Province of the
EASTERN CAPE
EDUCATION

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Porafensie Ya Kapa Botjahabela: Lefapha la Thuto

NATIONAL SENIOR CERTIFICATE

GRADE 11

NOVEMBER 2025

TECHNICAL SCIENCES P2

MARKS: **75**

TIME: **1 ½ hours**

This question paper consists of 12 pages, including 4 data sheets.

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INSTRUCTIONS AND INFORMATION

1. Write your NAME and SURNAME in the appropriate spaces on the ANSWER BOOK.
2. This question paper consists of FIVE 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, for example between QUESTION 2.1 and QUESTION 2.2.
6. You may use a non-programmable calculator.
7. You may use appropriate mathematical instruments.
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. You are advised to use the attached DATA SHEETS
12. Write neatly and legibly.

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QUESTION 1: MULTIPLE-CHOICE QUESTIONS

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

1.1 Which ONE of the following is NOT an example of a heat engine?

A Steam locomotive

B Jet engine

C Diesel engine

D Refrigerator (2)

1.2 A system absorbs 600 J of heat and does 350 J of work. What is the change in internal energy of the system?

A 950 J

B 350 J

C 250 J

D 600 J (2)

1.3 If 8 400 J of heat is added to 1 kg of water, what will be the temperature change?

A 2 °C

B 1 °C

C 8 °C

D 4 °C (2)

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1.4 Consider the chemical equation for the reaction between lead and copper below.

$$Pb_{(s)} + Cu^{2+}_{(aq)} \rightarrow Pb^{2+}_{(aq)} + Cu_{(s)}$$

Which ONE of the following statements is CORRECT?

A Cu is oxidised and acts as the reducing agent.

B Pb is oxidised and act as the reducing agent.

C Cu^{2+} is oxidised and acts the reducing agent.

D Pb^{2+} is reduced and acts as the oxidising agent. (2)

1.5 What happens to the anions during electrolysis?

A They move toward the negative electrode and are oxidised.

B They move toward the negative electrode and are reduced.

C They move toward the positive electrode and are oxidised.

D They move toward the positive electrode and are reduced. (2)

[10]

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QUESTION 2 (Start on a new page.)

Thermodynamics is the study of how heat is transferred into or out of a system.
It describes what happens when systems are heated, cooled or used to do work.

2.1 Define the following terms:

2.1.1 *Open system* (2)

2.1.2 *Internal energy* (2)

2.2 Write down THREE thermodynamic variables that can influence the thermal state of a system. (3)

2.3 The internal energy of a thermodynamic system increases by 145 kJ of heat energy, when it absorbs 550 kJ of heat.

2.3.1 State the *first law of thermodynamics* in words. (2)

2.3.2 Calculate the work done during this process. (3)

2.3.3 Is the work done by the system or on the system?
Give a reason for the answer. (2)
[14]

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QUESTION 3 (Start on a new page.)

3.1 A 2 000 g block of copper is heated in a laboratory. The temperature of the block rises from 20 °C to 60 °C.

3.1.1 Define the term *heat capacity*. (2)

3.1.2 Calculate the heat capacity of the copper block. (3)

3.1.3 Calculate the heat gained by the block of copper. (3)

3.2 A warm block of lead with a mass of 358 g at a temperature of 90 °C is added to 400 g of water at a temperature of 16 °C. The highest final temperature of the water and the block is 18 °C.

3.2.1 Name the instrument that is used to measure temperature. (1)

3.2.2 State the *law of conservation of heat*. (2)

3.2.3 Use a calculation to show that the specific heat capacity of lead is 130 $J \cdot kg^{-1}K^{-1}$, rounded to the nearest whole number. (6)

[17]

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QUESTION 4 (Start on a new page.)

Redox reactions play a vital role in a wide range of everyday chemical processes, from the rusting of iron to the operation of batteries and certain biological processes in the human body.

4.1 Differentiate between *oxidation* and *reduction*. (4)

4.2 Determine the oxidation number of the underlined substance in each of the following:

4.2.1 $\underline{Mg}C\ell_2$ (2)

4.2.2 $\underline{N}O_3^-$ (2)

4.2.3 $Na_2\underline{C}O_3$ (2)

4.3 Consider the balanced chemical reaction below.

$$Fe_2O_{3\,(s)} + 2\,A\ell_{\,(s)} \rightarrow 2\,Fe_{(s)} + A\ell_2O_{3(s)}$$

4.3.1 Explain why this is a redox reaction. (2)

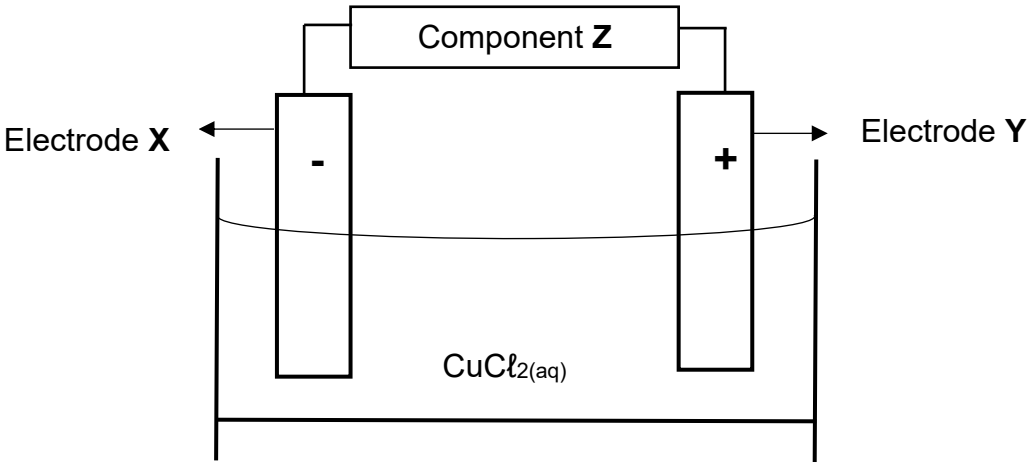
4.3.2 Which substance undergoes reduction? (2)

4.3.3 Which substance is the reducing agent?
Give a reason for the answer by referring to oxidation numbers. (3)
[17]

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QUESTION 5 (Start on a new page.)

The diagram below represents the experimental setup for the electrolysis of a $CuC\ell_2$ solution. Carbon electrodes are used in this electrochemical cell.



5.1 Define the term *electrolysis*. (2)

5.2 Write the NAME of the electrolyte used in this electrochemical cell. (1)

5.3 What does component **Z** represent? (1)

5.4 Define the term *oxidising agent*. (2)

5.5 Write down the NAME or FORMULA of the oxidising agent. (1)

5.6 Which one of the electrodes, **X** or **Y** is the anode?
Give a reason for the answer. (3)

5.7 Which ions, CATIONS or ANIONS will move toward the cathode? (1)

5.8 What observation will be made at electrode **Y**? (2)

5.9 Write down the half reaction that will take place at:

5.9.1 Electrode **X** (2)

5.9.2 Electrode **Y** (2)
[17]

TOTAL: 75

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DATA FOR TECHNICAL SCIENCES GRADE 11
PAPER 2/

GEGEWENS VIR TEGNIESE WETENSKAPPE GRAAD 11
VRAESTEL 2

TABLE 1: SPECIFIC HEAT CAPACITIES/
TABEL 1: SPESIFIEKE WARMTEKAPASITEIT

NAME/*NAAM*	VALUES/*WAARDES* ($J.kg^{-1}.K^{-1}$)
Water	4 200
Copper/*Koper*	400
Aluminium	900
Glass/*Glas*	700
Ethyl alcohol/*Etielalkohol*	2 460
Iron/*Yster*	460
Zinc/*Sink*	380
Lead/*Lood*	130
Ice/*Ys*	2 100
Brass	380
Mercury/*Kwik*	140
Methylated spirits/*Brandspiritus*	2 400

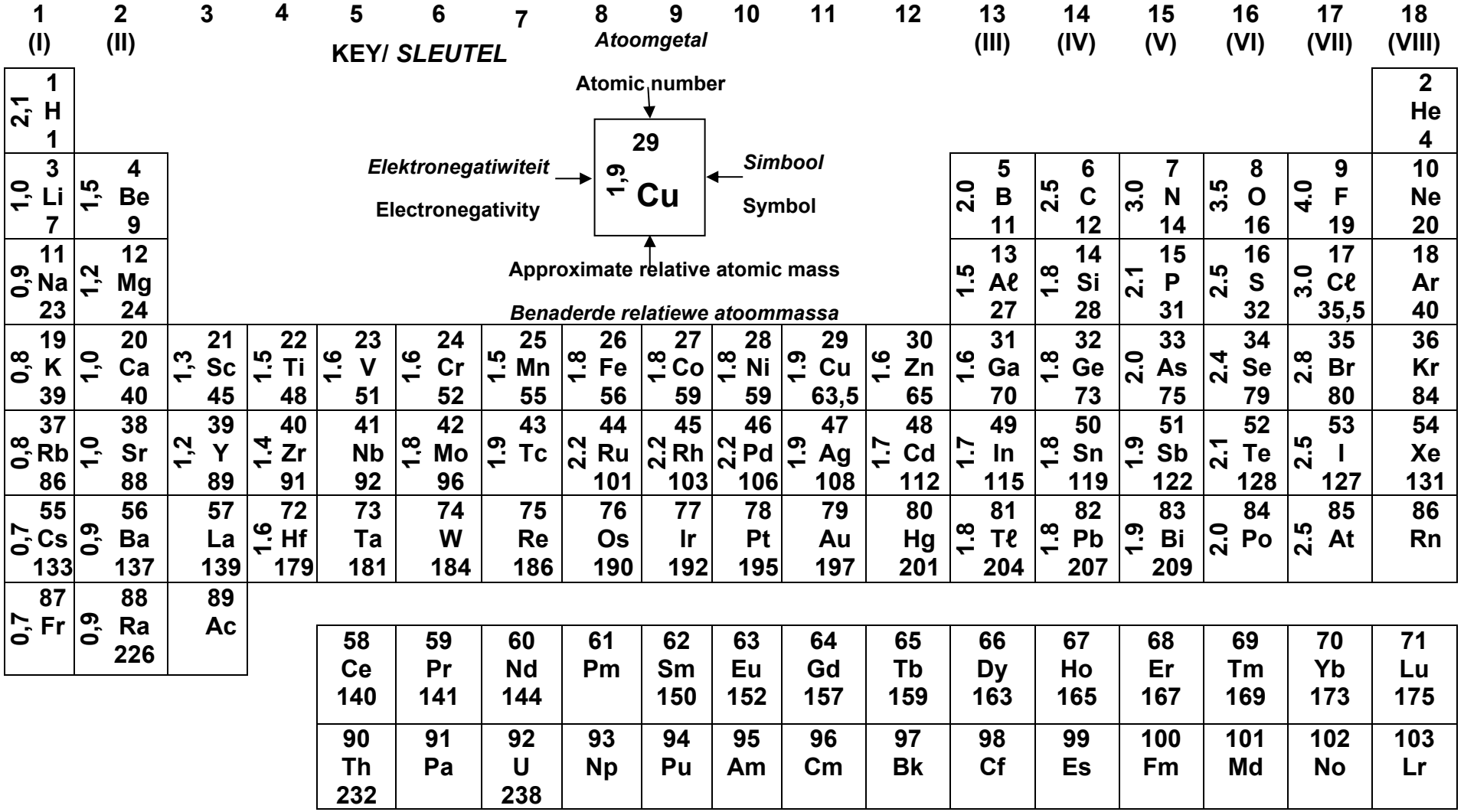
TABLE 2: HEAT AND THERMODYNAMICS/
TABEL 2: HITTE EN TERMODINAMIKA

$C = c\ m$	$Q = c\ m\ \Delta T$	$\Delta Q = \Delta U + \Delta W$

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TABLE 3: THE PERIODIC TABLE OF ELEMENTS/*TABEL 3: DIE PERIODIEKE TABEL VAN ELEMENTE*



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TABLE 4A: STANDARD REDUCTION POTENTIALS/ *TABEL 4A: STANDAARD REDUKSIEPOTENSIALE*

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/ *TABEL 4B: STANDAARD REDUKSIEPOTENSIALE*

Increasing oxidising ability/*Toenemende oksiderende vermoë* ↓

Increasing reducing ability/*Toenemende reduserende vermoë* ↑

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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