ACIDS AND BASES

Name:____________________________________

Block: ____ Due: __________________________

You know that some atoms can gain or lose electrons to form ions. That process is called ionization, and compounds formed in that way are called ionic compounds. When ionic compounds dissolve in water, their ions separate from one another in a process called dissociation (the opposite of association). One interesting feature of water and many other covalent compounds is that they, too, can dissociate into ions. Unlike ionic compounds, such as sodium chloride, they are not ionized before they dissociate; they accomplish ionization and dissociation simultaneously.

Color the heading Dissociation of Water, titles H_2O through H_3O^+, and the related structures.

When *water dissociates,* one of the hydrogen nuclei leaves its electron behind with the oxygen atom to become a *hydrogen ion,* while the oxygen and the other hydrogen atom become a *hydroxide ion.* Since the hydrogen ion has no electron to neutralize the positive charge on its proton, it has a full unit of positive charge and is symbolized as H^+. The hydroxide ion keeps the electron left behind by the departed hydrogen and therefore has one more electron than it has protons, so it has a full unit of negative charge and is symbolized as OH^- . The hydrogen ion (really just a proton) does not wander long by itself before it attaches to the oxygen atom of a second, un-ionized water molecule to form a *hydronium ion* (H_3O^+).

In any sample of water, very few of the molecules are dissociated at any one time: in fact, only about one in 550 million. There is, however, a constant change; as one hydrogen ion reattaches to a hydroxide ion to form a water molecule, another water molecule somewhere else dissociates.

Color the heading Hydrochloric Acid, title Cl^-, and the related structures.

Certain molecules, ionic and covalent, dissociate in such a way that they release a hydrogen ion without releasing a hydroxide ion. These substances are called acids. Since a hydrogen ion is really just a single proton in most cases, the chemist's definition of an acid is a "proton donor." If very many protons (hydrogen ions) are "donated," the effect can be very profound, burning your skin, dissolving a metal, and the like. The acid illustrated is hydrochloric acid. Pure hydrochloric acid is a gas, but it dissolves easily in water to produce a solution of hydrogen ion and *chloride ion.* Since nearly all of it is dissociated in water, it is called a strong acid. (Acids that do not dissociate completely are called weak acids.)

Color the heading Sodium Hydroxide, title Na^+, and the related structures.

The opposite of an acid is a base, better known in everyday language as an alkali. A typical strong base is sodium hydroxide, the principal component of lye, which dissociates in water to form *sodium ion* and hydroxide ion. A base is defined as a "proton acceptor." The most common bases produce hydroxide ion when they dissociate, and it is the hydroxide ion that accepts the proton. (A strong base can give your skin a much worse burn than an acid.)

Color the heading Neutralization, title B, and the related structures.

When a base and an acid are mixed, the hydroxide ion from the base combines with the hydrogen ion from the acid to form water. This process is called *neutralization.*

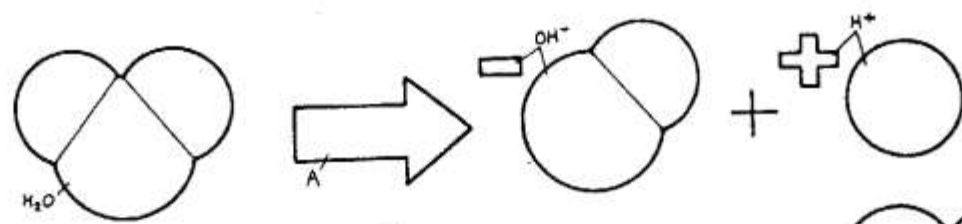
Color the heading pH Scale, titles H^+ and OH^-, and the related portions of the bar representing the pH scale.

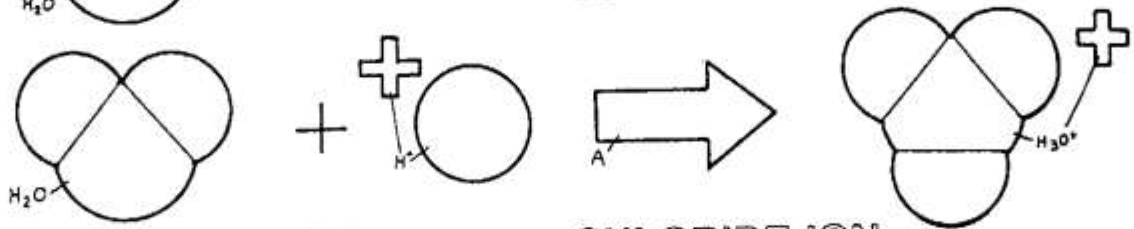
The quantities of acids and bases found in living organisms are extremely small in comparison with the solutions normally used in chemistry laboratories. As a result, biologists have adopted the pH scale. The pH scale ranges from 0 at the acid end to 14 at the basic end. These two extremes (pH 0 and pH 14) are only mildly acidic and mildly basic by comparison with many other acids and bases, but they are strong enough to be lethal to a living thing. Each change of one pH unit indicates a tenfold increase or decrease in *hydrogen ion concentration* and the opposite tenfold change in *hydroxide ion concentration.* Pure water has a pH of 7, which means it has equal (though extremely small) concentrations of hydrogen ion and hydroxide ion (10^{-7} molar, if you are a chemist). A solution with a pH of 6 has ten times the hydrogen ion concentration of a pH 7 solution … and only one-tenth the hydroxide ion concentration; it is therefore slightly acidic. Most fluids in living things have a pH not too far from 7, although stomach acid can get to pH 1.

ACIDS AND BASES.

DISSOCIATION OF WATER.*

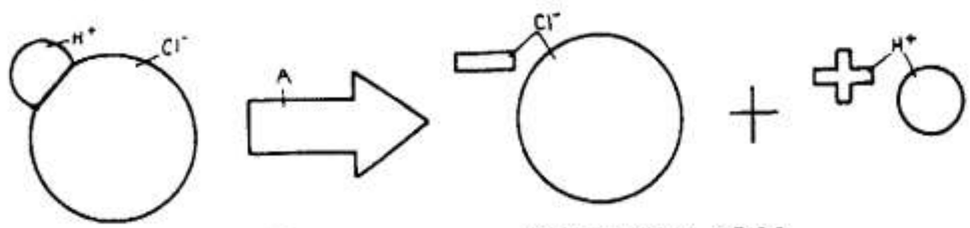
WATER$_{H_2O}$ DISSOCIATION$_A$ HYDROXIDE ION$_{OH^-}$
HYDROGEN ION$_{H^+}$ HYDRONIUM ION$_{H_3O^+}$





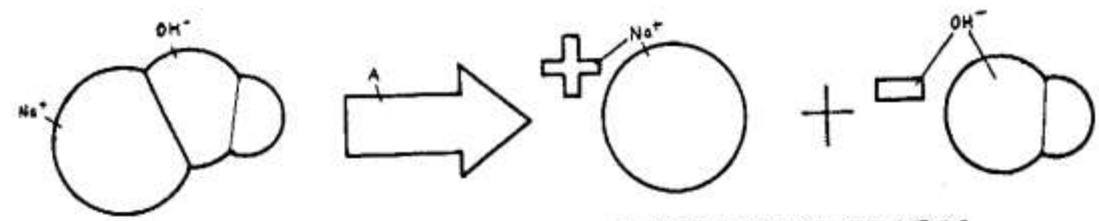
HYDROCHLORIC ACID.*

CHLORIDE ION$_{Cl^-}$



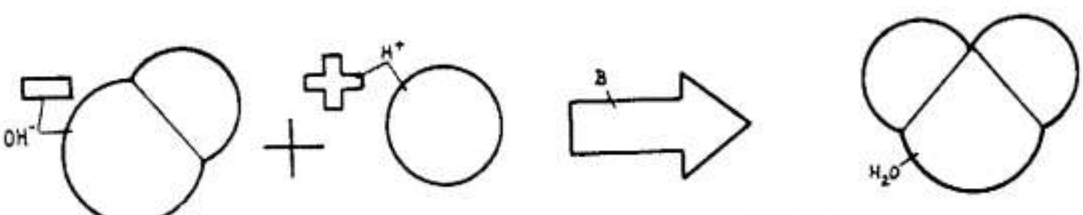
SODIUM HYDROXIDE.*

SODIUM ION$_{Na^+}$



NEUTRALIZATION.*

NEUTRALIZATION$_B$



pH SCALE.*

HYDROXIDE ION CONC.$_{OH^-}$

HYDROGEN ION CONC.$_{H^+}$