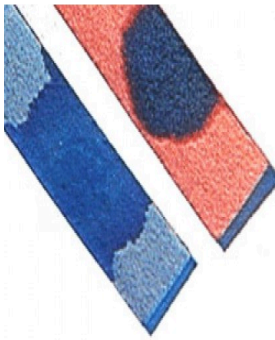
D. Acids and Bases

Materials around us can be classified as acids, bases or neutral. In this section we will cover their characteristics and general uses.

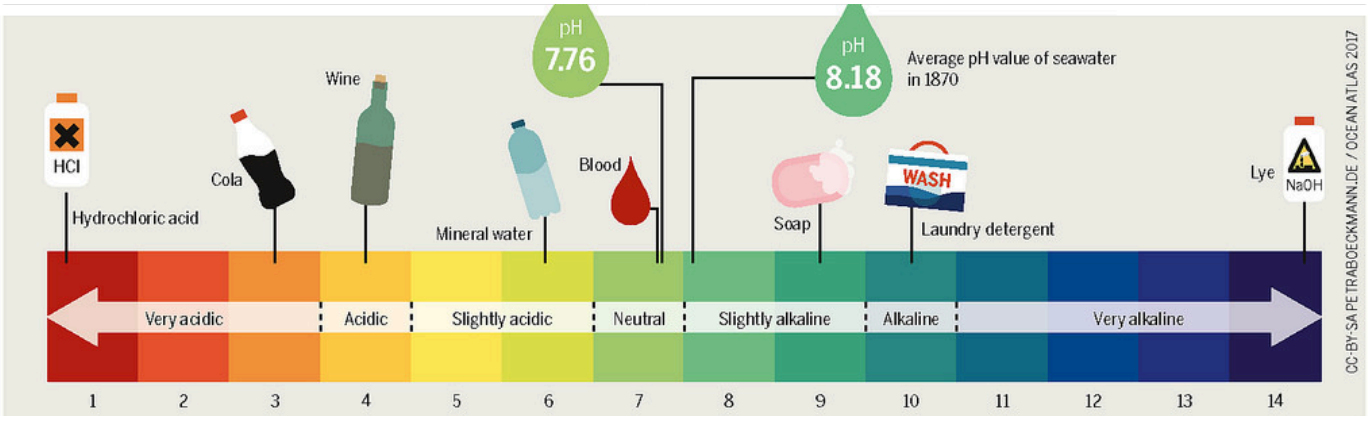
1. Acids

- Taste sour (Citric acid in lemons, limes, citrus fruits)
- Turns blue litmus paper red
- Reacts with metals to produce H^+ gas
- Can neutralize a base
- Conducts electricity as solutions
- Supply hydrogen ions (H^+) to the solution
- Has a pH less than 7 (strong acids are close to 0)
- Uses: Car batteries (Sulfur acid), pickling (Vinegar/Acetic acid)
- Pop (Phosphoric acid), fertilizers (Nitric acid), Digestion (Hydrocholic acid)



2. Bases

- Taste bitter or chalky (tums, rolaids)
- Turns red litmas paper blue
- React with fat to produce soap
- Can neutralize an acid
- Conducts electricity as a solution
- Supply hydroxide ions (OH^-) to the reaction
- Have a pH more than 7 (Strong bases are close to 14)
- Uses: drain cleaner (Sodium Hydroxide)
- Window cleaner (ammonia), bleach (Sodium hypochlorite)



Note: **pH** means the "power or potential of Hydrogen"

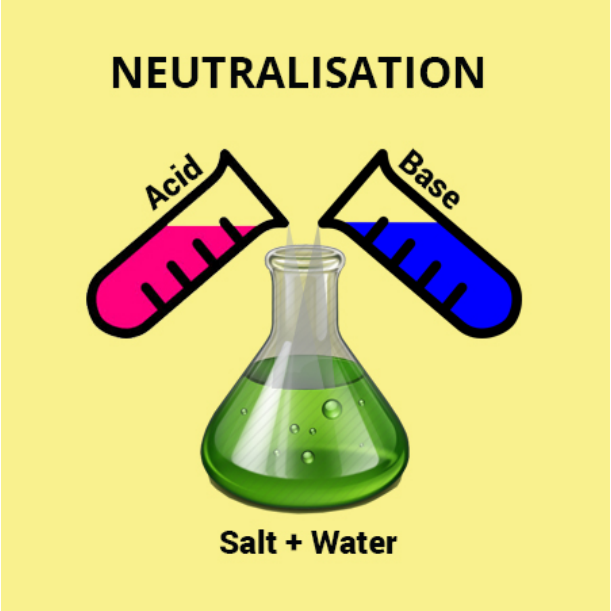
Neutralization Reactions

When acids and bases are combined together a neutralization reaction occurs.

Strong acids have a high concentration of Hydrogen ions (H^+).

Strong bases have a high concentration of Hydroxide ions (OH^-) .

During the neutralization, the excess hydrogen ions (H+) are absorbed by the hydroxide ions (OH^-).



$H^+ + OH^- \rightarrow H_2O$ (water)

This brings the pH more towards the middle (7 or neutral) and these reactions are often called "water forming".

Examples:

1. $HCl_{(aq)} + NaOH_{(aq)} \rightarrow NaCl_{(aq)} + H_2O_{(l)}$

   (hydrochloric acid + sodium hydroxide → sodium chloride + water)

Acid + Base → Salt + Water

2. $H_2SO_{4\,(aq)} + 2\ NH_4OH_{(aq)} \rightarrow (NH_4)_2SO_{4\,(aq)} + 2\ H_2O_{(l)}$

   (sulfuric acid + ammonium hydroxide → ammonium sulfate + water)

Acid + Base → Salt + Water

In general, neutralization reactions take the form of:

Acids + Bases → Salt + Water

E. Indicators

Acids and bases are used for very different roles, so it is important to be able to identify acids and bases. Taste and feel are not always safe tests so we need to use something else to identify acids from bases. In the chemistry classroom we use indicators for this purpose.

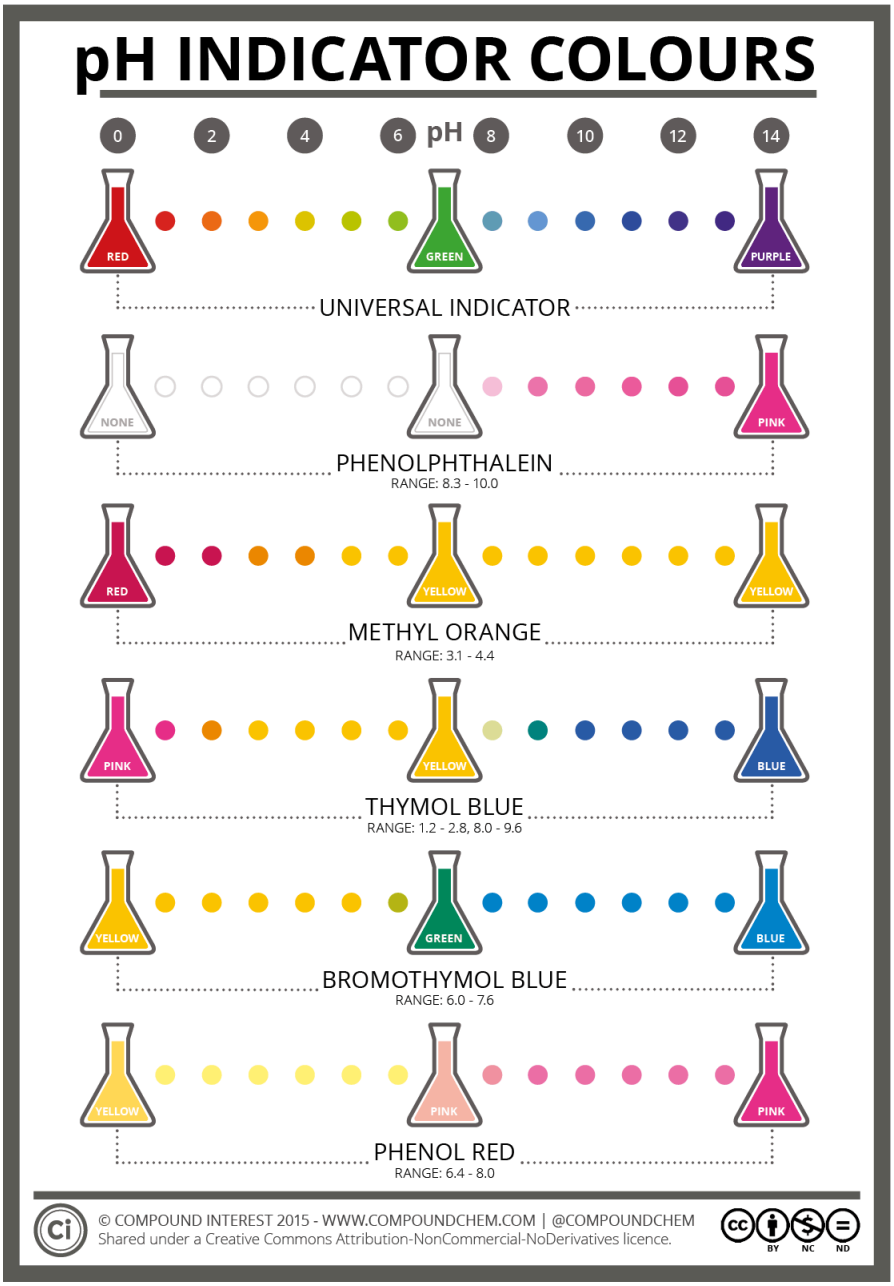
def'n: **indicator**

A chemical that changes colour to indicate the pH of a solution

One of the best known indicators is litmus paper; which is extracted from plants. Litmus will turn red in an acid and blue in a base, but this gives us some limitations. If we want to know a more exact pH we must use something else.

pH paper has become a popular test as it changes different colors ranging from red to dark blue based on the different pH.

We also have some chemical indicators that will change colors based on pH changes.



F. Acid Rain

One of the more important issues surrounding the environment is acid rain. In this section we will look at what it is, how it forms and what we can do to deal with it.

Def'n: **acid precipitation (acid rain)**

Rain or snow containing acid compounds from the air

The oxides that react with water are produced in large amounts by human beings. When we burn organic compounds we are producing large amounts of CO_2, as well as small amounts of NO_x and SO_3. Because these emissions are carried by the wind, acid precipitation can be deposited a long way from the original source of these oxides.

Each of the following below are reactants that create a type of acid that could result in acid rain.

Reactants	Product(s)	Acid Name
$SO_{2\ (g)} + H_2O_{(l)} \rightarrow$	$H_2SO_{3\ (aq)}$	Sulfurous Acid
$SO_{3\ (g)} + H_2O_{(l)} \rightarrow$	$H_2SO_{4\ (aq)}$	Sulfic Acid
$2NO_{2\ (g)} + H_2O_{(l)} \rightarrow$	$HNO_{2\ (aq)}$ or $HNO_{3\ (aq)}$	Nitrous Acid or Nitric Acid
$CO_{2\ (g)} + H_2O_{(l)} \rightarrow$	$H_2CO_{3\ (aq)}$	Carbonic Acid

The normal pH range of rain is 5-6 (slightly acidic), whereas acid rain can be as low as 1.7 - 3.0.

Use the internet to answer the following questions:

1. How does acid rain damage aquatic ecosystems (streams, rivers, lakes, marshes)?

2. How does acid rain affect soil?

3. How does acid rain affect forests and trees?

4. How does acid rain affect structures, monuments and buildings (especially marble)?

5. One way of restoring the pH balance in an acidified lake is called "liming". Explain what this process is and how it works.

There have been multiple agreements put in place to attempt to decrease the amount of pollution being released into the atmosphere. In 1996, Canada and the United States agreed to reduce industrial exhaust emissions by 10 percent by the year 2000.

In 1997 the United Nations Framework Convention on Climate Change (UNFCCC) was held in Kyoto, Japan. This convention had more than 150 nations attend and adopt an international treaty on controlling and reducing emissions. In 2005, the Kyoto protocol, which simply stated that emissions of CO_2, methane (CH_4), nitrous oxide, hydrofluorocarbons (HFCs), perfluorocarbons (PFCs) and sulphur hexafluorides would be diminished took effect in over 192 countries; Canada (-6%), United States (-7%) and China did not agree to the terms.

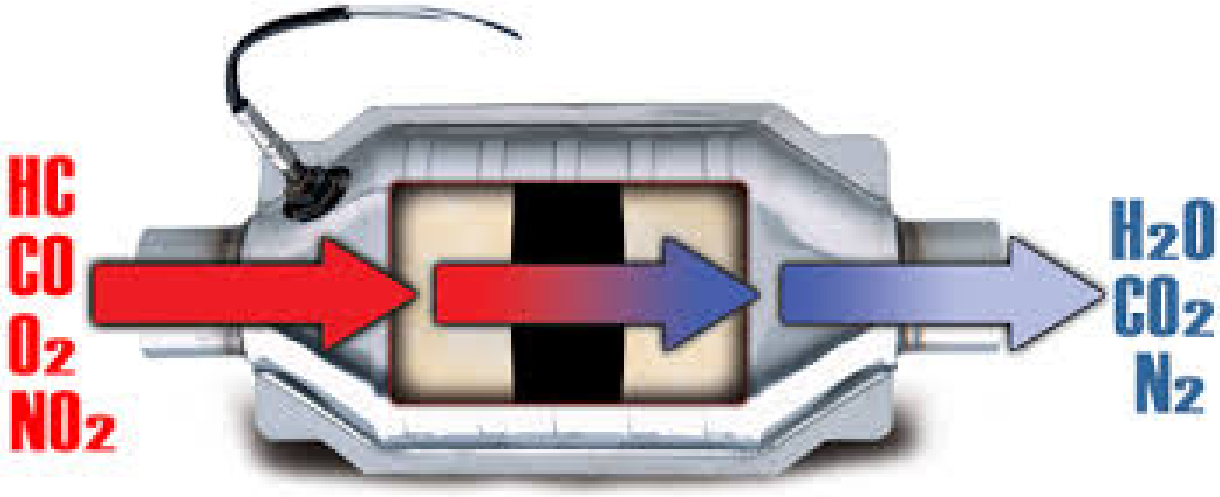
In 2015, the Paris Agreement was negotiated and agreed upon; it states that each country must determine, plan and regularly report on the contribution that it undertakes to decrease global warming. As of November of 2018, 195 members (including the United States) have signed the agreement. President Trump publicly announced in August of 2017 his plan to withdraw from the agreement at the earliest possible date (November 2020). On November 4, 2020 the US formally withdrew from the Paris Agreement but on January 20, 2021 newly elected President Biden signed back into the Agreement.

G. Controlling Harmful Emissions

The best way to control harmful emissions is to reduce the amount of oxides that are emitted into the air. Eliminating cars, factories and home heating is not practical, so other ways have been created to reduce the oxides produced.

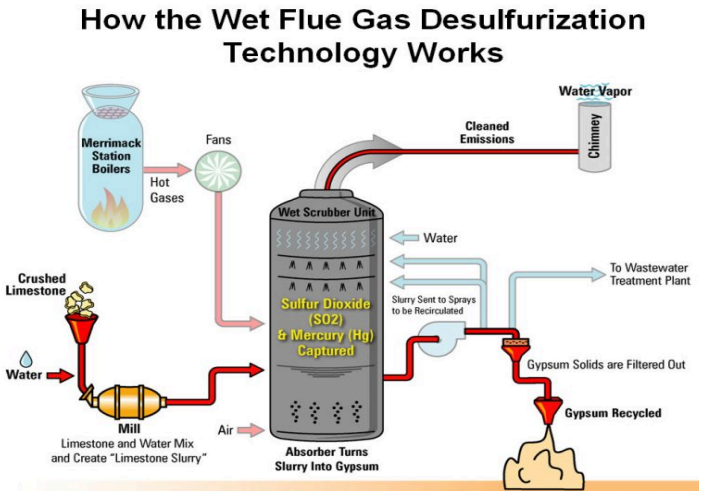
1. **Catalytic Converters**

- placed in Vehicles Exhaust Systems to make the combustion (burning) of fuels complete. Therefore fewer Nitrogen oxides (NO_X) from vehicles get into the air.
- contains a ceramic or honeycomb structure coated with metals such as Platinum or palladium. The surfaces get very hot and the large area helps make the burning complete.
- in order to work properly the converters must be hot.



2. Scrubbers

- emissions from factories and power plants produce large amounts of Sulfur oxides (SO_X) due to the burning of coal (particularly the type that is high in sulfur).
- scrubbers are installed to capture the oxides before they are released into the air.



- chemical reactions change these oxides into usable products.

Note: Both catalytic converters and scrubbers decrease the amount of sulfur and nitrogen oxides that are emitted to the air. This:

- Reduces air pollution and smog
- Reduces the formation of acid rain