Student Name: Amrith Senaratne

Student Number: 8607778

Partner's Name and Student #: Yasmin Abdelazim 8726239

Demonstrator's Name: No TA

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

Lab Day (T/W/Th/F): T

Lab Week (even/odd): odd

Lab time (10:00, 2:30, 6:30): 2:30

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 _AS_

Data Tables

Table 1. Pure Metal

Data	Trial 1	Trial 2
Identity of Metal	Magnesium	Magnesium
Mass of metal (g)	0.00248	0.00257
Uncalibrated volume of eudiometer (mL)	-	-
Volume of hydrogen gas (mL)	25.9	28.8
Height of water column (cm)	33.8	23.9
Density of water (kg/m^3)	1000	1000
Acceleration due to gravity (m/s^2)	9.81	9.81
Pressure of water column (Pa)	3315.78	2344.59
Water Temperature (°C)	20	21
Water Vapour pressure (Pa)	2340	2490
Atmospheric Pressure (Torr)	753.81	753.81
Pressure of Hydrogen (Pa)	94844.	95665.
Room Temperature (°C)	22	22
Ideal Gas Constant, R (J/mol.K)	8.314	8.314
Actual Moles of Hydrogen (mol)	1.001×10^{-3}	1.123×10^{-3}
Theoretical moles of Hydrogen (mol)	1.02×10^{-3}	1.06×10^{-3}
Percent Yield (%)	98.14	102.02

Observations (Part 1):

- The acid gradually moved down the eudiometer once it was flipped
- Bubbles began forming on the metal once the acid reached it
- The metal gradually started moving upwards
- Bubbles were appearing faster and the metal finally disappeared

Table 2. Alloy

Data	Trial 1	Trial 2
Unknown Number	3335	3335
Mass of alloy (g)	0.0401	0.0402
Uncalibrated volume of eudiometer (mL)	-	-
Volume of hydrogen gas (mL)	23.2	23.8
Height of water column (cm)	30.3	38.7
Density of water (kg/m^3)	1000	1000
Acceleration due to gravity (m/s^2)	9.81	9.81
Pressure of water column (Pa)	2972.43	3796.47
Water Temperature (°C)	24	24
Water Vapour pressure (kPa)	2.98	2.98
Atmospheric Pressure (Torr)	753.81	753.81
Pressure of Hydrogen (kPa)	94.5	93.7
Room Temperature (°C)	22	22
Ideal Gas Constant, R (J/mol.K)	8.314	8.314
Moles of Hydrogen (mol)	8.93×10^{-4}	9.09×10^{-4}
Mass of Zinc (g)	0.0332	0.0328
Mass of Aluminum (g)	0.0069	0.0073
Percent Zinc (%)	82.79	81.84
Percent Aluminum (%)	17.21	18.16
Average Percent (%)	Zn = 82.32 Al = 17.69	

Observations (Part 2):

- The acid gradually moved down the eudiometer once it was flipped
- Reaction was much slower than the pure metal
- A grey-ish mixture was formed before the solution cleared up and the alloy disappeared

Sample Calculation: Magnesium (Pure Metal)

Calculations shown for Trial 1

1. Uncalibrated Volume of the Eudiometer:

   The eudiometer we used was calibrated

2. Volume of Hydrogen gas:

   25.9 mL

3. Pressure exerted by the water column:

   $P = dgh$
   $= 1000 \times 9.81 \times 0.338$
   $= 3315.78$ Pa

4. Pressure of hydrogen gas:

   $P_{h2} = P_{atm} - P_{water\ column} - P_{water\ vapour}$
   $= (100.5 \times 10^3) - 3315.78 - (2.34 \times 10^3)$
   $= 94844.$ Pa
   $= 94.8$ kPa

5. Moles of hydrogen gas (experimental):

   $PV = nRT$
   $n = (PV/RT)$
   $= (94.8 \times 25.9 \times 10^{-3}) / (8.314 \times 295.15)$
   $= 1.001 \times 10^{-3}$ mol

6. Moles of hydrogen gas (theoretical):

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

1 mol of Mg = 24.31 g
No. of moles of Mg = (mass Mg x 1 mol of Mg)/ molar mass Mg
No. of moles of Mg = (0.0248 x 1) / 24.31
= 1.02×10^{-3} mol
According to the balanced chemical equation, 1 mol of Mg produces 1 mol of H_2, therefore,

No. of moles of H_2 = 1.02×10^{-3} mol

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

Percentage Purity = (Actual no. of moles of H_2 / Theoretical no. of moles of H_2) x 100

Percentage Purity = $(1.001 \times 10^{-3} / 1.02 \times 10^{-3}) \times 100$
= 98.14 %

8. Average Percent Purity:

Average Percent Purity = (98.14 + 105.9) / 2
= 102.02%

Sample Calculation: Zinc/Aluminum (Alloy)

Calculations shown for Trial 2

1. Pressure of water column and hydrogen gas:

$P_{water\ column}$ = dgh
= 1000 x 9.81 x 0.387
= 3796.47 Pa

P_{h2} = P_{atm} – $P_{water\ column}$ – $P_{water\ vapour}$
= (100.5 x 10^3) – 3796.47 – (2.98 x 10^3)
= 93723. Pa
= 93.7 kPa

2. Moles of hydrogen gas:

PV = nRT
n = PV / RT
= (93.7 x 23.8 x 10^{-3}) / (8.314 x 295.15)
= 9.09 x 10^{-4} mol

3. Masses of Zinc and Aluminum in the alloy:

n_{H2} = (m_{Zn}/MM_{Zn}) + (3/2) . (m_{Al}/MM_{Al}) ➔ 1

m_{alloy} = m_{Zn} + m_{Al} ➔ 2

m_{Zn} = m_{alloy} - m_{Al} ➔ 3

Substitute 3 to 1,

n_{H2} = ((m_{alloy} - m_{Al})/ MM_{Zn}) + (3/2) . (m_{Al}/MM_{Al})
9.09 x 10^{-4} = ((0.0402 – m_{Al})/65.38) + (3/2) . (m_{Al}/26.98)
0.0594 = 0.0402 – m_{Al} + 3.6349m_{Al}
2.6349m_{Al} = 0.0192
m_{Al} = 0.0073g

Substitute m_{Al} value in 3,

m_{Zn} = 0.0402 – 0.0039
= 0.0329 g

4. Percent composition of the alloy:

Mass%Zn = (m_{Zn}/m_{alloy}) x 100
= (0.0329/0.0402) x 100
= 81.84%

Mass%Al = (m_{Al}/m_{alloy}) x 100
= (0.0073/0.0402) x 100
= 18.16%

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

Average% composition of Zn = (81.84 + 82.79) / 2
= 82.32%

Average% composition of Al = (17.21 + 18.16) / 2
= 17.69%

Discussion: (within space provided)

Since we used a eudiometer for the experiment it has to be ensured that it is calibrated as an uncalibrated eudiometer would result in any readings taken being incorrect.

Without the metal being present the acid will have no reaction in the water. Therefore, it is important to measure the mass of metal as accurately as possible because if the measurement was not accurate the result of calculations may be higher or lower than expected. The only gas that should be collected in the eudiometer is H_2. If any air enters the eudiometer during the course of the experiment our calculations will include not only H_2 but also the air that entered the eudiometer, hence leading to errors in calculations. As mentioned earlier the metal is the most important component of the experiment, so if some metal sticks to the walls or does not react the experiment will be affected as the weighed amount of metal has not totally reacted with the acid. This will lead to further errors in calculations.

If the calculated percent yield is greater than 100% it means that the metal may contain certain impurities causing readings taken to be wrong. A 100% percent yield signifies a perfect experiment with no errors as the experimental values are the same as the theoretical values. Obtaining a percent yield less than 100% is a sign of errors such as spills, losses due to an incomplete reaction and human errors. The percent yield being less than 100% is the most common result as it is difficult to carry out an experiment without any flaws.

An alloy is a metal made by melting and mixing two or more metals or a metal and another material together. *(Source: Merriam-Webster's Learner's Dictionary)* An alloy would normally take longer to react than a pure metal and this was proven through the observation of the acid reacting with an alloy and a pure metal in this experiment. If multiple trials are carried out with an alloy similar results should be produced. However, there will always be variations due to various errors that can occur. As mentioned previously the mass of the metal and alloy used does affect the results of the experiment because the acid would not react if not for the metal and the alloy present in the experiment.

Any deviation from expected results is due to flaws in experimental work such as incorrect measurements or spills occurring during the experiment.

Conclusion: (no more than two lines)

The composition of the alloy was 0.0329g of Zinc and 0.0073g of Aluminium with a percentage composition of 82.32% and 17.69% respectively.

Raw Data Sheet (Pure Metal)

1st Trial (Magnesium)

Amrith S.

mass of Mg = 24.8mg

V of HCl = 10 mL

T of water = 20°C

V of H_2 = 25.9 mL

V of water = 22.5 mL H of water = 33.8×10^{-2} m

Water Vapour Pressure = 2.34kPa

Observations:

- HCl gradually moved down the eudiometer
- Bubbles formed on the metal & started moving up slowly at first & then faster until the metal dissolved.

2nd Trial (Magnesium)

mass of Mg = 25.7mg

V of HCl = 10 mL

T of Water = 21°C

V of H_2 = 28.8 mL

V of Water = 15.9 mL H of Water = 23.9×10^{-2} m

Water Vapour Pressure = 2.49 kPa

Observations:

- same as 1st Trial

Room T = 22°C

Atmospheric Pressure = 100.5 kPa

Raw Data Sheet (Alloy)

Amrith S.

1st Trial (Alloy)

Unknown number = 3335
mass of Alloy = 40.1 mg

V of HCl = 10 mL

T of Water = 24°C

V of H_2 = 23.2 mL

V of water = 20.2 mL H of Water = 30.3 cm

Water Vapour Pressure = 2.98 kPa

Observations:

- Reaction was much slower than for magnesium
- A grey-ish mixture was formed before it cleared up completely.

2nd Trial (Alloy)

Unknown number = 3335
mass of Alloy = 40.2 mg

V of HCl = 10 mL

T of water = 24°C

V of H_2 = 23.8 mL

V of water = 25.8 mL H of Water = 38.7 cm

Water Vapour Pressure = 2.98 kPa

Observations:

- same as 1st Trial

Room T = 22°C

Atmospheric Pressure = 100.5 kPa