GAUTENG PROVINCE
EDUCATION
REPUBLIC OF SOUTH AFRICA

PREPARATORY EXAMINATION

2023

11102

TECHNICAL SCIENCES

(PAPER 2)

TIME: 1½ hours

MARKS: 75

10 pages and 4 data sheets

11102E

X05

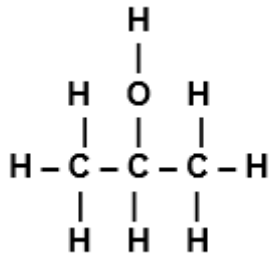
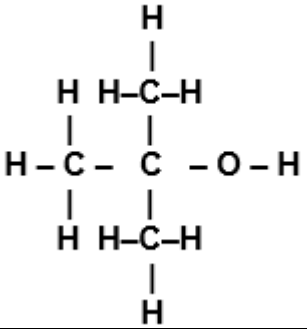
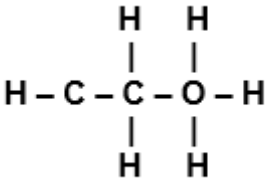
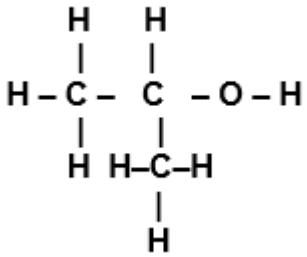
INSTRUCTIONS AND INFORMATION

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

QUESTION 1: MULTIPLE-CHOICE QUESTIONS

Various options are provided as possible answers to the following questions. Choose the correct answer and write only the letter (A – D) next to the question numbers (1.1 to 1.6) in the ANSWER BOOK, e.g. 1.7 D.

1.1 Which of the following compounds is a tertiary alcohol?

A		B	
C		D	

(2)

1.2 The general formula, C_nH_{2n}, describes the following homologous series:

A Alkane
B Alkene
C Alkyne
D Haloalkane (2)

1.3 Dipole-dipole forces increase with the increase of polarity of functional groups:

A Alkanes < aldehydes < esters < ketones < alcohols < carboxylic acid
B Alkanes < esters < aldehydes < alcohols < ketones < carboxylic acid
C Alkanes < esters < aldehydes < ketones < alcohols < carboxylic acid
D Alkanes < aldehydes < ketones < alcohols < carboxylic acid < esters (2)

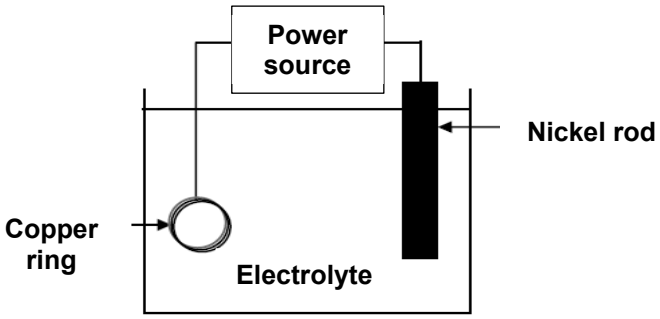
1.4 Which of the following types of intermolecular forces is the strongest?

A London forces
B Dipole-dipole forces
C Van der Waals forces
D Hydrogen bonds (2)

1.5 Which of the following statements regarding the anode of a standard galvanic cell in operation is CORRECT?

A The anode accepts electrons.
B The mass of the anode increases.
C The concentration of the electrolyte in the half-cell containing the anode increases.
D The anode is the positive terminal of the cell. (2)

1.6 A learner wants to electroplate a copper ring with nickel. He uses the experimental setup shown in the simplified diagram below.



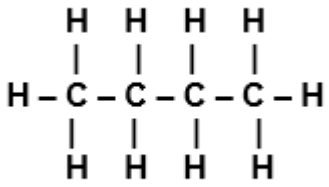
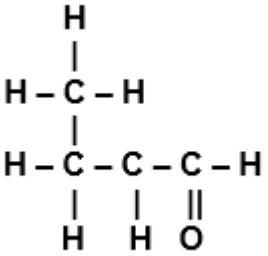
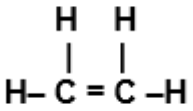
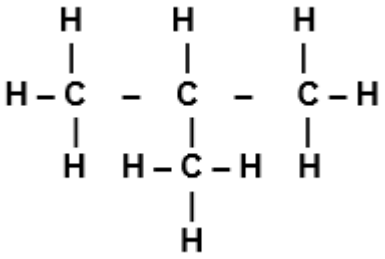
Which of the following is CORRECT?

	ANODE	CATHODE	ELECTROLYTE
A	Copper ring	Nickel rod	$CuSO_4$
B	Nickel rod	Copper ring	$CuSO_4$
C	Copper ring	Nickel rod	$NiSO_4$
D	Nickel rod	Copper ring	$NiSO_4$

(2)
[12]

QUESTION 2 (Start on a new page.)

Study the following table of organic molecules as represented by letters **A** to **F** below and answer the following questions.

A		**B**	
C	Ethyl propanoate	**D**	3-methylbutan-2-one
E		**F**	

2.1 Define a *homologous series.* (2)

2.2 Write down the letter(s) that represent(s) the compound that is/are:

2.2.1 Unsaturated (1)

2.2.2 An Ester (1)

2.2.3 A ketone (1)

2.2.4 Chain isomers (2)

2.3 Write down the following:

2.3.1 The structural formula of compound **C** (3)

2.3.2 The functional isomer of compound **C** (3)

[13]

QUESTION 3 (Start on a new page.)

Esters are used for its pleasant fruity odours. It is also used in paint and coating adhesives, lubricants, intermediates, processing aids and as a solvent in paint, glue, nail polish and graffiti removers.

Use the table of esters below to answer the following questions.

	Ester	Molar Mass ($g.mol^{-1}$)	Melting point (^oC)	Boiling point (^oC)
A	$HCOOCH_3$	60	-99	32
B	$HCOOCH_2CH_3$	74	-98	57
C	$HCOOCH_2CH_2CH_3$	88	-88	80

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

3.2 What is the difference between the esters' molecular structures above? (2)

3.3 Explain why compound **C** has a higher boiling point than compound **A** in terms of the type of intermolecular forces, strength of these intermolecular forces and the energy needed. (3)

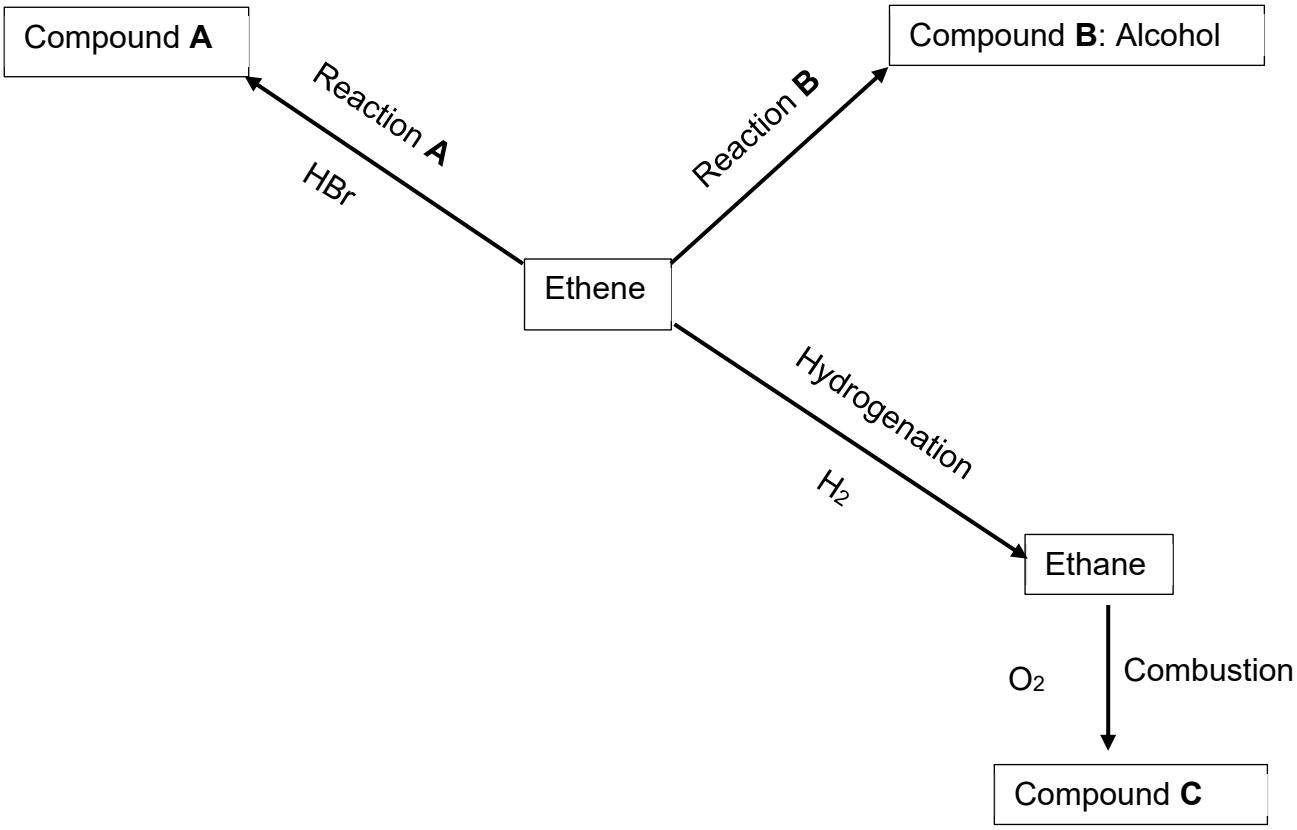
3.4 Which compound would have the highest vapour pressure? (1)

3.5 Explain your answer to QUESTION 3.4 above. (3)

[11]

QUESTION 4 (Start on a new page.)

The flow diagram below shows the interconversion between alcohols, alkenes and haloalkanes. The letters **A – C** represent addition or substitution.



4.1 What type of reaction is represented by reaction **B**? Write down only ADDITION or SUBSTITUTION. (1)

4.2 Write down the name of the inorganic substance needed for this reaction to form an alcohol. (1)

4.3 Use structural formula and write down the major product of compound **B.** (2)

4.4 Identify the type of reaction that is represented by reaction **A** if HBr is added to ethene. Write down the full reaction name. (1)

4.5 Give the IUPAC name of compound **A.** (2)

Hydrogenation is a chemical reaction where hydrogen is added to an alkene to form ethane. Ethane is considered a more efficient fuel source for fast growing and developing countries.

4.6 Write down a balanced chemical equation where ethane is burned in excess oxygen. Use molecular formula. (3)

[10]

QUESTION 5 (Start on a new page.)

Silicon is the most common semiconductor material used in solar cells, representing approximately 95% of the modules sold today. It is also the second most abundant material on earth (after oxygen) and the most common semiconductor used in computer chips.

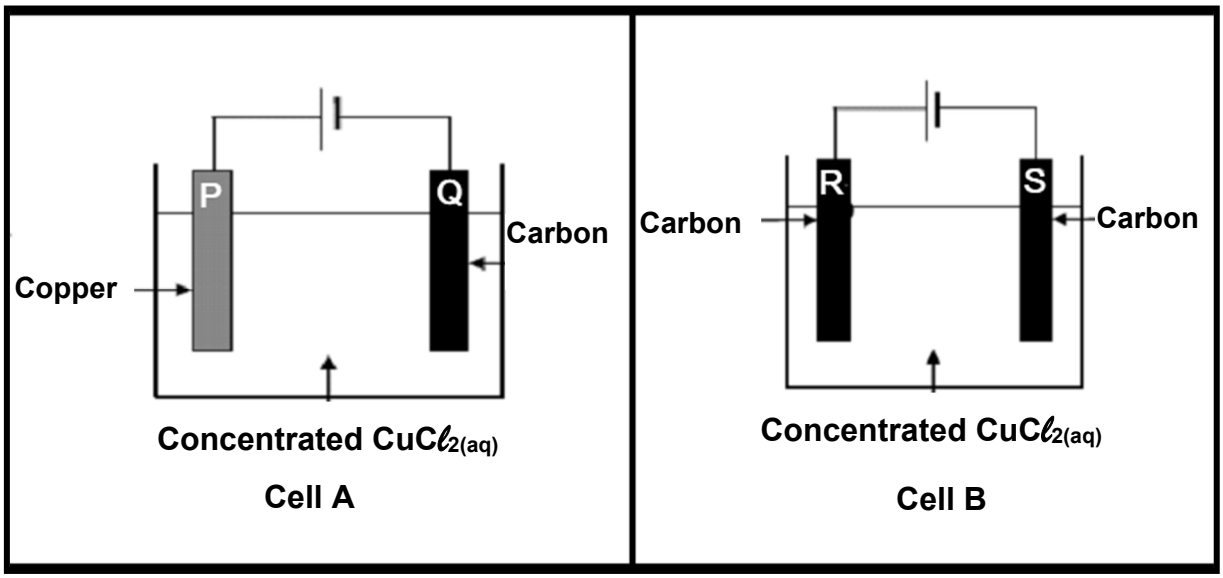
5.1 Define *intrinsic semiconductor.* (2)

5.2 Write down the name of the type of material of which an intrinsic semiconductor is made and that is found between the metals and non-metals on the periodic table. (1)

5.3 Draw the symbol of a p-n type diode. (2)
[5]

QUESTION 6 (Start on a new page.)

Two different cells, **A** and **B** are shown in the diagram below. Both Cell **A** and Cell **B** contain a concentrated solution of copper(II) chloride ($CuC\ell_2$). In Cell **A**, **P** is a copper electrode and **Q** is a carbon electrode**.** In cell **B**, both **R** and **S** are identical carbon electrodes.



6.1 Are the above electrochemical cells *electrolytic* or *galvanic*? (1)

6.2 Give a reason for your answer to QUESTION 6.1. (1)

6.3 Write down the name of the electrolytic process taking place at Cell **A.** (1)

6.4 Give a reason for your answer to QUESTION 6.3. (1)

6.5 Write down ONE importance of the electrolytic process mentioned in QUESTION 6.3. (1)

6.6 Write down the NAME or SYMBOL of an anion in the electrolyte in Cell **B**. (1)

6.7 Write down the chemical equation for the half-reaction taking place at electrode **Q**. (2)

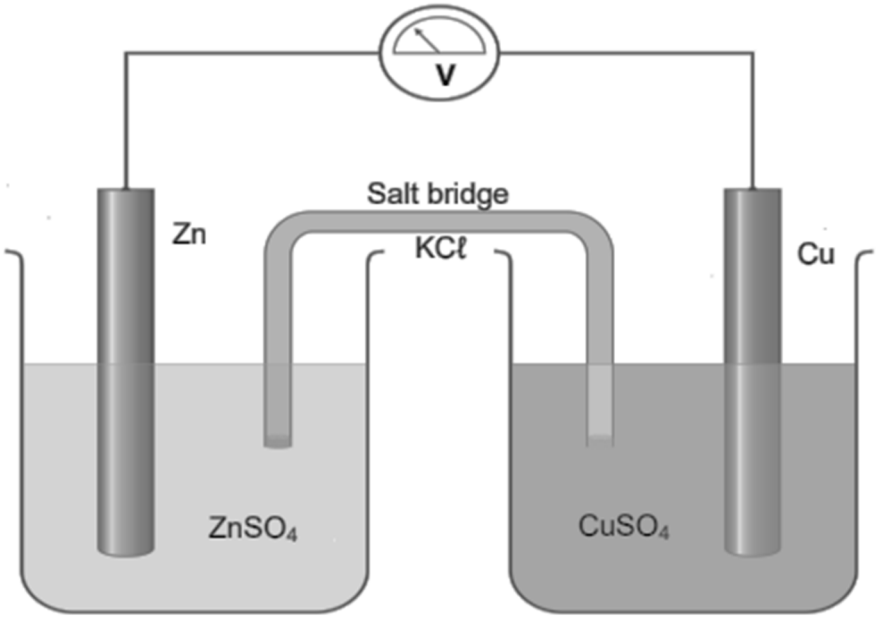
6.8 Write down the NAME or SYMBOL of the product formed at electrode **R**. (1)

6.9 What happens to the concentration of the electrolyte in Cell **B** when the cell is in operation? Write down INCREASES, DECREASES, or REMAINS THE SAME. Give a reason for your answer. (3)

[12]

QUESTION 7 (Start on a new page.)

Grade 12 learners performed an experiment to determine the electrode potential of a zinc-copper cell. They assembled the apparatus as shown in the diagram below. The experiment was performed at an initial concentration of 1 mol·dm^{-3} and a temperature of 25 ^{o}C.



7.1 Define *galvanic cell.* (2)

7.2 Give a reason why the standard condition of the pressure of 101,3 kPa is not applicable to the zinc-copper cell. (1)

7.3 Use a calculation to show that this electrochemical cell is spontaneous. (4)

7.4 Write down the overall (net) cell reaction for this cell. (3)

7.5 The voltmeter is now replaced with a 2V bulb. Will the bulb glow to its maximum brightness? Answer YES or NO and give a reason for your answer. (2)

[12]

TOTAL: 75

END

DATA FOR TECHNICAL SCIENCES GRADE 12/ *GEGEWENS VIR TEGNIESE WETENSKAPPE GRAAD 12* PAPER/*VRAESTEL* 2

TABLE/*TABEL* 1

PHYSICAL CONSTANTS/*FISIESE KONSTANTES*		
CONSTANT/*KONSTANTE*	**SYMBOL/*SIMBOOL***	**VALUE/*WAARDE***
Planck's constant *Planck se konstante*	h	$6{,}63 \times 10^{-34}$ J.s
Speed of light *Spoed van lig*	c	3×10^{8} m.s^{-1}

TABLE/*TABEL* 2

WAVES, SOUND AND LIGHT/*GOLWE, KLANK EN LIG*	
Speed/*Spoed*	$c = f\lambda$
Energy/*Energie*	$E = hf$ or/*of* $E = \frac{hc}{\lambda}$

TABLE/*TABEL* 3

ELECTROCHEMISTRY/*ELEKTROCHEMIE*	
Emf/*Emk*	$E^{\theta}_{cell} = E^{\theta}_{cathode} - E^{\theta}_{anode}$ / $E^{\theta}_{sel} = E^{\theta}_{katode} - E^{\theta}_{anode}$ or/*of* $E^{\theta}_{cell} = E^{\theta}_{reduction} - E^{\theta}_{oxidation}$ / $E^{\theta}_{sel} = E^{\theta}_{reduksie} - E^{\theta}_{oksidasie}$ or/*of* $E^{\theta}_{cell} = E^{\theta}_{oxidising\ agent} - E^{\theta}_{reducing\ agent}$ / $E^{\theta}_{sel} = E^{\theta}_{oksideermiddel} - E^{\theta}_{reduseermiddel}$

TABLE 4A: STANDARD REDUCTION POTENTIALS/ *TABEL 4A: STANDAARD-REDUKSIEPOTENSIALE*

Increasing oxidising ability/*Toenemende oksiderende vermoë* ↑

Half-reactions/*Halfreaksies*	E^{θ} (V)
$F_2(g) + 2e^- \rightleftharpoons 2F^-$	+ 2,87
$Co^{3+} + e^- \rightleftharpoons Co^{2+}$	+ 1,81
$H_2O_2 + 2H^+ + 2e^- \rightleftharpoons 2H_2O$	+1,77
$MnO_4^- + 8H^+ + 5e^- \rightleftharpoons Mn^{2+} + 4H_2O$	+ 1,51
$C\ell_2(g) + 2e^- \rightleftharpoons 2C\ell^-$	+ 1,36
$Cr_2O_7^{2-} + 14H^+ + 6e^- \rightleftharpoons 2Cr^{3+} + 7H_2O$	+ 1,33
$O_2(g) + 4H^+ + 4e^- \rightleftharpoons 2H_2O$	+ 1,23
$MnO_2 + 4H^+ + 2e^- \rightleftharpoons Mn^{2+} + 2H_2O$	+ 1,23
$Pt^{2+} + 2e^- \rightleftharpoons Pt$	+ 1,20
$Br_2(\ell) + 2e^- \rightleftharpoons 2Br^-$	+ 1,07
$NO_3^- + 4H^+ + 3e^- \rightleftharpoons NO(g) + 2H_2O$	+ 0,96
$Hg^{2+} + 2e^- \rightleftharpoons Hg(\ell)$	+ 0,85
$Ag^+ + e^- \rightleftharpoons Ag$	+ 0,80
$NO_3^- + 2H^+ + e^- \rightleftharpoons NO_2(g) + H_2O$	+ 0,80
$Fe^{3+} + e^- \rightleftharpoons Fe^{2+}$	+ 0,77
$O_2(g) + 2H^+ + 2e^- \rightleftharpoons H_2O_2$	+ 0,68
$I_2 + 2e^- \rightleftharpoons 2I^-$	+ 0,54
$Cu^+ + e^- \rightleftharpoons Cu$	+ 0,52
$SO_2 + 4H^+ + 4e^- \rightleftharpoons S + 2H_2O$	+ 0,45
$2H_2O + O_2 + 4e^- \rightleftharpoons 4OH^-$	+ 0,40
$Cu^{2+} + 2e^- \rightleftharpoons Cu$	+ 0,34
$SO_4^{2-} + 4H^+ + 2e^- \rightleftharpoons SO_2(g) + 2H_2O$	+ 0,17
$Cu^{2+} + e^- \rightleftharpoons Cu^+$	+ 0,16
$Sn^{4+} + 2e^- \rightleftharpoons Sn^{2+}$	+ 0,15
$S + 2H^+ + 2e^- \rightleftharpoons H_2S(g)$	+ 0,14
$2H^+ + 2e^- \rightleftharpoons H_2(g)$	**0,00**
$Fe^{3+} + 3e^- \rightleftharpoons Fe$	– 0,06
$Pb^{2+} + 2e^- \rightleftharpoons Pb$	– 0,13
$Sn^{2+} + 2e^- \rightleftharpoons Sn$	– 0,14
$Ni^{2+} + 2e^- \rightleftharpoons Ni$	– 0,27
$Co^{2+} + 2e^- \rightleftharpoons Co$	– 0,28
$Cd^{2+} + 2e^- \rightleftharpoons Cd$	– 0,40
$Cr^{3+} + e^- \rightleftharpoons Cr^{2+}$	– 0,41
$Fe^{2+} + 2e^- \rightleftharpoons Fe$	– 0,44
$Cr^{3+} + 3e^- \rightleftharpoons Cr$	– 0,74
$Zn^{2+} + 2e^- \rightleftharpoons Zn$	– 0,76
$2H_2O + 2e^- \rightleftharpoons H_2(g) + 2OH^-$	– 0,83
$Cr^{2+} + 2e^- \rightleftharpoons Cr$	– 0,91
$Mn^{2+} + 2e^- \rightleftharpoons Mn$	– 1,18
$A\ell^{3+} + 3e^- \rightleftharpoons A\ell$	– 1,66
$Mg^{2+} + 2e^- \rightleftharpoons Mg$	– 2,36
$Na^+ + e^- \rightleftharpoons Na$	– 2,71
$Ca^{2+} + 2e^- \rightleftharpoons Ca$	– 2,87
$Sr^{2+} + 2e^- \rightleftharpoons Sr$	– 2,89
$Ba^{2+} + 2e^- \rightleftharpoons Ba$	– 2,90
$Cs^+ + e^- \rightleftharpoons Cs$	- 2,92
$K^+ + e^- \rightleftharpoons K$	– 2,93
$Li^+ + e^- \rightleftharpoons Li$	– 3,05

Increasing reducing ability/*Toenemende reduserende vermoë* ↓

TABLE 4B: STANDARD REDUCTION POTENTIALS/ *TABEL 4B: 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

TABLE 5: THE PERIODIC TABLE OF ELEMENTS/*TABEL 5: DIE PERIODIEKE TABEL VAN ELEMENTE*

