

Student Name:

Student Number:

Partner's Name and Student #:

Demonstrator's Name: Jodi Allard

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

Lab Day (T/W/Th/F): Fri

Lab Week (even/odd): Odd Lab11

Lab time (10:00, 2:30, 6:30): 6:30

Laboratory Report Form

Experiment 1.

Determination of the Composition of an Alloy

Checklist:

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

Student's Initials _____

Data Tables

Table 1. Pure Metal

Data	Trial 1	Trial 2
Identity of Metal	Zinc	Zinc
Mass of metal (g)	0.0540g	0.0435g
Uncalibrated volume of eudiometer (mL)	0ml (already calibrated)	0ml (already calibrated)
Volume of hydrogen gas (mL)	21.5ml	17.8ml
Height of water column (cm)	38.0cm	44.0cm
Density of water (kg/m ³)	1000kg/m ³	1000kg/m ³
Acceleration due to gravity (m/s ²)	9.81m/s ²	9.81m/s ²
Pressure of water column (Pa)	3728Pa	4315Pa
Water Temperature (°C)	22°C	22°C
Water Vapour pressure (Pa)	2640Pa	2640Pa
Atmospheric Pressure (Torr)	758.3Torr	758.3Torr
Pressure of Hydrogen	94.70kPa	94.15kPa
Room Temperature	22.1°C	22.1°C
Ideal Gas Constant, R	8.314 $\frac{L*kPa}{K*mol}$	8.314 $\frac{L*kPa}{K*mol}$
Actual Moles of Hydrogen (mol)	$8.297 * 10^{-4} mol$	$7.778 * 10^{-4} mol$
Theoretical moles of Hydrogen (mol)	$8.259 * 10^{-4} mol$	$6.653 * 10^{-4} mol$
Percent Yield (%)	100.5%	117.0%

Observations (Part 1):

1. Zinc was dissolving slowly.
2. During the reaction, more and more bubbles was generated while zinc became thinner.
3. The reaction stopped when no zinc can be observed in water.

Table 2. Alloy

Data	Trial 1	Trial 2
Unknown Number	5278	5278
Mass of alloy (g)	0.0410g	0.0413g
Uncalibrated volume of eudiometer (mL)	0ml (already calibrated)	0ml (already calibrated)
Volume of hydrogen gas (mL)	25.1ml	25.5ml
Height of water column (cm)	36.4cm	33.9cm
Density of water (kg/m ³)	1000kg/m ³	1000kg/m ³
Acceleration due to gravity (m/s ²)	9.81m/s ²	9.81m/s ²
Pressure of water column (Pa)	3570Pa	3325Pa
Water Temperature (°C)	21°C	22°C
Water Vapour pressure (kPa)	2.49KPa	2.64KPa
Atmospheric Pressure (Torr)	758.3Torr	758.3Torr
Pressure of Hydrogen	95.04KPa	95.14KPa
Room Temperature	22.1°C	22.1°C
Ideal Gas Constant, R	8.314 $\frac{L*kPa}{K*mol}$	8.314 $\frac{L*kPa}{K*mol}$
Moles of Hydrogen (mol)	9.755 * 10 ⁻⁴ mol	9.887 * 10 ⁻⁴ mol
Mass of Zinc (g)	3.236 * 10 ⁻² g	3.244 * 10 ⁻² g
Mass of Aluminum (g)	8.645 * 10 ⁻³ g	8.858 * 10 ⁻³ g
Percent Zinc (%)	78.9%	78.1%
Percent Aluminum (%)	21.1%	21.9%
Average Percent	78.5% and 21.5%	78.5% and 21.5%

Observations (Part 2):

1. Bubbles came out steadily during the reaction.
2. The alloy broke into pieces and floated rapidly to the surface of water in the eudiometer at the end of reaction. Reaction went faster when shook the tube.

Sample Calculation :Zinc

1. Uncalibrated Volume of the Eudiometer:

The eudiometer was already calibrated.

2. Volume of Hydrogen gas:

$$\text{Trial 1: } V_{\text{Hydrogen gas}} = 21.5\text{ml}$$

$$\text{Trial 2: } V_{\text{Hydrogen gas}} = 17.8\text{ml}$$

3. Pressure exerted by the water column:

$$\begin{aligned}\text{Trial 1: } P_{\text{water}} &= \rho gh = 1000\text{kg/m}^3 * 9.81\text{m/s}^2 * 0.38\text{m} \\ &= 3727.8 \frac{\text{kg}}{\text{ms}^2} \\ &\approx 3728\text{Pa}\end{aligned}$$

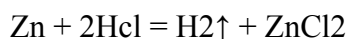
$$\begin{aligned}\text{Trial 2: } P_{\text{water}} &= \rho gh = 1000\text{kg/m}^3 * 9.81\text{m/s}^2 * 0.44\text{m} \\ &= 4315.4 \frac{\text{kg}}{\text{ms}^2} \\ &\approx 4315\text{Pa}\end{aligned}$$

4. Pressure of hydrogen gas:

$$\begin{aligned}\text{Trial 1: } P_{\text{hydrogen gas}} &= P_{\text{Atmosphere}} - P_{\text{water}} - P_{\text{water vapour}} \\ &= (101.1 \text{ kPa}) - 3.728\text{kPa} - 2.64 \text{ kPa} \\ &\approx 94.70\text{kPa}\end{aligned}$$

$$\begin{aligned}\text{Trial 1: } P_{\text{hydrogen gas}} &= P_{\text{Atmosphere}} - P_{\text{water}} - P_{\text{water vapour}} \\ &= (101.1 \text{ kPa}) - 4.315\text{kPa} - 2.64 \text{ kPa} \\ &\approx 94.15\text{kPa}\end{aligned}$$

5. Moles of hydrogen gas (experimental):



$$\begin{aligned} \text{Trial 1: } n_{\text{hydrogen ACTUAL}} &= \frac{PV}{RT} \\ &= \frac{94.70\text{kPa} \cdot 0.0215\text{L}}{8.314\frac{\text{L}\cdot\text{kPa}}{\text{K}\cdot\text{mol}} \cdot (22 + 273.15\text{K})} \\ &\approx 8.297 \cdot 10^{-4} \text{ mol} \end{aligned}$$

$$\begin{aligned} \text{Trial 2: } n_{\text{hydrogen ACTUAL}} &= \frac{PV}{RT} \\ &= \frac{94.15\text{kPa} \cdot 0.0178\text{L}}{8.314\frac{\text{L}\cdot\text{kPa}}{\text{K}\cdot\text{mol}} \cdot (22 + 273.15\text{K})} \\ &\approx 7.778 \cdot 10^{-4} \text{ mol} \end{aligned}$$

6. Moles of hydrogen gas (theoretical):

$$\text{Trial 1: } n_{\text{hydrogen THEORETICAL}} = 0.0540\text{g}_{\text{Zn}} \cdot \frac{1\text{mol}_{\text{Zn}}}{65.38\text{g}_{\text{Zn}}} \cdot \frac{1\text{mol}_{\text{hydrogen}}}{1\text{mol}_{\text{Zn}}} = 8.259 \cdot 10^{-4} \text{ mol}$$

$$\text{Trial 2: } n_{\text{hydrogen THEORETICAL}} = 0.0435\text{g}_{\text{Zn}} \cdot \frac{1\text{mol}_{\text{Zn}}}{65.38\text{g}_{\text{Zn}}} \cdot \frac{1\text{mol}_{\text{hydrogen}}}{1\text{mol}_{\text{Zn}}} = 6.653 \cdot 10^{-4} \text{ mol}$$

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

$$\text{Trial 1: Percent Purity of Zinc} = \frac{n_{\text{Zn ACTUAL}}}{n_{\text{Zn THEORETICAL}}} \cdot 100\% = \frac{8.297 \cdot 10^{-4} \text{ mol}}{8.259 \cdot 10^{-4} \text{ mol}} \approx 100.5\%$$

$$\text{Trial 1: Percent Purity of Zinc} = \frac{n_{\text{Zn ACTUAL}}}{n_{\text{Zn THEORETICAL}}} \cdot 100\% = \frac{7.778 \cdot 10^{-4} \text{ mol}}{6.653 \cdot 10^{-4} \text{ mol}} \approx 117.0\%$$

8. Average Percent Purity:

$$\begin{aligned} \text{Percent Purity}_{\text{average}} &= \frac{\text{Percent Purity}_{\text{Zn(1)}} + \text{Percent Purity}_{\text{Zn(2)}}}{2} \\ &= \frac{100.5\% + 117.0\%}{2} \\ &\approx 108.8\% \end{aligned}$$

Sample Calculation : #5278 Alloy

1. Pressure of water column and hydrogen gas:

The pressure of water column:

$$\text{Trial 1: } P_{\text{water}} = \rho gh = 1000 \text{kg/m}^3 * 9.81 \text{m/s}^2 * 0.364 \text{m} \approx 3570 \text{Pa}$$

$$\text{Trial 2: } P_{\text{water}} = \rho gh = 1000 \text{kg/m}^3 * 9.81 \text{m/s}^2 * 0.339 \text{m} \approx 3325 \text{Pa}$$

The pressure of hydrogen gas:

$$\begin{aligned} \text{Trial 1: } P_{\text{hydrogen gas}} &= P_{\text{Atmosphere}} - P_{\text{water}} - P_{\text{water vapour}} \\ &= (101.1 \text{ kPa}) - 3.570 \text{kPa} - 2.49 \text{kPa} \approx 95.04 \text{kPa} \end{aligned}$$

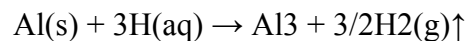
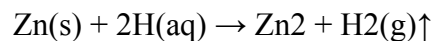
$$\begin{aligned} \text{Trial 2: } P_{\text{hydrogen gas}} &= P_{\text{Atmosphere}} - P_{\text{water}} - P_{\text{water vapour}} \\ &= (101.1 \text{ kPa}) - 3.325 \text{kPa} - 2.64 \text{kPa} \approx 95.14 \text{kPa} \end{aligned}$$

2. Moles of hydrogen gas:

$$\text{Trial 1: } n_{\text{hydrogen}} = \frac{PV}{RT} = \frac{95.04 \text{kPa} * 0.0251 \text{L}}{8.314 \frac{\text{J}}{\text{K} * \text{mol}} * (21 + 273.15 \text{K})} \approx 9.755 * 10^{-4} \text{ mol}$$

$$\text{Trial 2: } n_{\text{hydrogen}} = \frac{PV}{RT} = \frac{95.14 \text{kPa} * 0.0255 \text{L}}{8.314 \frac{\text{J}}{\text{K} * \text{mol}} * (22 + 273.15 \text{K})} \approx 9.887 * 10^{-4} \text{ mol}$$

3. Masses of Zinc and Aluminum in the alloy:



Trial 1: Assume the alloy contains x mole Zinc and y mole aluminum

$$x + \frac{2}{3}y = 9.755 * 10^{-4} \text{ mol}$$

$$65.38x + 26.98y = 0.0410 \text{g}$$

Solve for x and y

$$y = 3.20 * 10^{-4} mol, m_{Al} = 8.645 * 10^{-3} g.$$

$$x = 4.95 * 10^{-4} mol, m_{Zn} = 3.236 * 10^{-2} g.$$

Trial 2: Assume the alloy contains x mole Zinc and y mole aluminum

$$x + \frac{2}{3}y = 9.887 * 10^{-4} mol$$

$$65.38x + 26.98y = 0.0413g$$

Solve for x and y

$$y = 3.28 * 10^{-4} mol, m_{Al} = 8.858 * 10^{-3} g.$$

$$x = 4.96 * 10^{-4} mol, m_{Zn} = 3.244 * 10^{-2} g$$

4. Percent composition of the alloy:

$$\text{Trial 1: Percent of Zn} = \frac{m_{Zn}}{m_{Total}} * 100\% = \frac{3.236 * 10^{-2} g}{0.0410g} \approx 78.5\%$$

$$\text{Percent of Al} = \frac{m_{Al}}{m_{Total}} * 100\% = \frac{8.645 * 10^{-3} g}{0.0410g} \approx 21.5\%$$

$$\text{Trial 2: Percent of Zn} = \frac{m_{Zn}}{m_{Total}} * 100\% = \frac{3.244 * 10^{-2} g}{0.0413g} \approx 78.5\%$$

$$\text{Percent of Al} = \frac{m_{Al}}{m_{Total}} * 100\% = \frac{8.858 * 10^{-3} g}{0.0413g} \approx 21.5\%$$

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

$$\text{Average Percent}_{Zn} = \frac{\text{Percent}_{Zn(1)} + \text{Percent}_{Zn(2)}}{2}$$

$$= \frac{78.5\% + 78.5\%}{2}$$

$$= 78.5\%$$

$$\text{Average Percent}_{Al} = \frac{\text{Percent}_{Al(1)} + \text{Percent}_{Al(2)}}{2}$$

$$= \frac{21.5\% + 21.5\%}{2}$$

= 21.5%

Discussion:

The mass of metal or alloy should not affect the final result of purity or composition since we get nearly identical values in the experiments of alloy. Such big difference between the purity of Zinc in part 1 was not predicted while the experimental moles of hydrogen gas are also higher than the theoretical hydrogen gas, which makes the percent yield over 100%.

Source of error for Part 1:

-Errors may be caused by the leakage of extra gas and the uncleanness of the tubes and beakers we used.

-Another reason is that we added a little bit more HCl which made the reaction slow, some HCl gas may vapoured and mixed with hydrogen gas in the tube.

- The wrong measurement of temperature can make the volume of gas higher after the calculation by Ideal Gas Law if the temperature was actually lower than what we measured. In this case, the similarity of actual values cannot be expected because of the flaws in experiments.

Conclusion:

Both of zinc and aluminum can react with HCl successfully. The alloy contains 78.5% of Zinc and 21.5% of Aluminum.

Data Tables

Table 1. Pure Metal

Data	Trial 1	Trial 2
Identity of Metal	1178 Zinc	Zinc
Mass of metal (g)	0.0549g 0.0124g 0.041g	0.0435g
Uncalibrated volume of eudiometer (mL)	0	0
Volume of hydrogen gas (mL)	21.5 mL	17.8 mL
Height of water column (cm)	38 cm	44 cm
Density of water (kg/m ³)	1000 kg/m ³	1000 kg/m ³
Acceleration due to gravity (m/s ²)	9.8 m/s ²	9.8 m/s ²
Pressure of water column (Pa)	✓	
Water Temperature ((C)	22	22
Water Vapour pressure (Pa)	2.64 kPa	2.64 kPa
Atmospheric Pressure (Torr)	101.1 kPa	101.1 kPa
Pressure of Hydrogen	✓	
Room Temperature	22.1 °C	22.1 °C
Ideal Gas Constant, R	✓	
Actual Moles of Hydrogen (mol)	12 M	12 M
Theoretical moles of Hydrogen (mol)		
Percent Yield (%)		

= 19.5 mL
= 20.5 mL

Observations (Part 1):

The reaction was not too quick at first moment ~~water~~ the decrease of head was hard to observe since zinc was ^{slowly} reacting with acid. About 3 minutes later, the reaction became ~~more~~ little bit rapid, ~~fast~~ gas was producing quicker. Then the reaction ~~goes~~ ^{goes} steadily ^{until} the zinc float on the top of the water in tube.

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Jaedi Allad

Table 2. Alloy

Data	Trial 1	Trial 2
Unknown Number	5278	5278
Mass of alloy (g)	0.0410g	0.0413g
Uncalibrated volume of eudiometer (mL)	0	0
Volume of hydrogen gas (mL)	25.1ml	25.5ml
Height of water column (cm)	36.35cm	33.9cm
Density of water (kg/m ³)		
Acceleration due to gravity (m/s ²)		
Pressure of water column (Pa)		
Water Temperature ((C)	21°C	22°C
Water Vapour pressure (kPa)	2.49	2.64
Atmospheric Pressure (Torr)	101.1 kPa	101.1 kPa
Pressure of Hydrogen		
Room Temperature	22.1°C	22.1°C
Ideal Gas Constant, R		
Moles of Hydrogen (mol)	12	12
Mass of Zinc (g)		
Mass of Aluminum (g)		
Percent Zinc (%)	7	
Percent Aluminum (%)		
Average Percent		

Observations (Part 2):

Gas comes out quickly during the reaction, while the yield of gas descends ~~the~~ when the reaction goes on.

Jaeedi Allard