Common (Arrhenius) Acids and Bases

Arrhenius Acids:

- **Produce hydrogen ion (H^+) or hydronium ion (H_3O^+) in water solution**
- React with bases to produce salt and water
- React with metals to produce salt and hydrogen gas
- Taste sour
- Turn litmus (an indicator) red
- Turn phenolphthalein (an indicator) colorless (clear)
- Conduct electricity in water solutions

Common (Arrhenius) Acids and Bases

Arrhenius Bases:

- **Produce hydroxide ions (OH^-) in water solution**
- React with acids to produce salt and water
- Taste bitter
- Turn litmus (an indicator) blue
- Turn phenolphthalein (an indicator) red
- Conduct electricity in water solution

Brϕnsted-Lowry Acids & Bases

A Bronsted-Lowry acid is a proton donor

- A proton is the same as $H^+_{(aq)}$ or $H_3O^+_{(aq)}$
- A hydrogen atom is one proton and one electron.
- A hydrogen ion is formed when a hydrogen atom loses one electron - what is left is one proton ⇨ H^+
- When hydrogen ions are in water a hydronium ion will be formed ⇨ $H^+_{(aq)} + H_2O_{(l)} \rightarrow H_3O^+_{(aq)}$
- A Bronsted-Lowry acid is **exactly** the same as an Arrhenius acid.

Brϕnsted-Lowry Acids & Bases

A Bronsted-Lowry base is a proton acceptor

All Arrhenius bases are also proton acceptors ⇨

$H^+ + OH^- \rightarrow H_2O$

Some proton acceptors (Bronsted-Lowry bases) do not have hydroxide ions ⇨

$HCl_{(aq)} + NH_{3\,(aq)} \leftrightharpoons NH_4^+{}_{(aq)} + Cl^-{}_{(aq)}$

The hydrochloric acid is still the acid, the ammonia is the base even though there are no hydroxide ions.

Brϕnsted-Lowry Acids & Bases

Bronsted-Lowry acid base reactions always produce another acid and base in a reversible reaction

The “new” acid is called a conjugate acid

The “new” base is called a conjugate base

The acid on one side of the equation and the base on the other side are called a conjugate acid-base pair

Brϕnsted-Lowry Acids & Bases

Many substances can act as either an acid or as a base. These substances are called **amphoteric**.

Since some things are amphoteric there is an extra consideration when predicting equations with these substances. There will always be two possible equations - to simplify our problems we will consider the stronger acid to be the acid.

To determine which substance is a stronger acid we need some kind of table listing acid strengths.

Brϕnsted-Lowry Acids & Bases

A strong acid (or base) is one that ionizes completely:

$$HCl_{(aq)} \rightarrow H^+_{(aq)} + Cl^-_{(aq)}$$

A weak acid (or base) is one that only partially ionizes:

$$HC_2H_3O_{2\,(aq)} \leftrightharpoons H^+_{(aq)} + C_2H_3O_2^-{}_{(aq)}$$

The stronger the acid (or base) the larger the equilibrium constant (more ionization).

Brφnsted-Lowry Acids & Bases

$$HC_2H_3O_{2\,(aq)} \leftrightharpoons H^+_{(aq)} + C_2H_3O_2^-{}_{(aq)}$$

$$K_a = \frac{[H^+]\,[C_2H_3O_2^-]}{[HC_2H_3O_2]}$$

The larger the acid (or base) constant (K_a or K_b) the more ions are formed, the stronger the acid (or base)

Brφnsted-Lowry Acids & Bases

Example Problem: Predict the products, name all the compounds or ions, identify the conjugate acid-base pairs:

$HCl_{(aq)} + H_2O_{(l)} \leftrightharpoons$

HCl will be the acid (it is a stronger acid)

Water will be the base. Only one proton (H^+) will be transferred for each reaction (all the coefficients will be one).

Brϕnsted-Lowry Acids & Bases

$$HCl_{(aq)} + H_2O_{(l)} \leftrightharpoons Cl^-_{(aq)} + H_3O^+_{(aq)}$$

Hydrochloric acid is the acid on the left side of the equation, chloride ion is the base on the right side of the equation. They form one acid-base pair.

Brφnsted-Lowry Acids & Bases

$$HCl_{(aq)} + H_2O_{(l)} \rightleftharpoons Cl^-_{(aq)} + H_3O^+_{(aq)}$$

Water is the base on the left side and hydronium ion is the acid on the right side. They form the other acid-base pair.

Hydrochloric is a stronger acid than hydronium ion and water is a stronger base than chloride ion so the right side (weaker side) will have greater concentration than the left.