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.

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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}

$A_2 + B_2 \rightarrow 2C \quad \Delta H = + 150$ 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...

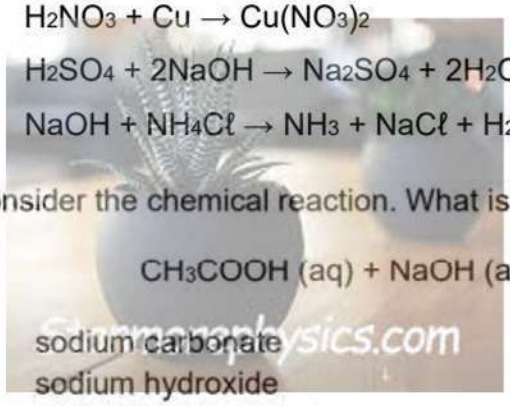
A. molar mass.
B. mass.
C. density.
D. number of molecules. (2)

1.3 Which of the following represents a neutralization reaction?

A. $HC\ell + Zn \rightarrow ZnC\ell_2$
B. $H_2NO_3 + Cu \rightarrow Cu(NO_3)_2$
C. $H_2SO_4 + 2NaOH \rightarrow Na_2SO_4 + 2H_2O$
D. $NaOH + NH_4C\ell \rightarrow NH_3 + NaC\ell + H_2O$ (2)

1.4 Consider the chemical reaction. What is the name of the salt formed in this reaction?

$$CH_3COOH\ (aq) + NaOH\ (aq) \rightarrow CH_3COONa\ (aq) + H_2O\ (l)$$



A. sodium carbonate
B. sodium hydroxide
C. sodium methanoate
D. sodium acetate (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?

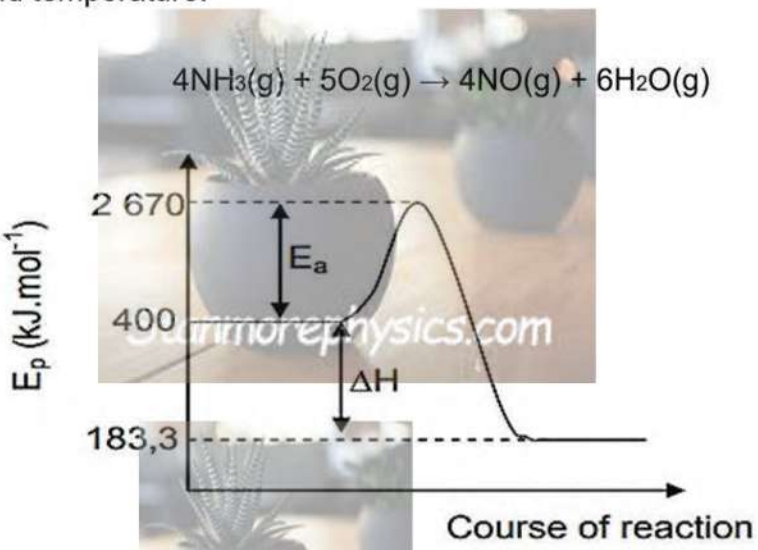
A. 250 kPa
B. 300 kPa
C. 350 kPa
D. 400 kPa (2)

[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)

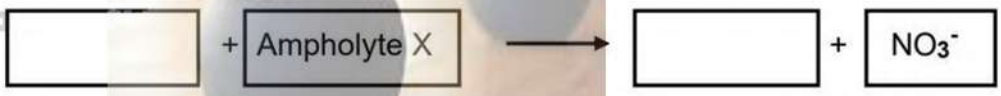
2.6.2 The heat of reaction? (1)

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.



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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.

$HC\ell(aq)+H_2O(l)\rightarrow H_3O^+(aq) + C\ell^-(aq)$ (2)

3.3 Describe the term *acid-base indicator.* (2)

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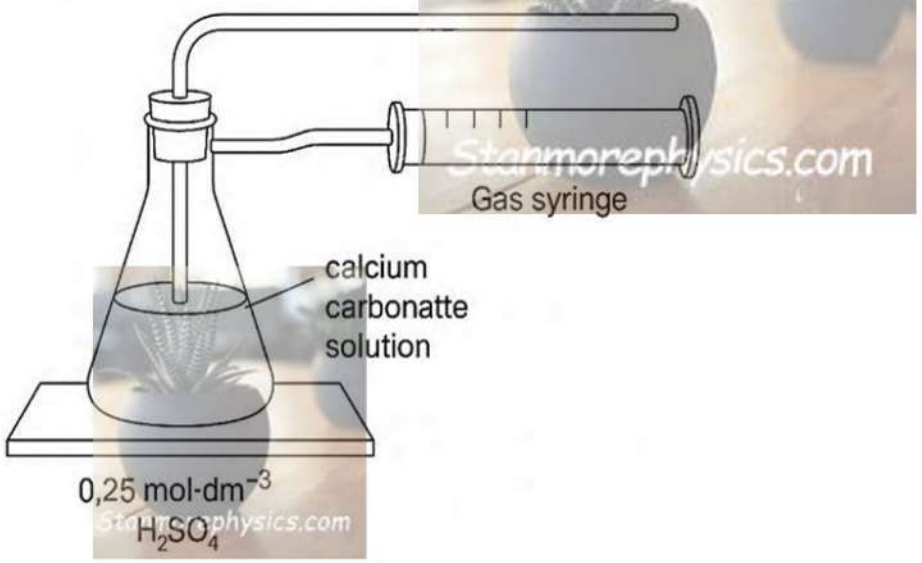
3.4 Write a balanced equation for this reaction and identify the acid and the base required to prepare potassium chloride. (3)

[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 $mol.dm^{-3}$ 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 (CO_2) and 0.0075 g of water, according to the following reaction:

$$C_nH_nO_n + 5O_2(g) \rightarrow CO_2\,(g) + H_2O(\ell)$$

5.2.1 Calculate the molar mass of H_2O (2)

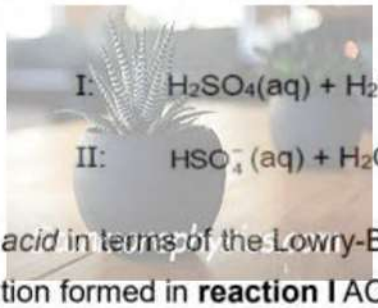
5.2.2 Given the percentages above, determine the empirical formula for the acid. (7)

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

[14]

QUESTION 6 (Start on a new page)

When sulphuric acid reacts with water, it ionises in two steps, as shown in the two balanced equations below:



I: $H_2SO_4(aq) + H_2O(\ell) \rightarrow H_3O^+(aq) + HSO_4^-(aq)$

II: $HSO_4^-(aq) + H_2O(\ell) \rightarrow H_3O^+(aq) + SO_4^{2-}(aq)$

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

6.2 Is the solution formed in **reaction I** ACIDIC or BASIC (ALKALINE)? Give a reason for your answer. (2)

6.3 Write down a conjugate base of H_3O^+ (2)

6.4 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:

6.4.1 Type of reaction that takes place. (2)

6.4.2 Balanced chemical equation for the reaction that takes place. (3)

6.4.3 Colour change of the indicator. Choose from the following:
Blue to yellow **OR** Yellow to blue **OR** Blue to purple (2)

6.4.4 Write down a reason why bromothymol blue is the most suitable indicator for this reaction. (1)

[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 dcm^3 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]

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

NAME/*NAAM*	SYMBOL/*SIMBOOL*	VALUE/*WAARDE*
Avogadro's constant *Avogadro-konstante*	N_A	$6{,}02 \times 10^{23}\ mol^{-1}$
Molar gas constant *Molêre gaskonstante*	R	$8{,}31\ J{\cdot}K^{-1}{\cdot}mol^{-1}$
Standard pressure *Standaarddruk*	p^{θ}	$1{,}013 \times 10^{5}\ Pa$
Molar gas volume at STP *Molêre gasvolume by STD*	V_m	$22{,}4\ dm^3{\cdot}mol^{-1}$
Standard temperature *Standaardtemperatuur*	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* $c = \frac{m}{MV}$

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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)
2,1 **H** 1																	**He** 4
1,0 **Li** 7	1,5 **Be** 9											2,0 **B** 11	2,5 **C** 12	3,0 **N** 14	3,5 **O** 16	4,0 **F** 19	**Ne** 20
0,9 **Na** 23	1,2 **Mg** 24											1,5 **Aℓ** 27	1,8 **Si** 28	2,1 **P** 31	2,5 **S** 32	3,0 **Cℓ** 35,5	**Ar** 40
0,8 **K** 39	1,0 **Ca** 40	1,3 **Sc** 45	1,5 **Ti** 48	1,6 **V** 51	1,6 **Cr** 52	1,5 **Mn** 55	1,8 **Fe** 56	1,8 **Co** 59	1,8 **Ni** 59	1,9 **Cu** 63,5	1,6 **Zn** 65	1,6 **Ga** 70	1,8 **Ge** 73	2,0 **As** 75	2,4 **Se** 79	2,8 **Br** 80	**Kr** 84
0,8 **Rb** 86	1,0 **Sr** 88	1,2 **Y** 89	1,4 **Zr** 91	**Nb** 92	1,8 **Mo** 96	1,9 **Tc**	2,2 **Ru** 101	2,2 **Rh** 103	2,2 **Pd** 106	1,9 **Ag** 108	1,7 **Cd** 112	1,7 **In** 115	1,8 **Sn** 119	1,9 **Sb** 122	2,1 **Te** 128	2,5 **I** 127	**Xe** 131
0,7 **Cs** 133	0,9 **Ba** 137	**La** 139	1,6 **Hf** 179	**Ta** 181	**W** 184	**Re** 186	**Os** 190	**Ir** 192	**Pt** 195	**Au** 197	**Hg** 201	1,8 **Tℓ** 204	1,8 **Pb** 207	1,9 **Bi** 209	2,0 **Po**	2,5 **At**	**Rn**
0,7 **Fr**	0,9 **Ra** 226	**Ac**															

Ce 140	**Pr** 141	**Nd** 144	**Pm**	**Sm** 150	**Eu** 152	**Gd** 157	**Tb** 159	**Dy** 163	**Ho** 165	**Er** 167	**Tm** 169	**Yb** 173	**Lu** 175
Th 232	**Pa**	**U** 238	**Np**	**Pu**	**Am**	**Cm**	**Bk**	**Cf**	**Es**	**Fm**	**Md**	**No**	**Lr**

KEY/*SLEUTEL*

Atomic number *Atoomgetal*

Electronegativity *Elektronegatiwiteit*

Symbol *Simbool*

Approximate relative atomic mass *Benaderde relatiewe atoommassa*

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

Increasing strength of oxidising agents / *Toenemende sterkte van oksideermiddels* ↑

Half-reactions / *Halfreaksies*			E^{θ} (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
$C\ell_2(g) + 2e^-$	⇌	$2C\ell^-$	+ 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
$Br_2(\ell) + 2e^-$	⇌	$2Br^-$	+ 1,07
$NO_3^- + 4H^+ + 3e^-$	⇌	$NO(g) + 2H_2O$	+ 0,96
$Hg^{2+} + 2e^-$	⇌	$Hg(\ell)$	+ 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
$A\ell^{3+} + 3e^-$	⇌	$A\ell$	– 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

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Increasing strength of reducing agents / *Toenemende sterkte van reduseermiddels* ↓

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

Increasing strength of oxidising agents / *Toenemende sterkte van oksideermiddels* ↓

Increasing strength of reducing agents / *Toenemende sterkte van reduseermiddels* ↑

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

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SUBMIT THIS SHEET WITH THE ANSWER SHEET

QUESTION 7.2.2

NAME: ..... CLASS .....

