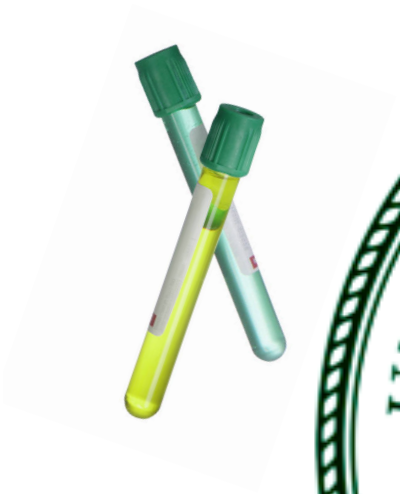
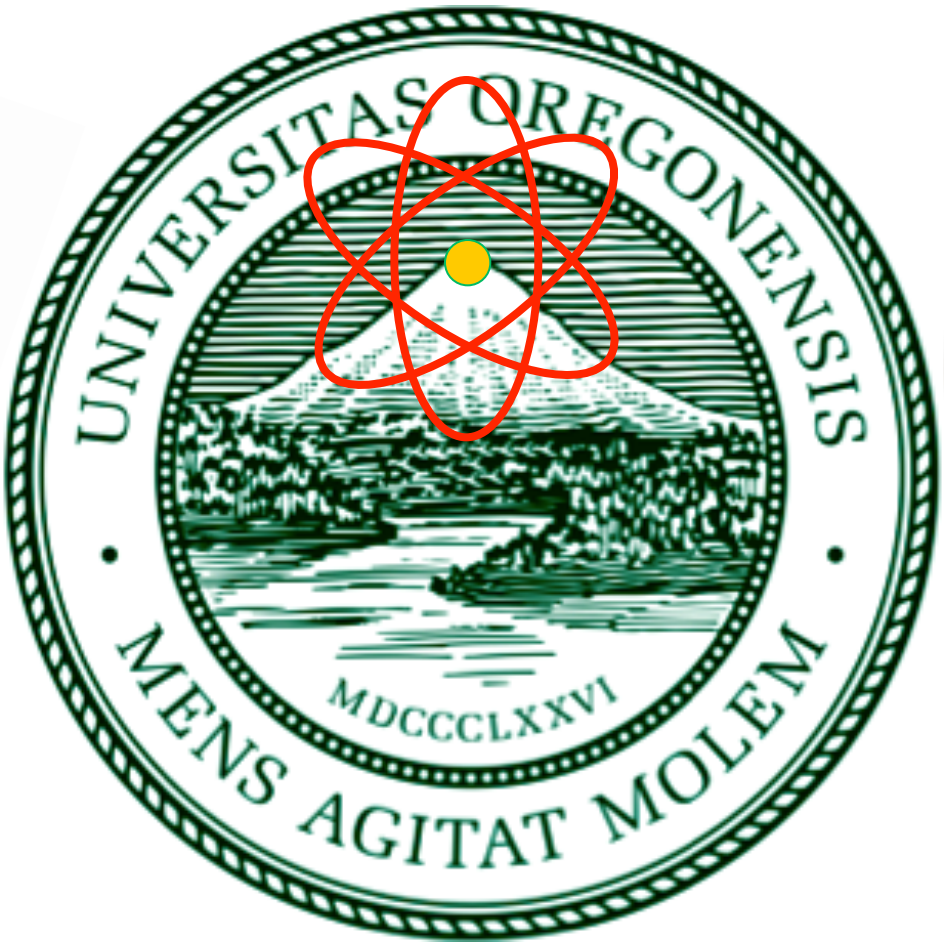
Acid/Base Chemistry:

Laboratory Notebook

University of Oregon





Name:_____

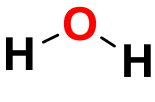
Date:_____

Favorite Element:_____

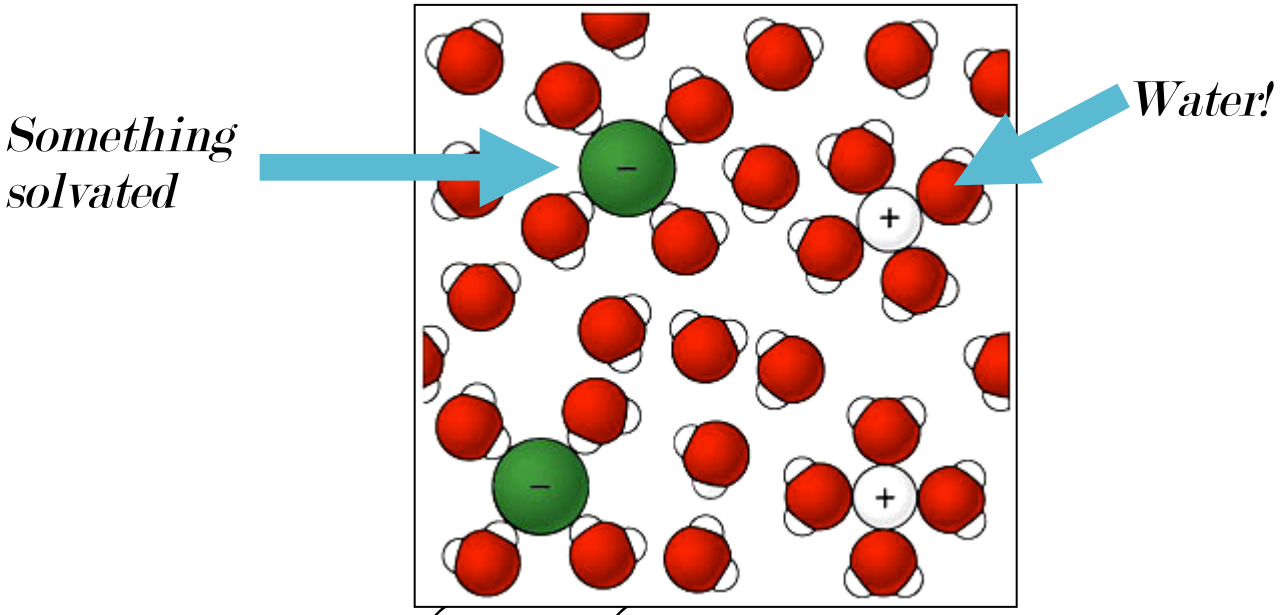
What are Acids and Bases?

Before discussing acids and bases, let's talk about water!

All substances are made up of millions of tiny atoms. These atoms form small groups called molecules. In water, for example, each molecule is made up of two hydrogen atoms and one oxygen atom. The formula for a molecule of water is H_2O. "H" means hydrogen, "2" means 2 hydrogen atoms, and the "O" means oxygen.

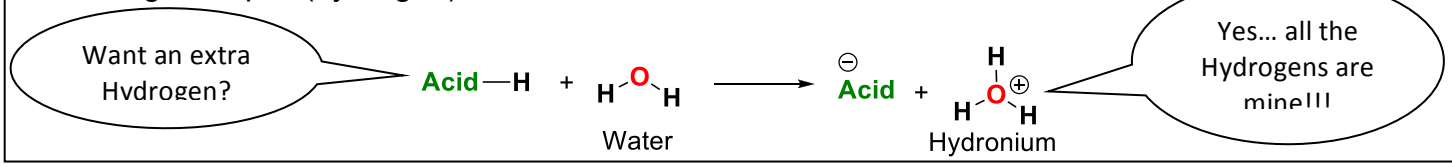
H_2O =  = a water molecule = 

When things are added to water and dissolve, they form a **solution**.

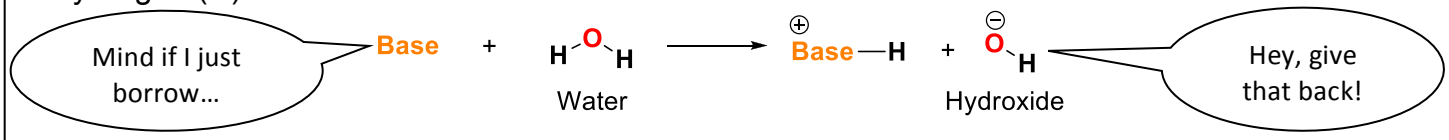


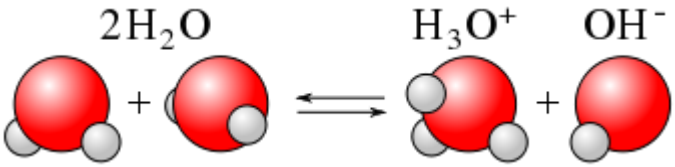
Acids and Bases in Water

We know something is an **acid** by the way it reacts with water. When an acid is poured into water, it gives up H (hydrogen) to the water.



When a **base** is poured into water, it gives up OH (hydroxide) to the water, usually by stealing a Hydrogen (H) from the water.

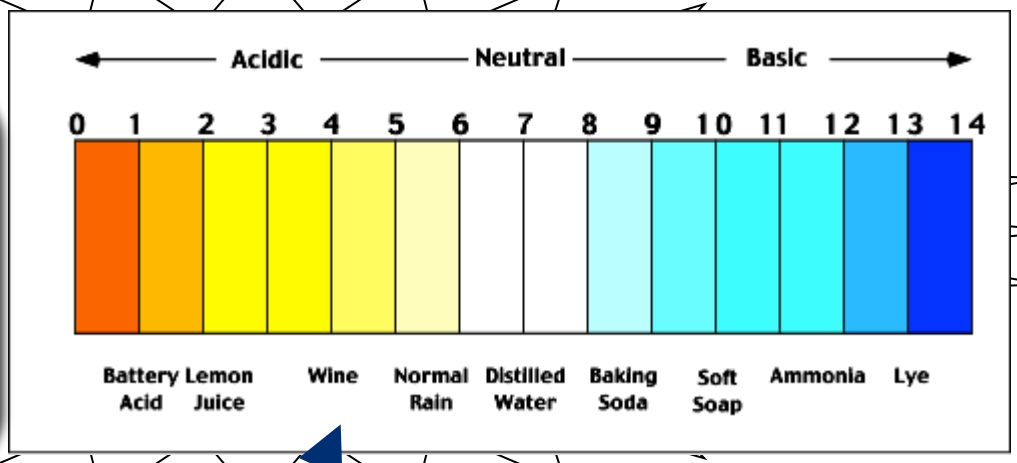




So, something that is acidic has lots of extra H_3O^+ floating around in solution. Something that is basic has lots of extra OH^- floating around in solution. OH^- and H_3O^+ react very differently to other chemicals, *so knowing whether you have an acid or base is important*.

How can we tell?

The way we can tell how basic (OH^-) or acidic (H_3O^+) water is, we use something called the **pH scale**.

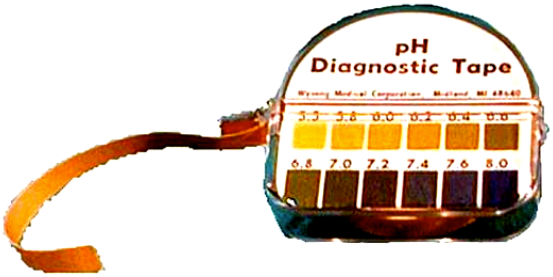


The pH Scale

- ⇒ The pH scale is a measure of the **hydronium ion** concentration (H_3O^+).
- ⇒ It spans from a **pH of 0** (very acidic, lots of H_3O^+) to a **pH of 14** (very basic, lots of OH-).
- ⇒ If something is neither an acid nor a base, it is called **neutral**, it has a **pH of 7**, or the middle of the pH scale.

So, any pH number **greater than 7** is considered a **base** and any **pH number less than 7** is considered an **acid**. 0 is the strongest acid and 14 is the strongest base.

An **indicator** is a special type of compound that changes color as the pH of a solution changes, thus telling us the pH of the solution. This is how scientists like you can tell whether something is an acid or a base



Experiment 1: pH of Common Chemicals

Objective: *Use pH strips to see if you can tell whether each house-hold chemical is an acid, a base, or neither (neutral).*

Instructions:

- Tear up a pH strip into smaller squares.
- For each household chemical, add a few drops or a small amount into a plastic beaker and fill half way with water. Mix lightly.
- Take one drop and place it on a small square of pH strip.
- Use the color change to determine what the pH of the chemical is.
- Record your observations in the table below:

Common Chemical	Color of pH strip	Acid, Base, or Neutral	pH
Water			
Coca-cola			
Soda Water			
Sugar			
Salt			
Lemon Juice			
Baking Soda			
Aspirin			
Alka-seltzer			
Windex (ammonia)			
Soap			
Milk of Magnesia			
Tums			
Vinegar			

Questions:

Why did we test water first? _____

_____

_____

Which chemicals are acids? _____

_____

_____

Which chemicals are bases? _____

_____

_____

Which chemicals should react? (hint: acids and bases react with each other)

_____

_____

_____

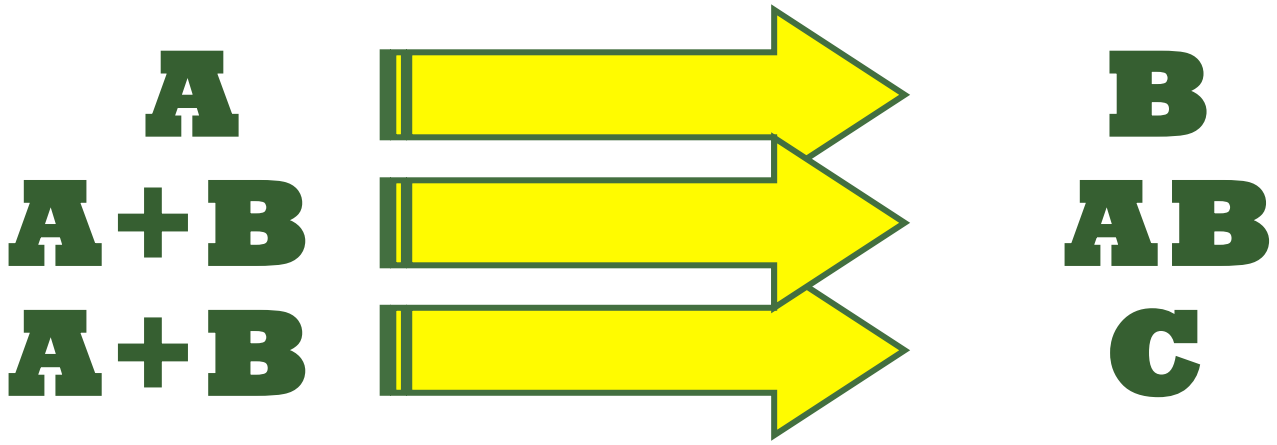
ACID/BASE REACTIONS

How do we use acids and bases?

Chemical Reactions!

A chemical reaction is transformation of one set of chemical substances to another. Chemical reactions can be either **spontaneous**, requiring no input of energy, or **non-spontaneous**, requiring energy. Classically, chemical reactions involve the movement of electrons to make and break chemical bonds between atoms!

Chemical reactions are described by chemical equations.



Is it a chemical change or a physical change?

Some changes can be classified as either a chemical or physical change.

- Burning paper is a chemical change
- Tearing paper is a physical change

How can you tell if a chemical reaction has happened?

What happens when an acid and base react?

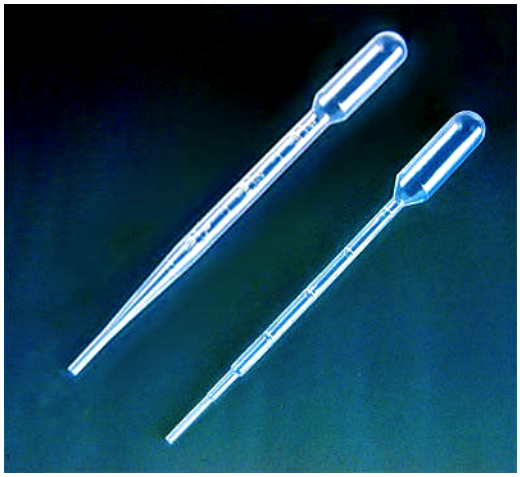
A proton is transferred from the acid to the base. If the base is water, it is protonated to make the hydronium ion, H_3O^+.

H A + B → H B + A

(Acid) (Base) (Products)

A neutralization reaction is a reaction in which an acid and a base react to form a salt and water.

What happens when $H_2PO_4^-$ reacts with different bases? Lets Experiment!



1st: Using a pipet, measure an amount of acid. To know how much you have measured, look at the markings on the side of the pipet (if they do not align, make your best guess.)

2nd: Add that amount to your solution of base.

3rd: Look and see if there is an indicator for a chemical reaction.

Base H_2O	Color Change	Precipitate	Temperature Change	Gas Bubbles
What happened?				

Did a Reaction Happen?

How much acid did you add before the reaction finished?

Base $Ca(OAc)_2$	Color Change	Precipitate	Temperature Change	Gas Bubbles
What happened?				

Did a Reaction Happen?

How much acid did you add before the reaction finished?

Base HPO_4^{2-}	Color Change	Precipitate	Temperature Change	Gas Bubbles
What happened?				

Did a Reaction Happen?

How much acid did you add before the reaction finished?

Base $NaHCO_3$	Color Change	Precipitate	Temperature Change	Gas Bubbles
What happened?				

Did a Reaction Happen?

How much acid did you add before the reaction finished?

Base $NaCl$	Color Change	Precipitate	Temperature Change	Gas Bubbles
What happened?				

Did a Reaction Happen?

How much acid did you add before the reaction finished?

Base $CuCl_2$	Color Change	Precipitate	Temperature Change	Gas Bubbles
What happened?				

Did a Reaction Happen?

How much acid did you add before the reaction finished?

Base HPO_4^{2-}	Color Change	Precipitate	Temperature Change	Gas Bubbles
What happened?				

Did a Reaction Happen?

How much acid did you add before the reaction finished?

Carbonate and Carbon dioxide

Carbon dioxide (CO_2) is a gas that can be used in several different ways. Today we will be doing two different experiments that explore CO_2 and acidity!

What is dry ice?

Dry ice is CO_2 that has been cooled until frozen solid. At -70 °F (VERY COLD) dry ice **sublimes** from a solid to a gas!

What are soda bubbles?

Soda bubbles are formed from CO_2 that has been dissolved in water. The CO_2 that is dissolved into water reacts with the water to form **carbonic acid**, H_2CO_3. This technique is called carbonation!

$$CO_2 + H_2O \longrightarrow H_2CO_3$$

GAS WATER ACID

What will happen to the pH?

As more CO_2 dissolves in the water, it becomes more **acidic**. Chemicals called **buffers** can be added to water that help resist acidity changes. Buffers are critical to human life by holding our bodies constant at pH = 7.4.

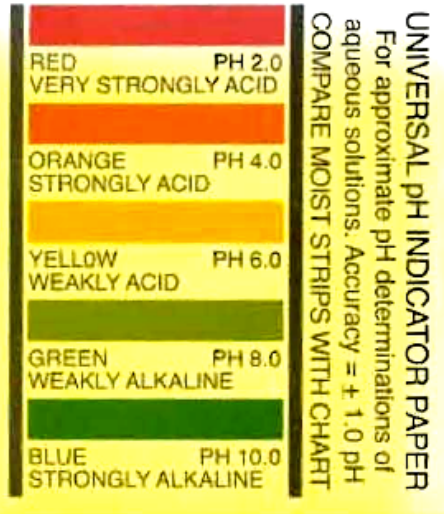
CO_2 EXPERIMENT 1: DRY ICE AND ACIDITY

Purpose: *To see how the pH of water changes over time with the addition of dry ice.*

Procedure: **Dry Ice in Normal Water**

1. Every 30 seconds put a drop of water on your pH paper using plastic dropper.
2. Write down the color you observe in the table below.
3. After 5 minutes, use the color-coded key to determine the pH at each time.
4. Then plot your data, putting time on the x-axis and pH on the y-axis.

Time (minutes)	Color (Blue, Green, Yellow)	pH
0.0		
0.5		
1.0		
1.5		
2.0		
2.5		
3.0		
3.5		
4.0		
4.5		
5.0		

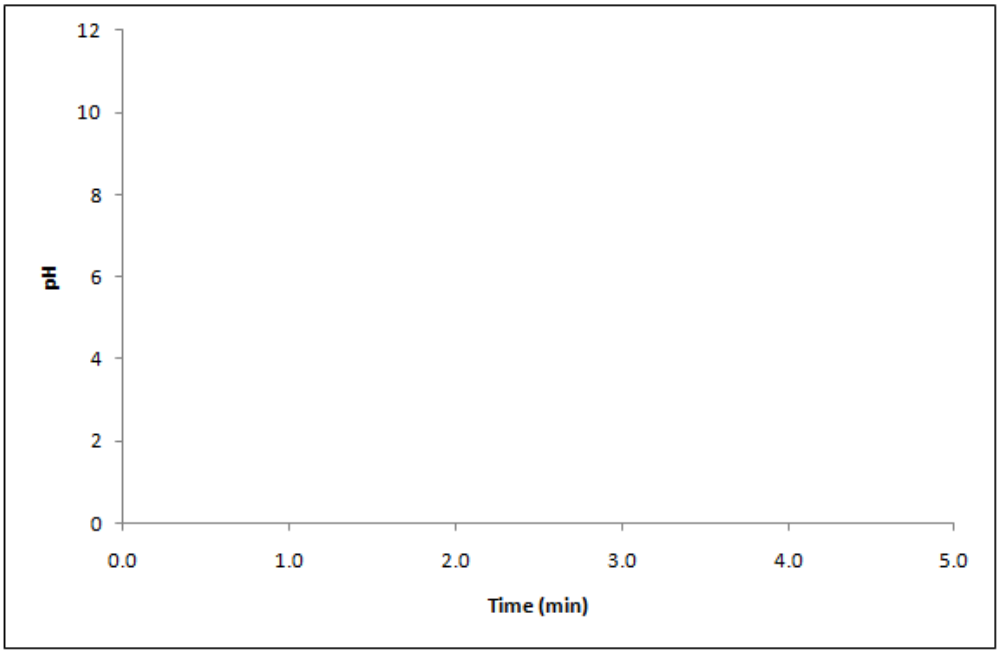


Dry Ice in Buffered Water

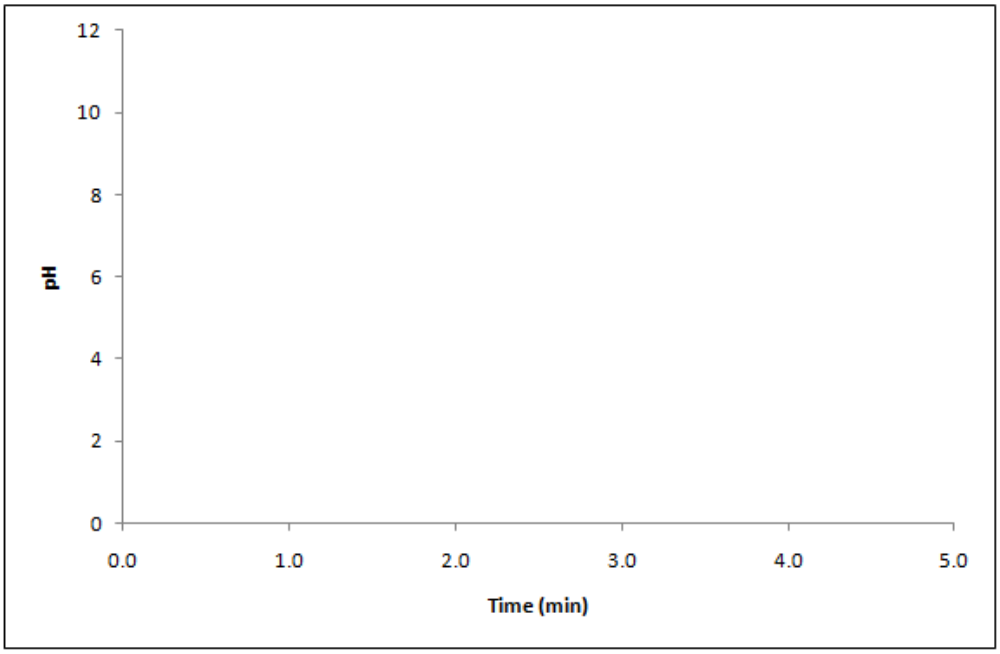
Time (minutes)	Color (Blue, Green, Yellow)	pH
0.0		
0.5		
1.0		
1.5		
2.0		
2.5		
3.0		
3.5		
4.0		
4.5		
5.0		

Results:

Dry Ice in Water

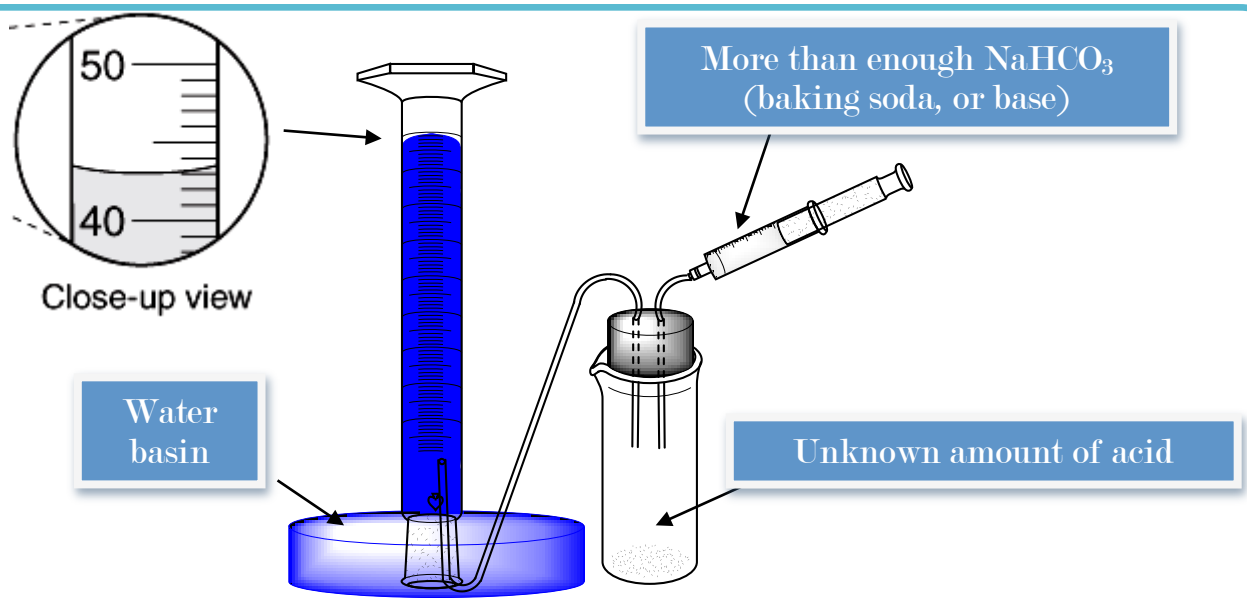


Dry Ice in Buffered Water

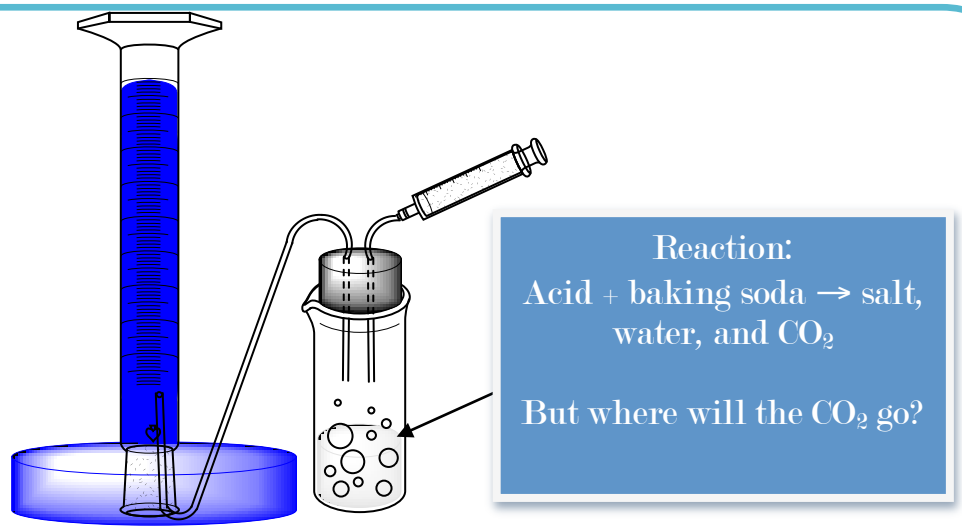


CO_2 EXPERIMENT II: HOW MUCH ACID?!

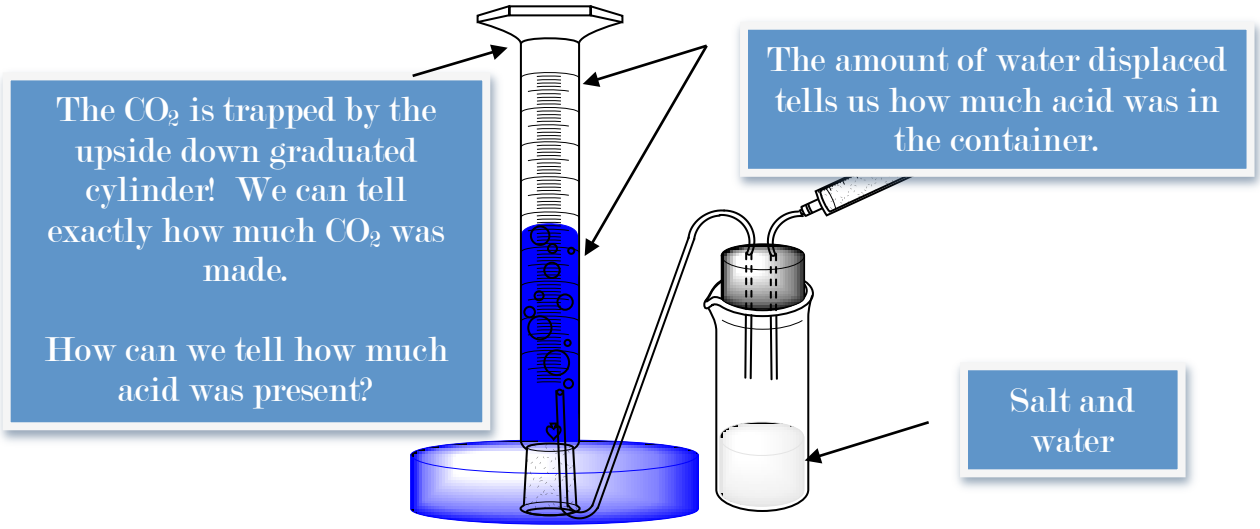
SETUP



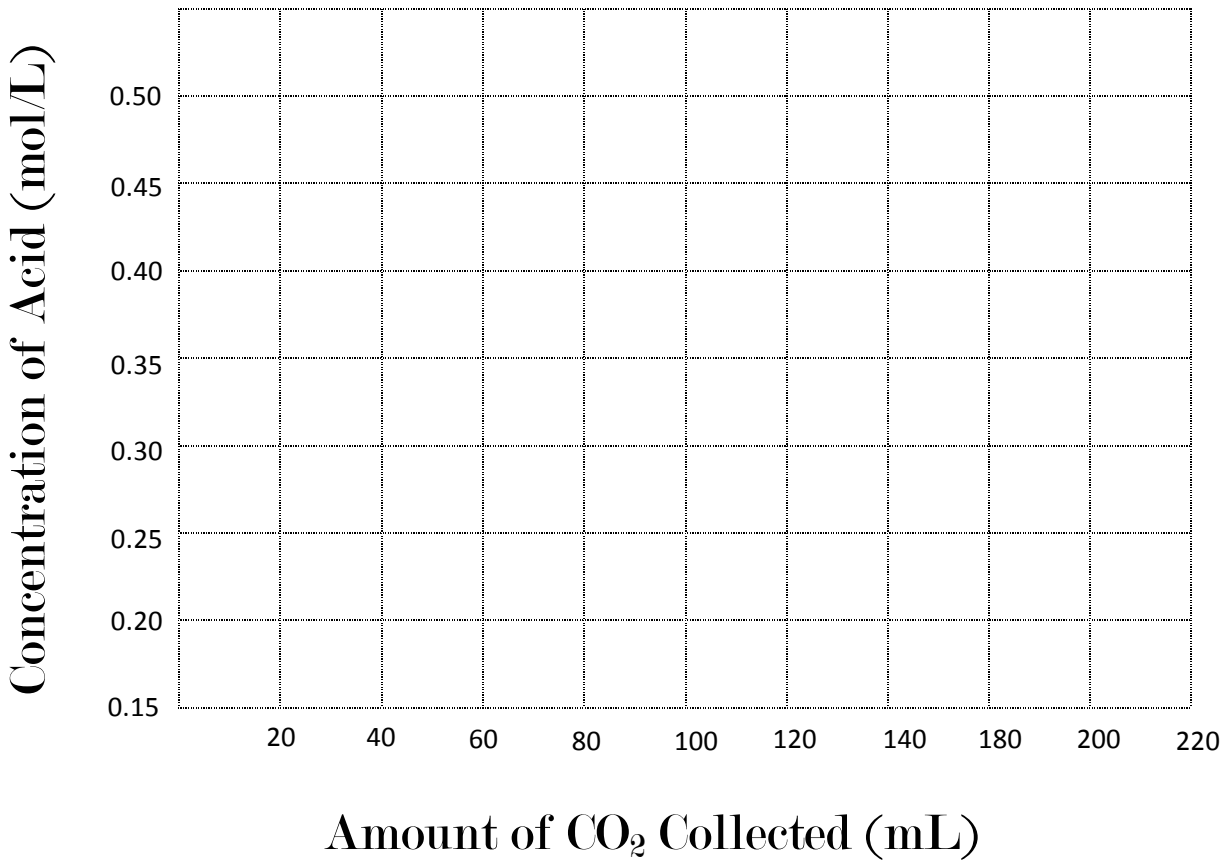
REACTION



RESULT



Unknown Concentration of Acid in Vinegar



Trial 1:
Concentration: 0.45 mol/L

Starting Volume:_____

Ending Volume:_____

Volume Displaced(Ending volume – starting volume – 10): _____

Trial 2:
Concentration: 0.23 mol/L

Starting Volume:_____

Ending Volume:_____

Volume Displaced(Ending volume – starting volume – 10): _____

Trial 3:
Concentration: 0.15 mol/L

Starting Volume:_____

Ending Volume:_____

Volume Displaced(Ending volume – starting volume – 10): _____

Trial 4:
Concentration:_____

Starting Volume:_____

Ending Volume:_____

Volume Displaced(Ending volume – starting volume – 10): _____

Observations and Notes:

PERIODIC TABLE *of the* ELEMENTS