

# Water Molecule Model Building

Name(s): \_\_\_\_\_

Date: \_\_\_\_\_

Water is a compound essential to all living things. The average human body is 70% water by volume. Without water, cells would have difficulty maintaining their shape and chemical messengers and vital nutrients could not travel around the body. Water is the medium in which the business of life is conducted.

Water is formed when one oxygen atom forms a single covalent bond with two separate hydrogen atoms. This arrangement gives oxygen the two electrons it needs to fill its outer shell and allows both hydrogen atoms to receive the single electrons they need for their outer shells.

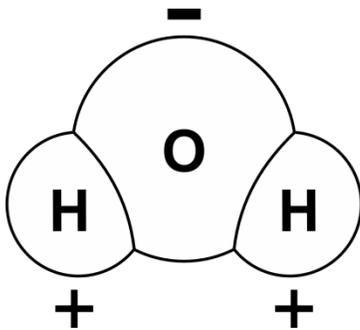


Figure 1: Water is polar molecule

The oxygen and hydrogen atoms share electrons but they don't exactly share evenly. Oxygen has eight protons in its nucleus and each hydrogen atom has only one. Because oxygen's nucleus has so many more protons, the pull it has on the orbiting electrons is much greater than the pull exerted by the much smaller hydrogen nuclei. As a result the electrons spend a greater amount of their time on the oxygen side of the water molecule. This creates a region of slightly negative charge on the oxygen side of water and a region of slightly positive charge on the hydrogen side of water. A molecule with an uneven distribution of charge is known as a **polar** molecule.

The polar nature of water allows it to demonstrate some unique properties. When water molecules are close to one another, the negatively charged oxygen side of one water molecule will attract to the positively charged hydrogen side of another water molecule. The bond that results is known as a **hydrogen bond**. Hydrogen bonding between water molecules gives water the property of **cohesion**. Cohesion is the property of like molecules sticking together. The cohesive nature of water can be observed whenever you see droplets form on a window or certain bugs walk on water. More importantly, cohesion of water molecules can aid the life functions of certain organisms. Plants use cohesion to pull water from the roots up to the leaves, sometimes hundreds of feet in the air!

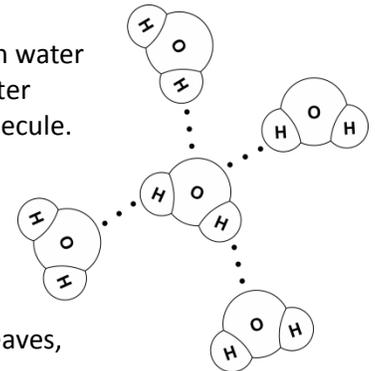


Figure 2: Hydrogen Bonding

Water has been called the greatest solvent on Earth because of its ability to dissolve so many substances. For example, water can easily dissolve ionic compounds (compounds formed from the attraction of positively and negatively charged ions) such as table salt (NaCl). Water dissolves salt by causing the sodium (Na<sup>+</sup>) and Chlorine (Cl<sup>-</sup>) ions to pull away or disassociate from one another. The water molecules form a **hydration sphere** around each ion. The negative side of the water molecule will orientate toward the positive sodium ions and the positive side of the water molecule will orientate toward the negative chlorine ions. If the water evaporates, the sodium and chlorine ions will come together again to form salt crystals.

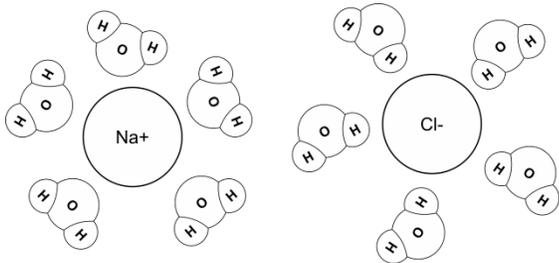


Figure 3: Hydration Spheres

## Procedure

Using the *Water Molecule Model Building Cut-Outs* page:

1. Color the oxygen atoms of each water molecule red.
2. Indicate the relative charge of each side of the water molecules by placing pluses and minuses on the correct sides.
3. Cut out 5 of the water molecules.
4. Model a water droplet by gluing the water molecules in an arrangement similar to Figure 2.
5. Indicate the hydrogen bonds between each water molecule by drawing three black circles as seen in Figure 2.
6. Cut out the sodium ( $\text{Na}^+$ ) and chlorine ( $\text{Cl}^-$ ) ions and the remaining water molecules.
7. Create hydration spheres around the ions by pasting the  $\text{Na}^+$ ,  $\text{Cl}^-$ , and water molecules in an arrangement similar to that in Figure 3.

## Discussion Questions

1. How does the high surface tension of water affect living organisms such as a water strider? Include the cause of surface tension in your answer.
2. What kinds of bonds can form between two adjacent water molecules?
3. How does the size of oxygen's nucleus affect the distribution of electrons in the water molecule?
4. What does it mean to be a polar molecule?
5. Give an example of water's cohesive nature playing a role in a biological process. Describe cohesion in your answer.
6. Why is water referred to as the universal solvent?
7. What structures are formed when water molecules surrounds individual ions?
8. What is adhesion? How does adhesion affect biological processes such as transpiration?
9. How does the high specific heat of water affect living systems? Use a dog panting or a human sweating as your example in your explanation.

Water Molecule  
Model Building  
Cut-Outs

