Province of the
EASTERN CAPE
EDUCATION

NATIONAL SENIOR CERTIFICATE

GRADE 12

JUNE 2017

PHYSICAL SCIENCES P2

MARKS: **150**

TIME: **3 hours**

This question paper consists of 20 pages, including data sheets.

INSTRUCTIONS AND INFORMATION

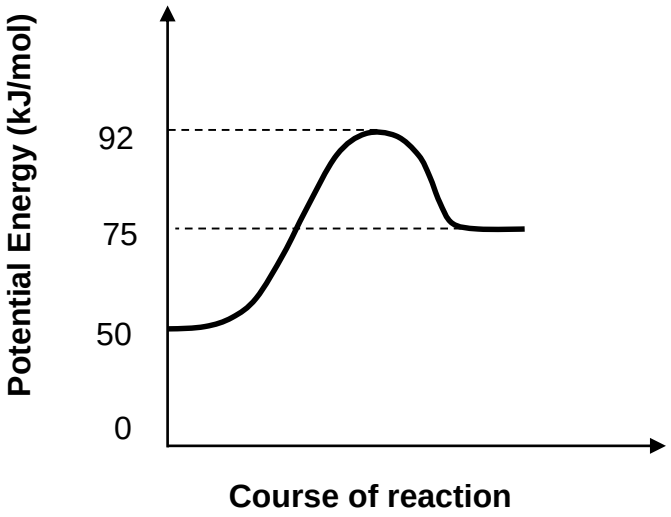
1. Write your full NAME and SURNAME in the appropriate spaces on the ANSWER BOOK.
2. This question paper consists of EIGHT questions. Answer ALL the questions in the ANSWER BOOK.
3. Start EACH question on a NEW page in the ANSWER BOOK.
4. Number your answers correctly according to the numbering system used in this question paper.
5. Leave ONE line between two sub questions, for example between QUESTION 2.1 and QUESTION 2.2.
6. You may use a non-programmable calculator.
7. You may use appropriate mathematical instruments.
8. Show ALL formulae and substitutions in ALL calculations.
9. Round off your final numerical answers to a minimum of TWO decimal places.
10. Give brief motivations, discussions et cetera where required.
11. You are advised to use the attached DATA SHEETS.
12. Write neatly and legibly.

QUESTION 1: MULTIPLE-CHOICE QUESTIONS

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

1.1 A potential energy diagram for a hypothetical reaction is given below:

$X_2(g) \longrightarrow 2\ X(g)$



The ΔH for the reaction in kJ/mol is …

A 17.
B -17.
C 25.
D -25. (2)

1.2 Which pair of compounds represents UNSATURATED hydrocarbons?

A Alkenes and Alkynes
B Alkanes and Alkynes
C Alkanes and Alkenes
D Alcohols and Alkenes (2)

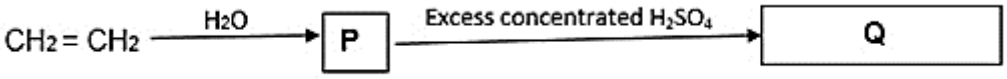
1.3 An atom, group of atoms or a bond that gives a group of organic compounds its characteristic physical and chemical properties is called a …

A polymer.
B monomer.
C functional group.
D homologous series. (2)

1.4 Which ONE of the following statements is always TRUE about the relationship between strength of intermolecular forces and boiling point?

A Boiling point is directly proportional to the strength of intermolecular forces.
B As the strength of intermolecular forces increases boiling point increases.
C As the strength of intermolecular forces increases boiling point decreases.
D As the strength of intermolecular forces increases the boiling point is not affected. (2)

1.5 In the flow diagram below, **P** and **Q** represent two organic compounds.



Which ONE of the following is the CORRECT condensed molecular formula for compound **Q**?

A CH_2CH_2
B CH_3CH_3
C CH_3CH_2Br
D CH_3CH_2OH (2)

1.6 In a homogeneous reaction the reactants and products are always …

A gases.
B liquids.
C solids.
D in the same phase. (2)

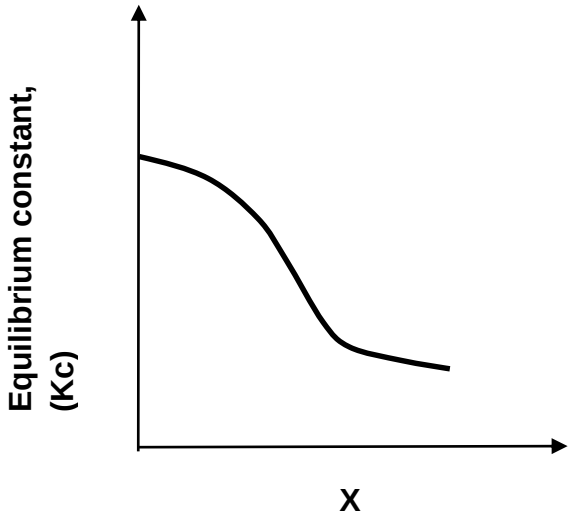
1.7 Which ONE of the following changes will NOT INFLUENCE the rate at which oxygen is produced?

$$2\ H_2O_2\ (aq) \longrightarrow 2\ H_2O(\ell) + O_2(g)$$

A Increase pressure
B Increase temperature
C Add a suitable catalyst
D Increase the concentration of H_2O_2 (2)

1.8 The following graph shows the relationship between the equilibrium constant Kc and the quantity **X** for the hypothetical reaction:

$$A_2(g) + B_2(g) \rightleftharpoons 2AB(g)$$



What quantity is represented by **X** on the horizontal axis?

A Mass
B Pressure
C Temperature
D Concentration (2)

1.9 A strong acid is titrated with a base. The dissociation constant for the base, K_b is $2,8 \times 10^{-6}$ at 25 °C.

Which ONE of the following indicators is most suitable for the titration?

Indicator	**pH range over which indicator changes colour**
A	4,2 to 6,2
B	6,0 to 7,6
C	8,0 to 9,6
D	10,0 to 12

(2)

1.10 Chromate (yellow solution) and dichromate ions (orange solution) are in equilibrium with each other in an aqueous solution according to the following balanced equation:

$$2CrO_4^{2-}(aq) + 2H^+(aq) \rightleftharpoons Cr_2O_7^{2-}(aq) + H_2O(\ell)$$

Yellow Orange

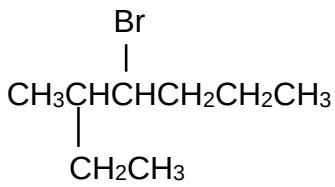
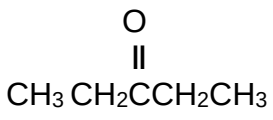
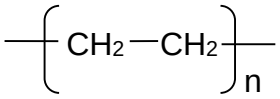
What ONE of the following changes should be made to change the colour of the solution to orange?

A Add more H_2O
B Lower the pH
C Increase the pH
D Increase $[Cr_2O_7^{2-}]$ (2)

[20]

QUESTION 2

The letters **A** to **H** in the table represent eight organic compounds:

A		**B**	
C	$C_4H_{10}O$	**D**	Methyl ethanoate
E	2,3-dimethylbutane	**F**	
G	Ethanoic acid	**H**	C_nH_{2n}

2.1 Write down the letter that represents a compound that is:

2.1.1 A proton donor (1)

2.1.2 A large molecule composed of small monomer units covalently bonded in a repeating pattern (1)

2.2 Write down the:

2.2.1 GENERAL FORMULA of the homologous series to which compound **E** belongs (1)

2.2.2 NAME of the functional group found in compound **G** (1)

2.2.3 EMPIRICAL FORMULA of compound **H** (1)

2.3 Write down the IUPAC name of:

2.3.1 Compound **A** (3)

2.3.2 Compound **B** (2)

2.3.3 A FUNCTIONAL ISOMER of compound **G** (2)

2.4 Write down the STRUCTURAL FORMULA of compound **E**. (2)

2.5 Compound **D** is prepared from the reaction of a carboxylic acid and an alcohol in the presence of an inorganic acid catalyst. A water bath is used to heat the reaction mixture.

Write down the:

2.5.1 NAME or FORMULA of the inorganic acid catalyst (1)

2.5.2 STRUCTURAL FORMULA of compound **D** (2)

2.5.3 Property of alcohols that make it necessary to use a water bath to heat the reaction mixture instead of direct heat (1)

2.6 Compound **C** is a TERTIARY alcohol.

Write down the STRUCTURAL FORMULA and IUPAC name of compound **C**. (4)

2.7 Write down the MOLECULAR FORMULAE of the TWO products formed during the complete combustion of compound **E**. (2)

[24]

QUESTION 3

Learners use alcohols **A** to **C** to investigate a factor that influences boiling points of alcohols.

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

Compounds	Alcohols
A	CH_3OH
B	CH_3CH_2OH
C	$CH_3CH_2CH_2OH$

3.2 For this investigation write down the:

3.2.1 Independent variable (1)

3.2.2 Apparatus used to measure the boiling point (1)

3.3 Which ONE of the three compounds will have the HIGHEST boiling point? (1)

3.4 Explain your answer to QUESTION 3.3. (3)

3.5 The learners now compare the boiling points of compounds **D** and **E**, shown in the table below. Compounds **D** and **E** belong to different homologous series.

	Compounds	Boiling point (°C)
D	Ethanol	78,1
E	Ethanal	20,2

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

3.5.2 Explain fully why the boiling point of compound **D** is HIGHER than that of compound **E**. (4)

3.5.3 Which ONE of the compounds **D** or **E** will have a HIGHER vapour pressure? Use information from the table to give a reason. (2)

[16]

QUESTION 4

The flow diagram below shows three organic reactions that involve the compound 2-bromobutane.

Reaction A: Alkane + **Y** ⟶ 2-bromobutane + HBr

Reaction B: 2-bromobutane + KOH ⟶ Compound **X** + KBr + H_2O

Reaction C: 2-bromobutane + KOH ⟶ Alcohol + KBr

4.1 Write down the type of reaction represented by:

4.1.1 Reaction **A** (1)

4.1.2 Reaction **B** (1)

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

4.2.1 NAME or FORMULA of the inorganic reagent **Y** (1)

4.2.2 One reaction condition needed for the reaction to take place (1)

4.2.3 IUPAC name of the alkane (2)

4.3 Write down the STRUCTURAL FORMULA of compound **X** the major organic product produced in reaction **B.** (2)

4.4 Write down the STRUCTURAL formula of the alcohol produced in reaction **C**. (2)

4.5 In both reactions **B** and **C** the same inorganic reagent KOH is used. Write down TWO reaction conditions that will favour reaction **C** over reaction **B**. (2)

[12]

QUESTION 5

A group of learners uses the reaction of hydrochloric acid with magnesium ribbon to investigate the factors that influence rate of reaction. The balanced equation for the reaction is given below:

$$Mg(s) + 2\,HC\ell\,(aq) \longrightarrow MgC\ell_2(aq) + H_2(g)$$

The hydrochloric acid is in EXCESS and the same mass of magnesium is used in ALL the experiments.

Experiment	REACTION CONDITIONS			
	Concentration of $HC\ell$ (aq) ($mol.dm^{-3}$)	Temperature (°C)		State of division of 0,24 g Magnesium
		Before	After	
1	2	35	57	powder
2	2	30	48	ribbon
3	2	20	33	ribbon
4	1,5	30	45	ribbon

5.1 Define *reaction rate*. (2)

5.2 In which experiment is the reaction rate HIGHEST? Give TWO reasons. (3)

5.3 The reaction in **Experiment 2** is compared to the reaction in **Experiment 4.**

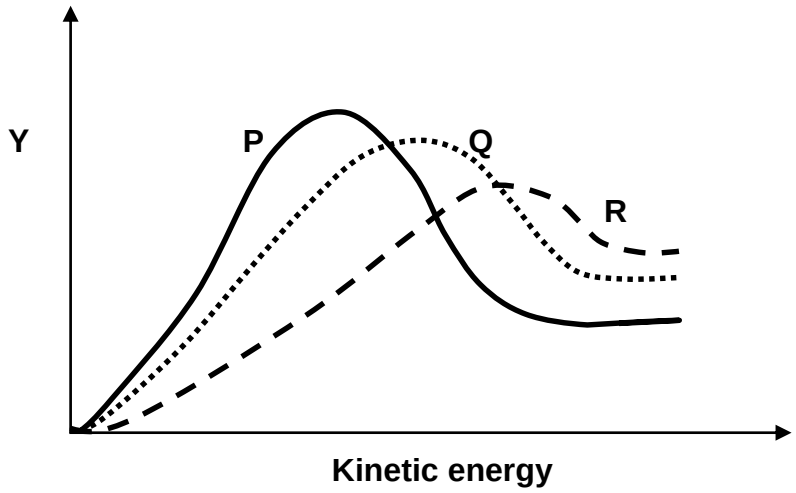
5.3.1 Write down ONE control variable for this comparison. (1)

5.3.2 How does the amount of hydrogen gas produced in **Experiment 2** compare to the amount produced in **Experiment 4** if the same volume of acid is used in both experiments?
Write down only HIGHER THAN, SMALLER THAN or EQUAL TO.
Give a reason for your answer. (2)

5.4 Give a reason why it is not a fair test to compare the rate of reaction of **Experiment 1** with that of **Experiment 3**. (1)

5.5 Calculate the mass of hydrochloric acid that remains in the flask at the completion of the reaction in **Experiment** 1 if the initial volume of the hydrochloric acid is 80 cm^3. (7)

5.6 The Maxwell-Boltzman distribution curves labelled **P**, **Q** and **R** for the reactions in experiments 1, 2 and 3 in random order are shown below.



5.6.1 Write down the name of the label, **Y,** on the vertical axis. (1)

5.6.2 Which curve (**Q**, **P** or **R**) represents the results of **Experiment 3**? (1)

5.6.3 With the aid of the collision theory explain the effect of temperature on reaction rate. (4)
[22]

QUESTION 6

The following reaction reaches chemical equilibrium in a sealed container at 70 °C.

$$N_2O_4\,(g) \quad \rightleftharpoons \quad 2\,NO_2\,(g)$$

6.1 Define the term *chemical equilibrium*. (2)

6.2 What effect will the following changes have on the number of moles of NO_2 at equilibrium?

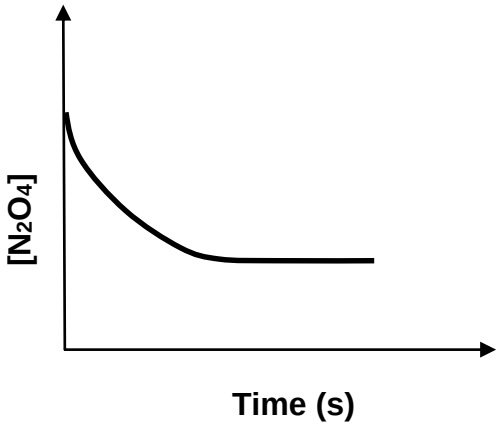
Write down only INCREASES, DECREASES or REMAINS UNCHANGED.

6.2.1 Adding more N_2O_4 into the container. (1)

6.2.2 Increasing the pressure by decreasing the volume. (1)

6.3 Explain the answer to QUESTION 6.2.2 above by referring to Le Chatelier's principle. (3)

6.4 The following graph shows the changes in the concentration of N_2O_4 against time.



Redraw the graph on the same set of axes use a dotted line to sketch a graph that would be obtained when a catalyst is added to the reaction mixture at the start of the reaction. (2)

6.5 The table below gives the equilibrium constant values Kc for the reaction at different temperatures.

Temperature (°C)	**K_c**
23	8,03
70	0,32
100	0,067

6.5.1 At which temperature is the yield of NO_2 highest? Give a reason. (2)

6.5.2 When the reaction establishes equilibrium at 70 °C it is found that the concentration of N_2O_4 in the equilibrium mixture is 0,5 mol.dm^{-3}. Calculate the initial concentration of N_2O_4. (7)

6.5.3 Is the forward reaction ENDOTHERMIC or EXOTHERMIC? With the aid of information from the table and Le Chateliers' principle, fully explain the answer. (4)

[22]

QUESTION 7

7.1 Ethanoic acid is a monoprotic acid that ionises in water according to the equation.

$CH_3COOH(\ell) + H_2O(\ell) \rightleftharpoons CH_3COO^-(aq) + H_3O^+(aq)$ $K_a = 1,8 \times 10^{-5}$ at 25 ºC

7.1.1 Define the term *monoprotic acid*. (2)

7.1.2 Write down the NAME or FORMULA of the conjugate base of ethanoic acid. (1)

7.1.3 Is ethanoic acid a STRONG or WEAK acid?
Refer to the given information to give a reason. (2)

7.2 A sodium hydroxide solution (NaOH) has a concentration of 1×10^{-5} mol.dm^{-3}.

Calculate the:

7.2.1 pH of the solution (4)

7.2.2 Volume to which 10 cm^3 of the sodium hydroxide solution must be diluted to obtain a solution with a concentration of 1×10^{-6} mol.dm^{-3} (3)

7.3 A certain compound has sodium carbonate (Na_2CO_3) as the main ingredient. To determine the amount of sodium carbonate present in a sample of the compound 100 cm^3 of a 0,8 mol.dm^{-3} solution of sulphuric acid was added to the sample in a flask.

The sulphuric acid solution is in EXCESS.
The equation below shows the reaction taking place in the flask.

$Na_2CO_3(s) + H_2SO_4(aq) \longrightarrow Na_2SO_4(aq) + CO_2(g) + H_2O(\ell)$ **Reaction 1**

7.3.1 Calculate the amount in moles of sulphuric acid added to the flask. (3)

*In a titration exactly 35 cm^3 of a 0,3 mol.dm^{-3} potassium hydroxide solution neutralises the excess amount of sulphuric acid left over in **Reaction 1** according to the balanced equation shown below*.

$2\ KOH(aq) + H_2SO_4(aq) \longrightarrow K_2SO_4(aq) + 2\ H_2O(\ell)$ **Reaction 2**

7.3.2 Calculate the mass of sodium carbonate present in the sample. (8)

7.4 Write down a balanced equation for the hydrolysis of sodium carbonate (Na_2CO_3). (3)

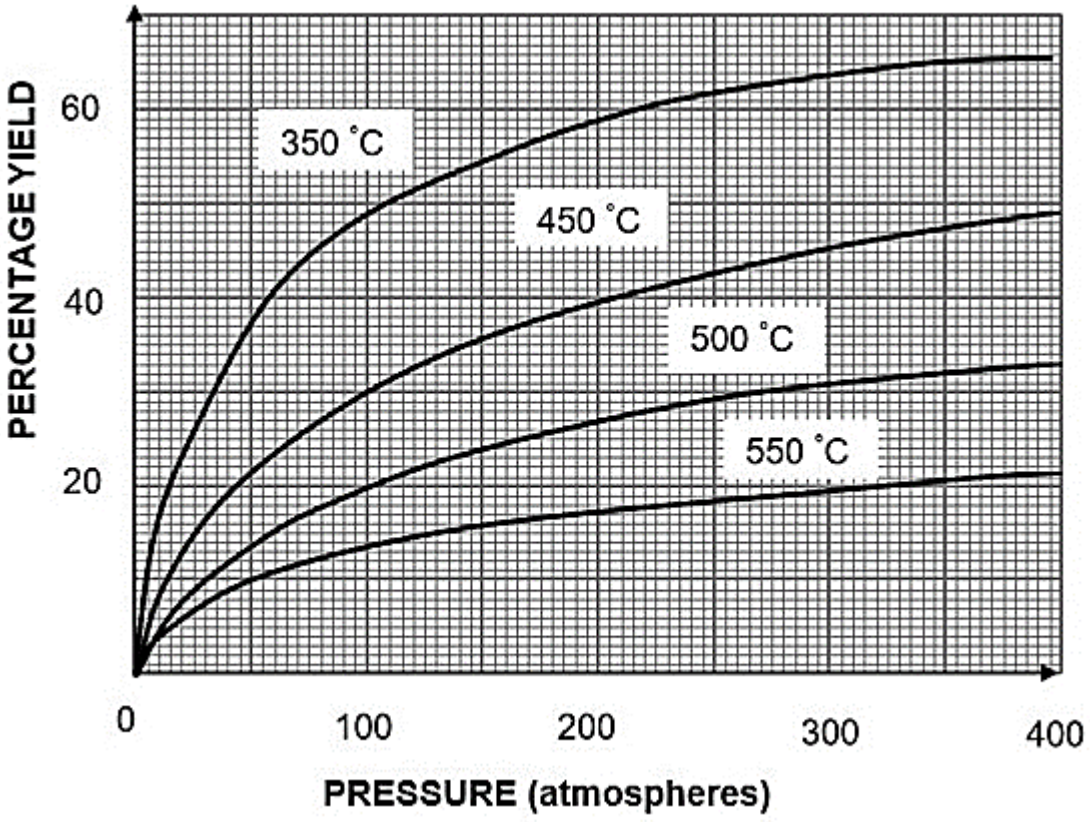
[26]

QUESTION 8

The graph of percentage yield of NH_3, produced in the reaction given below, versus pressure at different temperatures is shown below.

$$N_2(g) + 3\ H_2(g) \rightleftharpoons 2\ NH_3(g)$$

GRAPH OF PERCENTAGE YIELD AT DIFFERENT TEMPERATURES VERSUS PRESSURE



8.1 Write down:

8.1.1 In words the relationship between temperature and percentage yield at constant pressure for this reaction (2)

8.1.2 The percentage yield at a temperature of 350 °C and a pressure of 100 atmospheres (1)

8.1.3 The pressure at which the percentage yield is 40% at 450 °C (1)

8.2 Exactly 112 grams of nitrogen gas was allowed to react with hydrogen gas in a closed container. The reaction reached equilibrium at a temperature of 350 °C and a pressure of 200 atmospheres.

Calculate the actual yield (in moles) of NH_3. (4)
[8]

TOTAL: 100

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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*

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 $n = \frac{V}{V_o}$	$c = \frac{n}{V}$ or/of $c = \frac{m}{MV}$ $\frac{c_a V_a}{c_b V_b} = \frac{n_a}{n_b}$	$pH = -\log[H_3O^+]$ $K_w = [H_3O^+][OH^-] = 1 \times 10^{-14}$ at /by 298K

$E^{\theta}_{cell} = E^{\theta}_{cathode} - E^{\theta}_{anode}$ / $E^{\theta}_{sel} = E^{\theta}_{katode} - E^{\theta}_{anode}$

$E^{\theta}_{cell} = E^{\theta}_{reduction} - E^{\theta}_{oxidation}$ / $E^{\theta}_{sel} = E^{\theta}_{reduksie} - E^{\theta}_{oksidasie}$

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

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 1 H 1																	2 He 4
1,0 3 Li 7	1,5 4 Be 9											2.0 5 B 11	2.5 6 C 12	3.0 7 N 14	3.5 8 O 16	4.0 9 F 19	10 Ne 20
0,9 11 Na 23	1,2 12 Mg 24											1.5 13 Aℓ 27	1.8 14 Si 28	2.1 15 P 31	2.5 16 S 32	3.0 17 Cℓ 35,5	18 Ar 40
0,8 19 K 39	1,0 20 Ca 40	1,3 21 Sc 45	1,5 22 Ti 48	1,6 23 V 51	1,6 24 Cr 52	1,5 25 Mn 55	1,8 26 Fe 56	1,8 27 Co 59	1,8 28 Ni 59	1,9 29 Cu 63,5	1,6 30 Zn 65	1.6 31 Ga 70	1.8 32 Ge 73	2.0 33 As 75	2.4 34 Se 79	2.8 35 Br 80	36 Kr 84
0,8 37 Rb 86	1,0 38 Sr 88	1,2 39 Y 89	1,4 40 Zr 91	41 Nb 92	1,8 42 Mo 96	1,9 43 Tc	2,2 44 Ru 101	2,2 45 Rh 103	2,2 46 Pd 106	1,9 47 Ag 108	1,7 48 Cd 112	1.7 49 In 115	1.8 50 Sn 119	1.9 51 Sb 122	2.1 52 Te 128	2.5 53 I 127	54 Xe 131
0,7 55 Cs 133	0,9 56 Ba 137	57 La 139	1,6 72 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 81 Tℓ 204	1.8 82 Pb 207	1.9 83 Bi 209	2.0 84 Po	2.5 85 At	86 Rn
0,7 87 Fr	0,9 88 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*

Atoomgetal

Atomic number

29

Elektronegatiwiteit / Electronegativity

1,9 Cu

Simbool / Symbol

Benaderde relatiewe atoommassa

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

Increasing oxidising ability/*Toenemende oksiderende vermoë* ↓

Increasing reducing ability/*Toenemende reduserende 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