education

Department of Education
FREE STATE PROVINCE

PREPARATORY EXAMINATION

GRADE 12

PHYSICAL SCIENCES
PAPER 2
(CHEMISTRY)

SEPTEMBER 2016

MARKS: 150

TIME: 3 HOURS

This question paper consists of 14 pages and 4 data sheets.

INSTRUCTIONS AND INFORMATION

1. Write your name and other applicable information in the appropriate spaces on the ANSWER BOOK.

2. The question paper consists of TEN questions. Answer ALL the questions in the ANSWER BOOK.

3. Start EACH question on a NEW page in the ANSWER BOOK.

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

5. Leave one line between two sub-questions, for example between QUESTION 3.1 and QUESTION 3.2.

6. Non-programmable pocket calculators may be used.

7. Appropriate mathematical instruments may be used.

8. You are advised to use the attached DATA SHEETS.

9. Show ALL formulae and substitutions in ALL calculations.

10. Round off your final numerical answers to a minimum of TWO decimal places where necessary.

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

12. 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. Choose the answer and write only the letter (A – D) next to the question number (1.1 – 1.10) in your ANSWER BOOK, for example 1.11 E.

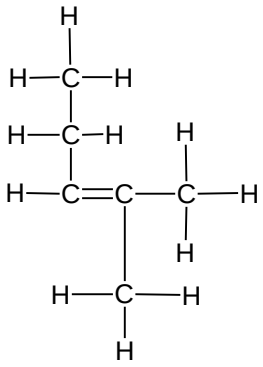
1.1 The most important mineral nutrient essential for the development of roots, is …

A nitrogen.
B phosphorus.
C potassium.
D calcium. (2)

1.2 The functional group of carboxylic acids is:

A ─ COO ─
B ─ COOH
C ─ OH
D ─ CHO (2)

1.3 Consider the following structural formula of an organic compound.



The IUPAC name of this compound is:

A 2-methyl-3-ethylprop-1-ene
B 2-methyl-1-ethylprop-1-ene
C 4-methylpent-3-ene
D 2-methylpent-2-ene (2)

1.4 Which ONE of the following represents condensation polymerisation?

A Hydration
B Esterification
C Hydrolysis
D Dehydration (2)

1.5 50 cm^3 of a 0,1 $mol.dm^{-3}$ solution of hydrochloric acid is poured on to 5 g of granulated zinc which is inside a glass beaker at room temperature.
Which one of the following factors will **not** increase the initial rate of the reaction?

A Grinding the granulated zinc into powder
B Using 30 cm^3 of a 0,2 $mol.dm^{-3}$ hydrochloric acid at room temperature
C Increasing the temperature of the acid solution to 50 °C
D Using 100 cm^3 of a 0,1 $mol.dm^{-3}$ solution of hydrochloric acid at room temperature (2)

1.6 The reaction represented below reaches equilibrium in a closed container.

$CH_4(g) + H_2O(g) \rightleftharpoons CO(g) + 3H_2(g) \quad \Delta H > 0$

Which ONE of the following changes will increase the yield of $H_2(g)$?

A Add a catalyst
B Decrease pressure by increasing the volume
C Decrease the temperature
D Increase pressure by decreasing the volume (2)

1.7 Consider the reaction:

$2H_2O(\ell) \rightleftharpoons H_3O^+(aq) + OH^-(aq)$

The equilibrium constant for this reaction at 25 °C is 10^{-14}. At 60 °C the equilibrium constant for this reaction is 10^{-13}. From the above information one can conclude that this reaction at 60 °C …

A is an exothermic reaction.
B has a high product yield.
C the concentration of H_3O^+ decreases.
D the concentration of products does not change. (2)

1.8 A saturated solution of NaCℓ in water is prepared at 50 °C. The equation for this equilibrium is:

$NaC\ell(s) \rightleftharpoons Na^+(aq) + C\ell^-(aq) \qquad \triangle H > 0$

Which ONE of the following changes will cause more NaCℓ(s) to form?

A Add dilute hydrochloric acid
B Add a catalyst at constant temperature
C Increase the pressure on the solution
D Decrease the temperature (2)

1.9 The cell notation of a GALVANIC CELL is given as:

$Ni(s)|Ni^{2+}(aq)\ (1mol.dm^{-3})||Ag^+(aq)\ (1mol.dm^{-3})|Ag(s)$

A bulb connected across the two electrodes glows brightly. After some time the brightness of the bulb decreases. This is because …

A the silver electrode is used up.
B the nickel electrode is used up.
C the concentration of Ag^+ decreases.
D the concentration of Ni^{2+} decreases. (2)

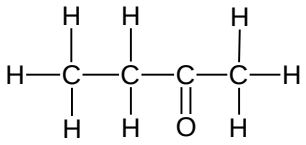
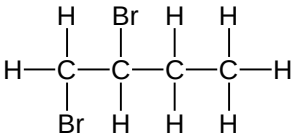
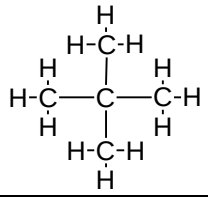
1.10 During the electrolysis of a concentrated sodium chloride solution, water is reduced and not sodium ions because…

A Na^+ is a stronger oxidising agent than H_2O.
B H_2O is a stronger reducing agent than Na^+.
C H_2O is a stronger oxidising agent than Na^+.
D Na^+ is a stronger reducing agent than H_2O. (2)

[20]

QUESTION 2 (Start on a new page.)

The letters **A** to **F** in the table below represent six organic compounds.

A	Butanal	**B**	$CH_3CH_2CCCH_3$
C		**D**	
E		**F**	Ethyl ethanoate

Use the information in the table to answer the questions that follow.

2.1 Write down the letter(s) representing:

2.1.1 A compound with the general formula C_nH_{2n+2} (1)

2.1.2 A ketone (1)

2.1.3 An aldehyde (1)

2.1.4 An unsaturated hydrocarbon (1)

2.2 For compound **F**, write down the:

2.2.1 Structure of the functional group to which it belongs (2)

2.2.2 IUPAC name of the acid and an alcohol needed to prepare **F** (2)

2.3 Write down the IUPAC name of:

2.3.1 Compound **C** (2)

2.3.2 Compound **D** (2)

2.4 Write down the condensed structural formula for **C**. (2)

2.5 Write down the structural formula of:

2.5.1 A chain isomer of compound **E** (2)

2.5.2 Compound **F** (2)
[18]

QUESTION 3 (Start on a new page.)

During a practical investigation the boiling points of five (5) organic compounds, with known molar masses, were determined and the results were recorded in the table below. The five organic compounds are represented by the letter **A** to **E**.

	COMPOUND	**MOLAR MASS ($g.mol^{-1}$)**	**BOILING POINT (°C)**
A	$CH_3CH_2CH_3$	44	- 42
B	$CH_3CH_2CH_2CH_3$	58	-1
C	$CH_3CH_2CH_2CH_2CH_3$	72	36
D	$CH_3CH(CH_3)CH_2CH_3$	72	28
E	$CH_3C(CH_3)_2CH_3$	72	10

3.1 Consider only compounds **A**, **B** and **C** and write down:

3.1.1 The independent variable (1)

3.1.2 The dependent variable (1)

3.1.3 An investigative question (2)

3.2 What is the trend in boiling point from compound **C** to compound **E**? Write down INCREASES or DECREASES. Fully explain this trend. (4)

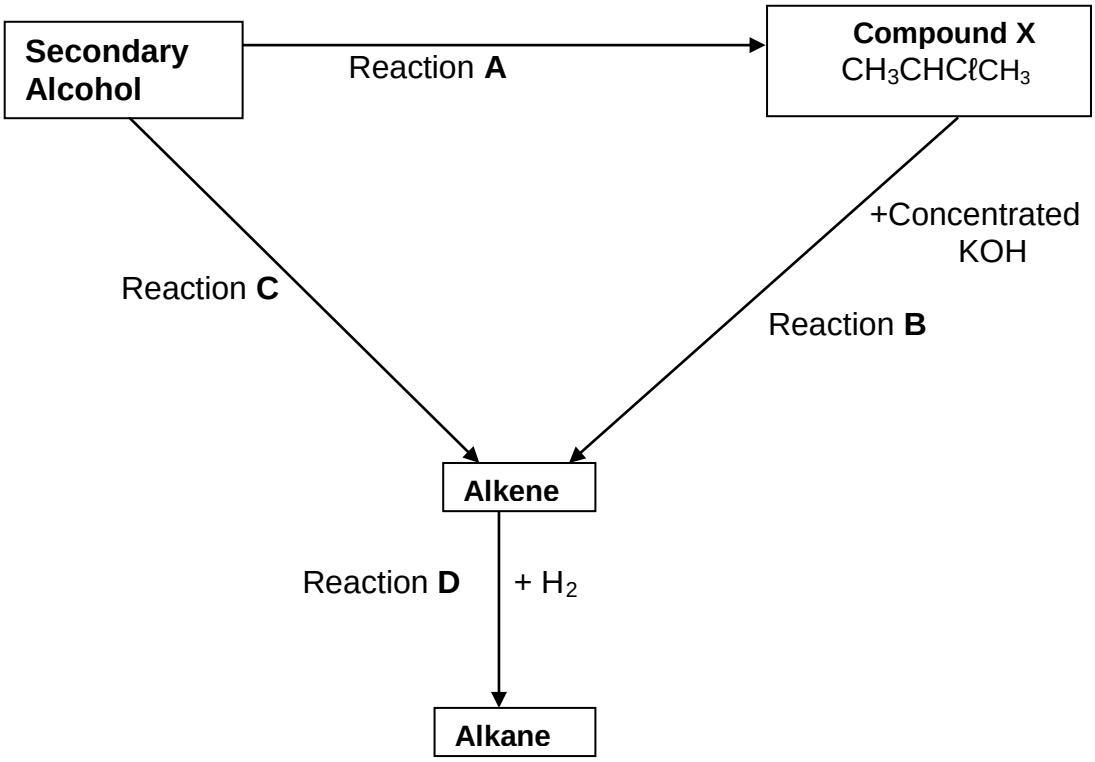
3.3 Consider compound **E**.

3.3.1 Write down the NAME of the homologous series to which it belongs. (1)

3.3.2 Write down the IUPAC name of this compound. (2)
[11]

QUESTION 4 (Start on a new page.)

The flow diagram below shows how alcohols can react to form other organic compounds.



4.1 Write down the type of reaction represented by reaction:

4.1.1 **A** (1)

4.1.2 **B** (1)

4.1.3 **D** (1)

4.2 In reaction **B**, compound **X** is converted to an alkene. Write down the:

4.2.1 IUPAC name of compound **X** (2)

4.2.2 Balanced equation for the reaction **B**, using structural formulae (4)

4.3 Reaction **C** takes place in the presence of a strong acid.

4.3.1 Explain the term *secondary alcohol* (2)

4.3.2 Write down the IUPAC name of the alcohol used (2)

[13]

QUESTION 5 (Start on a new page.)

In an investigation of the rate of reaction, excess magnesium powder is added to dilute hydrochloric acid at room temperature. The following spontaneous reaction takes place:

$Mg(s) + 2HC\ell(aq) \rightarrow MgC\ell_2(aq) + H_2(g)$ $\Delta H < 0$

5.1 Define the term *spontaneous reaction*. (2)

5.2 Write down the limiting reagent for the above reaction. (1)

5.3 How will each of the following changes affect the rate of the reaction between magnesium and hydrochloric acid according to the above reaction? Choose from INCREASES, DECREASE or REMAINS THE SAME.

5.3.1 The same mass of magnesium ribbon is used instead of powder. (1)

5.3.2 A more concentrated solution of hydrochloric acid is used. (1)

5.3.3 The diluted hydrochloric acid solution is heated before being added to the magnesium. (1)

5.4 Use the collision theory to explain your answer in QUESTION 5.3.3. (3)
[9]

QUESTION 6 (Start on a new page.)

During the industrial preparation of ammonia, nitrogen gas and hydrogen gas react in a closed container until the following equilibrium is established at a constant temperature of 472 °C. Kc is 0,1 at this temperature of 472 °C. The volume of the container is 0,5 dm^3.

$$N_2(g) + 3H_2(g) \rightleftharpoons 2NH_3(g) \qquad \Delta H = -92\ kJ{\cdot}mol^{-1}$$

The equilibrium concentrations are:

$[NH_3] = 2,7 \times 10^{-3}\ mol{\cdot}dm^{-3}$
$[H_2] = 1,221 \times 10^{-1}\ mol{\cdot}dm^{-3}$

6.1 Write down the term for the underlined phrase. (1)

6.2 Write down the NAME or FORMULA of the catalyst used in this reaction. (1)

6.3 After equilibrium has been established, the temperature remained constant. Explain this observation. (2)

6.4 Calculate the initial mass of nitrogen gas. (10)

6.5 Explain why such a high temperature is used although the yield is low. (3)
[17]

QUESTION 7 (Start on a new page.)

7.1 Hydrochloric acid is a highly corrosive strong acid with many industrial uses. When 0,02 dm^3 of sodium hydroxide is added to 0,15 dm^3 of diluted hydrochloric acid of concentration 0,03 $mol.dm^{-3}$, the pH of the mixture changes to 4.

7.1.1 Give a reason why hydrochloric acid is classified as a strong acid. (2)

7.1.2 Write down a balanced chemical equation to show the dissociation of HCℓ in water. (3)

7.1.3 Will the final mixture be acidic or basic? Give a reason for your answer by referring to the pH of the mixture. (2)

7.1.4 Calculate the final concentration of the H^+ ion in the mixture. (3)

7.1.5 Calculate the original concentration of the sodium hydroxide solution. (6)

7.2 Calcium carbonate solutions provide living organisms with the substance they need to grow their protective shells and skeletons. For example, eggshells are composed of calcium carbonate. Grade 12 learners decide to calculate the percentage calcium carbonate in eggshells at STP.

They take 5 g of crushed eggshells and react it with excess hydrochloric acid according to the following equation:

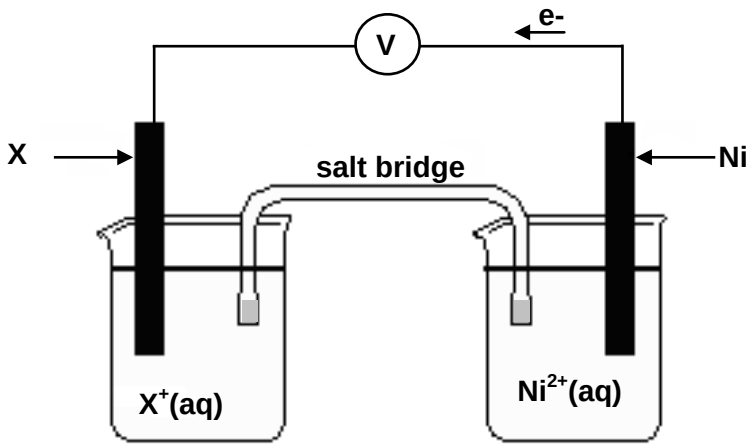
$CaCO_3(s) + 2\ HC\ell(aq) \rightarrow CaC\ell_2(aq) + CO_2(g) + H_2O(\ell)$

The carbon dioxide gas produced is collected and found to be 1,06 dm^3 after all the calcium carbonate has reacted. Calculate the percentage calcium carbonate in the 5 g eggshells. Show all the calculations. (6)

[22]

QUESTION 8 (Start on a new page.)

An electrochemical cell is set up at **standard conditions** as shown below. The electron flow is as indicated. The reading on the voltmeter is **1,07 V**.



8.1 Write down ONE function of the salt bridge. (1)

8.2 Which electrode of the cell is the anode? Write only **X** or **Ni**. (1)

8.3 Using a calculation, identify the unknown metal **X**. (5)

8.4 Write down the balanced net (overall) equation for the above cell. (3)

Metal **X** is now replaced by zinc.

8.5 For the new galvanic cell, write down:

8.5.1 The NAME or FORMULA of the oxidising agent (1)

8.5.2 The half reaction for the ANODE (2)

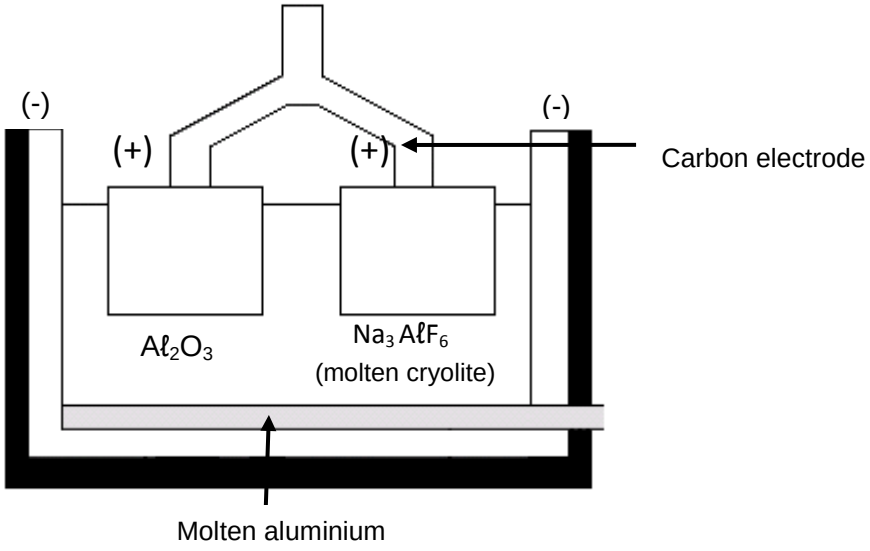
8.5.3 The cell notation of the new cell (3)

[16]

QUESTION 9 (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.

ℓThe simplified diagram below represents an electrolytic cell used in the extraction of aluminium.



9.1 Write down the energy conversion that takes place in this cell. (1)

9.2 Write down the name of the mineral ore of aluminium. (1)

9.3 Write down the role played by cryolite in this cell. (1)

9.4 The carbon rods need to be replaced from time to time. Write down the balanced chemical equation that explains why they need to be replaced. (2)

9.5 Write down the half-reaction at the cathode. (1)

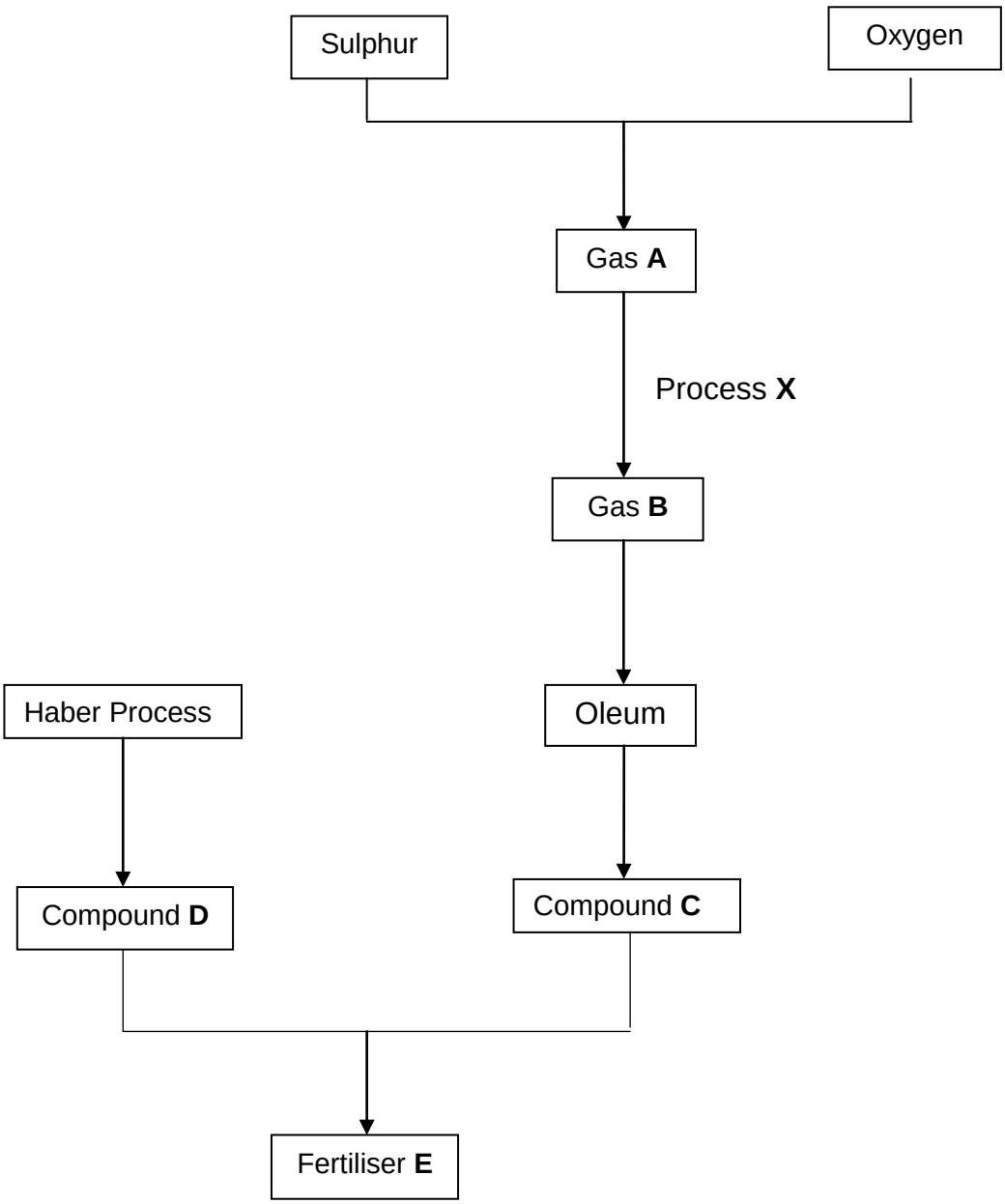
9.6 Write down TWO negative impacts of this cell on the environment. (2)

9.7 It is preferable to recycle aluminium products rather than extracting it from its mineral ore. Give a reason to substantiate the above statement. (2)

[10]

QUESTION 10 (START ON A NEW PAGE)

Different processes used in the preparation of fertiliser **E** are represented in the flow diagram below.



10.1 Use the above information and write down the:

10.1.1 NAME or FORMULA of gas **A** (1)

10.1.2 Name of process **X** (1)

10.1.3 NAME or FORMULA of the catalyst used in process **X** (1)

10.1.4 FORMULA of oleum (2)

10.1.5 Balanced equation for the preparation of fertiliser **E** (4)

10.2 Describe ONE negative impact on humans when fertiliser runs off into dams and rivers as a result of rain. (2)

10.3 Write down the NAME of the most important primary nutrient required to enhance:

10.3.1 Leaf growth of spinach (1)

10.3.2 Flower and fruit production of peach trees (1)

10.4 Which ONE of the three primary nutrients is absorbed by plants the least? (1)
[14]

GRAND TOTAL: 150

DATA FOR PHYSICAL SCIENCES GRADE 12
PAPER 2 (CHEMISTRY)

GEGEWENS VIR FISIESE WETENSKAPPE GRAAD 12
VRAESTEL 2 (CHEMIE)

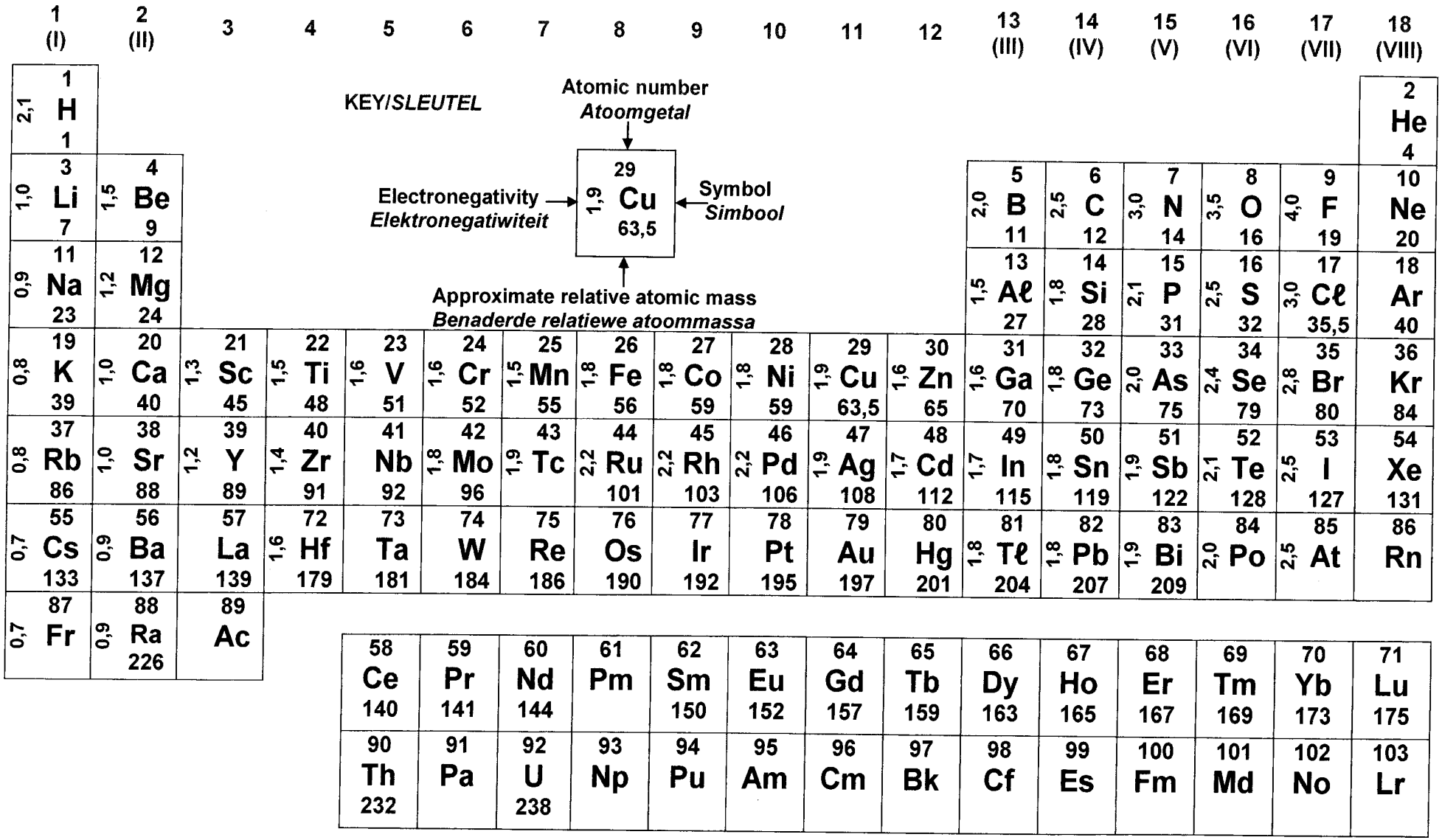
TABLE 1: PHYSICAL CONSTANTS / *TABEL 1: FISIESE KONSTANTES*

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	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 $c = \frac{m}{MV}$	$n = \frac{V}{V_m}$
$\frac{c_a V_a}{c_b V_b} = \frac{n_a}{n_b}$	$pH = -\log[H_3O^+]$
$K_w = [H_3O^+][OH^-] = 1 \times 10^{-14}$ at 298 K	
$E^{\theta}_{cell} = E^{\theta}_{cathode} - E^{\theta}_{anode}$ $E^{\theta}_{cell} = E^{\theta}_{reduction} - E^{\theta}_{oxidation}$ $E^{\theta}_{cell} = E^{\theta}_{oxidisingagent} - E^{\theta}_{reducingagent}$	

TABLE 3: THE PERIODIC OF ELEMENTS



1 (I)	2 (II)	3	4	5	6	7	8	9	10	11	12	13 (III)	14 (IV)	15 (V)	16 (VI)	17 (VII)	18 (VIII)
2,1 H 1																	2 He 4
1,0 Li 7	1,5 Be 9											2,0 B 11	2,5 C 12	3,0 N 14	3,5 O 16	4,0 F 19	10 Ne 20
0,9 Na 23	1,2 Mg 24											1,5 Aℓ 27	1,8 Si 28	2,1 P 31	2,5 S 32	3,0 Cℓ 35,5	18 Ar 40
0,8 K 39	1,0 Ca 40	1,3 Sc 45	1,5 Ti 48	1,6 V 51	1,6 Cr 52	1,5 Mn 55	1,8 Fe 56	1,8 Co 59	1,8 Ni 59	1,9 Cu 63,5	1,6 Zn 65	1,6 Ga 70	1,8 Ge 73	2,0 As 75	2,4 Se 79	2,8 Br 80	36 Kr 84
0,8 Rb 86	1,0 Sr 88	1,2 Y 89	1,4 Zr 91	92 Nb	1,8 Mo 96	1,9 Tc	2,2 Ru 101	2,2 Rh 103	2,2 Pd 106	1,9 Ag 108	1,7 Cd 112	1,7 In 115	1,8 Sn 119	1,9 Sb 122	2,1 Te 128	2,5 I 127	54 Xe 131
0,7 Cs 133	0,9 Ba 137	57 La 139	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	1,8 Tℓ 204	1,8 Pb 207	1,9 Bi 209	2,0 Po	2,5 At	86 Rn
0,7 Fr	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

Half-reactions / *Halfreaksies*			$E^{\ominus}$ (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*	$E^{\ominus}$ (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