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acid and base

Two groups of chemical compounds called **acids** and **bases** have many members that react together to produce new products. **Acids**, **bases**, and the products of their reactions are vital to many life processes and are valuable to industry.

An acid is defined as a substance containing hydrogen that dissociates (breaks up) in water to produce hydrogen ions. An acid may also be defined as a compound in which the hydrogen can be replaced by a metal. The other part of the compound is called the acid radical. For example, in sulfuric acid (H2SO4) one atom of sulfur and four of oxygen form the acid radical that is joined to two atoms of hydrogen.

A typical metal-acid reaction occurs when zinc is placed in a solution of sulfuric acid. Hydrogen is released as a gas, and zinc unites with the acid radical to form zinc sulfate:

H2SO4+ZnZnSO4+H2

The strongest **acids** are the mineral, or inorganic, **acids**. These include sulfuric acid, nitric acid, and hydrochloric acid. More important to life are hundreds of weaker organic **acids**. These include acetic acid (in vinegar), citric acid (in lemons), lactic acid (in sour milk), and the amino **acids** (in proteins).

A base is a substance containing the hydroxide ion, OH-, or the hydroxyl group, OH, which dissociates in water as the hydroxide ion, OH-. Basic solutions have a characteristic brackish taste. The hydroxides of metals are metal compounds that have the hydroxyl group, and they are **bases**. Hydroxides of the metals lithium, sodium, potassium, rubidium, and cesium have the special name of alkalies. The oxides of beryllium, magnesium, calcium, strontium, and barium are called alkaline earths. A basic solution is also called an alkaline solution.

These descriptions help explain why **acids** and **bases** react so readily with each other. An acid has hydrogen to exchange for a metal, and a base has a metal to exchange for hydrogen. When the two react, the exchange takes place. These reactions or exchanges are sometimes violent. **Acids** and **bases** react to form compounds that are called salts. The reaction of sodium hydroxide and sulfuric acid produces a salt, sodium sulfate (Na2SO4), and water: 2NaOH+H2SO4Na2SO4+2H2O

Another typical acid-base reaction is that between calcium hydroxide and phosphoric acid to produce calcium phosphate and water: 3Ca(OH)2+2H3PO4Ca3(PO4)2+6H2O

Acids and **bases** react freely in aqueous (water) solutions. It is said that when an acid dissociates, it forms an acid radical and a hydrogen ion. Actually, the hydrogen ion (H+) does not exist in large concentrations in the aqueous solution. Instead, the hydrogen ion attaches itself to a water molecule to form the hydronium ion, H3O+. It is customary, however, to simplify reaction equations by using the symbol for the hydrogen ion, H+.

When a base dissociates, it produces a hydroxide ion (OH-) with a negative charge and a metal ion with a positive charge. The hydrogen ion and the hydroxide ion combine to form a molecule of water. The negative acid radical and the positive metal ion can then form a salt.

Acids and **bases** can cause many organic substances to change color. For example, if lemon juice is added to tea, the tea becomes lighter in color. This occurs because the acid in the lemon juice changes the color of a substance in the tea from dark brown to light brown. The reaction can be reversed by adding an alkaline substance, such as baking soda (NaHCO3), to the tea. This addition restores the original color. A substance that changes color when an acid or base is added to it is called an indicator.

Litmus paper is a common indicator. It turns red in an acid solution and blue in a basic solution. A solution that gives litmus paper a color midway between red and blue is called a neutral solution. This is a solution that contains hydrogen ions and hydroxide ions in equal amounts. Thus, a solution with an excess of hydrogen ions is an acid solution. A solution with an excess of hydroxide ions is a basic solution.

Pure water is a neutral solution. It ionizes slightly and releases an equal number of hydrogen and hydroxide ions. The concentration of these ions has been measured and found to be 110-7. Instead of saying that the hydrogen ion concentration in pure water is 110-7, it is customary to say that the pH of water is 7. The pH is the logarithm of the reciprocal of the hydrogen ion concentration. It is written: pH=log1[H+]Since water has a pH of 7 and is neutral, solutions with pH less than 7 are acid, and solutions with pH greater than 7 are basic.

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