Student Name:

Student Number:

Partner's Name and Student #:

Demonstrator's Name:

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 MH

Data Tables

Table 1. Pure Metal

Data	Trial 1	Trial 2
Identity of Metal	Magnesium	Magnesium
Mass of metal (g)	0.0302 $g \pm 0.001$	0.0270 $g \pm 0.001$
Uncalibrated volume of eudiometer (mL)	already calibrated	already calibrated
Volume of hydrogen gas (mL)	31.6 mL ± 0.1	28.7 mL ± 0.1
Height of water column (cm)	15.5 cm ± 0.1	18.5 cm ± 0.1
Density of water (kg/m^3)	1000 kg/m^3	1000 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)	152 Pa	181 Pa
Water Temperature (°C)	23°C	23°C
Water Vapour pressure (Pa)	2810 Pa	2810 Pa
Atmospheric Pressure (Torr)	767.25 torr	767.25 torr
Pressure of Hydrogen	99.34 kPa	99.49 kPa
Room Temperature	23.1°C	23.1°C
Ideal Gas Constant, R	8.314 $\frac{L(kPa)}{K(mol)}$	8.314 $\frac{L(kPa)}{K(mol)}$
Actual Moles of Hydrogen (mol)	1.27×10^{-3} mol	1.16×10^{-3} mol
Theoretical moles of Hydrogen (mol)	1.24×10^{-3} mol	1.11×10^{-3} mol
Percent Yield (%)	102%	105%

Observations (Part 1):

The overall reaction happened rather fast, especially in contrast with the second reaction. During the reaction, there were many bubbles (fizzy) in the eudiometer.

Table 2. Alloy

Data	Trial 1	Trial 2
Unknown Number	2276	2276
Mass of alloy (g)	0.0412 g	0.0374 g
Uncalibrated volume of eudiometer (mL)	already calibrated	already calibrated
Volume of hydrogen gas (mL)	25.65 mL	26.2 mL
Height of water column (cm)	26.1 cm	25.5 cm
Density of water (kg/m^3)	1000 kg/m^3	1000 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)	2560 Pa	$2.50*10^3$ Pa
Water Temperature (°C)	23°C	20°C
Water Vapour pressure (kPa)	2.81 kPa	2.20 kPa
Atmospheric Pressure (Torr)	767.25 torr	767.25 torr
Pressure of Hydrogen	96.9 kPa	97.6 kPa
Room Temperature	23.1°C	23.1°C
Ideal Gas Constant, R	8.314 $\frac{L(kPa)}{K(mol)}$	8.314 $\frac{L(kPa)}{K(mol)}$
Moles of Hydrogen (mol)	$1.01*10^{-3}$ mol	$1.04*10^{-3}$ mol
Mass of Zinc (g)	0.0318 g	0.0258 g
Mass of Aluminum (g)	0.00943 g	0.00160 g
Percent Zinc (%)	77.1 %	69.0%
Percent Aluminum (%)	22.9 %	31.0 %
Average Percent	100%	100%

Observations (Part 2):

Gray/black aqueous solute on top of the diluted HCl in eudiometer. Very slow reaction. Fizz-like bubbles at the top.

Sample Calculation: Magnesium

1. Uncalibrated Volume of the Eudiometer:

Eudiometer was already calibrated

2. Volume of Hydrogen gas:

$$V_{H_2O_{(g)}} = 31.6\, mL\ \pm 0.1$$

3. Pressure exerted by the water column:

Let d be density of water
g be acceleration due to gravity
h be height of water column

$$P_{H_2O_{(l)}} = dgh$$

$$=(1000.0\, \frac{kg}{m^3})(9.81\, \frac{m}{s^2})(0.155\ m)$$

$$=1520.55\, \frac{kg}{ms^2}$$

$$\boldsymbol{P_{H_2O_{(l)}}} \mathbf{=1520\ Pa \pm 0.1}$$

4. Pressure of hydrogen gas:

$$P_{H_2Gas} = P_{Atmosphere} - P_{H_2O_{(l)}} - P_{H_2O_{(v)}}$$

$$= \left(1.023\, bar * \frac{100000\, Pa}{1\, bar}\right) - (1520\, Pa) - (2810\, Pa)$$

$$P_{H_2Gas} = 97969\, Pa$$

$$\boldsymbol{P_{H_2Gas} = 98.0\, kPa}$$

5. Moles of hydrogen gas (experimental):

$$n_{H_2ACTUAL} = \frac{pV}{RT}$$

$$= \frac{(97.97\, kPa)(0.0316L)}{\left(8.314\, \frac{L(kPa)}{K(mol)}\right)(23.1℃+273.15)}$$

$$\boldsymbol{n_{H_2ACTUAL} = 1.26 * 10^{-3}\, mol}$$

6. Moles of hydrogen gas (theoretical):

$$n_{H_2THEORETICAL} = 0.0302\, g_{Mg} * \frac{1\, mol_{Mg}}{24.31\, g_{Mg}} * \frac{1\, mol_{H2}}{1\, mol_{Mg}}$$

$$\boldsymbol{n_{H_2THEORETICAL} = 1.24 * 10^{-3} mol}$$

7. Percentage Purity of metal:

$$Mg_{(s)} + 2\,HCl_{(aq)} \rightarrow MgCl_{2\,(aq)} + H_{2\,(g)}$$
$$n_{H_2} : n_{Mg}$$

$$\%Purity_{Mg} = \frac{n_{Mg(ACTUAL)}}{n_{Mg(THEORETICAL)}} * 100\%$$
$$\%Purity_{Mg} = \frac{1.26*10^{-3}mol}{1.24*10^{-3}mol} * 100\%$$
$$\%\boldsymbol{Purity_{Mg}} = \mathbf{101}\,\%$$

8. Average Percent Purity:

$$\%Purity_{Average} = \frac{\%Purity_{Mg\,(1)} + \%Purity_{Mg\,(2)}}{2}$$
$$= \frac{101\% + 103\%}{2}$$
$$\%\boldsymbol{Purity_{Average}} = \mathbf{102}\%$$

Evidently does not make sense… please see discussion

Sample Calculation: #2276 Alloy

1. Pressure of water column and hydrogen gas:

For pressure of water column:

Let d be density of water
g be acceleration due to gravity
h be height of water column

$$P_{H_2O_{(l)}} = dgh$$
$$= (1000.0\,\frac{kg}{m^3})(9.81\,\frac{m}{s^2})(0.261\text{ m})$$
$$= 2560.41\,\frac{kg}{ms^2}$$
$$\boldsymbol{P_{H_2O_{(l)}}} = \mathbf{2560\ Pa \pm 0.1}$$

For pressure of hydrogen gas:

$$P_{H_2Gas} = P_{Atmosphere} - P_{H_2O_{(l)}} - P_{H_2O_{(v)}}$$
$$= \left(1.023\,bar * \frac{100000\,Pa}{1\,bar}\right) - (2560\,Pa) - (2810\,Pa)$$
$$P_{H_2Gas} = 96929.6\,Pa$$
$$\boldsymbol{P_{H_2Gas} = 96.9\,kPa}$$

2. Moles of hydrogen gas:

$$n_{H_2ACTUAL} = \frac{pV}{RT}$$
$$= \frac{(96.9\ kPa)(0.02565L)}{\left(8.314\frac{L(kPa)}{K(mol)}\right)(23.1℃+273.15)}$$
$$\boldsymbol{n_{H_2ACTUAL} = 1.01 * 10^{-3}\ mol}$$

3. Masses of Zinc and Aluminum in the alloy:

For mass of Aluminium:

$$mass_{TOTAL} = mass_{Al} + mass_{Zn}$$
[a] $mass_{Zn} = mass_{TOTAL} - mass_{Al}$

[b] $n_{H_2} = \frac{mass_{Zn}}{Mm_{Zn}} + \frac{3\ mass_{Al}}{2\ Mm_{Al}}$

Sub [a] into [b]

$$n_{H_2} = \frac{mass_{TOTAL}}{Mm_{Zn}} - \frac{mass_{Al}}{Mm_{Zn}} + \frac{3\ mass_{Al}}{2\ Mm_{Al}}$$
$$1.01 * 10^{-3} = \frac{0.0412\ g}{65.41\ g/mol} - \frac{mass_{Al}}{65.41\ g/mol} + \frac{3\ mass_{Al}}{2(26.98g/mol)}$$
$$3.8013 * 10^{-4} = \frac{3\ mass_{Al}(65.41) - 53.96\ mass_{Al}}{(3529.52)}$$
$$mass_{Al} = 9.431 * 10^{-3} g$$
$$\boldsymbol{mass_{Al} = 9.43\ mg}$$

For mass of Zinc:

$$mass_{TOTAL} = mass_{Al} + mass_{Zn}$$
$$41.2\ mg = 9.43\ mg + mass_{Zn}$$
$$\boldsymbol{mass_{Zn} = 31.77\ mg}$$

4. Percent composition of the alloy:

$$\%_{Al} = \frac{mass_{Al}}{mass_{TOTAL}} * 100\%$$
$$\%_{Al} = \frac{9.43\ mg}{41.2\ mg} * 100\%$$
$$\boldsymbol{\%_{Al} = 22.0\%}$$

$$\%_{Zn} = \frac{mass_{Zn}}{mass_{TOTAL}} * 100\%$$
$$\%_{Al} = \frac{31.77\ mg}{41.2\ mg} * 100\%$$
$$\boldsymbol{\%_{Al} = 77.1\%}$$

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

$$\%Al_{Average} = \frac{\%Al_1 + \%Al_2}{2}$$

$$\%Al_{Average} = \frac{22.9\% + 31.0\%}{2}$$

$$\%\boldsymbol{Al_{Average}} = \mathbf{27.0}\%$$

$$\%Zn_{Average} = \frac{\%Zn_1 + \%Zn_2}{2}$$

$$\%Zn_{Average} = \frac{77.1\% + 69\%}{2}$$

$$\%\boldsymbol{Zn_{Average}} = \mathbf{73.1}\%$$

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

<u>For Part 1:</u>

The percentage yield exceeds over 100% for one predominant reason: whilst doing the experiment, there may have been air bubbles formed inside the eudiometer which interfered with the accuracy of the metal yield.

Sources of error could include: calibration of the ruler, eudiometer, excess mass from dirt and grease from fingers

<u>For Part 2:</u>

Sources of error could include small remnants of the allow falling through when transferring it into the vial. Again, gas bubbles could have formed to interfere with the accuracy of the result.

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

Therefore, the composition of the metal alloy consists of about 27% aluminium and 73% Zinc.

1 BAR = 10^5 PA

ATMOSPHERE = 1.023 BAR
Temp = 23.1°C

MG METAL

OB: BUBBLES VERY FAST
METAL REACT IN HCl WITHIN
SECONDS
-gas
-H2 WAS
[illegible]

TRIAL #1
M_{mg} = 0.0302g
T_{water} = 23°C
V_{gas} = 31.9 ml
H_{water} = 15.5 cm

TRIAL #2
M_{mg} = 0.027g
T_{water} = 23°C
H_{water} = 13.5 cm
V_{gas} = 28.? mL

ALLOY #2276

TRIAL #1
M_{alloy} = 41.2mg
T_{water} = 23°C
H_{water} = 26.1 cm
V_{gas} = 25.65 mL

TRIAL #2
M_{alloy} = 0.0374g
T_{water} = 19°C → 20°C
V_{gas} = 26.2 mL
H_{water} = 25.5 ~~mL~~ cm

OB: GRAY AQ, BLACK SOLID ON TOP Mg
very slow
fizzy @ end