



LIMPOPO
PROVINCIAL GOVERNMENT
REPUBLIC OF SOUTH AFRICA

DEPARTMENT OF
EDUCATION

**NATIONAL
SENIOR CERTIFICATE**

GRADE 11

**PHYSICAL SCIENCES
TERM 3 CONTROLLED TEST
SEPTEMBER 2025**

MARKS: 100

TIME: 2 hours

This question paper consists of 10 pages, 4 data sheets and 1 graph paper.

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INSTRUCTIONS AND INFORMATION

1. Write your name and other applicable information in the appropriate spaces on the ANSWER BOOK.
2. The question paper consists of SEVEN questions. Answer ALL the questions in the ANSWER BOOK, except question 7.2.2 which should be answered on the provided graph paper on page 15.
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 sub-questions, for example between QUESTION 3.1 and QUESTION 3.2.
6. You may use a non-programmable pocket 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 maximum of THREE decimal places where necessary.
10. Give brief motivations, discussions, etc. where required.
11. You are advised to use the attached DATA SHEETS.
12. 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. Choose the answer and write only the letter (A – D) next to the question number (1.1 – 1.5) in the ANSWER BOOK, e.g. 1.6 A.

- 1.1 The activation energy for the forward reaction of the reaction below is 230 kJ.mol^{-1}



What is the enthalpy change for this reaction?

- A. 380
- B. 230
- C. 150
- D. 80

(2)

- 1.2 ONE mole of water (H_2O) and ONE mole of carbon dioxide (CO_2) will have the same...

- A. molar mass.
- B. mass.
- C. density.
- D. number of molecules.

(2)

- 1.3 Which of the following represents a neutralization reaction?

- A. $\text{HCl} + \text{Zn} \rightarrow \text{ZnCl}_2$
- B. $\text{H}_2\text{NO}_3 + \text{Cu} \rightarrow \text{Cu}(\text{NO}_3)_2$
- C. $\text{H}_2\text{SO}_4 + 2\text{NaOH} \rightarrow \text{Na}_2\text{SO}_4 + 2\text{H}_2\text{O}$
- D. $\text{NaOH} + \text{NH}_4\text{Cl} \rightarrow \text{NH}_3 + \text{NaCl} + \text{H}_2\text{O}$

(2)

- 1.4 Reducing agent is a substance ...

- A. that gains electrons
- B. that is reduced
- C. whose oxidation number decreases
- D. that is oxidized

(2)

1.5 The pressure of a gas is 200 kPa when its volume is 3 000 cm³. If the gas is compressed to 2 000 cm³ at constant temperature, what is its new pressure?

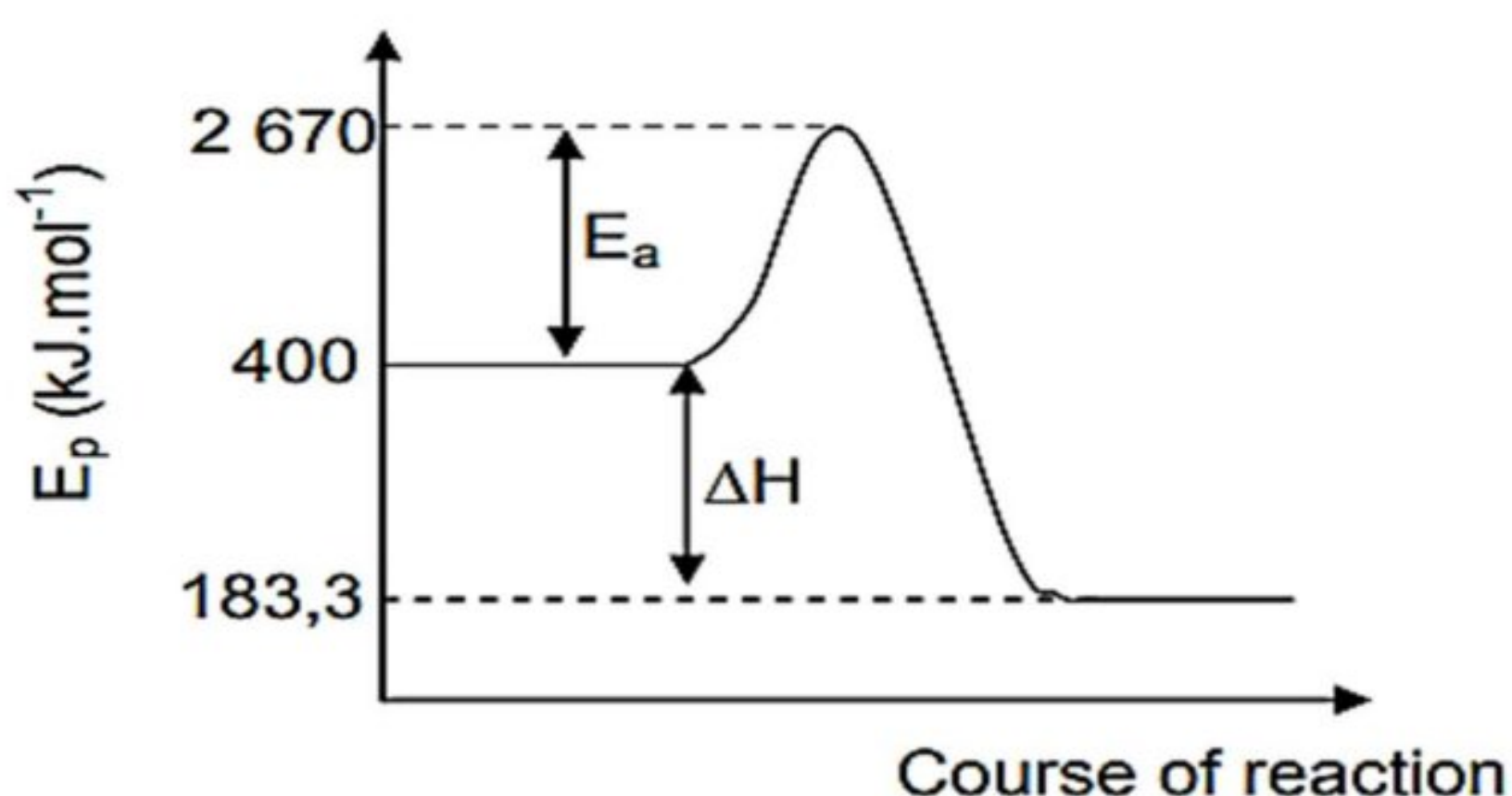
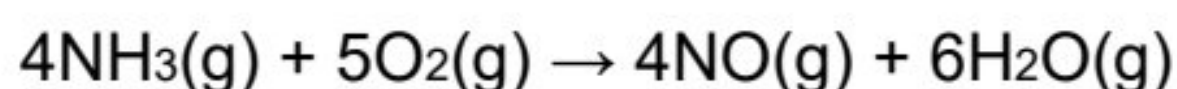
- A. 250 kPa
- B. 300 kPa
- C. 350 kPa
- D. 400 kPa

(2)

[10]

QUESTION 2 (Start on a new page)

The following reaction between Ammonia and Oxygen takes place at constant pressure and temperature:

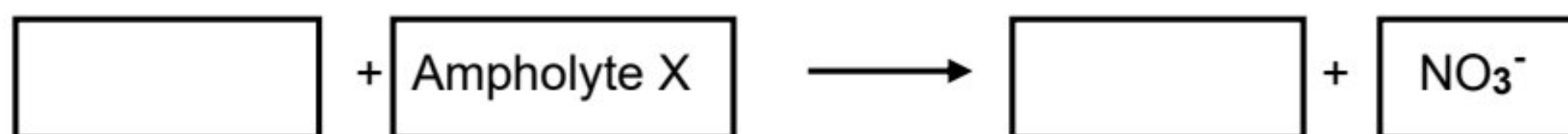


- 2.1 Define the term *activation energy*. (2)
- 2.2 Give a reason why this reaction is exothermic. (1)
- 2.3 Redraw the graph and indicate with a dotted line the effect of a catalyst on the activation energy. (1)
- 2.4 Write down the values for the:
 - 2.4.1 Energy of the products (1)
 - 2.4.2 Energy of the reactants (1)
 - 2.4.3 Activation energy for the reverse reaction (1)
 - 2.4.4 Activation energy for the forward reaction. (1)
- 2.5 Calculate the heat of reaction, (ΔH), for the reverse reaction. (2)
- 2.6 What effect will the addition of the catalyst have on:
(Choose from INCREASES, DECREASES or REMAINS THE SAME)
 - 2.6.1 The energy of the products? (1)
 - 2.6.2 The heat of reaction? (1)
 - 2.6.3 The activation energy for the reverse reaction? (1)

[13]

QUESTION 3 (Start on a new page)

- 3.1 The diagram below shows the reactions of nitric acid with ampholyte **X** to form hydronium ion and a nitrate ion according to the reaction below. Study the flow diagram carefully and answer the questions that follow.



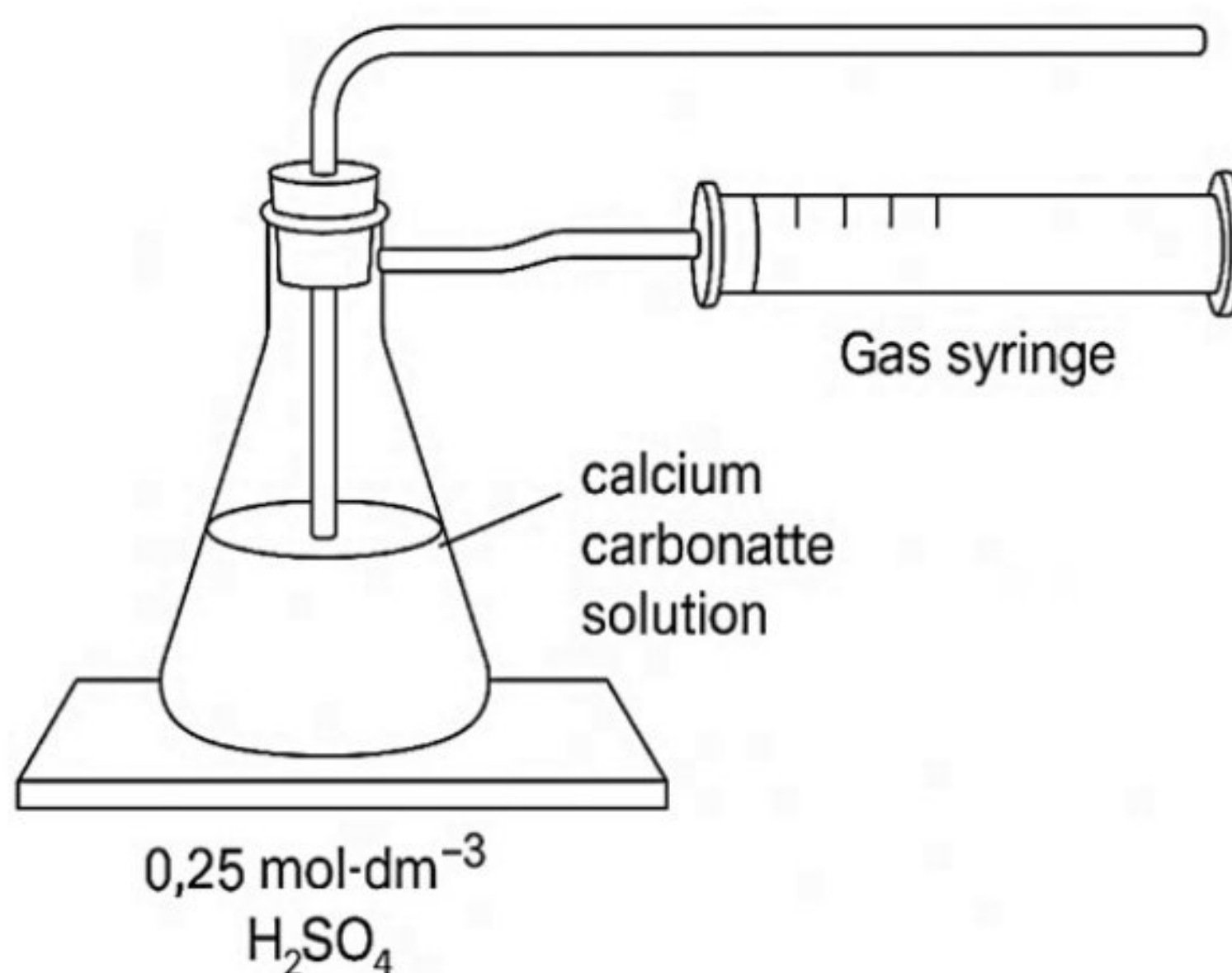
- 3.1.1 Define a *base* in terms of Arrhenius theory. (2)
- 3.1.2 Write a chemical equation for the reaction above. (3)
- 3.1.3 Write down the NAME of ampholyte **X**. (2)
- 3.2 Explain why water identifies as a base in the reaction below. (2)
- $$\text{HCl(aq)} + \text{H}_2\text{O(l)} \rightarrow \text{H}_3\text{O}^+(\text{aq}) + \text{Cl}^-(\text{aq})$$
- 3.3 Describe the term *acid-base indicator*. (2)
- 3.4 Write a balanced equation for this reaction and identify the acid and the base required to prepare potassium chloride. (3)

[14]

QUESTION 4 (Start on a new page)

A solution of calcium carbonate (CaCO_3) was prepared by dissolving 20 g of powdered CaCO_3 in 500 cm^3 of water.

This solution was then added to 500 cm^3 sulphuric acid (H_2SO_4) solution with a concentration of $0.25 \text{ mol}\cdot\text{dm}^{-3}$ as in the set up below.



- 4.1 Define the term *limiting agent*. (2)
- 4.2 Write a balanced equation for the reaction in the set up above. (3)
- 4.3 Calculate the initial concentration of the CaCO_3 solution. (4)
- 4.4 Which substance is the limiting reagent? Show by means of a suitable calculation. (4)
- 4.5 Calculate the percentage purity of the excess reagent. (5)

[18]

QUESTION 5 (Start on a new page)

5.1 Define the term *molar mass* in words. (2)

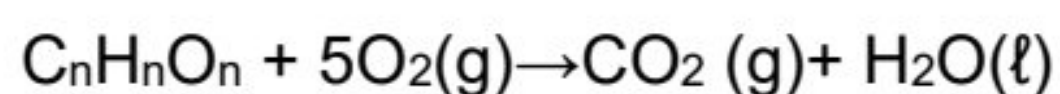
5.2 An organic acid was analysed and found that it has the following chemical composition:

76.6%carbon(C)

12.05%Hydrogen (H)

11.35%oxygen(O)

The reaction of this acid with alcohols produces a compound that has a fruity smell. During combustion, 0.01272g of this acid was used and it produced 0.01863g of carbon dioxide (CO₂) and 0.0075 g of water, according to the following reaction:



5.2.1 Calculate the molar mass of H₂O (2)

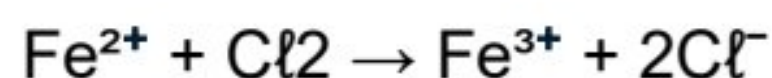
5.2.2 Given the percentages above, determine the empirical formula for the acid. (7)

5.3 Calculate the number of moles of carbon dioxide produced (3)

[14]

QUESTION 6 (Start on a new page)

6.1 Consider the balanced redox reaction:



6.1.1 Define the term *oxidizing agent* in terms of oxidation number. (2)

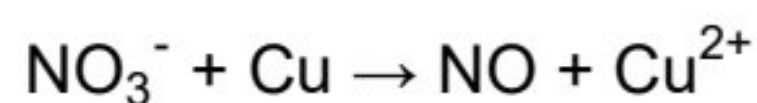
6.2 Write down the:

6.2.1 formula of the oxidizing agent. (1)

6.2.2 explanation for the answer in QUESTION 6.2.1 by referring to the oxidation numbers. (2)

6.2.3 oxidation half reaction. (2)

6.3 Consider the UNBALANCED equation below:



6.3.1 In the given reaction above, which substances are:

(a) oxidized? (1)

(b) reduced? (1)

6.3.2 Determine the oxidation number of N in NO_3^- . (2)

6.3.3 Provide the balanced net equation using the half-reaction method. (3)

[14]

QUESTION 7 (Start on a new page)

- 7.1 State *Boyle's law* in words. (2)
- 7.2 A sample of an ideal gas occupies a volume of 5.0 L at a pressure of 200 kPa. If the pressure is decreased to 150 kPa at constant temperature,
- 7.2.1 what is the value of the final volume? (4)
- 7.2.2 Use the graph paper provided to draw a pressure vs volume graph (not according to scale) and show by means of point **X** on the graph the initial and the final value of the volume. (4)
- 7.3 A gas sample has a mass of 16 g and occupies a volume of 11.2 dcm³ at standard temperature and pressure (STP).
Determine, by calculation, the formula of the gas. (5)
- 7.4 A bicycle tire is compressed, reducing its volume by half. If the temperature remains constant, what happens to the pressure of the air inside the tire? Explain your answer. (2)

[17]**TOTAL: [100]**

TABLE 1: PHYSICAL CONSTANTS/TABEL 1: FISIIESE 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

$P_1V_1 = P_2V_2$	
$n = \frac{m}{M}$	$n = \frac{N}{N_A}$
$n = \frac{V}{V_m}$	$c = \frac{n}{V}$ OR/OF $c = \frac{m}{MV}$

TABLE 3: THE PERIODIC TABLE OF ELEMENTS

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 H 1																	2 He 4
3 Li 7	4 Be 9											5 B 11	6 C 12	7 N 14	8 O 16	9 F 19	10 Ne 20
11 Na 23	12 Mg 24											13 Al 27	14 Si 28	15 P 31	16 S 32	17 Cl 35,5	18 Ar 40
19 K 39	20 Ca 40	21 Sc 45	22 Ti 48	23 V 51	24 Cr 52	25 Mn 55	26 Fe 56	27 Co 59	28 Ni 59	29 Cu 63,5	30 Zn 65	31 Ga 70	32 Ge 73	33 As 75	34 Se 79	35 Br 80	36 Kr 84
37 Rb 86	38 Sr 88	39 Y 89	40 Zr 91	41 Nb 92	42 Mo 96	43 Tc 96	44 Ru 101	45 Rh 103	46 Pd 106	47 Ag 108	48 Cd 112	49 In 115	50 Sn 119	51 Sb 122	52 Te 128	53 I 127	54 Xe 131
55 Cs 133	56 Ba 137	57 La 139	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	81 Tl 204	82 Pb 207	83 Bi 209	84 Po 209	85 At 209	86 Rn 222
87 Fr 223	88 Ra 226	89 Ac															
			58 Ce 140	59 Pr 141	60 Nd 144	61 Pm 147	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 231	92 U 238	93 Np 237	94 Pu 244	95 Am 243	96 Cm 247	97 Bk 247	98 Cf 251	99 Es 252	100 Fm 257	101 Md 288	102 No 289	103 Lr 260	

KEY/SLEUTEL

Atomic number
AtoomgetalElectronegativity
ElektronegatiwiteitSymbol
SimboolApproximate relative atomic mass
Benaderde relatiewe atoommassa

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
$Cl_2(g) + 2e^- \rightleftharpoons 2Cl^-$	+ 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
$Pl^{2+} + 2e^- \rightleftharpoons Pl$	+ 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 strength of oxidising agents / Toenemende sterkte van oksideermiddels

Increasing strength of reducing agents / Toenemende sterkte van reduseermiddels

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

Half-reactions / Halfreaksies		E^{θ} (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
$\text{Hg}^{2+} + 2\text{e}^{-}$	$\rightleftharpoons \text{Hg}(\text{l})$	+0,85
$\text{NO}_3^{-} + 4\text{H}^{+} + 3\text{e}^{-}$	$\rightleftharpoons \text{NO}(\text{g}) + 2\text{H}_2\text{O}$	+0,96
$\text{Br}_2(\text{l}) + 2\text{e}^{-}$	$\rightleftharpoons 2\text{Br}^{-}$	+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 strength of oxidising agents / Toenemende sterkte van oksideermiddels

Increasing strength of reducing agents / Toenemende sterkte van reduseermiddels

SUBMIT THIS SHEET WITH THE ANSWER SHEET

QUESTION 7.2.2

NAME: **CLASS**

