

Student Name: _____*Marwan El Helaly*

Student Number: _____*8579576*

Partner's Name and Student #: _____*Dennis Wu*
_____ *8597574*

Demonstrator's Name:
_____ *Adrian Pelin*

PLEASE NOTE: If ANY of the above information is UNCLEAR or not provided, your grade will NOT be recorded!!

Lab Day (F):

Lab Week (odd):

Lab time (6:30):

Laboratory Report Form

Experiment 1.

Determination of the Composition of an Alloy

Checklist:

- Raw Data Sheet written in pen, signed by TA and attached
- Report Form typed and attached

Student's Initials _____ *ME* _____

Data	Trial 1	Trial 2
Identity of Metal	Magnesium	Magnesium
Mass of metal (g)	0.0231 g	0.0261
Uncalibrated volume of eudiometer (mL)	The eudiometer we used was already calibrated	The eudiometer we used was already calibrated
Volume of hydrogen gas (mL)	24.5 ml	28.0 ml
Height of water column (cm)	28.5 cm	24.6cm
Density of water (kg/m ³)	1000	1000
Acceleration due to gravity (m/s ²)	9.81	9.81
Pressure of water column (Pa)	$P=d \cdot g \cdot h$ $P_a = 1000 \text{ kg/m}^3 \times 9.81 \text{ m/s}^2 \times 0.285 \text{ m}$ $\therefore P_a = 2.8 \text{ Kpa}$	$P_a = 1000 \text{ kg/m}^3 \times 9.81 \text{ m/s}^2 \times 0.261 \text{ m}$ $\therefore P_a = 2.6 \text{ Kpa}$
Water Temperature (°C)	22.0	23.0
Water Vapour pressure (Pa)	2.64 Kpa	2.81 Kpa
Atmospheric Pressure (Torr)	760	760
Pressure of Hydrogen	Equation, $P_{\text{hydrogen}} = P_{\text{atmospheric}} - P_{\text{water column}} - P_{\text{water vapour}}$ $P_{\text{hydrogen}} = 101 \text{ Kpa} - 2.8 \text{ Kpa} - 2.64 \text{ Kpa}$ $= 95.6 \text{ Kpa}$	Equation, $P_{\text{hydrogen}} = P_{\text{atmospheric}} - P_{\text{water column}} - P_{\text{water vapour}}$ $P_{\text{hydrogen}} = 101 \text{ Kpa} - 2.6 \text{ Kpa} - 2.81 \text{ Kpa}$ $= 95.6 \text{ Kpa}$
Room Temperature	22.0	22.0
Ideal Gas Constant, R	8.314 J mol ⁻¹ K ⁻¹	8.314 J mol ⁻¹ K ⁻¹

Actual Moles of Hydrogen (mol)	$n = PV/RT$ $n = (95.6 \times 0.0245 \text{ ml}) / (8.314 \times 295.15)$ $= 9.54 \text{E-}4 \text{ moles}$	$n = (95.6 \times 0.028 \text{ ml}) / (8.314 \times 295.15)$ $= 1.1 \text{E-}3 \text{ moles}$
Theoretical moles of Hydrogen (mol)	$\text{Mg}_{(s)} + 2\text{HCl}_{(aq)} \rightarrow \text{MgCl}_{(aq)} + \text{H}_{2(g)}$ <p>According to this reaction, 1 mole of Mg yields one moles of H₂ gas Thus, $n_{\text{Mg}} = 0.0231 \text{ g} / 24.305 = 9.5042 \text{E-}4$ $\therefore n_{\text{H}_2} = 9.5042 \text{E-}4$</p>	$\text{Mg}_{(s)} + 2\text{HCl}_{(aq)} \rightarrow \text{MgCl}_{(aq)} + \text{H}_{2(g)}$ <p>According to this reaction, 1 mole of Mg yields one moles of H₂ gas Thus, $n_{\text{Mg}} = 0.0261 \text{ g} / 24.305 = 1.0739 \text{E-}3$ $\therefore n_{\text{H}_2} = 1.0739 \text{E-}3$</p>
Percent Yield (%)	<p>(Actual yeild/ theoretical yield) x100%</p> <p>Percent Yield = $(9.54 \text{E-}4 / 9.5042 \text{E-}4) \times 100 = 100.4\%$</p>	<p>(Actual yeild/ theoretical yield) x100%</p> <p>Percent Yield = $(1.1 \text{E-}3 / 1.0739 \text{E-}3) \times 100 = 102.4\%$</p>

Data Tables

Table 1. Pure Metal

Observations (Part 1):

- HCl → colourless liquid
- Magnesium metal → dark grey ductile metal. Form, strips
- As soon as the eudiometer is flipped and the acid comes in contact with the magnesium strips the reaction occurs, formation of bubbles(H₂ gas) which then rises to the top of the eudiometer.
- strong reaction, was done within 1-2 minutes of acid contact with the metal

Table 2. Alloy

Data	Trial 1	Trial 2
Unknown Number	6592	6592
Mass of alloy (g)	0.0409	0.0389
Uncalibrated volume of eudiometer (mL)	The eudiometer we used was already calibrated	The eudiometer we used was already calibrated
Volume of hydrogen gas (mL)	24.9 ml	24.2ml
Height of water column (cm)	22.5cm	27.2cm
Density of water (kg/m ³)	1000 kg/m ³	1000 kg/m ³
Acceleration due to gravity (m/s ²)	9.81m/s ²	9.81m/s ²
Pressure of water column (Pa)	$P = d * g * h$ $P_a = 1000 \text{ kg/m}^3 \times 9.81 \text{ m/s}^2 \times 0.225$ $\therefore P_a = 2.2 \text{ Kpa}$	$P_a = 1000 \text{ kg/m}^3 \times 9.81 \text{ m/s}^2 \times 0.0272$ $\therefore P_a = 2.6 \text{ kpa}$
Water Temperature (°C)	22.0	23.0
Water Vapour pressure (kPa)	2.64Kpa	2.81 Kpa
Atmospheric Pressure (Torr)	760	760
Pressure of Hydrogen	$P_{\text{hydrogen}} = P_{\text{atmospheric}} - P_{\text{water column}} - P_{\text{water vapour}}$ $P_{\text{hydrogen}} = 101 \text{ Kpa} - 2.2 \text{ Kpa} - 2.64 \text{ Kpa}$ $= 96.2 \text{ Kpa}$	$P_{\text{hydrogen}} = P_{\text{atmospheric}} - P_{\text{water column}} - P_{\text{water vapour}}$ $P_{\text{hydrogen}} = 101 \text{ Kpa} - 2.6 \text{ Kpa} - 2.64 \text{ Kpa}$ $= 95.76 \text{ Kpa}$
Room Temperature	22.0	22.0
Ideal Gas Constant, R	8.314	8.314
Moles of Hydrogen (mol)	$n = PV/RT$ $n = (96.2 \times 0.0249) / (8.314 \times 295.15)$ $= 9.76 \text{E-4 moles}$	$n = PV/RT$ $n = (95.76 \times 0.0242) / (8.314 \times 295.15)$ $= 9.44 \text{E-4}$

Mass of Zinc (g)	(See Calculations in sample calculations) Mass of Zinc=0.033g	(See calculations in sample calculations) Mass of zinc=0.0389g
Mass of Aluminum (g)	Mass of Al =8.05E-3g	8.627E-3 g
Percent Zinc (%)	= 80.7%	77.9%
Percent Aluminum (%)	19.3%	22.2%
Average Percent		

Observations (Part 2):

- Zinc + Aluminium Alloy → in a solid state, Shiny clustered pieces.
- When eudiometer is flipped upside down and the acid sinks down it takes a while for the reaction to take place.
- When the reaction finally takes place, bubbles are formed (H₂ gas) which move up to the top of the eudiometer.
- Reaction took a lot more time than the first experiment.

Sample Calculation :(Trial 1) Pure Metal

1. Uncalibrated Volume of the Eudiometer:

The eudiometer we used was already calibrated

2. Volume of Hydrogen gas:

24.5 ml

3. Pressure exerted by the water column:

$$P=d \cdot g \cdot h$$

$$P_a = 1000 \text{ kg/m}^3 \times 9.81 \text{ m/s}^2 \times 0.285 \text{ m}$$

$$\therefore P_a = 2.8 \text{ Kpa}$$

4. Pressure of hydrogen gas:

Equation,

$$P_{\text{hydrogen}} = P_{\text{atmospheric}} - P_{\text{water column}} - P_{\text{water vapour}}$$

$$P_{\text{hydrogen}} = 101 \text{ Kpa} - 2.8 \text{ Kpa} - 2.64 \text{ Kpa}$$

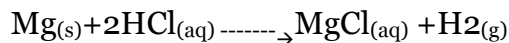
$$= 95.6 \text{ Kpa}$$

5. Moles of hydrogen gas (experimental):

$$n = PV/RT$$

$$n = (95.6 \times 0.0245 \text{ ml}) / (8.314 \times 295.15) \\ = 9.54 \text{E-4 moles}$$

6. Moles of hydrogen gas (theoretical):



According to this reaction, 1 mole of Mg yields one moles of H₂ gas

Thus, $n_{\text{Mg}} = 0.0231\text{g} / 24.305$

$$= 9.5042\text{E-}4$$

$$\therefore n_{\text{H}_2} = 9.5042\text{E-}4$$

7. Percentage Purity of metal (percentage yield of hydrogen):

$$(\text{Actual yield} / \text{theoretical yield}) \times 100\%$$

$$\text{Percent Yield} = (9.54\text{E-}4 / 9.5042\text{E-}4) \times 100$$

$$= 100.4\%$$

8. Average Percent Purity:

$$\text{Trial 1} + \text{trial} / 2$$

$$= 101.4\%$$

Sample Calculation: (Trial1) #6592Alloy

1. Pressure of water column and hydrogen gas:

$$P_{\text{hydrogen}} = P_{\text{atmospheric}} - P_{\text{water column}} - P_{\text{water vapour}}$$

$$P_{\text{hydrogen}} = 101\text{Kpa} - 2.2\text{Kpa} - 2.64\text{Kpa}$$

$$= 96.2 \text{ Kpa}$$

2. Moles of hydrogen gas:

$$n = PV/RT$$

$$n = (96.2 \times 0.0249) / (8.314 \times 295.15) \\ = 9.76 \times 10^{-4} \text{ moles}$$

3. Masses of Zinc and Aluminum in the alloy:

Given:

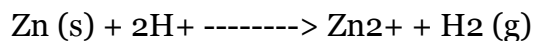
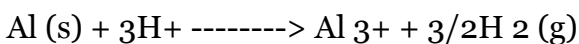
$$M_{Al} = 26.98$$

$$M_{Zn} = 65.38$$

$$m_{\text{alloy}} = m_{Zn} + m_{Al}$$

$$m_{Zn} = 0.0409 - m_{Al} \quad \leftarrow \text{Equation 1}$$

From the Equations



We know that,

$$n_{H_2} = n_{Zn} + 1.5n_{Al}$$

$$9.5 \times 10^{-4} = m_{Zn} / M_{Zn} + 1.5(m_{Al} / M_{Al})$$

plug in Equation 1 into this expression

$$9.5 \times 10^{-4} = (0.0409 - m_{Al}) / 26.98 + 1.5(m_{Al} / 65.38)$$

Isolate for m_{Al} (see full written work attached to the end of file)

$$m_{Al} = 8.05 \times 10^{-3} \text{ g}$$

and since, $m_{Zn} = 0.0409 - m_{Al}$

$$m_{Al} = 0.0409 - 8.05 \times 10^{-3}$$

$$= 0.033 \text{ g}$$

4. Percent composition of the alloy:

Trial 1:

Percent composition by mass:

$$\%Al = m_{Al} / m_{\text{Alloy}} \times 100\% = 8.05 \times 10^{-3} \text{ g} / 0.0409 \text{ g} \times 100\% = 19.3\%$$

Trial 2

$$\%Al: 22.2\%$$

$$\%Zn = mZn/mAlloy * 100\% = 0.033 \text{ g} / 0.0409\text{g} \times 100\% = 80.7\%$$

Trial 2:

$$\%zn=77.9\%$$

5. Average Percent composition of the alloy (average of zinc values and average of aluminum values):

$$\begin{aligned} \%Al &= (\%Trial\ 1 + \% Trial\ 2)/2 \\ &= (19.3 + 22.2)/2 \\ &= 20.8\% \end{aligned}$$

$$\begin{aligned} \%Zn &= (\%Trial\ 1 + \%Trial\ 2) / 2 \\ &= (80.7 + 77.9)/2 \\ &= 79.2\% \end{aligned}$$

Discussion: (within space provided)

As first year university students, and this being our first lab using the Ottawa u labs and equipment, I personally was thrilled by the molar concentration of the acid(12M). Throughout 4 years of high school we have only used within 1-2 molar concentrations. For experiment 1, my partner and I hypothesised that the reaction would be a very strong one. We of course based this hypothesis on the concentration of the HCl acid. We then came to witness a very strong reaction, the metal was completely consumed by the HCl(M), which shows that the amount of hydrogen produced is dependant on the metal.(thus, shows that the metal is the limiting reagent in this reaction), and that our hypothesis correct.

For experiment number 2 however, even though we used the same concentration for HCl, my partner and I both hypothesised that this reaction will take a while longer than the first one. The reason for that is an alloy is a mixture of two or mole metals, hence giving the metal a longer life span, higher resistance to corrosion and overall strength. We also assumed that percent yield would be within the 90-100% range which is usually the accepted range for an experiment. After the reaction took place, we noticed that what our hypothesis was correct in some aspects. For example, the alloy did take a a lot longer to react with the acid, and once it did it took a lot longer to complete the reaction. The percent yield exceeded the 100%, and this may be a result of inaccurate measuring. There is a lot of human error that can occur within an experiment. Another reason could be that there was some impurities within the alloy itself

Conclusion: (no more than two lines)

After completing this experiment, we can conclude that the average percent composition of the alloy by mass is 79.2 % Zinc and 20.8% Aluminum.

