LIMPOPO
PROVINCIAL GOVERNMENT
REPUBLIC OF SOUTH AFRICA

DEPARTMENT OF
EDUCATION

NATIONAL SENIOR CERTIFICATE

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GRADE 11

PHYSICAL SCIENCES: CHEMISTRY (P2)

JUNE 2025

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MARKS: 100

TIME : 2 Hours

This question paper consists of 13 pages including this cover page and 3 data sheets.

INSTRUCTIONS AND INFORMATION

1. Write your NAME in the appropriate space on the ANSWER BOOK.
2. This question paper consists of 5 questions. Answer ALL the questions.
3. Number the answers correctly according to the numbering system used in this question paper.
4. Leave ONE line between two sub questions, for example between QUESTION 2.1 and QUESTION 2.2.
5. You may use a non-programmable calculator.
6. You may use appropriate mathematical instruments.
7. Show ALL formulae and substitutions in ALL calculations.
8. Round off your FINAL numerical answers to **TWO** decimal places.
9. Diagrams are NOT necessarily drawn to scale.
10. Write neatly and legibly.

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QUESTION 1: MULTIPLE-CHOICE QUESTIONS

Four options are provided as possible answers to the following questions. Each question has only ONE correct answer. Write only the letter (A – D) next to the number (1.1 – 1.10) in the ANSWER BOOK. Eg. 1.11 A

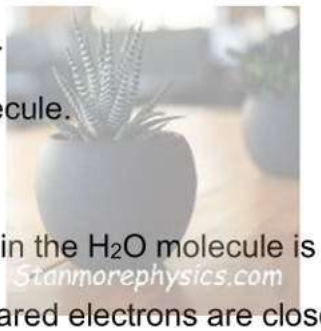
1.1 The type of particle which results from covalent bonding of atom is called

A an isotope.

B an atom.

C an ion.

D a molecule. (2)



1.2 The bonding in the H_2O molecule is described as polar covalent because

A the shared electrons are closer to the oxygen atom than the hydrogen atom.

B the shared electrons are closer to the hydrogen atom than the oxygen atom.

C electrons are transferred from hydrogen atoms to oxygen atoms.

D there is a large electronegativity difference between the two atoms. (2)

1.3 The $CC\ell_4$ molecule is considered to be non-polar because

A the shape of the molecule is linear.

B the molecule is symmetrical.

C the electronegativity difference is very small.

D the molecule is asymmetrical. (2)

1.4 Which ONE of the following contains ionic bonds?

A $NaC\ell$

B OF_2

C $CH_3C\ell$

D H_2O (2)

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1.5 Bond length is the average distance between the…

A molecules of the same substance.

B nuclei of two bonded atoms.

C electrons in two bonded atoms.

D orbitals of two bonded atoms. (2)

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1.6 Which ONE of the following statements represents the best explanation for the term 'electronegativity'?

A a measure of the tendency of an atom to attract a bonding pair of electrons.

B a measure of the tendency of an atom to attract an electron.

C a measure of the strength of a covalent bond.

D a measure of the strength of an ionic bond. (2)

1.7 Sodium chloride ($NaC\ell$) is a solid which is soluble in water. Which ONE of the following describes the intermolecular forces that exist between sodium chloride and water in solution?

A Induced dipole-dipole.

B Ion-induced dipole.

C Dipole-dipole.

D Ion-dipole. (2)

1.8 Consider the structure of hexane



A molecule of hexane is considered to be non-polar. Which ONE of the following statements best describes the reason why hexane is non-polar?

A Hexane contains only single bonds between atoms.

B The electronegativity difference between C and H atoms is so small as to be considered non-polar.

C Hexane is a linear molecule, hence is symmetrical.

D The charge distribution of electrons within the hexane molecule is symmetrical. (2)

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1.9 Hydrogen bonds and London forces (induced dipole forces) have a common characteristic in that they …

A are both stronger than chemical bonds.

B both occur between non-polar molecules.

C both occur between polar molecules.

D are both intermolecular forces. (2)

1.10 Hydrogen bonding is a type of intermolecular force that can exist between the molecules of certain compounds. Which ONE of the statements below best describes the condition under which hydrogen bonding is most likely to occur? It occurs between:

A A small molecule which contains hydrogen atoms.

B Molecules in which hydrogen is bonded to small atoms with high electronegativity.

C Large molecules which contain both hydrogen and oxygen atoms.

D Molecules in which hydrogen is bonded to small atoms with low electronegativity. (2)

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QUESTION 2 (Start on a new page)

Molecules such as **CO_2** and **H_2O** are formed through covalent bonding.

2.1 Define the term *covalent bond*. (2)

2.2 ONE of the above molecules has lone pairs of electrons on the central atom.

2.2.1 Explain what is meant by a lone pair. (2)

2.2.2 Draw the Lewis structure for this molecule (2)

2.2.3 Identify the central atom in this molecule. (2)

2.2.4 How many lone pairs of electrons are present in this molecule (1)

2.2.5 What is the molecular shape of this molecule. (2)

2.3 **H_2O** can form a dative covalent bond to form **H_3O^+**.

2.3.1 Use the Lewis electron diagram for water molecule to explain the dative covalent bond. (6)

2.3.2 State TWO conditions for the formation of such a bond. (4)

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QUESTION 3 (Start on a new page)

Hydrogen fluoride (HF) can be prepared by treating calcium fluoride (CaF_2) with an acid.

3.1 Define the term *electronegativity*. (2)

3.2 Use electronegativity differences to explain the difference in the type of bonding found in HF and CaF_2. (4)

3.3 Using a Lewis diagram, illustrate fully how bonding occurs in CaF_2 (4)

3.4 HF is described as a polar molecule. Explain what is meant by this term. (2)

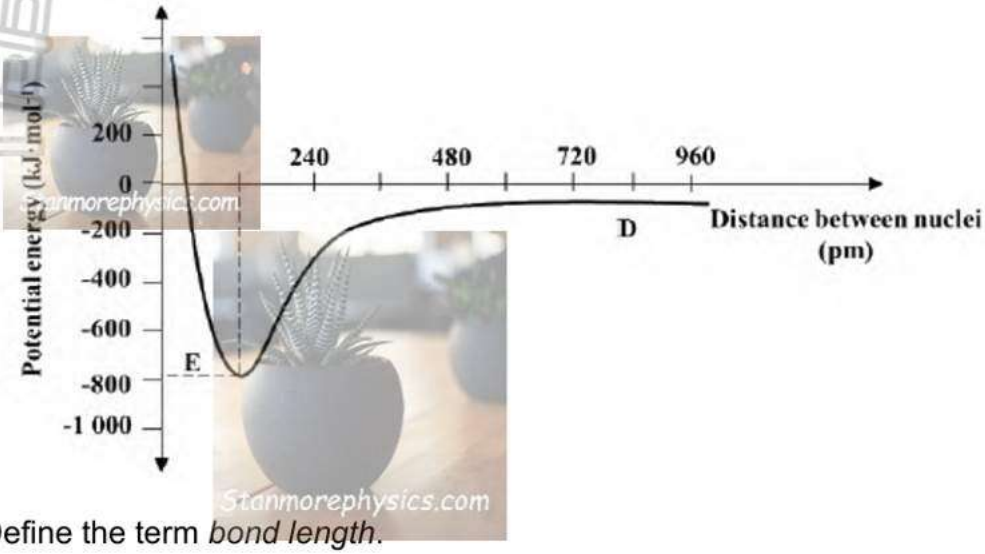
3.5 HF is an example of a group of three molecules that exhibit what is known as hydrogen bonding. What TWO identifying characteristics are crucial in a molecule being able to exhibit hydrogen bonding. (2)

[14]

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QUESTION 4 (Start on a new page)

The graph below shows the change in energy that takes place when an oxygen atom approaches a carbon atom during the formation of a **C=O** bond.



4.1 Define the term *bond length*. (2)

4.2 From the graph, write down the:

4.2.1 bond length, in pm, of the **C=O** bond. (2)

4.2.2 bond energy, in Kj.mol^{-1} needed to break the **C=O** bond. (2)

4.2.3 name the potential energy represented by **E**. (2)

4.3 How will the bond length of an **S=O** bond compares to that of the **C=O** bond? Write down EQUAL TO, SHORTER THAN or LONGER THAN. Give a reason for your answer. (2)

4.4 What can be said about the forces between the two atoms at point **D**? (2)

4.5 The table below shows the bond lengths and bond energies for different bonds between two carbon atoms.

	Bond	Length (pm)	Energy (kJ·mol^{-1})
A	C – C	154	348
B	C = C	134	614
C	C ≡ C	120	839

4.5.1 Describe the relationship between bond length and bond energy as shown in the above table? (2)

4.5.2 Which ONE of the bonds (**A, B** or **C**) will be the weakest? Explain (3)

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QUESTION 5 (Start on a new page)

The boiling points of four compounds of hydrogen at standard pressure are given in the table below.

Formula	Boiling point (°C)
CH_4	-164
NH_3	–33
H_2O	100
SiH_4	–112



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

5.2 Fully explain the difference in boiling points between CH_4 and:

5.2.1 NH_3 (3)

5.2.2 SiH_4 (3)

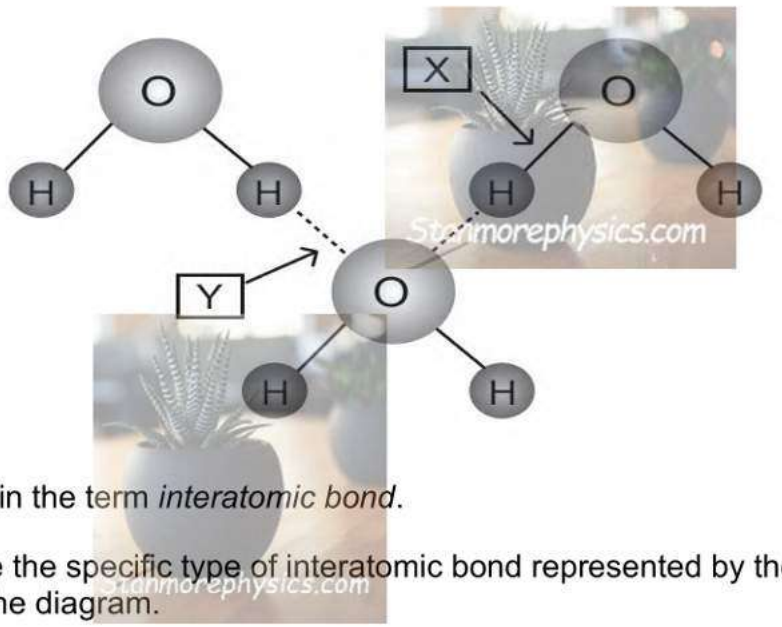
5.3 Explain why the boiling points of NH_3 and H_2O differ by referring to the electronegativity, the molecular shapes and the intermolecular forces in these substances. (4)

5.4 Select substances from the table above which are classified as either:

5.4.1 Non-polar molecules. (2)

5.4.2 Polar molecules. (2)

5.5 Consider the diagram below, showing an arrangements of water molecules in the liquid phase.



5.5.1 Explain the term *interatomic bond*. (2)

5.5.2 Name the specific type of interatomic bond represented by the letter **X** in the diagram. (2)

5.5.3 Define the term *intermolecular force*. (2)

5.5.4 Name the specific type of intermolecular force represented by the letter **Y** in the diagram. (2)

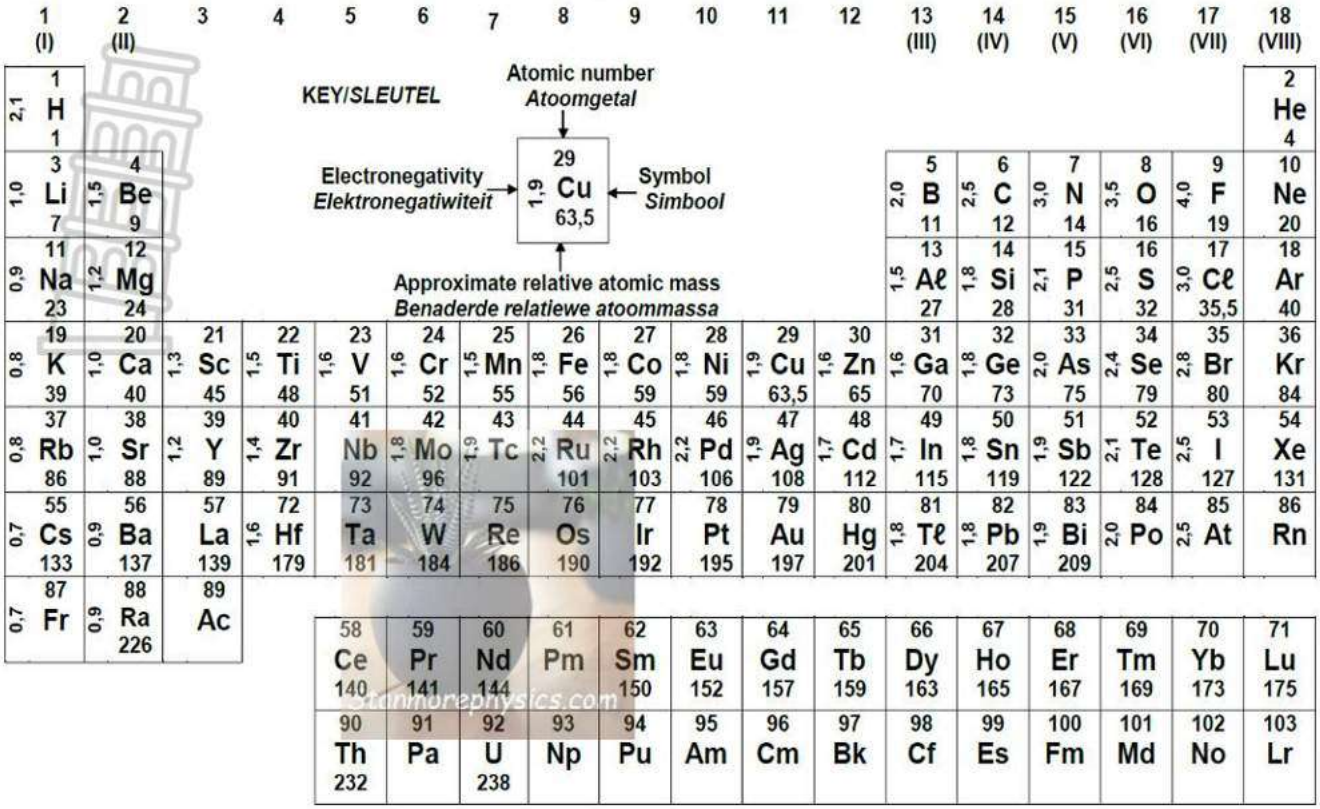
5.5.5 State TWO properties of the oxygen atom that make this type of intermolecular force **Y** possible (2)

5.5.6 What is the partial charge on the hydrogen atom in the water molecule. (2)

[28]

TOTAL MARKS: 100

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	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	La 139	1,6 Hf 179	Ta 181	W 184	Re 186	Os 190	Ir 192	Pt 195	Au 197	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	0,9 Ra 226	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

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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

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Increasing oxidising ability/*Toenemende oksiderende vermoë* ↑

Increasing reducing ability/*Toenemende reduserende vermoë* ↓

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

Half-reactions/*Halfreaksies*			$E^{\ominus}$ (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
$SO_4^{2-} + 4H^+ + 2e^-$	⇌	$SO_2(g) + 2H_2O$	+ 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*

Increasing reducing ability/*Toenemende reduserende vermoë*

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