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education

Department:
Education
North West Provincial Government
REPUBLIC OF SOUTH AFRICA

PROVINCIAL ASSESSMENT

GRADE 11

PHYSICAL SCIENCES P2
NOVEMBER 2024

Marks: 150

Time: 3 hours

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

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INSTRUCTIONS AND INFORMATION:

1. Write your name on the ANSWER BOOK provided.
2. This question paper consists of NINE questions. Answer ALL 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 2.1 and QUESTION 2.2.
6. You may use a non-programmable calculator.
7. You are advised to use the attached DATA SHEETS.
8. Show ALL formulae and substitutions in ALL calculations.
9. Round off your FINAL numerical answers to a minimum of TWO decimal places.
10. Give brief motivations, discussions, et cetera where required.
11. Write neatly and legibly.

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QUESTION 1: MULTIPLE CHOICE QUESTIONS

Various 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 numbers (1.1 to 1.10) in the ANSWER BOOK, e.g. 1.11 B.

1.1 The type of bond which occurs when two atoms share one or more electron pairs will always be ...

A ionic.

B polar.

C metallic.

D covalent. (2)

1.2 The molecular shape of NH_3 is ...

A linear.

B trigonal planar.

C angular.

D trigonal pyramidal. (2)

1.3 Which ONE of the following chlorides will most likely have the most ionic character?

A $LiC\ell$

B $CsC\ell$

C $BeC\ell_2$

D $CaC\ell_2$ (2)

1.4 A solution of calcium chloride ($CaC\ell_2$) is added to bromine (Br_2) water. The force of attraction that exists between $CaC\ell_2$ particles and Br_2 is called a(n) … interaction.

A ion-dipole

B ion-induced dipole

C dipole induced dipole

D dipole-dipole (2)

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1.5 How many moles of copper (II) oxide are there in 52,8 g of the substance?

A 0,369 mole

B 0,664 mole

C 1,51 mole

D 2,71 mole (2)

1.6 The boiling point of CH_4 is much lower than that of HF. Which ONE of the following best explains this difference in boiling points?

A HF molecules are more polar than CH_4 molecules.

B CH_4 molecules are more polar than HF molecules.

C There are London forces between CH_4 molecules.

D There are dipole-dipole forces between CH_4 molecules. (2)

1.7 A fixed amount of gas occupies a volume **V** exerts a pressure **P** at a constant temperature. If the volume is doubled, the new pressure of the gas will be ...

A $^1/_4$ **P**

B $^1/_2$ **P**

C **P**

D 4 **P** (2)

1.8 Consider the incomplete chemical equation below.

$$\mathbf{X} + 2HNO_3 \rightarrow Zn(NO_3)_2 + H_2O + CO_2$$

Which ONE of the following is represented by **X** in the above equation?

A $ZnCO_3$

B $ZnHCO_3$

C $ZnCO_2$

D $Zn(OH)_2$ (2)

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1.9 Which ONE of the following statements is TRUE for an EXOTHERMIC reaction?

A More energy is released than absorbed.

B More energy is absorbed than released.

C Heat of reaction (ΔH) is positive.

D Energy of the products is greater than the energy of the reactants. (2)

1.10 Consider the reaction represented by the balanced ionic equation below.

$$Cr_2O_7^{2-}(aq) + 14H^+(aq) + 3S^{2-}(aq) \rightarrow 2Cr^{3+}(aq) + 3S(s) + H_2O(\ell)$$

Which ONE of statements below is true when this reaction takes place.

A The oxidation number of sulphur does not change.

B S^{2-} is reduced by the $Cr_2O_7^{2-}(aq)$.

C $H^+(aq)$ oxidises the $S^{2-}(aq)$.

D $S^{2-}(aq)$ is oxidised by the $Cr_2O_7^{2-}(aq)$. (2)
[20]

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QUESTION 2 (Start on a new page.)

A chemical bond is defined as a mutual attraction between two atoms resulting from the simultaneous attraction between their nuclei and the outer electrons. Answer the following questions in terms of chemical bonding.

2.1 Define the term *electronegativity*. (2)

2.2 Show by means of electronegativity what type of bond will be formed between the elements in each of the following substances.

2.2.1 LiF (2)

2.2.2 $C\ell_2$ (2)

2.3 Consider the following molecules and answer the questions that follow:

CO_2 , C_2H_2 and CH_4

2.3.1 Define the term *valence electrons*. (2)

2.3.2 How many valence electrons does carbon have. (1)

Draw the Lewis structure for the following molecules:

2.3.3 CO_2 (2)

2.3.4 CH_4 (2)

2.4 Write down the molecular shape of the following molecules.

2.4.1 CO_2 (1)

2.4.2 CH_4 (1)

2.5 The bond length between the carbon atoms in C_2H_4 and C_2H_6 are compared.

2.5.1 Define the term *bond length.* (2)

2.5.2 Fully explain why the bond length of the bond between the carbon atoms in C_2H_4 is shorter than that in C_2H_6. (3)

2.5.3 What is the relationship between the bond length and bond energy. (2)

2.5.4 How will the bond energy of the bond between the carbon atoms in C_2H_4 compare to that in C_2H_6?

Choose from SMALLER THAN, GREATER THAN or EQUAL TO. (1)

2.6 Explain the difference between a polar molecule and a non-polar molecule, using the compounds $CHCl_3$ and CCl_4 as examples. (4)

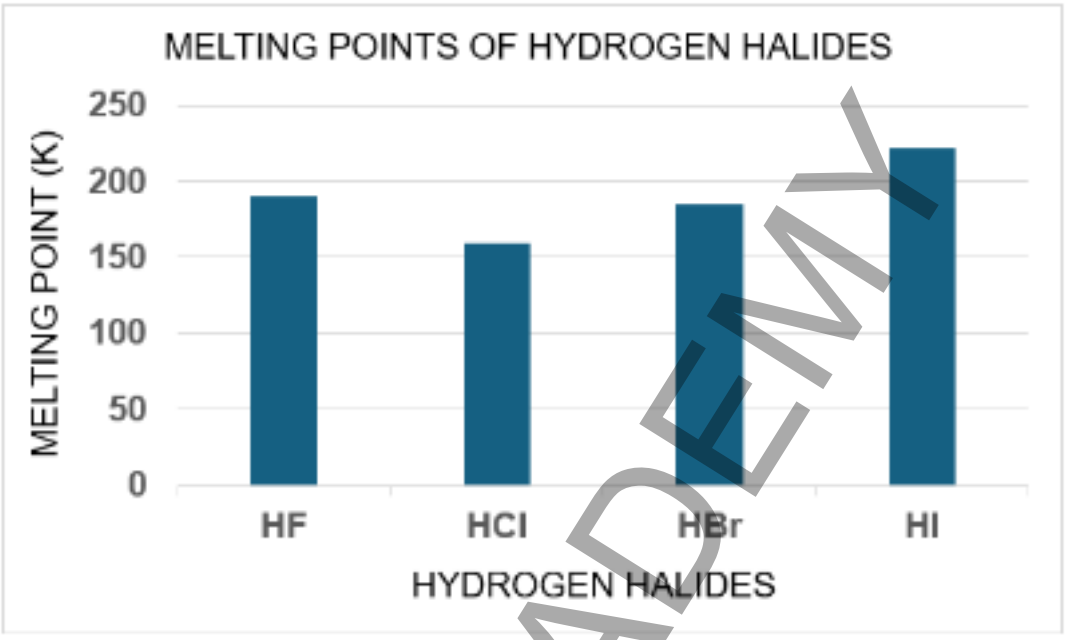
[27]

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QUESTION 3 (Start on a new page.)

During an investigation, the MELTING POINTS of the hydrogen halides were determined. The results of the investigation are shown in the graph below.



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

3.2 The melting points of HBr and HCℓ are compared.

3.2.1 What is the relationship between strength of the intermolecular forces and melting point? (2)

3.2.2 Explain the difference in the melting points of HBr and HCℓ by referring to the MOLECULAR MASS, STRENGTH OF INTERMOLECULAR FORCES and ENERGY. (3)

3.3 Which ONE of the hydrogen halides in the graph above has the lowest vapour pressure. (1)

3.4 Explain in terms of INTERMOLECULAR FORCES why solid iodine (I_2) does not dissolve in water. (2)

[10]

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QUESTION 4 (Start on a new page.)

The relationship between pressure and the volume of an enclosed gas at 30 °C is investigated, by varying the pressure on the gas and then observing the corresponding volume occupied by the gas in each case.

The results obtained are shown in the table below.

p (kPa)	V (cm^3)
128,5	35
180	25
220	**V**
330	20

4.1 STATE the gas law being investigated. (2)

4.2 For this investigation write down the:

4.2.1 Independent variable. (1)

4.2.2 TWO controlled variables. (2)

4.3 Calculate the value represented by the letter **V** in the table. (3)

4.4 Hydrogen and helium are very close to ideal gases.

4.4.1 Write down TWO properties of an ideal gas. (2)

4.4.2 Write down the TWO conditions under which real gases behave more like an ideal gas. (2)

4.5 Explain, in terms of the kinetic molecular theory, the effect that an increase in the temperature of a gas will have on its pressure at constant volume. (2)
[14]

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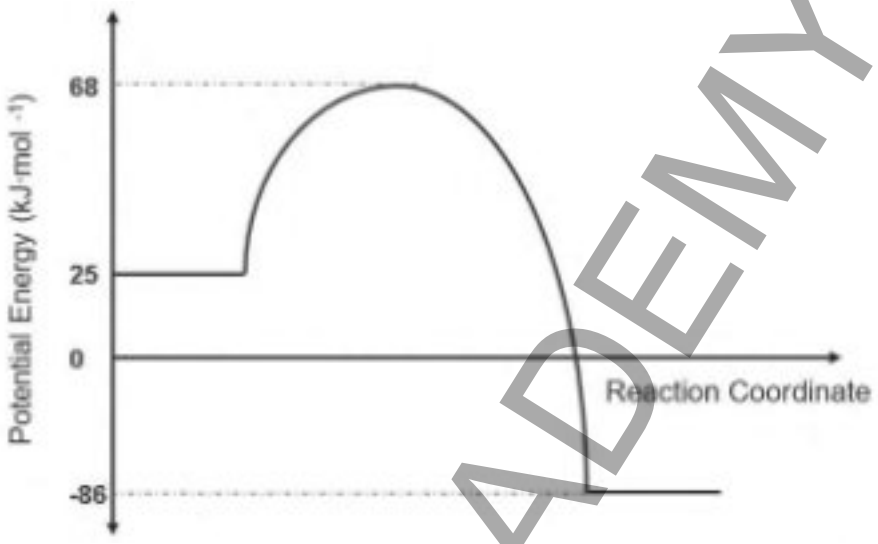
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QUESTION 5 (Start on a new page.)

One of the steps in the preparation of sulphuric acid in the industry is represented by the following reaction:

$$2SO_2(g) + O_2(g) \rightarrow 2SO_3(g)$$

The graph below shows the energy change during this reaction.



5.1 Write down the type of reaction represented by above graph. Choose from EXOTHERMIC or ENDOTHERMIC. Explain your answer. (2)

5.2 Calculate the change in enthalpy for this reaction. (2)

Vanadium pentoxide is added as a catalyst in the above reaction.

5.3 How will the addition of the catalyst affect the following? Write down only INCREASES, DECREASES or REMAIN THE SAME.

5.3.1 Activation energy. (1)

5.3.2 Heat of reaction. (1)

5.4 At 68 kJ·mol^{-1} an activated complex is formed.

5.4.1 Define the term *activated complex*. (2)

5.4.2 Write down the activation energy for the reverse reaction. (2)

5.5 Calculate the volume of SO_3 gas formed in the container when 50 cm^3 of SO_2 reacts completely with oxygen. (2)

[12]

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QUESTION 6 (Start on a new page.)

Nicotine, an alkaloid in the nightshade family of plants that is mainly responsible for the addictive nature of cigarettes, contains 74,02 % C, 8,71 % H and 17,27 % N.

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

6.2 Determine the empirical formula of nicotine. (5)

It was found experimentally that 40,57 g of nicotine contains 0,25 mol nicotine.

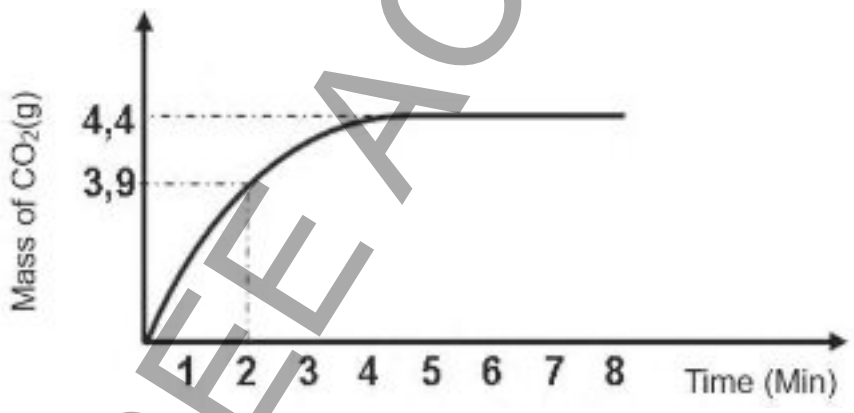
6.3 Determine the molecular formula of nicotine? (5)
[12]

QUESTION 7 (Start on a new page.)

A 12 g sample of IMPURE solid calcium carbonate, $CaCO_3$, reacted with 150 cm^3 of a 2 $mol \cdot dm^{-3}$ excess hydrochloric acid, $HC\ell$, according to the following balanced equation:

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

The graph below shows how the mass of CO_2 changes with time at STP.



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

7.2 Write down the NAME or FORMULA of the limiting reagent in the above reaction. (1)

7.3 Calculate the:

7.3.1 Maximum volume of CO_2 produced. (4)

7.3.2 Percentage purity of calcium carbonate. (6)

7.3.3 Moles of $HC\ell$ in excess. (5)
[18]

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QUESTION 8 (Start on a new page.)

8.1 Define a Brønsted-Lowry base. (2)

8.2 Calculate the pH of a 0,1 mol·dm^{-3} of HCℓ (3)

8.3 Write down the FORMULA for the conjugate base of HCℓ. (1)

8.4 Why is HSO_4^- regarded as an ampholyte? (2)

8.5 Write down a balanced chemical equation for the reaction of HSO_4^- with water to form the hydronium ion. (3)

8.6 A solution of potassium hydroxide(KOH) is prepared by dissolving 7,9 g of potassium hydroxide in 250 cm^3 of distilled water.

8.6.1 Calculate the concentration of potassium hydroxide solution. (3)

During titration 25 cm^3 of the above solution is neutralised by 40 cm^3 of a DILUTE sulphuric acid solution according to the balanced equation:

$$H_2SO_4(aq) + 2KOH(aq) \rightarrow K_2SO_4(aq) + 2H_2O$$

8.6.2 Calculate the concentration of the DILUTE acid. (4)

The DILUTE acid in QUESTION 8.6.2 was prepared by adding 10 cm^3 of CONCENTRATED acid to 490 cm^3 distilled water.

8.6.3 Calculate the concentration of the CONCENTRATED acid. (4)
[22]

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QUESTION 9 (Start on a new page.)

A mixture containing Aluminium and Manganese oxide was heated to initiate the following redox reaction:

$$2A\ell + 3MnO \rightarrow A\ell_2O_3 + 3Mn$$

9.1 Define the term *reduction* in terms of oxidation numbers. (2)

9.2 Write down the oxidation numbers of the following substances:

9.2.1 Mn in MnO (1)

9.2.2 $A\ell$ in $A\ell_2O_3$ (1)

9.3 Identify an oxidising agent in the above-mentioned reaction. Explain your answer by referring to oxidation numbers. (3)

9.4 Consider the following reaction:

$$H^+ + Cu + NO_3^- \rightarrow H_2O + Cu^{2+} + NO$$

Write down the:

9.4.1 Oxidation half reaction. (2)

9.4.2 Reduction half reaction. (2)

9.4.3 Balanced net ionic equation. (4)
[15]

TOTAL: 150

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DATA FOR PHYSICAL SCIENCES GRADE 11

PAPER 2 (CHEMISTRY)

TABLE 1: PHYSICAL CONSTANTS

NAME	SYMBOL	VALUE
Standard pressure	p^{θ}	$1{,}013 \times 10^5$ Pa
Molar gas volume at STP	V_m	$22{,}4$ dm^3·mol^{-1}
Standard temperature	T^{θ}	273 K
Charge on electron	e	$-1{,}6 \times 10^{-19}$ C
Avogadro's constant	N_A	$6{,}02 \times 10^{23}$ mol^{-1}

TABLE 2: FORMULAE

$n = \frac{m}{M}$ or $n = \frac{N}{N_A}$ or $n = \frac{V}{V_m}$	$c = \frac{n}{V}$ or $c = \frac{m}{MV}$ $\frac{c_a V_a}{c_b V_b} = \frac{n_a}{n_b}$	$pH = -\log[H_3O^+]$ $K_w = [H_3O^+][OH^-] = 1 \times 10^{-14}$ at 298K

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TABLE 4A: STANDARD REDUCTION POTENTIALS

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 oxidising ability/*Toenemende oksiderende vermoë*

Increasing reducing ability/*Toenemende reduserende vermoë*

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TABLE 4B: STANDARD REDUCTION POTENTIALS

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

Increasing oxidising ability/*Toenemende oksiderende vermoë*

Increasing reducing ability/*Toenemende reduserende vermoë*

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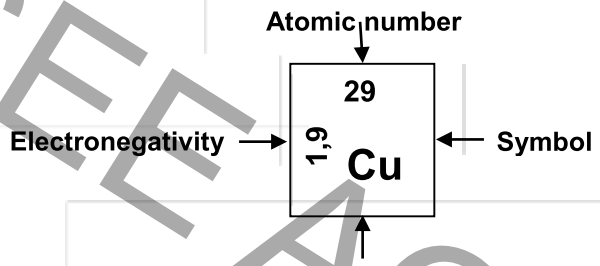
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THE PERIODIC TABLE OF ELEMENTS

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)
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

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