Student Name: Woojin Lee

Student Number: 7237750

Partner's Name and Student #: David Clarke (7325539)

Demonstrator's Name: Danny Pau (dpau011@uottawa.ca)

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 completed in pen (or typed) and attached**

Student's Initials *WL*

Data Tables

Table 1. Pure Metal

Data	Trial 1	Trial 2
Identity of Metal	Zinc	zinc
Mass of metal (g)	0.0474 g	0.0483g
Uncalibrated volume of eudiometer (mL)	0mL (already calibrated)	0mL (already calibrated)
Volume of hydrogen gas (mL)	19.18mL	20.00mL
Height of water column (cm)	34.0 cm	31.0cm
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)	3332Pa	3038Pa
Water Temperature (°C)	24.4°C	24.7°C
Water Vapour pressure (Pa)	2980Pa	3170Pa
Atmospheric Pressure (Torr)	749.9 Torr	749.9 Torr
Pressure of Hydrogen	93.60 kPa	93.70 kPa
Room Temperature	24°C	24°C
Ideal Gas Constant, R	$8.3144621\frac{(kPa)(L)}{(K)(mol)}$	$8.3144621\frac{(kPa)(L)}{(K)(mol)}$
Actual Moles of Hydrogen (mol)	$7.266*10^{-4}$ mol	$7.759*10^{-4}$ mol
Theoretical moles of Hydrogen (mol)	$7.24*10^{-4}$ mol	$7.38*10^{-4}$mol
Percent Yield (%)	100%	105%

Observations (Part 1):

Once the 12M HCl had made contact with the zinc, bubbles slowly began to form and rise to the top of the eudiometer. The rate of bubbles increased very fast, and slowly reduced in rate until all the zinc was used up.

Table 2. Alloy

Data	Trial 1	Trial 2
Unknown Number	2542	2542
Mass of alloy (g)	0.0369g	0.0363g
Uncalibrated volume of eudiometer (mL)	0mL (already calibrated)	0mL (already calibrated)
Volume of hydrogen gas (mL)	23.10mL	22.85mL
Height of water column (cm)	28.65cm	29.99cm
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)	2808 Pa	2939 Pa
Water Temperature (°C)	25.4°C	25.4°C
Water Vapour pressure (kPa)	3170Pa	3170Pa
Atmospheric Pressure (Torr)	749.9 Torr	749.9 Torr
Pressure of Hydrogen	93.93kPa	93.80kPa
Room Temperature	24°C	24°C
Ideal Gas Constant, R	$8.3144621\frac{(kPa)(L)}{(K)(mol)}$	$8.3144621\frac{(kPa)(L)}{(K)(mol)}$
Moles of Hydrogen (mol)	$8.782*10^{-4}$ mol	$8.675*10^{-4}$
Mass of Zinc (g)	$2.91*10^{-2}$ g	$2.86*10^{-2}$ g
Mass of Aluminum (g)	$7.78*10^{-3}$ g	$7.75*10^{-3}$ g
Percent Zinc (%)	78.9%	78.8%
Percent Aluminum (%)	21.1%	21.3%
Average Percent	Zn (78.9%)	Al (21.2%)

Observations (Part 2):

Once the 12M HCl made contact with the unidentified alloy, bubbles rapidly formed and floated towards the top. The rate of bubbles increased quickly for a few seconds, then slowly decreased in rate until all the alloy was used up.

Sample Calculation: Trial One Pure Metal

1. Uncalibrated Volume of the Eudiometer:

Eudiometer was already calibrated

2. Volume of Hydrogen gas:

Measured volume of gas: 19.18mL

$$19.18\cancel{mL} * \frac{1L}{1000\cancel{mL}} = 0.01918L$$

0.01918L

Trial 2: 0.02000L

3. Pressure exerted by the water column:

$P_{water\ column}$ = dgh

$$=\left(1000\frac{kg}{m^3}\right)\left(9.8\frac{m}{s^2}\right)(0.340m)$$

$$=3332\frac{kg}{ms^{\wedge}2}$$

=3.33kPa

Trial 2: 3.04kPa

4. Pressure of hydrogen gas:

$P_{hydrogen\ gas} = P_{atmosphere} - P_{water\ column} - P_{water\ vapour}$

$$=\left(749.4\cancel{Torr} * \frac{101.325kPa}{760.0\cancel{Torr}}\right) - 3.33kPa - 2.98kPa$$

=93.60kPa

Trial 2: 93.70kPa

5. Moles of hydrogen gas (experimental):

PV=nRT

n=PV/RT

$n_{Hydrogen\ gas} = \frac{(93.60kPa)(0.01918L)}{(8.3144621\frac{(kPa)(L)}{(K)(mol)})(297.15K)}$

= $7.266*10^{-4}$ mol

Trial 2: $7.759*10^{-4}$ mol

6. Moles of hydrogen gas (theoretical):

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

$n_{Hydrogen\ gas} = m_{Zn} / M_{Zn} * \frac{1\ mol\ H_2}{1\ mol\ Zn}$

$= 0.0474\ \cancel{g\ Zn} * \frac{1\ \cancel{mol\ Zn}}{65.409\ \cancel{g\ Zn}} * \frac{1\ mol\ H_2}{1\ \cancel{mol\ Zn}}$

= $7.24*10^{-4}$ mol

Trial 2: $7.38*10^{-4}$ mol

7. Percentage Purity of metal:

Percent purity = $\frac{n_{hydrogen\ gas\ (experimental)}}{n_{hydrogen\ gas\ (theoretical)}} * 100$

$= \frac{7.266*10^{-4}}{7.24*10^{-4}} * 100$

= 100%

Trial 2: 105%

8. Average Percent Purity:

Average percent purity = $\frac{(100+105)}{2}$

= 102%

<u>Sample Calculation : trial 1 Alloy</u>

1. Pressure of water column and hydrogen gas:

$P_{water\ column}$ = dgh

= (1000 kg/m^3)(9.8 m/s^2)(0.2865m)

=2808kg/ms^2

= 2.808 kPa   trial 2: 2.939 kPa

$P_{hydrogen\ gas}$ = $P_{atmosphere}$ – $P_{water\ column}$ – $P_{water\ vapour}$

= $\left(749.4\,\cancel{Torr} * \frac{101.325kPa}{760.0\,\cancel{Torr}}\right) - 2.808kPa - 3.17kPa$

= 93.93 kPa

Trial 2: 93.80 kPa

2. Moles of hydrogen gas:

PV=nRT
n=PV/RT

$n_{\text{hydrogen gas}} = \dfrac{(93.93kPa)(0.02310L)}{(8.3144621\frac{(kPa)(L)}{(K)(mol)})(297.15K)}$

= $8.782 * 10^{-4}$ mol

Trial 2: $8.675 * 10^{-4}$ mol

3. Masses of Zinc and Aluminum in the alloy:

$n_{\text{hydrogen gas total}} = n_{\text{hydrogen from Zn}} + n_{\text{hydrogen from Al}}$

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

$= \dfrac{m_{Zn}}{M_{Zn}} + \dfrac{3m_{Al}}{2M_{Al}}$

$m_{alloy} = m_{Zn} + m_{Al}$

$m_{Zn} = m_{alloy} - m_{Al}$

$n_{\text{hydrogen gas total}} = \dfrac{m_{alloy} - m_{Al}}{M_{Zn}} + \dfrac{3m_{Al}}{2M_{Al}}$

$n_{\text{hydrogen gas total}} = \dfrac{m_{alloy}}{M_{Zn}} - \dfrac{m_{Al}}{M_{Zn}} + \dfrac{3m_{Al}}{2M_{Al}}$

$n_{\text{hydrogen gas total}} - \dfrac{m_{alloy}}{M_{Zn}} = -\dfrac{m_{Al}}{M_{Zn}} + \dfrac{3m_{Al}}{2M_{Al}}$

$n_{\text{hydrogen gas total}} - \dfrac{m_{alloy}}{M_{Zn}} = m_{Al}\left(-\dfrac{1}{M_{Zn}} + \dfrac{3}{2M_{Al}}\right)$

$\dfrac{(n_{\text{hydrogen gas total}} - \frac{m_{alloy}}{M_{Zn}})}{(-\frac{1}{M_{Zn}} + \frac{3}{2M_{Al}})} = m_{Al}$

$m_{Al} = \dfrac{8.782*10^{-4} mol - \frac{0.0369g}{65.36g/mol}}{\frac{3}{2(\frac{26.98g}{mol})} - \frac{1}{65.39g/mol}}$

m_{Al} = $7.78 * 10^{-3}$ g Al

$m_{Zn} = m_{alloy} - m_{Al}$

$= 0.0369 - 7.78*10^{-3}$

$= 2.91*10^{-2}$ g Zn

Trial 2: $m_{Al} = 7.75*10^{-3}$ g Al

$m_{Zn} = 2.86*10^{-2}$ g Zn

4. Percent composition of the alloy:

Percent composition of zinc = $m_{Zn} / m_{alloy} *100$

$= 2.91*10^{-2} / 0.0369 *100$

= 78.9%

Percent composition of aluminum = $m_{Al} / m_{alloy} *100$

$=7.78*10^{-3} / 0.0369 *100$

=21.1%

Trial 2: percent composition of Zn = 78.8%

Percent composition of Al = 21.3%

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

Avg percent composition of Zn = (78.9 + 78.8) / 2

= 78.9%

Avg percent composition of Al = (21.3 + 21.1) / 2

=21.2%

Discussion: (within space provided)

The purpose of this lab was to calculate the purity of a sample of zinc, and to determine the percent composition of an alloy comprised of zinc and aluminum. To determine the purity of the zinc and the composition of the alloy, we reacted both samples of zinc and alloy with hydrochloric acid, and recorded the volume of hydrogen gas that was produced and collected in a eudiometer. After collecting the data, we used the ideal gas laws and basic stoichiometry to determine the approximate composition of the alloy, the approximate purity of the zinc sample, and the percent error of our trials. It is important to note that our average percent purity for the zinc was 102% which means our experimental yield was greater than our theoretical yield.

One source of experimental error may have come from when we took our thumb off the top of the eudiometer, if taken off too early, air may have gotten inside the eudiometer tube and would increase the amount of space occupied by gases in the eudiometer tube. This could mean we recorded the volume of hydrogen gas produced and the volume of air accidently let into the eudiometer, giving us a higher experimental yield than the theoretical yield.

A second source of error may have come from not having all the bubbles of hydrogen reach the top of the tube when we took measurements. Microbubbles too small for us to have noticed may still have been submerged in the water, this means that not all the hydrogen produced is being accounted for in our measurements which would lower the experimental yield and lower our percent purity of zinc.

Conclusion: (no more than two lines)

The average percent purity of our sample of zinc was about 102%. The average percent composition of our alloy was about 78.9% zinc and 21.2% aluminum.