Student Name: Essam Sorwar

Student Number: 8076645
Partner's Name and Student #: 8212944

Demonstrator's Name: Sarwat Khan

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

Lab Day (circle): Fri

Lab Week (circle): 1

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 ES

Data Tables

Table 1. Pure Metal

Data	Trial 1	Trial 2
Identity of Metal	Magnesium	Magnesium
Mass of metal (g)	0.0205g	0.0208g
Uncalibrated volume of eudiometer (mL)	4.7	4.3
Volume of hydrogen gas (mL)	13.4+4.7=18.1	16.9+4.3=21.2
Height of water column (cm)	38.2	34.5
Density of water (kg/m^3)	1000	1000
Acceleration due to gravity (m/s^2)	9.81	9.81
Pressure of water column (Pa)	3747.42	3384.45
Water Temperature (°C)	19.3,19.0	19.3,19.4
Water Vapour pressure (Pa)	2200	2200
Atmospheric Pressure (Torr)	765.815	765.815
Pressure of Hydrogen	96152.86 pa	96515.83 pa
Room Temperature	17.9 C	17.9
Ideal Gas Constant, R	8.314(J/mol*k)	8.314(J/mol*k)
Actual Moles of Hydrogen (mol)	1.510*10^-3	1.376*10^-3
Theoretical moles of Hydrogen (mol)	8.434*10^-4	8.558*10^-4
Percent Yield (%)	44.16%	38.71%

Observations (Part 1):

The $HCl_{(aq)}$ started bubbling when the eudiometer was inverted and placed on the sample holder. The $Mg_{(s)}$ strip started to travel gradually to the top. It also began to dissolve as it went to complete reaction. However, the temperature did not change.

Table 2. Alloy

Data	Trial 1	Trial 2
Unknown Number	2529	2529
Mass of alloy (g)	0.0441	0.0411
Uncalibrated volume of eudiometer (mL)	3.5	3.7
Volume of hydrogen gas (mL)	22.3+3.5=25.8	21.8+3.7=25.5
Height of water column (cm)	30.5	27.5
Density of water (kg/m^3)	1000	1000
Acceleration due to gravity (m/s^2)	9.81	9.81
Pressure of water column (Pa)	2992.05	2697.75
Water Temperature (°C)	18.9	18.9
Water Vapour pressure (kPa)	2.20	2.20
Atmospheric Pressure (Torr)	765.815	765.815
Pressure of Hydrogen	96908.22Pa	97202.52Pa
Room Temperature	17.9	17.9
Ideal Gas Constant, R	8.314(J/mol*k)	8.314(J/mol*k)
Moles of Hydrogen (mol)	1.221*10^-3	1.105*10^-3
Mass of Zinc (g)	3.0539*10^-2	2.9287*10^-2
Mass of Aluminum (g)	1.3561*10^-2	1.1813*10^-2
Percent Zinc (%)	69.25%	71.26%
Percent Aluminum (%)	30.75%	28.74%
Average Percent	70.25% of Zn	29.75% of Al

Observations (Part 2):
Some of the alloy started to flout out of the sample holder, before the eudiometer was inverted. The water level was reduced to stop form letting this occur. When the eudiometer was inverted for trial 2 some of the $HCl_{(aq)}$ leaked out on the 1000ml beaker before it was placed on top of the sample holder. The $HCl_{(aq)}$ started bubbling when the eudiometer was inverted and placed on the sample holder. The alloy strip started to travel gradually to the top. It also began to dissolve as it went to complete reaction. Again the temperature did not change.

Sample Calculation : Pure Metal

1. Uncalibrated Volume of the Eudiometer:

Trial 1: $V_{extra} = V_{GC} - V_{eudiometer}$
V=8.1ml – 4.6ml =3.5ml

Trial 2: $V_{extra} = V_{GC} - V_{eudiometer}$
V=8.1ml – 4.4ml =3.7ml

2. Volume of Hydrogen gas:

Trial 1: $V_{H2} = V_{extra} + V_{eudiometer}$
V_{H2} =4.7ml +13.4 ml = 18.1ml

Trial 2: $V_{H2} = V_{extra} + V_{eudiometer}$
V_{H2} =4.3ml +16.9 ml = 21.2ml

3. Pressure exerted by the water column:

Trial 1:
P=dgh
$=1000kg/m^3 * 9.81m/s^2 * 0.382m$
$=3747.42Kg*m/s^2$ Or 3747.42Pa

Trial 2:
P=dgh

$=1000 kg/m^3 * 9.81 m/s^2 * 0.345 m$
$=3384.45 kg*m/s^2$ Or 3384.45Pa

4. Pressure of hydrogen gas:

Conversions:
1 torr = 133.322368 Pa
(133.322368Pa/1 torr)(765.815 torr)
=102100.27Pa

Trial 1:
$P_{H2} = P_{atm} - P_{wc} - P_{wv}$
= 102100.27Pa - 3747.42Pa – 2200Pa
=96152.86Pa

Trial 2:
$P_{H2} = P_{atm} - P_{wc} - P_{wv}$
= 102100.27Pa – 3384.45Pa – 2200Pa
=96515.83Pa

5. Moles of hydrogen gas (experimental):

Conversions:
P_1= 96152.86Pa/1000 = 96.15286KPa
P_2= 96515.83Pa/1000 = 96.51583KPa
V_1= 38.2ml/1000 = 0.0382L
V_2= 34.5ml/1000 = 0.0345L
T= 17.9 +273.15 = 291.05

Trial 1:
PV=nRT
(96.15286 KPa)(0.0382L)=n(8.314J/mol*k)(291.05K)
n= 1.510*10^-3

Trial 2:
PV=nRT
(96.51583KPa KPa)(0.0345L)=n(8.314J/mol*k)(291.05)
n= 1.376*10^-3

6. Moles of hydrogen gas (theoretical):

Trial 1:

G				W
Mg(s)	+	2HCl (aq)	→ MgCl2(aq) +	H_2(g)

m= 0.0205g — n=(8.434*10^-4)*(w/g)
M= 24.3050g — =(8.434*10^-4)*(1/1)
n= (m/M) — =8.434*10^-4mol
= (0.0205g/24.3050g/mol)
= 8.434*10^-4

Trial 2:

G				W
Mg(s)	+	2HCl (aq)	→ MgCl2(aq) +	H_2(g)

m= 0.0208g — n=(8.558*10^-4)*(w/g)
M= 24.3050g — =(8.558*10^-4)*(1/1)
n= (m/M) — =8.558*10^-4mol
= (0.0208g/24.3050g/mol)
= 8.558*10^-4

7. Percentage Purity of metal:

Trial 1:
%Yield= |[(Actual- Theoretical)/(actual)]|*100
= |[(1.510*10^-3 - 8.558*10^-4)/(1.510*10^-3)]|*100
= 44.16%

Trial 2:
%Yield= |[(Actual- Theoretical)/(actual)]|*100
= |[(1.376*10^-3- 8.434*10^-4)/(1.376*10^-3)]|*100
= 38.71%

8. Average Percent Purity:
Average = (yield 1 + yield 2)/2
= (44.26 + 38.71)/2
=41.49%

Sample Calculation : Alloy

1. Pressure of water column and hydrogen gas:

Conversions:
1 torr = 133.322368 Pa
(133.322368Pa/1 torr)(765.815 torr)
=102100.27Pa

Trial 1:
P=dgh
=1000kg/m^3*9.81m/s^2*0.305m
=2992.05Kg*m/s^2 Or 2992.05Pa

P_{H2}= P_{atm} - P_{wc} - P_{wv}
= 102100.27Pa – 2992.05Pa – 2200Pa
=96908.22Pa

Trial 2:
P=dgh
=1000kg/m^3*9.81m/s^2*0.275m
=2697.75kg*m/s^2 Or 2697.75Pa

P_{H2}= P_{atm} - P_{wc} - P_{wv}
= 102100.27Pa - 2697.75Pa – 2200Pa
=97202.52Pa

2. Moles of hydrogen gas:

Conversions:

P_1= 96908.22Pa/1000 = 96.90822KPa
P_2= 97202.52Pa/1000 = 97.20252KPa
V_1= 30.5ml/1000 = 0.0305L
V_2= 27.5ml/1000 = 0.0275L
T= 17.9 +273.15 = 291.05

Trial 1:
PV=nRT
(96.90822KPa)(0.0305L)=n(8.314J/mol*k)(291.05)
n= 1.221*10^-3 mol

Trial 2:
PV=nRT
(97.20252KPa)(0.0275L)=n(8.314J/mol*k)(291.05)
n= 1.105*10^-3 mol

3. Masses of Zinc and Aluminum in the alloy:

Masses of Zinc and Aluminum in the alloy:

$$n_{hydrogen\ total} = \frac{\text{mass of zinc}}{\text{molar mass of zinc}} + \frac{3}{2}\,\frac{\text{mass of aluminum}}{\text{molar mass of aluminum}}$$

$$M_{total\ of\ alloy} = m_{zinc\ in\ alloy} + m_{aluminum\ in\ alloy}$$

$$M_{total\ of\ alloy} - M_{zinc\ alloy} = M_{aluminum\ in\ alloy}$$

$$n_{hydrogen\ total} = \frac{\text{mass of zinc}}{\text{molar mass of zinc}} + \frac{3}{2}\,\frac{M_{total} - M_{zinc}}{\text{molar mass of aluminum}}$$

Trial 1:

$$1.221 \times 10^{-3}\ mol = \frac{m_{zinc}}{65.38\ g/mol} + \frac{3\,(0.0441 - m_{zinc})}{2\,(26.982\ g/mol}$$

$$1.221 \times 10^{-3}\ mol = \frac{53.964\ m_{zinc} + 8.649774 - 196.14\ m_{zinc}}{3528.16632}$$

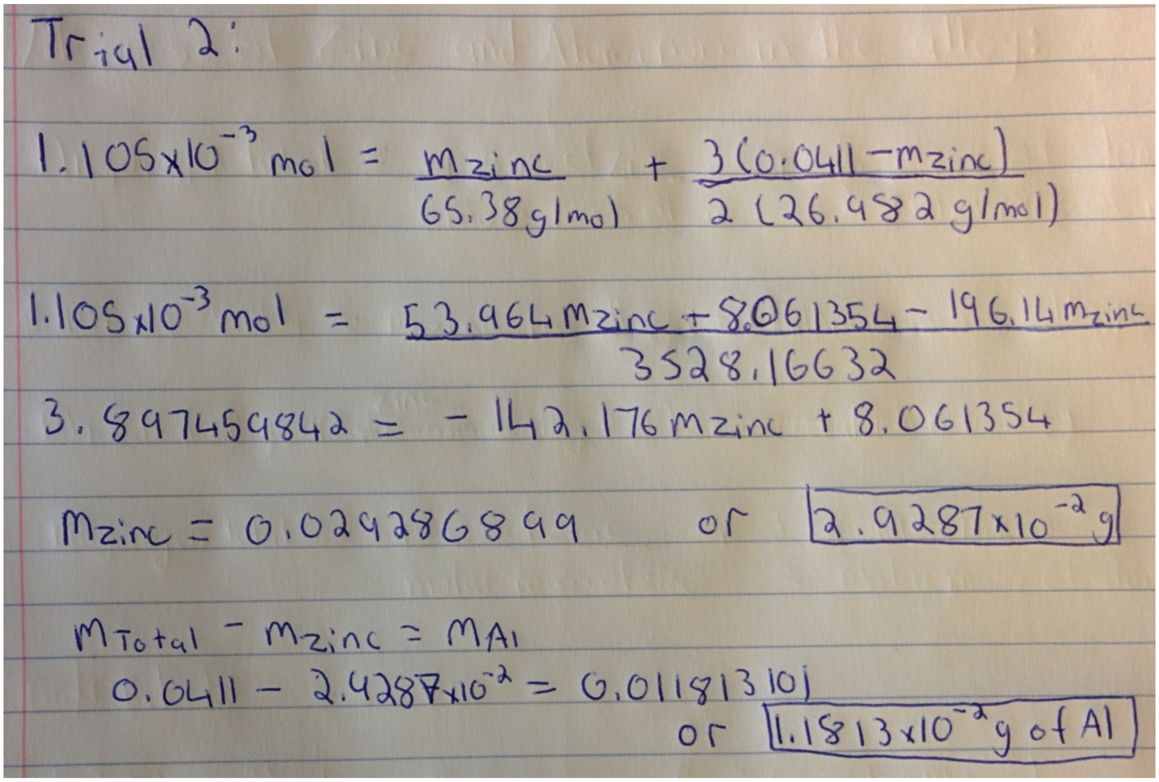
$$4.307891077 = -142.176\ m_{zinc} + 8.649974$$

$m_{zinc} = 0.0305387844\ldots$ or $\boxed{3.0539 \times 10^{-2}\ g}$ of zinc

$$m_{Total} - m_{zinc} = m_{aluminum}$$

$0.0441 - 3.0539 \times 10^{-2} = 0.0135612106\ldots$

or $\boxed{1.3561 \times 10^{-2}\ g}$ of Al



Trial 2:

$$1.105\times10^{-3}\,mol = \frac{m_{zinc}}{65.38\,g/mol} + \frac{3(0.0411 - m_{zinc})}{2(26.982\,g/mol)}$$

$$1.105\times10^{-3}\,mol = \frac{53.964\,m_{zinc} + 8.061354 - 196.14\,m_{zinc}}{3528.16632}$$

$$3.89745984 2 = -142.176\,m_{zinc} + 8.061354$$

$$m_{zinc} = 0.029286899 \quad \text{or} \quad \boxed{2.9287\times10^{-2}\,g}$$

$$m_{Total} - m_{zinc} = m_{Al}$$

$$0.0411 - 2.4287\times10^{-2} = 0.01181310 1$$

$$\text{or} \quad \boxed{1.1813\times10^{-2}\,g \text{ of Al}}$$

4. Percent composition of the alloy:

Trail 1:
%Zn= (m_{zn}/m_T)*100
=(3.0539*10^-3/0.0441)*100
=69.25%
%Al=(m_{al}/m_T)*100
=(1.3561*10^-2/0.0441)*100
=30.75%

Trail 2:
%Zn= (m_{zn}/m_T)*100
=(2.9287*10^-3/0.0411)*100
=71.26%
%Al=(m_{al}/m_T)*100
=(1.1818*10^-2/0.0411)*100
=28.74%

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

   Average of Zn =(% composition 1 + % composition 2)/2
   =(69.25% + 71.26%)/2
   =70.25%

   Average of Al =(% composition 1 + % composition 2)/2
   =(30.75% + 28.74%)/2
   =29.75%

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

The experiment conducted over all was decent as our errors were not too great to temper with the initial expectations of how the results would be. During the set up of the the unknown alloy, there were some complications as the sample of alloy placed in the holder would start flouting away. This turn made it difficult to invert the Eudiometer, which incidentally also led to the loss of some HCl solution. This was the major cause of any errors in the final results. The purity of the metal obtain through various calculation appears to be concerning as it was only 41.49%. The results obtained by this experiment compared with results by obtained from experiments of reacting $Mg_{(s)}$ with $HCl_{(aq)}$, the data observed was similar with the purity around the 40-55%.

Since alloys are compounds consisting two or more metals, in this case two metals aluminum and zinc, the moles of hydrogen were used to find the unknown masses. The alloy also underwent complete reaction as it disappeared when it reacted with $HCl_{(aq)}$. The masses fortunately were positive as other experiments had negative masses for the compositions of elements.

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

With the use of key concepts of ideal gas laws and stoichiometry, the number of moles of hydrogen gas released when under going an acid reaction can be obtained.

Data Tables

Table 1. Pure Metal

Data	Trial 1	Trial 2
Identity of Metal	Magnesium	Magnesium
Mass of metal (g)	0.0205 g	0.0208 g
Uncalibrated volume of eudiometer (mL)	4.7 mL	4.3 mL
Volume of hydrogen gas (mL)	13.4 + 4.7 = 18.1	16.9 + 4.3 = 21.2
Height of water column (cm)	38.2	34.5
Density of water (kg/m^3)	1000	1000
Acceleration due to gravity (m/s^2)	9.81	9.81
Pressure of water column (Pa)	3747.42	3384.45
Water Temperature (°C)	19.3°C, 19.0	19.3, 19.4
Water Vapour pressure (Pa)	2200	2200
Atmospheric Pressure (Torr)	765.815	765.815
Pressure of Hydrogen	96152.8 Pa	96515.83 Pa
Room Temperature	17.9°C	17.9°C
Ideal Gas Constant, R	8.314	8.314
Actual Moles of Hydrogen (mol)	1.5×10^{-3} mol	1.4×10^{-3} mol
Theoretical moles of Hydrogen (mol)		
Percent Yield (%)		

Observations (Part 1):

STK

Table 2. Alloy 2529

Data	Trial 1	Trial 2
Unknown Number	2529	2529
Mass of alloy (g)	0.0441g	0.0411g
Uncalibrated volume of eudiometer (mL)	3.5mL	3.7
Volume of hydrogen gas (mL)	22.3 + 3.5	21.8 + 3.7
Height of water column (cm)	30.5	27.5
Density of water (kg/m^3)		
Acceleration due to gravity (m/s^2)		
Pressure of water column (Pa)		
Water Temperature (°C)	18.9	18.9
Water Vapour pressure (kPa)		
Atmospheric Pressure (Torr)	1.021 barr	1.021 barr
Pressure of Hydrogen		
Room Temperature	17.9	17.9
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):