Province of the
EASTERN CAPE
EDUCATION

NATIONAL SENIOR CERTIFICATE

GRADE 12

SEPTEMBER 2015

PHYSICAL SCIENCES P2

MARKS: 150

TIME: 3 hours

PHSCE2

This question paper consists of 19 pages.

INSTRUCTIONS AND INFORMATION

1. Write your examination number and centre number in the appropriate spaces on the ANSWER BOOK.
2. This question paper consists of TEN questions. Answer ALL the questions in the ANSWER BOOK.
3. Start EACH question on a NEW page.
4. Number the answers correctly according to the numbering system used in this question paper.
5. Leave ONE line open between two subsections, e.g. between QUESTIONS 2.1 and QUESTION 2.2.
6. Give brief motivations, discussions, etc. where required.
7. You may use a non-programmable calculator.
8. You may use appropriate mathematical instruments.
9. You are advised to use the attached DATA SHEETS.
10. Show ALL formulae and substitutions in ALL calculations.
11. Round off your final numerical answers to a minimum of TWO decimal places.
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. 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 D.

1.1 A family of carbon compounds in which one member differs with a -CH_2- group from the next member of the family, is known as …

A isomers.
B a homologous series.
C a hydrocarbon series.
D unsaturated compounds. (2)

1.2 The group of atoms that determine the physical and chemical properties of ketones is a ...

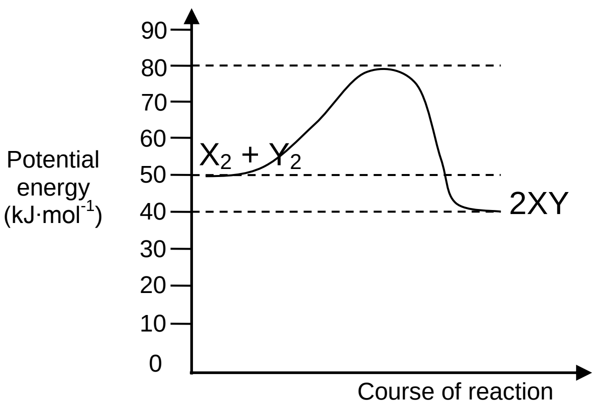
A carboxyl group.
B formyl group.
C carbonyl group.
D hydroxyl group. (2)

1.3 In which ONE of the following options are the three compounds arranged in order of increasing (lowest to highest) boiling points?

A	CH_3CH_2COOH	$CH_3CH_2CH_2CH_2CH_3$	$CH_3CH_2CH_2CH_2OH$
B	$CH_3CH_2CH_2CH_2OH$	$CH_3CH_2CH_2CH_2CH_3$	CH_3CH_2COOH
C	$CH_3CH_2CH_2CH_2CH_3$	$CH_3CH_2CH_2CH_2OH$	CH_3CH_2COOH
D	$CH_3CH_2CH_2CH_2CH_3$	CH_3CH_2COOH	$CH_3CH_2CH_2CH_2OH$

(2)

1.4 The potential energy diagram below refers to the following hypothetical reaction taking place in a closed container: $X_2 + Y_2 \rightleftharpoons 2XY$



What is the heat of reaction, in $kJ \cdot mol^{-1}$, for the reverse reaction that is $2XY \rightarrow X_2 + Y_2$?

A + 30
B + 10
C - 10
D - 40 (2)

1.5 Consider the following reaction:

$$CH_3NH_2(aq) + H_2O(\ell) \rightleftharpoons CH_3NH_3^+(aq) + OH^-(aq)$$

The CH_3NH_2 acts as a/an …

A proton donor.
B proton acceptor.
C oxidising agent.
D reducing agent. (2)

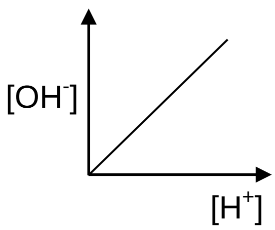
1.6 A solution of ethanoic acid (acetic acid) is titrated against a standard sodium hydroxide solution. Which ONE of the following indicators would be the most suitable for this titration?

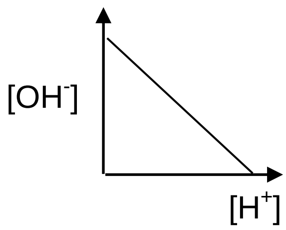
	Indicator	**pH range of the indicator**
A	Phenolphthalein	8,3–10
B	Methyl orange	3,1–4,4
C	Bromothymol blue	6,0–7,6
D	Universal indicator	Changes colour over a wide range of pH values

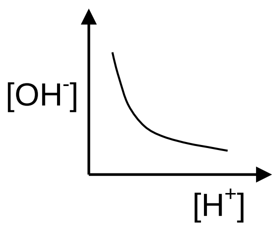
(2)

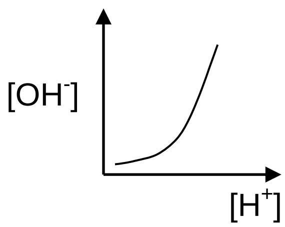
1.7 A few drops of concentrated sulphuric acid are gradually added to 1 dm^3 of water at 25 °C.

Which ONE of the following graphs illustrates the relationship between $[H^+]$ and $[OH^-]$ as the acid is added to the water?

A


B


C


D


(2)

1.8 Which ONE of the following correctly gives the direction, as well as the medium, in which electrons move in a galvanic cell?

	DIRECTION	**MEDIUM**
A	cathode to anode	salt bridge
B	anode to cathode	external wire
C	cathode to anode	external wire
D	anode to cathode	salt bridge

(2)

1.9 Sulphuric acid is produced in industry by the …

A Ostwald process.
B contact process.
C catalytic oxidation of ammonia.
D fractional distillation of air. (2)

1.10 Phosphorous rich fertilisers:

A Are essential for growing plants with strong stems and healthy, green leaves.
B Improves the quality of fruit and flowers and makes plants frost and disease resistant.
C Are produced in the industry by the Ostwald process.
D Are fertilisers that are used to stimulate root growth in plants. (2)

[20]

QUESTION 2 (Start on a new page.)

Consider the organic compounds represented by the letters **A** to **I** in the table below.

A	Butane	**F**	$CH_3 - \underset{\underset{CH_3}{\vert}}{C} = CH - CH_3$
B	$CH_3\text{-}CH_2\text{-}\overset{\overset{O}{\Vert}}{C}\text{-}OH$	**G**	2-methylpropane
C	$CHC\ell_3$	**H**	$CH \equiv CH$
D	Butan-2-ol	**I**	$\begin{array}{ccccccccc} & & H & & H & & & & O \\ & & \vert & & \vert & & & & \Vert \\ H & - & C & - & C & - & O & - & C - H \\ & & \vert & & \vert & & & & \\ & & H & & H & & & & \end{array}$
E	Butan-1-ol		

2.1 Write down the letter(s) that represent(s) the following:

2.1.1 Two compounds that are CHAIN ISOMERS (1)

2.1.2 A PRIMARY ALCOHOL (1)

2.1.3 A weak, MONOPROTIC ACID (1)

2.2 Write down:

2.2.1 The IUPAC name of compound **F** (2)

2.2.2 The NAME of the homologous series to which compound **C** belongs (1)

2.2.3 A balanced equation for the complete combustion of compound **H** using MOLECULAR FORMULAE (3)

2.3 Compound **I** is the product of an esterification reaction.

For Compound **I**, write down the:

2.3.1 IUPAC name (2)

2.3.2 STRUCTURAL FORMULA of the alcohol from which it is synthesised (2)

2.3.3 IUPAC name of the carboxylic acid from which it is synthesised (1)

2.4 *"Propanoic acid is a functional isomer of compound* ***I****."*

Explain this statement fully.
In your explanation, give the molecular formulae and structural formulae of both isomers and indicate any differences and similarities. (4)

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QUESTION 3 (Start on a new page.)

3.1 Petroleum companies use an elimination reaction to break longer hydrocarbons into shorter, more useable hydrocarbons.
An example of such a reaction is given:

$$C_{10}H_{22} \xrightarrow{\text{Heat/catalyst}} C_8H_{18} + \mathbf{X}$$

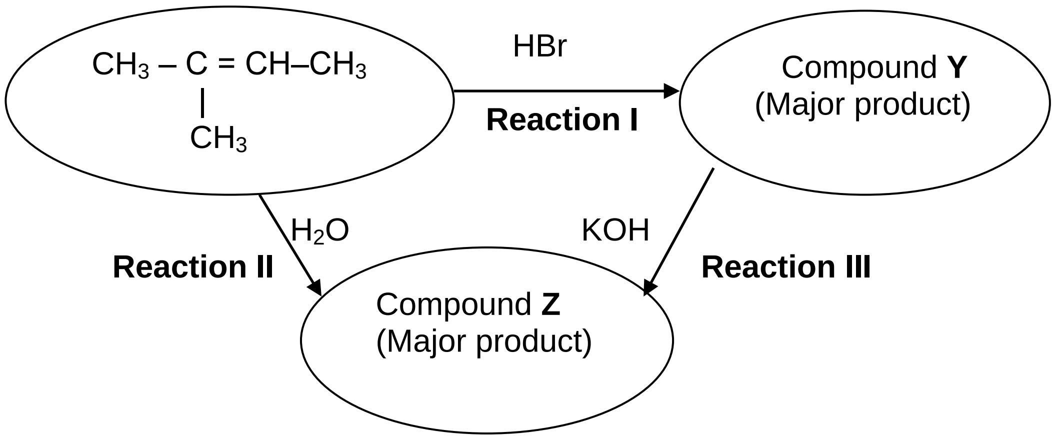
3.1.1 Name the TYPE of elimination reaction referred to above. (1)

Molecules of compound **X** can bond to each other to form a polymer.

3.1.2 What is this TYPE of POLYMERISATION called? (1)

3.1.3 Using STRUCTURAL FORMULAE, write down a balanced equation for this polymerisation reaction. (3)

3.2 The flow diagram below shows some organic reactions.



3.2.1 Write down the STRUCTURAL FORMULA of compound **Y** formed in **reaction 1**. (2)

3.2.2 Name the TYPE of reaction represented by **reaction I**. (1)

3.2.3 Using STRUCTURAL FORMULAE, write down a balanced equation for **reaction II**. (4)

3.2.4 Write down the IUPAC name of compound **Z**. (2)

3.2.5 Name the TYPE of reaction of which **reaction III** is an example. (1)

3.2.6 List TWO reaction conditions needed for **reaction III** to take place effectively. (2)

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QUESTION 4 (Start on a new page.)

4.1 Define the term *vapour pressure.* (3)

4.2 The table below shows the vapour pressure values of three alkanes.

Name	Vapour pressure (kPa at 20 °C)
ethane	3 750
propane	843
butane	204

4.2.1 Fully explain why the vapour pressure DECREASES from ethane to butane. (3)

4.2.2 Which of the alkanes will be the most difficult to ignite at room temperature? (1)

4.3 4.3.1 Predict whether ethanol will have a HIGHER or a LOWER vapour pressure than ethane. (1)

4.3.2 Fully explain the answer to QUESTION 4.3.1. (2)

[10]

QUESTION 5 (Start on a new page.)

Learners use the reaction of a sodium thiosulphate solution ($Na_2S_2O_3$) with a hydrochloric acid solution ($HC\ell$) to investigate the factors which influence reaction rate.
The balanced equation for the reaction is:

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

The time lapse from the moment of mixing equal volumes of the two solutions until a certain degree of turbidity (sulphur precipitation formation) appeared, is taken as a measure of the rate of the reaction.

5.1 Consider **INVESTIGATION A:**

	Temperature (°C)	**Concentration of $Na_2S_2O_3$ ($mol \cdot dm^{-3}$)**	**Concentration of $HC\ell$ ($mol \cdot dm^{-3}$)**	**Time (s)**
Experiment 1	20	0,5	0,5	40
Experiment 2	20	0,9	0,5	25
Experiment 3	20	1,4	0,5	15

5.1.1 For investigation **A**, name the:

(a) Dependent variable (1)

(b) Independent variable (1)

5.1.2 What conclusion can be drawn from the results of investigation **A**? (2)

5.1.3 Which ONE of the two reactants ($Na_2S_2O_3$ or $HC\ell$) in experiment **1** of investigation **A** is the limiting reactant? Explain your answer. (3)

5.2 Consider **INVESTIGATION B**:

	Temperature (°C)	**Concentration of $Na_2S_2O_3$ ($mol \cdot dm^{-3}$)**	**Concentration of $HC\ell$ ($mol \cdot dm^{-3}$)**	**Time (s)**
Experiment 4	20	0,5	0,5	40
Experiment 5	30	0,5	0,5	20
Experiment 6	50	0,5	0,5	10

5.2.1 In which experiment is the rate of the reaction the fastest? Give a reason for your answer. (2)

5.2.2 Explain your observation in QUESTION 5.2.1 in terms of the collision theory. (3)

[12]

QUESTION 6 (Start on a new page.)

6.1 Solid potassium chromate (K_2CrO_4) is dissolved in water. In solution, the chromate ions (CrO_4^{2-}) reach equilibrium with the dichromate ions ($Cr_2O_7^{2-}$) according to the following balanced equation.

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

Concentrated nitric acid is now added to the equilibrium mixture.

6.1.1 Predict the change in colour (if any) that will be observed as the nitric acid is added to the solution. ONLY Write down "Orange to Yellow", "Yellow to Orange" or "No Change". (1)

6.1.2 Which ONE of the two ions (CrO_4^{2-} or $Cr_2O_7^{2-}$) is more stable in a solution with a low pH? (1)

When the temperature is increased gradually, it is observed that the colour of the solution changes to yellow.

6.1.3 Is the forward reaction represented above exothermic or endothermic? (1)

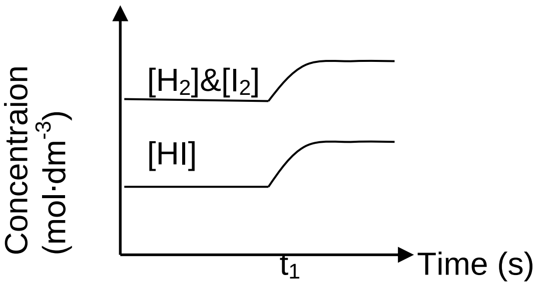
6.1.4 Explain the answer in QUESTION 6.1.3 by referring to Le Chatelier's principle. (3)

6.2 Five (5) moles of hydrogen gas and 5 moles of iodine vapour are sealed in a 2 dm^3 vessel at a temperature of 600 K. The reaction reaches equilibrium according to the following balanced chemical equation:

$$H_2(g) + I_2(g) \rightleftharpoons 2HI(g)$$

6.2.1 Calculate the concentration of the hydrogen iodide (HI) at equilibrium if the equilibrium constant, K_c, at 600 K is 0,36. (8)

6.2.2 The pressure on the system is now changed. The graphs below shows the changes in concentrations of the reactants and products as a result of this change.



Did the pressure INCREASE or DECREASE at t_1? Briefly explain. (3)

[17]

QUESTION 7 (Start on a new page.)

0,28 g of potassium hydroxide is dissolved in water and titrated against a solution of sulphuric acid. The end point is reached after adding exactly 20 cm^3 of a sulphuric acid solution.

The balanced equation for this reaction is:

$$2KOH\,(aq) + H_2SO_4\,(\ell) \rightarrow K_2SO_4\,(aq) + 2H_2O\,(\ell)$$

7.1 Define the term *endpoint*. (2)

7.2 Calculate the concentration of the sulphuric acid solution. (5)

7.3 Ammonium nitrate is used to lower the pH of agricultural soil. It is produced by the reaction of ammonia (NH_3) with nitric acid (HNO_3).

7.3.1 Name the TYPE of reaction that takes place between ammonia and nitric acid. (1)

7.3.2 Write down a balanced equation for the preparation of ammonium nitrate. (3)

7.3.3 Is an aqueous solution of ammonium nitrate ACIDIC, ALKALINE or NEUTRAL? (1)

7.3.4 Explain your answer to QUESTION 7.3.3 with the aid of a balanced equation. (4)

[16]

QUESTION 8 (Start on a new page.)

8.1 The chloro-alkali industry makes use of brine as electrolyte to produce sodium hydroxide, chlorine and hydrogen gas.
The unbalanced ionic equation for this reaction is:

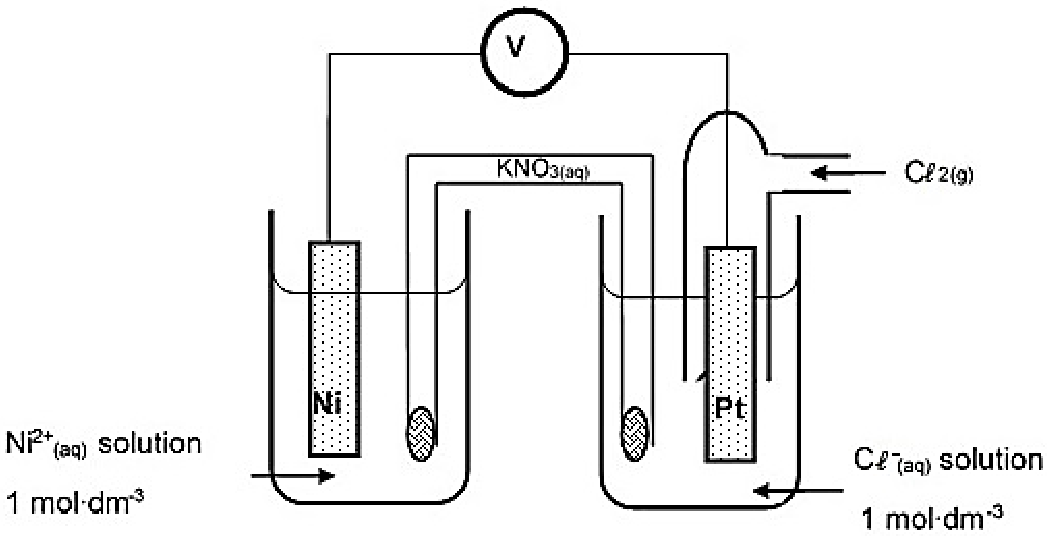
$$C\ell^-(aq) + H_2O(\ell) \rightarrow C\ell_2(g) + H_2(g) + OH^-(aq)$$

8.1.1 Define the term *electrolyte.* (2)

8.1.2 Write down the FORMULA of the oxidising agent in the above reaction. Use oxidation numbers to explain the answer. (3)

8.1.3 Balance the equation above using half-reactions. (4)

8.2 The following diagram represents a galvanic cell that functions under standard conditions.



8.2.1 Which electrode is the anode? (1)

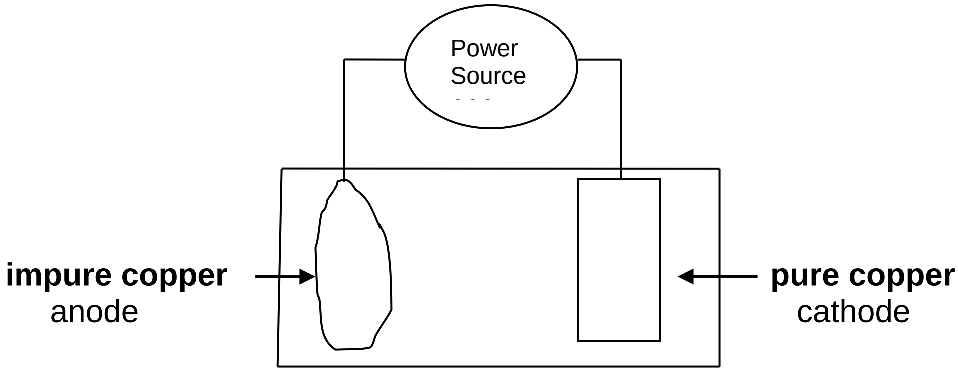
8.2.2 Write down the equation for the oxidation half-reaction that takes place. (2)

8.2.3 It is found that the voltmeter gives an initial reading of 1,61 V.
Would the voltmeter reading be HIGHER or LOWER if the nickel half-cell is replaced by a copper half-cell under the same conditions?
Verify your answer with a calculation. (5)

[17]

QUESTION 9 (Start on a new page.)

A learner sets up an electrolytic cell, represented in the diagram below, to purify copper which contains platinum and silver impurities.



During the purification of 28 g of the impure copper, 0,8 mol of electrons were transferred from the anode to the cathode.

9.1 Calculate the number of copper atoms formed at the cathode. (3)

9.2 The copper used for electrical wiring and cables must be 99,99% pure. Determine by calculation whether the IMPURE copper sample is suitable for use in electrical wiring and cables.
(Assume that all the copper at anode has reacted.) (5)

During the purification, a sludge containing the metals platinum and silver forms at the bottom of the container.

9.3 Use the relative strengths of reducing agents to explain why platinum and silver atoms are not oxidised during the purification of copper. (3)

[11]

QUESTION 10 (Start on a new page.)

10.1 Ammonia is used as a reactant in the preparation of nitrogen-based fertilisers.

Write down:

10.1.1 The NAME of the industrial process by which ammonia is prepared. (1)

10.1.2 A balanced equation for the industrial preparation of ammonia. (3)

10.1.3 The NAME of the catalyst used in this reaction. (1)

10.2 *"Overuse of nitrogen-based fertilisers poses a threat to the environment."*

Briefly discuss this statement by referring to algal bloom and eutrophication. (4)

10.3 A farmer wants to grow a better quality fruit.

10.3.1 Which ONE of the following fertilisers must he use? **Fertiliser A** (4:5:8) or **Fertiliser B** (13:5:9)? (1)

10.3.2 Briefly explain the answer to QUESTION 10.3.1. (2)
[12]

TOTAL: 150

NATIONAL SENIOR CERTIFICATE
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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 $n = \frac{V}{V_m}$	$c = \frac{n}{V}$ or/of $c = \frac{m}{MV}$ $\frac{c_aV_a}{c_bV_b} = \frac{n_a}{n_b}$	$pH = -\log[H_3O^+]$ $K_w = [H_3O^+][OH^-] = 1 \times 10^{-14}$ 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*

KEY/ *SLEUTEL*

Atoomgetal Atomic number	29
Elektronegatiwiteit Electronegativity	1,9
Simbool Symbol	Cu
Benaderde relatiewe atoommassa Approximate relative atomic mass	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: STANDAARD REDUKSIEPOTENSIALE

Increasing oxidising ability/*Toenemende oksiderende vermoë* (↑)

Increasing reducing ability/*Toenemende reduserende vermoë* (↓)

Half-reactions/*Halfreaksies*			E^θ (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
$\mathbf{2H^+ + 2e^-}$	⇌	$\mathbf{H_2(g)}$	**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

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

Increasing reducing ability/*Toenemende reduserende vermoë*