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**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): Tuesday*

*Lab Week (even/odd): even*

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

## **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 BA***\_\_\_\_\_

## Data Tables

**Table 1. Pure Metal**

Data	Trial 1	Trial 2
Identity of Metal	Zinc	Zinc
Mass of metal (g)	0.0571	0.0513
Uncalibrated volume of eudiometer (mL)	N/A	N/A
Volume of hydrogen gas (mL)	23.3	21.3
Height of water column (cm)	30.5	30.5
Density of water (kg/m <sup>3</sup> )	1.00x10 <sup>3</sup>	1.00x10 <sup>3</sup>
Acceleration due to gravity (m/s <sup>2</sup> )	9.81	9.81
Pressure of water column (Pa)	2990	3280
Water Temperature (°C)	22.0	22.0
Water Vapour pressure (Pa)	2640	2640
Atmospheric Pressure (Torr)	755	755
Pressure of Hydrogen (kPa)	95.0	94.7
Room Temperature (°C)	22.0	22.0
Ideal Gas Constant, R	8.31	8.31
Actual Moles of Hydrogen (mol)	9.0x10 <sup>-4</sup>	8.2x10 <sup>-4</sup>
Theoretical moles of Hydrogen (mol)	8.2x10 <sup>-4</sup>	7.8x10 <sup>-4</sup>
Percent Yield (%)	103	105

### Observations (Part 1):

#### **Trial 1:**

The zinc took a long time to start reacting, once it started, it began to slowly dissolve. During the reaction the tube started a minimal vibration, lots of bubbles were produced but the reaction was slow.

#### **Trial 2:**

The zinc reacted pretty slowly, long time to get started. Bubbles eventually started to speed up, once this happened the tube had a little bit of a vibration to it. Vibration did not last long. I could not smell anything significant during the reaction.

**Table 2. Alloy**

<b>Data</b>	<b>Trial 1</b>	<b>Trial 2</b>
<b>Unknown Number</b>	5200	5200
Mass of alloy (g)	0.0400	0.0420
Uncalibrated volume of eudiometer (mL)	N/A	N/A
Volume of hydrogen gas (mL)	24.7	27.7
Height of water column (cm)	28.6	26.5
Density of water (kg/m <sup>3</sup> )	1.00x10 <sup>3</sup>	1.00x10 <sup>3</sup>
Acceleration due to gravity (m/s <sup>2</sup> )	9.81	9.81
Pressure of water column (Pa)	2800	2600
Water Temperature (°C)	22.0	23.0
Water Vapour pressure (kPa)	2640	2640
Atmospheric Pressure (Torr)	755	755
Pressure of Hydrogen	95.1	95.4
Room Temperature	22.0	22.0
Ideal Gas Constant, R	8.31	8.31
Moles of Hydrogen (mol)	9.60x10 <sup>-4</sup>	1.10x10 <sup>-3</sup>
Mass of Zinc (g)	3.10x10 <sup>-2</sup>	2.80x10 <sup>-2</sup>
Mass of Aluminum (g)	8.60x10 <sup>-3</sup>	1.20x10 <sup>-2</sup>
Percent Zinc (%)	78.0	70.0
Percent Aluminum (%)	22.0	30.0
Average Percent	Zinc: 74.0 Aluminum: 26.0	Zinc: 74.0 Aluminum: 26.0

**Observations (Part 2):****Trial 1:**

Once the alloy reacts, the whole eudiometer turns to white bubbles, very cloudy, cannot see through. After this, most of the alloy floats up to the top of the water level and turns into a grey/black colour which eventually disappears.

**Trial 2:**

This alloy slowly reacts with minimal bubbles. Once it gets going, lots more bubbles appear and eudiometer turns white. Alloy eventually floats to the top and turns into a grey/black colour, continues to react. A piece of alloy escaped from the sample holder before the reaction began.

### Sample Calculation : Zinc Pure Metal

1. Uncalibrated Volume of the Eudiometer:

N/A

2. Volume of Hydrogen gas:

$$V_{H_2} = 23.3 \text{ mL}$$

3. Pressure exerted by the water column:

$$P = ?$$

$$g = 9.81 \text{ m/s}^2$$

$$h = 0.335 \text{ m}$$

$$d = 1.00 \times 10^3 \text{ kg/m}^3$$

$$P_{H_2O(l)} = dgh$$

$$= (1.00 \times 10^3 \text{ kg/m}^3)(9.81 \text{ m/s}^2)(0.335 \text{ m})$$

$$P_{H_2O(l)} = 3280 \text{ Pa}$$

Therefore, the pressure exerted by the water column was 3280 Pascal's.

4. Pressure of hydrogen gas:

$$p(H_2) = p_{atm} - p_{H_2O(v)} - p_{H_2O(l)}$$

$$p(H_2) = 100.6 \text{ kPa} - 2.64 \text{ kPa} - 3.28 \text{ kPa}$$

$$p(H_2) = 94.7 \text{ kPa}$$

Therefore, the pressure of hydrogen gas in the eudiometer was 94.7 kPa.

5. Moles of hydrogen gas (experimental):

$$PV = nRT$$

$$n = PV/RT$$

$$P = 94.7 \text{ kPa}$$

$$V=2.13 \times 10^{-2} \text{ L}$$

$$n=?$$

$$R=8.31$$

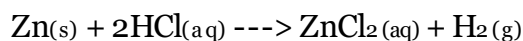
$$T=295 \text{ K}$$

$$n=(94.7 \text{ kPa} \times 2.13 \times 10^{-2}) / (8.31 \times 295 \text{ K})$$

$$n=8.20 \times 10^{-4} \text{ mol}$$

Therefore, the actual yield of hydrogen gas that was obtained is  $8.2 \times 10^{-4}$  mol.

#### 6. Moles of hydrogen gas (theoretical):



$$m_{\text{Zn}}=0.0513 \text{ g}$$

$$n=7.80 \times 10^{-4} \text{ mol}$$

$$M_{\text{Zn}}=65.4 \text{ g/mol}$$

$$n=m/M$$

$$n=0.0513 \text{ g} / 65.4 \text{ g/mol}$$

$$n=7.80 \times 10^{-4} \text{ mol}$$

Since the mole ratio from Zn to H<sub>2</sub> is 1:1, they have the same number of moles. Therefore, the theoretical yield of hydrogen gas is  $7.80 \times 10^{-4}$  moles.

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

$$\% \text{ Yield} = (\text{actual yield} / \text{theoretical yield}) \times 100\%$$

$$\% \text{ yield} = (8.2 \times 10^{-4} \text{ mol} / 7.8 \times 10^{-4} \text{ mol}) \times 100\%$$

$$\% \text{ yield} = 105\%$$

Therefore, the percent purity of zinc is 105%.

#### 8. Average Percent Purity:

$$\text{Average \% Purity} : \text{Trial 1\%} + \text{Trial 2\%} / 2$$

$$103\% + 105\% / 2 = 104\%$$

Therefore, the average percent purity for zinc from the two trials is 104%.

### **Sample Calculation : 5200 Alloy**

1. Pressure of water column and hydrogen gas:

$$P_{H_2O(l)}=?$$

$$g=9.81\text{m/s}^2$$

$$h=0.286\text{m}$$

$$d=1.00 \times 10^3 \text{kg/m}^3$$

$$P_{H_2O(l)}=dgh$$

$$=(1.00 \times 10^3 \text{kg/m}^3)(9.81 \text{m/s}^2)(0.286 \text{m})$$

$$P_{H_2O(l)}=2803 \text{ Pa}$$

Therefore, the pressure exerted by the water column was 2803 Pascal's.

$$p(H_2) = p_{\text{atm}} - p_{H_2O(v)} - p_{H_2O(l)}$$

$$p(H_2) = 100.6 \text{kPa} - 2.640 \text{kPa} - 2.803 \text{kPa}$$

$$p(H_2) = 95.1 \text{ kPa}$$

Therefore, the pressure of hydrogen gas in the eudiometer was 95.1 kPa.

2. Moles of hydrogen gas:

$$PV=nRT$$

$$n=PV/RT$$

$$P= 95.1 \text{ kPa}$$

$$V=2.47 \times 10^{-2} \text{ L}$$

$$n=(95.1 \text{kPa} * 2.47 \times 10^{-2}) / (8.31 * 295 \text{K})$$

$$n=?$$

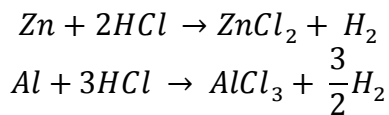
$$R=8.31$$

$$n=9.6 \times 10^{-4} \text{ mol}$$

$$T=295 \text{K}$$

Therefore, this reaction produced  $9.6 \times 10^{-4}$  moles of hydrogen gas.

3. Masses of Zinc and Aluminum in the alloy:



$$n_{\text{H}_2} = n_{\text{Zn}} + \frac{3}{2}n_{\text{Al}}$$

$$n_{\text{H}_2} = \frac{m_{\text{Zn}}}{M_{\text{Zn}}} + \frac{m_{\text{Al}}}{M_{\text{Al}}}$$

$$m_{\text{Zn}} = m_{\text{all}} - m_{\text{Al}}$$

$$n_{\text{H}_2} = \frac{m_{\text{all}}}{M_{\text{Zn}}} + \frac{m_{\text{Al}}}{M_{\text{Zn}}} + \frac{3}{2} \frac{m_{\text{Al}}}{M_{\text{Al}}}$$

$$= \frac{0.040\text{g}}{65.4\text{g/mol}} - \frac{m_{\text{Al}}}{\frac{65.4\text{g}}{\text{mol}}} + \frac{3}{2} \frac{m_{\text{Al}}}{26.9\text{g/mol}}$$

$$9.6 \times 10^{-4} = 6.1 \times 10^{-4} - \frac{m_{\text{Al}}}{\frac{65.4\text{g}}{\text{mol}}} + \frac{3}{2} \frac{m_{\text{Al}}}{26.9\text{g/mol}}$$

$$3.5 \times 10^{-4} = \frac{3m_{\text{Al}}}{53.9\text{g/mol}} - \frac{m_{\text{Al}}}{65.4\text{g/mol}}$$

$$= \frac{196.0m_{\text{Al}} - 54.0m_{\text{Al}}}{3530\text{g/mol}}$$

$$= \frac{142m_{\text{Al}}}{3530\text{g/mol}}$$

$$1.24 = 142m_{\text{Al}}$$

$$m_{\text{Al}} = 0.0086\text{g}$$

$$m_{\text{All}} = 0.040\text{g}$$

$$m_{\text{Zn}} = 0.040\text{g} - 0.0086\text{g}$$

$$m_{\text{Zn}} = 0.0314\text{g}$$

Therefore, the mass of Aluminum in the alloy is  $8.6 \times 10^{-3}\text{g}$  and the mass of Zinc is  $3.1 \times 10^{-2}\text{g}$ .

4. Percent composition of the alloy:

$$\% \text{Zn} = \frac{m_{\text{Zn}}}{m_{\text{All}}} \times 100\% \quad \% \text{Zn} = \frac{0.0314\text{g}}{0.040\text{g}} \times 100\% \quad \% \text{Zn} = 78.0\%$$

$$\% \text{Al} = \frac{m_{\text{Al}}}{m_{\text{All}}} \times 100\% \quad \% \text{Al} = \frac{0.0086\text{g}}{0.040\text{g}} \times 100\% \quad \% \text{Al} = 22.0\%$$

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

Zinc

Trial 1: 0.0314g

Trial 2: 0.023g (70%)

$$\text{Average \% Composition of Zinc} = \frac{78\% + 70\%}{2} = 74.0\%$$

Aluminum

Trial 1: 0.0086g       $\text{Average \% Composition of Aluminum} = \frac{22\% + 30\%}{2} = 26.0\%$

Trial 2: 0.012g (30%)

Therefore, the average composition of the alloy is 74.0% Zinc and 26.0% Aluminum.

### **Discussion: (within space provided)**

In this experiment, we calculated the average percent purity of zinc which was 104%. We also determined the composition of the aluminum/zinc alloy which resulted in 74% zinc and 26% aluminum. However, there was one apparent error in these calculations which is that a metal cannot have a percent purity of over 100%. Some sources of error that explained why we obtained 104% could be that the “pure” zinc was impure. The purity of the zinc could have been sacrificed when we were measuring the mass because of the moisture on our fingers. Another reason for this error could be because a piece of metal could stick to the eudiometer. This did not happen in our experiments, but if it did it would affect the results because we measured an exact mass that was expected to react completely and all calculations were acquired from that mass. It is important to measure the exact mass of the metal but not the volume of the acid because the metal is going to react the same way no matter how much acid is added, but if the mass is larger than we thought it will take longer to react and would produce a different amount of hydrogen gas. If air enters the eudiometer this will affect the results of the experiment because it would increase the volume of gas collected, interfering with the true volume of gas collected from the reaction itself.

For the composition of an alloy (a metal composed of two different elements) ours contained zinc and aluminum. I would expect the alloy to react more vigorously with the acid than the metal because it has two different elements with different characteristics and when these combine, I would assume that it would produce a more powerful reaction, which it did. Under these circumstances, I would not expect multiple trials with the alloy to produce similar results. I believe this because the samples that I take are going to be made up of different compositions of zinc and aluminum. Since zinc and aluminum react differently, a sample of say 23% zinc and 77% aluminum would react much differently than those roles reversed.

Overall, in the lecture component of this course, we are studying the behavior of gases and the ideal gas law, this helps to understand what is going on in the experiments and how we can calculate the desired outcome. Knowing the composition of alloys is important to the world around us because nearly every metal that you encounter is an alloy. These alloys can be things like; steel, brass, rose gold, etc. It is interesting to know what elements they are made up of because they behave so differently when they are mixed together.

### **Conclusion: (no more than two lines)**

In conclusion, using Zinc for the metal in this experiment resulted in average percent yield of 104%. The average percent composition for the alloy 5200 was 74% Zinc and 26% Aluminum.

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**Data Tables**

**Table 1. Pure Metal** 0) HCl - 20.5 mL  
(1) HCl - 20.4 mL

Data	Trial 1	Trial 2
Identity of Metal	Zinc	Zinc
Mass of metal (g)	0.0571	0.0513
Uncalibrated volume of endiometer (mL)	—	—
Volume of hydrogen gas (mL)	23.3	21.3
Height of water column (cm)	30.5	33.5
Density of water (kg/m <sup>3</sup> )		
Acceleration due to gravity (m/s <sup>2</sup> )		
Pressure of water column (Pa)		
Water Temperature (°C)	22°	22°
Water Vapour pressure (Pa)		
Atmospheric Pressure (Torr)	100.6 kPa → 754.6 torr	100.4 kPa → 754.6 torr
Pressure of Hydrogen		
Room Temperature	22°	22°
Ideal Gas Constant, R		
Actual Moles of Hydrogen (mol)		
Theoretical moles of Hydrogen (mol)		
Percent Yield (%)		

**Observations (Part 1):**

Trial 1: took a long time to start reacting, once it started the metal started to shimmy around. During the reaction the tube started a minimal vibration, lots of bubbles but reacted slowly.

Trial 2: the zinc reacted pretty slowly, long time to get started. Bubbles eventually started to speed up, once this happened the tube had a little bit of a vibration to it. Vibration didn't last very long.

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(1) HCl = 10.3 mL  
(2) HCl = 9.9 mL

Table 2. Alloy

Data	Trial 1	Trial 2
Unknown Number	5200	5200
Mass of alloy (g)	0.040	0.042
Uncalibrated volume of eudiometer (mL)	/	/
Volume of hydrogen gas (mL)	24.7	27.7
Height of water column (cm)	25.6	26.5
Density of water (kg/m <sup>3</sup> )		
Acceleration due to gravity (m/s <sup>2</sup> )		
Pressure of water column (Pa)		
Water Temperature (°C)	22	23
Water Vapour pressure (kPa)		
Atmospheric Pressure (Torr)		
Pressure of Hydrogen		
Room Temperature	22	23
Ideal Gas Constant, R		
Moles of Hydrogen (mol)		
Mass of Zinc (g)		
Mass of Aluminum (g)		
Percent Zinc (%)		
Percent Aluminum (%)		
Average Percent		

Observations (Part 2):

Trial 1: once it reacts, whole tube turns to bubbles, before alloy floats up  
↳ all alloy floats to top and turns in grey/black colour

Trial 2: slowly reacts, minimal bubbles. Once it gets going, lots more bubbles and whole eudiometer turns white

↳ alloy eventually floats to the top and turns into a grey/black colour, still reacting