Student Name:
xxxxxxxxxxxxxx

Student Number: xxxxxxxxx

Partner's Name and Student #: xxxxxxxxxxxx

Demonstrator's Name:
xxxxxxxxxxxx

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

Lab Day (circle): *Tues aft* *Tues night* *Wed* *Thurs aft* ***Thurs night*** *Fri*

Lab Week (circle): *1* ***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 _Y.Z._

Data Tables

Table 1. Pure Metal

Data	Trial 1	Trial 2
Identity of Metal	Magnesium	Magnesium
Mass of metal (g)	0.0282 g	0.0273 g
Uncalibrated volume of eudiometer (mL)	0	0
Volume of hydrogen gas (mL)	29.2 mL	28.9 mL
Height of water column (cm)	16.8 mL / 18.5 cm	18.9 mL / 20.6 cm
Density of water (kg/m^3)	999.97	999.97
Acceleration due to gravity (m/s^2)	9.81	9.81
Pressure of water column (Pa)	$1.81x10^3$	$2.02x10^3$
Water Temperature (°C)	21	22
Water Vapour pressure (Pa)	2490	2640
Atmospheric Pressure (Torr)	765.8	765.8
Pressure of Hydrogen	97.7 kPa	97.4 kPa
Room Temperature (°C)	22.9	22.9
Ideal Gas Constant, R	8.314	8.314
Actual Moles of Hydrogen (mol)	$1.17x10^{-3}$	$1.15x10^{-3}$
Theoretical moles of Hydrogen (mol)	$1.16x10^{-3}$	$1.12x10^{-3}$
Percent Yield (%)	101%	103%

Observations (Part 1):

-The eudiometer was calibrated already. It is filled with 10 mL of HCL and distilled water.

- After eudiometer is placed on top of the sample holder, bubbles formed on the magnesium metal as the HCl descended down the length of the tube to react with the metal.

-Eventually the magnesium metal rises along with bubbles through the eudiometer tube.

-Eudiometer tube is tapped to slow down rise of metal and hydrogen gas.

-Overall reaction took around 30-45 seconds.

-Hydrogen gas forms at top of eudiometer.

Table 2. Alloy

Data	Trial 1	Trial 2
Unknown Number	3326	3326
Mass of alloy (g)	0.0402 g	0.0088 g
Uncalibrated volume of eudiometer (mL)	0	0
Volume of hydrogen gas (mL)	23 mL	9.9 mL
Height of water column (cm)	23.2 mL / 21.3 cm	36.9 mL / 29.4 cm
Density of water (kg/m^3)	999.97	999.97
Acceleration due to gravity (m/s^2)	9.81	9.81
Pressure of water column (Pa)	$2.09x10^3$	$2.88x10^3$
Water Temperature (°C)	23.0	23.0
Water Vapour pressure (kPa)	2810	2810
Atmospheric Pressure (Torr)	765.8	765.8
Pressure of Hydrogen	97.2kPa	96.4kPa
Room Temperature	22.9	22.9
Ideal Gas Constant, R	8.314	8.314
Moles of Hydrogen (mol)	$9.08x10^{-4}$	$3.88x10^{-4}$
Mass of Zinc (g)	$3.29x10^{-2}$	$2.51x10^{-3}$
Mass of Aluminum (g)	$7.28x10^{-3}$	$6.29x10^{-3}$
Percent Zinc (%)	81.8%	28.5%
Percent Aluminum (%)	18.1%	71.5%
Average Percent	72.3%	27.7%

Observations (Part 2):

-Pieces of metal floats out of sample holder.
-Reaction occurs once HCl descends through the eudiometer and reacts with the alloy metals.
-Eventually alloy metal rises along with hydrogen bubbles through the eudiometer tube.
-Pieces of metal stuck to the eudiometer tube glass, no longer reacting with the HCl.
-Alloy eventually dissolves as hydrogen gas forms, slower reaction than pure metal.
-Overall reaction took around 10-15 minutes.
-Hydrogen gas forms at top of eudiometer.

Sample Calculation: Pure Metal

1. Uncalibrated Volume of the Eudiometer:

The eudiometer did not need to be calibrated, as there was no empty space above the zero mark.

2. Volume of Hydrogen gas:

Trial 1: 29.2mL = 0.0292 L

Trial 2: 28.9mL = 0.0289 L

3. Pressure exerted by the water column:

Trial 1:

Pa = dgh = $(999.97 kg/m^3)(9.81 m/s^2)(0.185 m) = 1814.79 = 1.81 x 10^3 Pa$

Trial 2:

Pa = dgh = $(999.97 kg/m^3)(9.81 m/s^2)(0.206 m) = 2020.79 = 2.02 x 10^3 Pa$

4. Pressure of hydrogen gas:

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

Trial 1: P_H = 102098.27 Pa – 1814.79 Pa – 2490 Pa = 97793.48 Pa = 97.7 KPa

Trial 2: P_H = 102098.27 Pa – 2020.79 Pa – 2640 Pa = 97437.48 Pa = 97.4 KPa

5. Moles of hydrogen gas (experimental):

n = PV / RT

Trial 1: (97.7 kPa)(0.0292 L) / (8.314)(21 + 273.15) = 2.853 / 2445.563
= 0.001166 = $1.17 x 10^{-3}$ mol of H_2

Trial 2: (97.4 kPa)(0.0289 L) / (8.314)(22 + 273.15) = 2.815 / 2453.877
= 0.001147 = $1.15x10^{-3}$mol of H_2

6. Moles of hydrogen gas (theoretical):

$Mg + 2 HCl \rightarrow MgCl_2 + H_2$

Amount of H_2 produced should equal amount of moles of Mg reacted.

Trial 1:

0.0282 g of Mg / 24.3 molar mass of Mg = 0.00116 Mg moles x (1 H_2 mole / 1 Mg mole) = 0.00116 = $1.16x10^{-3}$ H_2 moles

Trial 2:

0.0273 g of Mg / 24.3 molar mass of Mg = 0.00112 Mg moles x (1 H_2 mole / 1 Mg mole) = 0.00112 = $1.12x10^{-3}$ H_2 moles

7. Percentage Purity of metal:

$Mg + 2 HCl \rightarrow MgCl_2 + H_2$

Amount of Mg moles should equal amount of moles of H_2.

Trial 1:

Experimental ($1.17x10^{-3}$mol of Mg) / Theoretical ($1.16x10^{-3}$mol of Mg)
=101%

Trial 2:

Experimental ($1.15x10^{-3}$mol of Mg) / Theoretical ($1.12x10^{-3}$mol of Mg)
=103%

8. Average Percent Purity:

Experimental: ($1.17x10^{-3}$mol of Mg + $1.15x10^{-3}$mol of Mg) / 2 = 0.00116 mol

Theoretical: ($1.16x10^{-3}$mol of Mg + $1.12x10^{-3}$mol of Mg) / 2 = 0.00114 mol

Experimental (0.00116 mol of Mg) / Theoretical (0.00114 mol of Mg)
=102%

Sample Calculation: Alloy

1. Pressure of water column and hydrogen gas:

Pressure of Water Column:

Trial 1:

Pa = dgh = (999.97kg/m^3)(9.81m/s^2)(0.213m) = 2089.47 = $2.09x10^3$Pa

Trial 2:

Pa = dgh = (999.97kg/m^3)(9.81m/s^2)(0.294m) = 2884.05 = $2.88x10^3$Pa

Pressure of Hydrogen gas:

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

Trial 1: P_H = 102098.27 Pa – 2089.47 Pa – 2810 Pa = 97198.8 Pa = 97.2 KPa

Trial 2: P_H = 102098.27 Pa – 2884.05 Pa – 2810 Pa = 96404.2 Pa = 96.4 KPa

2. Moles of hydrogen gas:

n = PV / RT

Trial 1: (97.2 kPa)(0.023 L) / (8.314)(23 + 273.15) = 2.2356 / 2462.191
= 0.00090797 = $9.08x10^{-4}$mol of H_2

Trial 2: (96.4 kPa)(0.0099 L) / (8.314)(23 + 273.15) = 0.9544 / 2462.191
= 0.00038762 = $3.88x10^{-4}$mol of H_2

3. Masses of Zinc and Aluminum in the alloy:

$Zn (s) + 2 H^+ (aq) \rightarrow Zn^{2+} (aq) + H_2 (g)$
$Al (s) + 3 H^+ (aq) \rightarrow Al^{3+} (aq) + 3/2H_2 (g)$

N (hydrogen total) = N(hydrogen, zinc) + N(hydrogen, aluminum)

N (hydrogen total) = N(zinc) + N(aluminum)
= (mass of zinc/molar mass of zinc) + (3/2 x (mass of aluminum/molar mass of aluminum))

Mass of alloy = Mass of zinc in alloy + Mass of aluminum in alloy

Trial 1:

9.08×10^{-4}mol of H_2 = (M_{zinc} / 65.4) + [(3x$M_{aluminum}$) / (2x27)]

0.0402 g = M_{zinc} + $M_{aluminum}$

M_{zinc} = 0.0402 g - $M_{aluminum}$

9.08×10^{-4}mol of H_2 = [(0.0402 g - $M_{aluminum}$) / 65.4] + [(3x$M_{aluminum}$) / (2x27)]

$M_{aluminum}$ = A

9.08×10^{-4} = [(0.0402 - A) / 65.4] + [(3xA) / (54)]
= [54 (0.0402 – A) + 65.4x3A]/3531.6
9.08×10^{-4} x 3531.6 = [(2.1708 + 142.2 A)/3531.6] x 3531.6
3.20669 – 2.1708 = 142.2 A
1.0359 / 142.2 = A
0.0072848 = A
7.28×10^{-3}g = A = Mass of aluminum

M_{zinc} = 0.0402 g - 7.28×10^{-3}g
M_{zinc} = 0.03292 g = 3.29×10^{-2}

Mass of zinc = 3.29×10^{-2} g
Mass of aluminum = 7.28×10^{-3}g

Trial 2:

3.88×10^{-4}mol of H_2 = (M_{zinc} / 65.4) + [(3x$M_{aluminum}$) / (2x27)]

0.0088 g = M_{zinc} + $M_{aluminum}$

M_{zinc} = 0.0088 g - $M_{aluminum}$

$3.88x10^{-4}$mol of H_2 = [(0.0088 g - $M_{aluminum}$) / 65.4] + [(3x$M_{aluminum}$) / (2x27)]

$M_{aluminum}$ = A

$3.88x10^{-4}$ = [(0.0088 - A) / 65.4] + [(3xA) / (54)]
= [54 (0.0088 – A) + 65.4x3A]/3531.6
$3.88x10^{-4}$ x 3531.6 = [(0.4752 + 142.2 A)/3531.6] x 3531.6
1.37026 – 0.4752 = 142.2 A
0.89506 / 142.2 = A
0.0062943 = A
$6.29x10^{-3}$g = A = Mass of aluminum

M_{zinc} = 0.0088 g - $6.29x10^{-3}$g
M_{zinc} = 0.00251 g = $2.51x10^{-3}$

Mass of zinc = $2.51x10^{-3}$g
Mass of aluminum = $6.29x10^{-3}$g

4. Percent composition of the alloy:

% by mass element = total mass of element in compound / molecular mass of compound x 100

Trial 1:

% Zinc = $3.29x10^{-2}$ g / 0.0402 g x 100 = 0.81840 = 81.8%

% Aluminum = $7.28x10^{-3}$g /0.0402 g x 100 = 0.18109 = 18.1%

Trial 2:

% Zinc = $2.51x10^{-3}$g / 0.0088 g x 100 = 0.28522 = 28.5%

% Aluminum = $6.29x10^{-3}$g /0.0088 g x 100 = 0.71477 = 71.5%

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

Average of zinc: ($3.29x10^{-2}$ g + $2.51x10^{-3}$g) / 2 = 0.017705 g

Average of aluminum: ($7.28x10^{-3}$g + $6.29x10^{-3}$g) / 2 = 0.006785 g

Average mass of alloy: (0.0402 g + 0.0088 g) / 2 = 0.0245 g

Average percent composition:

% Zinc ave = 0.017705 g / 0.0245 g x 100 = 0.72265 = 72.3%

% Aluminum ave = 0.006785 g /0.0245 g x 100 = 0.27694= 27.7%

Discussion: (within space provided)

In this experiment four trials were conducted in the determination of a pure metal and the determination of the composition of an alloy. The first two trials were a reaction between magnesium metal and hydrochloric acid ($Mg + 2 HCl \rightarrow MgCl_2 + H_2$), in which 0.0282 g and 0.0273 g in trial 1 and 2 are reacted with HCl respectively. After attaining moles of metal reacted via moles of hydrogen through ideal gas equation as well as via mass of Mg over molar mass of Mg, the purity of the metal was determined by experimental over theoretical. Between the two trials, an average of 102% is calculated, while 101% and 103% for trial 1 and 2 respectively. A likely consideration as to why the percent purity exceeds 100% may be due to imprecise measurement of the individual masses of the metal used in each trial which causes more product to be formulated. Another consideration may be addition of other materials, such as impurity of hydrogen gas produced (contain water vapour) or lingering substances on the metal sample. Difference of percent purities in between the two trials for the pure magnesium metal are likely a result due to different masses of the magnesium metal used. For the determination of the alloy sample, an alloy sample containing zinc and aluminum were reacted with hydrochloric acid to produce hydrogen gas, ($Zn (s) + 2 H^+ (aq) \rightarrow Zn^{2+} (aq) + H_2 (g)$ & $Al (s) + 3 H^+ (aq) \rightarrow Al^{3+} (aq) + 3/2H_2 (g)$). Amount of hydrogen gas produced is the sum of H_2 from zinc reaction and aluminum reaction. From the moles of hydrogen gas and the alloy sample masses, using the two equations of N (hydrogen total) = (mass of zinc/molar mass of zinc) + (3/2 x (mass of aluminum/molar mass of aluminum)) and Mass of alloy = Mass of zinc + Mass of aluminum, the over masses of zinc and aluminum were calculated and their individual percentage compositions determined for each trial. There is a drastic difference between the percent composition data attained from each of the trials, in trial 1 zinc has 81.8% and aluminum has 18.1% while in trial 2, zinc has 28.5% and aluminum has 71.5%. Such accentuated difference in calculations could be result of the significant mass difference between the two samples used in trial 1 and 2, which are 0.0402 g and 0.0088 g respectively. Error in mass of alloy would influence moles of hydrogen gas calculations as with different masses of metal, different amounts of H_2 is produced as result. Furthermore, in calculations of individual masses of component metals, errors would result due to alloy mass used. Another consideration would be the metal pieces which floated out of the sample holder as it was being put into the beaker a well as pieces of alloy which stuck to the eudiometer tube during the reaction and thus left unreacted, both would likely influence the overall mass of the alloy as well as determination of percent composition as the samples used or reacted with the HCl did not include the overall sample. The average percent composition of the alloy would therefore produce a compromised result due to alloy sample mass difference for trial 1 and trial 2. Between determination of metal and alloy, one included reaction of a pure substance with acid, the other included a mixed substance with acid.

Conclusion: (no more than two sentences)

In conclusion, for determination of pure metal via reaction with hydrochloric acid, using experimental over theoretical component- percentage purities of over 100% were determined, with the average as 102%. For determination of alloy sample via reaction with hydrochloric acid, masses of metals that make up the alloy are used to determine an average percent composition of 72.3% zinc and 27.7% aluminum.