basic education

Department:
Basic Education
REPUBLIC OF SOUTH AFRICA

NATIONAL SENIOR CERTIFICATE

GRADE 12

TECHNICAL SCIENCES P2

NOVEMBER 2024

MARKS: 75

TIME: 1½ hours

This question paper consists of 11 pages and 4 data sheets.

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 Consider the following examples of isomers:

Example 1	but-1-ene	but-2-ene
Example 2	1-chloropropane	2-chloropropane

Both examples represent …

A functional isomers.

B positional isomers.

C chain isomers.

D structural isomers. (2)

1.2 Which ONE of the following is the CORRECT condensed structural formula for 2,3-dimethylbutane?

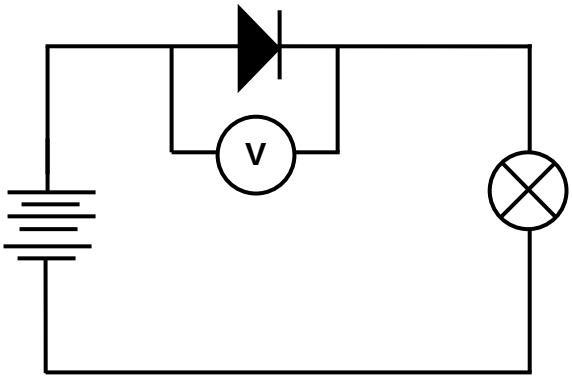
A $CH_3C(CH_3)_2CH_2CH_3$

B $CH_3CH(CH_3)CH_2CH_2CH_3$

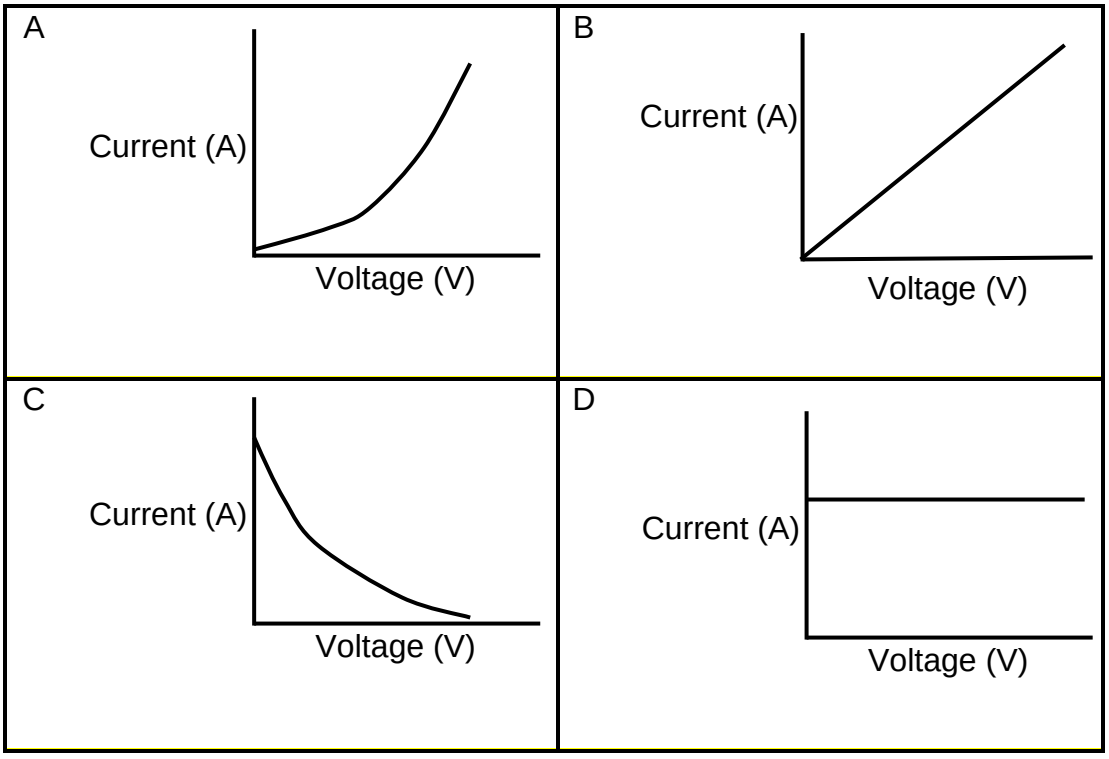
C $CH_3CH(CH_3)CH(CH_3)CH_3$

D $CH_3CH_2CH_2CH_2CH_2CH_3$ (2)

1.3 Consider the circuit diagram below.



Which ONE of the following graphs best describes the relationship between the current and applied voltage?



(2)

1.4 Which ONE of the following combinations is TRUE for an electrolytic cell?

	ANODE	CATHODE	ENERGY CONVERSION
A	Negative	Positive	Chemical to electrical
B	Positive	Negative	Electrical to chemical
C	Negative	Positive	Mechanical to electrical
D	Positive	Negative	Electrical to mechanical

(2)

1.5 ONE of the disadvantages of photovoltaic cells is that …

A toxic chemicals are used in the production process.

B the cells are placed on an unused space on rooftops.

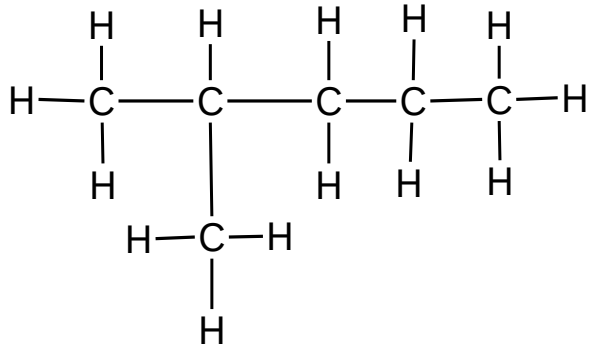
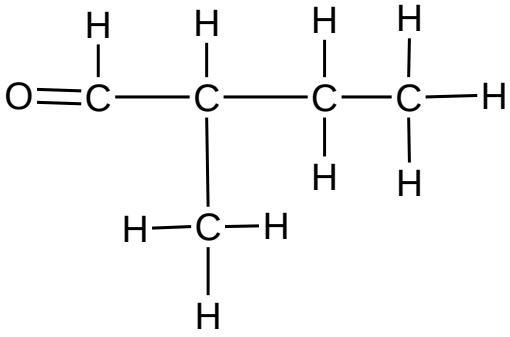
C photovoltaic systems are quiet and not a disturbance.

D energy produced by solar cells is clean. (2)

[10]

QUESTION 2 (Start on a new page.)

Consider the following organic compounds represented by letters **A** to **E**.

A 	**B** 
C Methyl propanoate	**D** H_2CCH_2
E 2-methylpropan-2-ol	

2.1 Refer to compound **A** and write down the:

2.1.1 IUPAC name (2)

2.1.2 Molecular formula (1)

2.1.3 General formula for the homologous series to which the compound belongs (1)

2.1.4 Molecular formulae of the products formed during the combustion of this compound (2)

2.2 Refer to compound **B** and write down the:

2.2.1 Name of the homologous series to which this compound belongs (1)

2.2.2 Name of its functional group (1)

2.3 Compound **C** is formed when a carboxylic acid reacts with an alcohol.

2.3.1 Draw the structural formula of the functional group of compound **C**. (1)

2.3.2 Write down the IUPAC name of the carboxylic acid used. (1)

2.4 Write down the letter that represents a compound that is a/an:

2.4.1 Monomer of polythene (1)

2.4.2 Alcohol (1)

2.5 Classify the alcohol referred to in QUESTION 2.4.2 as PRIMARY, SECONDARY or TERTIARY. (1)

[13]

QUESTION 3 (Start on a new page.)

Use the organic compounds below to answer the questions that follow.

Bromoethane	Ethanol	Ethane	Ethanoic acid

3.1 Define the term *boiling point.* (2)

3.2 Arrange the compounds in order of decreasing boiling point. (1)

3.3 Write down the relationship between the boiling points of organic compounds and their intermolecular forces. (2)

3.4 Which ONE of the compounds will have the highest vapour pressure when they are compared at the same temperature? (1)

3.5 Identify the type of intermolecular forces present in bromoethane and ethane, and compare their strengths. (3)

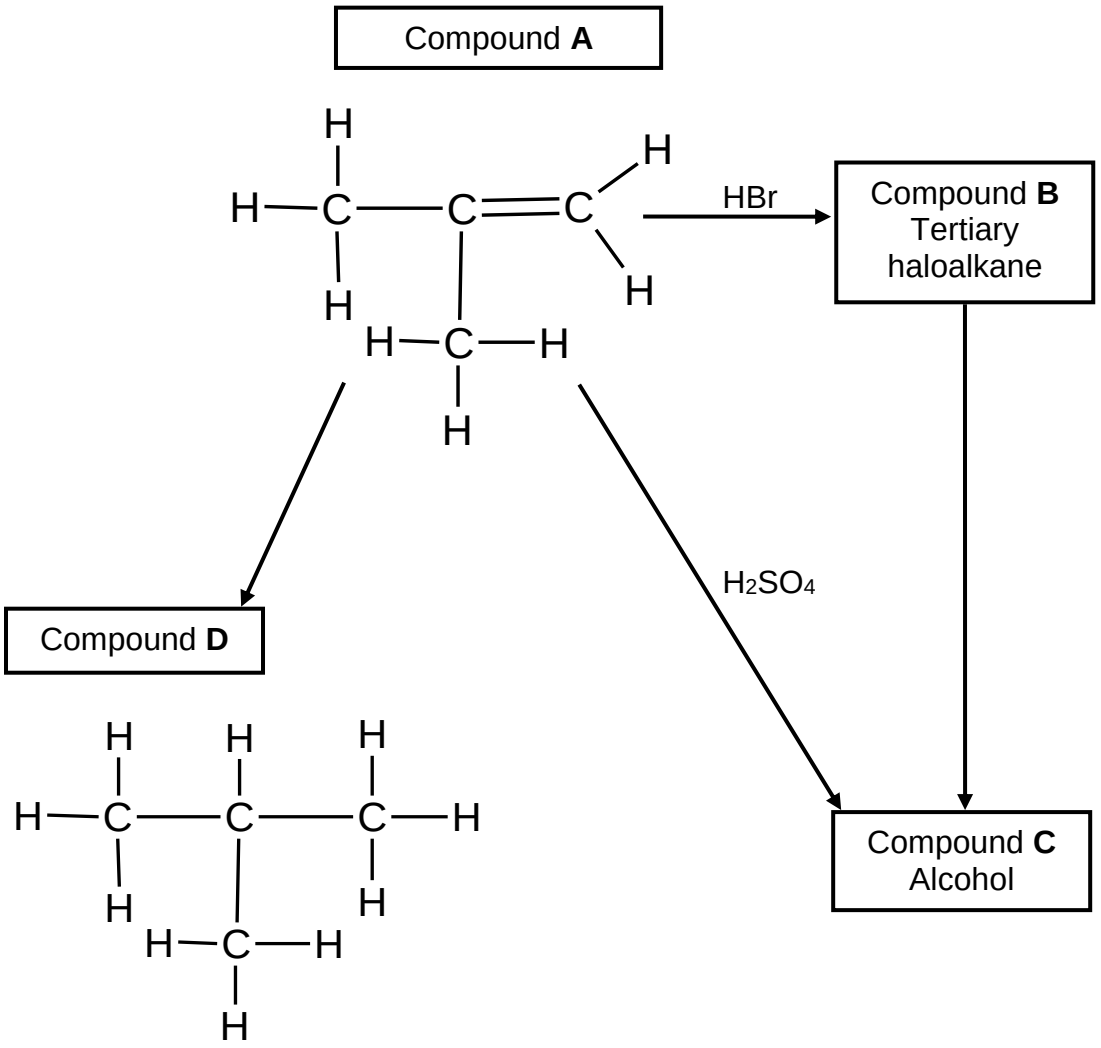
3.6 Methyl methanoate is an isomer of ethanoic acid.

3.6.1 What type of isomers are these organic compounds? (1)

3.6.2 Define the type of isomer referred to in QUESTION 3.6.1. (2)
[12]

QUESTION 4 (Start on a new page.)

The flow chart below illustrates different organic reactions in which compound **A** is converted to different compounds, **B, C** and **D**. Study the flow chart carefully and then answer the questions that follow.



4.1 Write down the homologous series to which compound **A** belongs. (1)

4.2 Consider the reaction in which compound **A** is converted to compound **B**.

4.2.1 Draw the structural formula of compound **B**. (2)

4.2.2 Explain why compound **B** is called a tertiary haloalkane. (2)

4.2.3 Why is it important that there should be no water in the reaction mixture? (2)

4.3 Consider the reaction in which compound **B** is converted to compound **C**.

4.3.1 Write down ONE reaction condition for this reaction. (1)

4.3.2 Use molecular formulae to write a balanced chemical equation for this reaction. (3)

4.4 Consider the conversion of compound **A** to compound **C**.

4.4.1 Write down the NAME and the TYPE of this chemical reaction. (2)

4.4.2 Write down the chemical formula of the inorganic reactant that is used. (1)

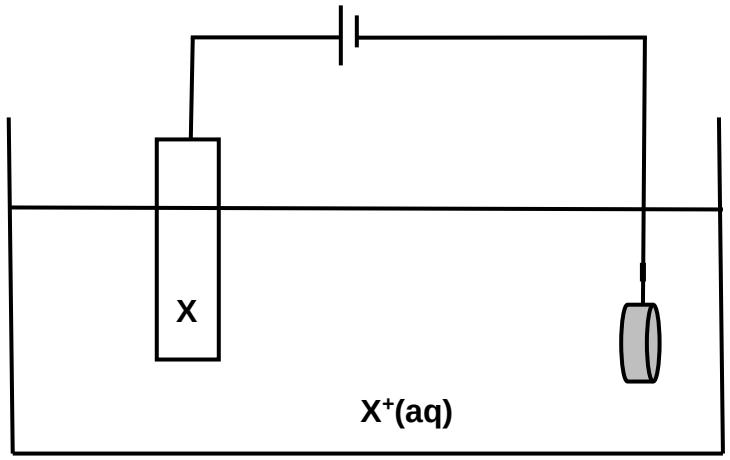
4.5 Consider the reaction where compound **A** is converted to compound **D**. Write down the:

4.5.1 NAME of the inorganic reactant needed for the reaction (1)

4.5.2 Symbol of the catalyst used during the reaction (1)
[16]

QUESTION 5 (Start on a new page.)

A learner wants to electroplate an iron ring with silver to enhance its appearance and increase its value. The iron ring is cleaned thoroughly before the electroplating takes place.



5.1 Define the term *electrolysis*. (2)

5.2 Why must the iron ring be cleaned thoroughly before electroplating takes place? (2)

5.3 Is electrode **X** the anode or cathode? (1)

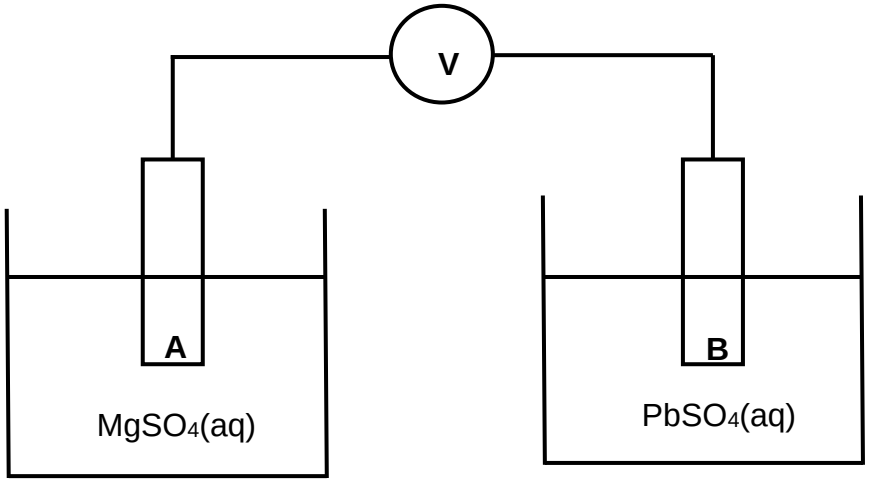
5.4 Give a reason for the answer to QUESTION 5.3. (2)

5.5 Write down the NAME of ion $\mathbf{X^+}$. (1)

5.6 Write down the half-reaction taking place at the iron ring. (2)
[10]

QUESTION 6 (Start on a new page.)

A group of learners set up an electrochemical cell, as shown in the diagram below. The cell is INCOMPLETE.



6.1 What type of electrochemical cell is this? (1)

6.2 Explain the answer to QUESTION 6.1. (2)

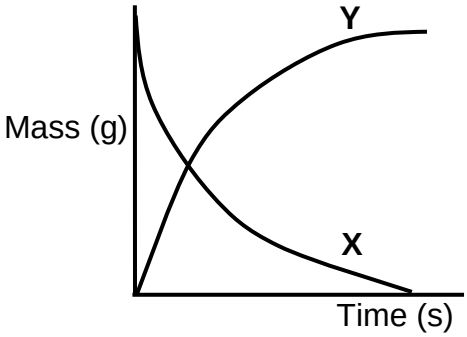
6.3 What is the reading on the voltmeter? (1)

6.4 Write down the name of the component needed to complete the circuit. (1)

6.5 State TWO functions of the component named in QUESTION 6.4. (2)

The component in QUESTION 6.4 is inserted and the voltmeter reading increases. The graphs below show the change in the masses of both electrodes **A** and **B** while the cell is in operation.

6.6 Which graph (**X** or **Y**) below represents the change in the mass of electrode **A**? Write down only **X** or **Y**.



(1)

6.7 Is electrode **A** an oxidising agent or reducing agent? Explain the answer. (2)

6.8 Calculate the emf of the cell while in operation. (4)

[14]

TOTAL: 75

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^{θ}	$1{,}01 \times 10^{5}$ Pa
Standard temperature *Standaardtemperatuur*	T^{θ}	0 °C/273 K

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

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

KEY/*SLEUTEL*

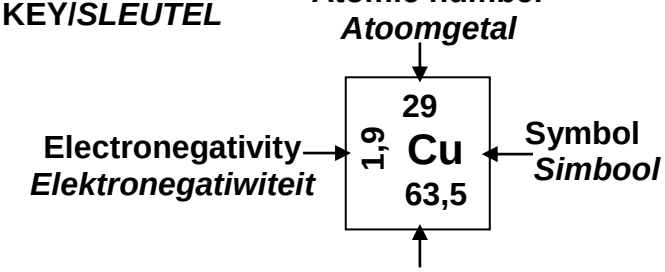


TABLE 4A: STANDARD REDUCTION POTENTIALS
TABEL 4A: STANDAARD-REDUKSIEPOTENSIALE

Increasing oxidising ability/*Toenemende oksiderende vermoë* ↑

Half-reactions/*Halfreaksies*			$E^{\ominus}$ (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 reducing ability/*Toenemende reduserende vermoë* ↓

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

Increasing strength of oxidising agents/*Toenemende sterkte van oksideermiddels* ↓

Half-reactions/*Halfreaksies*			$E^{\ominus}$ (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
$SO_4^{-} + 4H^+ + 2e^-$	⇌	$SO_2(g) + 2H_2O$	+ 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
$Cr_2O_7^{-} + 14H^+ + 6e^-$	⇌	$2Cr^{3+} + 7H_2O$	+ 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 strength of reducing agents/*Toenemende sterkte van reduseermiddels* ↑