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GRADE 12

TECHNICAL SCIENCES P2

NOVEMBER 2022

MARKS: 75

TIME: 1½ hours

This question paper consists of 9 pages and 4 data sheets.

INSTRUCTIONS AND INFORMATION

1. Write your centre number and examination number in the appropriate spaces on the ANSWER BOOK.
2. This question paper consists of SIX questions. Answer ALL the 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 subquestions, e.g. 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. Round off your FINAL numerical answers to a minimum of TWO decimal places.
9. Give brief motivations, discussions, etc. where required.
10. Write neatly and legibly.

QUESTION 1: MULTIPLE-CHOICE QUESTIONS

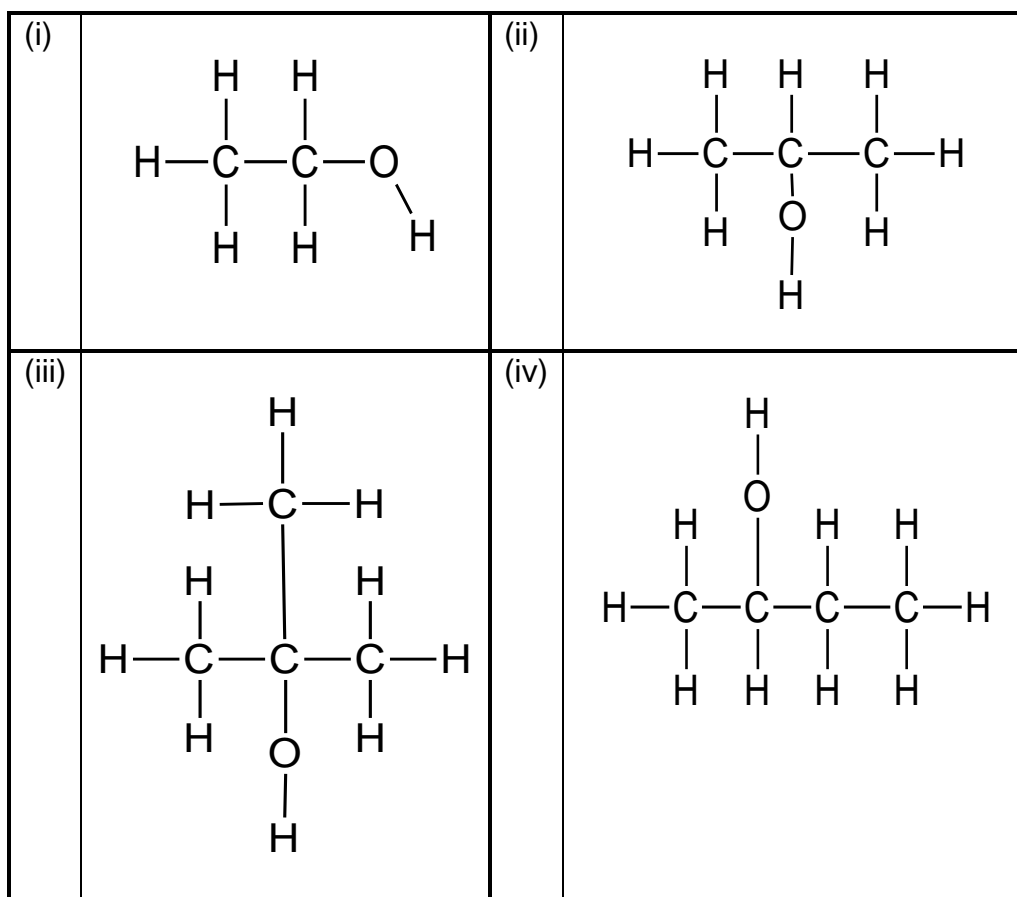
Various options are provided as possible answers to the following questions. Choose the answer and write only the letter (A–D) next to the question numbers (1.1 to 1.5) in the ANSWER BOOK, e.g. 1.6 D.

1.1 Which ONE of the compounds below represents a saturated hydrocarbon?

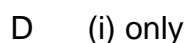
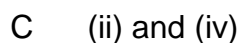
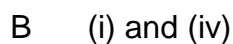
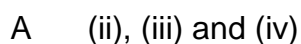


(2)

1.2 Consider the structural formulae of the alcohols below.



Which ONE of the following combinations represents a secondary alcohol?



(2)

- 1.3 ... are examples of PURE SEMICONDUCTORS.
- A Diamonds, silicon and germanium
 - B Germanium, copper and lead
 - C Silicon, germanium and lead
 - D Diamonds, silicon and krypton (2)
- 1.4 Electroplating is a common application of electrolysis. Which ONE of the following is NOT used for electroplating metals?
- A To enhance the appearance
 - B To make it stronger
 - C To increase the value
 - D To prevent rusting (2)
- 1.5 The net cell reaction taking place in a fuel cell is
- $$2\text{H}_2(\text{g}) + \text{O}_2(\text{g}) \longrightarrow 2\text{H}_2\text{O}(\ell) + \text{energy}$$
- This is a/an ...
- A electrolytic cell and the reaction is endothermic.
 - B electrolytic cell and the reaction is exothermic.
 - C galvanic cell and the reaction is endothermic.
 - D galvanic cell and the reaction is exothermic. (2)
- [10]**

QUESTION 2 (Start on a new page.)

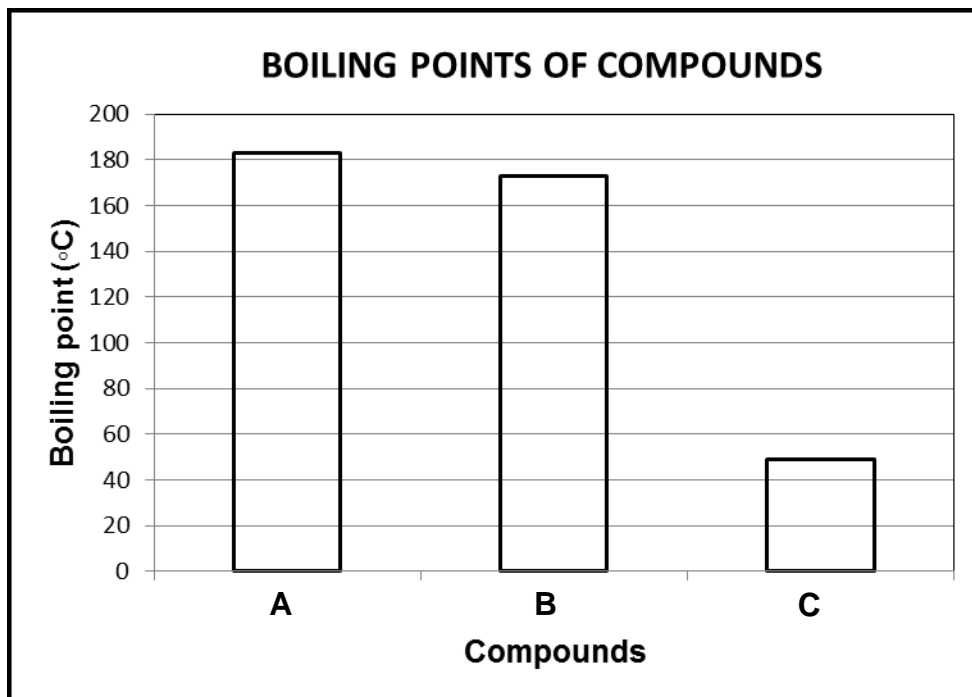
The table below represents organic molecules with different functional groups.

A	$ \begin{array}{cccc} \text{H} & \text{H} & \text{Br} & \text{H} \\ & & & \\ \text{H}-\text{C} & -\text{C} & -\text{C} & -\text{C}-\text{H} \\ & & & \\ \text{H} & & \text{H} & \text{H} \\ & & & \\ & \text{H}-\text{C}-\text{H} & & \\ & & & \\ & \text{H} & & \end{array} $	B	$ \begin{array}{cccc} & \text{H} & \text{H} & \text{O} \\ & & & \\ \text{H}-\text{C} & -\text{C} & -\text{C} & -\text{O}-\text{H} \\ & & & \\ \text{H} & \text{H} & & \end{array} $
C	Methyl ethanoate	D	$ \begin{array}{cccc} & \text{H} & \text{O} & \text{H} & \text{H} \\ & & & & \\ \text{H}-\text{C} & -\text{C} & -\text{C} & -\text{C}-\text{H} \\ & & & & \\ \text{H} & & & \text{H} & \text{H} \end{array} $
E	$ \begin{array}{cccc} \text{H} & \text{H} & \text{H} & \text{H} \\ & & & \\ \text{H}-\text{C} & -\text{C} & -\text{C} & -\text{C}-\text{H} \\ & & & \\ \text{H} & \text{H} & \text{H} & \text{H} \end{array} $	F	Prop-1-ene

- 2.1 Define the term *homologous series*. (2)
- 2.2 Write down the letter (A–F) that represents the following:
- 2.2.1 Haloalkane (1)
- 2.2.2 Functional isomers (2)
- 2.2.3 Ketone (1)
- 2.2.4 Unsaturated hydrocarbon (1)
- 2.3 Write down the IUPAC name of compound **E**. (2)
- 2.4 Draw the structural formula of the following:
- 2.4.1 Compound **C** (2)
- 2.4.2 Functional group of compound **F** (2)
- [13]**

QUESTION 3 (Start on a new page.)

The graph below shows the boiling points of three different compounds represented by the letters **A**, **B** and **C**. These compounds are from different homologous series.



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

3.2 Which ONE of the compounds above contains the weakest type of intermolecular force? (1)

In no specific order, the above compounds are identified as propan-1-ol, propanal and propanoic acid.

3.3 Write down the NAMES of the compounds above represented by the following letters:

3.3.1 **A** (1)

3.3.2 **B** (1)

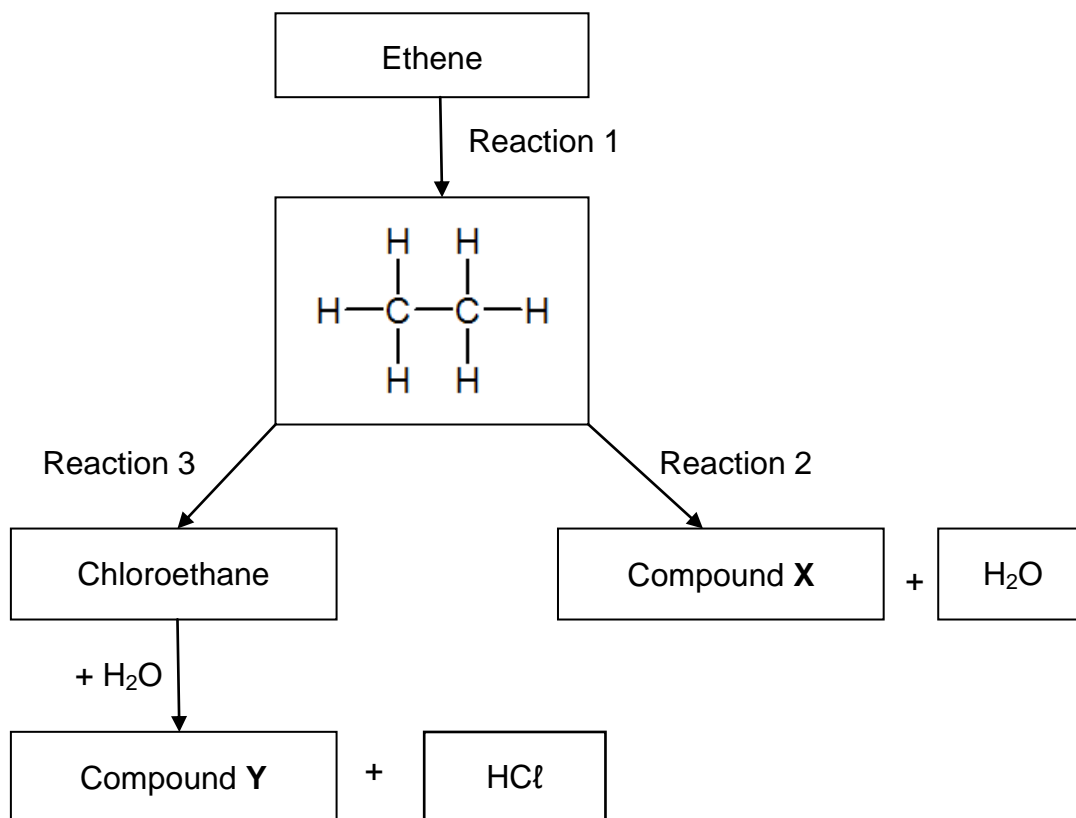
3.3.3 **C** (1)

3.4 Explain the difference in the vapour pressure of propanoic acid and propan-1-ol. Refer to the TYPE OF INTERMOLECULAR FORCES, STRENGTH OF THE INTERMOLECULAR FORCES and the ENERGY NEEDED. (4)

3.5 Which compound has the highest melting point? Write down only **A**, **B** or **C**. (1)
[11]

QUESTION 4 (Start on a new page.)

Consider the flow diagram below that shows different organic reactions.



- 4.1 Write down the TYPE of reaction represented by the following:
- 4.1.1 Reaction 1 (1)
- 4.1.2 Reaction 3 (1)
- 4.2 Using molecular formulae, write down a balanced chemical equation for reaction 1. (3)
- 4.3 Excess oxygen is the other reactant in reaction 2.
- 4.3.1 Identify the type of reaction. (1)
- 4.3.2 Write down the NAME or FORMULA of compound X. (2)
- 4.4 Chloroethane reacts with water to form compound Y.
Write down the following for this reaction:
- 4.4.1 The type of reaction (1)
- 4.4.2 TWO reaction conditions (2)
- 4.4.3 The NAME of compound Y (2)

4.5 Materials consisting of certain elements in group IV have electrical conductivity between conductors and insulators.

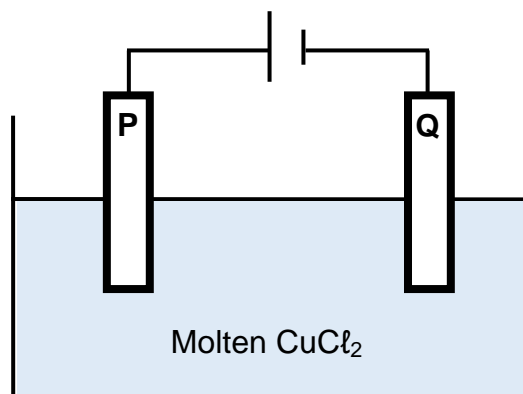
4.5.1 Write down the NAME of the materials referred to in the above statement. (1)

4.5.2 Define the term *doping*. (2)

4.5.3 A diode is constructed by connecting the positive terminal of the battery to a p-type material and the negative terminal to an n-type material. What type of a diode is this? Write down only FORWARD BIAS or REVERSE BIAS. (1)
[17]

QUESTION 5 (Start on a new page.)

The diagram below represents the electrochemical cell used in the electrolysis of molten CuCl_2 . **P** and **Q** are carbon electrodes.



5.1 Write down the magnitude of the copper charge in CuCl_2 . (1)

5.2 Define the term *electrolysis*. (2)

5.3 Is the reaction ENDOTHERMIC or EXOTHERMIC? (1)

5.4 Which electrode is the cathode? Write down only **P** or **Q**. (1)

5.5 Write down the observations made at the following electrodes:

5.5.1 **P** (1)

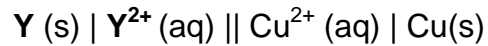
5.5.2 **Q** (1)

5.6 Write down a balanced chemical equation for the net cell reaction of the above cell. (3)

5.7 Give a reason why CuCl_2 is used in its molten form instead of its solid state. (2)
[12]

QUESTION 6 (Start on a new page.)

The cell notation of a standard galvanic (voltaic) cell containing an unknown metal **Y** is shown below.



- 6.1 What do the single vertical lines (|) in the cell notation represent? (1)
- 6.2 State TWO standard conditions for the cell. (2)
- 6.3 Write down the NAME or FORMULA of the oxidising agent. (2)
- 6.4 Identify the polarity of the:
- 6.4.1 Anode (1)
- 6.4.2 Cathode (1)
- 6.5 The initial reading on a voltmeter connected across the electrodes is 1,10 V. Use a calculation to identify metal **Y**. (5)

[12]**TOTAL: 75**

**DATA FOR TECHNICAL SCIENCES GRADE 12
PAPER 2
GEGEWENS VIR TEGNIESE WETENSKAPPE GRAAD 12
VRAESTEL 2**

TABLE 1/TABEL 1: PHYSICAL CONSTANTS/FISIESTE KONSTANTES

NAME/NAAM	SYMBOL/SIMBOOL	VALUE/WAARDE
Standard pressure <i>Standaarddruk</i>	p^\ominus	$1,01 \times 10^5 \text{ Pa}$
Standard temperature <i>Standaardtemperatuur</i>	T^\ominus	$273 \text{ K}/0 \text{ }^\circ\text{C}$

TABLE 2/TABEL 2: FORMULAE/FORMULES

Emf/Emk	$E^\ominus_{\text{cell}} = E^\ominus_{\text{cathode}} - E^\ominus_{\text{anode}} \quad / \quad E^\ominus_{\text{sel}} = E^\ominus_{\text{katode}} - E^\ominus_{\text{anode}}$ <p style="text-align: center;"><i>or/of</i></p> $E^\ominus_{\text{cell}} = E^\ominus_{\text{reduction}} - E^\ominus_{\text{oxidation}} \quad / \quad E^\ominus_{\text{sel}} = E^\ominus_{\text{reduksie}} - E^\ominus_{\text{oksidasie}}$ <p style="text-align: center;"><i>or/of</i></p> $E^\ominus_{\text{cell}} = E^\ominus_{\text{oxidising agent}} - E^\ominus_{\text{reducing agent}} \quad /$ $E^\ominus_{\text{sel}} = E^\ominus_{\text{oksideermiddel}} - E^\ominus_{\text{reduseermiddel}}$
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TABLE 4A: STANDARD REDUCTION POTENTIALS

Half-reactions		E° (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
$Cl_2(g) + 2e^-$	$\rightleftharpoons 2Cl^-$	+ 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
$Br_2(l) + 2e^-$	$\rightleftharpoons 2Br^-$	+ 1,07
$NO_3^- + 4H^+ + 3e^-$	$\rightleftharpoons NO(g) + 2H_2O$	+ 0,96
$Hg^{2+} + 2e^-$	$\rightleftharpoons Hg(l)$	+ 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
$Al^{3+} + 3e^-$	$\rightleftharpoons Al$	- 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

Increasing reducing ability

TABLE 4B: STANDARD REDUCTION POTENTIALS

Half-reactions			E^{\ominus} (V)
$\text{Li}^+ + \text{e}^-$	\rightleftharpoons	Li	- 3,05
$\text{K}^+ + \text{e}^-$	\rightleftharpoons	K	- 2,93
$\text{Cs}^+ + \text{e}^-$	\rightleftharpoons	Cs	- 2,92
$\text{Ba}^{2+} + 2\text{e}^-$	\rightleftharpoons	Ba	- 2,90
$\text{Sr}^{2+} + 2\text{e}^-$	\rightleftharpoons	Sr	- 2,89
$\text{Ca}^{2+} + 2\text{e}^-$	\rightleftharpoons	Ca	- 2,87
$\text{Na}^+ + \text{e}^-$	\rightleftharpoons	Na	- 2,71
$\text{Mg}^{2+} + 2\text{e}^-$	\rightleftharpoons	Mg	- 2,36
$\text{Al}^{3+} + 3\text{e}^-$	\rightleftharpoons	Al	- 1,66
$\text{Mn}^{2+} + 2\text{e}^-$	\rightleftharpoons	Mn	- 1,18
$\text{Cr}^{2+} + 2\text{e}^-$	\rightleftharpoons	Cr	- 0,91
$2\text{H}_2\text{O} + 2\text{e}^-$	\rightleftharpoons	$\text{H}_2(\text{g}) + 2\text{OH}^-$	- 0,83
$\text{Zn}^{2+} + 2\text{e}^-$	\rightleftharpoons	Zn	- 0,76
$\text{Cr}^{3+} + 3\text{e}^-$	\rightleftharpoons	Cr	- 0,74
$\text{Fe}^{2+} + 2\text{e}^-$	\rightleftharpoons	Fe	- 0,44
$\text{Cr}^{3+} + \text{e}^-$	\rightleftharpoons	Cr^{2+}	- 0,41
$\text{Cd}^{2+} + 2\text{e}^-$	\rightleftharpoons	Cd	- 0,40
$\text{Co}^{2+} + 2\text{e}^-$	\rightleftharpoons	Co	- 0,28
$\text{Ni}^{2+} + 2\text{e}^-$	\rightleftharpoons	Ni	- 0,27
$\text{Sn}^{2+} + 2\text{e}^-$	\rightleftharpoons	Sn	- 0,14
$\text{Pb}^{2+} + 2\text{e}^-$	\rightleftharpoons	Pb	- 0,13
$\text{Fe}^{3+} + 3\text{e}^-$	\rightleftharpoons	Fe	- 0,06
$2\text{H}^+ + 2\text{e}^-$	\rightleftharpoons	$\text{H}_2(\text{g})$	0,00
$\text{S} + 2\text{H}^+ + 2\text{e}^-$	\rightleftharpoons	$\text{H}_2\text{S}(\text{g})$	+ 0,14
$\text{Sn}^{4+} + 2\text{e}^-$	\rightleftharpoons	Sn^{2+}	+ 0,15
$\text{Cu}^{2+} + \text{e}^-$	\rightleftharpoons	Cu^+	+ 0,16
$\text{SO}_4^{2-} + 4\text{H}^+ + 2\text{e}^-$	\rightleftharpoons	$\text{SO}_2(\text{g}) + 2\text{H}_2\text{O}$	+ 0,17
$\text{Cu}^{2+} + 2\text{e}^-$	\rightleftharpoons	Cu	+ 0,34
$2\text{H}_2\text{O} + \text{O}_2 + 4\text{e}^-$	\rightleftharpoons	4OH^-	+ 0,40
$\text{SO}_2 + 4\text{H}^+ + 4\text{e}^-$	\rightleftharpoons	$\text{S} + 2\text{H}_2\text{O}$	+ 0,45
$\text{Cu}^+ + \text{e}^-$	\rightleftharpoons	Cu	+ 0,52
$\text{I}_2 + 2\text{e}^-$	\rightleftharpoons	2I^-	+ 0,54
$\text{O}_2(\text{g}) + 2\text{H}^+ + 2\text{e}^-$	\rightleftharpoons	H_2O_2	+ 0,68
$\text{Fe}^{3+} + \text{e}^-$	\rightleftharpoons	Fe^{2+}	+ 0,77
$\text{NO}_3^- + 2\text{H}^+ + \text{e}^-$	\rightleftharpoons	$\text{NO}_2(\text{g}) + \text{H}_2\text{O}$	+ 0,80
$\text{Ag}^+ + \text{e}^-$	\rightleftharpoons	Ag	+ 0,80
$\text{Hg}^{2+} + 2\text{e}^-$	\rightleftharpoons	$\text{Hg}(\ell)$	+ 0,85
$\text{NO}_3^- + 4\text{H}^+ + 3\text{e}^-$	\rightleftharpoons	$\text{NO}(\text{g}) + 2\text{H}_2\text{O}$	+ 0,96
$\text{Br}_2(\ell) + 2\text{e}^-$	\rightleftharpoons	2Br^-	+ 1,07
$\text{Pt}^{2+} + 2\text{e}^-$	\rightleftharpoons	Pt	+ 1,20
$\text{MnO}_2 + 4\text{H}^+ + 2\text{e}^-$	\rightleftharpoons	$\text{Mn}^{2+} + 2\text{H}_2\text{O}$	+ 1,23
$\text{O}_2(\text{g}) + 4\text{H}^+ + 4\text{e}^-$	\rightleftharpoons	$2\text{H}_2\text{O}$	+ 1,23
$\text{Cr}_2\text{O}_7^{2-} + 14\text{H}^+ + 6\text{e}^-$	\rightleftharpoons	$2\text{Cr}^{3+} + 7\text{H}_2\text{O}$	+ 1,33
$\text{Cl}_2(\text{g}) + 2\text{e}^-$	\rightleftharpoons	2Cl^-	+ 1,36
$\text{MnO}_4^- + 8\text{H}^+ + 5\text{e}^-$	\rightleftharpoons	$\text{Mn}^{2+} + 4\text{H}_2\text{O}$	+ 1,51
$\text{H}_2\text{O}_2 + 2\text{H}^+ + 2\text{e}^-$	\rightleftharpoons	$2\text{H}_2\text{O}$	+ 1,77
$\text{Co}^{3+} + \text{e}^-$	\rightleftharpoons	Co^{2+}	+ 1,81
$\text{F}_2(\text{g}) + 2\text{e}^-$	\rightleftharpoons	2F^-	+ 2,87

Increasing oxidising ability

Increasing reducing ability