Student Name: _Dana Chisholm________

Student Number: _8706527_______________

Partner's Name and Student #: _Emma Frank (8588940)___

Demonstrator's Name: _Nik Bode_______

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):*

*Lab Week (**even**/odd):*

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

Laboratory Report Form

Experiment 1.

Determination of the Composition of an Alloy

<u>Checklist:</u>

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

Student's Initials _D.C.____

Data Tables

Table 1. Pure Metal

Data	Trial 1	Trial 2
Identity of Metal	Magnesium	Magnesium
Mass of metal (g)	0.0264g	0.0237g
Uncalibrated volume of eudiometer (mL)	N/A	N/A
Volume of hydrogen gas (mL)	28.70ml	25.45ml
Height of water column (cm)	25.50cm	26.30cm
Density of water (kg/m^3)	1000.0 kg/m^3	1000.0 kg/m^3
Acceleration due to gravity (m/s^2)	9.8m/s^2 [down]	9.8m/s^2 [down]
Pressure of water column (Pa)	2499.0Pa	2577.4Pa
Water Temperature (°C)	22.70°C	22.10
Water Vapour pressure (Pa)	2.81 KPa	2.64 KPa
Atmospheric Pressure (Torr)	100.6 KPa	100.6 KPa
Pressure of Hydrogen	95.291 KPa	95.3826 KPa
Room Temperature	22.0	22.0
Ideal Gas Constant, R	8.3145	8.3145
Actual Moles of Hydrogen (mol)	0.001111798 mol	0.000988851 mol
Theoretical moles of Hydrogen (mol)	0.001111798 mol	0.000988851 mol
Percent Yield (%)	102.38%	101.43%

Observations (Part 1):

Water + HCl level is beginning to decrease, magnesium is giving off bubbles

Reaction progressed quite quickly and hydrogen gas has filled part of the eudiometer tube

Table 2. Alloy

Data	Trial 1	Trial 2
Unknown Number	3051	3051
Mass of alloy (g)	0.0398g	0.0392g
Uncalibrated volume of eudiometer (mL)	N/A	N/A
Volume of hydrogen gas (mL)	30.10ml	24.60ml
Height of water column (cm)	22.40cm	26.50cm
Density of water (kg/m^3)	1000kg/m^3	1000kg/m^3
Acceleration due to gravity (m/s^2)	9.8m/s^2 [down]	9.8m/s^2 [down]
Pressure of water column (Pa)	2195.2 Pa	2597 Pa
Water Temperature (°C)	22.3	22.2
Water Vapour pressure (kPa)	2.64kPa	2.64kPa
Atmospheric Pressure (Torr)	100.6 kPa	100.6 kPa
Pressure of Hydrogen	95.7648 kPa	95.363 kPa
Room Temperature	22.0	22.0
Ideal Gas Constant, R	8.3145	8.3145
Moles of Hydrogen (mol)	0.001173416 mol	0.000955304 mol
Mass of Zinc (g)	0.0261g	0.00846g
Mass of Aluminum (g)	0.0137g	0.03074g
Percent Zinc (%)	65.58%	78.42%
Percent Aluminum (%)	34.42%	21.58%
Average Percent	72.0% Zn	28.0%Al

Observations (Part 2):

Similar to the pure metal, water + HCl level begins to decrease, and alloy gives off bubbles
Reaction did not progress as quickly as pure metal, however, hydrogen gas once again began to fill eudiometer tube, replacing water + acid solution

Sample Calculation : Pure Metal

1. Uncalibrated Volume of the Eudiometer:

N/A Eudiometer was already calibrated.

2. Volume of Hydrogen gas:

Trial 1:

28.70ml/1000 = 0.0287L

Trial 2:

25.45ml/1000 = 0.02545L

3. Pressure exerted by the water column:

Trial 1:

$$p_{\text{water column}} = dgh$$
$$= (1000 kg/m^3)(9.8 m/s^2)(25.50 cm/100)$$
$$= (1000 kg/m^3)(9.8 m/s^2)(0.255 m)$$
$$= 2499.0 \text{ Pa or } 2.499 \text{ KPa}$$

Trial 2:

$$p_{\text{water column}} = (1000 kg/m^3)(9.8 m/s^2)(26.30 cm/100)$$
$$= (1000 kg/m^3)(9.8 m/s^2)(0.263 m)$$
$$= 2577.4 \text{ Pa or } 2.5774 \text{ KPa}$$

4. Pressure of hydrogen gas:

Trial 1:

$$p_{\text{hydrogen}} = p_{\text{atmosphere}} - p_{\text{water column}} - p_{\text{water vapour}}$$
$$= 100.6 \text{ KPa} - 2.499 \text{ KPa} - 2.81 \text{ KPa}$$
$$= 95.291 \text{ KPa}$$

Trial 2:

$$P_{\text{hydrogen}} = 100.6 \text{ KPa} - 2.5774 \text{ KPa} - 2.64 \text{ KPa}$$
$$= 95.3826 \text{ KPa}$$

5. Moles of hydrogen gas (experimental):

Trial 1:

$$n_{\text{hydrogen}} = PV/RT$$
$$= (95.291)(0.0287)/(8.3145)(295.85)$$
$$= 0.001111798 \text{ mol}$$

Trial 2:

$$n_{\text{hydrogen}} = (95.3826)(0.02545)/(8.3145)(295.25)$$
$$= 0.000988851 \text{ mol}$$

6. Moles of hydrogen gas (theoretical):

$Mg_{(s)} + 2HCl_{(aq)} \rightarrow MgCl_{2\,(aq)} + H_{2\,(g)}$

Trial 1:

nMg = m/MM

= 0.0264g/24.31g/mol

= 0.001085972 mol

Stoichiometry ratio of Mg to H_2 → 1:1

Therefore, nH_2 = 0.001085972 mol

Trial 2:

nMg = 0.0237g/24.31g/mol

= 0.000974907 mol

Stoichiometry ratio of Mg to H_2 → 1:1

Therefore, nH_2 = 0.000974907 mol

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

% yield = Actual yield/ Theoretical yield * 100%

Trial 1:

= (0.001111798)/(0.001085972)

= 1.02378 * 100%

= 102.38%

Trial 2:

= (0.000988851)/(0.000974907)

= 1.01430 * 100%

= 101.43%

8. Average Percent Purity:

Avg. % = (Trial 1 + Trial 2)/ 2

= (102.38 + 101.43)/2

= 101.91%

<u>Sample Calculation : Alloy</u>

1. Pressure of water column and hydrogen gas:

Trial 1:

$p_{water\ column}$ = (1000kg/m³)(9.8m/s²)(0.224m)

= 2195.2 Pa or 2.1952 KPa

$p_{hydrogen}$ = 100.6KPa – 2.1952KPa – 2.64KPa

= 95.7648 KPa

Trial 2:

$p_{water\ column}$ = (1000kg/m³)(9.8m/s²)(0.265m)

= 2597 Pa or 2.597 KPa

$p_{hydrogen}$ = 100.6 KPa – 2.597 KPa – 2.64 KPa

= 95.363 KPa

2. Moles of hydrogen gas:

Trial 1:

$n_{hydrogen}$ = **(95.7648)(0.0301)/ (8.3145)(295.45)**

= 0.001173416 mol

Trial 2:

$n_{hydrogen}$ = **(95.363)(0.0246)/ (8.3145)(295.35)**

= 0.000955304 mol

3. Masses of Zinc and Aluminum in the alloy:

$Zn_{(s)} + 2HCl_{(aq)} \rightarrow ZnCl_{2(aq)} + H_{2(g)}$

$Al_{(s)} + 3HCl_{(aq)} \rightarrow AlCl_{3(aq)} + 3/2H_{2(g)}$

$nH_2 = m_{alloy} / MM_{Zn} - m_{Al}/ MM_{Zn} + (3/2)m_{Al}/MM_{Al}$

Trial 1 :

$0.001173416 \text{ mol } H_2 = (0.0398_{g}/63.39_{g/mol}) - (m_{Al}/63.39_{g/mol}) + (3/2)(m_{Al})/26.98_{g/mol}$

$0.001173416 \text{ mol } H_2 = 0.000627859\text{mol} - (m_{Al}/63.39_{g/mol}) + (3/2)(m_{Al})/26.98_{g/mol}$

$0.001173416 - 0.000627859 = 0.000545557$

$0.000545557 = -(mAl/63.39_{g/mol}) + (3/2)(mAl)/26.98_{g/mol}$

$m_{Al} = 0.0137_{g}$

$m_{Zn} = 0.0398_{g} - 0.0137_{g}$

$= 0.0261_{g}$

Trial 2 :

$m_{Al} = 0.00846_{g}$

$m_{Zn} = 0.0392_{g} - 0.00846_{g}$

$= 0.03074_{g}$

4. Percent composition of the alloy:

%Zn = (mZn/ mAlloy) (100%)

Trial 1 = (0.0261g/0.0398g)*100%

= 65.58%

Trial 2 = (0.03074g/0.0392g)* 100%

= 78.42%

%Al = (mAl/ mAlloy)(100%)

Trial 1 = (0.0137g/0.0398g)*100%

= 34.42%

Trial 2 = (0.00846g/0.0392)*100%

= 21.58%

5. Average Percent composition of the alloy (average of zinc values and average of aluminum values):
   %Zn = (65.58% + 78.42%)/2
   = 72.0%

   %Al = (34.42% + 21.58%)/2
   = 28.0%

<u>Discussion: (within space provided)</u>

1.Does it matter if the eudiometer was calibrated or not?
The calibration does matter because if the eudiometer was not calibrated and was not accounted for, measurements such as the height of the water column and volume of hydrogen gas would be inaccurate therefore making the rest of the calculations inaccurate.

2. Why was it important to measure the mass of metal exactly but not the volume of acid added?
The metal in this experiment was the limiting reagent and therefore needed to be exact because all of it would be used up in the reaction whereas not all of the acid would be and therefore it was not as important in terms of being exact.

3.Is your result affected if air enters the eudiometer?
The results would be affected because then the volume of hydrogen gas measurement taken during the experiment would be inaccurate as some of the volume would now be air and we can't differentiate the two when in the eudiometer.

4. If some metal floats up and sticks to the eudiometer or does not react, is your result affected?
The results would be affected because during the experiment we are working under the assumption that all of the metal reacts, therefore some of it not reacting would make our results inaccurate.

5. What does it mean if your percent yield (percent purity of the metal) is a) greater than 100% b) 100% c) less than 100%?

a) It would be greater than 100 if there are impurities that makes the mass more than it was measured at, such as the metal coming into contact with some other substance (like your fingers) after the mass measurement was taken.
b) It would be equal to 100% if the actual mass in the experiment is equal to the theoretical mass.
c) It would be less than 100% if the reaction is incomplete and not all the metal reacted.

6.What is an alloy?
An alloy is two or more metals combined to make a metal.

7.How do you expect an alloy to react with acid compared to a pure metal?
I expect that an alloy reacts with acid in a similar way as a pure metal with the exception that an alloy takes a longer time to react with the acid.

8. Do you expect multiple trials with an alloy to produce similar results? Should you?
I expect that I would find similar results with multiple trials as long as I use the same alloy and the conditions under which I performed the experiment remain the same.

9. Does the mass of metal or the mass of alloy used affect your result? Should it?
The mass of the metal and the mass of the alloy do affect the result because as the theoretical chemical equation shows, the amount of hydrogen gas produced is dependent upon the amount of metal or alloy used.

10. If your results are not what you expected, is it due to a flaw in the theory? A flaw in the procedure? A flaw in your experimental work? Factors outside your control?
I do not believe that my skewed results are due to a flaw in the theory but due to imperfect procedure and experimental work. It is quite possible that I touched the metal or alloy sample after sanding and not all of the metal reacted during my trials. This affected my results and made them slightly inaccurate in comparison to the theoretical outcomes.

11. Think of a way in which this experiment relates to your work in the lecture course.
This experiment relates to what I have learned about stoichiometry in the lecture course as well as the applications of concepts such as the ideal gas law.

12. Think of a way in which this experiment connects to or has applications in the world around you.
Many metals found naturally in the environment are not 100% pure metal but are in fact alloys. This experiments can be and is often applied in fields such as mining as it is important to find out exactly how much of what types of metal are contained in an alloy that is found.

<u>Conclusion: (no more than two lines)</u>

This experiment has demonstrated that alloys and pure metal react in a similar way with acid by producing gas. This being said, alloys have a slower reaction time than pure metal.

Table 1 Pure Metal

	Trial 1	Trial 2
Identity of Metal	~~[illegible]~~ Magnesium	~~[illegible]~~ Magnesium
Mass of metal (g)	~~[illegible]~~ 0.0264g	~~[illegible]~~ 0.0237g
Uncalibrated volume of eudiometer (mL)	N/A	N/A
Volume of hydrogen gas (mL)	28.70mL	25.45mL
Height of water column (cm)	25.50cm	26.30cm
Density of Water (kg/m^3)		
Accel. due to gravity (m/s^2)		
Pressure of water column (Pa)		
Water temp (°C)	22.70°C	22.10°C
Water Vapour Pressure (Pa)		
Atmosphere's Pressure (Torr)	100.6 KPa	100.6 Kpa
Pressure of Hydrogen		
Room Temp.	22°C	22°C
Ideal gas constant, R		
Actual Moles of Hydrogen (mol)		
Theoretical moles of Hydrogen (mol)		
Percent Yield (%)		

Observations (Part 1):

- ~~water level~~
- water + HCl level is starting to decrase, ~~[illegible]~~ zinc is giving off bubbles

Table 2 Alloy

	Trial 1	Trial 2
Unknown Number	3051	3051
Mass of alloy (g)	0.0398g	0.0392
Uncalibrated vol. of eudiometer	N/A	N/A
Vol. of hydrogen gas (mL)	30.10mL	24.60mL
Height of water column (cm)	22.40cm	26.50cm
Density of water (Kg/m³)		
Accel. due to gravity (m/s^2)		
Pressure of water column (Pa)		
Water temp. (°C)	22.3°C	22.2°C
Water Vapour Pressure (KPa)		
Atmospheric Pressure (Torr)	100.6 KPa	100.6 KPa
Pressure of hydrogen		
Room Temp.	22.0°C	22.0°C
Ideal gas constant, R		
Moles of Hydrogen (mol)		
Mass of Zinc (g)		
Mass of Aluminum (g)		
Percent Zinc (%)		
Percent Aluminum (%)		
Avg. Percent		

Observations (Part 2)