Student Name: ___________Abiral Shrestha_______

Student Number: _________8230586_____________

Partner's Name and Student #: _Alex McSween__ 8367082___

Demonstrator's Name: ___Onkar Bhanushali__________

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 __A.S.__

Data Tables

Table 1. Pure Metal

Data	Trial 1	Trial 2
Identity of Metal	Zinc	Zinc
Mass of metal (g)	0.0557 g	0.0459 g
Uncalibrated volume of eudiometer (mL)	0 mL	4 mL
Volume of hydrogen gas (mL)	32.2 mL	36.9 mL
Height of water column (cm)	19.3 cm	26.2 cm
Density of water (kg/m^3)	999.7 kg/m^3	999.7 kg/m^3
Acceleration due to gravity (m/s^2)	9.81 m/s^2	9.81 m/s^2
Pressure of water column (Pa)	1890 Pa	2570 Pa
Water Temperature (°C)	15.9°C	15.7 °C
Water Vapour pressure (Pa)	1820 Pa	1820 Pa
Atmospheric Pressure (Torr)	765.8 torr	765.8 torr
Pressure of Hydrogen	9.84×10^4 Pa	9.77×10^4 Pa
Room Temperature	17.9 °C	17.9 °C
Ideal Gas Constant, R	8.3145 KPa·L $mol^{-1}K^{-1}$	8.3145 KPa·L $mol^{-1}K^{-1}$
Actual Moles of Hydrogen (mol)	1.32×10^{-3} mol	1.50×10^{-3} mol
Theoretical moles of Hydrogen (mol)	8.52×10^{-4} mol.	7.02×10^{-4} mol
Percent Yield (%)	155%	214%

Observations (Part 1):

- HCl is slowly coming down
- Fizzing starts slowly from the metal
- Bubbles slowly form
- Bubbles vigorously form
- Zinc completely dissolved
    - Bubbles stop forming

Table 2. Alloy

Data	Trial 1	Trial 2
Unknown Number	3236	3236
Mass of alloy (g)	0.0390 g	0.0414 g
Uncalibrated volume of eudiometer (mL)	0 mL (Already calibrated)	0 mL (Already calibrated)
Volume of hydrogen gas (mL)	31.3 mL	31.2 mL
Height of water column (cm)	19.4 cm	19.5 cm
Density of water (kg/m^3)	999.7 kg/m^3	999.7 kg/m^3
Acceleration due to gravity (m/s^2)	9.81 m/s^2	9.81 m/s^2
Pressure of water column (Pa)	1.90×10^3 Pa	1.90×10^3 Pa
Water Temperature (°C)	15.9°C	15.7°C
Water Vapour pressure (kPa)	1.82 kPa	1.82 kPa
Atmospheric Pressure (Torr)	765.8 torr	765.8 torr
Pressure of Hydrogen	9.83×10^4 Pa	9.81×10^4 Pa
Room Temperature	17.9°C	17.9°C
Ideal Gas Constant, R	8.3145 $KPa \cdot L\ mol^{-1}K^{-1}$	8.3145 $KPa \cdot L\ mol^{-1}K^{-1}$
Moles of Hydrogen (mol)	1.27×10^{-3} mol	1.27×10^{-3} mol
Mass of Zinc (g)	2.23×10^{-2} g	2.56×10^{-2} g
Mass of Aluminum (g)	1.67×10^{-2} g	1.58×10^{-2} g
Percent Zinc (%)	57.1%	61.8%
Percent Aluminum (%)	42.9 %	38.2 %
Average Percent	40.4 % (Al)	59.6 % (Zn)

Observations (Part 2):

- HCl descends
- Bubbles slowly form
- Bubbles vigorously form
- Some alloy dissolve during reaction
- "Gray dust" remains and continue to react under no more left

Sample Calculation : Pure Metal Trial 1

1. Uncalibrated Volume of the Eudiometer:

   0 mL (Already Calibrated)

2. Volume of Hydrogen gas:

   $V_{Hydrogen\ gas}$ = 32.2 mL

3. Pressure exerted by the water column:

   Temperature of Water = 15.9°C
   d_{water} = 999.7 kg/m^3
   Height of water column = 19.3 cm
   Acceleration due to gravity (g) = 9.81 m/s^2

   $p = dgh$
   $= (999.7\ kg/m^3)(9.81\ m/s^2)(0.193m)$
   $= 1892.762\ kg/ms^2$
   $= 1892.762$ Pa
   $= 1890$ Pa

   The pressure exerted by the water column is about 1890 Pa.

Pressure of hydrogen gas:

Temperature of Water = 15.9°C
Atmospheric Pressure = 1.021 bar = 102100 Pa
Water Vapor Pressure = 1.82 KPa = 1820 Pa
Water Pressure (liquid) = 1892.762 Pa

$p_{Hydrogen\ Gas} = p_{atm} - p_{Water\ Vapour} - p_{Liquid\ Water}$
= 102100 Pa - 1820 Pa - 1892.762 Pa
= 98387.238 Pa
= 9.84×10^4 Pa

The pressure of hydrogen gas is about 9.84×10^4 Pa.

4. Moles of hydrogen gas (experimental):

Pressure of hydrogen gas = (98387.238 ~~Pa~~)/((1kPa/1000~~Pa~~)) = 98.387238 KPa
Volume of hydrogen gas = (32.2 ~~mL~~)/((1L/1000~~mL~~)) = 0.0322 L
R constant = 8.3145 KPa·L mol^{-1} K^{-1}
Temperature = 15.9°C

$n_{Hydrogen\ Gas}$ = PV/RT
= (98.387238 ~~KPa~~)(0.0322 ~~L~~)/(8.3145 ~~KPa·L~~ mol^{-1} ~~K^{-1}~~)((273.15 + 15.9)~~K~~)
= 0.0013182 mol
= 1.32×10^{-3} mol

5. Moles of hydrogen gas (theoretical):

$Zn_{(s)} + 2HCl_{(aq)} \rightarrow ZnCl_{2\,(aq)} + H_{2\,(g)}$ Molar Ratio: Zn: H_2 ➔ 1: 1,
Therefore, $n_{Zn} = n_{H2}$

Mass of Zinc = 0.0557 g
Molar Mass of Zinc = 65.39 g/mol
$n_{Zn} = m_{Zn}/M_{Zn}$
= 0.0557~~g~~/65.39 ~~g~~/mol
= 0.000851812 mol
= 8.52×10^{-4} mol

$n_{H2} = 8.52 \times 10^{-4}$ mol

The theoretical moles of hydrogen gas are about 8.52×10^{-4} mol.

6. Percentage Purity of metal:

Moles of experimental hydrogen gas: 0.0013182 mol
Moles of theoretical hydrogen gas:

Percentage Purity = (mol_{actual}/$mol_{Theoretical}$) x 100
= (0.0013182 mol/0.000851812 mol) x 100
= 157.75 %
= 155%

The percentage purity of Zinc is about 155 %

8. Average Percent Purity:

Percentage Purity (Trial 1) = 155 %
Percentage Purity (Trial 2) = 214%

Average Percent Purity = (Trial 1 + Trial 2) ÷ 2
= (155% + 214%) ÷ 2
= 184.5 %
= 185%

The average percent purity is 185 %.

Sample Calculation: Alloy Trial 1

1. Pressure of water column and hydrogen gas:

   Temperature of Water = 17.3°C
   Density of liquid water: d= 999.7 kg/m^3
   Height of water column: h = (19.4 ~~cm~~/(1m/1000~~cm~~)) = 0.194 m
   Acceleration due to Gravity (g) = 9.81 m/s^2
   Atmospheric Pressure = 1.021 bar = 102100 Pa
   Pressure of Water Vapour = 1.94 KPa = 1940 Pa

   P_{H2O} = dgh
   = (999.7 kg/m^3)(9.81 m/s^2)(0.194 m)
   = 1902.569 kg/m·s^2
   = 1902.569 Pa
   = 1.90 x 10^3 Pa

   $P_{Hydrogen\ Gas} = p_{atm} - p_{Water\ Vapour} - p_{Liquid\ Water}$
   = 102100 Pa - 1940 Pa - 1902.569 Pa
   = 98257.432 Pa
   =9.83 x 10^4 Pa

   The pressure of the water column is about 1.90 x 10^3 Pa and the hydrogen gas has a pressure of about 9.83 x 10^4 Pa.

2. Moles of hydrogen gas:

   Pressure of hydrogen gas = 98257.432 Pa = 98.257432 KPa
   R constant = 8.3145 KPa·L mol^{-1} K^{-1}
   Temperature = 17.3°C
   Volume of hydrogen gas = 31.3 mL = 0.0313 L

   n_{H2} = PV/RT
   = (98.257432 ~~KPa~~)(0.0313 ~~L~~)/(8.3145 ~~KPa·L~~ mol^{-1} ~~K^{-1}~~)((273.15 + 17.3)~~K~~)
   = 0.0012735 mol
   = 1.27 x 10^{-3} mol There are about 1.27 x 10^{-3} moles of hydrogen gas.

3. Masses of Zinc and Aluminum in the alloy:

Mass of Alloy = 0.0390 g
Molar mass of Zinc = 65.39 g/mol
Molar mass of Aluminium = 26.98 g/mol
Moles of Hydrogen gas = 0.0012735 mol

$Zn_{(s)} + 2HCl_{(aq)} \rightarrow ZnCl_{2\,(aq)} + H_{2\,(g)}$
$Al_{(s)} + 3HCl_{(aq)} \rightarrow AlCl_{3\,(aq)} + 3/2H_{2\,(g)}$

$n_{H2} = n_{Zn} + 3/2n_{Al}$
$= m_{Zn}/M_{Zn} + 3m_{Al}/2M_{Al}$

$m_{Alloy} = m_{Zn} + m_{Al} \rightarrow m_{Zn} = m_{Alloy} - m_{Al}$

<u>Substitution</u>

$n_{H2} = n_{Zn} + 3/2n_{Al}$
$= (m_{Alloy} - m_{Al})/M_{Zn} + 3m_{Al}/2M_{Al}$
$0.0012735 \text{ mol} = (0.0390 \text{ g} - m_{Al})/65.39 \text{ g/mol} + 3m_{Al}/2(26.98 \text{ g/mol})$
$0.0012735 \text{ mol} = (0.0390 \text{ g} - m_{Al} + 3(65.39/53.96)m_{Al})/65.39 \text{ g/mol}$
$0.0012735 \cancel{\text{mol}}(65.39 \text{ g}/\cancel{\text{mol}}) - 0.0390 \text{ g} = (196.17\text{-}53.96/53.96)m_{Al}$
$(0.0012735 \cancel{\text{mol}}(65.39 \text{ g}/\cancel{\text{mol}}) - 0.0390 \text{ g})/ (196.17\text{-}53.96/53.96) = m_{Al}$
$m_{Al} = 0.016736 \text{ g}$
$= 1.67 \times 10^{-2} \text{ g}$

$m_{Zn} = m_{Alloy} - m_{Al}$
$= 0.0390\text{g} - 0.016736 \text{ g}$
$= 0.022264 \text{ g}$
$= 2.23 \times 10^{-2} \text{ g}$

The alloy is made of about 1.67×10^{-2} g Aluminium and 2.23×10^{-2} g Zinc.

4. Percent composition of the alloy:

   Mass of Aluminium = 0.016736 g
   Mass of Zinc = 0.022264 g
   Mass of Alloy = 0.0390 g

   $\% \text{ comp.}_{Al} = (m_{Al}/m_{Alloy}) \times 100$
   $= (0.016736\text{ ~~g~~}/0.0390\text{~~g~~}) \times 100$
   $= 42.913\ \%$
   $= 42.9\ \%$

   $\% \text{ comp.}_{Zn} = (m_{Zn}/m_{Alloy}) \times 100$
   $= (0.022264\text{~~g~~}/0.0390\text{~~g~~}) \times 100$
   $= 57.087\ \%$
   $= 57.1\%$

The Alloy is 42.9 % Aluminium and 57.1 % Zinc.

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

	Trial 1		**Trial 2**
Al:	42.9 %	-------------- Average------------------	38.2 %
Zn:	57.1 %	-------------- Average------------------	61.8 %

$\text{Avg } \% \text{ comp.}_{Al} = (\text{Trial 1} + \text{Trial 2}) \div 2$
$= (42.9\ \% + 38.2\ \%) \div 2$
$= 40.55\ \%$
$= 40.6\%$

$\text{Avg } \% \text{ comp.}_{Zn} = (\text{Trial 1} + \text{Trial 2}) \div 2$
$= (57.1\% + 61.8\%) \div 2$
$= 59.45\ \%$
$= 59.4\%$

The Average percent composition of Zinc is 59.4 % and 40.6% for Aluminium.

Discussion: (within space provided)

When comparing the data and results of the two trials from the pure metal portion of the experiment, you can see that there are very few similarities and more contrasting results. These include the masses, the height of the water column, the pressure, the volumes of hydrogen gas and the number of moles of hydrogen gas. The results show that the first trial had a greater mass but a lower mole count of hydrogen gas than the second trial, where it had a greater mole count but a lower metal mass. The result of a higher mole count increased the overall volume of the hydrogen gas in Trial 2 and lowered the height of the water column. With less volume and the same temperature, the pressure in the second trial was greater than the first trial. On the other hand, the alloy portion of the experiment had very similar results in both trials; everything from the volume of the hydrogen gas to the average percent composition of the alloy was very close to one another. However the main differences are the percent composition of the alloy. The second trial seemed to have a greater zinc composition of, whereas it was a fairly even in the first trial between the two metals. This didn't change the number of hydrogen moles, as for each aluminium reacted, three halves of moles of hydrogen gas is formed which is a greater ratio than the 1 to 1 of zinc. The larger mass of the second trial had more zinc than aluminium, and lower mass of the first trial had a fairly even spread and their compositional ratio was coincidently perfect enough to yield the same moles of hydrogen gas in both trials.

The experiment's results were undoubtedly affected by numerous sources of errors; one being the procedure itself, where it asks to turn the eudiometer upside to cover the metal. The process proved to be quite difficult because while doing so, we lost a lot of distilled water, thus creating an air bubble in the eudiometer before even setting it into place. This in turn increased the overall measurements of the volume of the hydrogen gas and lowered the height of the water column. The effects of the deviation of these data really hampered the final results as the percent yield of hydrogen gas went over 100% to even 200%. That is very unusual as 1 mole of the metal should result in the formation of 1 mole of hydrogen gas; however this error caused the actual amount of moles of hydrogen gas to be far greater than the theoretical mole value, resulting in the ridiculously inflated percent yield.

Conclusion: (no more than two lines)

The pure metal, zinc, had an average percent purity of 185 %. The alloy, number 3236, had an average percent of 59.6% zinc and 40.4 % aluminium.

C 11

Student Name: Abiral Shrestha

Student Number: 8230586

Partner's Name and Student #: Alex McSween 8367082

Demonstrator's Name: Omkar Bhanushali

Email:

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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

Rough Data

1 bar = 10^5 Pa

17.9°C RT

Data Tables

Table 1. Pure Metal

1mg → 0.001 g

Data	Trial 1	Trial 2
Identity of Metal	Zn	Zn
Mass of metal (g)	0.05 g 0.0557 g	0.05 g 0.0459 g
Uncalibrated volume of eudiometer (mL)		4 mL
Volume of hydrogen gas (mL)	32.2 mL	32.9 mL
Height of water column (cm)	19.3 cm	26.2 cm
Density of water (kg/m^3)		
Acceleration due to gravity (m/s^2)		
Pressure of water column (Pa)		
Water Temperature (°C)	15.9° C	15.7 °C
Water Vapour pressure (Pa)	~~1.022 bar~~	~~1.020 bar~~
Atmospheric Pressure (Torr)	1.021 bar	1.021 bar
Pressure of Hydrogen		
Room Temperature	17.9°C	17.9°C
Ideal Gas Constant, R		
Actual Moles of Hydrogen (mol)		
Theoretical moles of Hydrogen (mol)		
Percent Yield (%)		

Observations (Part 1):

Trial 1

- Zinc completely dissolved completely, bubbles stopped forming
- Bubbles started to form
- HCl slowly came down
- Bubbles vigourously form
- Fizzing from Zn

Rough Data

Table 2. Alloy

Data	Trial 1	Trial 2
Unknown Number	3236	3236
Mass of alloy (g)	0.0390 g	0.0414 g
Uncalibrated volume of eudiometer (mL)		
Volume of hydrogen gas (mL)	31.3	31.2
Height of water column (cm)	19.4	19.5
Density of water (kg/m^3)		
Acceleration due to gravity (m/s^2)		
Pressure of water column (Pa)		
Water Temperature (°C)	17.3 °C	17.7 °C
Water Vapour pressure (kPa)		
Atmospheric Pressure (Torr)	1.021 bar	1.021 bar
Pressure of Hydrogen		
Room Temperature	17.9 °C	17.9 °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):

- HCl descended
- Bubbles slowly form
- Vigorously formed bubbles
- Some alloy dissolved
- "Gray dust" formed later rxn to fall down again