



MOGALAKWENA DISTRICT

PHYSICAL SCIENCES

NATIONAL SENIOR CERTIFICATE

**TERM 3 CONTROLLED TEST
08 SEPTEMBER 2023
GRADE 11**

MARKS: 100

TIME: 2 hours

This question paper consists of 15 pages including this one

INSTRUCTIONS

1. This question paper consists of **15** pages including the cover page
2. Answer all the questions in the answer book
3. You are advised to use the attached DATA SHEETS.
4. Round off your final answer to a minimum of TWO decimal places
5. Show all your calculations including formulae where applicable.
6. Candidates may use non-programmable calculators.
7. Write neatly and legibly.

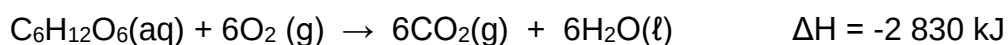
QUESTION 1: MULTIPLE-CHOICE QUESTIONS

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 (1.1 - 1.10) in the ANSWER BOOK

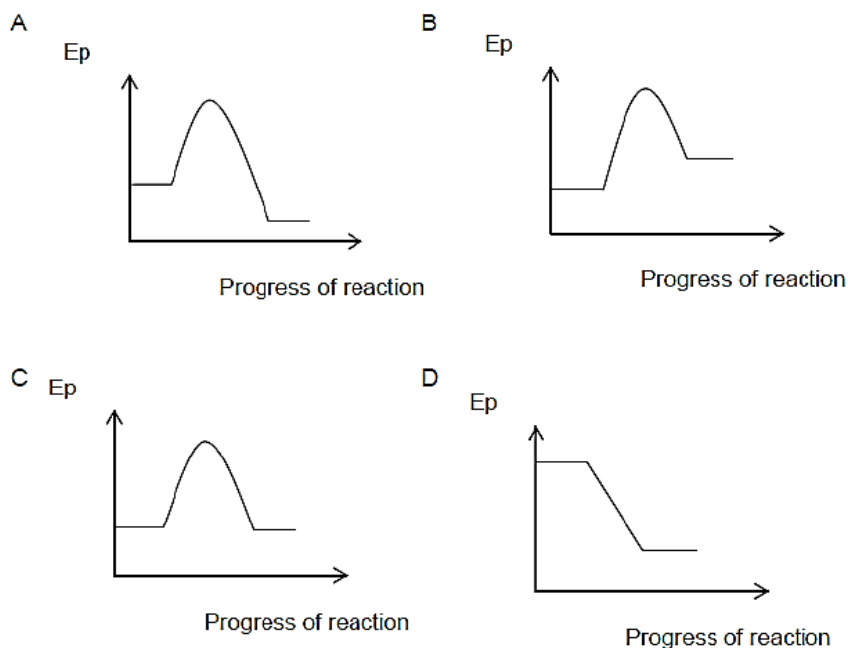
1.1 According to the Arrhenius theory, all bases ...

- A are proton donors.
- B are proton acceptors.
- C form H_3O^+ ions in solution
- D form OH^- ions in solution (2)

1.2 Cellular respiration occurs inside the cells of all living organisms. Oxygen reacts with glucose in cellular respiration to produce the following compounds according to the balanced equation below:

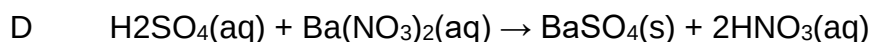
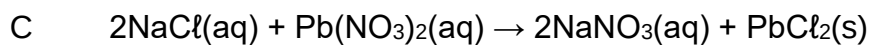
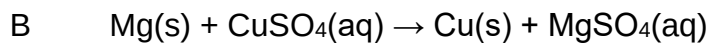


The potential energy versus progress of reaction diagram for this



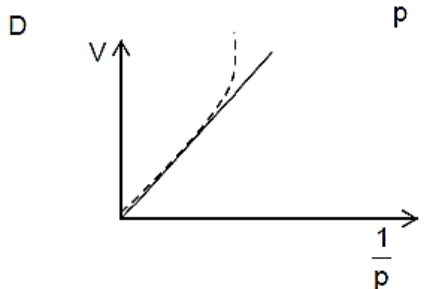
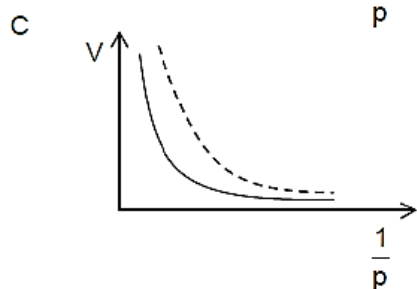
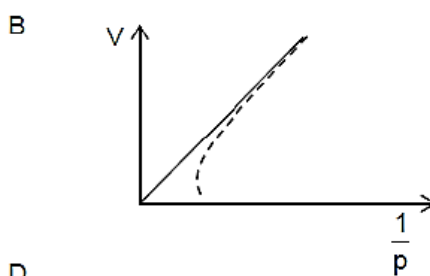
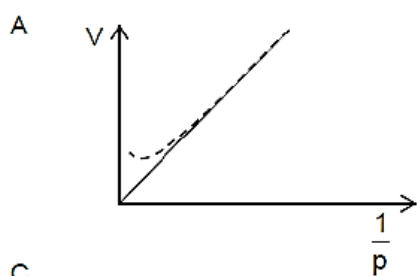
(2)

1.3 Which ONE of the following balanced equations represents a redox reaction?



(2)

1.4 Which ONE of the graphs below CORRECTLY represents the deviation of a real gas from ideal gas behaviour at very high pressures? The dotted line represents the graph of the real gas.



(2)

1.5 The oxidation number of phosphorus in H_3PO_4 is ...

A +3

B -2

C +2

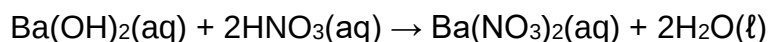
D +5

(2)

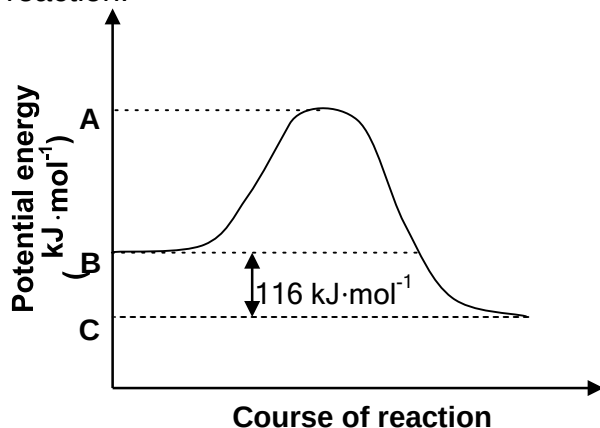
[10]

QUESTION 2 (START ON A NEW PAGE)

A barium hydroxide solution, $\text{Ba}(\text{OH})_2(\text{aq})$, reacts with a nitric acid solution, $\text{HNO}_3(\text{aq})$, according to the following balanced equation:



The potential energy graph below shows the change in potential energy for this reaction.



2.1 Is this reaction ENDOTHERMIC or EXOTHERMIC?

Give a reason for the answer.

(2)

2.2 Use energy values A, B and C indicated on the graph and write down an expression for each of the following:

2.2.1 The energy of the activated complex (1)

2.2.2 The activation energy for the forward reaction (1)

2.2.3 Potential energy of the products for the forward reaction (1)

2.2.3 ΔH for the reverse reaction (1)

2.3 Calculate the amount of energy released during the reaction if 0,18 moles of $\text{Ba}(\text{OH})_2(\text{aq})$ reacts completely with the acid.

(3)

[9]

QUESTION 3 (START ON A NEW PAGE)

The fizz produced when an antacid dissolves in water is caused by the reaction between sodium hydrogen carbonate (NaHCO_3) and citric acid ($\text{H}_3\text{C}_6\text{H}_5\text{O}_7$). The balanced equation for the reaction is:



- 3.1 Write down the FORMULA of the substance that causes the fizz when the antacid dissolves in water. (1)

A certain antacid contains 1,8 g of $\text{H}_3\text{C}_6\text{H}_5\text{O}_7$ and 3,36 g of NaHCO_3 . The antacid is dissolved in 100 cm^3 distilled water in a beaker.

- 3.2 Define *1 mole of a substance*. (2)
- 3.3 Calculate the number of moles of NaHCO_3 in the antacid. (3)
- 3.4 Determine, using calculations, which substance is the limiting reagent. (4)
- 3.5 Calculate the mass of the reactant in excess. (3)
- 3.6 Calculate the mass decrease of the beaker contents on completion of the reaction. (3)

[16]

QUESTION 4 (START ON A NEW PAGE)

- 4.1 Define the term *concentration*. (2)
- 4.2 Eight (8) grams of $\text{Na}_2\text{S}_2\text{O}_3$ is dissolved in water to prepare 500 cm^3 of solution. Calculate the concentration of the $\text{Na}_2\text{S}_2\text{O}_3$ solution. (3)
- 4.3 A 10 g sample of a compound contains 2,66 g of potassium, 3,54 g of chromium and 3,81 g of oxygen.
- 4.3.1 Define the term *empirical formula*. (2)
- 4.3.2 Determine the empirical formula of this compound. (7)

[14]

QUESTION 5 (START ON A NEW PAGE)

A certain amount of gas is sealed in a container of which the volume can change. The relationship between the pressure and volume of the gas at 20 °C is investigated. The results of the experiment are given in the table below.

PRESSURE (kPa)	VOLUME (dm ³)
140	348
190	256
260	187,2
330	148
410	118
480	102
520	94

- 5.1 Name the gas law that is represented by the results of the experiment. (1)
- 5.2 Write down a hypothesis for the investigation. (2)
- 5.3 Draw a graph of volume versus pressure on the ANSWER SHEET attached. (4)
- 5.4 Calculate the volume of the gas at 600 kPa. (3)
- 5.5 When the volume of the gas is measured at 600 kPa, it is 88 dm³.
Explain why the measured volume differs from the volume calculated in QUESTION 5.4. (2)
- 5.6 Which temperature condition will cause a gas to deviate from ideal behavior? Write only **HIGH** or **LOW**. (1)
- 5.7 Explain the answer to QUESTION 5.6. (2)
- 5.8 Calculate the number of moles of the gas in the container at the INITIAL pressure and volume. (4)

[19]

QUESTION 6 (START ON A NEW PAGE)

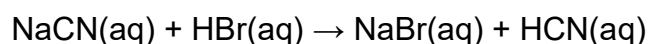
Acids and bases play a large part in industrial chemistry and in everyday life. Almost every biological chemical process is tightly bound up with acid-base equilibria in the organism, and the acidity or alkalinity of the soil and water are of great importance for the plants or animals living in them.

6.1 Define an *acid* in terms of the Lowry-Brønsted theory. (2)

6.2 Predict the products and write a balanced equation for the following chemical reaction:



6.3 Identify the Bronsted-Lowry acid and base and their conjugate pair in the following reaction: (4)



6.4 What is a term used to describe a substance that can act as either acid or Base (1)

6.5 A few drops of bromothymol blue indicator are added to a potassium hydroxide solution in a beaker. A dilute sulphuric acid solution is now gradually added to this solution until the colour of the indicator changes.

Write down the:

6.5.1 Type of reaction that takes place
(Write down only REDOX, PRECIPITATION or NEUTRALISATION.) (1)

6.5.2 Balanced equation for the reaction that takes place (3)

6.5.3 Colour change of the indicator (2)

6.5.4 NAME of the salt formed in this reaction (1)

[14]

QUESTION 7 (START ON A NEW PAGE)

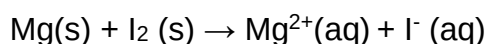
7.1 Oxidation numbers make it easier to determine whether an element or a substance is oxidised or reduced during a chemical reaction.

7.1.1 Define the term *oxidation* with reference to oxidation numbers. (2)

7.1.2 Calculate the oxidation number of chromium in $\text{Cr}_2\text{O}_7^{2-}$. (2)

7.1.3 Calculate the oxidation number of oxygen in H_2O_2 . (2)

7.2 Consider the UNBALANCED equation below:



7.2.1 Define the term REDUCING AGENT in terms of oxidation numbers. (2)

7.2.2 Identify the reducing agent in the above reaction. (1)

7.2.3 Write down the FORMULA of the substance that is reduced. (1)

Write down the balanced equation for:

7.2.4 Oxidation half-reaction (2)

7.2.5 Reduction half-reaction (2)

7.2.6 Balanced net redox reaction (2)

[16]

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

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

TABLE 1: PHYSICAL CONSTANTS/TABEL 1: FISIESTE KONSTANTES

NAME/NAAM	SYMBOL/SIMBOOL	VALUE/WAARDE
Avogadro's constant <i>Avogadro-konstante</i>	N_A	$6,02 \times 10^{23} \text{ mol}^{-1}$
Molar gas constant <i>Molêre gaskonstante</i>	R	$8,31 \text{ J} \cdot \text{K}^{-1} \cdot \text{mol}^{-1}$
Standard pressure <i>Standaarddruk</i>	p^θ	$1,013 \times 10^5 \text{ Pa}$
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^θ	273 K

TABLE 2: FORMULAE/TABEL 2: FORMULES

$\frac{p_1 V_1}{T_1} = \frac{p_2 V_2}{T_2}$	$pV = nRT$
$n = \frac{m}{M}$	$n = \frac{N}{N_A}$
$n = \frac{V}{V_m}$	$c = \frac{n}{V}$ OR/OF $c = \frac{m}{MV}$

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

Half-reactions/Halfreaksies	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/Toenemende oksiderende vermoë

Increasing reducing ability/Toenemende reduserende vermoë

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

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

Increasing oxidising ability/Toenemende oksiderende vermoë

Increasing reducing ability/Toenemende reduserende vermoë

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

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 1 H																	2 He
3 Li	4 Be											5 B	6 C	7 N	8 O	9 F	10 Ne
11 Na	12 Mg											13 Al	14 Si	15 P	16 S	17 Cl	18 Ar
19 K	20 Ca	21 Sc	22 Ti	23 V	24 Cr	25 Mn	26 Fe	27 Co	28 Ni	29 Cu	30 Zn	31 Ga	32 Ge	33 As	34 Se	35 Br	36 Kr
37 Rb	38 Sr	39 Y	40 Zr	41 Nb	42 Mo	43 Tc	44 Ru	45 Rh	46 Pd	47 Ag	48 Cd	49 In	50 Sn	51 Sb	52 Te	53 I	54 Xe
55 Cs	56 Ba	57 La	58 Ce	59 Pr	60 Nd	61 Pm	62 Sm	63 Eu	64 Gd	65 Tb	66 Dy	67 Ho	68 Er	69 Tm	70 Yb	71 Lu	
87 Fr	88 Ra	89 Ac	90 Th	91 Pa	92 U	93 Np	94 Pu	95 Am	96 Cm	97 Bk	98 Cf	99 Es	100 Fm	101 Md	102 No	103 Lr	

KEY/SLEUTEL

Atomic number
Atoomgetal

Electronegativity
Elektronegatiwiteit

Symbol
Simbool

Approximate relative atomic mass
Benaderde relatiewe atoommassa

SUBMIT THIS SHEET WITH THE ANSWER BOOK.

NAME _____ **CLASS** _____

QUESTION 5.3

