Data Tables

Table 1. Pure Metal

Data	Trial 1	Trial 2
Identity of Metal	$Mg_{(s)}$	$Mg_{(s)}$
Mass of metal (g)	0.0296	0.0301
Uncalibrated volume of eudiometer (mL)		
Volume of hydrogen gas (mL)	32.4	32.3
Height of water column (cm)	19.1	18.3
Density of water (kg/m^3)	1000	1000
Acceleration due to gravity (m/s^2)	9.8	9.8
Pressure of water column (Pa)	1793.4	1871.8
Water Temperature (°C)	22.5	23.2
Water Vapour pressure (Pa)	2639.78	2813.12
Atmospheric Pressure (Torr)	767.3131	767.3131
Pressure of Hydrogen (KPa)	96.69	96.83
Room Temperature (°C)	23.1	23.1
Ideal Gas Constant, R	62.364 Torr $mol^{-1}K^{-1}$ (8.314 kPa L $mol^{-1}k^{-1}$)	62.364 Torr $mol^{-1}K^{-1}$ (8.314 kPa L $mol^{-1}k^{-1}$)
Actual Moles of Hydrogen (mol)	1.24×10^{-3}	1.27×10^{-3}
Theoretical moles of Hydrogen (mol)	1.26×10^{-3}	1.21×10^{-3}
Percent Yield (%)	103.3%	104.95%

Observations (Part 1):

The reaction between $HCl_{(aq)}$ and $Mg_{(s)}$ was an immediate reaction that released heat and bubbles, which was hydrogen gas. The reaction happened as soon as the eudiometer was placed onto of the sample tube. The end of the reaction, $Mg_{(s)}$ dissolved and $H_{(g)}$ was produced, and also reducing the amount of $H_2O_{(l)}$ and $HCl_{(aq)}$

Table 2. Alloy

Data	Trial 1	Trial 2
Unknown Number	5301	5301
Mass of alloy (g)	0.041	0.042
Uncalibrated volume of eudiometer (mL)		
Volume of hydrogen gas (mL)	24.4	24.5
Height of water column (cm)	12	12.5
Density of water (kg/m^3)	1000	1000
Acceleration due to gravity (m/s^2)	9.8	9.8
Pressure of water column (Pa)	1234.8	1225
Water Temperature (°C)	23.1	23.3
Water Vapour pressure (kPa)	2.81	2.81
Atmospheric Pressure (Torr)	767.3131	767.3131
Pressure of Hydrogen (kPa)	93.7	93.7
Room Temperature	23.1	23.1
Ideal Gas Constant, R	62.364 Torr $mol^{-1}K^{-1}$ (8.3145 kPa L $mol^{-1}k^{-1}$)	62.364 Torr $mol^{-1}K^{-1}$ (8.3145 kPa L $mol^{-1}k^{-1}$)
Moles of Hydrogen (mol)	9.64×10^{-4}	$9.67 \times 10\text{-}^{4}$
Mass of Zinc (g)	3.26×10^{-2}	3.39×10^{-2}
Mass of Aluminum (g)	8.36×10^{-3}	8.06×10^{-3}
Percent Zinc (%)	80%	80%
Percent Aluminum (%)	20%	20%
Average Percent(%)	Zn: 80	Al: 20

Observations (Part 2):

The reaction of the Alloy and $HCl_{(aq)}$ was not immediate and was very slow. Once the reaction began, it created bubbles which was $H_{(g)}$ and also released heat. After the reaction completed, the alloy dissolved creating H(g) and reducing the amount of $H2O_{(l)}$ and $HCl_{(aq).}$ This reaction was slower compared to the first reaction with $Mg_{(s)}$.

Sample Calculation: Pure Metal

1. Uncalibrated Volume of the Eudiometer:
   Was calibrated
2. Volume of Hydrogen gas:

$$V_H = 32.3mL = 0.0323L$$

3. Pressure exerted by the water column:

$$Pressure = (density\ of\ water)(gravity)(height)$$
$$= (1000kg/m^3)(9.8m/s^2)(0.183)$$
$$= 1793.4\ Pa = 1.79\ kPa$$

4. Pressure of hydrogen gas:

$$P_H = P_{atm} - P_{water\ column} - P_{water\ vapour}$$
$$= (1.013 \text{ x } 10^5\ Pa) - (1793.4\ Pa) - (2813.102\ Pa)$$
$$= 9.669 \text{ x } 10^4\ Pa = 96.69\ kPa$$

5. Moles of hydrogen gas (experimental):

$$T = 23.3^{o}C + 273.15\ k = 296.45\ k$$

$$PV = nRT$$

$$n = \frac{PV}{RT} = \frac{(96.69\ kPa)(0.0323L)}{(8.314\ Pa\ L\ mol^{-1}k^{-1})(296.45k)}$$

$$= 1.26\times 10^{-3} mols\ H_2$$

6. Moles of hydrogen gas (theoretical):

$$Mg_{(s)} + 2HCl_{(aq)} = H_{2(g)} + MgCl_{2(aq)}$$

$$0.0301g\ Mg \times \frac{1mol\ Mg}{24.31M\ Mg} = 1.24\times10^{-3} mol\ Mg$$

$$n_{H_2} = n_{Mg}\times\frac{1\ mol\ H_2}{1\ mol\ Mg}$$

$$n_{H_2} = 1.24\times10^{-3}\ mol\ H_2$$

7. Percentage Purity of metal:

$$\frac{Actual(\text{Experimental})}{Theoretical}\times100\%$$

$$\frac{1.26\times10^{-3}}{1.24\times10^{-3}}\times100\%$$

$$= 101.6\%$$

8. Average Percent Purity:

$$Avg.percent\ Yield = \frac{Yield_{trial\ 1} + Yield_{Trial\ 2}}{2}$$

$$= \frac{101.6+104.95}{2}$$

$$= 103.3\%$$

Sample Calculation: Alloy

1. Pressure of water column and hydrogen gas:

$$Pressure_{water\ column}(density\ of\ water)(gravity)(height)$$
$$= (1000kg/m^3)\ (9.8m/s^2)(0.125)$$
$$= 1225\ Pa = 1.23\ kPa$$

$$P_H = P_{atm} - P_{water\ column} - P_{water\ vapour}$$
$$= (1.013 \text{ x } 10^5) - (1225) - (2813.102)$$
$$= 97261.89\ Pa = 97.3\ kPa$$

2. Moles of hydrogen gas:

$$T = 23.3^oC + 273.15\ k = 296.45\ k$$
$$PV = nRT$$
$$n = \frac{PV}{RT} = \frac{(97.3\ kPa)(2.45 \text{ x } 10^{-5}m^3)}{(8.3145\ m^3Pa\ mol^{-1}k^{-1})(296.45k)}$$
$$= 9.67 \times 10^{-4} mols\ H_2$$

3. Masses of Zinc and Aluminum in the alloy:

$$n_H = m_{Zn} + \frac{2}{3}m_{Al}$$
$$m_{total} = m_{Zn} + m_{Al}$$
$$n_H = \frac{(m_{total} - m_{Al})}{M_{Zn}} + \frac{3m_{Al}}{2M_{Al}}$$
$$n_H = \frac{2M_{Al}(m_{total} - m_{Al})}{2M_{Al}M_{Zn}} + \frac{3m_{Al}M_{Zn}}{2M_{Al}M_{Zn}}$$
$$2M_{Al}M_{Zn}n_H = 2M_{Al}(m_{total} - m_{Al}) + 3m_{Al}M_{Zn}$$
$$2(26.98)(65.38)(9.67 \times 10^{-4}) =$$
$$= 2(26.98)(0.042) - (2\text{x}26.98)m_{Al} + 3(65.38)m_{Al}$$
$$3.412 = 2.266 - (53.96)m_{Al} + (196.14)m_{Al}$$
$$1.461 = (142.18)m_{Al}$$
$$\boldsymbol{m_{Al} = 8.06{\times}10^{-3}g}$$
$$m_{total} = m_{Zn} + m_{Al}$$
$$0.042 - 1.05{\times}10^{-2} = m_{Zn}$$
$$\boldsymbol{m_{Zn} = 3.39{\times}10^{-2}g}$$

4. Percent composition of the alloy:

Trial 1:

$$\%Zn = \frac{Mass\ Zn}{Total\ Mass\ Alloy} \times 100\%$$

$$\%Zn = \frac{3.39 \times 10^{-2}}{0.042} \times 100\%$$

$$\%Zn = 80.71\%$$

$$\%Al = \frac{Mass\ Al}{Total\ Mass\ Alloy} \times 100\%$$

$$\%Al = \frac{8.06 \times 10^{-3}}{0.042} \times 100\%$$

$$\%Al = 19.19\%$$

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

$$Avg.\,Zn\% = \frac{Zn_{Trial\ 1} + Zn_{Trial\ 2}}{2}$$

$$= \frac{80.71 + 79.60}{2}$$

$$= 80.15\%$$

$$= 80\%$$

$$Avg.\,Al\% = \frac{Al_{Trial\ 1} + Al_{Trial\ 2}}{2}$$

$$= \frac{19.19 + 20.4}{2}$$

$$= 19.8\%$$

$$= 20\%$$

Discussion: (within space provided)

The purpose of this lab is to determine the purity of $Mg_{(s)}$ and the composition of the alloy (#5301). As $Mg_{(s)}$ and the Alloy reacts with $HCl_{(aq)}$, the reactants got dissolved and $H_{2(g)}$ was produced. Since the reaction released heat, it can be said that it is an exothermic reaction. The purity of the metal and composition of the alloy was determined through the amount of Hydrogen gas produced. From the calculations, the percent yield for $Mg_{(s)}$ on trial one is, 103% and trial two is 104%. This makes the average 103.5%. As a result, there is an error that was caused throughout the lab. A source of human error is inevitable. For the alloys, is measured to have about 80% Zn and 20% Al. This was calculated by finding the moles then using the molarity to find the mass.

However, an instrumental error is a possibility. To measure the height of the water column, a centimeter ruler was used. Thus, there are uncertainties and also not to mention that it may have went deeper in the water rather than the complete surface of the water. This would either increase or decrease the water column height, which would have a great affect in all of the calculations. Not to mention, the possibility of a human error, one might have mis-looked the measurement on the ruler.

Also another error is an experimental limitation, when measuring the mass of the metal and alloy, skin material (ex. oil from skin) could have covered the metal. This would increase the mass of the metal and alloy.

To minimize errors, one should use more precise and accurate measuring equipment, this would result in true calculations and results. Also, the use of gloves when working with metals would limit the human substances (ex. skin oil) on the material.

Conclusion: (no more than two lines)

In Conclusion, the average yield percentage for magnesium is 103.3%. While alloy #5301 had an average percent composition of 20% Al and 80% Zn.