# Tutorial 13: Introduction to Acids and Bases, pH and Buffers

Goals:

- ✓ Be able to write an equation for a neutralization reaction.
- ✓ Understand the definition of an acid and a base, and be able to classify strong acids and bases.
- ✓ Understand the pH scale, and be able to convert between the pH of a solution and the hydronium ion concentration.
- ✓ Understand the basic components of a buffer solution.

# Characteristics of Acids and Bases

**Characteristics of Acids:**

- Sour taste
- Produce hydronium ions ($H_3O^+$) when dissolved in water by donation of $H^+$
- Acids produce positively and negatively charged ions in aqueous solution, thus acidic solutions conduct electricity and are **electrolytes**
- In the simplest definition, acids are H+ donors (Bronsted-Lowry definition)

**Characteristics of Bases:**

- Bitter taste
- Produce hydroxide ions ($OH^-$) when dissolved in water
- Bases produce positively and negatively charged ions in aqueous solution, thus basic solutions conduct electricity and are **electrolytes**
- In the simplest definition, bases are H+ acceptors (Bronsted-Lowry definition)

**Electrolyte:** An electrolyte is a substance that conducts electricity when dissolved in water. Anything that forms ions when dissolved in water is an electrolyte. The list that follows summarizes the type of substances that are electrolytes:

- Any soluble salt
- All acids
- All bases

**NOTE:** Molecular compounds (other than those that are acids and bases) and insoluble salts can not form ions in solution, and are therefore not electrolytes.

# Strong Versus Weak Acids and Bases

**Six Strong Acids:** Strong acids give up an H+ easily, and 100% ionize in water.

| ***Acid Name*** | ***Acid Formula*** |
|---|---|
| Hydrochloric Acid | HCl |
| Hydrobromic Acid | HBr |
| Hydroiodic Acid | HI |
| Sulfuric Acid | $H_2SO_4$ |
| Nitric Acid | $HNO_3$ |
| Perchloric Acid | $HClO_4$ |

**Strong Bases:** Strong bases have a high affinity for H+. The most common strong bases are hydroxides of the Group 1A and 2A metals.

# Neutralization Reactions

- An acid and a base will neutralize one another.
- For the reaction between an acid and a metal hydroxide base the products will be a salt and water.
- The salt is formed from the cation of the base combining with the anion of the acid, as shown in the following generic reaction.

$$HA(aq) + BOH(aq) \rightarrow BA\ (aq \text{ or } s) + H_2O\ (l)$$

**Example:**

$HCl(aq) + NaOH(aq) \rightarrow NaCl\ (aq) + H_2O\ (l)$

# pH Scale

- It is often more convenient to refer to the acidity of a solution in terms of pH.
- The pH of a solution is the negative base 10 logarithm of the $[H_3O^+]$.

$$pH = -\log[H_3O^+]$$

- This means that a one unit increase on the pH scale corresponds to a 10 fold decrease in the $[H_3O^+]$.
- A pH below 7 is acidic, a pH above 7 is basic, and a pH equal to 7 is neutral.

# Buffers

- A buffer is a solution that resists changes in pH when small amounts of acid or base are added.
- Buffers contain similar concentrations of a weak acid and its conjugate base.
  - Added acid is neutralized by the conjugate base present in the buffer solution.
  - Added base is neutralized by the weak acid present in the buffer solution.
- Bodily fluids maintain acid-base homeostasis through three main buffer systems: the carbonic acid/bicarbonate system, the dihydrogen phosphate/hydrogen phosphate system, and protein molecules that can function as an acid or a base.