

# NATIONAL

# SENIOR CERTIFICATE

**GRADE 12**

**PHYSICAL SCIENCES: CHEMISTRY (P2)**

**MAY/JUNE 2017**

**MARKS: 150**

**DURATION: 3 hours**

**This question paper consists of 13 pages, 4 data sheets and 1 answer sheet.**

**INSTRUCTIONS AND INFORMATION**

1. Write your name in the appropriate space on your ANSWER BOOK.

2. 2.1 Answer QUESTION 1 on the attached ANSWER SHEET.

2.2 Write your class and name in the spaces on the ANSWER SHEET. Hand in the ANSWER SHEET with your ANSWER BOOK.

1. This question paper consists of NINE questions. Answer QUESTION 2 to 9in 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 subquestions, for example between

QUESTION 2.1 and QUESTION 2.2.

1. You may use a non-programmable calculator.
2. You may use appropriate mathematical instruments.
3. You are advised to use the attached DATA SHEETS.
4. Show ALL formulae and substitutions in ALL calculations.
5. Round off your final numerical answers to a minimum of TWO decimal places.
6. Give brief motivations, discussions, et cetera where required.
7. Write neatly and legibly.

**QUESTION 1: MULTIPLE-CHOICE QUESTIONS**

Various options are provided as possible answers to the following questions.

Write down the question number (1.1–1.10) on the ANSWER SHEET attached to the question paper, choose the answer and make a cross (X) over the letter (A–D) of your choice.

EXAMPLE:

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| *1.1.9 1.11* | **A** | **B** | **C** | **D** |

* 1. To which homologous series does the molecule, C4H8O2 belong?

A Aldehyde

B Alcohol

C Ester

D Ketone (2)

1.2 Consider the following compound:

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
|  | Br | CH3 | H |  |
| H | C | C | C | H |
|  | H | CH3 | H |  |

 The IUPAC name for this compound is …

 A 1-bromo-2,2-dimethylpropane

 B 3-bromo-2,2-dimethylpropane

 C 2,2-dimethyl-1-bromopropane

 D 2,2-dimethyl- 3-bromopropane (2)

1.3 An example of a saturated hydrocarbon is …

A ethene

B propyne

C but-1-ene

D methylpropane (2)

1.4 A simple reaction scheme is shown below:

HBr

 CH3CH=CH2 X reflux with Y + HBr

 NaOH (aq)

 The formula for Y is …

 A CH3CH2COOH

 B CH3CHOHCH3

 C CH3CHBrCH2OH

 D CH3CHOHCH2Br (2)

1.5 A solid K reacts with a solution L in a flask to form products which remain in solution. Which ONE of the following changes will probably

 have NO effect on the rate of reaction?

 A Crushing the solid K into a fine powder.

 B Increasing the concentration of solution L.

 C Reducing the pressure on the reaction mixture.

 D Adding a suitable catalyst to the reaction mixture. (2)

1.6 The Kc for a certain reaction is 0,0023. This small Kc value indicates that …

 A equilibrium should be achieved at a slow rate.

 B at equilibrium there will be a larger yield of products.

 C at equilibrium the rate of the forward reaction will be smaller than the rate of the reverse reaction.

 D the concentration of the reactants at equilibrium is greater

 than the concentration of the products. (2)

1.7 Consider the hypothetical reaction that reached equilibrium in a

 closed container at 450° C:

 XY (s) ⇌ X(g) + Y(s) ΔH$>0$

 Which ONE of the following changes will NOT affect the equilibrium position?

 A Increase in temperature

 B Increase in the amount of Y (s)

 C Decrease in pressure at constant volume

 D Increase in the volume of the container (2)

1.8 In the titration of ethanoic acid (CH3COOH) and sodium hydroxide (NaOH)

 the pH at the end point is 8,72. The most suitable indicator for this titration

 will be …

 A methyl orange

 B phenolphthalein

 C bromothymol blue

 D universal indicator (2)

1.9 Which ONE of the following is a conjugate acid-base pair in the following

 reaction?

 CH3COOH + NH3→ CH3COO-  + NH4+

|  |  |  |
| --- | --- | --- |
|  | **Acid** | **Conjugate base** |
| A | NH3 | NH4+ |
| B | CH3COO- | NH4+ |
| C | CH3COOH | NH3 |
| D | CH3COOH | CH3COO- |

1.10 N2O4(g) is placed in an evacuated, sealed container.

 The following reaction takes place in the container at constant temperature:

 N2O4(g) ⇌ 2NO2(g)

 The concentration of the product is measured over time.

 Which ONE of the following graphs correctly illustrates the relationship

 between the nitrogen dioxide (NO2) concentration and time?

**A B**

**[NO2]**

**[NO2]**

**Time (s)**

**Time (s)**

 **C D**

**Time (s)**

**[NO2]**

**[NO2]**

**Time (s)**

**QUESTION 2 (Start on a new page.)**

Study the following organic compounds, represented by the letters **A** to **F** in the table below:

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **A**

|  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | **H** | **H** | **H** | **H** | **H** | **H** | **H** | **H** |  |
|  |  |  |  |  |  |  |  |  |  |
|  |  |  |  |  |  |  |  |  |  |
| **H** | C | C | C | C | C | C | C | C | **H** |
|  |  |  |  |  |  |  |  |  |  |
|  |  |  |  |  |  |  |  |  |  |
|  | **H** | **H** | **H** | **H** | **H** | **H** | **H** | **H** |  |

 | **B**

|  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | **CH2CH3** |  | **H** |  | **CH2** |  | **H** |  |  |
|  |  |  |  |  |  |  |  |  |  |
| **H** | **C** |  | **C** |  | **C** |  | **C** |  | **H** |
|  |  |  |  |  |  |  |  |  |  |
|  | **H** |  | **H** |  | **H** |  | **H** |  |  |

 |
| C C3H7Cl | D Propanoic acid |
| E Polyethene | F CnH2nO2 |

Use the information in the table to answer the following questions:

2.1 Write down the LETTER of the compound that:

 2.1.1 has a carboxyl group (1)

 2.1.2 is used to make plastic (1)

2.2 Write down the …

 2.2.1 IUPAC name of compound **B** (3)

 2.2.2 STRUCTURAL FORMULA of the monomer of compound **E** (2)

2.3 Compound A is an alkane.

 Write down the …

 2.3.1 GENERAL FORMULA for alkanes. (2)

 2.3.2 MOLECULA FORMULAE of each of the two products obtained

 during the complete combustion of compound **A**. (2)

2.4 Compound **C** is a primary haloalkane.

 2.4.1 Write down the STRUCTURAL FORMULA and IUPAC name of a STRUCTURAL ISOMER of compound **C**. (4)

 2.4.2 Classify the isomer I QUESTION 2.4.1 as CHAIN, POSITIONAL or FUNCTIONAL. (1)

2.5 Chemical analysis of compound **F** shows that it has the following composition:

 X % of carbon(C), Y % of hydrogen (H) and 12,5 % of oxygen (O).

 By means of a calculation, determine the VALUE of X. (4)

 **[20]**

**QUESTION 3 (Start on a new page.)**

3.1 The flow diagram shows how two compounds can be formed from

 the compound of 2-bromopentane.

   NaOH (concentrated)

2-bromopentane

**A**

Pentan-2-ol

 **Reaction 1**

 **Reaction 2** **Reaction 3**

 H2SO4(concentrated)

**Reaction 1** takes place in the presence of concentrated sodium hydroxide.

Write down:

 3.1.1 An additional reaction condition for this reaction. (1)

 3.1.2 The type of reaction that occurs in **Reaction 1**. (1)

 3.1.3 The STRUCTURAL FORMULA of compound **A**. (2)

**Reaction 2** takes place in the presence of a certain inorganic compound.

Write down:

 3.1.4 The NAME of the inorganic compound. (1)

 3.1.5 The type of reaction that occurs in **Reaction 2**. (1)

**Reaction 3** occurs in the presence of concentrated sulphuric acid and heat.

 3.1.6 Write down the type of reaction that converts pentan-2-ol to

 Compound **A.** (1)

3.2 A learner is preparing an ester using ethanol (C2H6O) and ethanoic acid (C2H4O2).The balanced chemical equation is given below:

 C2H6O + C2H4O2→C4H8O2 + H2O

 Write down the:

 3.2.1 Type of the reaction represented in the above equation? (1)

 3.2.2 IUPAC name of the ester formed. (2)

3.3 When 70g of methanol fully reacts with excess ethanoic acid, it provides

 80,64g C3H6O2. Calculate the % purity of the ethanol. (5)

 **[15]**

**QUESTION 4 (Start on a new page.)**

The boiling points of compounds **A**, **B**, **C**, **D** and **E** are determined under the same conditions:

The table below shows the results during a practical investigation.

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
|  | **Name** | **Formula** | **Molecular mass(g·mol-1)** | **Boiling point (°C)** |
| A | Pentan-1-ol | CH3(CH2)4OH | 88 | 138 |
| B | Pentanal | CH3(CH2)3CHO | 88 | 103 |
| C | Butanoic acid | CH3(CH2)2CO2H | 88 | 164 |
| D | Ethyl ethanoate | CH3CO2C2H5 | 88 | 77 |
| E | Hexane | CH3(CH2)4CH3 | 88 | 69 |

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

4.2 Provide an investigative question for this experiment. (2)

4.3 For this experiment give the:

 4.3.1 Independent variable (1)

 4.3.2 Dependent variable (1)

4.4 Why must the molecular mass of each compound be kept the same

 during this experiment? (2)

4.5 How do the boiling points of compounds **A** and **C** compare? Explain,

 referring to MOLECULAR STRUCTURE, STRENGTH of Intermolecular

 forces and the ENERGY involved. (4)

 **[12]**

**QUESTION 5 (Start on a new page.)**

Consider the reaction represented by the equation below.

 CO2(g) + 2H2O(ℓ) → CH4(g) + 2O2(g)

During the reaction the temperature of the reaction mixture decreases.

5.1 Define the term *enthalpy change*. (2)

5.2 Is the enthalpy change for this reaction positive or negative? Explain the answer by referring to the energy involved. (2)

5.3 Sketch a labelled potential energy graph for this reaction. On the graph,

 show the position of the reactants, products, ΔH and the activation energy. (6)

 **[10]**

**QUESTION 6 (Start on a new page.)**

A catalyst speeds up the rate of a reaction. This behaviour of a catalyst can be explained in terms of the activation energy and the collision theory.

The diagram below shows the Maxwell-Boltzmann distribution curve for a certain reaction.

**Activation energy**

**Number of particles with enough energy to react**

**Energy**

**Number of particles**

6.1 State ANY two reaction conditions in which particles must collide in terms of collision theory. (2)

6.2 Explain, using collision theory and activation energy, how a catalyst

 Influences the rate of a reaction. (4)

6.3 Redraw the above distribution curve into the answer book and show the

 new activation energy when a catalyst is added to the reaction mixture

 on the diagram. (2)

 **[08]**

**QUESTION 7**

The grade 12 learners have to plan an experiment to investigate the reaction rate

of the following chemical reaction.

The initial mass of the beaker and HCℓ was 250g. An excess of dilute HCℓ is used to dissolve pieces of CuCO3.

The balanced equation for this reaction is as follows:

 CuCO3(s) + 2HCℓ(aq) →CuCℓ2(aq) + H2O(ℓ) + CO2(g)

The table below shows the results of the investigation.

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| **Total mass of beaker with contents(g)** | 300 | 260 | 230 | 210 | 200 | 200 |
| **Time(s)** | 0 | 10 | 20 | 30 | 40 | 50 |

7.1 State TWO ways in which the rate of the reaction above can be increased. (2)

7.2 Determine the mass of CO2 that was formed. (2)

7.3 Why did the mass of the beaker with HCℓ and CuCO3 decrease during the

 first 40 s? (2)

7.4 Did the reaction reach completion? Explain your answer. (4)

7.5 Calculate the average reaction rate over the first 40 s. (3)

7.6 Use the data to draw a graph (curve A) of the mass of the beaker with its contents (beaker + HCℓ + CuCO3) against time. On the same system of

 axes, draw the second graph (curve B) that will be obtained if CuCO3 powder, instead of pieces, is used. (5)

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**QUESTION 8 (Start on a new page.)**

The reaction between hydrogen chloride and oxygen reaches equilibrium in a closed container according to the following balanced chemical equation:

 4 HCℓ(aq) + O2(g) ⇌ 2H2O(g) + 2Cℓ2(g) ΔH = -113kJ

8.1

 8.1.1 Explain the term *closed system*. (2)

 8.1.2 Is this reaction exothermic or endothermic? Give a reason for the answer. (2)

8.2 The graph below, not drawn to scale, show how the amounts of reactants present in the container change with time at a specific temperature. The volume of the container is 5dm3.

 **1,0**

**t1**

**t2**

**t3**

**Time (minutes)**

**Amount (mol)**

**HCℓ(aqq**)

**O2(g)**

 **0,3**

 **0,1**

 8.2.1 How does the rate of the forward reaction at time t1 compare to

 that at time t2? Write down GREATER THAN, SMALLER THAN or EQUAL TO. Use the graphs to give a reason for the answer. (2)

 8.2.2 Calculate the equilibrium constant (Kc) for this reaction at this temperature. (9)

8.3 The pressure is NOW increased. How will this change affect the value of

 the equilibrium constant?

 Write down INCREASES, DECREASES or REMAINS THE SAME. Explain the answer. (3)

8.4 How will each of the following changes affect the equilibrium concentration

 of Cℓ2(g)? Write down INCREASES, DECREASES or REMAINS THE SAME.

 8.4.1 Water vapour is added into the container. (1)

 8.4.2 A catalyst is added. (1)

 8.4.3 The volume of the container is increased. (1)

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**QUESTION 9 (Start on a new page.)**

9.1 Carbonic acid (H2CO3) which is a weak acid reacts with sodium hydroxide (NaOH) which is a strong base to form sodium carbonate and compound X.

 9.1.1 Define the term *strong base*. (2)

 9.1.2 Write down the NAME of compound **X**. (1)

 9.1.3 Will the solution formed during this reaction be ACIDIC, BASIC or

 NEUTRAL? Write a relevant equation to support your answer. (3)

9.2 A learner determines the pH of a number of solutions at 25 °C. He obtained the following results:

|  |  |  |  |
| --- | --- | --- | --- |
| **SOLUTION** | A | B | C |
| **pH** | 1,5 | 4,2 | 12 |

 9.2.1 Which of the solutions **A**, **B** or **C** contains the highest concentration

 of hydrogen ions? (1)

 9.2.2 How will the pH of solution **A** change when: (only write INCREASES, DECREASES or STAYS THE SAME)

1. more of solution **A** of the same concentration is added to it? (1)
2. some of solution **C** is added to it. (1)

 9.2.3 Calculate the concentration of solution **B**. (5)

9.3 The hydrogen carbonate ion in sodium hydrogen carbonate can act as both acid and base. It reacts with water according to the balanced chemical equation:

 HCO3-(aq)+ H2O(ℓ) → H2CO3(aq) + OH-(aq)

 9.3.1 Write down ONE WORD or TERM for the underlined phrase. (2)

 9.3.2 Write down the FORMULA of the conjugate acid of HCO3-(aq. (2)

9.4 During a titration, 25 cm3 of a 0,1mol·dm-3 sulphuric acid solution is

 titrated with 0,25mol·dm-3 sodium hydroxide solution. The equation for the

 reaction is:

 H2SO4(aq) + 2NaOH(aq) → Na2SO4(aq) +2H2O(ℓ)

Calculate the volume of the sodium hydroxide solution used. (5)

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 **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* |  | 1,013 x 105 Pa |
| Molar gas volume at STP*Molêregasvolume by STD* | Vm | 22,4 dm3∙mol-1 |
| Standard temperature*Standaardtemperatuur* |  | 273 K |
| Charge on electron*Lading op elektron* | e | -1,6 x 10-19 C |
| Avogadro's constant*Avogadro-konstante* | NA | 6,02 x 1023 mol-1 |

**TABLE 2: FORMULAE/*TABEL 2: FORMULES***

|  |  |
| --- | --- |
|  |  |
|  or/*of* |  |
|  | pH = -log[H3O+] |
| Kw = [H3O+][OH-] = 1 x 10-14 at/*by* 298 K |
|  /or/*of*/or/*of* / |

**TABLE 3: THE PERIODIC TABLE OF ELEMENTS**

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **1****(I)** | **2****(II)** | **3** | **4****29****Cu** **63,5****1,9****Symbol** ***Simbool*****Electronegativity*****Elektronegatiwiteit*****Approximate relative atomic mass*****Benaderde relatiewe atoommassa*****Atomic number*****Atoomgetal*****KEY/*SLEUTEL*** | **5** | **6** | **7** | **8** | **9** | **10** | **11** | **12** | **13****(III)** | **14****(IV)** | **15****(V)** | **16****(VI)** | **17****(VII)** | **18****(VIII)** |
| **2,1** | **1****H****1** |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  | **2****He****4** |
| **1,0** | **3****Li****7** | **1,5** | **4****Be****9** |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  | **2,0** | **5****B****11** | **2,5** | **6****C****12** | **3,0** | **7****N****14** | **3,5** | **8****O****16** | **4,0** | **9****F****19** |  | **10****Ne****20** |
| **0,9** | **11****Na****23** | **1,2** | **12****Mg****24** |  |  |  |  |  |  |  |  |  |  | **1,5** | **13****Aℓ****27** | **1,8** | **14****Si****28** | **2,1** | **15****P****31** | **2,5** | **16****S****32** | **3,0** | **17****Cℓ****35,5** |  | **18****Ar****40** |
| **0,8** | **19****K****39** | **1,0** | **20****Ca****40** | **1,3** | **21****Sc****45** | **1,5** | **22****Ti****48** | **1,6** | **23****V****51** | **1,6** | **24****Cr****52** | **1,5** | **25****Mn****55** | **1,8** | **26****Fe****56** | **1,8** | **27****Co****59** | **1,8** | **28****Ni****59** | **1,9** | **29****Cu****63,5** | **1,6** | **30****Zn****65** | **1,6** | **31****Ga****70** | **1,8** | **32****Ge****73** | **2,0** | **33****As****75** | **2,4** | **34****Se****79** | **2,8** | **35****Br****80** |  | **36****Kr****84** |
| **0,8** | **37****Rb****86** | **1,0** | **38****Sr****88** | **1,2** | **39****Y****89** | **1,4** | **40****Zr****91** |  | **41****Nb****92** | **1,8** | **42****Mo****96** | **1,9** | **43****Tc** | **2,2** | **44****Ru****101** | **2,2** | **45****Rh****103** | **2,2** | **46****Pd****106** | **1,9** | **47****Ag****108** | **1,7** | **48****Cd****112** | **1,7** | **49****In****115** | **1,8** | **50****Sn****119** | **1,9** | **51****Sb****122** | **2,1** | **52****Te****128** | **2,5** | **53****I****127** |  | **54****Xe****131** |
| **0,7** | **55****Cs****133** | **0,9** | **56****Ba****137** |  | **57****La****139** | **1,6** | **72****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** | **81****Tℓ****204** | **1,8** | **82****Pb****207** | **1,9** | **83****Bi****209** | **2,0** | **84****Po** | **2,5** | **85****At** |  | **86****Rn** |
| **0,7** | **87****Fr** | **0,9** | **88****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** |

***TABEL 3: DIE PERIODIEKE TABEL VAN ELEMENTE***

**TABLE 4A: STANDARD REDUCTION POTENTIALS**

***TABEL 4A: STANDAARDREDUKSIEPOTENSIALE***

|  |  |
| --- | --- |
| **Half-reactions/*Halfreaksies*** |  **(V)** |
| F2(g) + 2e− | ⇌ | 2F− | + 2,87 |
| Co3+ + e− | ⇌ | Co2+ | + 1,81 |
| H2O2 + 2H+ +2e− | ⇌ | 2H2O | +1,77 |
| MnO + 8H+ + 5e− | ⇌ | Mn2+ + 4H2O | + 1,51 |
| Cℓ2(g) + 2e− | ⇌ | 2Cℓ− | + 1,36 |
| Cr2O + 14H+ + 6e− | ⇌ | 2Cr3+ + 7H2O | + 1,33 |
| O2(g) + 4H+ + 4e− | ⇌ | 2H2O | + 1,23 |
| MnO2+ 4H+ + 2e− | ⇌ | Mn2+ + 2H2O | + 1,23 |
| Pt2+ + 2e−**Increasing oxidising ability/*Toenemende oksiderende vermoë*** | ⇌ | Pt | + 1,20**Increasing reducing ability/*Toenemende reduserende vermoë*** |
| Br2(ℓ) + 2e− | ⇌ | 2Br− | + 1,07 |
| NO + 4H+ + 3e− | ⇌ | NO(g) + 2H2O | + 0,96 |
| Hg2+ + 2e− | ⇌ | Hg(ℓ) | + 0,85 |
| Ag+ + e− | ⇌ | Ag | + 0,80 |
| NO + 2H+ + e− | ⇌ | NO2(g) + H2O | + 0,80 |
| Fe3+ + e− | ⇌ | Fe2+ | + 0,77 |
| O2(g) + 2H+ + 2e− | ⇌ | H2O2 | + 0,68 |
| I2 + 2e− | ⇌ | 2I− | + 0,54 |
| Cu+ + e− | ⇌ | Cu | + 0,52 |
| SO2 + 4H+ + 4e− | ⇌ | S + 2H2O | + 0,45 |
| 2H2O + O2 + 4e− | ⇌ | 4OH− | + 0,40 |
| Cu2+ + 2e− | ⇌ | Cu | + 0,34 |
| SO + 4H+ + 2e− | ⇌ | SO2(g) + 2H2O | + 0,17 |
| Cu2+ + e− | ⇌ | Cu+ | + 0,16 |
| Sn4+ + 2e− | ⇌ | Sn2+ | + 0,15 |
| S + 2H+ + 2e− | ⇌ | H2S(g) | + 0,14 |
| **2H+ + 2e−** | **⇌** | **H2(g)** | **0,00** |
| Fe3+ + 3e− | ⇌ | Fe | − 0,06 |
| Pb2+ + 2e− | ⇌ | Pb | − 0,13 |
| Sn2+ + 2e− | ⇌ | Sn | − 0,14 |
| Ni2+ + 2e− | ⇌ | Ni | − 0,27 |
| Co2+ + 2e− | ⇌ | Co | − 0,28 |
| Cd2+ + 2e− | ⇌ | Cd | − 0,40 |
| Cr3+ + e− | ⇌ | Cr2+ | − 0,41 |
| Fe2+ + 2e− | ⇌ | Fe | − 0,44 |
| Cr3+ + 3e− | ⇌ | Cr | − 0,74 |
| Zn2+ + 2e− | ⇌ | Zn | − 0,76 |
| 2H2O + 2e− | ⇌ | H2(g) + 2OH− | − 0,83 |
| Cr2+ + 2e− | ⇌ | Cr | − 0,91 |
| Mn2+ + 2e− | ⇌ | Mn | − 1,18 |
| Aℓ3+ + 3e− | ⇌ | Aℓ | − 1,66 |
| Mg2+ + 2e− | ⇌ | Mg | − 2,36 |
| Na+ + e− | ⇌ | Na | − 2,71 |
| Ca2+ + 2e− | ⇌ | Ca | − 2,87 |
| Sr2+ + 2e− | ⇌ | Sr | − 2,89 |
| Ba2+ + 2e− | ⇌ | Ba | − 2,90 |
| Cs+ + e- | ⇌ | Cs | - 2,92 |
| K+ + e− | ⇌ | K | − 2,93 |
| Li+ + e− | ⇌ | Li | − 3,05 |

**TABLE 4B: STANDARD REDUCTION POTENTIALS**

***TABEL 4B: STANDAARDREDUKSIEPOTENSIALE***

|  |  |
| --- | --- |
| **Half-reactions/*Halfreaksies*** |  **(V)** |
| Li+ + e− | ⇌ | Li | − 3,05 |
| K+ + e− | ⇌ | K | − 2,93 |
| Cs+ + e− | ⇌ | Cs | − 2,92 |
| Ba2+ + 2e− | ⇌ | Ba | − 2,90 |
| Sr2+ + 2e− | ⇌ | Sr | − 2,89 |
| Ca2+ + 2e− | ⇌ | Ca | − 2,87 |
| Na+ + e− | ⇌ | Na | − 2,71 |
| Mg2+ + 2e− | ⇌ | Mg | − 2,36 |
| Aℓ3+ + 3e− | ⇌ | Aℓ | − 1,66 |
| Mn2+ + 2e− | ⇌ | Mn | − 1,18 |
| Cr2+ + 2e− | ⇌ | Cr | − 0,91 |
| 2H2O + 2e− | ⇌ | H2(g) + 2OH− | − 0,83 |
| Zn2+ + 2e− | ⇌ | Zn | − 0,76 |
| Cr3+ + 3e− | ⇌ | Cr | − 0,74 |
| Fe2+ + 2e− | ⇌ | Fe | − 0,44 |
| Cr3+ + e− | ⇌ | Cr2+ | − 0,41 |
| Cd2+ + 2e− | ⇌ | Cd | − 0,40 |
| Co2+ + 2e− | ⇌ | Co | − 0,28 |
| Ni2+ + 2e− | ⇌ | Ni | − 0,27 |
| Sn2+ + 2e− | ⇌ | Sn | − 0,14 |
| Pb2+ + 2e− | ⇌ | Pb | − 0,13 |
| Fe3+ + 3e− | ⇌ | Fe | − 0,06 |
| **2H+ + 2e−** | **⇌** | **H2(g)** | **0,00** |
| S + 2H+ + 2e− | ⇌ | H2S(g) | + 0,14 |
| Sn4+ + 2e− | ⇌ | Sn2+ | + 0,15 |
| Cu2+ + e− | ⇌ | Cu+ | + 0,16 |
| SO + 4H+ + 2e− | ⇌ | SO2(g) + 2H2O | + 0,17 |
| Cu2+ + 2e− | ⇌ | Cu | + 0,34 |
| 2H2O + O2 + 4e− | ⇌ | 4OH− | + 0,40 |
| SO2 + 4H+ + 4e− | ⇌ | S + 2H2O | + 0,45 |
| Cu+ + e− | ⇌ | Cu | + 0,52 |
| I2 + 2e− | ⇌ | 2I− | + 0,54 |
| O2(g) + 2H+ + 2e− | ⇌ | H2O2 | + 0,68 |
| Fe3+ + e− | ⇌ | Fe2+ | + 0,77 |
| NO + 2H+ + e− | ⇌ | NO2(g) + H2O | + 0,80 |
| Ag+ + e− | ⇌ | Ag | + 0,80 |
| Hg2+ + 2e− | ⇌ | Hg(ℓ) | + 0,85 |
| NO + 4H+ + 3e− | ⇌ | NO(g) + 2H2O | + 0,96 |
| Br2(ℓ) + 2e− | ⇌ | 2Br− | + 1,07 |
| Pt2+ + 2 e− | ⇌ | Pt | + 1,20 |
| MnO2+ 4H+ + 2e− | ⇌ | Mn2+ + 2H2O | + 1,23 |
| O2(g) + 4H+ + 4e− | ⇌ | 2H2O | + 1,23 |
| Cr2O + 14H+ + 6e− | ⇌ | 2Cr3+ + 7H2O | + 1,33 |
| Cℓ2(g) + 2e− | ⇌ | 2Cℓ− | + 1,36 |
| MnO + 8H+ + 5e− | ⇌ | Mn2+ + 4H2O | + 1,51 |
| H2O2 + 2H+ +2 e− | ⇌ | 2H2O | +1,77 |
| Co3+ + e− | ⇌ | Co2+ | + 1,81 |
| F2(g) + 2e− | ⇌ | 2F− | + 2,87 |

**Increasing oxidising ability/*Toenemende oksiderende vermoë***

**Increasing reducing ability/*Toenemende reduserende vermoë***

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**CLASS/KLAS**

**NAME/NAAM**