1: THE WATER MOLECULE

Water is essential to life. Our bodies are 60 to 70 percent water. (Younger people tend to have more water, and older people have less.) If you removed all the water from our bodies, we'd be nothing but a small pile of dry, dusty minerals.

Water is made of one oxygen atom and two hydrogen atoms. The hydrogens stay attached to the oxygen because they are sharing electrons. Oxygen would like to gain two electrons (it has six in its outer shell but would like to have eight) so it works out very well if two hydrogens come over and share their electrons. This type of bond (sharing electrons) is called a **covalent bond**. In general, non-metal atoms (such as carbon, nitrogen, and oxygen) form covalent bonds.

Atoms at the top of the Periodic Table obey what is called the "Octet Rule." They want to have 8 electrons in their outer shell. (If you would like a review activity about electrons shells and orbitals, try the "Quick and Easy Atom-izer" posted at www.ellenjmchenry.com; click on free downloads, then on chemistry.) Ideally, an atom with only 2 electrons in its outer shell will try to pair up with an atom that has 6 electrons in its outer shell. Between the two of them they will have 8, fulfilling the Octet Rule. It doesn't always work out this perfectly. Sometimes atoms have to "double share" to make things work out. For example, the oxygen in the air we breathe forms O_2 molecules. Each oxygen atom has 6 electrons in its outer shell and wants 2 more. They each give the other a pair of electrons, forming a **double bond**. It's not a covalent bond where everything adds up to eight, but it seems to work well enough for the O_2 molecule. Oxygen molecules can even take on a third oxygen temporarily, forming ozone, O_3.

Chemists have actually been able to measure the angle at which the hydrogen atoms sit on the oxygen atom, and found it to be about 104 degrees (meaning geometry degrees, not heat). The placement of the hydrogens makes the molecule look a bit comical to us; it has been compared to a teddy bear, or to Mickey Mouse or Kermit the Frog.

Water molecules are constantly vibrating. The hydrogens go in and out, closer to and further from the oxygen. They also tumble around, bumping into each other like bumper cars at an amusement park. The faster they move, the more heat there is. Slower activity goes along with decreased temperatures. (Try the online interactive demo posted as an activity for this lesson. It lets you increase and decrease the movement of the molecules and see what happens.)

The oxygen atom is bigger than the hydrogen atoms. The oxygen atom has 8 protons, whereas the hydrogens have just one. This gives the oxygen a huge advantage when it comes to controlling the 8 electrons they are all sharing. The oxygen's large nucleus attracts those electrons strongly and keeps them circulating around it most of the time. Those poor hydrogens get an electron whizzing around them once in a while, but the electrons spend more time around the oxygen atom. This causes the entire molecule to become slightly unbalanced, so to speak. If you imagine the molecule to look like a teddy bear head, the chin of the bear becomes more negative because of the constant presence of the electrons, which carry a negative charge. The bear's ears, those hydrogens, are essentially made of nothing but a proton, and since protons carry a positive charge, the ear side of the molecule is more positive. This difference in charge between the two sides makes the molecule **polar**. Polarity is when a molecule is more negative on one side and more positive on the other. Polarity is what gives water so many of its amazing qualities, such as being able to dissolve so many substances. We'll meet the concept of polarity again in future lessons. It is very important.

Hydrogen atoms sometimes leave their water molecules. This means that at any given time, there are some H's and some OH's floating around. We call these partial molecules **ions.** An ion is an electrically unbalanced atom or molecule, with more electrons than protons or more protons than electrons. When a hydrogen atom leaves its water molecule, it leaves its electron behind. Without its electron, hydrogen becomes nothing but a proton. In a normal hydrogen atom there is one proton and one electron, so the positive and negative charges are equal. But a hydrogen ion has only one proton and zero electrons, so its overall electrical charge is +1. We can use the abbreviation H+ to represent a hydrogen ion. (You must always remember that the words "hydrogen ion" and "proton" can be used interchangeably since they are the same thing.)

In the case of OH, it has lost a proton (H+), so now it has one more electron than it does protons. Overall, it carries a negative (-) charge. We will therefore write it like this: OH-. The proper name of this molecule is the **hydroxide ion**.

The strangest molecule in a drop of water has to be the **hydronium ion**, H_3O. A hydrogen ion (a proton) goes and attaches itself to a regular molecule, turning H_20 into H_30. This does not work out so well, and one of the hydrogens immediately leaves, returning the molecule to normal water.