



HILLCREST HIGH SCHOOL  
PHYSICAL SCIENCE  
GRADE 11  
PAPER 2- Chemistry



NOVEMBER 2013  
TIME: 3 HRS

Total 150

## Instructions

1. Answer ALL the questions.
2. This question paper consists of TWO sections:
3. SECTION A (25)  
SECTION B (125)  
  
Answer SECTIONS A and B in the ANSWER BOOK.
4. Non-programmable calculators may be used.
5. Appropriate mathematical instruments may be used.
6. Number the answers correctly according to the numbering system used in this question paper.
7. Data sheets and a periodic table are attached for your use.
8. Give brief motivations, discussions, et cetera where required.
9. Numbers must be rounded off to **two decimal** places.

## SECTION A

### QUESTION 1: ONE-WORD ITEMS

Give ONE word/term for each of the following descriptions. Write only the word/term next to the question number (1.1 – 1.5) in the ANSWER BOOK.

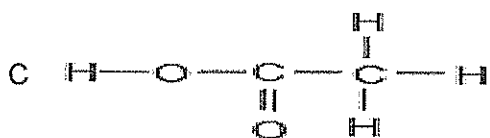
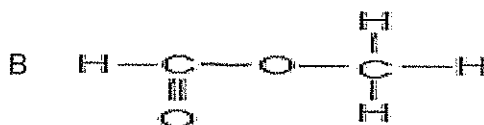
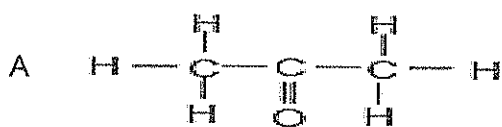
- 1.1 The homologous series to which  $\text{H} - \text{C} \equiv \text{C} - \text{H}$  belongs.
- 1.2 The electrode in a galvanic cell where reduction takes place.
- 1.3 The type of chemical reaction that absorbs energy.
- 1.4 The minimum energy needed to start a reaction.
- 1.5 A substance that can act as either an acid or a base.

[1 x 5 = 5]

### QUESTION 2: MULTIPLE-CHOICE QUESTIONS

Four options are provided as possible answers to the following questions. Each question has only ONE correct answer. Write only the letter (A – D) next to the question number (2.1 – 2.10) in the ANSWER BOOK.

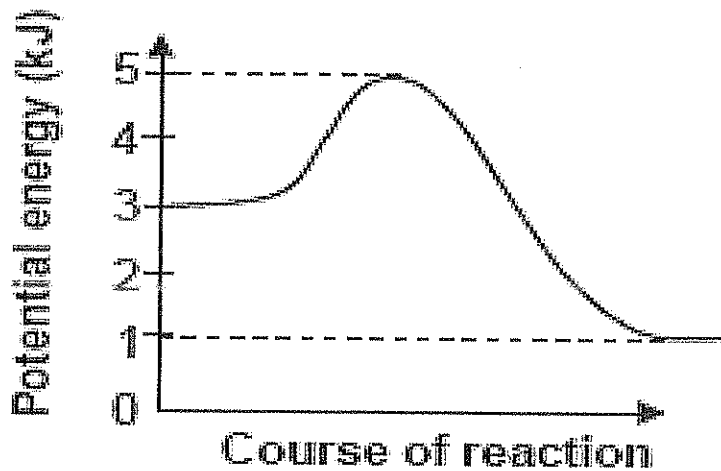
- 2.1 Which ONE of the following compounds represents a ketone?



- 2.2 In an **electrolytic cell** which statement is **INCORRECT**?

- A. The anode is positively charged
- B. There is no salt bridge
- C. The cathode is negatively charged
- D. Electrical energy is converted to chemical energy

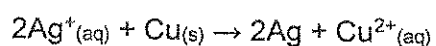
- 2.3 The graph below represents the relationship between potential energy and course of reaction for a certain chemical reaction.



The activation energy for the forward reaction is ...

- A. 1 kJ
  - B. 2 kJ
  - C. 3 kJ
  - D. 4 kJ
- 2.4 Which ONE 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 decreases.
  - C. The concentration of the electrolyte in the half-cell containing the anode initially decreases.
  - D. The anode is the positive terminal of the cell.

2.5 Consider the reaction represented by the following equation:



Which ONE of the following represents the oxidising agent in the above reaction?

- A.  $\text{Ag}^+$
- B. Ag
- C. Cu
- D.  $\text{Cu}^{2+}$

2.6 Which ONE of the following compounds CANNOT be an alkene?

- A.  $\text{C}_2\text{H}_4$
- B.  $\text{C}_3\text{H}_6$
- C.  $\text{C}_3\text{H}_8$
- D.  $\text{C}_4\text{H}_8$

2.7 1.01 gram of hydrogen gas at STP occupies a volume of:

- A.  $5.6\text{dm}^3$
- B.  $11.2\text{dm}^3$
- C.  $22.4\text{dm}^3$
- D.  $44.8\text{dm}^3$

2.8 A Bronsted-Lowry acid is:

- A. A proton acceptor
- B. A substance which is able to accept more than one  $\text{H}^+$
- C. A substance that can either accept or donate a proton depending on the reaction
- D. A proton donor

- 2.9 What is the intermolecular force present in a jar filled with HCl.
- A. Ion induced dipole
  - B. Dipole-dipole
  - C. Dipole induced dipole
  - D. Hydrogen bonds
- 2.10 Consider carbon dioxide. What combination below best describes this **molecule** in terms of bond and shape?
- A. Non-polar linear molecule
  - B. Polar linear molecule
  - C. Polar bent molecule
  - D. Non polar tetrahedral molecule
- [2 x 10 = 20]

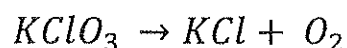
## SECTION B

### INSTRUCTIONS AND INFORMATION

1. Leave ONE line between two sub questions, for example between QUESTION 3.1 and QUESTION 3.2.
2. Show the formulae and substitutions in ALL calculations.
3. Round off your numerical answers to **TWO** decimal places.

### Question 3

- 3.1 Look at the equation below:



- 3.1.1 Balance the equation for the decomposition of potassium chlorate (1)
- 3.1.2 What mass of potassium chlorate (KClO<sub>3</sub>) should be heated to produce 24g of O<sub>2</sub>? (5)
- 3.2 Solution A consists of 2g sodium hydroxide in 50dm<sup>3</sup> solution. Solution B consists of 1.25g sodium hydroxide in 33cm<sup>3</sup> solution. What is the difference in concentration between these two solutions? (8)

- 3.3 What is meant by the term empirical formula. (2)
- 3.4 A compound with a relative formula mass of  $148\text{g}\cdot\text{mol}^{-1}$  consists of 48.48% oxygen, 54.55% carbon and 9.09% hydrogen. Calculate the true formula. (8)

[24]

#### Question 4

Jo and Jennifer carried out a titration in the laboratory, where 10ml of nitric acid was titrated against a standard solution of sodium carbonate that has a concentration of  $0.5\text{mol}\cdot\text{dm}^{-3}$ . It was found that 25ml of the base ***“just neutralised the acid”***.

- 4.1 What is a standard solution? (2)
- 4.2 Write a balanced equation for the reaction. (4)
- 4.3 What is the name given to the stage of the reaction when the base has ***“just neutralised the acid”***? (1)
- 4.4 Suggest an indicator which could be used for the titration. (1)
- 4.5 List 2 precautions (or safety measures) the girls should take when performing a titration. (2)
- 4.6 Calculate the concentration of the acid. (4)

[14]

#### Question 5

Hot / cold packs are used by athletes to minimise swelling of injuries such as muscle and joint sprains.

A certain warm pack contains the following chemicals: Fine iron powder, water and sodium chloride absorbed in an inactive powder, carbon catalyst. As soon as the polythene bag is opened **the iron powder and the oxygen react to form iron (III) oxide**. The reaction produces heat and temperatures between  $55^{\circ}\text{C}$  and  $70^{\circ}\text{C}$  are maintained over a specified period.

- 5.1 Write a balanced chemical equation for the formation of rust in the warm pack. (3)
- 5.2 Is the above reaction exothermic or endothermic? Give a reason for your answer. (2)
- 5.3 Draw a labelled energy profile for this reaction. Ensure to indicate the following:
- Change in enthalpy
  - Activation energy
  - Energy of the activated complex
  - Energy of the reactants
  - Energy of the products
  - Activation energy

(7)

[12]

## Question 6

6.1 Refer to the following reaction:



6.1.1 Give the oxidation number of each of the three underlined elements as they appear in each molecule represented above. (3)

6.1.2 Name the reducing agent in the above reaction. (1)

6.1.3 There are two common greenhouse gases represented in the above reaction. Name them. (2)

6.2 Learners conduct an investigation to determine which combination of two half-cells will provide the largest emf at standard conditions.

Three half-cells, represented as **A**, **B** and **C** in the table below are available.

HALF-CELL A	HALF- CELL B	HALF-CELL C
Mg Mg <sup>2+</sup>	Pb Pb <sup>2+</sup>	Al Al <sup>3+</sup>

The learners set up galvanic cells using different combinations of the above half-cells.

6.2.1 Write down the standard conditions under which these cells operate. (2)

6.2.2 Write down the dependent variable in this investigation. (1)

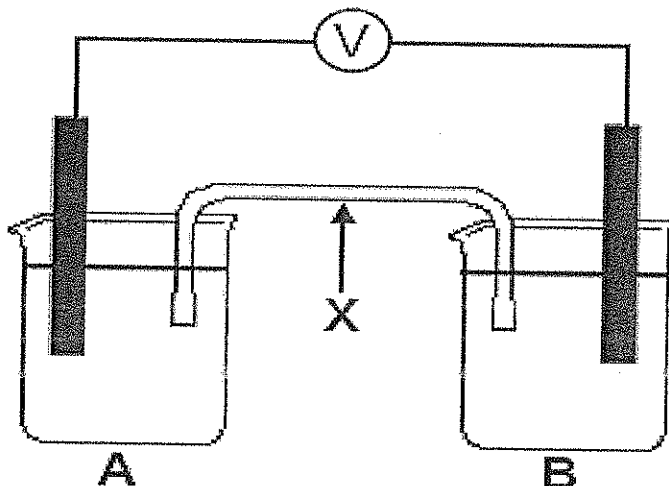
Using the table of standard reduction potentials determine which one of the three half-cells (**A**, **B** or **C**) contains the:

6.2.3 Strongest reducing agent (1)

6.2.4 Strongest oxidising agent (1)

6.2.5 Without any calculation, write down the combination of two half-cells which will produce the highest emf. Write down only **AB**, **BC** or **AC**. (1)

- 6.3 A group of learners set up a galvanic cell using half-cells A ( $\text{Mg}|\text{Mg}^{2+}$ ) and B ( $\text{Pb}|\text{Pb}^{2+}$ ) from the table in question 6.2. The galvanic cell which they set up is shown below. X represents one of the components of the galvanic cell.



- 6.3.1 State which substance will be formed at the anode? Write only **Mg** or **Mg<sup>2+</sup>**. Give a reason for your answer. (2)
- 6.3.2 Write down the reduction half reaction for the above cell. (2)
- 6.3.3 Calculate the initial emf of this cell. (4)
- 6.3.4 How will an increase in the concentration of the electrolyte in the half-cell B affect the initial emf of the cell? Write down only **INCREASE**, **DECREASE** or **REMAINS THE SAME**. (1)
- 6.3.5 Briefly explain how component X ensures electrical neutrality while the cell is functioning. (2)
- 6.4 The learners want to plate an electrode with aluminium and so decide to set up an **electrolytic cell**.
- 6.4.1 State which half-cell (**A**, **B** or **C**) from the table in question 6.2 the learners should use. (1)
- 6.4.2 Name **THREE** changes the learners would have to make to the above galvanic cell in order to construct the electrolytic cell. (3)

[27]

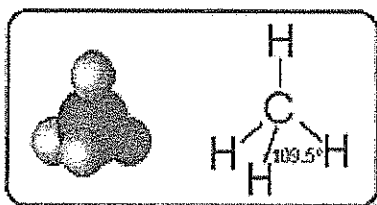
### Question 7

Two compounds have the following Lewis notation respectively.

COMPOUND A	COMPOUND B

Suppose a jar contained only molecules of compound A, which is a **liquid at room temperature** and another jar contained only molecules of compound B, **which is a foul smelling gas at room temperature**. H = hydrogen. Y = oxygen and Z = sulphur.

- 7.1 Give the **name** of compound A and B. (2)
- 7.2 State the name of the intermolecular forces between the molecules of compound A. (1)
- 7.3 State the name of the intermolecular forces between the molecules of compound B. (1)
- 7.4 Give a brief description and comparison of the intermolecular forces named in questions 7.2 and 7.3. (2)
- 7.5 From your descriptions above, make an educated assumption as to which compound will have the higher boiling point. Write down only **A** or **B**. (1)
- 7.6 State the polarity of the bonds in compound A. Give a reason for your answer. (2)
- 7.7 State and explain the shape of a molecule of compound A. You may use a diagram to help with your explanation. (3)
- 7.8 Name the shape of the following molecules:



(1)

[13]

### Question 8

Consider the table below and answer the questions which follow.

NAME	STRUCTURAL FORMULA	FUNCTIONAL GROUP
Propane	8.1.1	8.1.2
8.1.3	$  \begin{array}{c}  \text{H H OH} \\        \\  \text{H}-\text{C}-\text{C}-\text{C}-\text{H} \\        \\  \text{H H H}  \end{array}  $	8.1.4
But-2-ene	8.1.5	8.1.6

8.1 Complete the table by providing the appropriate answers for numbers 8.1.1 to 8.1.6. (8)

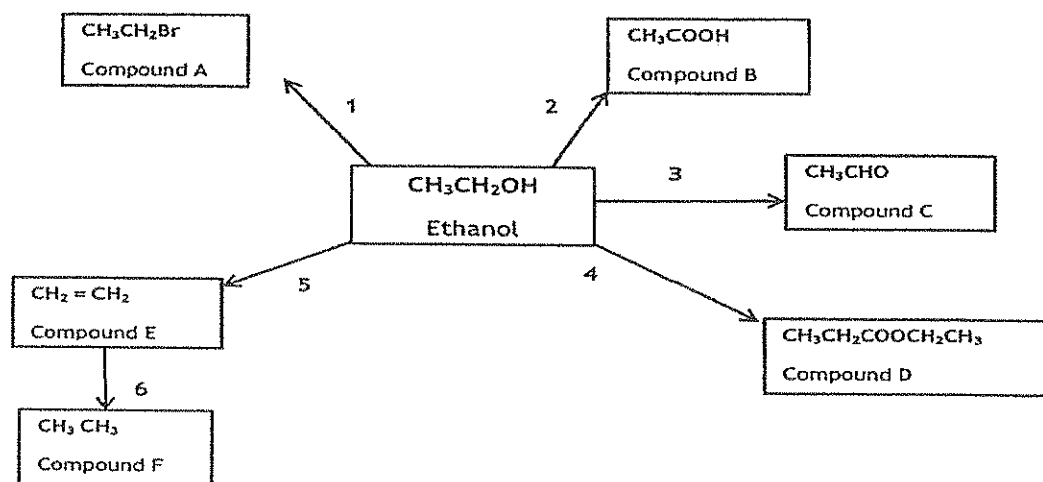
8.2 Name the alcohol and the carboxylic acid which are used to prepare methyl ethanoate. (2)

8.3 Using structural formula write down a chemical equation for the reaction above where methyl ethanoate is formed. (5)

[15]

### Question 9

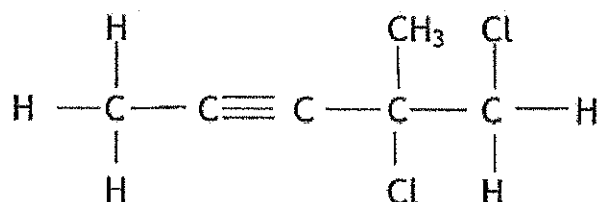
Consider the following diagram which represents the synthesis of various organic compounds using ethanol as the starting reaction.



9.1 Give the name of the homologous series to which compounds A, B and C belong. (3)

9.2 Name the type of reaction represented by process 4. (1)

- 9.3 Name compounds C and D. (3)
- 9.4 Which would you expect to have a higher boiling point, ethanol or compound F? (1)
- 9.5 Briefly explain your answer to 9.4 by referring to intermolecular forces. (3)
- 9.6 What is an isomer? (2)
- 9.7 Using structural formulae, draw an isomer of compound D which belongs to a **different** homologous series to compound D. (2)
- 9.8 Name the compound you have drawn in 9.6. (2)
- 9.9 Name the following compound:



(3)  
[20]

**TOTAL 150**



**DATA FOR PHYSICAL SCIENCES GRADE 11  
PAPER 2 (CHEMISTRY)**

**GEGEWENS VIR FISIESTE WETENSAPPE GRAAD 11  
VRAESTEL 2 (CHEMIE)**

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

NAME/NAAM	SYMBOL/SIMBOOL	VALUE/WAARDE
Standard pressure <i>Standaarddruk</i>	$p^\ominus$	$1,013 \times 10^5 \text{ Pa}$
Molar gas volume at STP <i>Molêre gasvolume by STD</i>	$V_m$	$22,4 \text{ dm}^3 \cdot \text{mol}^{-1}$
Standard temperature <i>Standaardtemperatuur</i>	$T^\ominus$	273 K
Charge on electron <i>Lading op elektron</i>	$e$	$-1,6 \times 10^{-19} \text{ C}$

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

$n = \frac{m}{M}$	$c = \frac{n}{V}$ or/of $c = \frac{m}{MV}$	$n = \frac{V}{V_o}$  $\frac{n_a}{n_b} = \frac{c_a V_a}{c_b V_b}$
$q = I \Delta t$ $W = Vq$	$E_{\text{cell}}^\ominus = E_{\text{cathode}}^\ominus - E_{\text{anode}}^\ominus$ / $E_{\text{sel}}^\ominus = E_{\text{katode}}^\ominus - E_{\text{anode}}^\ominus$ or/of $E_{\text{cell}}^\ominus = E_{\text{reduction}}^\ominus - E_{\text{oxidation}}^\ominus$ / $E_{\text{sel}}^\ominus = E_{\text{reduksie}}^\ominus - E_{\text{oksidasie}}^\ominus$ or/of $E_{\text{cell}}^\ominus = E_{\text{oxidising agent}}^\ominus - E_{\text{reducing agent}}^\ominus$ / $E_{\text{sel}}^\ominus = E_{\text{oksideermiddel}}^\ominus - E_{\text{reduseermiddel}}^\ominus$	

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

Half-reactions/Halfreaksies	$E^{\circ}$ (V)
$F_2(g) + 2e^- = 2F^-$	+ 2,87
$Co^{3+} + e^- = Co^{2+}$	+ 1,81
$H_2O_2 + 2H^+ + 2e^- = 2H_2O$	+1,77
$MnO_4^- + 8H^+ + 5e^- = Mn^{2+} + 4H_2O$	+ 1,51
$Cl_2(g) + 2e^- = 2Cl^-$	+ 1,36
$Cr_2O_7^{2-} + 14H^+ + 6e^- = 2Cr^{3+} + 7H_2O$	+ 1,33
$O_2(g) + 4H^+ + 4e^- = 2H_2O$	+ 1,23
$MnO_2 + 4H^+ + 2e^- = Mn^{2+} + 2H_2O$	+ 1,23
$Pt^{2+} + 2e^- = Pt$	+ 1,20
$Br_2(l) + 2e^- = 2Br^-$	+ 1,07
$NO_3^- + 4H^+ + 3e^- = NO(g) + 2H_2O$	+ 0,96
$Hg^{2+} + 2e^- = Hg(l)$	+ 0,85
$Ag^+ + e^- = Ag$	+ 0,80
$NO_3^- + 2H^+ + e^- = NO_2(g) + H_2O$	+ 0,80
$Fe^{3+} + e^- = Fe^{2+}$	+ 0,77
$O_2(g) + 2H^+ + 2e^- = H_2O_2$	+ 0,68
$I_2 + 2e^- = 2I^-$	+ 0,54
$Cu^+ + e^- = Cu$	+ 0,52
$SO_2 + 4H^+ + 4e^- = S + 2H_2O$	+ 0,45
$2H_2O + O_2 + 4e^- = 4OH^-$	+ 0,40
$Cu^{2+} + 2e^- = Cu$	+ 0,34
$SO_4^{2-} + 4H^+ + 2e^- = SO_2(g) + 2H_2O$	+ 0,17
$Cu^{2+} + e^- = Cu^+$	+ 0,16
$Sn^{4+} + 2e^- = Sn^{2+}$	+ 0,15
$S + 2H^+ + 2e^- = H_2S(g)$	+ 0,14
$2H^+ + 2e^- = H_2(g)$	0,00
$Fe^{3+} + 3e^- = Fe$	- 0,06
$Pb^{2+} + 2e^- = Pb$	- 0,13
$Sn^{2+} + 2e^- = Sn$	- 0,14
$Ni^{2+} + 2e^- = Ni$	- 0,27
$Co^{2+} + 2e^- = Co$	- 0,28
$Cd^{2+} + 2e^- = Cd$	- 0,40
$Cr^{3+} + e^- = Cr^{2+}$	- 0,41
$Fe^{2+} + 2e^- = Fe$	- 0,44
$Cr^{3+} + 3e^- = Cr$	- 0,74
$Zn^{2+} + 2e^- = Zn$	- 0,76
$2H_2O + 2e^- = H_2(g) + 2OH^-$	- 0,83
$Cr^{2+} + 2e^- = Cr$	- 0,91
$Mn^{2+} + 2e^- = Mn$	- 1,18
$Al^{3+} + 3e^- = Al$	- 1,66
$Mg^{2+} + 2e^- = Mg$	- 2,36
$Na^+ + e^- = Na$	- 2,71
$Ca^{2+} + 2e^- = Ca$	- 2,87
$Sr^{2+} + 2e^- = Sr$	- 2,89
$Ba^{2+} + 2e^- = Ba$	- 2,90
$Cs^+ + e^- = Cs$	- 2,92
$K^+ + e^- = K$	- 2,93
$Li^+ + e^- = Li$	- 3,05

Increasing oxidising ability/Toenemende oksiderende vermoë

Increasing reducing ability/Toenemende reduserende vermoë

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

Half-reactions/Halfreaksies	E <sup>o</sup> (V)
$\text{Li}^+ + \text{e}^- = \text{Li}$	-3,05
$\text{K}^+ + \text{e}^- = \text{K}$	-2,93
$\text{Cs}^+ + \text{e}^- = \text{Cs}$	-2,92
$\text{Ba}^{2+} + 2\text{e}^- = \text{Ba}$	-2,90
$\text{Sr}^{2+} + 2\text{e}^- = \text{Sr}$	-2,89
$\text{Ca}^{2+} + 2\text{e}^- = \text{Ca}$	-2,87
$\text{Na}^+ + \text{e}^- = \text{Na}$	-2,71
$\text{Mg}^{2+} + 2\text{e}^- = \text{Mg}$	-2,36
$\text{Al}^{3+} + 3\text{e}^- = \text{Al}$	-1,66
$\text{Mn}^{2+} + 2\text{e}^- = \text{Mn}$	-1,18
$\text{Cr}^{2+} + 2\text{e}^- = \text{Cr}$	-0,91
$2\text{H}_2\text{O} + 2\text{e}^- = \text{H}_2(\text{g}) + 2\text{OH}^-$	-0,83
$\text{Zn}^{2+} + 2\text{e}^- = \text{Zn}$	-0,76
$\text{Cr}^{3+} + 3\text{e}^- = \text{Cr}$	-0,74
$\text{Fe}^{2+} + 2\text{e}^- = \text{Fe}$	-0,44
$\text{Cr}^{3+} + \text{e}^- = \text{Cr}^{2+}$	-0,41
$\text{Cd}^{2+} + 2\text{e}^- = \text{Cd}$	-0,40
$\text{Co}^{2+} + 2\text{e}^- = \text{Co}$	-0,28
$\text{Ni}^{2+} + 2\text{e}^- = \text{Ni}$	-0,27
$\text{Sn}^{2+} + 2\text{e}^- = \text{Sn}$	-0,14
$\text{Pb}^{2+} + 2\text{e}^- = \text{Pb}$	-0,13
$\text{Fe}^{3+} + 3\text{e}^- = \text{Fe}$	-0,06
$2\text{H}^+ + 2\text{e}^- = \text{H}_2(\text{g})$	0,00
$\text{S} + 2\text{H}^+ + 2\text{e}^- = \text{H}_2\text{S}(\text{g})$	+0,14
$\text{Sn}^{4+} + 2\text{e}^- = \text{Sn}^{2+}$	+0,15
$\text{Cu}^{2+} + \text{e}^- = \text{Cu}^+$	+0,16
$\text{SO}_4^{2-} + 4\text{H}^+ + 2\text{e}^- = \text{SO}_2(\text{g}) + 2\text{H}_2\text{O}$	+0,17
$\text{Cu}^{2+} + 2\text{e}^- = \text{Cu}$	+0,34
$2\text{H}_2\text{O} + \text{O}_2 + 4\text{e}^- = 4\text{OH}^-$	+0,40
$\text{SO}_2 + 4\text{H}^+ + 4\text{e}^- = \text{S} + 2\text{H}_2\text{O}$	+0,45
$\text{Cu}^+ + \text{e}^- = \text{Cu}$	+0,52
$\text{I}_2 + 2\text{e}^- = 2\text{I}^-$	+0,54
$\text{O}_2(\text{g}) + 2\text{H}^+ + 2\text{e}^- = \text{H}_2\text{O}_2$	+0,68
$\text{Fe}^{3+} + \text{e}^- = \text{Fe}^{2+}$	+0,77
$\text{NO}_3^- + 2\text{H}^+ + \text{e}^- = \text{NO}_2(\text{g}) + \text{H}_2\text{O}$	+0,80
$\text{Ag}^+ + \text{e}^- = \text{Ag}$	+0,80
$\text{Hg}^{2+} + 2\text{e}^- = \text{Hg}(\text{l})$	+0,85
$\text{NO}_3^- + 4\text{H}^+ + 3\text{e}^- = \text{NO}(\text{g}) + 2\text{H}_2\text{O}$	+0,96
$\text{Br}_2(\text{l}) + 2\text{e}^- = 2\text{Br}^-$	+1,07
$\text{Pt}^{2+} + 2\text{e}^- = \text{Pt}$	+1,20
$\text{MnO}_2 + 4\text{H}^+ + 2\text{e}^- = \text{Mn}^{2+} + 2\text{H}_2\text{O}$	+1,23
$\text{O}_2(\text{g}) + 4\text{H}^+ + 4\text{e}^- = 2\text{H}_2\text{O}$	+1,23
$\text{Cr}_2\text{O}_7^{2-} + 14\text{H}^+ + 6\text{e}^- = 2\text{Cr}^{3+} + 7\text{H}_2\text{O}$	+1,33
$\text{Cl}_2(\text{g}) + 2\text{e}^- = 2\text{Cl}^-$	+1,36
$\text{MnO}_4^- + 8\text{H}^+ + 5\text{e}^- = \text{Mn}^{2+} + 4\text{H}_2\text{O}$	+1,51
$\text{H}_2\text{O}_2 + 2\text{H}^+ + 2\text{e}^- = 2\text{H}_2\text{O}$	+1,77
$\text{Co}^{3+} + \text{e}^- = \text{Co}^{2+}$	+1,81
$\text{F}_2(\text{g}) + 2\text{e}^- = 2\text{F}^-$	+2,87

Increasing oxidising ability/Toenemende oksiderende vermoë

Increasing reducing ability/Toenemende reduserende vermoë

