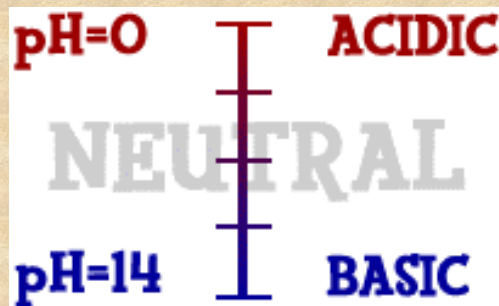


Acid – Base Reactions

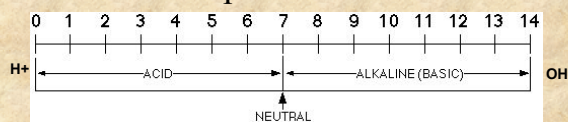


The pH Scale



- **Neutral** is the pH at which there are equal numbers of $[H^+]$ ions and $[OH^-]$ ions.
- **pH** is the negative logarithm of the hydrogen ion concentration.

pH scale



- $pH = -\log [H^+]$ or $[H^+] = 10^{-pH}$
- In a neutral solution $[H^+] = 10^{-7} M$, and the $pH = 7$
The math: $-\log 10^{-7} = -(-7) = 7$
- Values for pH **decline** as $[H^+]$ **increase**
- Most biological fluids have pH values in the range of 6 to 8
- However, human stomach acid can reach the pH of 2

A strong acid will react with a strong base

- Determine which is the limiting reagent.
- Find the final concentration of the excess reagent.
- The final concentration of the excess reagent will determine the pH.
DONE.

A strong acid will react with a conjugate base.

- The reaction will go to completion.
- Determine which is the limiting reagent.
- If conjugate base is limiting, there is excess strong acid. This determines the pH. DONE.
- If the strong acid is limiting, there will be excess conjugate base and the pH is determined for the buffer (produced from the conjugate base and the weak acid)

A strong base will react with a weak acid.

- The reaction will go to completion
- Determine the limiting reagent.
- If the weak acid is limiting, there is excess strong base. This determines the pH.
DONE
- If the strong base is limiting, there will be excess weak acid and the pH is determined for the buffer (produced from the conjugate base and the weak acid).

Acid vs. Base

- | | |
|--|--|
| <ul style="list-style-type: none"> Increases hydrogen ion concentration of a solution H⁺ H⁺ donor | <ul style="list-style-type: none"> Reduces hydrogen ion concentration of a solution OH⁻ H⁺ acceptor |
|--|--|

Brønsted-Lowry Style

- Reactions that proceed to a large extent:
 - $\text{HCl} + \text{H}_2\text{O} \rightleftharpoons \text{H}_3\text{O}^+ + \text{Cl}^-$
- HCl - is an acid, because it has a proton available to be transferred.
- H₂O - is a base, since it gets the proton that the acid lost.

Lewis Acid & Base

- The modern way to define a Lewis acid and base is a bit more concise
- Acid: an electron acceptor.
- Base: an electron donor.

pH VALUES OF SOME FAMILIAR SUBSTANCES



Common Acids

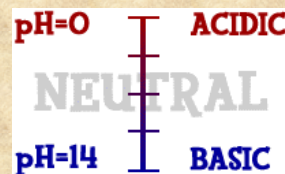
- | | | |
|------------------------|--|---------------|
| • Acetic acid | $\text{HC}_2\text{H}_3\text{O}_2$ | vinegar |
| • Acetylsalicylic acid | $\text{HC}_9\text{H}_7\text{O}_4$ | Aspirin |
| • Ascorbic acid | $\text{H}_2\text{C}_6\text{H}_6\text{O}_6$ | Vitamin C |
| • Citric acid | $\text{H}_3\text{C}_6\text{H}_5\text{O}_7$ | Lemon Juice |
| • Hydrochloric acid | HCl | gastric juice |
| • Sulfuric acid | H_2SO_4 | Battery acid |

Common Bases

- Ammonia NH_3 Household cleaners
- Calcium hydroxide Ca(OH)_2 Slacked Lime (mortar building)
- Magnesium hydroxide Mg(OH)_2 Milk of Magnesia (antacid & laxative)
- Sodium hydroxide NaOH Drain cleaners, oven cleaners

Acid & Base Indicators

- Litmus Paper
 - Test for acid, base or neutral substance
- pH Paper
 - Test for the pH of a substance



Acid Property #1

- All acids taste sour.
- Well known from ancient times: vinegar, sour milk and lemon juice.
- Aspirin tastes sour if you don't swallow it fast enough. Its scientific name is acetylsalicylic acid.

Base Property #1

- All bases taste bitter.
- Mustard tastes bitter.
- Many medicines, cough syrup is one, taste bitter.
- This is the reason cough syrups are advertised as having a “great grape taste”. Remember, a spoon full of sugar helps the medicine go down?

Property #2

- **Acid**
 - In 1663, Robert Boyle wrote that acids would make a blue vegetable dye called "litmus" turn red.
- **Base**
 - Bases are substances which will restore the original blue color of litmus after having been reddened by an acid.

Property #3

- **Acid**
 - Acids destroy the chemical properties of bases.
- **Base**
 - Bases destroy the chemical properties of acids.

Property #4

- **Acid**
 - Acids conduct an electric current.
- **Base**
 - Bases conduct an electric current.

This is a common property shared with salts, aka ionic compounds.

- Acids, bases and salts are grouped together into a category called **electrolytes**
 - meaning that a water solution will conduct an electric current
- **Non-electrolyte** solutions cannot conduct a current.
 - The most common example of this is sugar dissolved in water.

Property #5

Acid

- **Upon chemically reacting with an active metal, acids will evolve hydrogen gas (H_2).**
 - Some metals, like gold, silver or platinum are, for the most part, unreactive and it takes extreme conditions to get these "unreactive" metals to react.
- **Exception:** The alkali metals (**Group I**, Li to Rb), the alkaline earth metals (**Group II**, Be to Ra), as well as zinc and aluminum.
 - Bring the acid and the metal together at room temperature and reaction occurs.

Base Property #5

- Bases feel slippery, sometimes people say soapy.
 - This is because they dissolve the fatty acids and oils from your skin and this cuts down on the friction between your fingers as you rub them together.
 - In essence, the base is making soap out of you.

- Bases are involved in the production of soap!
 - In the early years of soap making, the soaps were very harsh on the skin and clothes due to the high **base** content.
 - Even today, people with very sensitive skin must sometimes use a non-soap based product for bathing.

Buffers

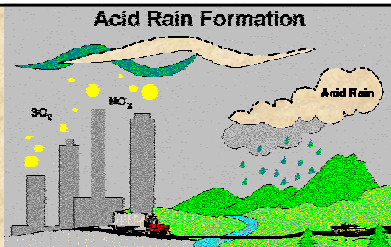
- Substances that prevent large and sudden changes in pH
- Combinations of H^+ donor and OH^- acceptors
- Significance-most organisms exist in a very narrow pH range (internally and externally)
- Slight changes in [] of pH can cause extreme danger in a **cell**



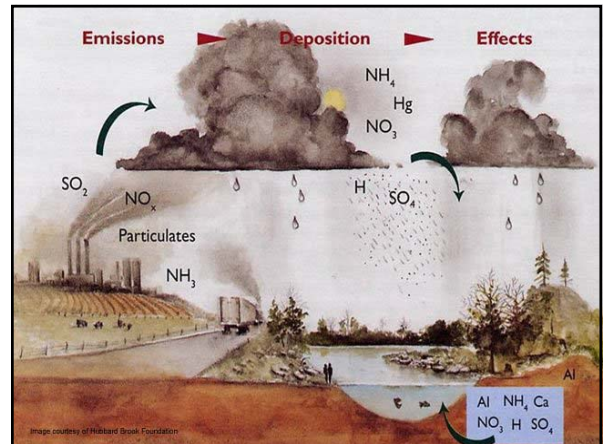
Acid Rain

- More and more rain is acidic
- Air pollution seems to be the reason
 - Rain as acidic as lemon juice fell in Wheeling, West Virginia
 - many lakes in New York State are dying from acid rain

- Acid rain starts out as regular rain.
- When rain falls through clouds of air pollution, it changes into a weak acid.
- This acid is strong enough to
 - kill trees
 - dissolve marble
 - kill whole lakes



- Caused by the presence of sulfur oxides and nitrogen oxides
- Burning of fossil fuels
- pH of 4.2 results in the death of aquatic life and changes the soil and its solubility



Pulp mill



EFFECTS OF ACID RAIN ON A FOREST



Acid rain damage to statuary, 1908 & 1968



Clean Air Legislation

- **Act of 1963** – 1st national legislation in the US aimed at air pollution
- Amendments in 1990
 - **Acid rain**
 - Urban Smog
 - Ozone protection
 - NO_x emissions: improved standards for sport utility vehicles (SUVs), personal watercraft, and other rec. activities.

pH indicator



Cabbage Indicator

