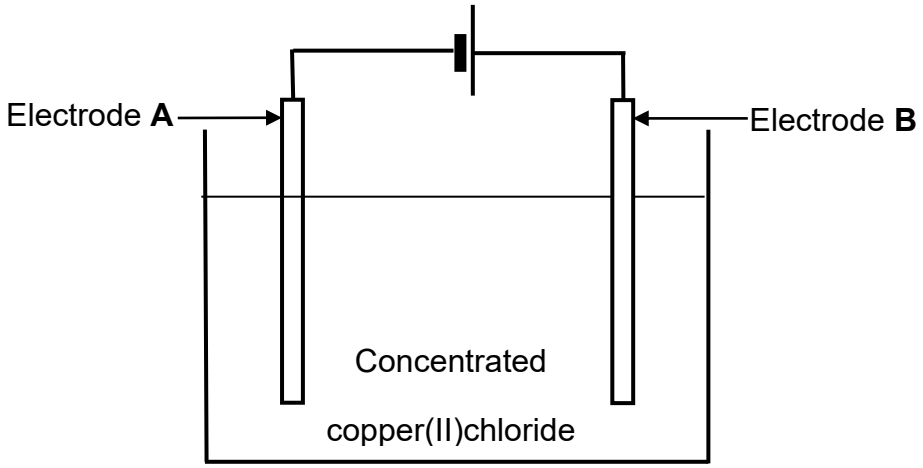
5.2.1 **Name** the **process described** in the above **statements**. (1)

5.2.2 **What type** of a **semiconductor material** is **formed** during this **process**? (1)

5.2.3 **Give** a **reason** for your **answer** in **QUESTION 5.2.2**. (1)
[5]

QUESTION 6 (Start on a new page.)

DIAGRAM:
The diagram **represents** an **electrochemical cell**.
It is **used** to **decompose** a **concentrated copper(II)chloride solution using inactive electrodes**.



6.1. **What** is *electrolysis*? (2)

6.2. **Write** down the **energy conversion** that **takes place** in this **cell**. (1)

6.3 At **which electrode** does **reduction take place**?
Write down **A** or **B** only. (1)

6.4 **Write** down the:

6.4.1. **NAME** of the **gas formed** while the **cell** is **functioning** (1)

6.4.2. **Half-reaction** that **takes place** at electrode **A** (2)

6.4.3 **NAME** or **FORMULA** of the **oxidising agent**.
Give a **reason** for the **answer** (2)

6.4.4 **NAME** of a **substance** that can be **used** as **electrodes** in this **cell** (1)

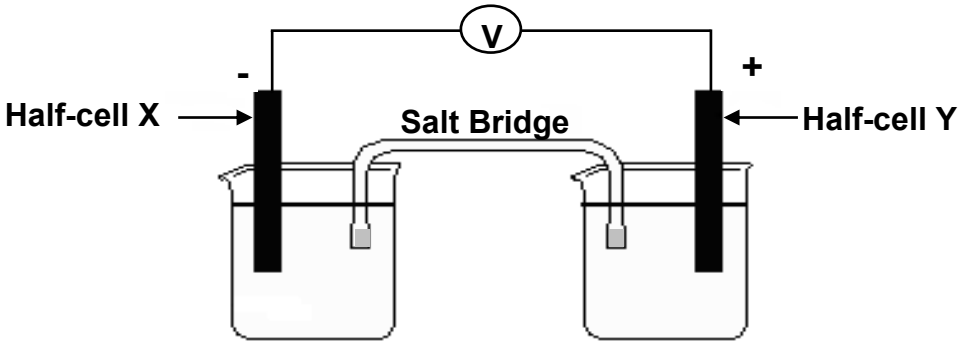
6.5. **How** does the **concentration** of the **copper(II)chloride solution change** as the **reaction proceeds**?

Write **INCREASES**, **DECREASES** or **NO CHANGE**.

Give a **reason.** (2)
[12]

QUESTION 7 (Start on a new page.)

DIAGRAM:
Learners use an **electrochemical cell** as shown.
This is in an **investigation** to **compare** the **reducing abilities** of **different metals**.



7.1 **Name** the **type** of **electrochemical cell depicted(shown)** in the diagram. (1)

7.2 **What** will the **voltmeter reading** be if the **salt bridge** is **removed**? (2)

7.3 Name **TWO standard conditions** for this **experiment.** (2)

7.4 **TABLE:**
In their **investigation**, they **use different combinations** of **half reactions** as **depicted(shown)** in the table.
This is to **compare** the **reducing abilities** of Cu, Zn and Al.
The **cell potential** for **each combination** of the **half cells** is **recorded**.

COMBINATION	Half-Cell X	Half-Cell Y	VOLTMETER READING (V)
1	Cu/Cu^{2+}	Al/Al^{3+}	-1,8
2	Al/Al^{3+}	Zn/Zn^{2+}	+0,8
3	Zn/Zn^{2+}	Cu/Cu^{2+}	+1,0

Write:

7.4.1 **Possible reason** why the **voltmeter reading** for a **copper-aluminium cell** is **negative** (2)

7.4.2 **Suitable conclusion** for this **investigation** (2)

7.5 **Write** the **NAME** or **SYMBO**L of the:

7.5.1 **Metal** which is **oxidised** in **COMBINATION 2** (1)

7.5.2 **Reducing agent** in **COMBINATION 3** (1)
[11]

TOTAL: 75

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DATA FOR TECHNICAL SCIENCES GRADE 12
PAPER 2 (CHEMISTRY)

GEGEWENS VIR TEGNIESE WETENSKAPPE GRAAD 12
VRAESTEL 2 (CHEMIE)

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
Molar gas volume at STP *Molêre gasvolume teen 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 *Avogadro se konstante*	N_A	$6{,}02 \times 10^{23}$ mol^{-1}

TABLE 2: FORMULAE/*TABEL 2: FORMULES*

$n = \frac{m}{M}$ **OR/OF** $n = \frac{N}{N_A}$ **OR/OF** $n = \frac{V}{V_m}$	$c = \frac{n}{V}$ **OR/OF** $c = \frac{m}{MV}$ $\frac{c_a V_a}{c_b V_b} = \frac{n_a}{n_b} P$ $pV = nRT$	$pH = -\log[H_3O^+]$ $K_w = [H_3O^+][OH^-] = 1 \times 10^{-14}$ at /by 298K
$E^\theta_{cell} = E^\theta_{cathode} - E^\theta_{anode}$ / $E^\theta_{sel} = E^\theta_{katode} - E^\theta_{anode}$ $E^\theta_{cell} = E^\theta_{reduction} - E^\theta_{oxidation}$ / $E^\theta_{sel} = E^\theta_{reduksie} - E^\theta_{oksidasie}$ $E^\theta_{cell} = E^\theta_{oxidising\ agent} - E^\theta_{reducing\ agent}$ / $E^\theta_{sel} = E^\theta_{oksideermiddel} - E^\theta_{reduseermiddel}$		
$q = I\Delta t$ $n = \frac{Q}{e}$ **OR/OF** $n = \frac{Q}{q_e}$		

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

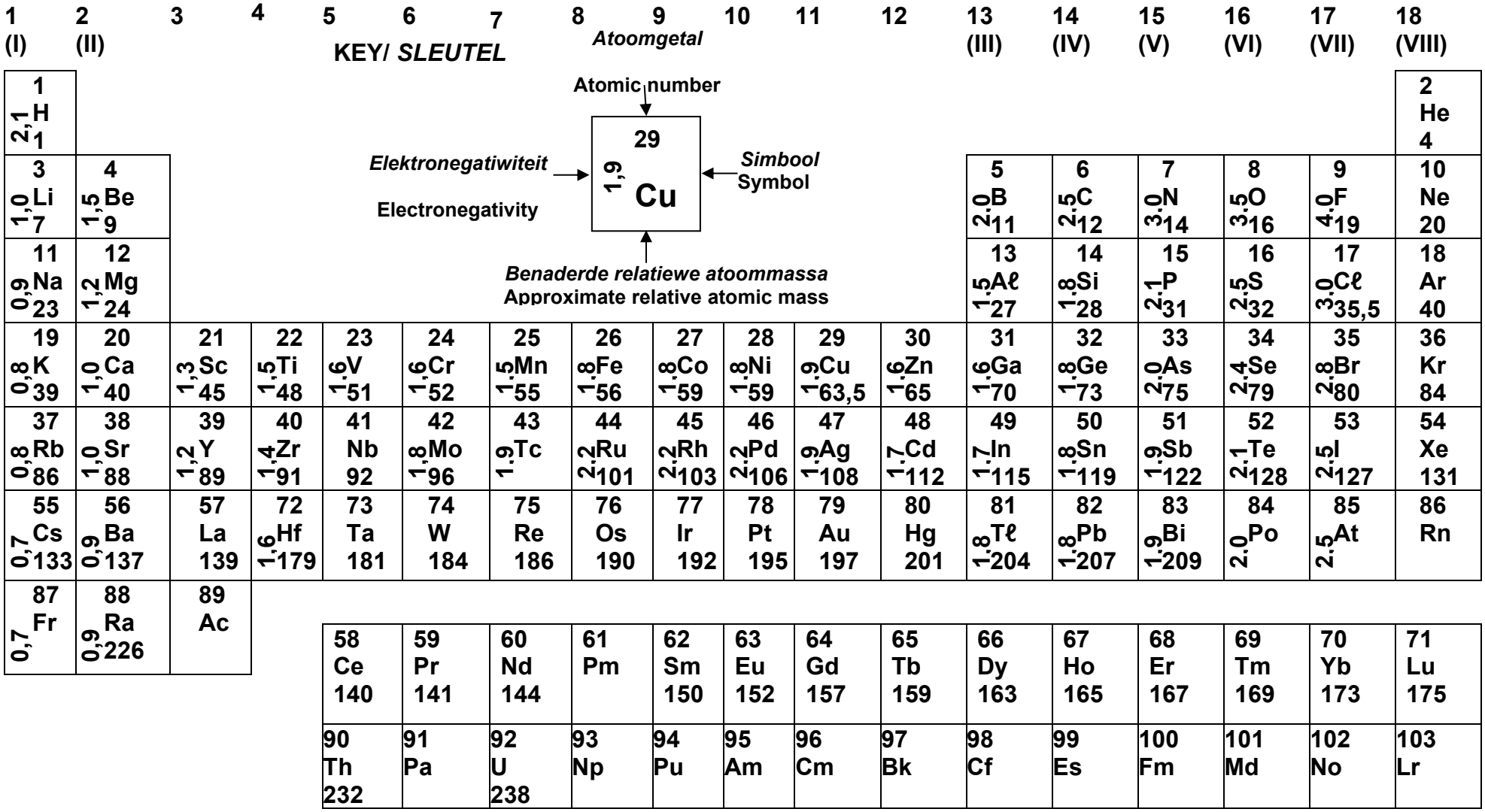

TABLE 4A: STANDARD REDUCTION POTENTIALS
TABEL 4A: STANDAARD REDUKSIEPOTENSIALE

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
$2H^+ + 2e^-$	**$\rightleftharpoons$**	**$H_2(g)$**	**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
$A\ell^{3+} + 3e^-$	$\rightleftharpoons$	$A\ell$	– 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

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
$A\ell^{3+} + 3e^-$	⇌	Aℓ	– 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(ℓ)	+ 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*

Increasing reducing ability/*Toenemende reduserende vermoë*