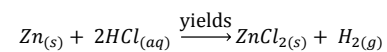


## Experiment #13

- The reactivity of metals with Hydrochloric Acid
  - Zinc
  - Aluminum
  - Magnesium
  - Manganese
- We will determine the stoichiometric conversion of the above equations.
- We will then verify the amount of Hydrogen gas evolved

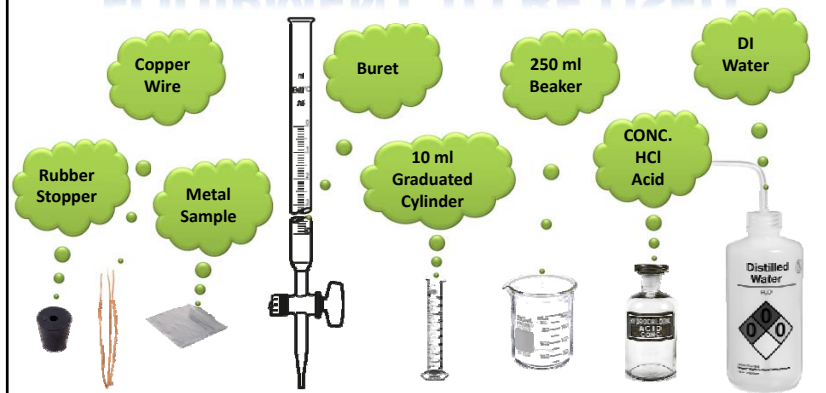
Element
Zn
Al
Mg
Mn

### 4 - Equations are REQUIRED!!!



\*  
\*  
\*  
\*  
\*

## EQUIPMENT TO BE USED



## Overview of Experiment (I)

Wrap Metal in Cu

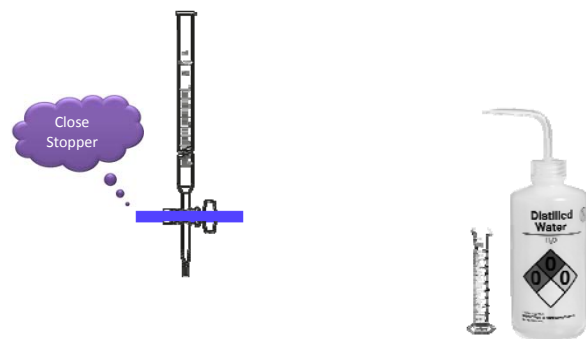
Type equation here.

Mass of sample. You need to record this value

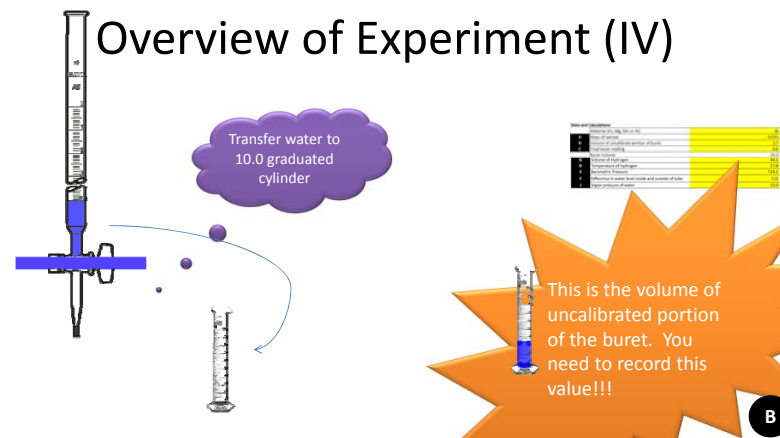
Data and Calculations	
Initial Zn, Mg, Fe or Al	0.00 g
Mass of sample	0.00 g
Volume of solution portion of buret	0.00 mL
Final buret reading	0.00 mL
Final volume	0.00 mL
Volume of hydrogen	0.00 mL
Temperature of hydrogen	0.00 °C
Barometric Pressure	0.00 mm Hg
Pressure in water bath inside and outside of tube	0.00 mm Hg
Water potential at water	0.00 mm Hg

A

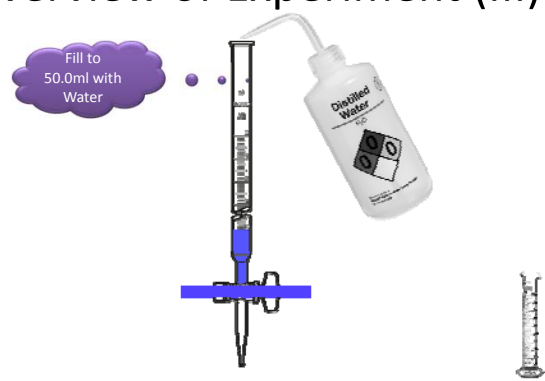
## Overview of Experiment (II)



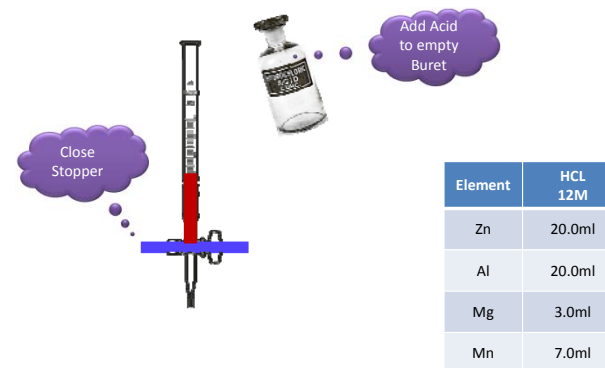
## Overview of Experiment (IV)



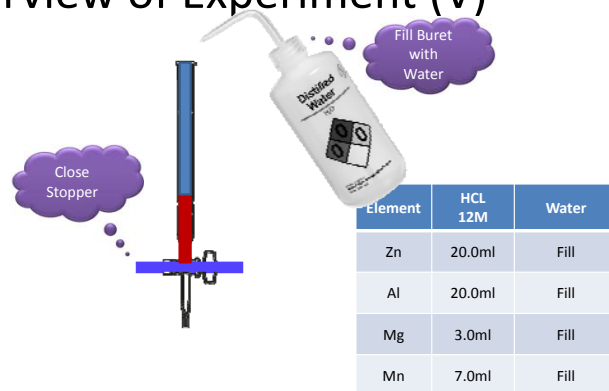
## Overview of Experiment (III)



## Overview of Experiment (V)

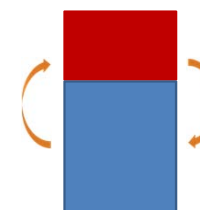


## Overview of Experiment (V)



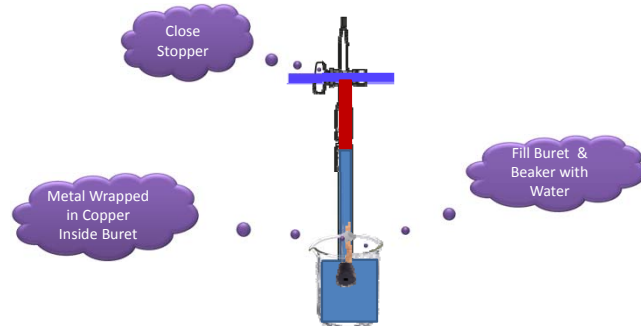
Element	HCL 12M	Water
Zn	20.0ml	Fill
Al	20.0ml	Fill
Mg	3.0ml	Fill
Mn	7.0ml	Fill

## Overview of Experiment (VII)



The density of the HCl(aq) is greater than the H<sub>2</sub>O(l). You should be able to see the convection currents of the acid dropping.

## Overview of Experiment (VI)



## Overview of Experiment (VIII)

- Measure the temperature of the gas/water **D**
- Measure the barometric pressure of the room **E**

Data and Calculations	
Material (Zn, Mg, Fe or Al)	Al
A Mass of sample	0.013 g
B Volume of uncalibrated portion of buret	3.2 ml
C Final buret reading	9.6 ml
D Initial volume	56.6 ml
E Volume of hydrogen	44.2 ml
F Temperature of hydrogen	21.6°C
G Barometric Pressure	724.5 torr
H Difference in water level inside and outside of tube	13.2 mm H <sub>2</sub> O
I Vapor pressure of water	17.5 torr

## Overview of Experiment (IX)

All gas should be collected in Buret

All metal should be consumed

No More Bubbles

Measure the final buret reading. You need to record this value **C**

Measure the difference in water level inside and outside of the buret. You need to record this value **F**

Data and Calculations	
Mass of metal	0.0101 g
Volume of uncalibrated portion of buret	1.2 mL
Final buret reading	36.0 mL
Buret Volume	34.8 mL
Volume of hydrogen	34.8 mL
Temperature of hydrogen	17.8 °C
Barometric Pressure	127.4 mmHg
Influence on water level inside and outside of tube	1.2 mm H <sub>2</sub> O
Water Vapor Pressure	14.5 mmHg

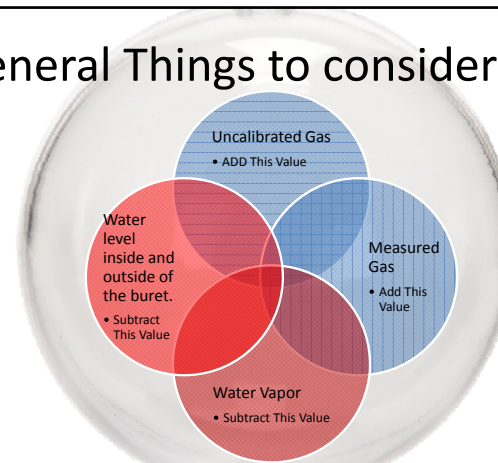
## General Things to consider (I)

- Volume of gas produced...
  - Sum of uncalibrated portion of buret
  - Buret volume of gas
  - Need to consider also...
    - The Partial Pressure of water in buret
    - The negative pressure of the difference in what level inside and outside of the tube.

## Data you should now have (I)

- Mass of metal sample
- Volume of gas
  - Uncalibrated portion of the buret
  - Buret Volume of gas
- Height of water level inside and outside of buret

## General Things to consider (II)



## First, Calculate the volume of H<sub>2</sub>

- Calculate the volume of hydrogen
  - Volume of gas total:
    - Volume of buret reading (+50.0ml)
    - Volume of the uncalibrated portion of the buret (+x.xml)
    - Less the final buret reading (-x.x)

Data and Calculations		Initial	Final
A	Material (Zn, Mg, Mn or Al)		
B	Mass of sample	0.033 g	
C	Volume of uncalibrated portion of buret	3.2 ml	
	Final buret reading	36 ml	
	Buret Volume	50.0 ml	
D	Volume of hydrogen	44.1 ml	
E	Temperature of hydrogen	22.8 °C	
F	Barometric Pressure	754.1 torr	
G	Difference in water level inside and outside of tube	112 mm H <sub>2</sub> O	
H	Vapor pressure of water	19.7 torr	

G

TABLE 3 Vapor Pressure of Water at Different Temperatures

Temperature (°C)	Vapor Pressure (torr)	Temperature (°C)	Vapor Pressure (torr)
10 (ice)	1.0	28	28.3
-5 (ice)	3.0	29	30.0
0	4.6	30	31.8
5	6.5	35	42.2
10	9.2	40	55.3
15	12.8	45	71.9
16	13.6	50	92.5
17	14.5	55	118.0
18	15.5	60	148.4
19	16.5	65	187.5
20	17.5	70	233.7
21	18.6	75	289.1
22	19.8	80	355.1
23	21.1	90	525.8
24	22.4	100	760.0
25	23.8	150	3570.5
26	25.2	200	11659.2
27	26.7		

J

Next, Calculate the equivalent difference in water levels. (Inside and out side of the buret.)

&

The partial pressure of Water

- Find the partial pressure of water at temp
- Convert water height into mercury height

H

- Convert water height into mercury height

$$\text{Water Height Difference} * \frac{\text{Density of Water } 1.0 \text{ g/mm}}{\text{Density of Mercury } 13.6 \text{ g/mm}} = \text{negative pressure due to water height}$$

H

- Get rid of the partial pressure of water and water level factors

$$\text{Barometric Pressure} - \text{Partial Pressure of Water} - \text{Water height difference} = \text{Dry H}_2 \text{ Pressure}$$

K

Data and Calculations		Initial	Final
A	Material (Zn, Mg, Mn or Al)		
B	Mass of sample	0.033 g	
C	Volume of uncalibrated portion of buret	3.2 ml	
	Final buret reading	36 ml	
	Buret Volume	50.0 ml	
D	Volume of hydrogen	44.1 ml	
E	Temperature of hydrogen	22.8 °C	
F	Barometric Pressure	754.1 torr	
G	Difference in water level inside and outside of tube	112 mm H <sub>2</sub> O	
H	Vapor pressure of water	19.7 torr	

## Convert the Dry H<sub>2</sub> Pressure into STP

- Need to account for Standard Temperature
- Need to account for Standard Pressure

$$\text{Volume of H}_2 \text{ Gas} * \frac{273K}{\text{Temperature of water } K} * \frac{760.0 \text{ torr}}{\text{Dry H}_2 \text{ Pressure}} = \text{Volume of dry H}_2 \text{ at STP}$$

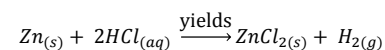
G

K

Data and Calculations	
Mass of sample	0.033 g
Volume of unreactive portion of buret	1.0 ml
Total buret reading	49.0 ml
Buret Volume	48.0 ml
Volume of Hydrogen	47.0 ml
Temperature of Hydrogen	273 K
Barometric Pressure	760.0 torr
Difference in water level inside and outside of tube	112 mm H <sub>2</sub> O
Vapor pressure of water	15.0 torr

M

## 4- Equations are REQUIRED!!!



Using 22.4L/Mole at STP

$$\frac{\text{Mass of Metal } g}{\text{Volume of Dry H}_2 \text{ at STP } ml} * \frac{1000 \text{ ml}}{1 \text{ L}} * \frac{22.4 \text{ L}}{\text{Mole}} * \frac{1 \text{ Mole H}}{2 \text{ eq}} = \text{Metal } gram/equivalents$$

N

## Using 22.4L/Mole at STP

$$\frac{\text{Mass of Metal } g}{\text{Volume of Dry H}_2 \text{ at STP } ml} * \frac{1000 \text{ ml}}{1 \text{ L}} * \frac{22.4 \text{ L}}{\text{Mole}} * \frac{1 \text{ Mole H}}{2 \text{ eq}} = \text{Metal } gram/equivalents$$

Data and Calculations	
Mass of sample	0.033 g
Volume of unreactive portion of buret	1.0 ml
Total buret reading	49.0 ml
Buret Volume	48.0 ml
Volume of Hydrogen	47.0 ml
Temperature of Hydrogen	273 K
Barometric Pressure	760.0 torr
Difference in water level inside and outside of tube	112 mm H <sub>2</sub> O
Vapor pressure of water	15.0 torr

N

## 4 – Equations are REQUIRED !!!

$$\frac{(\text{Metal } gram/equivalents) - (\text{Molecular Mass}_{\text{Metal}} / \text{Equivalents})}{(\text{Molecular Mass}_{\text{Metal}} / \text{Metal Equivalents})} * 100\%$$

Data and Calculations	
Mass of sample	0.033 g
Volume of unreactive portion of buret	1.0 ml
Total buret reading	49.0 ml
Buret Volume	48.0 ml
Volume of Hydrogen	47.0 ml
Temperature of Hydrogen	273 K
Barometric Pressure	760.0 torr
Difference in water level inside and outside of tube	112 mm H <sub>2</sub> O
Vapor pressure of water	15.0 torr

P

Data and Calculations			
	Material (Zn, Mg, Mn or Al)	Zn	
<b>A</b>	Mass of sample	0.0123 g	
<b>B</b>	Volume of uncalibrate portion of buret	3.00 ml	Add
<b>C</b>	Final buret reading	6.00 ml	Minus
	Buret Volume	50.0 ml	Add
<b>G</b>	Volume of Hydrogen	47.0 ml	Total
<b>D</b>	Temperature of hydrogen	20.0 C	
<b>E</b>	Barometric Pressure	759.0 torr	
<b>F</b>	Difference in water level inside and outside of tube	100 mm H <sub>2</sub> O	
<b>J</b>	Vapor pressure of water	17.6 torr	
Data		Calculations	
<b>H</b>	mm Hg (torr) equivalent of difference of water levels 13.6g/mm for Hg, 1.0g/mm for Water	100 * 1.0g/mm /13.6gmm	7.4 torr
<b>K</b>	Pressure of H <sub>2</sub> after correction of difference in H <sub>2</sub> O level and for vapor pressure and barometric temperature correction	759 - 7.3 - 17.6483384162473	734.0 torr
<b>L</b>	Temperature, absolute	20 + 273	293 K
<b>M</b>	Volume of dry H <sub>2</sub> at standard conditions, i.e., corrected for vapor pressure, pressure, and temperature	47ml * (273K/293K)/(733.9torr/760.0torr)	42.3 ml
<b>N</b>	Equivalent Mass	0.0123g Zn/42.2ml*(11200 ml/equivalent)	3.3 g/eq
	Molecular Mass of Zn	From periodic table	65 g/mole
	Equivalent of Zn		2.0 eq
<b>P</b>	Percentage of relative error =	Less than 5% is great	-90.0%