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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: *Tues afternoon*

Lab Week: *2*

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: AT

20mg = 0.02g

PV=nRT, Room constant

Data Tables

magnesium Alloy sample # 3064

Table 1. Pure Metal

Data	Trial 1 (3)	Trial 2
Identity of Metal	Magnesium	Magnesium
Mass of metal (g)	~~0.0184g~~ 0.0306g	0.0206g
Uncalibrated volume of eudiometer (mL)	9-4.2mL ≈0.35	N/A
Volume of hydrogen gas (mL)	27.2mL	21.6mL
Height of water column (cm)	23.3mL	32cm
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)	100400 Pa	100400Pa
Water Temperature (°C)	19.6°C	19.2°C
Water Vapour pressure (Pa)	100400 Pa,	
Atmospheric Pressure (Torr)	1.004 bar / 753 .24torr	1.004bar/753.24torr
Pressure of Hydrogen	1.004 bar	
Room Temperature	19.5°C	19.5°C
Ideal Gas Constant, R	0.0831497 (bar.L)/(mol.K)	
Actual Moles of Hydrogen (mol)	4.36×10^{-4} mol	
Theoretical moles of Hydrogen (mol)	1.26×10^{-3} mol	
Percent Yield (%)	34.6%	

Observations (Part 1): 1 bar = 10^5 Pa

bubbles, gets warm

8.3+15
23.3

metal: strip
shiny
flat

H. Dinadhwen

$Mg + 2HCl \rightarrow MgCl_2 + H_2(g)$

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① 0.0415g
② 0.0587g

Table 2. Alloy

Data	Trial 1	Trial 2
Unknown Number	3064	3064
Mass of alloy (g)	0.0490g	0.0587g
Uncalibrated volume of eudiometer (mL)	5.1 +0.05	N/A
Volume of hydrogen gas (mL)	23.6mL	34.8mL
Height of water column (cm)	24.7	11.9cm
Density of water (kg/m^3)		
Acceleration due to gravity (m/s^2)		
Pressure of water column (Pa)		
Water Temperature (°C)	19.2	18.5
Water Vapour pressure (kPa)		
Atmospheric Pressure (Torr)		
Pressure of Hydrogen		
Room Temperature	19.5C	19.5C
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):

alloy darkened (murky grey)

metal: shavings silver

0.0490g

15.0
9.7
24.7

A.Donelson

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Data Tables

Table 1. Pure Metal

Data	Trial 1	Trial 2
Identity of Metal	Magnesium	Magnesium
Mass of metal (g)	0.0306g	0.0206g
Uncalibrated volume of eudiometer (mL)	9.7mL	N/A
Volume of hydrogen gas (mL)	36.9mL	21.6mL
Height of water column (cm)	23.3cm	32.0cm
Density of water (kg/m^3)	1000kg/m^3	1000kg/m^3
Acceleration due to gravity (m/s^2)	9.8m/s^2	9.8m/s^2
Pressure of water column (Pa)	2283.4 Pa	3136 Pa
Water Temperature (°C)	19.6℃	19.2℃
Water Vapour pressure (Pa)	2200 Pa	2200 Pa
Atmospheric Pressure (Torr)	1.004bar/753.2Torr/ 100 400 Pa	1.004bar/753.2Torr/ 100 400 Pa
Pressure of Hydrogen	95.92 kPa	95.2 kPa
Room Temperature	19.5℃	19.5℃
Ideal Gas Constant, R	$0.0831497\frac{(bar \cdot L)}{(mol \cdot K)}$	$0.0831497\frac{(bar \cdot L)}{(mol \cdot K)}$
Actual Moles of Hydrogen (mol)	1.522×10^{-3} mol	8.912×10^{-4} mol
Theoretical moles of Hydrogen (mol)	1.26×10^{-3}mol	8.47×10^{-4} mol
Percent Yield (%)	102.8%	105.2%

Observations (Part 1):

-a lot of bubbles

-got warm

-metal was a shiny flat strip

Table 2. Alloy

Data	Trial 1	Trial 2
Unknown Number	3064	3064
Mass of alloy (g)	0.0490g	0.0587g
Uncalibrated volume of eudiometer (mL)	10-0.05 =9.95mL	N/A
Volume of hydrogen gas (mL)	23.6mL	34.8mL
Height of water column (cm)	24.7cm	14.9cm
Density of water (kg/m^3)	1000kg/m^3	1000kg/m^3
Acceleration due to gravity (m/s^2)	9.8m/s^2	9.8m/s^2
Pressure of water column (Pa)	2420 Pa	1460 Pa
Water Temperature (°C)	19.2	18.5
Water Vapour pressure (kPa)	2200 Pa	2200 Pa
Atmospheric Pressure (Torr)	1.004bar/753.2Torr/ 100 400 Pa	1.004bar/753.2Torr/ 100 400 Pa
Pressure of Hydrogen	95.78kPa	96.74kPa
Room Temperature	19.5	19.5
Ideal Gas Constant, R	$0.0831497\frac{(bar\cdot L)}{(mol\cdot K)}$	$0.0831497\frac{(bar\cdot L)}{(mol\cdot K)}$
Moles of Hydrogen (mol)	9.737x10-4 mol	1.436x10-3 mol
Mass of Zinc (g)	0.0458g	0.0511g
Mass of Aluminum (g)	3.165×10^{-3}g	7.596x10-3g
Percent Zinc (%)	93.3%	87.1%
Percent Aluminum (%)	6.5%	12.9%
Average Percent	90.2% (Zinc)	9.7% (Aluminum)

Observations (Part 2):

-alloy and surrounding water darkened

-turned murky grey

-metal was like silver shavings

Sample Calculation : Pure Metal

1. Uncalibrated Volume of the Eudiometer:

Trial 1: 10mL-0.3mL=9.7mL

Trial 2: N/A

2. Volume of Hydrogen gas:

Trial 1: 27.2mL+9.7mL=36.9mL

Trial 2: 21.6mL

3. Pressure exerted by the water column:

Pressure=water density x acceleration of gravity x height of water column

Trial 1:

P=(1000kg/m^3)(9.8m/s^2)(0.233m)

$=2283.4\frac{kg}{m\cdot s^2}$

=2283.4 Pa

Trial 2:

P=(1000kg/m^3)(9.8m/s^2)(0.32m)

$=3136\frac{kg}{m\cdot s^2}$

=3136 Pa

4. Pressure of hydrogen gas:

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

$n=\frac{PV}{RT}$

Trial 1:

P= (100.4kPa) – (2.2834 kPa) – (2.20 kPa)

=95.9166 kPa

=95.92 kPa

Trial 2:

P= (100.4kPa) – (3.136 kPa) – (2.20 kPa)

=95.064 kPa

=95.2 kPa

5. Moles of hydrogen gas (experimental):

Trial 1

$n=\frac{(1.004\ bar)(0.0369L)}{(0.0831497\frac{(bar\cdot L)}{(mol\cdot K)})(292.65K)}$

n=1.522x10^{-3} mol

Trial 2

$n=\frac{(1.004\ bar)(0.0216L)}{(0.0831497\frac{(bar\cdot L)}{(mol\cdot K)})(292.65K)}$

n=8.912x10^{-4} mol

6. Moles of hydrogen gas (theoretical):

$Mg + 2HCl \rightarrow MgCl_2 + H_2$

Trial 1

$n=\frac{m}{MM}$

$n=\frac{0.0306g}{24.31g/mol}$

n=1.26x10^{-3}mol

Trial 2

$n=\frac{m}{MM}$

$n=\frac{0.0206g}{24.31g/mol}$

n=8.47x10^{-4}mol

7. Percentage Purity of metal:

$$\%yield = \frac{actual}{theoretical} x100$$

Trial 1

$$\%yield = \frac{actual}{theoretical} x100$$

$$= \frac{1.522x10^{-3}\ \mathrm{mol}}{1.26x10^{-3}\ \mathrm{mol}} x100$$

=102.8%

Trial 2

$$\%yield = \frac{actual}{theoretical} x100$$

$$= \frac{8.912x10^{-4}\mathrm{mol}}{8.47x10^{-4}\mathrm{mol}} x100$$

=105.2%

8. Average Percent Purity:

$$Avg = \frac{102.8+105.2}{2}$$

=104%

Sample Calculation : Alloy

1. Pressure of water column and hydrogen gas:

Pressure=water density x acceleration of gravity x height of water column

Trial 1:

$P=(1000kg/m^3)(9.8m/s^2)(0.247m)$

$=2420\frac{kg}{m \cdot s^2}$

=2420 Pa

Trial 2:

$P=(1000kg/m^3)(9.8m/s^2)(0.149m)$

$=1460\frac{kg}{m \cdot s^2}$

= 1460 Pa

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

Trial 1:

P= (100.4kPa) – (2.420 kPa) – (2.20 kPa)

=95.78kPa

Trial 2:

P= (100.4kPa) – (1.460 kPa) – (2.20 kPa)

=96.74kPa

2. Moles of hydrogen gas:

Trial 1

$n=\frac{(1.004\ bar)(0.0236L)}{(0.0831497\frac{(bar\cdot L)}{(mol\cdot K)})(292.65K)}$

$n=9.737\times10^{-4}$ mol

Trial 2

$n=\frac{(1.004\ bar)(0.0348L)}{(0.0831497\frac{(bar\cdot L)}{(mol\cdot K)})(292.65K)}$

$n=1.436\times10^{-3}$ mol

3. Masses of Zinc and Aluminum in the alloy:

Trial 1:

$M_{total}=M_{zinc}+M_{aluminum}$

$M_{total}=0.0490g$

1.$M_{zinc}=M_{total}-M_{aluminum}$

2. $n_H=n_{Zn}+\frac{3}{2}(n_{Al})$

$n_H=(\frac{\text{Mzinc}}{\text{MMzinc}}) + \frac{3}{2}(\frac{\text{Maluminum}}{\text{MMaluminum}})$

$n_H=(\frac{\text{Mtotal}-\text{Maluminum}}{\text{MMzinc}}) + \frac{3}{2}(\frac{\text{Maluminum}}{\text{MMaluminum}})$

$n_H=(\frac{0.0490\text{g}-\text{Maluminum}}{\text{MMzinc}}) + (\frac{3\text{Maluminum}}{2\text{MMaluminum}})$

$n_H = \frac{2MAl(0.0490g)-2MAlxMMAl+MZnx3MAl}{MMZnx2MMAl}$

n_Hx MMZnx2MMAl = 2MMAl(0.0490g)-2MAlxMMAl+MMZnx3Mal

(9.737×10^{-4} mol)(65.39g/mol)(53.96g/mol) = 2(26.98g/mol)(0.0490g)-2MAlx(26.98g/mol)+(65.39g/mol)x3MAl

3.4356=2.644 - 53.96MAl + 196.17MAl

0.7916 = 250.13 MAl

3.165×10^{-3}g=MAl

$M_{zinc}=M_{total}-M_{aluminum}$

M_{zinc} = 0.0490g - 3.165×10^{-3}g

M_{zinc} = 0.0458g

Trial 2:

n_Hx MMZnx2MMAl = 2MMAl(0.0587g)-2MAlxMMAl+MMZnx3Mal

(1.436×10^{-3} mol)(65.39g/mol)(53.96g/mol) = 2(26.98g/mol)(0.0587g)-2MAlx(26.98g/mol)+(65.39g/mol)x3MAl

5.067=3.167 - 53.96MAl + 196.17MAl

1.9=250.13 MAl

7.596×10^{-3}g=Mal

$M_{zinc}=M_{total}-M_{aluminum}$
$M_{zinc}=0.0587g-7.596x10^{-3}g$
$M_{zinc}=0.0511g$

4. Percent composition of the alloy:
   Trial 1:

Aluminum=$\frac{mAl}{mT}$x100
=$\frac{3.165x10-3g}{0.0490g}$x100
=6.5%

Zinc=$\frac{mZn}{mT}$x100
=$\frac{0.0458g}{0.0490g}$x100
=93.3%

Trial 2:

Aluminum=$\frac{mAl}{mT}$x100
=$\frac{7.596x10-3g}{0.0587g}$x100
=12.9%

Zinc=$\frac{mZn}{mT}$x100
=$\frac{0.0511g}{0.0587g}$x100
=87.1%

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

$\%m_{Zn} = \frac{93.3\%+87.1\%}{2}$
=90.2%
$\%m_{Al} = \frac{12.9\%+6.5\%}{2}$
=9.7%

Discussion: (within space provided)

The objective of this lab was to witness how the Ideal Gas Law is used first hard, use stoichiometry, determine the uncalibrated volume of a eudiometer tube, compare theoretical and experimental yields as well as understand how to solve for the percentage of known metal in an unknown alloy. The main use of an alloy is to increase the metal's strength, for example aluminum on it's own is a very soft metal, but once combined with copper it can be used to build aircraft frames. In this lab Magnesium, as well as an alloy combine of Zinc and Aluminum undergo reactions with hydrochloric acid. Two trials for both the metal, and alloy were conducted. Although they are not the same metals, their final results were used to calculate the percent of Zinc and Aluminum of the unknown alloy as well as the purity of the strip of Magnesium. In this specific experiment the outcome was Magnesium was 104% pure, which is impossible, and the unknown alloy was 90.2% Zinc and 9.7% Aluminum.

Whenever an experiment is being conducted there is always room for errors to occur which in turn changes the outcome and results. During the experiment there are things that are unavoidable, such as loss of gas due to the eudiometer not being able to collect everything because the entire system is not enclosed and there may be some that will escape under it. This is a big problem because it can change the percent purity, in the following experiment the percent purity was above 100, this could contribute to the cause. There is also room for error when it comes to the mass of the metal, it could be the wrong size therefore there may still be oxide left on the metal therefore the results would change and contain error. Another example of error that could occur is calculation error. Sometimes the numbers of significant digits that can be recorded during an experiment aren't exactly accurate since they are not measured precise. A problem that was observed during the experiment was that the alloy continuously floated up to the surface so it could be that some of the alloy was not accounted for or did not fully react with the hydrochloric acid. It is expected that during both trials similar results would occur, however having two different eudiometers might have added error due to the inconsistency.

At the end of the experiment there were obvious errors that were present due to the inconsistency between trial 1 and trial 2. For example, for the percent composition of the alloy, in trial one the results were 6.5% Aluminum and 93.3% Zinc, while in trial 2 they were 12.9% Aluminum and 87.1% Zinc. Although there is error in the results, the goal of the experiment was understood. It is possible to determine unknown using other known values. The expectation going into the experiment for the reaction between hydrochloric acid and Magnesium were slightly disappointing because the expectation was for there to be a bigger reaction. This is because Magnesium is highly reactive and the time frame for the reaction was longer than expected. However the reaction between the alloy and acid did not

Conclusion: (no more than two lines)

In conclusion, for the metal, the average percent purity came out to be 104%. For the alloy it was made up of 90.2% Zinc and 9.7% Aluminum.