LIMPOPO
PROVINCIAL GOVERNMENT
REPUBLIC OF SOUTH AFRICA

DEPARTMENT OF EDUCATION

NATIONAL SENIOR CERTIFICATE

GRADE 12

PHYSICAL SCIENCES: CHEMISTRY (P2)
SEPTEMBER 2025

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MARKS: 150

TIME: 3 hours

This question paper consists of 17 pages, 4 data sheets.

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INSTRUCTIONS AND INFORMATION

1. Write your name and surname (and centre number if applicable) in the appropriate spaces on the ANSWER BOOK/ANSWER SHEET.
2. This question paper consists of NINE questions. Answer ALL the questions in the ANSWER BOOK.
3. Start EACH question on a NEW page in the ANSWER BOOK.
4. Non-programmable calculators may be used.
5. Appropriate mathematical instruments may be used.
6. Leave ONE line between two sub questions, e.g. between QUESTION 2.1 and QUESTION 2.2.
7. Number the answers correctly according to the numbering system used in this question paper.
8. Data sheets are attached for your use.
9. Wherever motivations, discussions, et cetera are required, be brief.
10. Show ALL formulae and substitutions in ALL calculations.
11. Write neatly and legibly.

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QUESTION1: MULTIPLE CHOICE QUESTIONS

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

1.1 Which one of the following compounds is unsaturated hydrocarbon?

A. $CH_3CH_2CH_2CH_2CH_2CH_2CH_2CH_3$

B. $CH_3CH(CH_3)CH_2CH_2CH_2CH_2CH_3$

C. $CH_3CH_2CHCHCH_2CH_2CH_2CH_3$

D. $CH_3C(CH_3)_2C(CH_3)_2CH_3$ (2)

1.2 Which of the following is the functional group for ketones?

A. Carbonyl group.

B. Carboxyl group.

C. Formyl group.

D. Hydroxyl group. (2)

1.3 Which of the following pairs of organic compounds are chain isomers?

A. Butane and methyl butane.

B. Hexane and 2,2 – dimethyl butane.

C. 2 – methyl pentane and 3 – methyl pentane.

D. Pentanoic acid and methylbutanoate.

1.4 Which one of the following compounds is a product of the cracking of octane?

A. CH_2CH_2.

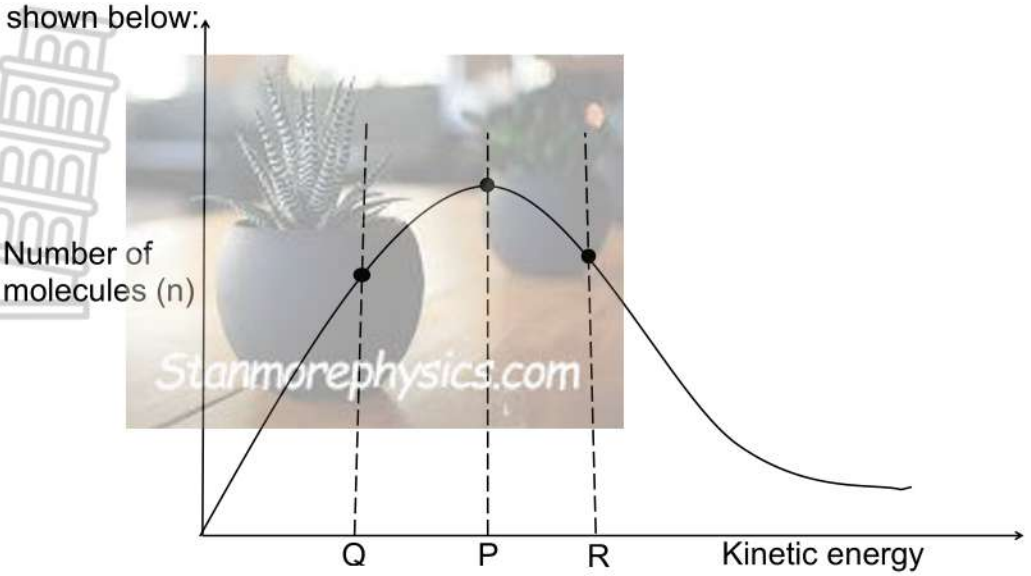
B. CH_3CH_2Cl

C. CH_3CH_2Br

D. CH_3CHO (2)

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1.5 The Boltzman distribution curve for a certain gas at constant temperature is shown below:



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If the temperature of the gas is REDUCED by 20^0C, the shape of the graph changes.

What happens to the values of n for the kinetic energies Q, P and R?

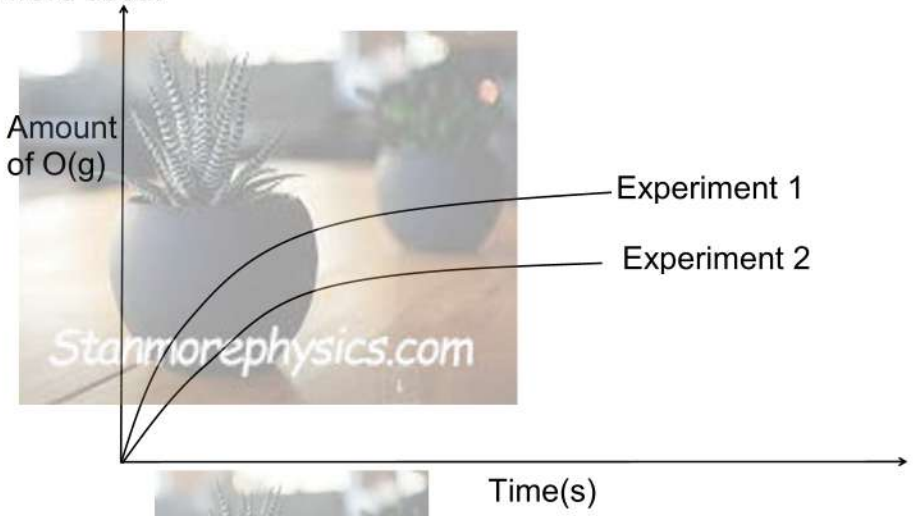
	Q	P	R
A	Higher.	Lower.	Higher.
B	Higher.	Lower.	Lower.
C	Lower.	Higher.	Lower.
D	Lower.	Lower.	Lower.

(2)

1.6 Consider the following hypothetical reversible reaction below:

$M(g) + N(g) \rightleftharpoons O(g) + P(l)$

Two experiments in which the production of O was measured were carried out. The results are shown in the graph below. The same initial amounts of M and N were used.



What change in the conditions can explain the results shown?

A. A lower pressure was used in experiment 2.

B. A catalyst was used in experiment 2.

C. A higher temperature was used in experiment 2.

D. A lower temperature was used in experiment 2. (2)

1.7 Which of the following statements is/are true regarding the equivalence point of a reaction between ethanoic acid and sodium hydroxide?

(i) It is the point where the acid and the base have reacted so that neither is in excess.

(ii) $[H_3O^+] = [OH^-]$

(iii) pH = 7

A. (i) only.

B. (i) and (ii).

C. (i), (ii) and (iii).

D. (ii) and (iii). (2)

1.8 A beaker contains a dilute solution of hydrochloric acid. A second beaker contains a solution of sodium hydroxide. Water is added to EACH solution. What happens to the pH of each solution?

	Hydrochloric acid solution	Sodium hydroxide solution
A	Decreases.	Increases.
B	Increases.	Decreases.
C	Decreases.	Decreases.
D	Increases.	Increases.

(2)

1.9 Consider the galvanic cell represented by the cell notation below:

$Ni(s)/Ni(NO_3)_2(aq)//AgNO_3(aq)/Ag(s)$

Which one of the following describes the movement of ions between the two half cells?

	Positive ions	Negative ions
A	From Ni to Ag.	From Ni to Ag.
B	From Ni to Ag.	From Ag to Ni.
C	From Ag to Ni.	From Ag to Ni.
D	From Ag to Ni.	From Ni to Ag.

(2)

1.10 Which ONE of the half reactions below will occur at the POSITIVE electrode during the electrolysis of $CuCl_2(aq)$?

A. $Cu^{2+} + 2e^- \rightarrow Cu$

B. $2H_2O + 2e^- \rightarrow H_2 + 2OH^-$

C. $2H_2O \rightarrow O_{2\ +4H^+} + 2e^-$

D. $2Cl^- \rightarrow Cl_2 + 2e^-$ (2)

[20]

QUESTION 2

The table below represents organic compounds. Study the table and answer the questions that follow.

A	HCHO	**B**	CH_3-$CHBr$-CH_2-$C(CH_3)_3$
C	$C(CH_3)_4$	**D**	$CH_3(CH_2)_2CHCH_2$
E	C_XH_y	**F**	Methyl propanoate

2.1 Define the term chain isomer. (2)

2.2 Write down the:

2.2.1 Letter that represents a chain isomer of pentane. (1)

2.2.2 IUPAC name of compound **B.** (3)

2.2.3 IUPAC name of compound **D.** (2)

2.2.4 GENERAL FORMULA of the homologous series to which compound D belongs. (1)

2.3 Draw a STRUCTURAL FORMULA of compound **F.** (2)

2.4 Write down a balanced equation, using MOLECULAR FORMULAE, for the complete combustion of compound **C.** (3)

2.5 To which homologous series does **A** belongs? (1)

2.6 Compound **E is** an alkane with an extra 20% of C-atoms than compound **C**. Determine the values of X and Y. (4)

[19]

QUESTION 3

The melting and boiling points of the first four straight-chain alkanes are compared under the same conditions.

Number of C atoms	Name	Melting point	Boiling point
1	Methane	-183	-162
2	Ethane	-172	-89
3	Propane	-186	-42
4	Butane	-136	0

3.1 Define the term melting point. (2)

3.2 What CONCLUSION can be drawn from data in the table? (2)

3.3 How will the strength of intermolecular forces butane compare to its isomer? Write only STRONGER THAN, WEAKER THAN or EQUAL TO. (1)

3.4 Is this comparison fair or unfair? Give a reason to your answer. (2)

3.5 In which phase will propane be at room temperature? Write only GAS, LIQUID or SOLID. (1)

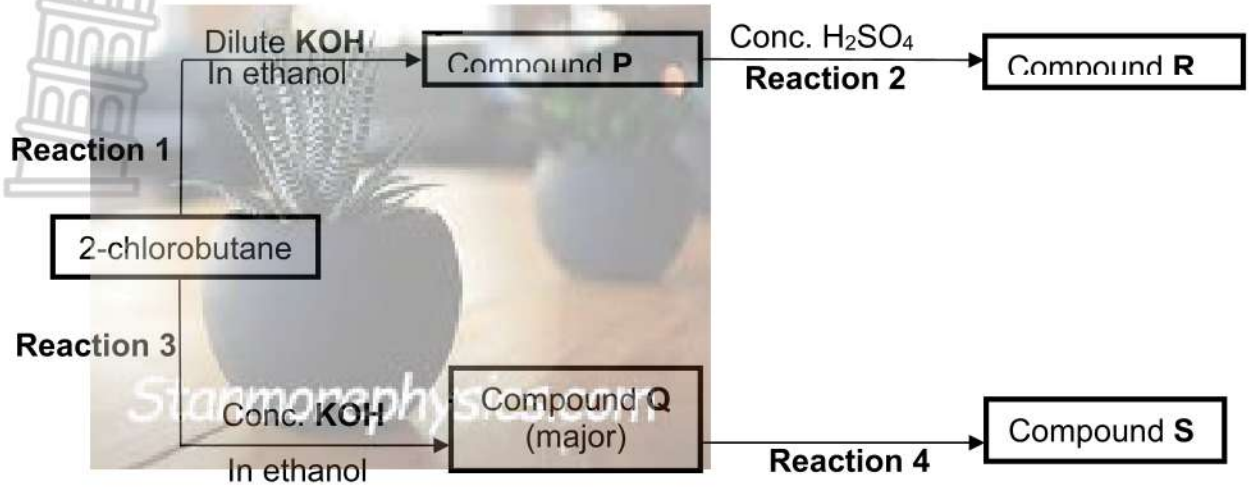
3.6 Explain the difference in boiling point between ethane and propane. (3)

[11]

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QUESTION 4

The flow diagram below shows different organic reactions.Compounds P, Q, R and S are organic compounds.



4.1 **Reaction 1**, Write down:

4.1.1 The TYPE of reaction. (1)

4.1.2 IUPAC name of compound **P**. (2)

4.2 Consider **reaction 2**.

4.2.1 Write down the STRUCTURAL formula of compound R. (2)

4.2.2 Apart from concentrated sulphuric acid, what is the other condition for this reaction to take place? (1)

4.3 For **reaction 3**, write down:

4.3.1 A balanced equation using STRUCTURAL FORMULAE for this reaction. (5)

4.3.2 The IUPAC name of compound **Q.** (2)

4.4 **Reaction 4**: compound S is an alkane. Write down the:

4.4.1 TYPE of reaction. (1)

4.4.2 NAME or FORMULA of a catalyst needed for this reaction (1)

4.5 Compound **S**, can undergo cracking under certain conditions.

4.5.1 Define the term cracking. (2)

4.5.2 Except for high temperature and high pressure, what is the other condition required for compound S to undergo cracking? (1)

[18]

QUESTION 5

Rolaids is a tablet which contains calcium carbonate as one of the active ingredients. A pharmacist wants to determine the rate of reaction between stomach acid and Rolaids. He performs an experiment using calcium carbonate powder and concentrated hydrochloric acid of concentration 0,1mol/dm^3. He then performs the same experiment using a lump of calcium carbonate of the same mass as the powder. The reaction takes place according to the following chemical equation:

$CaCO_3(s) + 2HCl(aq) \rightarrow CaCl_2(aq) + H_2O(l) + CO_2(g)$

5.1 Define the term rate of reaction. (2)

5.2 What type of reaction takes place between the Rolaids tablet and hydrochloric acid? (1)

5.3 The pharmacist repeated the same experiment using the same mass of calcium carbonate lumps. Which factor affecting the rate of reaction is the pharmacist investigating? (1)

5.4 What is the dependent variable for the investigation? (1)

5.5 In the second experiment 53cm^3 of carbon dioxide was produced in one minute. Calculate the average rate of reaction in *mol.s^{-1}*. (5)

[10]

QIUESTION 6

6.1 The following reaction is one of the steps in the production of sulphuric acid:

$2SO_2(g) + O_2(g) \rightleftharpoons 2SO_3(g)$ $\triangle H = -196kJ/mol$

6.1.1 Define the term chemical equilibrium. (2)

6.1.2 In an industry, they mix a certain moles x of sulphur dioxide with 0,5 mol of oxygen gas. The reaction proceeds until equilibrium is reached in a 2dm^3 container. Upon analysis of the equilibrium mixture it was discovered that a quarter (¼) of the initial number of moles of oxygen remains. The Kc value for this reaction is 10. Calculate the initial number of moles of sulphur dioxide that was in the container. (8)

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6.1.3 Calculate the mass of sulphur dioxide that was sealed in the container. (3)

6.2 Certain changes were made to the equilibrium conditions. What effect will they have on the yield of SO_3? Write only INCREASES, DECREASES or STAYS THE SAME.

6.2.1 Increase in temperature. (1)

6.2.2 Catalyst added. (1)

6.2.3 Pressure decreased. Use Le Chatelier's principle to explain your choice. (3)

[18]

QUESTION 7

Ammonia is a weak base found in many household cleaning products.

7.1 Define the term weak base. (2)

In an attempt to determine the concentration of ammonia in a local carpet cleaner, Thabo added 20 cm^3 of the carpet cleaner to a 250cm^3 volumetric flask and added water up to the 250 cm^3 mark. 31,2 cm^3 of this solution was neutralised by 25 cm^3 of sulphuric acid of concentration 0,02 $mol.dm^{-3}$

7.2 Calculate the concentration of hydroxide ions, OH^-, in the acid. (4)

The balanced equation for the neutralisation reaction is;

$2NH_3\,(aq) + H_2SO_4\,(aq) \longrightarrow (NH_4)_2SO_4(aq)$

7.3.1 Calculate the concentration of ammonia in the household cleaner. (7)

7.3.2 At the equivalence point the pH of the mixture is not 7. State whether the pH is ABOVE 7 or BELOW 7 and explain your answer using a relevant equation. (4)

7.4 A diprotic weak acid ionises in water in two steps as shown in the two equations shown below.

I $H_2C_2O_4(aq) + H_2O(\ell) \longrightarrow HC_2O_4^-(aq) + H_3O^+\,(aq)$

II $HC_2O_4^-(aq) + H_2O(\ell) \longrightarrow C_2O_4^{2-}(aq) + H_3O^+\,(aq)$

7.4.1 Define the term ampholyte. (2)

From the above reactions, write down the formulae of the:

7.4.2 Ampholyte. (1)

7.4.3 Two acids in equation **I**. (2)

[22]

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QUESTION 8

A galvanic cell is set up under standard conditions as represented by the cell notation below.

$Cr|Cr^{3+}(aq)||Sn^{4+}(aq)|Sn^{2+}(aq)|Pt$

8.1 Define the term galvanic cell. (2)

8.2 Write down the standard conditions under which this cell operates. (2)

8.3 Write down the formula of the:

8.3.1 Cathode. (1)

8.3.2 Reducing agent. (1)

8.4 What is the total concentration of tin ions in the electrolyte of the Sn half-cell? (1)

8.5 Write down a balanced equation for the net cell reaction. (3)

8.6 Calculate the initial Emf of the cell. (4)

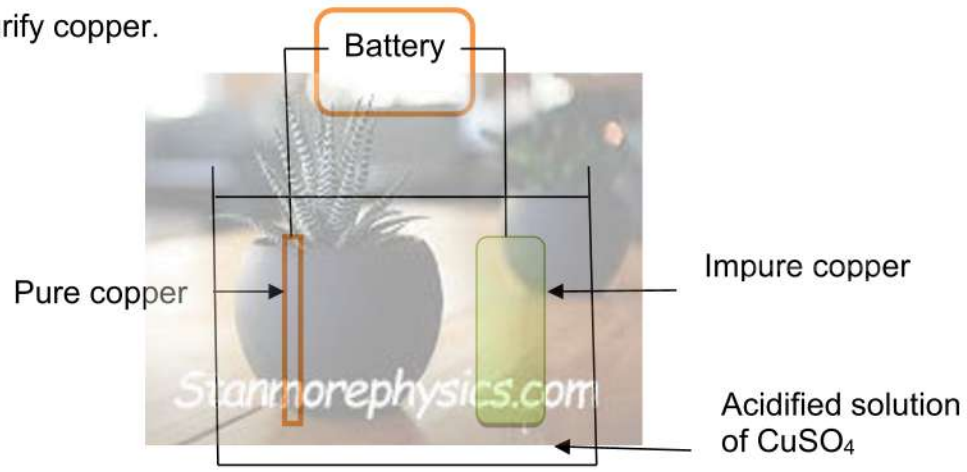
8.7 How does an increase in the initial concentration of Cr^{3+} ions affect the voltmeter reading? Write only INCREASES, DECREASES or REMAINS THE SAME (1)

[16]

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QUESTION 9

Copper metal of very high purity is required to manufacture electrical copper cables. The diagram below shows an electrochemical cell used to purify copper.



9.1 Define the term electrolysis. (2)

9.2 Write down a balanced equation for the anode half reaction. (2)

9.3 Which electrode is the positive electrode of the cell? Write only PURE COPPER or IMPURE COPPER. (1)

9.4 The impure copper contains zinc, silver, gold and nickel as impurities

9.4.1 Identify one impurity that may be oxidised. (1)

9.4.2 Explain your answer to 9.3.1 (2)

9.4.3 State what happens to the impurities that are not oxidised. (1)

A current was passed through the solution for a certain period of time. The electrodes were weighed before and after electrolysis. The results are shown in the table below.

	Mass of impure copper(g)	Mass of pure copper(g)
Before electrolysis	600	150
After electrolysis	390	320

9.5 Use the information in the table to calculate the percentage purity of the impure copper. (4)

9.6 What happens to the concentration of the electrolyte during the process? Explain your answer. (3)

[16]

TOTAL: 150

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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 *Avogadro se konstante*	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$[H_3O^+]$
$K_w = [H_3O^+][OH^-] = 1 \times 10^{-14}$ at/by 298 K	
$E^{\theta}_{cell} = E^{\theta}_{cathode} - E^{\theta}_{anode}$ / $E^{\theta}_{sel} = E^{\theta}_{katode} - E^{\theta}_{anode}$ Or/of $E^{\theta}_{cell} = E^{\theta}_{reduction} - E^{\theta}_{oxidation}$ / $E^{\theta}_{sel} = E^{\theta}_{reduksie} - E^{\theta}_{oksidasie}$ Or/of $E^{\theta}_{cell} = E^{\theta}_{oxidising\ agent} - E^{\theta}_{reducing\ agent}$ / $E^{\theta}_{sel} = E^{\theta}_{oksideer\ middel} - E^{\theta}_{reduseer\ middel}$	

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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 **H** 1																	**He** 2 4
1,0 **Li** 3 7	1,5 **Be** 4 9											2,0 **B** 5 11	2,5 **C** 6 12	3,0 **N** 7 14	3,5 **O** 8 16	4,0 **F** 9 19	**Ne** 10 20
0,9 **Na** 11 23	1,2 **Mg** 12 24											1,5 **Aℓ** 13 27	1,8 **Si** 14 28	2,1 **P** 15 31	2,5 **S** 16 32	3,0 **Cℓ** 17 35,5	**Ar** 18 40
0,8 **K** 19 39	1,0 **Ca** 20 40	1,3 **Sc** 21 45	1,5 **Ti** 22 48	1,6 **V** 23 51	1,6 **Cr** 24 52	1,5 **Mn** 25 55	1,8 **Fe** 26 56	1,8 **Co** 27 59	1,8 **Ni** 28 59	1,9 **Cu** 29 63,5	1,6 **Zn** 30 65	1,6 **Ga** 31 70	1,8 **Ge** 32 73	2,0 **As** 33 75	2,4 **Se** 34 79	2,8 **Br** 35 80	**Kr** 36 84
0,8 **Rb** 37 86	1,0 **Sr** 38 88	1,2 **Y** 39 89	1,4 **Zr** 40 91	**Nb** 41 92	1,8 **Mo** 42 96	1,9 **Tc** 43	2,2 **Ru** 44 101	2,2 **Rh** 45 103	2,2 **Pd** 46 106	1,9 **Ag** 47 108	1,7 **Cd** 48 112	1,7 **In** 49 115	1,8 **Sn** 50 119	1,9 **Sb** 51 122	2,1 **Te** 52 128	2,5 **I** 53 127	**Xe** 54 131
0,7 **Cs** 55 133	0,9 **Ba** 56 137	**La** 57 139	1,6 **Hf** 72 179	**Ta** 73 181	**W** 74 184	**Re** 75 186	**Os** 76 190	**Ir** 77 192	**Pt** 78 195	**Au** 79 197	**Hg** 80 201	1,8 **Tℓ** 81 204	1,8 **Pb** 82 207	1,9 **Bi** 83 209	2,0 **Po** 84	2,5 **At** 85	**Rn** 86
0,7 **Fr** 87	0,9 **Ra** 88 226	**Ac** 89															

Ce 58 140	**Pr** 59 141	**Nd** 60 144	**Pm** 61	**Sm** 62 150	**Eu** 63 152	**Gd** 64 157	**Tb** 65 159	**Dy** 66 163	**Ho** 67 165	**Er** 68 167	**Tm** 69 169	**Yb** 70 173	**Lu** 71 175
Th 90 232	**Pa** 91	**U** 92 238	**Np** 93	**Pu** 94	**Am** 95	**Cm** 96	**Bk** 97	**Cf** 98	**Es** 99	**Fm** 100	**Md** 101	**No** 102	**Lr** 103



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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

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

Increasing oxidising ability/*Toenemende oksiderende vermoë* ↓

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
$A\ell^{3+} + 3e^-$	⇌	$A\ell$	− 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

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