LIMPOPO
PROVINCIAL GOVERNMENT
REPUBLIC OF SOUTH AFRICA

DEPARTMENT OF EDUCATION

NATIONAL SENIOR CERTIFICATE

GRADE 12

PHYSICAL SCIENCES: CHEMISTRY (P2)

PREPARATORY EXAMINATION

SEPTEMBER 2020

MARKS: 150

TIME: 3 hours

This question paper consists of 16 pages and 4 data sheets

INSTRUCTIONS AND INFORMATION

1. Write your NAME in the appropriate space on the ANSWER BOOK.
2. This question paper consists of EIGHT questions. Answer ALL the questions in the ANSWER BOOK.
3. Start EACH question on a NEW page in the ANSWER BOOK.
4. You may use a non-programmable calculator.
5. YOU ARE ADVISED TO USE THE ATTACHED DATA SHEETS.
6. Number the answers correctly according to the numbering system used in this question paper.
7. Give brief motivations, discussions, et cetera where required.
8. Show ALL formulae and substitutions in ALL calculations.
9. Round off your final numerical answers to a minimum of TWO decimal places.
10. Write neatly and legibly.

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 question number (1.1 – 1.10) in the ANSWER BOOK.

1.1 Consider the organic compound below.

$$\begin{array}{ccccccccc} & & C\ell & & & & & & \\ & & | & & & & & & \\ H_3C & - & CH & - & CH_2 & - & CH & - & CH_2OH \\ & & & & & & | & & \\ & & & & & & CH_3 & & \end{array}$$

The IUPAC name of this compound is:

A 4-chloro-1-methyl pentan-1-ol

B 2-chloro-4-methyl pentan-2-ol

C 4-chloro-2-methyl pentan-1-ol

D 2-methyl-4-chloro butan-2-ol (2)

1.2 Each of the reactions below represenst a cracking reaction of $C_{15}H_{32}$. During which reaction are two different alkenes produced?

A $C_{15}H_{32} \rightarrow C_8H_{18} + C_7H_{14}$

B $C_{15}H_{32} \rightarrow C_2H_2 + C_5H_{10} + C_8H_{18} + H_2$

C $C_{15}H_{32} \rightarrow C_7H_{16} + C_8H_{16}$

D $C_{15}H_{32} \rightarrow 2C_2H_4 + C_3H_6 + C_8H_{18}$ (2)

1.3 The monomer of polythene is:

A Ethane

B Ethene

C Propene

D Poly-ethene (2)

1.4 Which ONE of the following combinations of values for activation energy (E_a) and heat of reaction (ΔH) is possible for a reaction?

	ACTIVATION ENERGY (E_A) ($kJ \cdot mol^{-1}$)	**HEAT OF REACTION (ΔH) ($kJ \cdot mol^{-1}$)**
A	100	-50
B	100	+100
C	50	+50
D	50	+100

(2)

1.5 Consider the reaction represented by the following chemical equation:

$$CuO(s) + H_2SO_4(aq) \rightarrow CuSO_4(aq) + H_2O(\ell)$$

Which ONE of the following changes will have **no** influence on the rate of this reaction?

A Decreasing the temperature.

B Decreasing the pressure on the system.

C Increasing the concentration of the acid.

D Using copper oxide powder instead of copper oxide pieces. (2)

1.6 The reaction which is represented by the balanced equation below, has reached equilibrium in a closed container.

$$H_2(g) + I_2(g) \leftrightarrows 2HI(g) \qquad \Delta H<0$$

How will the equilibrium be influenced if first the volume of the container is decreased and then the temperature is increased?

A Initially there is no change and then the reverse reaction is favoured.

B The reverse reaction is favoured by both changes.

C Initially there is no change and then the forward reaction is favoured.

D Initially the reverse reaction is favoured and then the forward reaction is favoured. (2)

1.7 Consider the equation:

$$CaO(s) + SO_2(g) \leftrightarrows CaSO_4(s)$$

If the equilibrium concentration of $SO_2(g)$ at 25 °C is equal to x $mol \cdot dm^{-3}$, then the value of the equilibrium constant at this temperature will be equal to:

A x

B x^2

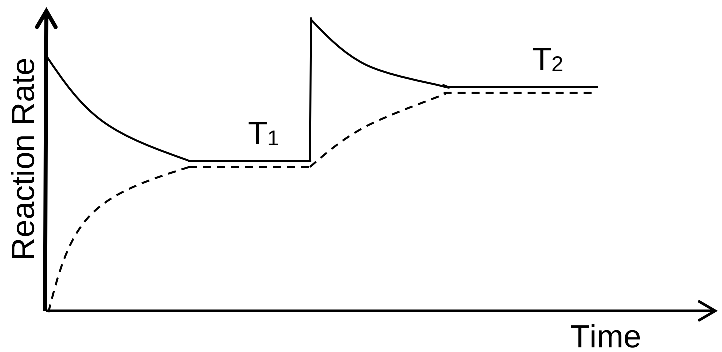
C $\frac{1}{x}$

D $\frac{1}{x^2}$ (2)

1.8 The decomposition reaction of a hypothetical compound $AX_3(g)$, which is represented by the following equation, reaches equilibrium in a closed container at a temperature T_1.

$$2AX_3(g) \leftrightarrows 2AX_2(g) + X_2(g)$$

The temperature is increased and the system again reaches equilibrium at a temperature T_2. The change in the rates of the forward and reverse reactions are represented by the graph below.



Which ONE of the following combinations regarding the forward reaction and the K_c value is correct?

	The forward reaction is:	**Change in K_c value**
A	Exothermic	K_c at T_1 < K_c atT_2
B	Exothermic	K_c at T_1 > K_c at T_2
C	Endothermic	K_c at T_1 < K_c at T_2
D	Endothermic	K_c at T_1 > K_c at T_2

(2)

1.9 Consider the following ionic reaction:

$$NH_3 + H_2O \leftrightharpoons NH_4^+ + OH^-$$

Which ONE of the following combinations represents a conjugated acid-base pair?

A NH_3 ; NH_4^+

B NH_3 ; H_2O

C H_2O ; NH_4^+

D NH_3 ; OH^- (2)

1.10 During a certain neutralisation reaction, 1 mole of base is used up for every 2 moles of acid. Which ONE of the following pairs can possibly be the base and the acid?

A $NaOH$ and $(COOH)_2$

B $Ba(OH)_2$ and CH_3COOH

C Na_2CO_3 and H_2SO_4

D KOH and HNO_3 (2)

[20]

QUESTION 2 (Start on a new page)

2.1 Consider the condensed structural formula of a halo-alkane below.

$$\begin{array}{c} CH_3CH_2\underset{\displaystyle \overset{|}{Br}}{C}(CH_3)CH_3 \end{array}$$

2.1.1 Is this halo-alkane a PRIMARY, SECONDARY or TERTIARY halo-alkane?
Give a reason for the answer. (2)

2.1.2 Write down the IUPAC name of this compound. (3)

2.1.3 Write down the IUPAC name of the MAJOR ORGANIC PRODUCT which forms when this compound undergoes an elimination reaction. (2)

2.2 The IUPAC name of an organic compound is propyl butanoate.

2.2.1 Define the term *homologous series*. (2)

2.2.2 To which homologous series does this compound belong? (1)

2.2.3 Write down the STRUCTURAL FORMULA of this compound. (2)

2.2.4 Give the IUPAC names of the organic acid and alcohol which react to form propyl butanoate. (2)

2.2.5 Write down the condensed structural formula of the functional isomer of propyl butanoate. (2)

2.3 Use MOLECULAR FORMULAE and write the balanced equation for the complete combustion of C_4H_{10}. (3)
[19]

QUESTION 3 (Start on a new page)

Compounds **A** to **E**, indicated in the table below, are used during two investigations to determine the factors which influence boiling point.

Investigation	Compound		Molecular mass ($g \cdot mol^{-1}$)	Boiling point (°C)
I	**A**	2,2-dimethyl propane	72	9
	B	2-methyl butane	72	27
	C	pentane	72	36
II	**D**	$CH_3CH_2CH_2CH_2OH$	74	117
	E	$CH_3CH_2CH_2CHO$	72	75

3.1 Compounds **A**, **B** and **C** are structural isomers. Write down the:

3.1.1 Definition of the term *structural isomer* (2)

3.1.1 GENERAL FORMULA of the homologous series to which these compounds belong (1)

3.1.2 Type of structural isomerism illustrated by these compounds (1)

3.2 Consider the boiling points of the compounds in investigation **I**.

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

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

3.2.3 Write down one control variable for this investigation. (1)

3.2.4 Explain fully why the boiling points increase from compound **A** to compound **C.** (3)

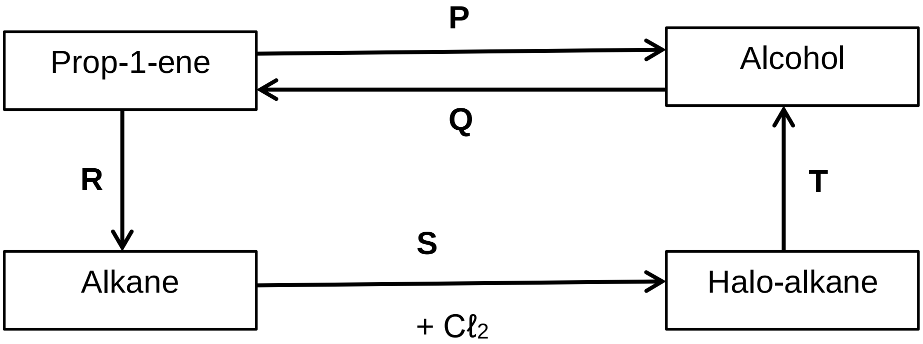
3.2.5 Which one of compounds **A** or **C** will have the highest vapour pressure at a certain temperature?
Refer to the data in the table and give a reason for the answer. (2)

3.3 To which homologous series does compound **E** belong? (1)

3.4 Consider investigation **II**. Refer to the type of Van Der Waals forces in each of the compounds and explain why the boiling point of compound **D** is higher than that of compound **E**. (3)
[17]

QUESTION 4 (Start on a new page)

In the flow diagram below, prop-1-ene is used as a starting compound for the preparation of other organic compounds. **P** to **T** represent chemical reactions.



4.1 Name the type of reaction represented by:

4.1.1 **P** (1)

4.1.2 **S** (1)

4.1.3 **Q** (1)

4.1.4 **T** (1)

4.2 For reaction **P**, write down the:

4.2.1 FORMULA of a suitable catalyst (1)

4.2.2 Structural formula of the alcohol that is formed (2)

4.2.3 IUPAC–name of this alcohol (2)

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

4.3.1 The type of addition reaction (1)

4.3.2 A balanced equation using structural formula (3)

4.4 During reaction **T**, the halo-alkane reacts in the presence of a base to form the alcohol in QUESTION 4.2.2. Write down the:

4.4.1 IUPAC name of the halo-alkane (2)

4.4.2 NAME of a suitable base (1)

4.4.3 TWO reaction conditions for this reaction (2)
[18]

QUESTION 5 (Start on a new page)

5.1 A reaction takes place in a test tube and the test tube becomes cold. (1)

5.1.1 In terms of energy change, name the type of reaction which occurs. (1)

5.1.2 Give a reason for the answer to QUESTION 5.1.1. (1)

5.2 A learner wants to investigate the rate of a reaction.
She places a glass beaker filled with nitric acid on a very sensitive scale in a fume cupboard. She adds a few pieces of copper to the beaker. The mass of the beaker and its contents are measured every 15 s from the instant that the copper is added to the beaker until the copper has been used up.

The following results are obtained.

Time (s)	**Mass of the beaker and contents (g)**	**Decrease in mass (g)**
0	114,6	0,0
15	114,0	0,6
30	112,4	2,2
45	110,4	4,2
60	109,4	5,2
75	108,7	5,9
90	108,4	6,2
105	108,3	6,3
120	108,3	6,3
135	108,3	6,3
150	108,3	6,3

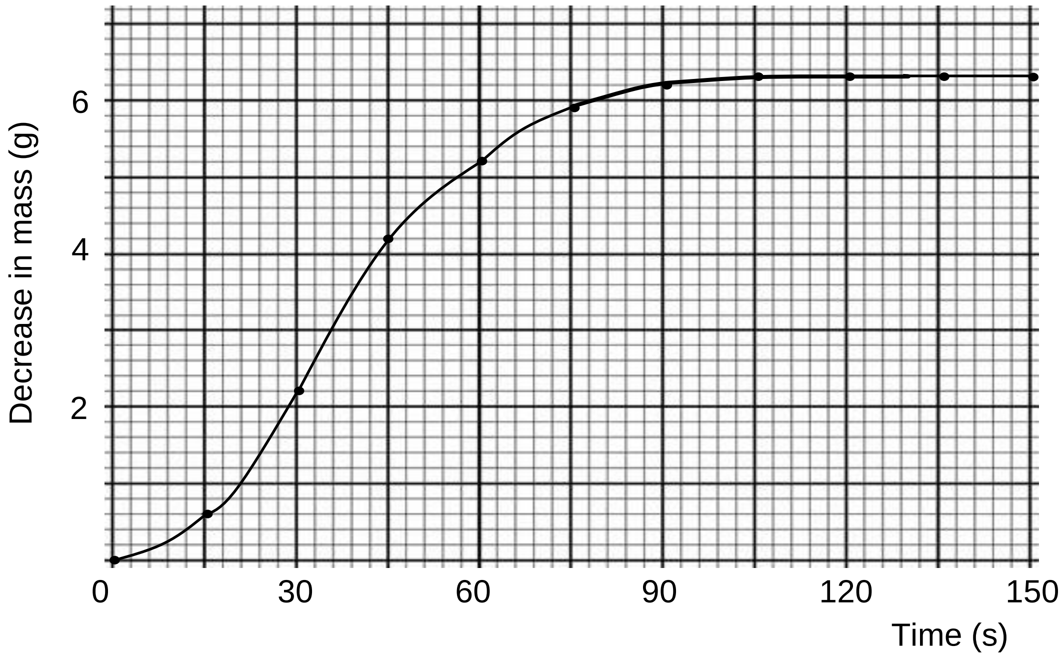
The reaction which occurs are represented by the following reaction:

$$Cu(s) + 4HNO_3(aq) \rightarrow Cu(NO_3)_2(aq) + 4NO(g) + 2H_2O(\ell) \quad \Delta H>0$$

5.2.1 Give a reason why the mass of the beaker and its contents DECREASES. (1)

5.2.2 Use the values in the table and calculate the average rate of the reaction in $g \cdot s^{-1}$ for the total duration of the reaction. (3)

Study the graph below which shows decrease in mass against time.



5.2.3 Give a reason for the shape of the graph from 105 s to 120 s. (1)

5.2.4 Give a reason why the rate of the reaction INCREASES from 0 s to 30 s. (1)

5.2.5 Give a reason why the rate of the reaction DECREASES from 45 s to 105 s. (1)

5.2.6 Use the collision theory to explain the answer to QUESTION 5.2.5. (2)

5.2.7 Calculate the mass of copper used during this reaction. (4)

5.2.8 Except for adding a catalyst, name THREE other changes which can be made n order to INCREASE the rate of this reaction. (3)

5.3 Another learner adds 100 cm^3 $HC\ell$ of concentration 0,25 $mol\cdot dm^{-3}$ to an excess of $Na_2S_2O_3(aq)$ and 0,24 g of sulphur is deposited. The equation for the reaction is:

$$Na_2S_2O_3(aq) + 2\ HC\ell(aq) \rightarrow 2NaC\ell(aq) + SO_2(g) + S(s) + H_2O(\ell)$$

Calculate the PERCENTAGE YIELD of sulphur. (6)

[25]

QUESTION 6 (Start on a new page)

Consider the following equation for the decomposition of ozone (O_3).

$$2O_3\text{ (g)} \leftrightarrows 3O_2\text{ (g)}$$

6.1 State *Le Chatelier's principle.* (2)

6.2 Use Le Chatelier's principle and explain how an increase in pressure will influence the amount of ozone at equilibrium. (3)

6.3 An increase in the temperature causes a decrease in the amount of oxygen.

6.3.1 Which reaction is favoured by the increase of temperature? Choose from FORWARDS or BACKWARDS. (1)

6.3.2 Is the forward reaction ENDOTHERMIC or EXOTHERMIC? (1)

6.3.3 What will happen to the value of the equilibrium constant? Choose from INCREASES, DECREASES or REMAINS THE SAME. (1)

6.4 Define the term *catalys*t. (2)

6.5 Explain how the addition of a suitable catalyst will influence the amount of oxygen at equilibrium. (2)

Ozone (O_3) reactions with nitrogen oxide (NO) as indicated in the reaction below.

$$O_3(g) + NO(g) \leftrightarrows O_2(g) + \underset{\text{BROWN}}{NO_2(g)} \qquad \Delta H < 0$$

Note that O_3, NO and O_2 are all colourless gases while NO_2 is a brown gas.
The colour of the gas mixture is light brown.

6.6 A mixture of the four gases is prepared in a 2 dm^3 sealed container with the following initial concentrations:

$[O_3]$ = 0,6 $mol{\cdot}dm^{-3}$ [NO] = 0,9 $mol{\cdot}dm^{-3}$

$[O_2]$ = 0,73 $mol{\cdot}dm^{-3}$ $[NO_2]$ = 0,55 $mol{\cdot}dm^{-3}$

The mixture is then heated to 1500 K. After equilibrium is established, it is found that the concentration of NO is 0,36 $mol{\cdot}dm^{-3}$.

Use the information given and calculate the value of the equilibrium constant at 1500 K. (7)

6.7 A number of changes are made to the equilibrium mixture and the mixture is allowed to reach a new equilibrium after each change.

Choose from INCREASES, DECREASES or REMAINS THE SAME to answer each of the following questions.

6.7.1 NO gas is added to the container.
How does the yield of NO_2 gas change? (1)

6.7.2 The pressure in the container is decreased.
What happens to the number of moles of O_3? (1)

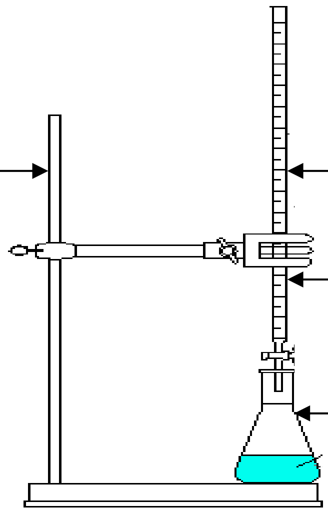
6.7.3 The temperature is increased.
What happens to the initial rate of the forward reaction? (1)

6.7.4 O_2 gas is added to the container.
What happens to the intensity of the brown colour? (1)

6.7.5 Ar(g) is pumped into the container.
What happens to the concentration of O_2 gas? (1)
[24]

QUESTION 7 (Start on a new page)

'A learner wants to determine the percentage ethanoic acid (CH_3COOH) in vinegar. The following apparatus is used:



7.1 Name **Q** in the above diagram. (1)

7.2 The following indicators are available:

INDICATOR	pH-RANGE OF COLOUR CHANGE
A	3,1 - 4,4
B	6,0 - 7,6
C	8,3 - 10,0

Which ONE of the indicators (**A**,**B** or **C**) above is most suited to indicate the exact endpoint of this titration?

Give a reason for the answer (2)

The learner adds 7,5 g commercial vinegar to 100 cm^3 of water.

25 cm^3 of this solution is neutralised by 28,5 cm^3 of a 0,11 $mol{\cdot}dm^{-3}$ sodium hydroxide (NaOH) solution.

The balanced equation for this reaction is:

$$NaOH\ (aq)\ +\ CH_3COOH\ (aq)\ \rightarrow\ CH_3COONa\ +\ H_2O$$

7.3 Ethanoic acid is a weak acid. Define a *weak acid*. (2)

7.4 Calculate the pH of the sodium hydroxide solution. (5)

7.5 Calculate the number of moles of sodium hydroxide which are used to neutralise 25 cm^3 of acid. (2)

7.6 Calculate the percentage ethanoic acid in the vinegar. (5)
[17]

QUESTION 8 (Start on a new page)

Concentrated sulphuric acid (H_2SO_4) is added to pure water at 25 °C. The pH of the solution is 1,6.

8.1 Is sulphuric acid a MONOPROTIC or a DIPROTIC acid? (1)

8.1 Calculate the concentration of the sulphuris acid solution. (3)

8.2 Ammonium chloride crystals ($NH_4C\ell$) are dissolved in water and undergo hydrolysis.

8.2.1 Define the term *hydrolysis.* (2)

8.2.2 Is ammonium chloride ACIDIC or BASIC in solution?
Explain your answer with the help of an equation. (4)

[10]

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

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

KEY/*SLEUTEL*

Atomic number	Electronegativity	Symbol	Approximate relative atomic mass
29	1,9	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: STANDAARDREDUKSIEPOTENSIALE

Increasing oxidising ability/*Toenemende oksiderende vermoë*

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 reducing ability/*Toenemende reduserende vermoë*

TABLE 4B: STANDARD REDUCTION POTENTIALS
TABEL 4B: STANDAARDREDUKSIEPOTENSIALE

Increasing oxidising ability/*Toenemende oksiderende 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

Increasing reducing ability/*Toenemende reduserende vermoë*