

Note: all data sheets and half reaction tables have been attached at the end of this worksheet.

Question 1

Give **one word/term** for the following:

- 1.1 The electrode where oxidation takes place in electrochemical cells

- 1.2 The part of a galvanic cell that prevents the build up of charge in the reaction vessels

- 1.3 A substance whose oxidation number increases during a chemical reaction

[3]

Question 2: Multiple choice questions

Four possible options are provided as answers to the following questions. Each question has only ONE correct answer. Only write the correct letter (**A - D**) of the answer next to the question number.

- 2.1 The oxidation number of an oxidizing agent
 - A. Decreases
 - B. Remain constant
 - C. Is always zero
 - D. Increases

2.2 Consider the reaction:



In this reaction, electrons are transferred from:

- A. Al to Al^{3+}
- B. Cu to Cu^{2+}
- C. Al to Cu^{2+}
- D. Cu to Al^{3+}

2.3 Make use of oxidation numbers to determine which one of the following reactions is a redox reaction.

- A. $\text{NaCl} + \text{AgNO}_3 \rightarrow \text{NaNO}_3 + \text{AgCl}$
- B. $\text{Mn} + \text{CuCl}_2 \rightarrow \text{Cu} + \text{MnCl}_2$
- C. $\text{H}_2\text{SO}_4 + 2\text{KNO}_3 \rightarrow \text{K}_2\text{SO}_4 + 2\text{HNO}_3$
- D. $\text{HCl} + \text{H}_2\text{O} \rightarrow \text{Cl}^- + \text{H}_3\text{O}^+$

2.4 Considering the following simplified cell notations. Which one of the following reactions does not occur spontaneously?

- A. $\text{Zn} / \text{Zn}^{+2} // \text{Cu}^{+2} / \text{Cu}$
- B. $\text{Mg} / \text{Mg}^{+2} // \text{Cu}^{+2} / \text{Cu}$
- C. $\text{Cu} / \text{Cu}^{+2} // \text{Fe}^{+2} / \text{Fe}$
- D. $\text{Cu} / \text{Cu}^{+2} // \text{Ag}^{+1} / \text{Ag}$

2.5 Which of the following is **NOT** the function of the salt bridge

- A. Keep two half-cells neutral
- B. Complete the circuit
- C. Allow ionic exchange
- D. Make one electrode an anode and the other the cathode.

[5]

Question 3

3.1 Give the oxidation state of the sulfur in the following compounds:

3.1.1 SO₂ (1)

3.1.2 H₂SO₄ (1)

3.1.3 H₂S (1)

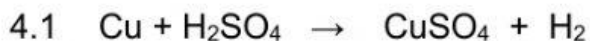
3.2 A standard electrochemical cell is constructed based on the following chemical reaction:



Give the oxidation state of the silver in the solution: (1)
[4]

Question 4

Write the oxidation and reduction half reactions for the following. (Don't include phase symbols.)



Oxidation: → +

Reduction: + →



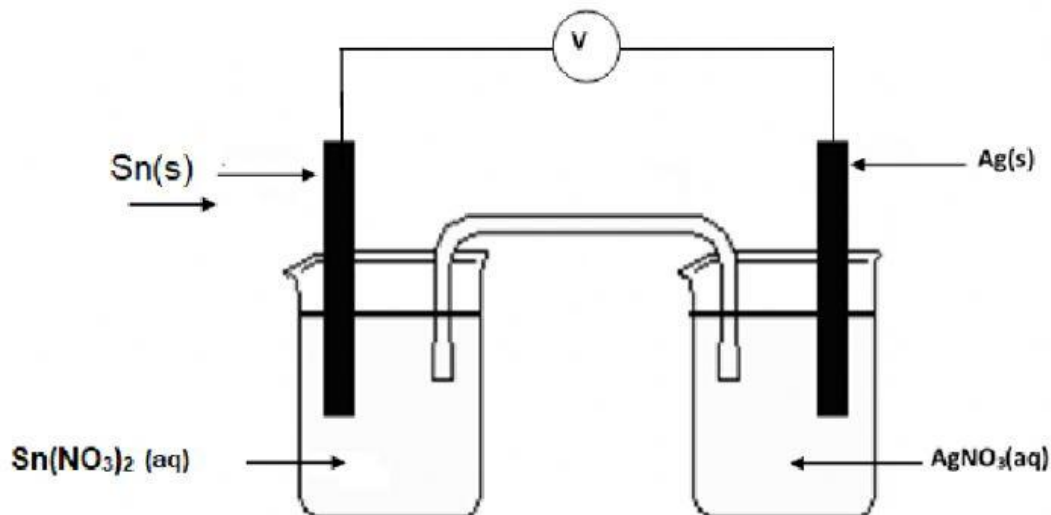
Oxidation: → +

Reduction: + →

[4]

Question 4

The diagram below represents a galvanic (voltaic) cell functioning under standard conditions with magnesium and silver as electrodes. A voltmeter is connected across the electrodes. **Include all the phase in these answers.**



4.1 State the energy conversion that takes place in this cell. (1)

energy → energy

4.2 Write the oxidation half-reaction for the above cell (1)

→ +

4.3 Write the reduction half-reaction for the above cell (1)

+ →

4.4 Write down the balanced equation for the net (overall) cell reaction that takes place in this cell. Omit the spectator ions but include phase symbols. (1)

+ → +

4.5 Write the symbol of the element that represents the anode of this cell. (1)

4.6 Write down the cell notation / (symbolic notation of this cell. (do not include the electrolytes concentration of 1 mol.m⁻³), but ensure to include the phases still.

/ // /

4.7 State in which direction the cations move in the above cell. (1)

From the _____ to the _____

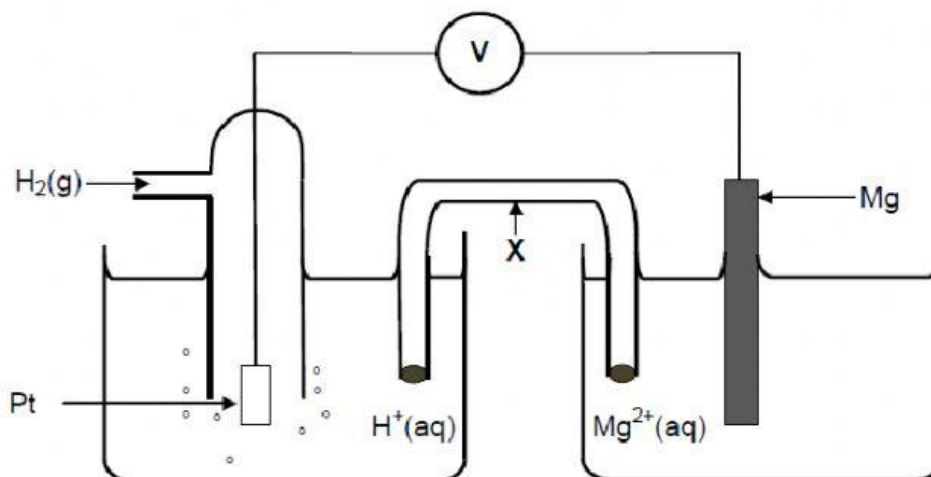
4.8 Calculate the reading on the voltmeter. (1)

$E^{\ominus}\text{Cell} =$

[8]

Question 5

The electrochemical cell represented below consists of a hydrogen half-cell and a magnesium half-cell at standard conditions.



The Voltmeter reading is 2,36V.

5.1 Write down the name of the item of apparatus labeled X. (1)

5.2. Is magnesium the ANODE or CATHODE in the half-cell above? (1)

5.3. Write down the balanced NET (overall) cell reaction that takes place in this cell. No spectator ions are required **but include phase symbols**. (1)



[3]

Total 23

**DATA FOR PHYSICAL SCIENCES GRADE 12
PAPER 2 (CHEMISTRY)**

**GEGEWENS VIR FISIESE WETENSKAPPE GRAAD 12
VRAESTEL 2 (CHEMIE)**

TABLE 1: PHYSICAL CONSTANTS/TABEL 1: FISIESE KONSTANTES

NAME/NAAM	SYMBOL/SIMBOOL	VALUE/WAARDE
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

$n = \frac{m}{M}$	$c = \frac{n}{V}$
$c = \frac{m}{MV}$	$E_{\text{cell}}^\theta = E_{\text{cathode}}^\theta - E_{\text{anode}}^\theta / E_{\text{sel}}^\theta = E_{\text{katode}}^\theta - E_{\text{anode}}^\theta$ $E_{\text{cell}}^\theta = E_{\text{reduction}}^\theta - E_{\text{oxidation}}^\theta / E_{\text{sel}}^\theta = E_{\text{reduksie}}^\theta - E_{\text{oksidasie}}^\theta$ $E_{\text{cell}}^\theta = E_{\text{oxidising agent}}^\theta - E_{\text{reducing agent}}^\theta / E_{\text{sel}}^\theta = E_{\text{oksideermiddel}}^\theta - E_{\text{reduseermiddel}}^\theta$

THE PERIODIC TABLE OF ELEMENTS
DIE PERIODIEKETABEL VAN ELEMENTE

SLEUTEL / KEY		Atoomgetal Atomic number																																																												
Elektronegatiwiteit Electronegativity	→	29																																																												
		Cu																																																												
		63,5																																																												
		Benaderde relatiewe atoommassa Approximate relative atomic mass																																																												
		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18																																											
(I)	(II)	(VIII)																																																												
1 1	2 2	3 3	4 4	5 5	6 6	7 7	8 8	9 9	10 10	11 11	12 12	13 13	14 14	15 15	16 16	17 17	18 18	19 19	20 20																																											
H 1	He 2	Li 3	Be 4	Na 11	Mg 12	Al 13	Si 14	P 15	S 16	Cl 17	Ar 18	K 19	Ca 20	Sc 21	Ti 22	V 23	Cr 24	Mn 25	Fe 26	Cu 29	Zn 30	Ga 31	Ge 32	As 33	Se 34	Br 35	Kr 36	Rb 37	Sr 38	Y 39	Zr 40	Nb 41	Mo 42	Tc 43	Ru 44	Rh 45	Pd 46	Ag 47	Cd 48	In 49	Sn 50	Sb 51	Te 52	I 53	Xe 54	Cs 55	Ba 56	La 57	Ce 58	Pr 59	Nd 60	Pm 61	Sm 62	Eu 63	Gd 64	Tb 65	Dy 66	Ho 67	Er 68	Tm 69	Yb 70	Lu 71
87 Fr	88 Ra	232 Ac	238 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	133 Cs	137 Ba	139 La	140 Ce	141 Pr	144 Nd	150 Sm	152 Eu	157 Gd	159 Tb	163 Dy	165 Ho	167 Er	169 Tm	173 Yb	175 Lu	204 Po	207 At	209 Bi	210 Po	211 At	212 Bi	216 Po	217 At	218 Rn	238 Ac	232 Th	231 Pa	238 U	234 Np	237 Pu	244 Am	243 Cm	247 Bk	247 Cf	251 Es	252 Fm	253 Md	254 No	257 Lr						

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

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

Increasing oxidising ability/Toenemende oksiderende vermoë

Increasing reducing ability/Toenemende reduserende vermoë

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^{\ominus} (V)
$\text{Li}^+ + e^- = \text{Li}$	-3,05
$\text{K}^+ + e^- = \text{K}$	-2,93
$\text{Cs}^+ + e^- = \text{Cs}$	-2,92
$\text{Ba}^{2+} + 2e^- = \text{Ba}$	-2,90
$\text{Sr}^{2+} + 2e^- = \text{Sr}$	-2,89
$\text{Ca}^{2+} + 2e^- = \text{Ca}$	-2,87
$\text{Na}^+ + e^- = \text{Na}$	-2,71
$\text{Mg}^{2+} + 2e^- = \text{Mg}$	-2,38
$\text{Al}^{3+} + 3e^- = \text{Al}$	-1,66
$\text{Mn}^{2+} + 2e^- = \text{Mn}$	-1,18
$\text{Cr}^{2+} + 2e^- = \text{Cr}$	-0,91
$2\text{H}_2\text{O} + 2e^- = \text{H}_2(\text{g}) + 2\text{OH}^-$	-0,83
$\text{Zn}^{2+} + 2e^- = \text{Zn}$	-0,76
$\text{Cr}^{3+} + 3e^- = \text{Cr}$	-0,74
$\text{Fe}^{2+} + 2e^- = \text{Fe}$	-0,44
$\text{Cr}^{3+} + e^- = \text{Cr}^{2+}$	-0,41
$\text{Cd}^{2+} + 2e^- = \text{Cd}$	-0,40
$\text{Co}^{2+} + 2e^- = \text{Co}$	-0,28
$\text{Ni}^{2+} + 2e^- = \text{Ni}$	-0,27
$\text{Sn}^{2+} + 2e^- = \text{Sn}$	-0,14
$\text{Pb}^{2+} + 2e^- = \text{Pb}$	-0,13
$\text{Fe}^{3+} + 3e^- = \text{Fe}$	-0,06
$2\text{H}^+ + 2e^- = \text{H}_2(\text{g})$	0,00
$\text{S} + 2\text{H}^+ + 2e^- = \text{H}_2\text{S}(\text{g})$	+0,14
$\text{Sn}^{4+} + 2e^- = \text{Sn}^{2+}$	+0,15
$\text{Cu}^{2+} + e^- = \text{Cu}^+$	+0,16
$\text{SO}_4^{2-} + 4\text{H}^+ + 2e^- = \text{SO}_2(\text{g}) + 2\text{H}_2\text{O}$	+0,17
$\text{Cu}^{2+} + 2e^- = \text{Cu}$	+0,34
$2\text{H}_2\text{O} + \text{O}_2 + 4e^- = 4\text{OH}^-$	+0,40
$\text{SO}_2 + 4\text{H}^+ + 4e^- = \text{S} + 2\text{H}_2\text{O}$	+0,45
$\text{Cu}^+ + e^- = \text{Cu}$	+0,52
$\text{I}_2 + 2e^- = 2\text{I}^-$	+0,54
$\text{O}_2(\text{g}) + 2\text{H}^+ + 2e^- = \text{H}_2\text{O}_2$	+0,68
$\text{Fe}^{3+} + e^- = \text{Fe}^{2+}$	+0,77
$\text{NO}_3^- + 2\text{H}^+ + e^- = \text{NO}_2(\text{g}) + \text{H}_2\text{O}$	+0,80
$\text{Ag}^+ + e^- = \text{Ag}$	+0,80
$\text{Hg}^{2+} + 2e^- = \text{Hg}(\text{l})$	+0,85
$\text{NO}_3^- + 4\text{H}^+ + 3e^- = \text{NO}(\text{g}) + 2\text{H}_2\text{O}$	+0,96
$\text{Br}_2(\text{l}) + 2e^- = 2\text{Br}^-$	+1,07
$\text{Pt}^{2+} + 2e^- = \text{Pt}$	+1,20
$\text{MnO}_2 + 4\text{H}^+ + 2e^- = \text{Mn}^{2+} + 2\text{H}_2\text{O}$	+1,23
$\text{O}_2(\text{g}) + 4\text{H}^+ + 4e^- = 2\text{H}_2\text{O}$	+1,23
$\text{Cr}_2\text{O}_7^{2-} + 14\text{H}^+ + 6e^- = 2\text{Cr}^{3+} + 7\text{H}_2\text{O}$	+1,33
$\text{Cl}_2(\text{g}) + 2e^- = 2\text{Cl}^-$	+1,36
$\text{MnO}_4^- + 8\text{H}^+ + 5e^- = \text{Mn}^{2+} + 4\text{H}_2\text{O}$	+1,51
$\text{H}_2\text{O}_2 + 2\text{H}^+ + 2e^- = 2\text{H}_2\text{O}$	+1,77
$\text{Co}^{3+} + e^- = \text{Co}^{2+}$	+1,81
$\text{F}_2(\text{g}) + 2e^- = 2\text{F}^-$	+2,87