education

Department:
Education
REPUBLIC OF SOUTH AFRICA

NATIONAL SENIOR CERTIFICATE

GRADE 12

PHYSICAL SCIENCES: CHEMISTRY (P2)

NOVEMBER 2009(1)

MARKS: 150

TIME: 3 hours

This question paper consists of 16 pages and 4 data sheets.

INSTRUCTIONS AND INFORMATION

1. Write your centre number and examination number in the spaces on the ANSWER BOOK.

2. Answer ALL the questions.

3. This question paper consists of TWO sections:

   SECTION A (25)
   SECTION B (125)

4. Answer SECTION A and SECTION B in the ANSWER BOOK.

5. Non-programmable calculators may be used.

6. Appropriate mathematical instruments may be used.

7. Number the answers correctly according to the numbering system used in this question paper.

8. Data sheets and a periodic table are attached for your use.

9. Give brief motivations, discussions, et cetera where required.

SECTION A

QUESTION 1: ONE-WORD ITEMS

Give ONE word/term for each of the following descriptions. Write only the word/term next to the question number (1.1 – 1.5) in the ANSWER BOOK.

1.1 The reaction type that can be used to convert hydrocarbons with high molecular masses to hydrocarbons with low molecular masses (1)

1.2 The theory that explains why an increase in temperature results in an increase in reaction rate (1)

1.3 The minimum energy needed for a reaction to take place (1)

1.4 A substance that shows a decrease in oxidation number during chemical reactions (1)

1.5 The process which can lead to dead zones in a dam or lake (1)
[5]

QUESTION 2: FALSE ITEMS

Each of the five statements below is FALSE. Correct each statement so that it is TRUE. Write down only the correct statement next to the question number (2.1 – 2.5) in the ANSWER BOOK.

NOTE: Correction by using the negative of the statement, for example "… IS NOT …", will not be accepted.

2.1 Ethanol is an example of a secondary alcohol that is completely soluble in water. (2)

2.2 The chlorination of methane is an addition reaction. (2)

2.3 A catalyst increases the yield (amount) of products in a chemical reaction. (2)

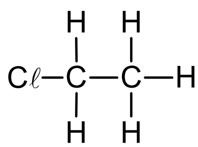
2.4 During electroplating of a steel teaspoon with silver, the teaspoon is the cathode and the electrolyte is a solution of any soluble compound. (2)

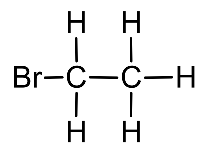
2.5 Nitrogen, phosphorus and potassium are the three essential nutrients needed by plants. (2)
[10]

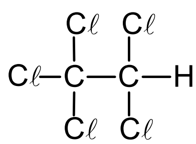
QUESTION 3: MULTIPLE-CHOICE QUESTIONS

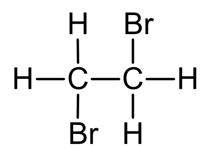
Four options are given as possible answers to the following questions. Each question has only ONE correct answer. Write only the letter (A – D) next to the question number (3.1 – 3.5) in the ANSWER BOOK.

3.1 Which ONE of the following compounds has structural isomers?

A 

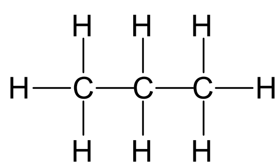
B 

C 

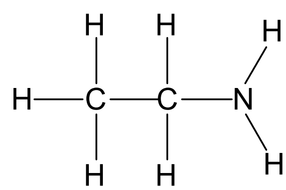
D 

(2)

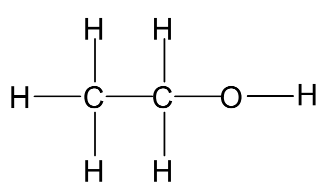
3.2 Consider the structural formula and IUPAC name of each compound shown below.



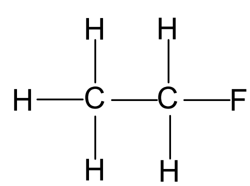
propane



ethanamine



ethanol



fluoroethane

Which ONE of these compounds has the highest vapour pressure at room temperature?

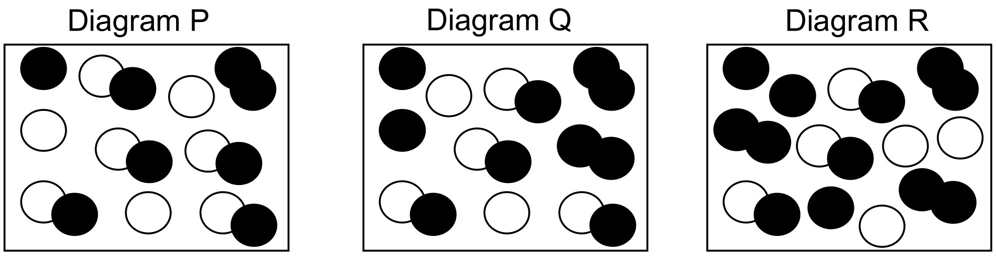
A Propane
B Ethanamine
C Ethanol
D Fluoroethane

(2)

3.3 Diagrams P, Q and R represent different reaction mixtures of the following hypothetical reaction that is at equilibrium in a closed container at a certain temperature.

$$X(g) + Y_2(g) \rightleftharpoons XY(g) + Y(g) \qquad \Delta H > 0$$

KEY X: ○ Y: ●



If at equilibrium **K_c = 2**, which diagram(s) correctly represent(s) the mixture at equilibrium?

A P only
B Q only
C R only
D P, R and Q (2)

3.4 The reactions below occur in two different electrochemical cells X and Y.

Cell X: $CuC\ell_2(aq) \rightarrow Cu(s) + C\ell_2(g)$

Cell Y: $Zn(s) + CuSO_4(aq) \rightarrow Cu(s) + ZnSO_4(aq)$

Which ONE of the following correctly describes the substance that forms at the CATHODE of each of these cells?

	Cell X	**Cell Y**
A	$C\ell_2(g)$	Cu(s)
B	Cu(s)	Cu(s)
C	$C\ell_2(g)$	$ZnSO_4(aq)$
D	Cu(s)	$ZnSO_4(aq)$

(2)

3.5 Which ONE of the following correctly describes the initial product(s) formed during the industrial fixation of nitrogen?

A Ammonia
B Ammonium nitrate
C Nitrogen dioxide
D Nitrogen and hydrogen (2)

[10]

TOTAL SECTION A: 25

SECTION B

INSTRUCTIONS AND INFORMATION

1. Start each question on a NEW page.
2. Leave one line between two subquestions, for example between QUESTION 4.1 and QUESTION 4.2.
3. The formulae and substitutions must be shown in ALL calculations.
4. Round off your answers to TWO decimal places where applicable.

QUESTION 4 (Start on a new page.)

Both esters and amides are considered derivatives of carboxylic acids and can be prepared by using carboxylic acids as one of the reactants.

Esters are known for their pleasant smells. Amides are the building blocks of proteins.

4.1 Write down the structural formula for the functional group of a primary amide. (1)

4.2 An ester with six carbon atoms is prepared using propanoic acid as one of the reactants.

4.2.1 Use structural formulae to write a balanced equation for the preparation of this ester. (6)

4.2.2 Write down the IUPAC name of this ester. (1)

4.2.3 Write down the name of the catalyst needed for this preparation. (1)

4.3 A certain amide has three carbon atoms in its stem (the carbon chain containing the carbonyl group). If the nitrogen atom of this amide has a methyl and an ethyl substituent, write down the amide's:

4.3.1 Structural formula (2)

4.3.2 IUPAC name (1)
[12]

QUESTION 5 (Start on a new page.)

The table below shows the results obtained during a practical investigation. Two experiments were performed to determine the boiling points of compounds from three different homologous series under the same conditions. Each letter A to F represents the organic compound written in the block next to it.

Experiment	Organic compound		Molar mass ($g \cdot mol^{-1}$)	Boiling point (°C)
I	**A**	CH_3COOH	60,5	118
	B	$CH_3CH_2CH_2OH$	60,1	97
	C	CH_3CH_2CHO	58,1	48
II	**D**	$CH_3(CH_2)_2COOH$	88,1	163
	E	$CH_3(CH_2)_3CH_2OH$	88,1	137
	F	$CH_3(CH_2)_3CHO$	88,1	103

5.1 Name the homologous series to which each of the following pairs of compounds belong:

5.1.1 A and D (1)

5.1.2 B and E (1)

5.1.3 C and F (1)

5.2 Write down the IUPAC name for:

5.2.1 Compound C (1)

5.2.2 Compound E (1)

5.3 Formulate an investigative question for this practical investigation. (2)

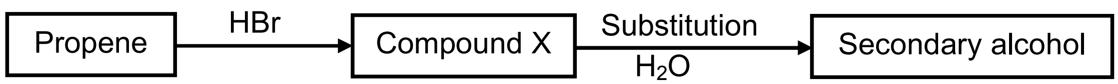
5.4 Which other variable, apart from the conditions for determining boiling points, was kept constant? (1)

5.5 What conclusion can be drawn from the results in Experiment II? (2)

5.6 Refer to intermolecular forces to explain the trend in boiling points, as shown in the table. (3)
[13]

QUESTION 6 (Start on a new page.)

The flow diagram below shows the conversion of propene to a secondary alcohol.



6.1 Give a reason why propene is classified as an unsaturated organic compound. (1)

6.2 Use structural formulae to write a balanced equation for the formation of compound X. (4)

6.3 Name the type of reaction that takes place when propene is converted to compound X. (1)

6.4 Write down the structural formula and IUPAC name for the secondary alcohol that is formed. (3)

6.5 Name the type of substitution reaction that takes place when compound X is converted to the secondary alcohol. (1)

6.6 With the aid of a catalyst, propene can be converted directly to the secondary alcohol, without the formation of the intermediate compound X.

6.6.1 Besides propene, write down the NAME of the reactant needed for this direct conversion. (1)

6.6.2 Write down the FORMULA of a catalyst that can be used. (1)

6.6.3 Name the type of reaction that will take place during this direct conversion. (1)

6.7 Instead of adding water to compound X, concentrated sodium hydroxide is added and the mixture is heated.

6.7.1 Write down the IUPAC name of the organic product that is formed. (1)

6.7.2 Name the type of reaction that takes place. (1)
[15]

QUESTION 7 (Start on a new page.)

A group of learners use the reaction between hydrochloric acid and magnesium powder to investigate one of the factors that influence the rate of a chemical reaction. The reaction that takes place is:

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

The learners use the apparatus and follow the method shown below to conduct the investigation.

Method – Experiment 1:

Step 1: Place a spatula of magnesium powder in a conical flask and add 50 cm^3 $HC\ell(aq)$ of known concentration.

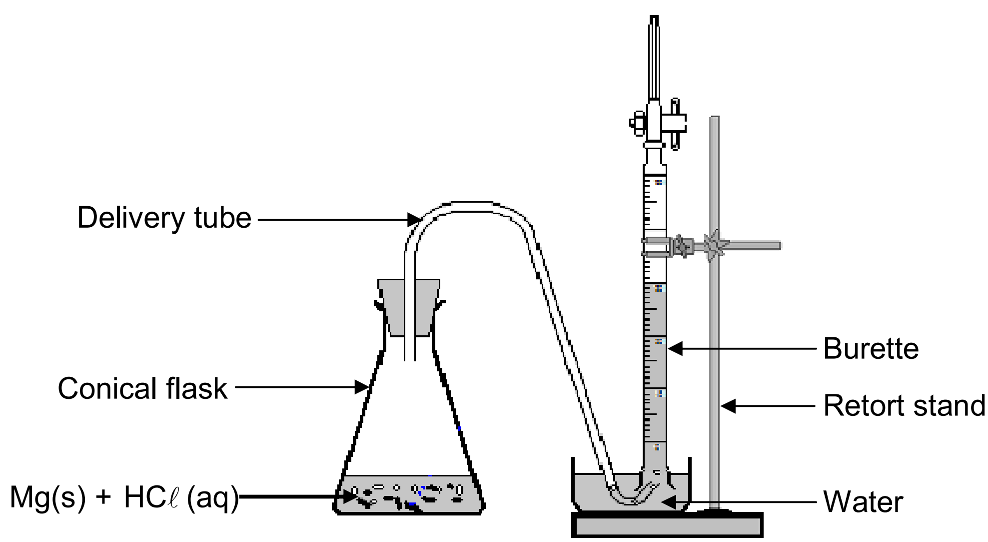
Step 2: Simultaneously start the stopwatch and close the flask with the rubber stopper containing the delivery tube.

Step 3: Measure the volume of the $H_2(g)$ formed in time intervals of 20 seconds.

Method – Experiment 2:

Repeat steps 1 to 3 above, but use only 25 cm^3 of the same $HC\ell(aq)$ diluted to 50 cm^3 with distilled water.

Apparatus:



7.1 How does the concentration of the acid used in Experiment 2 differ from the concentration of the acid used in Experiment 1? Write down only GREATER THAN, SMALLER THAN or EQUAL TO. (1)

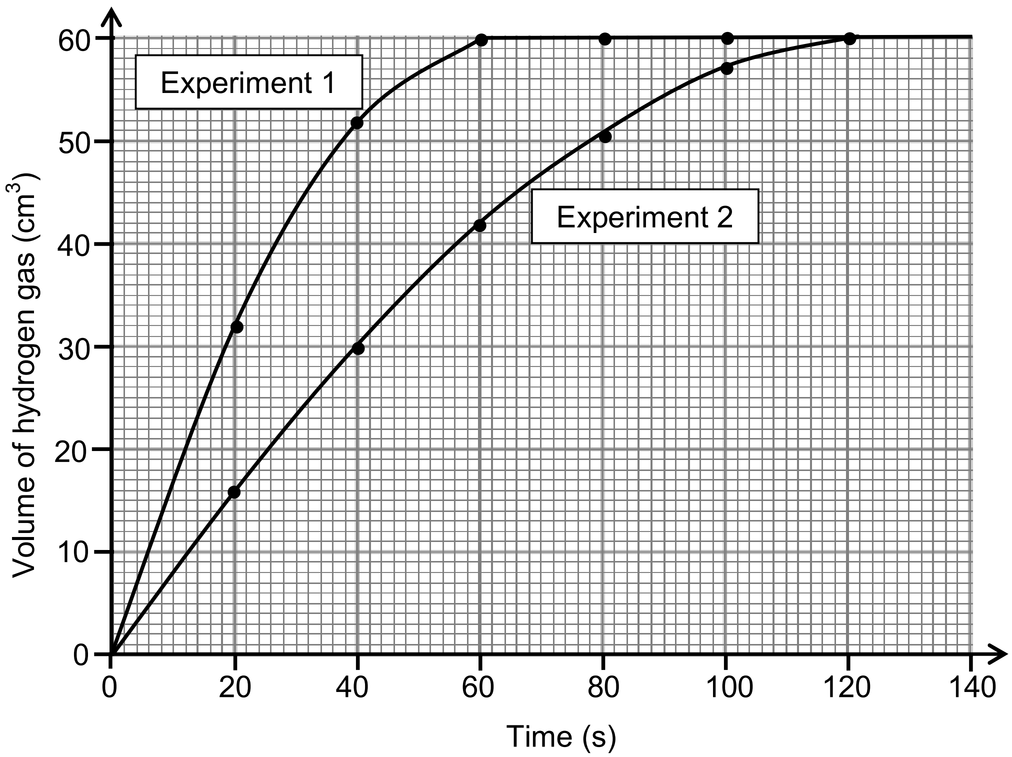
7.2 Write down a hypothesis for this investigation. (2)

7.3 Why should the learners ensure that equal amounts of magnesium powder are used in each of the two experiments? (2)

7.4 The learners use an excess of $HC\ell(aq)$ for the two experiments. Give a reason why the excess $HC\ell(aq)$ will not influence the results. (2)

After completing the investigation, the learners represent the results obtained during each experiment on the graph below.

Graph of volume of hydrogen gas versus time



7.5 Write down the volume of hydrogen gas formed during the first minute in:

7.5.1 Experiment 1 (1)

7.5.2 Experiment 2 (1)

7.6 Which one of the experiments (Experiment 1 or Experiment 2) took place at the faster rate? Refer to the shape of the curves to motivate your answer. (2)

7.7 Give a reason why the final volume of gas produced is the same in both experiments. (1)

7.8 What conclusion can the learners draw from the results obtained? (2)

7.9 How will an increase in the temperature influence the following:

7.9.1 Final volume of gas obtained in each experiment (Write down only INCREASES, DECREASES or REMAINS THE SAME.) (1)

7.9.2 Volume of gas obtained in each experiment after 40 s (Write down only INCREASES, DECREASES or REMAINS THE SAME.) (1)

[16]

QUESTION 8 (Start on a new page.)

The thermal decomposition of calcium carbonate ($CaCO_3$) is an example of a heterogeneous equilibrium. The decomposition that takes place in a closed container can be represented by the following equation:

$$CaCO_3(s) \rightleftharpoons CaO(s) + CO_2(g)$$

Initially 5 g of $CaCO_3$(s) is placed in a closed 500 cm^3 container and then heated. Equilibrium is reached at 900 °C.

8.1 Why is the above decomposition referred to as a heterogeneous equilibrium? (1)

8.2 Calculate the mass of unreacted $CaCO_3$(s) that remains in the container at equilibrium if K_c for the reaction is 0,0108 at 900 °C. (9)

8.3 It is found that the value of K_c increases when the container is heated to a higher temperature. Is the forward reaction exothermic or endothermic? Use Le Chatelier's principle to explain your answer. (3)

8.4 The volume of the container is now decreased to 250 cm^3 while the temperature is kept constant. How will each of the following be affected? Write down only INCREASES, DECREASES or REMAINS THE SAME.

8.4.1 The value of K_c (1)

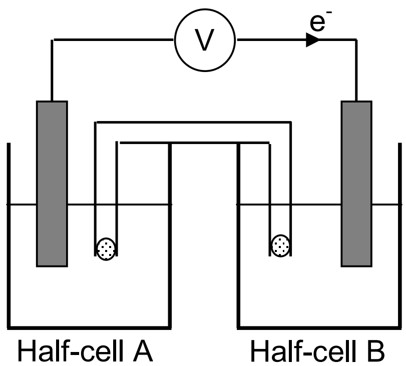
8.4.2 The number of moles of $CaCO_3$(s) present in the equilibrium mixture (1)

8.4.3 The concentration of CO_2(g) at the new equilibrium (1)

8.5 More $CaCO_3$(s) is now added to the equilibrium mixture in the 500 cm^3 container. How will this change influence the number of moles of CO_2(g)? Write down only INCREASES, DECREASES or REMAINS THE SAME. (1)
[17]

QUESTION 9 (Start on a new page.)

The galvanic cell represented in the diagram below consists of a Mg electrode dipped into a $Mg(NO_3)_2$ solution, and a Pb electrode dipped into a $Pb(NO_3)_2$ solution. Assume that the cell operates under standard conditions.



9.1 State TWO standard conditions under which this cell operates. (2)

9.2 Write down the half-reaction that takes place in half-cell A. (2)

9.3 Write down the cell notation for this cell. (3)

9.4 Calculate the emf of this cell. (4)

9.5 How will each of the following changes influence the value of the cell's emf calculated in QUESTION 9.4? Write down only INCREASES, DECREASES or REMAINS THE SAME.

9.5.1 An increase in $[Mg^{2+}(aq)]$ (1)

9.5.2 An increase in $[Pb^{2+}(aq)]$ (1)

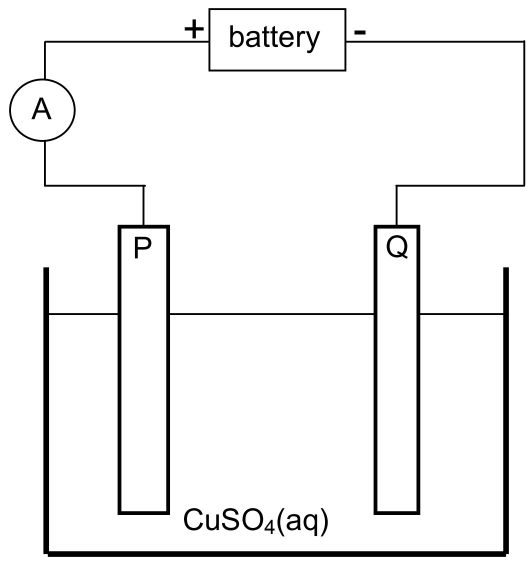
9.6 In which direction, from half-cell A to B or from half-cell B to A, do cations move within the salt bridge to maintain electrical neutrality? Explain how you arrived at your answer. (4)

[17]

QUESTION 10 (Start on a new page.)

Electrolysis is an important industrial process used to decompose compounds, extract metals from their ores and to purify metals like gold or copper.

The simplified diagram below represents an electrolytic cell used to purify copper.



10.1 Define the term *electrolysis.* (2)

10.2 Which electrode, P or Q, consists of the impure copper? Explain how you arrived at your answer. (3)

10.3 Write down the half-reaction that takes place at electrode Q. (2)

10.4 During purification, metals such as silver and platinum form sludge at the bottom of the container.

Refer to the relative strengths of reducing agents to explain why these two metals do not form ions during the purification process. (2)

10.5 Explain why the concentration of the copper(II) sulphate solution remains constant. Assume that the only impurities in the copper are silver and platinum. (2)

10.6 Why is the sludge of economic importance? (2)
[13]

QUESTION 11 (Start on a new page.)

The chloralkali industry is the second largest consumer of electricity among electrolytic industries. It makes use of brine as electrolyte to produce chlorine gas, hydrogen gas and sodium hydroxide. The overall reaction can be represented by the following equation:

$$2NaC\ell(aq) + 2H_2O(\ell) \rightarrow 2NaOH(aq) + C\ell_2(g) + H_2(g)$$

11.1 Define the term *electrolyte.* (2)

11.2 Give a reason why brine conducts electricity. (1)

11.3 Write down the NAME of the reducing agent in the above reaction. Give a reason for your choice. (2)

11.4 Write down a half-reaction to explain how hydroxide ions are formed during this reaction. (2)

11.5 At which electrode (anode or cathode) is chlorine gas formed? Give a reason for your answer. (2)

11.6 The chloride ions present in the brine solution can contaminate the sodium hydroxide. Briefly describe how this contamination is prevented in the membrane cell. (2)

11.7 Give ONE reason why it is not advisable to build a chloralkali plant close to a residential area. (1)

[12]

QUESTION 12 (Start on a new page.)

Some cells, such as the nickel-cadmium cell used in calculators and electric shavers, can be recharged. Others, such as those used in watches and torches, cannot be recharged.

12.1 Are rechargeable cells primary or secondary cells? (1)

12.2 The half-reactions occurring in a nickel-cadmium cell are shown below:

$Cd(s) + 2OH^-(aq) \rightarrow Cd(OH)_2(s) + 2e^-$ ……………………(I)

$NiO_2(s) + 2H_2O(\ell) + 2e^- \rightarrow Ni(OH)_2(s) + 2OH^-(aq)$……..…(II)

The emf of the nickel-cadmium cell is 1,4 V.

12.2.1 Which ONE of these half-reactions occurs at the cathode? Give a reason for your answer. (2)

12.2.2 Write down the balanced equation for the overall cell reaction. (3)

12.2.3 Calculate the maximum work done by the cell under standard conditions as 1 mol of Cd is used up.
(NOTE: 1 mole of electrons has a charge of $9,65 \times 10^4$ C.) (4)
[10]

TOTAL SECTION B: 125

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

TABLE 2: FORMULAE/*TABEL 2: FORMULES*

$n = \frac{m}{M}$	$c = \frac{n}{V}$ or $c = \frac{m}{MV}$
$q = I\Delta t$ $W = Vq$	$E^{\theta}_{cell} = E^{\theta}_{cathode} - E^{\theta}_{anode}$ / $E^{\theta}_{sel} = E^{\theta}_{katode} - E^{\theta}_{anode}$ $E^{\theta}_{cell} = E^{\theta}_{reduction} - E^{\theta}_{oxidation}$ / $E^{\theta}_{sel} = E^{\theta}_{reduksie} - E^{\theta}_{oksidasie}$ $E^{\theta}_{cell} = E^{\theta}_{oxidising\ agent} - E^{\theta}_{reducing\ agent}$ / $E^{\theta}_{sel} = E^{\theta}_{oksideermiddel} - E^{\theta}_{reduseermiddel}$

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

KEY/*SLEUTEL*

29 1,9 Cu 63,5

- **Atomic number** / ***Atoomgetal***: 29
- **Electronegativity** / ***Elektronegatiwiteit***: 1,9
- **Symbol** / ***Simbool***: Cu
- **Approximate relative atomic mass** / ***Benaderde relatiewe atoommassa***: 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* (↑)

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
$2H^+ + 2e^-$	**⇌**	**$H_2(g)$**	**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

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)
$Li^+ + e^-$	⇌	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