



**HILLCREST HIGH SCHOOL**

**PHYSICAL SCIENCE**

**GRADE 11**

**PAPER 2- Chemistry**



**NOVEMBER 2020**

**TIME: 3 HRS**

**Total 148**

Instructions

1. Answer ALL the questions.
2. This question paper consists of TWO sections:
3. SECTION A (20)  
SECTION B (130)  
  
Answer SECTIONS A and B in the ANSWER BOOK.
4. Non-programmable calculators may be used.
5. Appropriate mathematical instruments may be used.
6. Number the answers correctly according to the numbering system used in this question paper.
7. Data sheets and a periodic table are attached for your use.
8. Give brief motivations, discussions, et cetera where required.
9. Numbers must be rounded off to **two decimal** places.

## SECTION A

### 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 The percentage oxygen in  $\text{CuSO}_4 \cdot 5\text{H}_2\text{O}$  is:

- A. 40.13%
- B. 25.65%
- C. 43.13%
- D. 57.72%

1.2 The boiling points of three compounds are given in the table shown below.

Compound	Boiling point (K)
$\text{Cl}_2$	238
$\text{Br}_2$	332
$\text{I}_2$	457

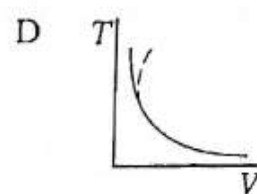
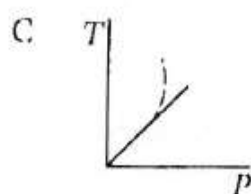
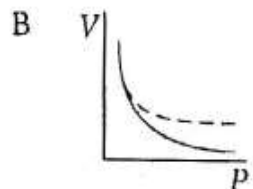
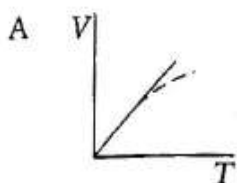
The increase in boiling point from top to bottom of the table is due to an increase in the strength of ...

- A London forces.
- B ion-dipole forces.
- C dipole-dipole forces.
- D hydrogen bonds.

1.3 At low temperatures, a real gas will liquefy while an ideal gas will not. What property of the real gas is responsible for this difference in behaviour?

- A. The real gas molecules have spaces between them.
- B. The real gas molecules are in continuous motion.
- C. The real gas molecules do have their own volume.
- D. The real gas molecules exert forces of attraction on each other.

1.4 Which graph correctly shows how a real gas will deviate from ideal gas behaviour?



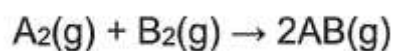
1.5 The following substance can NOT act as an ampholyte:

- A.  $\text{H}_2\text{O}$
- B.  $\text{PO}_4^{3-}$
- C.  $\text{HSO}_4^-$
- D.  $\text{HPO}_4^{2-}$

1.6 The shape of the  $\text{PCl}_5$  molecule is...

- A. Pentagonal
- B. Tetrahedral
- C. Trigonal planar
- D. Trigonal bipyramidal

1.7 Consider the reaction represented by the following balanced reaction:



The activation energy for the forward reaction is 180 kJ and that of the reverse reaction is 200 kJ.

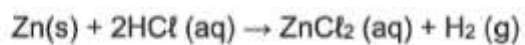
The heat of reaction ( $\Delta H$ ) for the forward reaction is:

- A. - 20 kJ
- B. + 20 kJ
- C. - 380 kJ
- D. + 380 kJ

1.8 The oxidation number of sulphur (S) in  $\text{HSO}_4^-$ ...

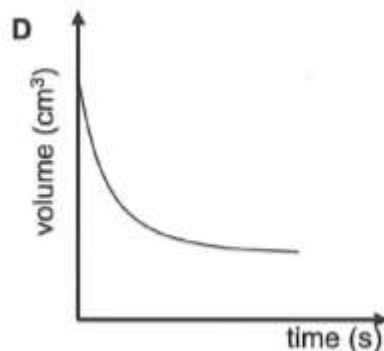
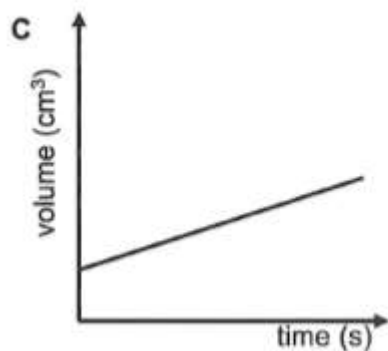
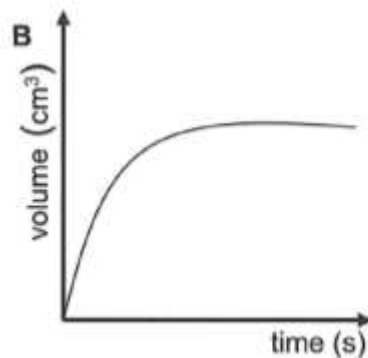
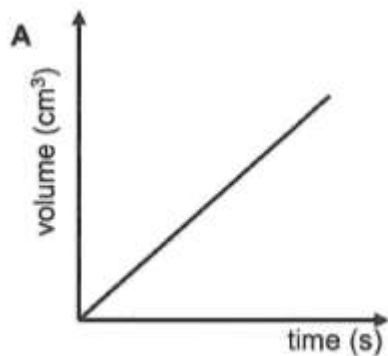
- A. - 2
- B. + 6
- C. + 1
- D. + 4

1.9 Consider the reaction represented by the following balanced reaction:



The reaction is allowed to run to completion.

Which ONE of the following graphs of volume against time best represents the formation of hydrogen gas?



1.10 Which ONE of the following CANNOT act as a reducing agent?

- A. Mg
- B. Br<sup>-</sup>
- C. MnO<sub>4</sub><sup>-</sup>
- D. Fe<sup>2+</sup>

[2 X 10 = 20]

## Section B

### Question 2

A laboratory analysis of a compound shows that it has the following chemical composition:

**Carbon: 72 %**

**Hydrogen: 12 %**

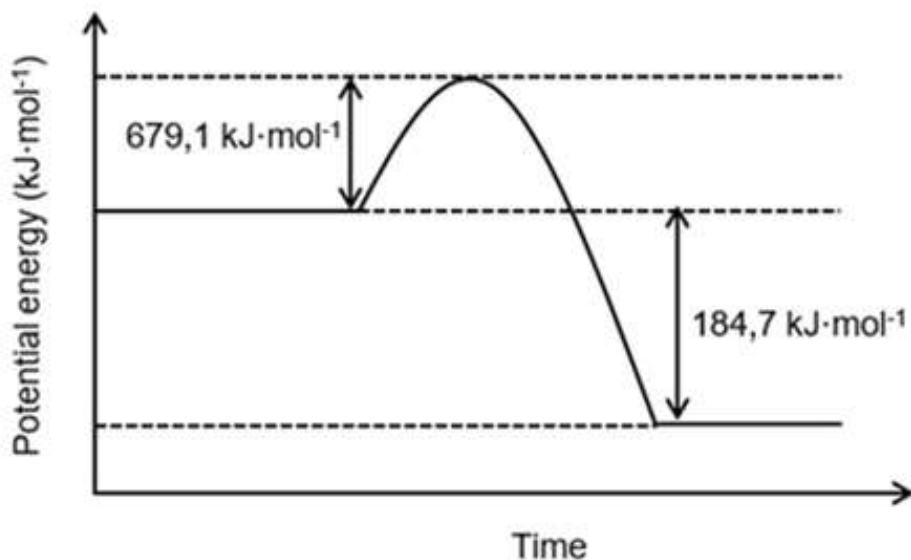
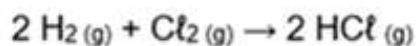
**Oxygen: 16 %**

- 2.1.1 Use the information to determine the empirical formula of the compound. (4)
- 2.1.2 If the molar mass of the compound is  $300 \text{ g}\cdot\text{mol}^{-1}$ , determine the molecular formula of the compound. (2)
- 2.2 14 g of iron reacts with 11.70 g of water during a corrosion reaction to form  $\text{Fe}_3\text{O}_4$  and  $\text{H}_2$ , according to the following balanced equation.
- $$3 \text{ Fe} + 4 \text{ H}_2\text{O} \rightarrow \text{Fe}_3\text{O}_4 + 4 \text{ H}_2$$
- 2.2.1 What is meant by 'reagent in excess'? (2)
- 2.2.2 Determine which substance is in excess. Show all calculations. (6)
- 2.2.3 Calculate the number of  $\text{H}_2$  molecules that will form in the above reaction. (5)
- 2.2.4 It is found that during the reaction,  $5.60 \text{ dm}^3$  of  $\text{H}_2$  is collected at STP. Calculate the percentage yield of the reaction. (4)

[23]

### Question 3

The diagram shows the potential energy changes during the following chemical reaction:



- 3.1 Define *activation energy*. (2)
- 3.2 Is the reaction EXOTHERMIC or ENDOTHERMIC?  
Give a reason for the answer. (2)
- 3.3 Calculate the activation energy of the reverse reaction. (2)
- 3.4 What effect will the addition of a catalyst have on the value 184,7 kJ·mol<sup>-1</sup>?  
Write down only INCREASE, DECREASE or NO EFFECT.  
Give a reason for the answer. (2)

[8]

#### Question 4

The following apparatus was used by a group of learners in an investigation to find out how surface area affects the rate of the reaction.

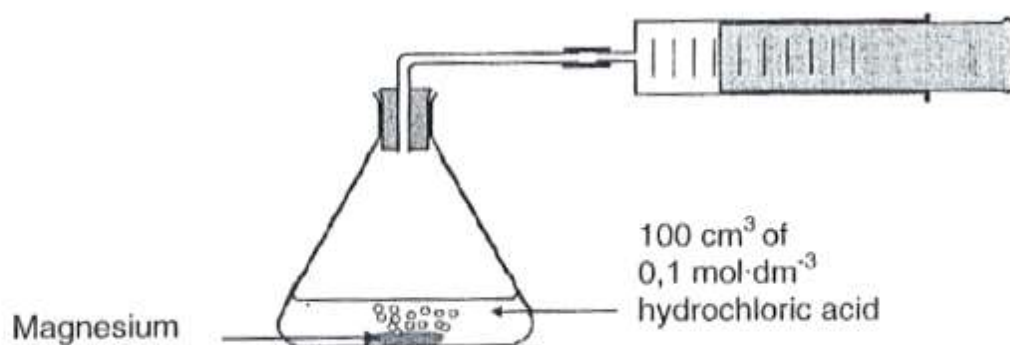
In both experiments, magnesium with the same mass (25g) were used.

In EXPERIMENT I, small pieces were used. In EXPERIMENT II, one big piece was used.

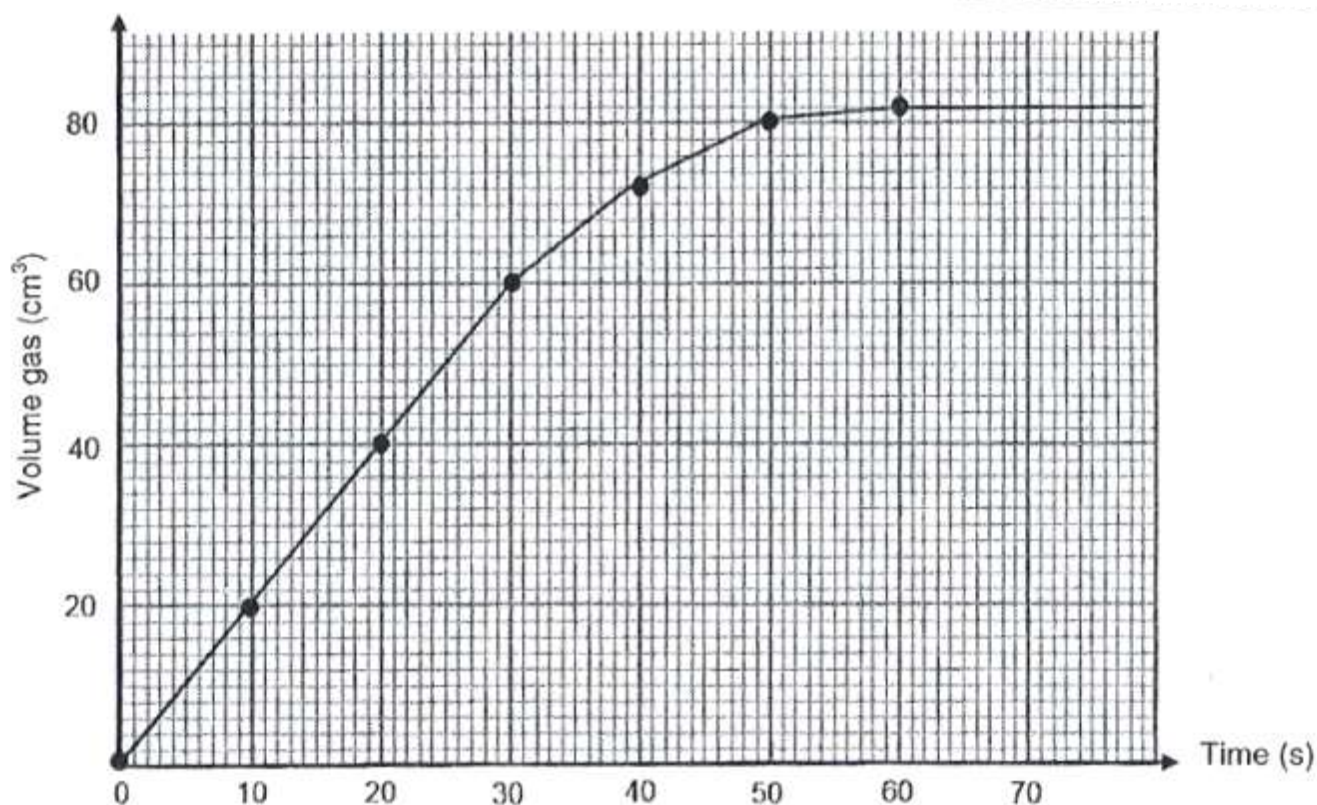
100 cm<sup>3</sup> of a 0,1 mol·dm<sup>-3</sup> hydrochloric acid solution was used in both experiments.

During the reaction, the gas that formed, was collected in the gas syringe which measures the volume of gas produced.

The balanced equation for the reaction is:



The learners performed the experiments and plotted a graph of their results for EXPERIMENT I, which is represented below.



- 4.1 Write down the dependent variable for this investigation. (1)
- 4.2 Besides the mass and the concentration of the reactants, give ONE other variable that must be kept constant during this investigation. (1)
- 4.3 Use the graph to calculate the average rate of the reaction (in  $\text{dm}^3 \cdot \text{s}^{-1}$ ) for the first 30 seconds. (3)
- 4.4 Predict how the gradient of EXPERIMENT II would compare to that of EXPERIMENT I plotted in the graph. Choose from GREATER THAN, LESS THAN or EQUAL TO. (1)
- 4.5 Use the collision theory to explain how the increase in surface area of the magnesium affects the rate of the reaction. (3)
- 4.6 Calculate the mass of magnesium that remains after the reaction has been completed. (6)

[15]

## Question 5

5.1 A monoprotic acid HY ionises completely when dissolved in water. The hydroxide ion concentration  $[\text{OH}^-]$  in the solution is  $1 \times 10^{-11} \text{ mol}\cdot\text{dm}^{-3}$ .

5.1.1 Define an acid in terms of the Bronsted-Lowry theory. (2)

5.1.2 Define the term *monoprotic acid*. (2)

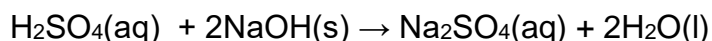
5.1.3 Is acid HY a WEAK or STRONG acid? Give a reason for your answer. (2)

5.1.4 Calculate the following:

a) The concentration of hydronium ions  $[\text{H}_3\text{O}^+]$  in the solution. (3)

b) The pH of the solution. (3)

5.2 7,5 g IMPURE sodium hydroxide pellets,  $\text{NaOH}(\text{s})$ , is added to a flask containing  $700 \text{ cm}^3$  of a  $0,15 \text{ mol}\cdot\text{dm}^{-3}$  sulphuric acid solution,  $\text{H}_2\text{SO}_4(\text{aq})$ . The balanced equation for the reaction is:



5.2.1 Calculate the number of moles of sulphuric acid in the flask. (3)

5.2.2 The percentage purity of the sodium hydroxide pellets used is 80%.

Calculate the pH of the solution in the flask after the addition of the  $\text{NaOH}(\text{s})$ . (7)

**[22]**

## Question 6

Consider the following molecules and answer the questions.

**H<sub>2</sub>S; CO<sub>2</sub>, BF<sub>3</sub>, NH<sub>3</sub>**

- 6.1 BF<sub>3</sub> and NH<sub>3</sub> both contain 3 bonds around the central atom. The BF<sub>3</sub> molecule is non-polar while the NH<sub>3</sub> molecule is polar. Account for this difference between the two compounds using the VSEPR theory. (4)
- 6.2 Determine with the aid of a calculation, whether the C – O bond on the CO<sub>2</sub> molecule is POLAR or NON-POLAR. (2)
- 6.3 The boiling point of H<sub>2</sub>S is –60°C and that of CO<sub>2</sub> is –78°C. Explain why the boiling point of H<sub>2</sub>S is higher than that of CO<sub>2</sub> by referring to the types of intermolecular forces and energy. (4)
- 6.4 NH<sub>3</sub> forms a dative covalent bond with the H<sup>+</sup> ion to form NH<sub>4</sub><sup>+</sup>.
- 6.4.1 What is a dative covalent bond? (2)
- 6.4.2 Use lewis dot structure to show the bonding in the NH<sub>4</sub><sup>+</sup> ion. (2)
- 6.4.3 Write down the FORMULA of another compound that has a molecular shape similar to the NH<sub>4</sub><sup>+</sup> ion. (1)

**[15]**

### Question 7

- 7 The table gives the melting points of the diatomic molecules of group VII elements.

ELEMENT	MOLAR MASS (g.mol <sup>-1</sup> )	MELTING POINT (°C)
F <sub>2</sub>	38	-223
Cl <sub>2</sub>	71	-102
Br <sub>2</sub>	160	-7,3
I <sub>2</sub>	254	113

- 7.1 In what phase, liquid or gas, does Br<sub>2</sub> exist at 25°C. (1)
- 7.2 Define the term melting point. (2)
- 7.3 How do the melting points of the molecules change on going from F<sub>2</sub> to I<sub>2</sub>? (1)
- 7.4 Explain the trend in melting points from F<sub>2</sub> to I<sub>2</sub> with reference to the forces between the molecules and the energy needed to weaken the intermolecular forces. (4)
- (8)

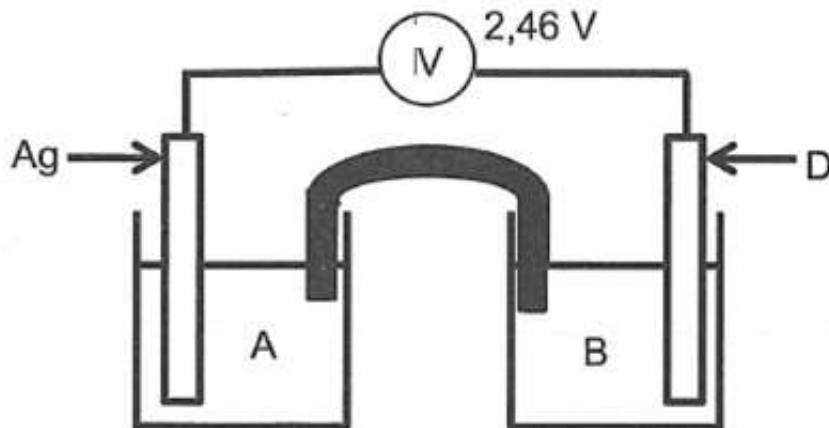
### Question 8

Kathy fills a weather balloon to a volume of  $300 \text{ dm}^3$  with helium gas at sea level, where the temperature is  $18^\circ\text{C}$  and the pressure is  $101,3 \text{ kPa}$ . She then releases the weather balloon to a height of  $10\,000 \text{ m}$  above sea level. At this height, the pressure in the air balloon decreases to  $10,3 \text{ kPa}$ , and the temperature is  $-37^\circ\text{C}$ .

- 8.1 Name two conditions under which real gas behaviour deviates from that of an ideal gas. (2)
- 8.2 Calculate the volume of the weather balloon at  $10\,000 \text{ m}$  above sea level. (5)
- 8.3 Assume that the helium gas behaves as an ideal gas. Calculate the mass of helium gas used to fill the balloon at sea level. (6)
- [13]**

### Question 9

A standard electrochemical cell is set up, using silver and an unknown electrode, D, as shown in the sketch below. The initial reading on the voltmeter is 2,46 V. After the cell was connected for some time, the mass of the silver electrode increased.



- 9.1 What process takes place at the silver electrode? Choose from OXIDATION or REDUCTION. (1)
- 9.2 Define an *oxidising agent* in terms of electron transfer. (1)
- 9.3 Write down the NAME of a solution which can be used in beaker A. (1)
- 9.4 Do electrons move in the external circuit from D to the silver electrode or from the silver electrode to D? (1)
- 9.5 Determine the standard electrode potential for electrode D and identify D from the standard potential table. (4)
- 9.6 Write down the cell notation for this cell. (3)

[11]



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

Half-reactions/Halfreaksies	$E^{\circ}$ (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
<b><math>2H^+ + 2e^- = H_2(g)</math></b>	<b>0,00</b>
$Fe^{3+} + 3e^- = Fe$	- 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
$Al^{3+} + 3e^- = Al$	- 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

Half-reactions/Halfreaksies	$E^{\circ}$ (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
$\text{Mg}^{2+} + 2e^- = \text{Mg}$	-2,36
$\text{Al}^{3+} + 3e^- = \text{Al}$	-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
$2\text{H}^+ + 2e^- = \text{H}_2(\text{g})$	<b>0,00</b>
$\text{S} + 2\text{H}^+ + 2e^- = \text{H}_2\text{S}(\text{g})$	+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
$\text{Hg}^{2+} + 2e^- = \text{Hg}(\ell)$	+0,85
$\text{NO}_3^- + 4\text{H}^+ + 3e^- = \text{NO}(\text{g}) + 2\text{H}_2\text{O}$	+0,96
$\text{Br}_2(\ell) + 2e^- = 2\text{Br}^-$	+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

Increasing reducing ability/Toenemende reduserende vermoë

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 Standaarddruk	$p^\theta$	$1,013 \times 10^5 \text{ Pa}$
Molar gas volume at STP <i>Molêre gasvolume by STD</i>	$V_m$	$22,4 \text{ dm}^3\cdot\text{mol}^{-1}$
Standard temperature Standaardtemperatuur	$T^\theta$	273 K

**TABLE 2: FORMULAE/TABEL 2: FORMULES**

$\frac{m}{n} = M$	$\frac{N}{n} = N_A$
$\frac{n}{c} = V$ or/of $\frac{m}{c} = MV$	$\frac{V}{n} = V_m$
$\frac{C_a V_a}{C_b V_b} = \frac{n_a}{n_b}$	$\text{pH} = -\log[\text{H}_3\text{O}^+]$
$K_w = [\text{H}_3\text{O}^+][\text{OH}^-] = 1 \times 10^{-14}$ at/by 298 K	
$E_{\text{cell}}^\theta = E_{\text{cathode}}^\theta - E_{\text{anode}}^\theta$ / $E_{\text{sel}}^\theta = E_{\text{katode}}^\theta - E_{\text{anode}}^\theta$ or/of $E_{\text{cell}}^\theta = E_{\text{reduction}}^\theta - E_{\text{oxidation}}^\theta$ / $E_{\text{sel}}^\theta = E_{\text{reduksie}}^\theta - E_{\text{oksidasie}}^\theta$ or/of $E_{\text{cell}}^\theta = E_{\text{oxidising agent}}^\theta - E_{\text{reducing agent}}^\theta$ / $E_{\text{sel}}^\theta = E_{\text{oksideermiddel}}^\theta - E_{\text{reduseermiddel}}^\theta$	

$\frac{p_1 V_1}{T_1} = \frac{p_2 V_2}{T_2}$	$pV = nRT$
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TABLE 3: THE PERIODIC TABLE OF ELEMENTS  
 TABEL 3: DIE PERIODIEKE TABEL VAN ELEMENTE

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18												
(I)	(II)										(III)	(IV)	(V)	(VI)	(VII)	(VIII)													
1 H 1,01												5 B 11	6 C 12	7 N 14	8 O 16	9 F 19	10 Ne 20												
	3 Li 7	4 Be 9										13 Al 27	14 Si 28	15 P 31	16 S 32	17 Cl 35,5	18 Ar 40												
	11 Na 23	12 Mg 24										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 98	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 210	85 At 210	86 Rn 222											
87 Fr 223	88 Ra 226	89 Ac																											
				58 Ce 140	59 Pr 141	60 Nd 144	61 Pm	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	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
	29	Cu	63,5
	Approximate relative atomic mass Benaderde relatiewe atoommassa		