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[redacted]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**

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Data Tables

Table 1. Pure Metal

Data	Trial 1	Trial 2
Identity of Metal	Magnesium (Mg)	Magnesium
Mass of metal (g)	0.0207g / 20.7 mg	0.0248g / 24.8mg
Uncalibrated volume of eudiometer (mL)	0mL	0mL
Volume of hydrogen gas (mL)	26.6 mL	26mL
Height of water column (cm)	~23cm	~25cm
Density of water (kg/m^3)		
Acceleration due to gravity (m/s^2)		
Pressure of water column (Pa)		
Water Temperature (°C)	21°C	22.3
Water Vapour pressure (Pa)		
Atmospheric Pressure (Torr)	100.5 kPA	100.5 kPA
Pressure of Hydrogen		
Room Temperature	22°C	22°C
Ideal Gas Constant, R		
Actual Moles of Hydrogen (mol)		
Theoretical moles of Hydrogen (mol)		
Percent Yield (%)		

Observations (Part 1):

Table 2. Alloy

Data	Trial 1	Trial 2
Unknown Number		
Mass of alloy (g)	0.0400g	0.0405g
Uncalibrated volume of eudiometer (mL)	/	/
Volume of hydrogen gas (mL)	24.3mL	21.7mL
Height of water column (cm)	30.5cm	34.1cm
Density of water (kg/m³)		
Acceleration due to gravity (m/s²)		
Pressure of water column (Pa)		
Water Temperature (°C)	21.5°C	22.0°C
Water Vapour pressure (kPa)		
Atmospheric Pressure (Torr)	100.5kPA	100.5kPA
Pressure of Hydrogen		
Room Temperature	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 (%)		
Average Percent		

Observations (Part 2):

Data Tables

Table 1. Pure Metal

Data	Trial 1	Trial 2
Identity of Metal	Mg	Mg
Mass of metal (g)	0.0207g	0.0248g
Uncalibrated volume of eudiometer (mL)	N/A	N/A
Volume of hydrogen gas (mL)	26.6mL	26mL
Height of water column (cm)	23cm	25cm
Density of water (kg/m^3)	1000kg/m^3	1000kg/m^3
Acceleration due to gravity (m/s^2)	9.8 m/s^2	9.8m/s^2
Pressure of water column (Pa)	2.254kpa	2.45kPa
Water Temperature (°C)	21	22.3
Water Vapour pressure (Pa)	2.64 kPa	2.64 Kpa
Atmospheric Pressure (Torr)	101.325 kPa	101.325 kPa
Pressure of Hydrogen		
Room Temperature (°C)	22	22
Ideal Gas Constant, R		
Actual Moles of Hydrogen (mol)		
Theoretical moles of Hydrogen (mol)		
Percent Yield (%)		

Observations (Part 1):

-A lot of gas/ bubbles formed
-Very fast reaction (<2 min)
- Reaction begun almost instantaneously.

Table 2. Alloy

Data	Trial 1	Trial 2
Unknown Number		
Mass of alloy (g)	0.0400g	0.0405g
Uncalibrated volume of eudiometer (mL)		
Volume of hydrogen gas (mL)	24.3	21.7mL
Height of water column (cm)	30.5	34.1
Density of water (kg/m^3)		
Acceleration due to gravity (m/s^2)		
Pressure of water column (Pa)		
Water Temperature (°C)	21.5	22.0
Water Vapour pressure (kPa)		
Atmospheric Pressure (Torr)	101.325kpa	101.325kPa
Pressure of Hydrogen (°C)		
Room Temperature	22	22
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):

- Very slow reaction
-Slow bubbles
-Most of the alloy reacted from the bottom of the sample holder (as opposed to floating up the eudiometer)

Sample Calculation : Pure Metal

1. Uncalibrated Volume of the Eudiometer:

   N/A

2. Volume of Hydrogen gas:

   26.6mL = 0.0266L

3. Pressure exerted by the water column:

Trial #1	Trial #2
p=dgh $=(1000\ kg/m^3)(9.8m/s^2)(0.23m)$ $=2254\ N/m^2$ $1kPa = 1000\ N/m^2$ $=2.254\ kPa$	p=dgh $=(1000kg/m^3)(9.8m/s^2)(0.25m)$ $=2450\ N/m^2$ $1kPa = 1000\ N/m^2$ $=2.45\ kPa$

4. Pressure of hydrogen gas:

Trial #1	Trial #2
$P_H = p_{atmos} - p_{water\ column} - p_{water\ vapour}$ =101.325kPa - 2.254kPa – 2.64kPa =96.385kPa	$P_H = p_{atmos} - p_{water\ column} - p_{water\ vapour}$ =101.325kPa - 2.45kPa – 2.64kPa =96.235kPa

5. Moles of hydrogen gas (experimental):

Trial #1	Trial #2
n=pV/RT =(101.325)(0.0266)/(8.314)(294.15) =0.001102096 mol	n=pV/RT =(101.325)(0.026)/(8.314)(295.45) =0.001072497 mol

6. Moles of hydrogen gas (theoretical):

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

Trial #1	Trial #2
nMg= (0.0207g)/(24.3050g/mol) = 0.000851677 *Stoichiometry Ratio for Mg to H_2 → 1:1 Therefore moles of H_2 = 0.000851677mol	nMg= (0.0248g)/(24.3050g/mol) = 0.0010203 *Stoichiometry Ratio for Mg to H_2 → 1:1 Therefore moles of H_2 = 0.0010203mol

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

Trial #1	Trial #2
%y= Actual Yield/Theoretical Yield = (0.001102096 mol/0.000851677mol) (100%) =129.40%	%y= Actual Yield/Theoretical Yield = (0.001072497 mol /0.0010203mol) (100%) = 105.12%

8. Average Percent Purity:

(129.40% + 105.12%)/2 = 117.26%

Sample Calculation : Alloy

1. Pressure of water column and hydrogen gas:

Water Column:

Trial #1	Trial #2
$p=dgh$ $=(1000\ kg/m^3)(9.8 m/s^2)(0.305 m)$ $=2989\ N/m^2$ $1 kPa = 1000\ N/m^2$ $=2.989\ kPa$	$p=dgh$ $=(1000 kg/m^3)(9.8 m/s^2)(0.341 m)$ $=3341.8\ N/m^2$ $1 kPa = 1000\ N/m^2$ $= 3.3418\ kPa$

Hydrogen Gas:

Trial #1	Trial #2
$P_H = p_{atmos} - p_{water\ column} - p_{water\ vapour}$ $=101.325 kPa - 2.989 kPa - 2.64 kPa$ $=95.696 kPa$	$P_H = p_{atmos} - p_{water\ column} - p_{water\ vapour}$ $=101.325 kPa - 3.3418 kPa - 2.64 kPa$ $=95.3432 kPa$

2. Moles of hydrogen gas:

Trial #1	Trial #2
$n=pV/RT$ $=(95.696)(0.23)/(8.314)(273.15)$ $=0.001024$ mol	$n=pV/RT$ $=(101.325)(0.25)/(8.314)(273.20)$ $=0.010358044$ mol

3. Masses of Zinc and Aluminum in the alloy:

$Zn (s) + 2HCl (aq) \rightarrow ZnCl_2 (aq) + H_2 (g)$

$Al (s) + 3HCl (aq) \rightarrow AlCl_3 (aq) + (3/2)H_2 (g)$

nH_2 = mAlloy / MM Zn – mAl/ MM Zn + (3/2) mAl/MM Al

0.0001130 mol H_2 = (0.0400g/63.39 g/mol) – (mAl /65.39g/mol) + ((3/2)(mAl)/26.98g

0.0001130 mol H_2 = 0.0006117mol - (mAl /65.39g/mol) + ((3/2)(mAl)/26.98g

0.0001130 mol – 0.0006117 = 0.04030Al

mAl = 0.01286g
mZn = mAlloy – mAl
= 0.0400g – 0.01286g
= 0.0271g

4. Percent composition of the alloy:

%Zn = (mZn/ mAlloy) (100%)
= (0.0271g/ 0.0400g)(100%)
= 67.75%

%Al = (mAl/ mAlloy)(100%)
= (0.01286g/0.0400)(100%)
= 32.15%

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

%Zn = (67.75% + 60.5%)/2
= 64.125%

%Al = (32.15% + 39.50%)/2
= 35.83%

<u>Percent Error</u>

%error =((|Experimental - Theoretical|)/ Theoretical)(100%)
=((|0.001102096 mol - 0.000851677mol |) / 0.000851677mol)(100%)
= 29.4%

Discussion:

1. Does it matter if the eudiometer was calibrated or not?

   Calibration of the eudiometer ensures you get the correct results when measuring the amount of HCl and water, as well as calculating volume of hydrogen gas. If the lab equipment is inaccurate, it is impossible for the results taken from that lab to be accurate as well.

2. Why was it important to measure the mass of metal exactly but not the volume of acid added?

   The mass of metal needed to be exact to ensure that the metal remains the limiting reactant and therefore reacts completely with the acid to get the maximum amount of H_2 gas that can be produced.

3. Is your result affected if air enters the eudiometer?

   Yes the results are affected. If air enters the eudiometer, it could react with the H_2 gas being released, as well as give an inaccurate reading of the amount of H_2 actually produced.

4. If some metal floats up and sticks to the eudiometer or does not react, is your result affected?

   Yes the results are affected. When doing the calculations, we used the mass of metal/alloy that we measured initially, not taking into account any metal that might not have reacted. There would be no way to know the mass of metal that didn't react, but in the calculations, all the metal reacted, making the results incorrect.

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) There was added mass after the mass measurement was taken. i.e. forgetting to sand, touching metal after sanding, etc.
   b) Theoretical and Actual moles/masses are equal
   c) Lab conditions were not ideal or mass measurements were not accurate enough

6. What is an alloy?

   A mixture of 2 metals

7. How do you expect an alloy to react with acid compared to a pure metal?

   The alloy would react much slower, due to the fact that a mixture of 2 metals creates different, normally stronger, properties then the 2 pure metals on their own.

8. Do you expect multiple trials with an alloy to produce similar results? Should you?

Multiply trials with an any should produce similar results, as long as the alloy and lab conditions remain the same.

9. Does the mass of metal or the mass of alloy used affect your result? Should it?

Yes it does, because the reaction of that specific amount of metal produces a specific amount of H_2, the mass of metal or alloy used should be directly proportional to the amount of H_2.

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 believe it would be a flaw in the procedure. Things like touching the metal or not sanding the metal, which happened during the experiment, would change measurements we had already taken, so when the experimental work was done, the results we were using wouldn't be from the measurements we initially took but were also using in the experimental work. Essentially, the reaction results did not correspond to the initial masses.

11. Think of a way in which this experiment relates to your work in the lecture course.

This lab gives a better understanding of gas properties and laws, as well as unit conversions and using stoichiometric ratios.

12. Think of a way in which this experiment connects to or has applications in the world around you.

Most metals found in the natural world are alloys and are rarely found as pure metals. This type pf experiments and calculations can be done to find out how much of that alloy is the metal you are looking for and help in the extraction process

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

The amount of H_2 gas produced is directly proportional to the mass of alloy or metal used in the experiment. The reaction of an alloy in HCl is slower than reaction of a pure metal.