

## Chemistry Lecture #89: Acids and Bases

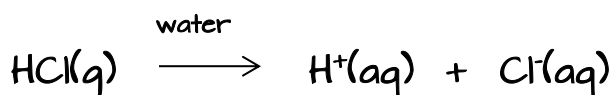
An acid solution is a water based solution that has an excess amount of  $H^+$ . Acid solutions have a sour taste. Lemon juice is an example of an acid solution.

A basic solution is a water based solution that has an excess amount of  $OH^-$ . Basic solutions have a bitter taste and feel slippery. Soap solutions are basic solutions. If you've ever had the misfortune of tasting soapy water, you'll know that it taste bitter. And when mixed with water, soap is a slippery substance.

A basic solution can be made if a substance dissociates and forms  $OH^-$  when placed in water. For example, solid NaOH will dissolve and form  $Na^+$  and  $OH^-$  when it is placed in water.



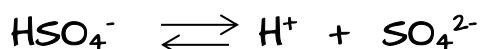
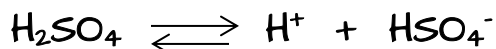
An acid solution can be made if a substance ionizes and forms  $H^+$  when placed in water. For example, when gaseous HCl molecules are bubbled through water, they will form  $H^+$  and  $Cl^-$ .



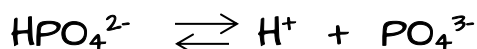
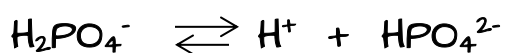
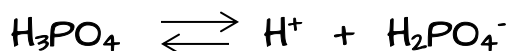
An HCl molecule produces a single hydrogen ion when placed in water. If a molecule produces a single hydrogen ion, it is a monoprotic acid.

Some molecules can produce more than one hydrogen ion. These are called polyprotic acids. For example,  $\text{H}_2\text{SO}_4$  can ionize to produce two hydrogen ions, which makes it a diprotic acid.

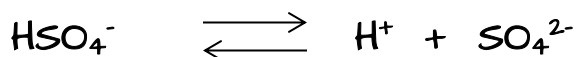
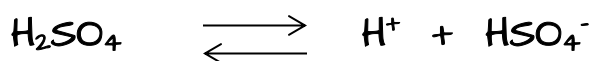
$\text{H}_2\text{SO}_4$  ionizes in two steps:



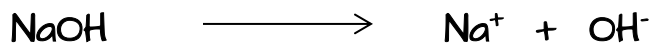
$\text{H}_3\text{PO}_4$  can produce three hydrogen ions, making it a triprotic acid. It can produce three hydrogen ions in three steps:



Substances do not necessarily have to contain hydrogen or hydroxide to produce  $\text{H}^+$  or  $\text{OH}^-$ . Oxides of nonmetallic elements can produce an acid in an aqueous solution. For example, if sulfur trioxide gas is bubbled through water, it produces  $\text{H}_2\text{SO}_4$ , which then ionizes to produce  $\text{H}^+$ .

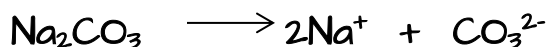


Oxides of metallic elements usually form basic solutions when placed in water. For example,  $\text{Na}_2\text{O}$  will produce  $\text{NaOH}$ , which then dissociates to form  $\text{OH}^-$ .

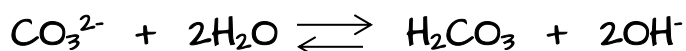


Oxides of nonmetals and metals that can be turned into acids or bases by placing them in water are called anhydrides.

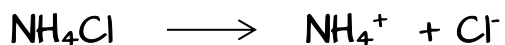
Soluble ionic compounds can react with water to form acidic or basic solutions. This process is called salt hydrolysis. For example, if  $\text{Na}_2\text{CO}_3$  is dissolved in water, it will produce a basic solution. It first dissociates to form sodium and carbonate ions.



The carbonate ion will then react with water to form  $\text{OH}^-$ .



An acidic solution can also be made by adding  $\text{NH}_4\text{Cl}$  to water.  $\text{NH}_4\text{Cl}$  first dissociates into ammonium and chloride ions.



The ammonium will then produce a hydrogen ion.



Actually, you never find  $H^+$  floating around by itself in an aqueous solution. It always attaches itself to a water molecule.



$H_3O^+$  is called a hydronium ion. So when you see  $H^+$ , it's short hand for  $H_3O^+$ .

Hydrogen ion =  $H^+$  =  $H_3O^+$  = hydronium ion

So another way to write the reaction of  $NH_4^+$  with water would be

