KWAZULU-NATAL PROVINCE

EDUCATION
REPUBLIC OF SOUTH AFRICA

NATIONAL SENIOR CERTIFICATE

PHYSICAL SCIENCES P2 (CHEMISTRY)

FINAL EXAMINATION

NOVEMBER 2025

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GRADE 11

MARKS: 150

TIME: 3 hours

This question paper consists of 12 pages and 4 data sheets.

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INSTRUCTIONS AND INFORMATION

1. This question paper consists of EIGHT questions. Answer ALL the questions in the ANSWER BOOK.
2. Start EACH question on a NEW page in the ANSWER BOOK.
3. Number the answers correctly according to the numbering system used in this question paper.
4. Leave ONE line between two sub-questions, for example between QUESTION 2.1 and QUESTION 2.2.
5. You may use a non-programmable 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.

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

1.1 The tendency of an atom to attract a bonded pair of electrons is known as …

A polarity.

B electron affinity.

C electronegativity.

D ionisation energy. (2)

1.2 Which ONE of the following atomic combinations will have the shortest bond length?

A C – C

B C – O

C C = C

D C ≡ C (2)

1.3 Which ONE of the following substances has a tetrahedral shape?

A CO_2

B SO_2

C HCN

D NH_4^+ (2)

1.4 In which ONE of the following are ION-DIPOLE forces present?

A NH_3 gas

B CO_2 gas

C LiCℓ aqueous solution

D $MgCl_2$ solid (2)

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1.5 One mole of a gas, SEALED in a container of volume **V**, exerts pressure **p.** The volume of the container is decreased to ⅓**V**, while the temperature remains constant. What is the pressure now exerted by the gas?

A ⅓ p

B 3 p

C p

D 1,5 p (2)

1.6 Consider the following statements about ideal gases:

(i) The gas particles occupy no volume.
(ii) There are no intermolecular forces between the particles
(iii) The collisions between the particles are perfectly elastic

Which of the above statements are true?

A (i) and (ii) only

B (i) and (iii) only

C (ii) and (iii) only

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

1.7 Which ONE of the following solutions will have the greatest concentration of H^+ ions?

A 2 mol·dm^{-3} NH_3

B 1,5 mol·dm^{-3} CH_3COOH

C 1,5 mol·dm^{-3} H_2SO_4

D 1,5 mol·dm^{-3} $HC\ell$ (2)

1.8 Consider the following reaction:

$$HNO_3\,(aq) + \mathbf{X} \rightarrow NO_3^-\,(aq) + HSO_4^-\,(aq)$$

In this reaction, **X** represents…

A SO_4^{2-} acting as a base

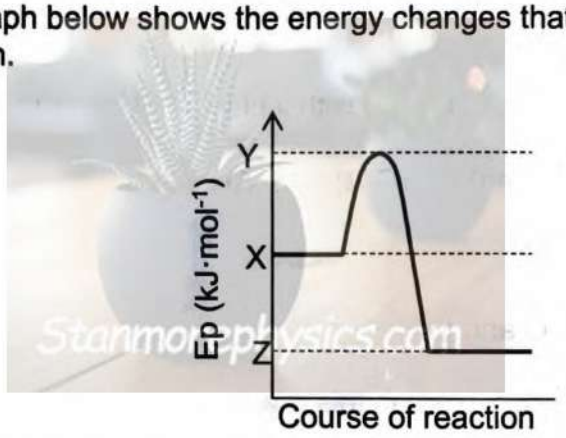
B SO_4^{2-} acting as an acid.

C H_2SO_4 acting as a base.

D H_2SO_4 acting as an acid. (2)

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1.9 The graph below shows the energy changes that take place during a chemical reaction.



Which ONE of the following expressions corresponds to the activation energy of the reverse reaction?

A Y - X

B Y

C X - Z

D Y - Z

(2)

1.10 Consider the following redox reaction:

$$10C\ell^- + 2MnO_4^- + 16H^+ \rightleftharpoons 2Mn^{2+} + 8H_2O + 5C\ell_2$$

A product of the reduction half reaction is …

A Mn^{2+}

B $C\ell^-$

C H^+

D $C\ell_2$

(2)

[2 x 10 = 20]

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QUESTION 2 (Start on a new page.)

Consider the following reaction of nitric acid (HNO_3) with lithium oxide (Li_2O).

$$2HNO_3\,(aq) + Li_2O\,(s) \rightarrow 2LiNO_3\,(aq) + H_2O\,(\ell) \qquad \Delta H = -139\ kJ\cdot mol^{-1}$$

2.1 Define the term *ionic bond*. (2)

2.2 Show that the bond between Li and O is ionic. (2)

2.3 Write down the name of the salt formed in this reaction. (1)

2.4 Consider the H_2O molecule.

2.4.1 Write down the valency of the O atom. (1)

2.4.2 Draw the Lewis structure for the H_2O molecule. (3)

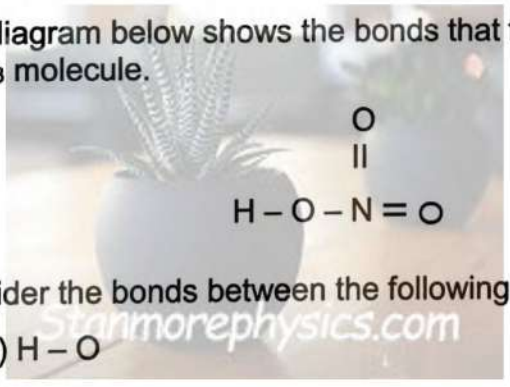
2.4.3 What is the shape of the H_2O molecule? (1)

2.4.4 NAME the ion that is formed when H_2O forms a dative covalent bond. (1)

2.5 The above reaction takes place in a beaker. How will the temperature of the contents of the beaker be affected? Choose from INCREASES, DECREASES or REMAINS THE SAME. Give a reason for the answer. (2)

2.6 Define *bond length*. (2)

2.7 The diagram below shows the bonds that form between the atoms in the HNO_3 molecule.



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Consider the bonds between the following atoms:

(a) H – O

(b) N – O

(c) N = O

2.7.1 Is the bond length larger in (a) or in (b)? Explain the answer. (3)

2.7.2 Is the bond energy greater in (b) or in (c)? Give a reason for the answer. (2)

[20]

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QUESTION 3 (Start on a new page.)

The following table provides the bond energies between atoms.

Bond	Energy ($kJ \cdot mol^{-1}$)
C≡C	839
C=O	804
O=O	498
C–C	348
O–O	145
H–O	463
C–O	358
H–C	413

Consider the following reaction:

$$CH_4\,(g) + 2O_2\,(g) \rightarrow CO_2\,(g) + 2H_2O\,(g)$$

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

3.2 Determine:

3.2.1 The activation energy for the reaction (3)

3.2.2 The heat of reaction in $kJ \cdot mol^{-1}$ (4)

3.3 How will the value calculated in QUESTION 3.2.2 be affected if a suitable catalyst is used? Choose from INCREASES, DECREASES or REMAINS THE SAME. Give a reason for the answer. (2)

3.4 24 g of CH_4 reacts completely with excess O_2 at STP.

3.4.1 Is there a NET ABSORPTION or a NET RELEASE of energy? (1)

3.4.2 Calculate the energy referred to in QUESTION 3.4.1. (3)

3.4.3 If 5,5 moles of gas is present when the reaction is complete, calculate the initial number of moles of O_2 (g) used in the reaction. (5)

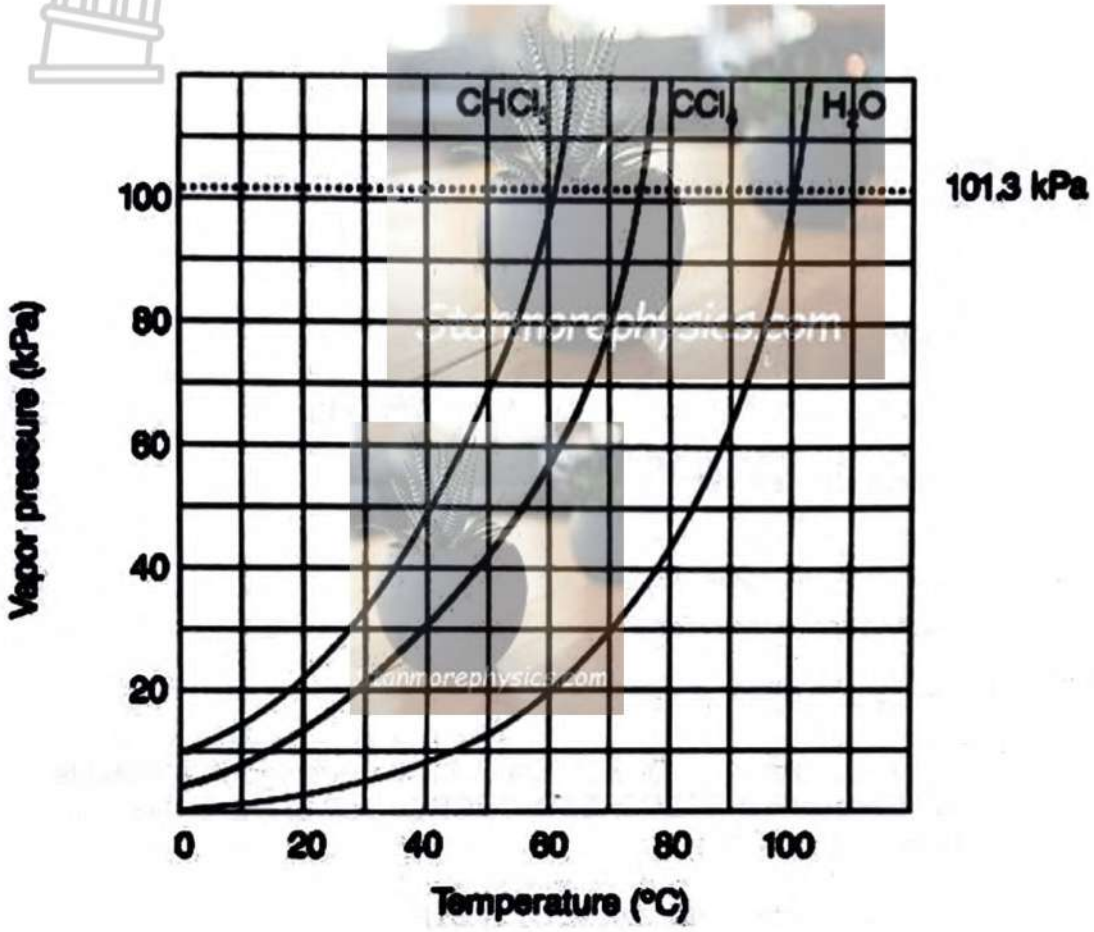
[20]

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QUESTION 4 (Start on a new page.)

The graphs below show the relationship between vapour pressure and temperature for $CHC\ell_3$, $CC\ell_4$ and H_2O respectively. Atmospheric pressure is 101,3 kPa.



4.1 Define the term *vapour pressure*. (2)

4.2 Write down the:

4.2.1 Vapour pressure of $CC\ell_4$ at 70°C (1)

4.2.2 Temperature at which the vapour pressure of $CHC\ell_3$ is 100 kPa (1)

4.2.3 Phase of $CHC\ell_3$ at 65°C (1)

4.2.4 Boiling point of $CC\ell_4$ (2)

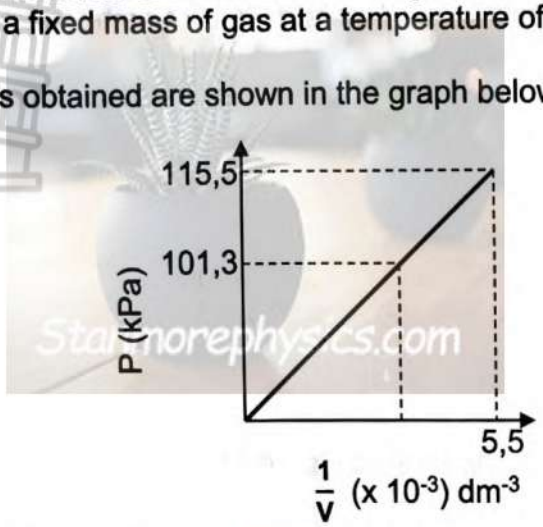
4.3 Fully explain the difference in the boiling points of $CC\ell_4$ and H_2O. (4)

4.4 Is $CC\ell_4$ soluble in H_2O? Choose from YES or NO.
Give a reason for the answer. (3)
[14]

QUESTION 5 (Start on a new page.)

An experiment was conducted to investigate the relationship between pressure and volume of a fixed mass of gas at a temperature of 273 K.

The results obtained are shown in the graph below.



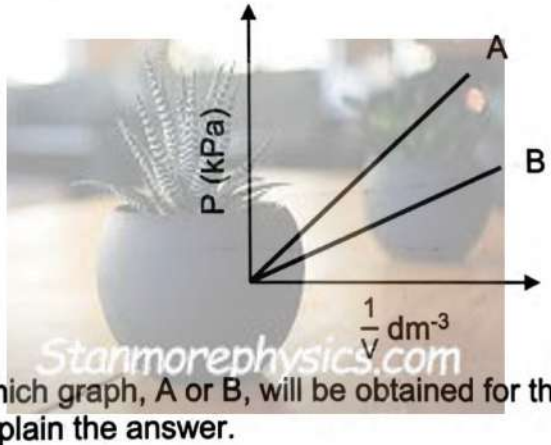
5.1 Named and state the law that was investigated. (3)

5.2 Calculate the volume of the gas when the pressure exerted by the gas is 101,3 kPa. (4)

5.3 Do real gases deviate from ideal gases at LOW pressures or HIGH pressures? Explain the answer. (3)

5.4 Draw a sketch graph of pressure (y-axis) vs volume (x-axis) for this experiment. No values or labels are required on the axes. (2)

The experiment is repeated using a greater mass of gas at 273 K. The results obtained are plotted on the same system of axes.



5.5 Which graph, A or B, will be obtained for the greater mass? Explain the answer. (3)

[15]

QUESTION 6 (Start on a new page.)

6.1 A 1,50 g sample of a compound containing carbon, hydrogen and oxygen was completely burned in air. The products formed were 1,74 g of carbon dioxide and 0,70 g of water.

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

6.1.2 Determine, by calculation, the empirical formula of the compound. (7)

6.1.3 If the ratio of empirical formula to molecular formula is 1:3, determine the molecular formula of the compound (2)

6.2 An iron ore (impure sample) contains 30% Fe_2O_3.

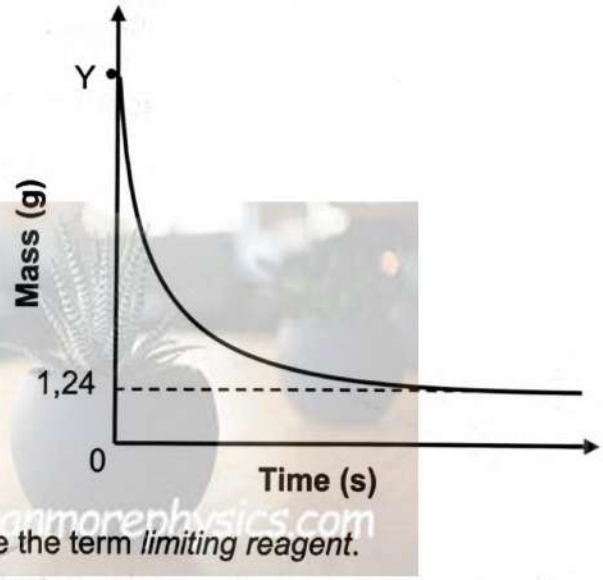
6.2.1 Write down the oxidation number of iron in Fe_2O_3 (1)

6.2.1 Calculate the mass of Fe that can be obtained from 150 g of this ore. (4)

6.3 In an experiment, a learner reacts 1,51 dm^3 of sulphuric acid, H_2SO_4, of concentration 0,43 $mol \cdot dm^{-3}$ with solid lithium. The balanced equation for the reaction is:

$$H_2SO_4 + 2Li \rightarrow Li_2SO_4 + H_2$$

The graph below shows how the mass of lithium changes with time during the reaction:



6.3.1 Define the term *limiting reagent*. (2)

6.3.2 Identify the limiting reagent in this reaction. Give a reason for the answer. (2)

6.3.3 Calculate the value of Y as shown in the graph. (7)

[27]

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QUESTION 7 (Start on a new page.)

7.1 Acetic acid (CH_3COOH) ionises in water according to the following balanced equation:

$$CH_3COOH(\ell) + H_2O(\ell) \rightleftharpoons H_3O^+(aq) + CH_3COO^-(aq)$$

7.1.1 Define an *acid* according to the Arrhenius theory (2)

7.1.2 Write down the FORMULAE of TWO acids in this reaction. (2)

7.1.2 Is acetic acid a STRONG acid or a WEAK acid? Give a reason for the answer. (2)

7.2 A nitric acid solution, $HNO_3(aq)$, has a concentration of 0,15 $mol \cdot dm^{-3}$. In a reaction, 31,3 cm^3 of the HNO_3 solution neutralises 24,5 cm^3 of a calcium hydroxide solution, $Ca(OH)_2(aq)$, according to the following balanced equation:

$$2HNO_3(aq) + Ca(OH)_2(aq) \rightarrow Ca(NO_3)_2(aq) + 2H_2O(\ell)$$

7.2.1 Calculate the concentration of the $Ca(OH)_2$ solution. (5)

250 cm^3 of the Nitric acid HNO_3 solution, with the same concentration of 0,15 $mol \cdot dm^{-3}$ is now reacted with pure Zn.

$$Zn(s) + 2HNO_3(aq) \rightarrow Zn(NO_3)_2(aq) + H_2(g)$$

The pH of the final solution is 2,174.
Assume that the volume of the solution does not change.

7.2.2 Calculate the mass of Zn that reacted. (8)

7.2.3 Determine the volume that the hydrogen gas produced will occupy at 25^0C.
Take molar gas volume as $24000 cm^3 \cdot mol^{-1}$ at 25^0C (3)
[22]

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QUESTION 8 (Start on a new page.)

8.1 A solution of iron (II) nitrate reacts with Aℓ (s) according to the following unbalanced ionic equation:

$$A\ell\ (s) + Fe^{2+}\ (aq) \rightleftharpoons A\ell^{3+}\ (aq) + Fe\ (s)$$

8.1.1 Define the term *redox reaction.* **(2)**

8.1.2 Identify the reducing agent in the above reaction. **(1)**

8.1.3 Give a reason why the nitrate ion, NO_3^-, is a spectator ion in the reaction. **(1)**

8.1.4 Give a reason why the reaction is unbalanced. **(2)**

8.2 The incomplete ionic reaction between dichromate ions ,$Cr_2O_7^{2-}$, and tin (II) ions, Sn^{2+}, in an acid medium is given below.

$$Cr_2O_7^{2-} + Sn^{2+} + H^+ \rightarrow Cr^{3+} + Sn^{4+}$$

8.2.1 Write down the oxidation number of Cr in the $Cr_2O_7^{2-}$ ion. **(1)**

8.2.2 Write down the reduction half-reaction. **(2)**

8.2.3 Using the Table of Standard Reduction Potentials, write down the balanced net ionic equation. **(3)**
[12]

TOTAL:150

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DATA FOR PHYSICAL SCIENCES GRADE 11
PAPER 2 (CHEMISTRY)
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VRAESTEL 2 (CHEMIE)

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

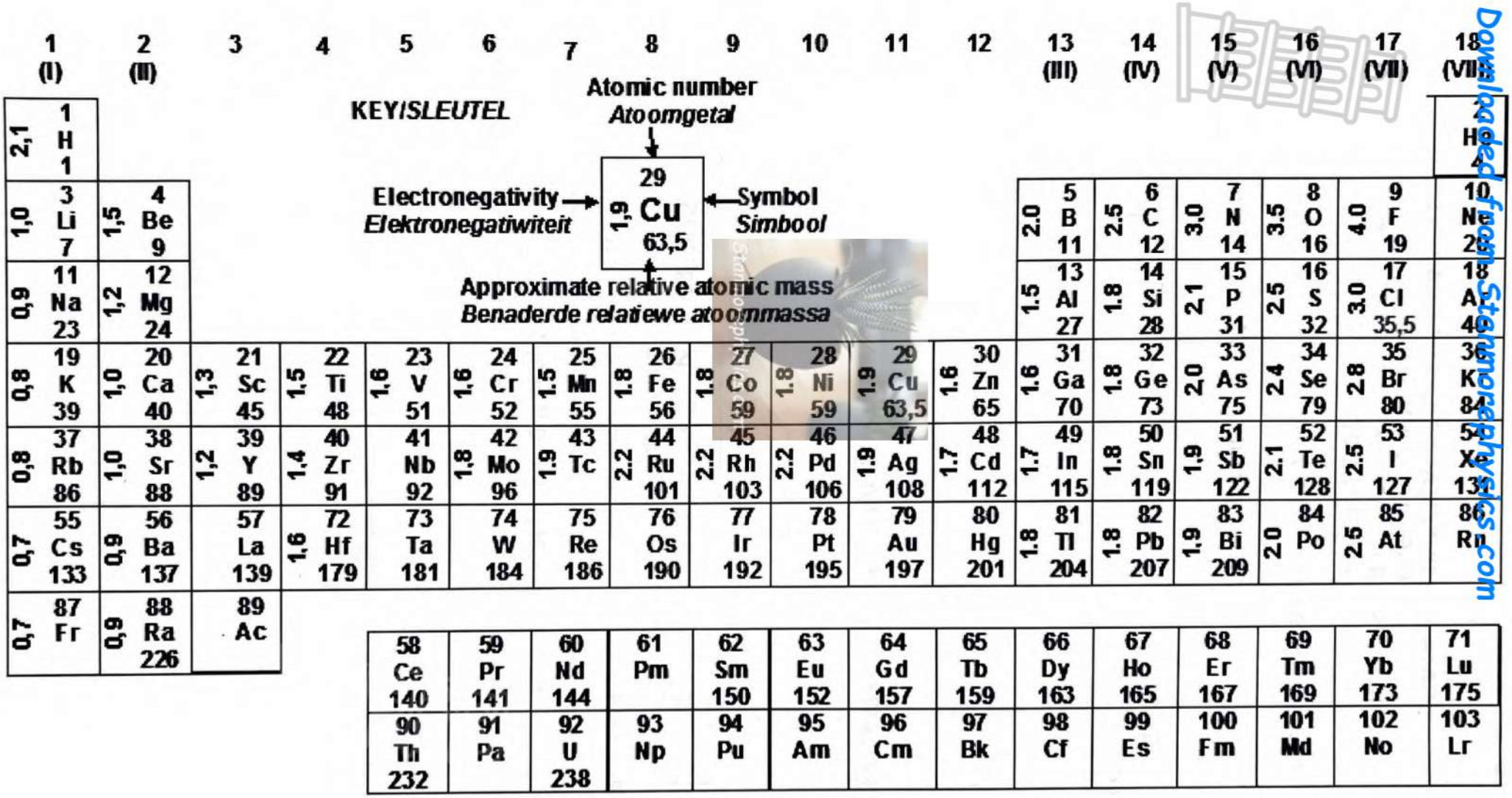
NAME/*NAAM*	SYMBOL/*SIMBOOL*	VALUE/*WAARDE*
Standard pressure *Standaarddruk*	p^{θ}	$1{,}013 \times 10^5$ Pa
Molar gas volume at STP *Molêre gasvolume by STD*	V_m	22,4 $dm^3 \cdot mol^{-1}$
Standard temperature *Standaardtemperatuur*	T^{θ}	273 K
Charge on electron *Lading op elektron*	e	$1{,}6 \times 10^{-19}$ C
Avogadro's constant *Avogadro-konstante*	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/*of* $c = \frac{m}{MV}$	$n = \frac{V}{V_m}$
$\frac{c_a v_a}{c_b v_b} = \frac{n_a}{n_b}$		$pH = -\log[H_3O^+]$
$P_1V_1 = P_2V_2$		$PV = nRT$
$K_w = [H_3O^+][OH^-] = 1 \times 10^{-14}$ at/*by* 298 K		

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

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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

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TABLE 4B: STANDARD REDUCTION POTENTIALS
TABEL 4B: STANDAARD-REDUKSIEPOTENSIALE

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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

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