Data Tables

Table 1. Pure Metal

Data	Trial 1	Trial 2
Identity of Metal	Zinc	Zinc
Mass of metal (g)	0.0406	0.0411
Uncalibrated volume of eudiometer (mL)	0	0
Volume of hydrogen gas (mL)	16.3	16.4
Height of water column (cm)	32	32.5
Density of water (kg/m^3)	1000	1000
Acceleration due to gravity (m/s^2)	9.8	9.8
Pressure of water column (Pa)	3136 pa	3185
Water Temperature (°C)	22	22.6
Water Vapour pressure (Pa)	2.64×10^3	2.74244×10^3
Atmospheric Pressure (Torr)	7.58312×10^2	7.58312×10^2
Pressure of Hydrogen	$9.54466x10^4$	$9.50726x10^4$ pa
Room Temperature	22.4	22.4
Ideal Gas Constant, R	0.08206	0.08206
Actual Moles of Hydrogen (mol)	0.000634	0.000630857 mol H2
Theoretical moles of Hydrogen (mol)	0.000621	0.000628632 mol
Percent Yield (%)	103	100

Observations (Part 1):

- When pouring the hydrochloric acid into the eudiometer, the smell was very strong. It was very visible to see when the reaction was occurring since bubbles could be seen. When the reaction first started to really occur a lot of bubbles could be seen as in it kept increasing. It was also very easy to tell when the reaction stopped since the amount of bubbles that could be seen would slowly decrease until there would be no more bubbles.

Table 2. Alloy

Data	Trial 1	Trial 2
Unknown Number	6458	6458
Mass of alloy (g)	0.0426	0.393
Uncalibrated volume of eudiometer (mL)	0	0
Volume of hydrogen gas (mL)	22	23
Height of water column (cm)	26	23
Density of water (kg/m^3)	1000	1000
Acceleration due to gravity (m/s^2)	9.8	9.8
Pressure of water column (Pa)	2548	2940
Water Temperature (°C)	21.7	21.4
Water Vapour pressure (kPa)	2.59671977	2.54965697
Atmospheric Pressure (Torr)	7.58312×10^2	7.58312×10^2
Pressure of Hydrogen	95855.28pa	95511 pa
Room Temperature	22.4	22.4
Ideal Gas Constant, R	0.08206	0.08206
Moles of Hydrogen (mol)	0.0008581429	0.000897
Mass of Zinc (g)	0.037	0.0318
Mass of Aluminum (g)	0.0056	0.0075
Percent Zinc (%)	86.9	81
Percent Aluminum (%)	81	19
Average Percent	83.5 (Zn)	16.05 (Al)

Observations (Part 2):

- While observing this reaction some things were similar to the reaction of the pure metals. Such as, the strong smell of the hydrochloric acid and the bubbles that can be seen when the reaction takes place, as well as when it stops to indicate the reaction is no longer taking place. Some differences were also noted. For example, the alloy took a longer time to react as well as sometimes the alloy would go up the tube and then go back down.

Sample Calculation : Pure Metal (trial 2)

1. Uncalibrated Volume of the Eudiometer:

   N/A since eudiometer was calibrated

2. Volume of Hydrogen gas:

   $V = 16.4 \text{ mL} \times 10^{-3}$
   $V = 0.0164\text{L}$

3. Pressure exerted by the water column:

   Height of water colum = 32.5 cm, so $32.5\text{cm} \times 10^{-2} = 0.325\text{m}$
   Therefore,

   $P = dgh$
   $= (1000\text{kg/m}^3)(9.8\text{m/s}^2)(0.325\text{m})$
   $= 3185$ pa

4. Pressure of hydrogen gas:

   $P_{atm} = 101$ kpa = 101000 pa
   Therefore,

   $P_{hydrogen} = P_{atm} - P_{water\ column} - P_{water\ vapor}$
   $= 101000 \text{ pa} - 3185 \text{ pa} - 2.74244\times10^3 \text{ pa}$
   $= 9.50726\times10^4$ pa

5. Moles of hydrogen gas (experimental):

   $V = 0.0164\text{mL}$, $P = 9.50726 \times 10^4$ pa $= 0.9382932149$ atm
   $R = 0.0206 \text{ L atm K}^{-1}\text{mol}^{-1}$, $T = 22.4$ Celsius $= 295.55\text{K}$
   Therefore,

   $pV = nRT$
   $n = pV/ RT$
   $n = (0.9382932149 \text{ atm})(0.0164\text{L}) / (0.083206 \text{ L atm K}^{-1}\text{mol}^{-1})(295.55\text{K})$
   $= 0.000630857$ mol H_2

6. Moles of hydrogen gas (theoretical):

Balanced chemical equation: $Zn + 2HCl = H2 + ZnCl2$

n= mass / Molar mass

$n = 0.0411 g / 65.38\ g\ mol^{-1}$

$= 0.000628632$ mol of Zn

Ratio of Zn to H_2 is 1:1, therefore there are 0.000628632 mol of H_2

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

Percentage yield = 100 x (actual yield/ theoretical yield)
= 100 x (0.000630857/0.000628632)
= 100.35%
therefore, about 100%

8. Average Percent Purity:

Average percent = 100% + 103%/2
= 101.5%

Sample Calculation : Alloy (trial 1)

1. Pressure of water column and hydrogen gas:
   - $P_{water\ column} = dgh$
     $= (1000\ kg/m^3)(9.8\ m/s^2)(0.26m)$
     $= 2548$ pa
   - $P_{hydrogen} = P_{atm} - P_{water\ column} - P_{water\ vapor}$
     $= 101000$ pa – 2548 – 2.59672×10^3 pa
     $= 95855.28$ pa

2. Moles of hydrogen gas:
   n = pV/ RT
   $n = (0.9460180607atm)(0.022l)/ (0.08206L\ atm\ K^{-1}mol^{-1})(295.55K)$
   n = 0.0008581429 mol of H_2

3. Masses of Zinc and Aluminum in the alloy:

- $n_{hydrogen\ total} = n_{zinc} + 3/2\ n_{aluminum}$

  $n_{hydrogen\ total}$ = m of Zn/ M of Zn + 3/2(m of Al/M of Al)

8.581429×10^{-4} H2 mol= x/ 65.38 g mol^{-1} + 3/2 (total m – m of Zn)/M of Al

= x/65.38 g mol^{-1} + 3/2(0.0426-x)/26.98

= x/65.38g mol^{-1} +3/2(0.0426/26.98 – x/26.98)

=x/65.38g mol^{-1} + 3/2(0.001578947 – x/26.98)

=x/65.38g mol^{-1} + 0.002368421- 3x/53.96

- 0.001510277 = x/65.38g mol^{-1} – 3x/53.96

= x (1/68.38 g mol^{-1} – 3/53.96)

= - 0.040301541 x

x = 0.037474425

therefore, about 0.037g of Zn

Also, 0.0426 – 0.037 = 0.0056 g Al

4. Percent composition of the alloy:

   Percent of zinc = 100 x (0.037/ 0.0426)
   = 100x (0.8685446)
   = 86.85446
   =86.9% of Zn

   Percent of aluminium = 100 x (0.0056/0.0426)
   = 100 x (0.131455399)
   = 13.14553991
   = 13.1% of Al

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

   Average percent of zinc = 81% + 86.9% / 2
   = 167.9 /2
   = 83.95%

   Average percent of aluminium = 19% + 13.1% / 2
   = 32.1 /2
   = 16.05 %

Discussion:

In many experiments such as this one, whether the eudiometer is calibrated or not is important. If it is not calibrated the results will not be accurate. Also, if air enters the eudiometer it does affect the results since now there would be a new substance, the volume of gas, that was not accounted for meaning that the calculations would be off.

If it is greater than 100% then that means that there are some impurities that may have entered the reaction causing it to be over 100. For example, in the pure metals experiment for trial one the percentage yield is 103%, obviously indicating that it is over 100% which could mean that in this trial some impurities could have jeopardized the end result. Meanwhile, for trial two the percentage yield is 100% which means that theoretical yield is equal to the actual yield. Yet, the average of both is over 100% since its 101.5%

An alloy is a metal that is made up of two different metals, such as the one used in this alloy experiment which is composed of zinc and aluminium. If more trials were done, it would still be expected for alloy to produce similar results but never the same. Just by observing the first two trials, they are quiet similar but not the same since there is always something that is bound to be different or a bit different or even the occurrence of human errors. Similar results would be expected since it is the same experiment being repeated multiple times. Metals or alloys with different masses would definitely affect the results of the experiment that is being conducted. With different masses, there would be a change in numbers of moles that could be formed as well as a change in percentage yield.

As it turns out, this experiment consisted of many components that have been learned in the chemistry lectures. There was a lot of stoichiometry used such as calculating the number of moles. Yet, there was also the concept of ideal gases used such as when calculating the pressure was needed. This experiment involved everything that was being learned.

Conclusion: (no more than two lines)

For the pure metal zinc, the average percentage yield was 101.5% while for the alloy, the zinc average percentage was 83.95% and for aluminum it was 16.05%. While both reactions were relatively similar, they were also different such as that an alloy takes longer to react than a pure metal.