Bergvliet High School

GRADE 11

Physical Science

Physics P2

November 2023

MARKS: 150

TIME: 3 hours

EXAMINER: S. van Harte

MODERATOR/S: Z. Booysen/ K. Stuck

This question paper consists of 11 pages and 3 data sheets.

Detach this sheet and attach it to the front of your answer sheets.

Name: _____ Teacher: Bn / Vh / Sk

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Question 1	Marker	**20**	Moderator	**Question 6**	Marker	**19**	Moderator
Question 2	Marker	**21**	Moderator	**Question 7**	Marker	**16**	Moderator
Question 3	Marker	**20**	Moderator				
Question 4	Marker	**29**	Moderator	**Total**	Marker	**150**	Moderator
Question 5	Marker	**25**	Moderator	**Percentage**	Marker	**100**	Moderator
Signature	Marker			**Signature**	Moderator		

INSTRUCTIONS

1. Write your **NAME** and science teacher code (**Bn/Vh/Sk**) in the appropriate space on the Cover Page and all scripts handed in.
2. The question paper consists 7 questions. Answer ALL the questions.
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 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. 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.
11. Give brief motivations, discussions, et cetera where required.
12. Write neatly and legibly.

Answer Sheet

Name: _____ **Teacher Code: Bn/Vh/Sk**

Question 1

Make a **cross (X)** in the appropriate box next to the relevant question number (1.1 – 1.10)

1.1	A	B	C	D
1.2	A	B	C	D
1.3	A	B	C	D
1.4	A	B	C	D
1.5	A	B	C	D
1.6	A	B	C	D
1.7	A	B	C	D
1.8	A	B	C	D
1.9	A	B	C	D
1.10	A	B	C	D
		Total		/20

QUESTION 1: MULTIPLE-CHOICE QUESTIONS

Four options are provided as possible answers to the following questions. Choose the answer and write only the letter (A–D) next to the question number (1.1–1.10), for example 1.10 E.

1.1 Use the VSEPR theory to predict the molecular geometry of CO_2.

A. Linear

B. Triangular pyramidal

C. Tetrahedral

D. Bent/Angular (2)

1.2 Which ONE of the following species contains a dative covalent bond?

A. H_3O^+

B. OH^-

C. H_2O

D. H_2O_2 (2)

1.3 Consider the forces between the molecules (represented by - - -) in the following liquids:

(i) H_2S - - - H_2S (ii) HF - - - HF (iii) CCl_4 - - - CCl_4

Place these forces in order of DECREASING strength.

A. (i), (ii), (iii)

B. (ii), (iii), (i)

C. (ii), (i), (iii)

D. (iii), (ii), (i) (2)

1.4 The intermolecular forces holding CO_2 molecules together are ...

A. ion-dipole forces.

B. Van der Waals forces.

C. covalent bonds.

D. hydrogen bonds. (2)

1.5 Which of the following represents 1 mole? The number of ...

A. atoms in 6,02 x 10^{23} g of sodium.

B. molecules in 22,4 dm^3 of water at STP.

C. protons in 1 g hydrogen gas.

D. molecules in 34 g of ammonium gas. (2)

1.6 Consider the following reaction.

$$2SO_3(g) \rightleftharpoons 2SO_2(g) \qquad \Delta H = 198\ kJ.mol^{-1}$$

Which one of the following statements is correct?

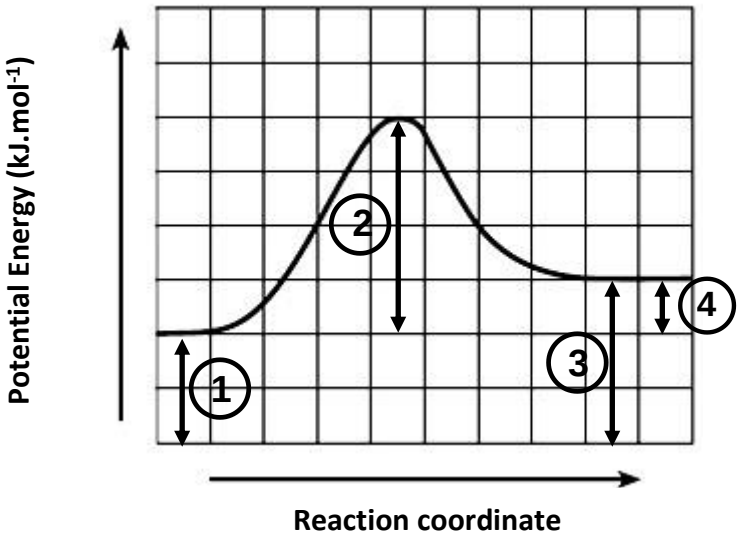
A. The reaction is exothermic.

B. The reaction container would feel warm.

C. 198 kJ of energy is given off as 2 g of SO_3 reacts.

D. 198 kJ of energy is required to produce 2 moles of SO_2. (2)

1.7 Given the potential energy diagram for a reversible chemical reaction:



Each interval (block) on the axis labelled "Potential Energy (kJ.mol^{-1})" represents 10 kJ.mol^{-1}. What is the activation energy of the forward reaction AND which numbered interval represent the reaction heat for the course of the reaction? (2)

	E_A *forward reaction*	ΔH *(numbered interval)*
A.	20 kJ.mol^{-1}	1
B.	40 kJ.mol^{-1}	2
C.	40 kJ.mol^{-1}	4
D.	60 kJ.mol^{-1}	4

1.8 Consider the following reaction:

$$HNO_3(aq) + NH_3(aq) \rightleftharpoons NO_3^-(aq) + NH_4^+(aq)$$

Which one of the following statements is true?

A. NH_3 accepts protons and is a Bronsted-Lowry acid.

B. HNO_3 accepts protons and is a Bronsted-Lowry acid.

C. NH_3 donates protons and is a Bronsted-Lowry acid.

D. HNO_3 donates protons and is a Bronsted-Lowry acid. (2)

1.9 Which substance can act as an ampholyte according to the Brønsted-Lowry definition?

A. H_3O^+

B. H_2O

C. NH_4^+

D. HCl (2)

1.10 What is the oxidation number of sulphur in $BaSO_4$?

A. +6

B. 0

C. +1

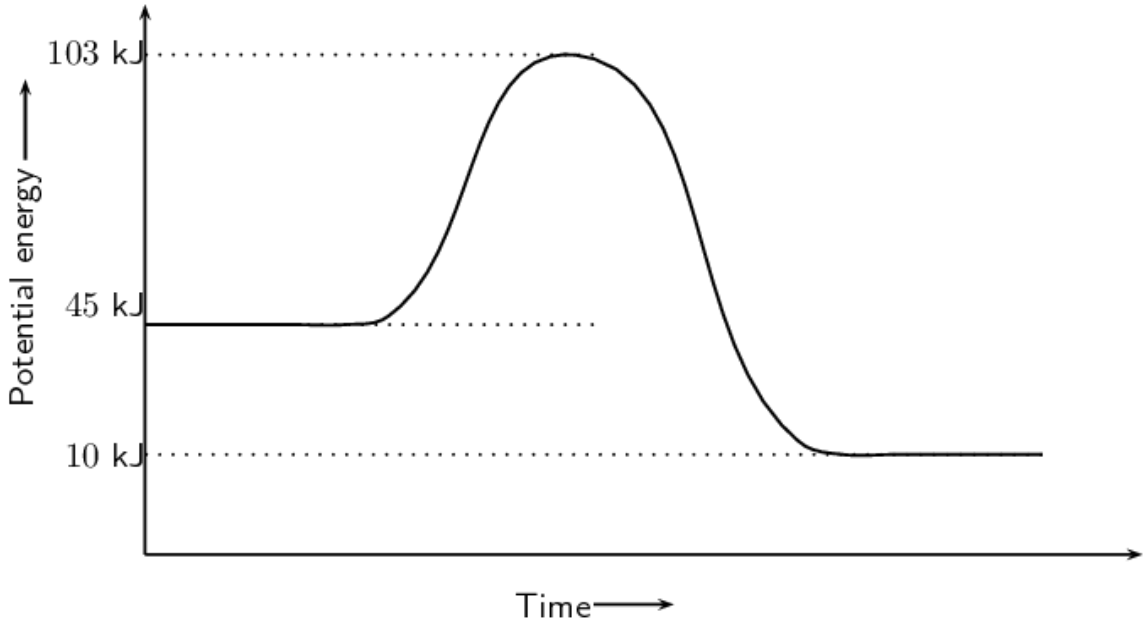
D. -2 (2)

[20]

QUESTION 2 (Start on a new page.)

The following graph shows the potential energy reaction:

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



2.1 Is the forward reaction endothermic or exothermic? Motivate you answer. (3)

2.2 Calculate ΔH for the forward reaction. (3)

2.3 Define the term *activation complex.* (2)

2.4 What is the energy of the activated complex? (1)

2.5 Define the term *activation energy.* (2)

2.6 A catalyst is now added to the reaction.

2.6.1 Explain what a catalyst does and why it is added to chemical reactions. (2)

2.6.2 How does the catalyst influence the reverse reaction? (2)

2.6.3 Does this affect the Heat of the reaction? Write only YES or NO. (1)

2.6.4 Redraw the graph to indicate the mechanism of how a catalyst will influence the reaction. (2)

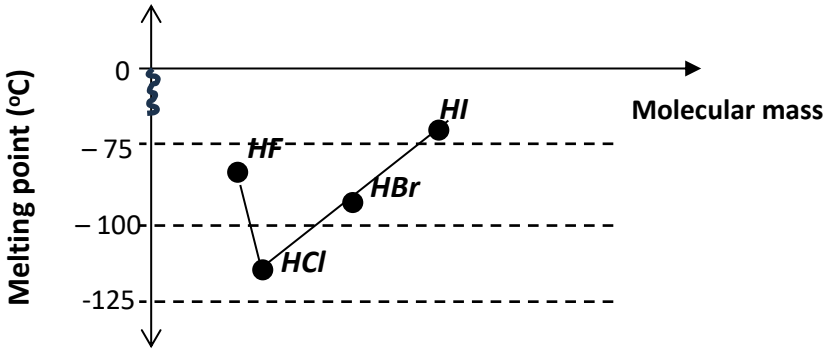
2.7 Draw the Lewis structure of ammonia. (2)

2.8 How many bonding pairs of electrons does an ammonia molecule possess? (1)

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QUESTION 3 (Start on a new page.)

Consider the following graph where the **melting points** of hydrogen halides are indicated.



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

3.2 Explain why HF has a higher melting point than HCl. (3)

3.3 Give a reason for the trend in increasing melting points from HCl down the group on the periodic table. (3)

In the table below the **boiling points** of four halogens are given.

Halogens	**A**	**B**	**C**	**D**
	F_2	Cl_2	Br_2	I_2
Boiling points (°C)	-188	-35	58.8	184

3.4 Which of the halogens in the table above has the ...

3.4.1 highest vapour pressure? (1)

3.4.2 Give a reason for your answer in 3.4.1, referring to the boiling point in the table above. (2)

3.4.3 strongest intermolecular forces? (1)

3.5 Looking at the molecules of HBr and Br_2 …

3.5.1 describe the term *intramolecular force*. (2)

3.5.2 compare these molecules according to their electronegativity difference and type of bond between the atoms of each molecule. (4)

3.5.3 what is their shape LINEAR or ANGULAR? (1)

3.5.4 which is stronger, intermolecular forces or intramolecular force? (1)

[20]

QUESTION 4 (Start on a new page.)

4.1 An oxide of sulphur contains 40% sulphur and 60% oxygen by mass.

4.1.1 Define the term *empirical formula.* (2)

4.1.2 Determine the empirical formula of this oxide of sulphur. (5)

4.2 The combustion of 50g of butane, C_4H_{10} (lighter fluid), with 50g of Oxygen produces CO_2 (g) and H_2O (g).

$$2C_4H_{10} + 13O_2 \rightarrow 8CO_2 + 10H_2O$$

4.2.1 Define the term *limiting reactant.* (2)

4.2.2 Identify the limiting reactant. (6)

4.2.3 Calculate how many grams of water is produced during this combustion. (5)

4.3 A 6g impure sample contains calcium carbonate, $CaCO_3$. When excess hydrochloric acid was added the sample, 1200 cm^3 of gas was produced (measured at STP).

The equation for the reaction is:

$$CaCO_3(s) + 2HCl(aq) \rightarrow CaCl_2(aq) + H_2O(l) + CO_2(g)$$

4.3.1 What does the abbreviation STP stand for in chemistry? (1)

4.3.2 Give the numerical value of one quantity represented by STP. (1)

4.3.3 Calculate the percentage purity of the calcium carbonate sample. (7)

[29]

QUESTION 5 (Start on a new page.)

5.1 Define an *acid* in terms of the Lowry-Bronsted theory. (2)

5.2 Based on the Lowry-Bronsted theory, write down the ionic formulas of the substances that are responsible for the characteristic properties of ACIDS and BASES. (2)

5.3 Hard water contains dissolved salts such as $Ca(HCO_3)_2$ or $Mg(HCO_3)_2$ and leads to the formation of lime scale (solid calcium carbonate) in kettles and cooking pots.

The lime scale may result from a reaction such as:

$$Ca(HCO_3)_2(aq) \rightarrow CaCO_3(s) + CO_2(g) + H_2O(l)$$

5.3.1 Name the type of reaction represented by the equation. Write only SYNTHESIS, DECOMPOSITION or ACID-BASE. (1)

5.3.2 A sample of hard water containing 0,002 mol.dm^{-3} $Ca(HCO_3)_2$ was heated. Upon heating it formed lime scale, $CaCO_3$.
Calculate the mass of lime scale which could be formed when 150 dm^3 of hard water is heated. (6)

5.4 A student places 25 mL of HCl(aq) of unknown concentration into a flask.
The solution is titrated with 0,150 mol.dm^{-3} KOH(aq) until the solution reaches its endpoint. The volume of KOH(aq) added is 18,5 mL.

5.4.1 Define an *acid* in terms of the Arrhenius theory. (2)

5.4.2 Write a balanced equation for the neutralization reaction that occurs during the titration. (2)

5.4.3 Identify the conjugate acid-base pairs in the reaction. (2)

5.4.4 Determine the concentration of the HCl(aq) solution, using the titration data. (4)

5.4.5 Before the solution was titrated, four drops of indicator was added. At the endpoint the solution turned faint pink. Which indicator was added? Write only METHYL ORANGE, PHENOLPHTHALIEN or BROMOTHYMOL BLUE. (1)

5.4.6 KOH is considered a *strong base*. Explain what this means. (2)

5.4.7 Describe one laboratory safety procedure that should be used if a drop of the KOH(aq) is spilled on the arm of the student. (1)

[25]

QUESTION 6 (Start on a new page.)

An oxidation-reduction reaction is represent by the following equation:

$$Al(s) + Cu^{2+}(aq) \rightarrow Al^{3+}(aq) + Cu(s)$$

6.1 Define the term *OXIDATION* in terms of oxidation numbers. (2)

6.2 Identify the substance that is oxidized. Give a reason for your answer. (2)

6.3 Which substance serves as the oxidising agent? (2)

6.4 Write down the oxidation and reduction half-reactions. (6)

6.5 How many electrons are donated by the reducing agent in this reaction? (2)

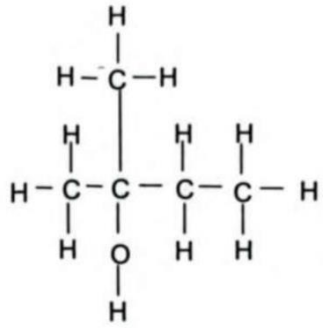
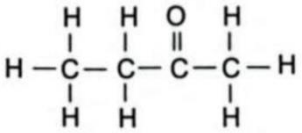
6.6 How many electrons will 3 mol of the oxidising agent gain in the same reaction? (2)

6.7 Silver, Ag, and Sodium, Na, react spontaneously. Write a balanced redox reaction by using half-reactions from the Table of Standard Reduction Potentials (Tables 4B). (3)

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QUESTION 7 (Start on a new page.)

The table below shows six organic molecules A to F

A. Pentane	B. CH_3-CH_2-OH
C. CH_3COOH	D. 
E. Methanal	F. 

7.1 Define the term *hydrocarbon*. (2)

7.2 Write down the:

7.2.1 Structural formula of compound **C** (2)

7.2.2 IUPAC name of compound **D** (3)

7.2.3 Homologous series to which **F** belongs (1)

7.2.4 Structural formula of **E** (2)

7.2.5 The general formula for compound **A**. (1)

7.3 Two types of alcohols are found in the table above. Which additional type of alcohol is absent from the provided table (PRIMARY, SECONDARY or TERTIARY), and explain the distinctive characteristics that differentiate it from the listed alcohols? (2)

7.4 Compound **B** reacts with another organic compound from the table to form an ester.

7.4.1 Write down the letter of the other organic compound that reacts with **B**. (1)

7.4.2 Write down the NAME of the ester that forms. (2)

[16]

TOTAL: 150

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(CHEMIE)
DATA FOR PHYSICAL SCIENCES GRADE 11
(CHEMISTRY)

TABLE 1: PHYSICAL CONSTANTS/TABEL 1: FISIESE KONSTANTES

NAME/*NAAM*	**SYMBOL/*SIMBOOL***	**VALUE/*WAARDE***
Avogadro's constant *Avogadro-konstante*	N_A	$6{,}02 \times 10^{23}\ mol^{-1}$
Charge on electron *Lading op elektron*	e	$-1{,}6 \times 10^{-19}\ C$
Electron mass *Elektronmassa*	m_e	$9{,}11 \times 10^{-31}\ kg$
Molar gas volume at STP *Molêre gasvolume by STD*	V_m	$22{,}4\ dm^3 \cdot mol^{-1}$
Standard pressure *Standaarddruk*	$p^\ominus$	$1{,}013 \times 10^5\ Pa$
Molar gas constant *Molêre gaskonstante*	R	$8{,}31\ J.K^{-1}.mol^{-1}$
Standard temperature *Standaardtemperatuur*	$T^\ominus$	273 K

TABLE 2: FORMULAE/TABEL 2: FORMULES

$n = \frac{m}{M}$	$c = \frac{n}{V}$ or/*of* $c = \frac{m}{MV}$	$n = \frac{V}{V_m}$	$n = \frac{N}{N_A}$

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

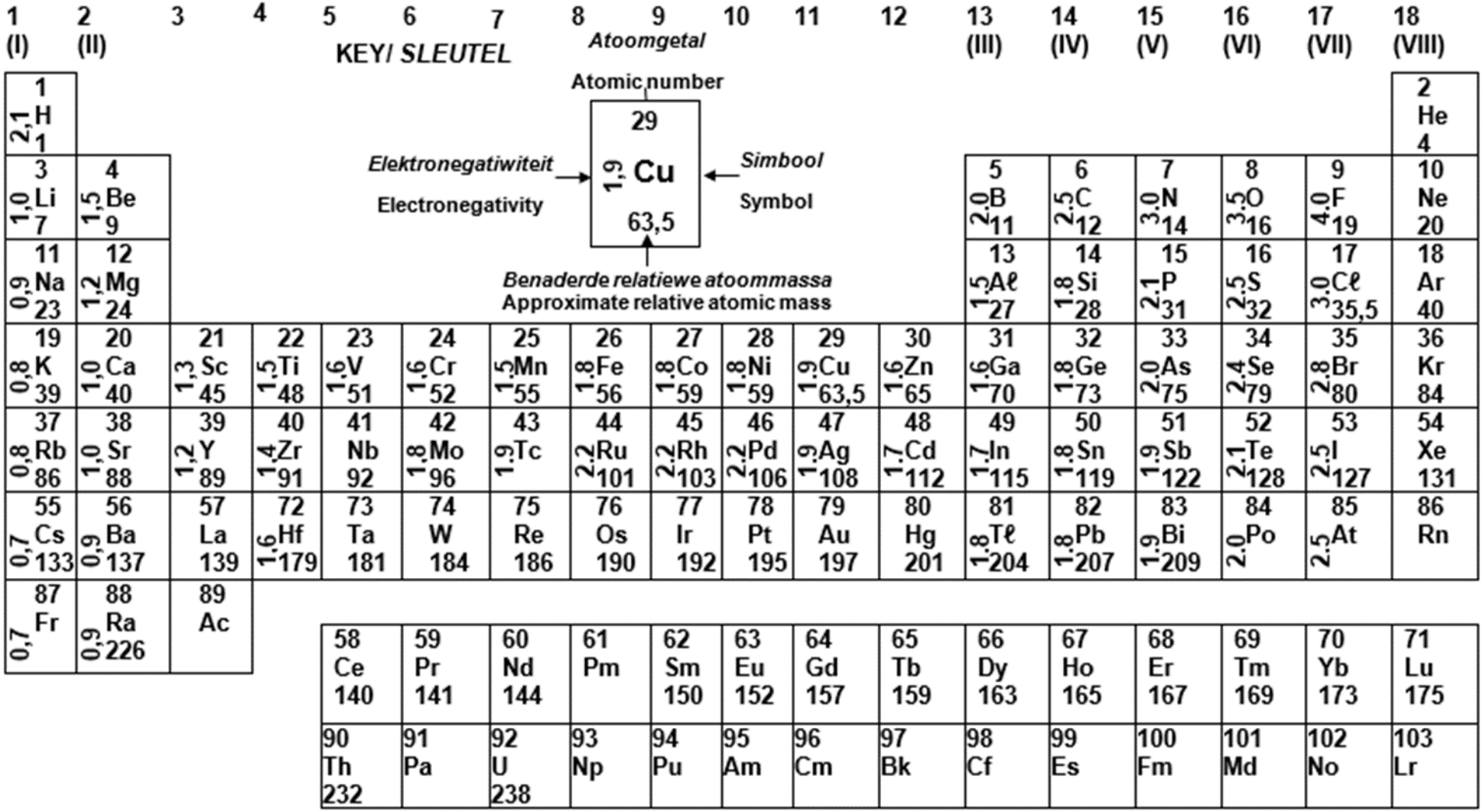


TABLE 4B: STANDARD REDUCTION POTENTIALS
TABEL 4B: STANDAARDREDUKSIEPOTENSIALE

Half-reactions			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
$\mathbf{2H^+ + 2e^-}$	⇌	$\mathbf{H_2(g)}$	**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 oxidising ability/*Toenemende oksiderende vermoë*

Increasing reducing ability/*Toenemende reduserende vermoë*