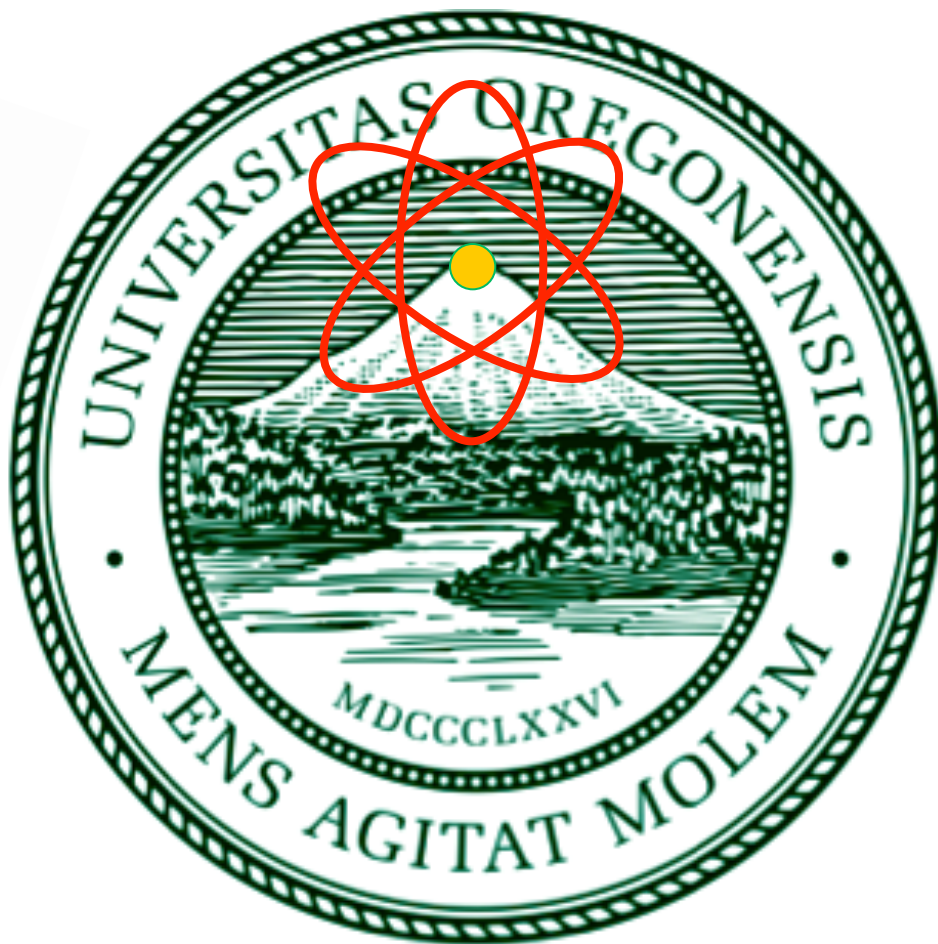


# Acid/Base Chemistry:

## Laboratory Notebook

University of Oregon

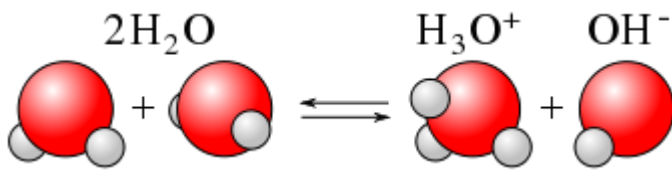


Name: \_\_\_\_\_

Date: \_\_\_\_\_

Favorite Element: \_\_\_\_\_



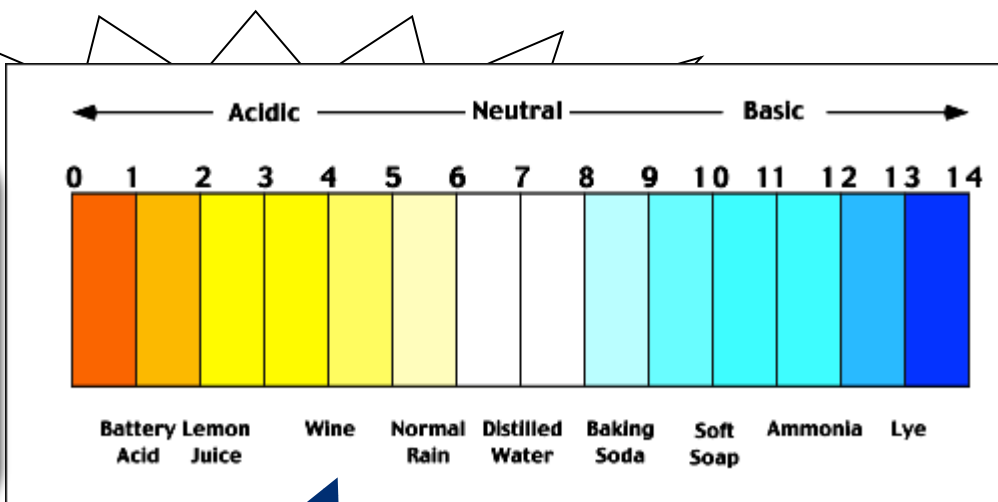


So, something that is acidic has lots of extra  $\text{H}_3\text{O}^+$  floating around in solution. Something that is basic has lots of extra  $\text{OH}^-$  floating around in solution.  $\text{OH}^-$  and  $\text{H}_3\text{O}^+$  react very differently to other chemicals, so *knowing whether you have an acid or base is important.*



## How can we tell?

The way we can tell how basic ( $\text{OH}^-$ ) or acidic ( $\text{H}_3\text{O}^+$ ) water is, we use something called the **pH scale**.



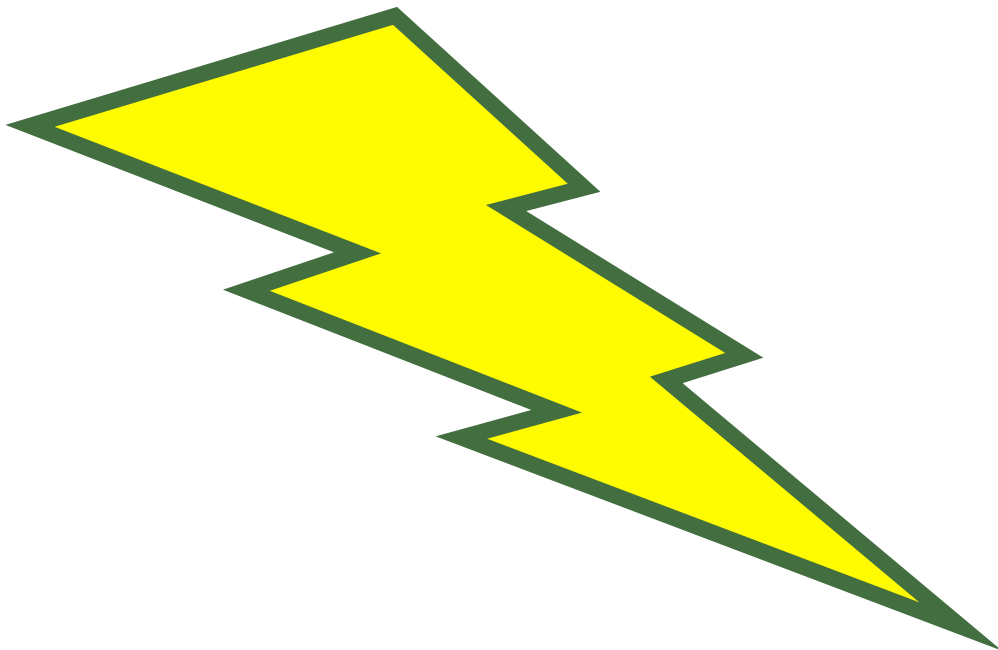
## The pH Scale

- ⇒ The pH scale is a measure of the **hydronium ion** concentration ( $\text{H}_3\text{O}^+$ ).
- ⇒ It spans from a **pH of 0** (very acidic, lots of  $\text{H}_3\text{O}^+$ ) to a **pH of 14** (very basic, lots of  $\text{OH}^-$ ).
- ⇒ 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)  
\_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_

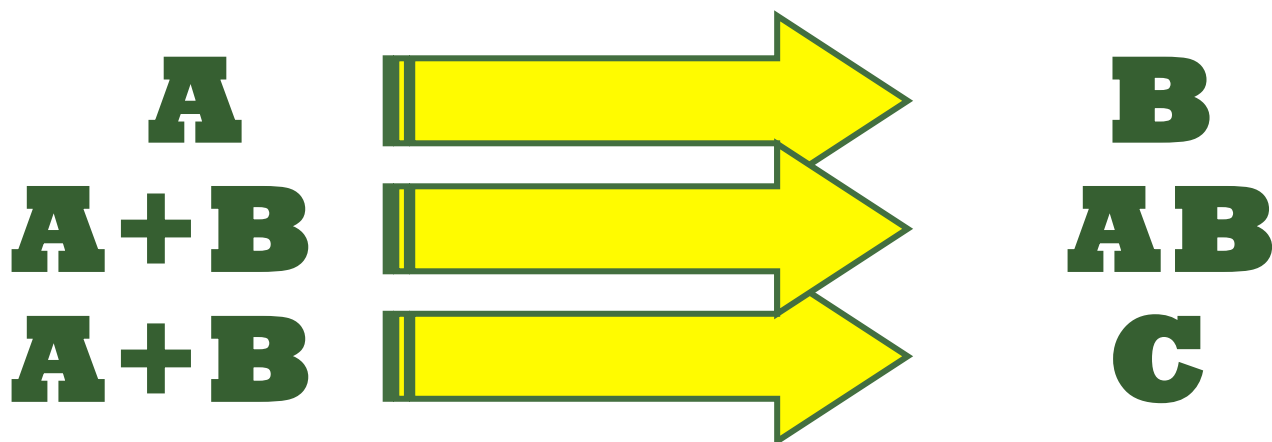
# ACID/BASE REACTIONS

## 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,  $\text{H}_3\text{O}^+$ .



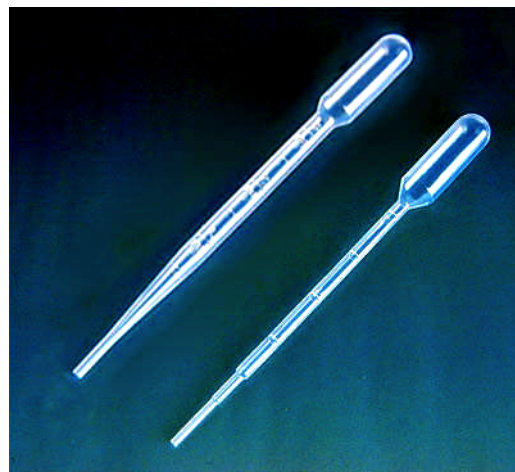
A neutralization reaction is a reaction in which an acid and a base react to form a salt and water.

## What happens when $\text{H}_2\text{PO}_4^-$ reacts with different bases? Lets Experiment!

**1<sup>st</sup>:** 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.)

**2<sup>nd</sup>:** Add that amount to your solution of base.

**3<sup>rd</sup>:** Look and see if there is an indicator for a chemical reaction.



Base <b><math>\text{H}_2\text{O}</math></b>	Color Change	Precipitate	Temperature Change	Gas Bubbles
What happened?				

Did a Reaction Happen?

How much acid did you add before the reaction finished?

Base <b><math>\text{Ca}(\text{OAc})_2</math></b>	Color Change	Precipitate	Temperature Change	Gas Bubbles
What happened?				

Did a Reaction Happen?

How much acid did you add before the reaction finished?

Base <b><math>\text{HPO}_4^{2-}</math></b>	Color Change	Precipitate	Temperature Change	Gas Bubbles
What happened?				

Did a Reaction Happen?

How much acid did you add before the reaction finished?

Base <b>NaHCO<sub>3</sub></b>	Color Change	Precipitate	Temperature Change	Gas Bubbles
What happened?				

Did a Reaction Happen?

How much acid did you add before the reaction finished?

Base <b>NaCl</b>	Color Change	Precipitate	Temperature Change	Gas Bubbles
What happened?				

Did a Reaction Happen?

How much acid did you add before the reaction finished?

Base <b>CuCl<sub>2</sub></b>	Color Change	Precipitate	Temperature Change	Gas Bubbles
What happened?				

Did a Reaction Happen?

How much acid did you add before the reaction finished?

Base <b>HPO<sub>4</sub><sup>2-</sup></b>	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<sub>2</sub>) is a gas that can be used in several different ways. Today we will be doing two different experiments that explore CO<sub>2</sub> and acidity!

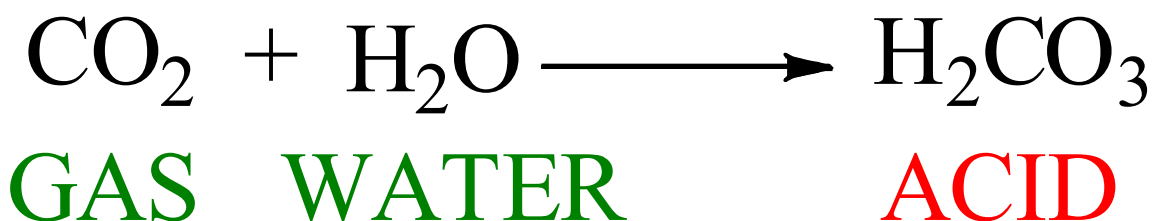
## What is dry ice?

Dry ice is CO<sub>2</sub> 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<sub>2</sub> that has been dissolved in water. The CO<sub>2</sub> that is dissolved into water reacts with the water to form **carbonic acid**, H<sub>2</sub>CO<sub>3</sub>. This technique is called carbonation!



## What will happen to the pH?

As more CO<sub>2</sub> 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<sub>2</sub> EXPERIMENT 1: DRY ICE AND ACIDITY

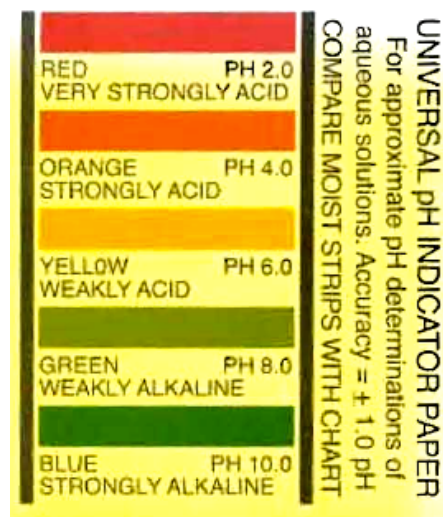
**Purpose:** *To see how the pH of water changes over time with the addition of dry ice.*

## Procedure:

### Dry Ice in Normal Water

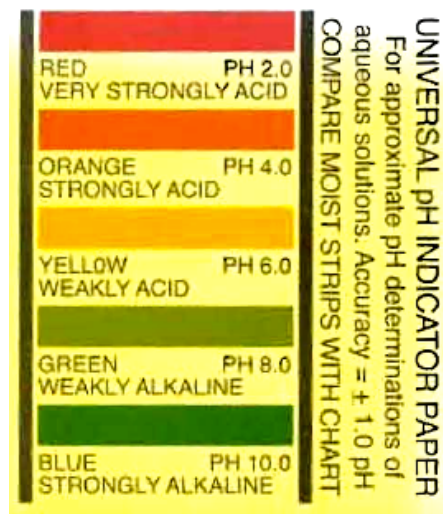
1. Every 30 seconds put a drop of water on your pH paper using plastic dropper.
2. Write down the color you observe in the table below.
3. After 5 minutes, use the color-coded key to determine the pH at each time.
4. Then plot your data, putting time on the x-axis and pH on the y-axis.

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		



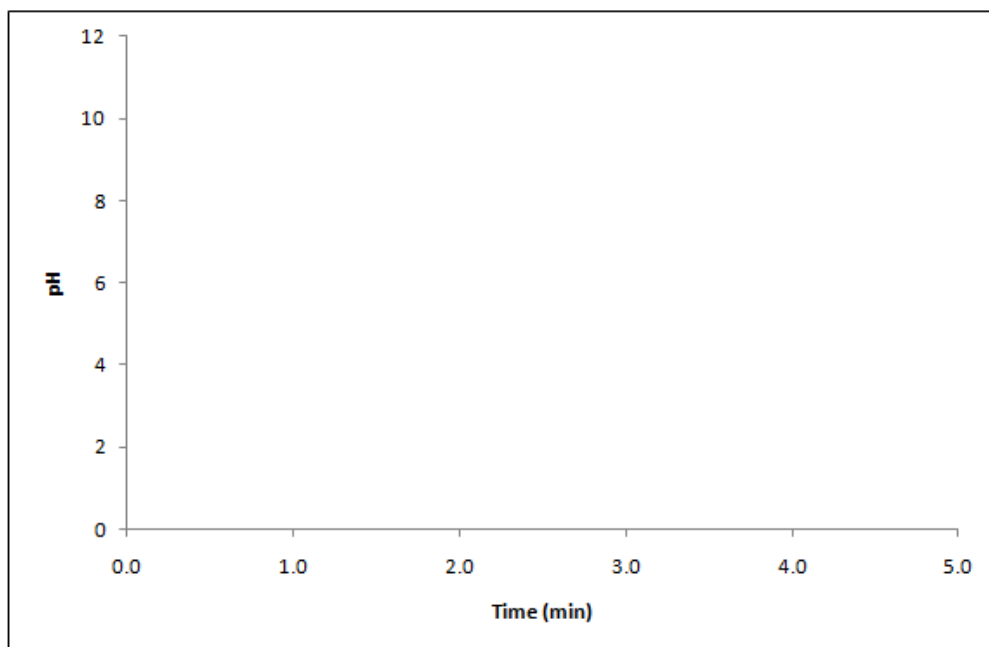
### Dry Ice in Buffered Water

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		

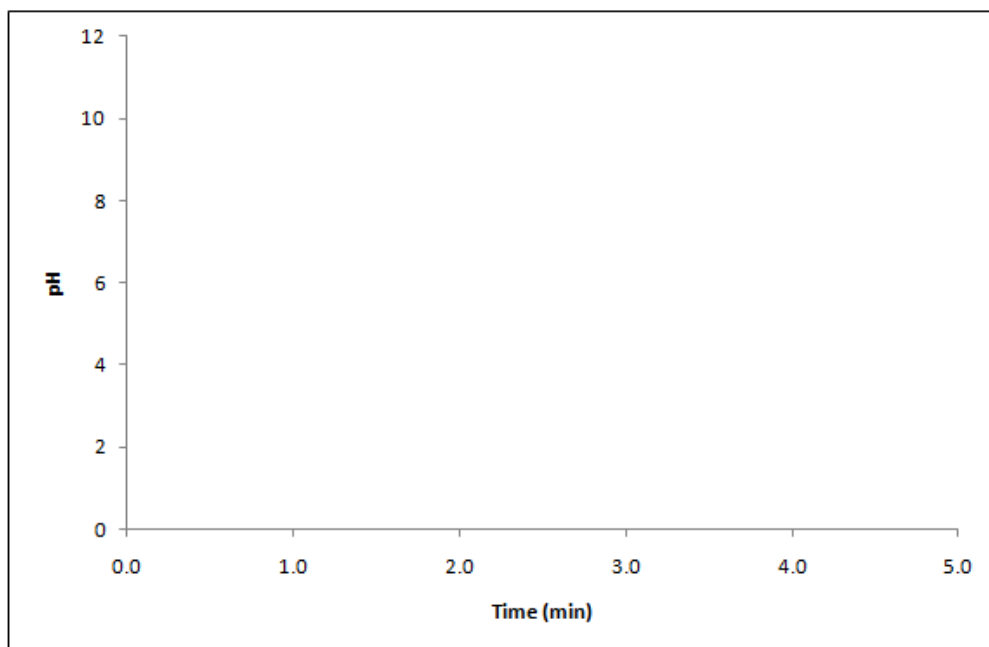


## Results:

### Dry Ice in Water

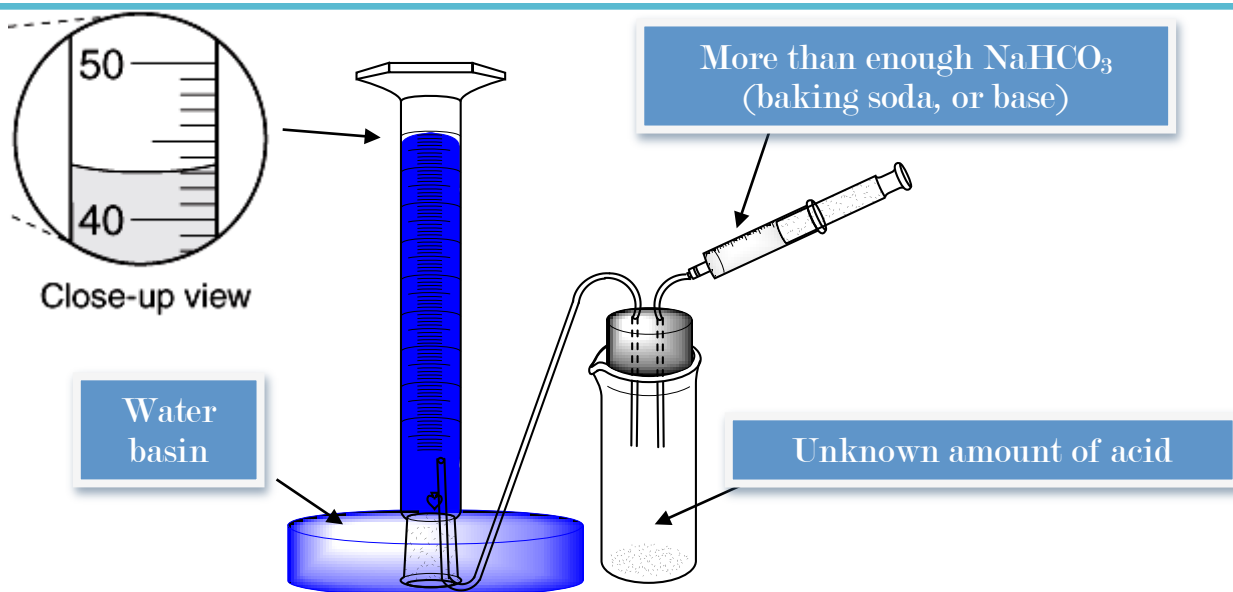


### Dry Ice in Buffered Water

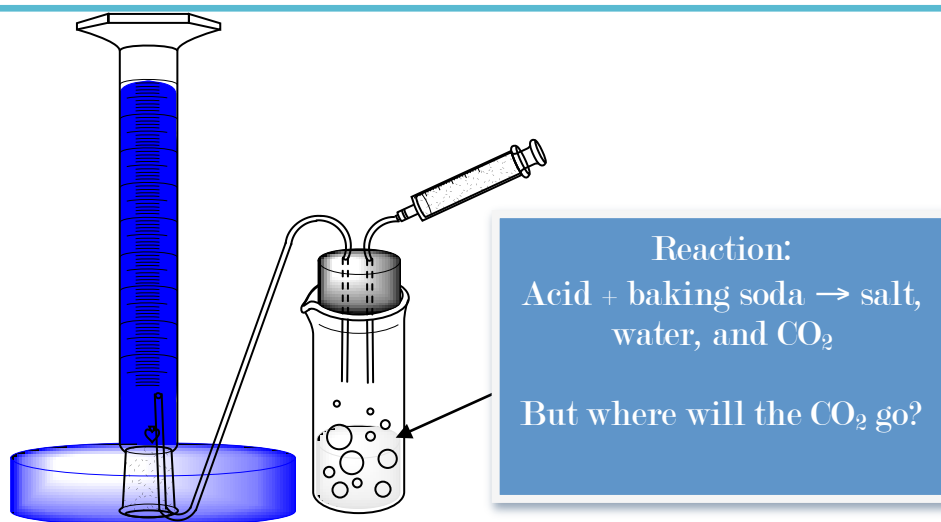


# CO<sub>2</sub> EXPERIMENT II: HOW MUCH ACID?!

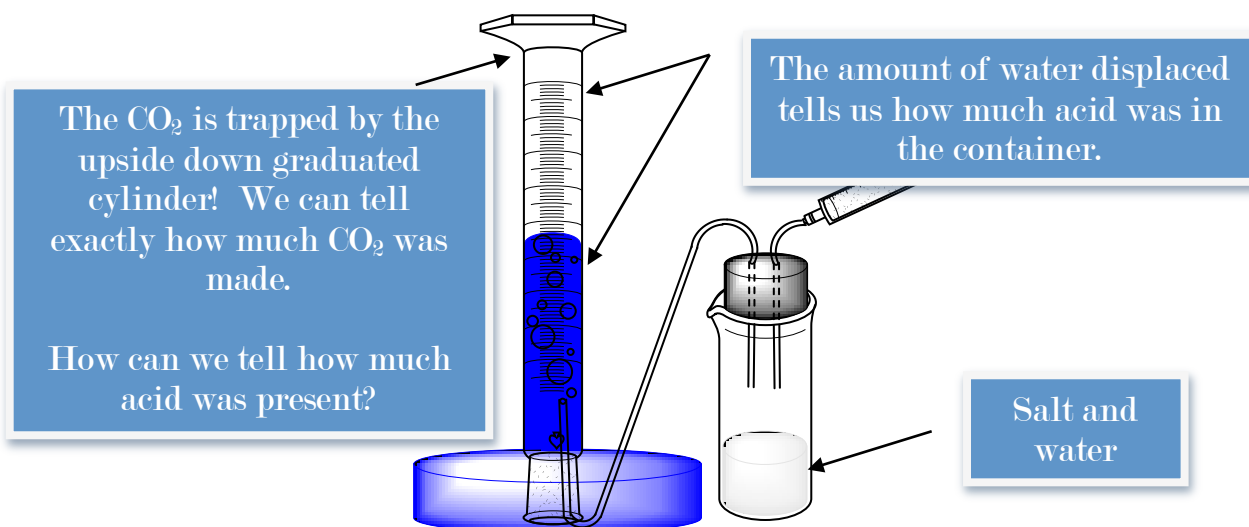
## SETUP



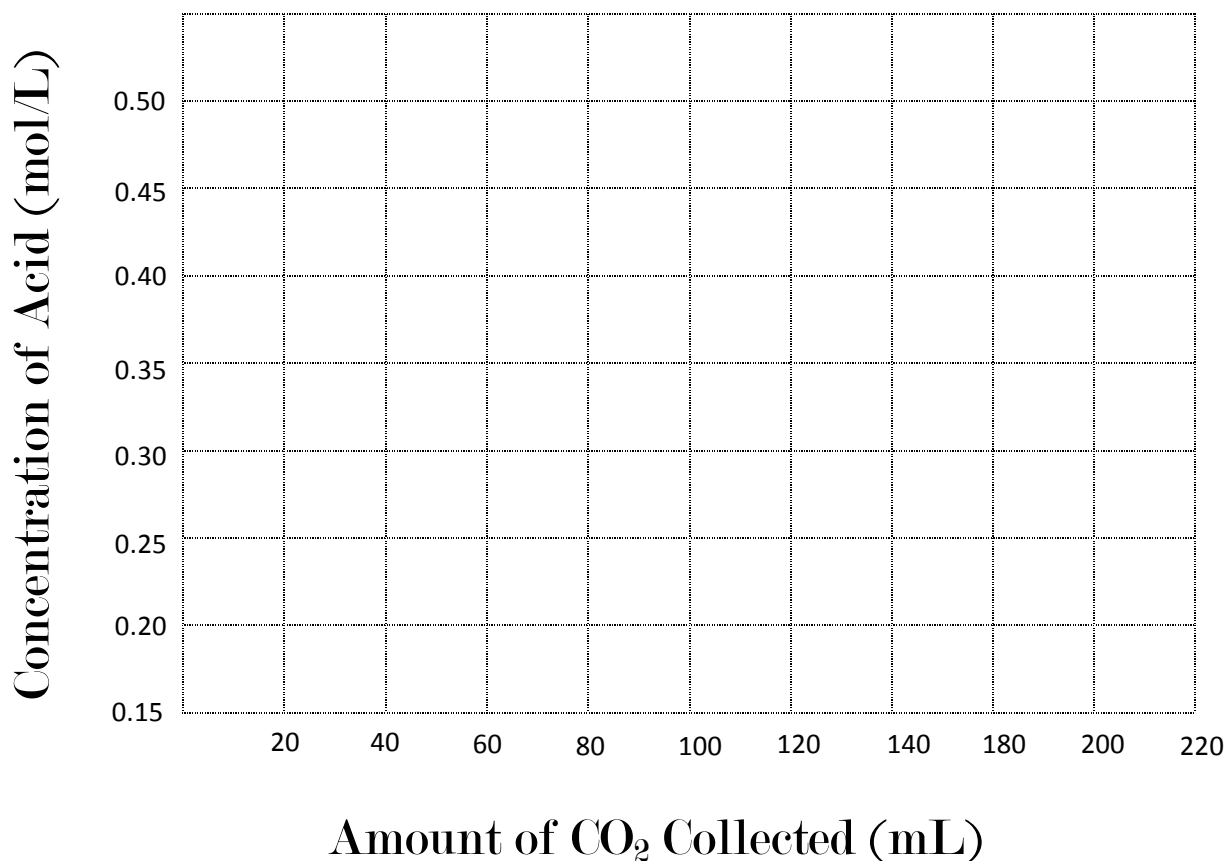
## REACTION



## 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 3:**

Concentration: 0.15 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 4:**

Concentration: \_\_\_\_\_

Starting Volume: \_\_\_\_\_

Ending Volume: \_\_\_\_\_

Volume Displaced(Ending volume – starting  
volume – 10): \_\_\_\_\_

## Observations and Notes:

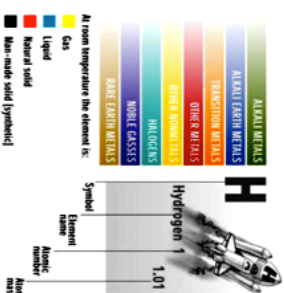
# PERIODIC TABLE of the ELEMENTS

DMITRI MENDELEEV (1834 - 1907)

The Russian chemist, Dmitri Mendeleev, was the first to observe that if elements were listed in order of atomic mass, they showed regular (periodical) repeating properties. He formulated his discovery in a periodic table of elements, now regarded as the backbone of modern chemistry.

The crowning achievement of Mendeleev's periodic table lay in his prophecy of then, undiscovered elements. In 1869, the year he published his periodic classification, the elements gallium, germanium and scandium were unknown. Mendeleev left spaces for them in his table and even predicted their atomic masses and other chemical properties. Six years later, gallium was discovered and his predictions were found to be accurate. Other discoveries followed and their chemical behaviour matched that predicted by Mendeleev.

This remarkable man, the youngest in a family of 17 children, has left the scientific community with a classification system so powerful that it became the cornerstone in chemistry teaching and the prediction of new elements ever since. In 1955, element 101 was named after him Md. Mendeleevium.



1 H Hydrogen 1.01	2 He Helium 4.00	3 Li Lithium 6.94	4 Be Beryllium 9.01	5 B Boron 10.81	6 C Carbon 12.01	7 N Nitrogen 14.01	8 O Oxygen 16.00	9 F Fluorine 18.99	10 Ne Neon 20.18
11 Na Sodium 22.99	12 Mg Magnesium 24.31	13 Al Aluminum 26.98	14 Si Silicon 28.09	15 P Phosphorus 30.97	16 S Sulfur 32.06	17 Cl Chlorine 35.45	18 Ar Argon 39.95	19 K Potassium 39.10	20 Ca Calcium 40.08
21 Sc Scandium 44.96	22 Ti Titanium 47.88	23 V Vanadium 50.94	24 Cr Chromium 52.00	25 Mn Manganese 54.94	26 Fe Iron 55.85	27 Co Cobalt 58.93	28 Ni Nickel 58.69	29 Cu Copper 63.55	30 Zn Zinc 65.38
31 Ga Gallium 69.72	32 Ge Germanium 72.64	33 As Arsenic 74.92	34 Se Selenium 78.96	35 Br Bromine 79.90	36 Kr Krypton 83.80	37 Rb Rubidium 85.47	38 Sr Strontium 87.62	39 Y Yttrium 88.91	40 Zr Zirconium 91.22
41 Nb Niobium 92.91	42 Mo Molybdenum 95.94	43 Tc Technetium 98.91	44 Ru Ruthenium 101.07	45 Rh Rhodium 102.91	46 Pd Palladium 106.42	47 Ag Silver 107.87	48 Cd Cadmium 112.41	49 In Indium 114.82	50 Sn Tin 118.71
51 Sb Antimony 121.76	52 Te Tellurium 127.60	53 I Iodine 126.90	54 Xe Xenon 131.29	55 Ba Barium 137.33	56 La Lanthanum 138.91	57 Ce Cerium 140.12	58 Pr Praseodymium 140.91	59 Nd Neodymium 144.24	60 Pm Promethium 144.91
61 Sm Samarium 150.36	62 Eu Europium 151.96	63 Gd Gadolinium 157.25	64 Tb Terbium 158.93	65 Dy Dysprosium 162.50	66 Ho Holmium 164.93	67 Er Erbium 167.26	68 Tm Thulium 168.93	69 Yb Ytterbium 173.05	70 Lu Lutetium 174.97
71 Hf Hafnium 178.49	72 Ta Tantalum 180.95	73 W Tungsten 183.85	74 Re Rhenium 186.21	75 Os Osmium 190.23	76 Ir Iridium 192.22	77 Pt Platinum 195.08	78 Au Gold 196.97	79 Hg Mercury 200.59	80 Tl Thallium 204.38
81 Pb Lead 207.20	82 Bi Bismuth 208.98	83 Po Polonium 209	84 At Astatine 210	85 Rn Radon 222	86 Fr Francium 223	87 Ra Radium 226	88 Ac Actinium 227	89 Th Thorium 232.04	90 Pa Protactinium 231.04
91 U Uranium 238.03	92 Np Neptunium 237.05	93 Pu Plutonium 244.06	94 Am Americium 243.06	95 Cm Curium 247.07	96 Bk Berkelium 247.07	97 Cf Californium 251.08	98 Es Einsteinium 252.08	99 Fm Fermium 257.10	100 Md Mendelevium 258.10
101 No Nobelium 259.10	102 Lr Lawrencium 260.10	103 Ac Actinium 227.03	104 Th Thorium 232.04	105 Pa Protactinium 231.04	106 U Uranium 238.03	107 Np Neptunium 237.05	108 Pu Plutonium 244.06	109 Am Americium 243.06	110 Cm Curium 247.07
111 Bk Berkelium 247.07	112 Cf Californium 251.08	113 Es Einsteinium 252.08	114 Fm Fermium 257.10	115 Md Mendelevium 258.10	116 No Nobelium 259.10	117 Lr Lawrencium 260.10	118 Ac Actinium 227.03	119 Th Thorium 232.04	120 Pa Protactinium 231.04
121 U Uranium 238.03	122 Np Neptunium 237.05	123 Pu Plutonium 244.06	124 Am Americium 243.06	125 Cm Curium 247.07	126 Bk Berkelium 247.07	127 Cf Californium 251.08	128 Es Einsteinium 252.08	129 Fm Fermium 257.10	130 Md Mendelevium 258.10
131 No Nobelium 259.10	132 Lr Lawrencium 260.10	133 Ac Actinium 227.03	134 Th Thorium 232.04	135 Pa Protactinium 231.04	136 U Uranium 238.03	137 Np Neptunium 237.05	138 Pu Plutonium 244.06	139 Am Americium 243.06	140 Cm Curium 247.07
141 Bk Berkelium 247.07	142 Cf Californium 251.08	143 Es Einsteinium 252.08	144 Fm Fermium 257.10	145 Md Mendelevium 258.10	146 No Nobelium 259.10	147 Lr Lawrencium 260.10	148 Ac Actinium 227.03	149 Th Thorium 232.04	150 Pa Protactinium 231.04
151 U Uranium 238.03	152 Np Neptunium 237.05	153 Pu Plutonium 244.06	154 Am Americium 243.06	155 Cm Curium 247.07	156 Bk Berkelium 247.07	157 Cf Californium 251.08	158 Es Einsteinium 252.08	159 Fm Fermium 257.10	160 Md Mendelevium 258.10
161 No Nobelium 259.10	162 Lr Lawrencium 260.10	163 Ac Actinium 227.03	164 Th Thorium 232.04	165 Pa Protactinium 231.04	166 U Uranium 238.03	167 Np Neptunium 237.05	168 Pu Plutonium 244.06	169 Am Americium 243.06	170 Cm Curium 247.07
171 Bk Berkelium 247.07	172 Cf Californium 251.08	173 Es Einsteinium 252.08	174 Fm Fermium 257.10	175 Md Mendelevium 258.10	176 No Nobelium 259.10	177 Lr Lawrencium 260.10	178 Ac Actinium 227.03	179 Th Thorium 232.04	180 Pa Protactinium 231.04
181 U Uranium 238.03	182 Np Neptunium 237.05	183 Pu Plutonium 244.06	184 Am Americium 243.06	185 Cm Curium 247.07	186 Bk Berkelium 247.07	187 Cf Californium 251.08	188 Es Einsteinium 252.08	189 Fm Fermium 257.10	190 Md Mendelevium 258.10
191 No Nobelium 259.10	192 Lr Lawrencium 260.10	193 Ac Actinium 227.03	194 Th Thorium 232.04	195 Pa Protactinium 231.04	196 U Uranium 238.03	197 Np Neptunium 237.05	198 Pu Plutonium 244.06	199 Am Americium 243.06	200 Cm Curium 247.07



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