## Acids, bases, salts, and pH scale

There are three major Theories of substances known as acids or bases.

1. ### The Arrhenius Theory of acids and bases
   The theory
   - Acids are substances which produce hydrogen ions [H$^+$] in solution.
   - Bases are substances which produce hydroxide ions [OH$^-$] in solution.

Neutralization happens because hydrogen ions and hydroxide ions react to produce water.

$$H^+_{(aq)} + OH^-_{(aq)} \longrightarrow H_2O_{(l)}$$
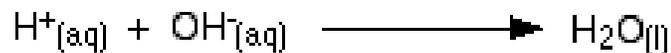
2. ### The Bronsted-Lowry Theory of acids and bases
   The theory
   - An acid is a proton (hydrogen ion) [H$^+$] donor.
   - A base is a proton (hydrogen ion) [H$^+$] acceptor.

   ❖ The relationship between the Bronsted-Lowry theory and the Arrhenius theory the Bronsted-Lowry theory doesn't go against the Arrhenius theory in any way - it just adds to it.
   ❖ Hydroxide ions [OH$^-$] are still bases because they accept hydrogen ions from acids and form water.
   ❖ An acid produces hydrogen ions in solution because it reacts with the water molecules by giving a proton to them.

consider an acid HA and think of the reaction as being reversible.

$$HA + H_2O \rightleftharpoons H_3O^+ + A^-$$
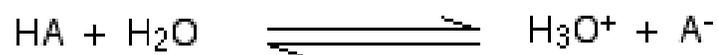
Thinking about the forward reaction:
   - The HA is an acid because it is donating a proton (hydrogen ion) to the water.

- The water H_2O is a base because it is accepting a proton from the HA.

But there is also a back reaction between the hydroxonium ion H_3O^+ and the A^- ion:

- The H_3O^+ is an acid because it is donating a proton (hydrogen ion) H^+ to the A^- ion.
- The A^- ion is a base because it is accepting a proton from the H_3O^+.

The reversible reaction contains *two* acids and *two* bases. We think of them in pairs, called *conjugate pairs*.
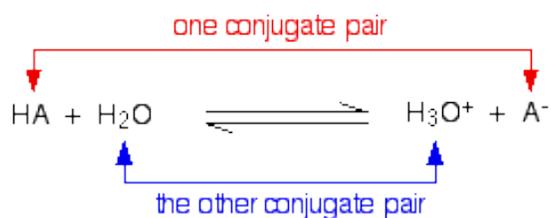
When the acid, HA. loses a proton it forms a base, A^-. When the base, A^-, accepts a proton back again, it obviously reforms the acid, HA. These two are a conjugate pair.

Members of a conjugate pair differ from each other by the presence or absence of the transferable hydrogen ion.

If you are thinking about HA as the acid, then A^- is its conjugate base.

If you are thinking about A^- as the base, then HA is its conjugate acid.

The water and the hydroxonium ion are also a conjugate pair. Thinking of the water as a base, the hydroxonium ion is its conjugate acid because it has the extra hydrogen ion which it can give away again.

Thinking about the hydroxonium ion as an acid, then water is its conjugate base. The water can accept a hydrogen ion back again to reform the hydroxonium ion.

3. The Lewis Theory of acids and bases

This theory extends well beyond the things you normally think of as acids and bases.

The theory

- An acid is an electron pair acceptor.
- A base is an electron pair donor.

Complex ions are polyatomic ions, which are formed from a central metal ion that has other smaller ions joined around it. While Brønsted theory can't explain this reaction Lewis acid-base theory can help. A Lewis Base is often the ligand of a coordination compound with the metal acting as the Lewis Acid

$$Al^{3+}+6H_2O \rightleftharpoons [Al(H_2O)6]^{3+}$$
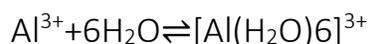
The Aluminum ion is the metal and is a cation with an unfilled valence shell, and it is a Lewis Acid. Water has lone-pair electrons and is an anion, thus it is a Lewis Base.
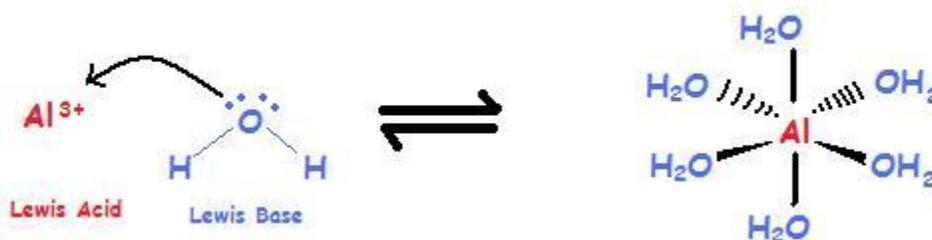
Strong Acid and Base

Strong acid: -
 An acid that is completely ionized in aqueous solution. this means when the strong acid placed in solution such as water ,all of the strong acid will dissociate into its ions to a weak acid . The general equation of the dissociation of a strong acid is:

$$HA_{(aq)} \rightarrow H^+{}_{(aq)}+A^-{}_{(aq)}$$
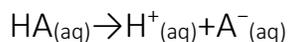
(H) represents hydrogen ion (cation)

(A) represents the conjugate base (anion) of the acid.

Strong Base:-
A base that is completely ionized in aqueous solution. This means when the strong base is placed in a solution such as water, all of the strong base will dissociate into its ions to a weak base. The general equation of the dissociation of a strong base is:

$$XOH_{(aq)} \rightarrow X^+_{(aq)} + OH^-_{(aq)}$$
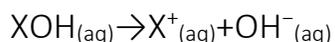
(OH) represents hydroxide ion (anion)

(X) represents the conjugate acid (cation) of the base.

6 Strong Acids		6 Strong Bases	
$HClO_4$	perchloric acid	LiOH	lithium hydroxide
HCl	hydrochloric acid	NaOH	sodium hydroxide
HBr	hydrobromic acid	KOH	potassium hydroxide
HI	hydroiodic acid	$Ca(OH)_2$	calcium hydroxide
HNO_3	nitric acid	$Sr(OH)_2$	strontium hydroxide
H_2SO_4	sulfuric acid	$Ba(OH)_2$	barium hydroxide

The salts

salt is an ionic compound that can be formed by the neutralization reaction of an acid and a base. Salts are composed of related numbers of cations (positively charged ions) and anions (negative ions) so that the product is electrically neutral (without a net charge). These component ions can be inorganic, such as chloride

(Cl^-), or organic, such as acetate ($CH3OO^-$) and can be monatomic, such as fluoride ($F-$), or polyatomic, such as sulfate (SO_4^{-2})

$$Acid + Base \longrightarrow Salt + Water$$

Kinds of salts

1. Alkali Salts
   Salts that produce when strong base react with weak acid for example

$$NaOH + CH_3COOH \longrightarrow CH_3COONa + H_2O$$

   sodium hydroxide + acetic acid $\longrightarrow$ sodium acetate + water

2. Acidic salts
   Salts that produce when strong acid react with weak base for example

$$NH_4OH + HCl \longrightarrow NH_4Cl + H_2O$$

   Hydroxide ammonium + hydrochloric acid $\longrightarrow$ Ammonium Chloride + water

3. Neutral salts
   Salts that produce when strong acid react with strong base for example

$$NaOH + HCl \longrightarrow NaCl + H_2O$$
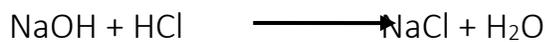
   Sodium hydroxide + hydrochloric acid $\longrightarrow$ Sodium chloride + water

PH scale

PH :- (potential of hydrogen) is a numeric scale used to specify the acidity or basicity of an aqueous solution. Solutions with a pH less than 7 are acidic and solutions with a pH greater than 7 are basic. Pure water is neutral, at pH 7 (25 °C), being neither an acid nor a base. Contrary to popular belief, the pH value can be less than 0 or greater than 14 for very strong acids and bases respectively

pH scale showing Acidic, Neutral, and Basic regions numbered 0 through 14. Labeled examples: Battery Acid, Lemon Juice, Wine, Normal Rain, Distilled Water, Baking Soda, Soft Soap, Ammonia, Lye.