

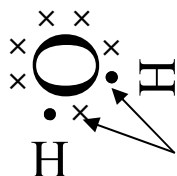
The Properties of Water

Structure of Water

As you know, water is composed of 2 Hydrogen Atoms and 1 Oxygen atom: H_2O .

H Hydrogen has 1 valence (outer) electron. Since the first electron shell can hold 2, it only needs 1 more.

Oxygen has 6 valence electrons in the second shell and needs 2 more to be full at 8.

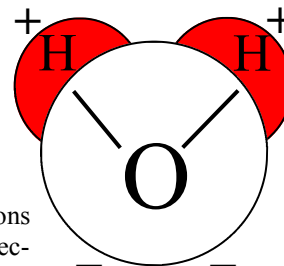


Neither oxygen or hydrogen will give up their electrons, so they share. These are called **covalent bonds**.

Shared Electrons: **covalent bonds**

Polarity Water

The sharing of unpaired electrons causes the water molecule to have a bent shape.

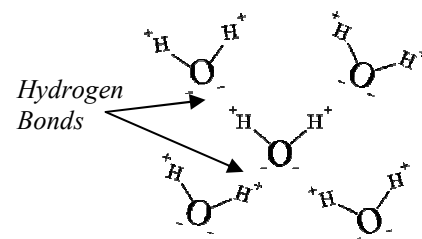


Since oxygen has more protons than hydrogen, the shared electrons spend more time around oxygen. This leaves the protons of the hydrogen atom more alone, causing a slight positive charge. The extra electrons around the oxygen give it a slight negative charge. These positive and negative regions cause the **polarity** of water.

Hydrogen Bonds

Opposites attract. The slightly charged ends of each water molecule attracts the oppositely charged ends of other water molecules. This attraction between two different water molecules is called a **hydrogen bond**. Individually, hydrogen bonds are weak, but strong as a group.

ALL of the Properties of water can be attributed to the hydrogen bonds that form between the molecules. This is what allow water to stick to other surfaces (adhesion), stick to itself (cohesion), store lots of energy (specific heat), and to allow objects to stay on top of the water (surface tension).



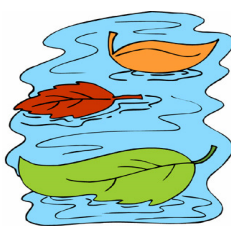
Adhesion and Cohesion

Adhesion is the attraction of dissimilar molecules: like water to glass. Water has high cohesion because hydrogen bonding can occur with molecules other than water. This is why frost forms on glass.

Cohesion is the attraction of similar molecules: water to water. Water has high cohesion due hydrogen bonding. Cohesion is the reason why water forms droplets and pools on a table.

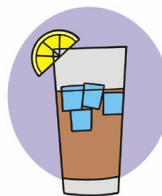


Surface Tension is the measure of how difficult it is to break the surface of a liquid. Because hydrogen bonds are strong as a



group, water has a high surface tension. In fact, water tension is strong enough to support leaves, water striders, and even one fast running lizard in Central America.

Density is how compact an object is and equals the mass of an object divided by its volume. Water has a density of 1g/ml. Water's density changes depending upon what state it is in (solid, liquid or gas). Solid water (ice) is the least dense form of water and liquid water is the most dense.

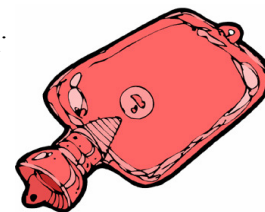


ICE FLOATS in Water!

This is a the exception: all other substance are more dense as a solid than as a liquid.

High Specific Heat (c_p)

Specific heat (c_p) is defined as the amount of energy required to raise 1 gram of a substance 1 degree Celsius. It tells you how hard it is to change a substance's temperature. Water has a very high c_p of 1cal/g/1°C [c_p of copper is only 0.093cal/g/°C!]. It takes a lot of energy to change water's temperature. This is why lakes take many days to freeze even in sub-zero temperatures and why we use hot water bottles to keep us warm.

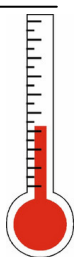


Nearly Universal Solvent

Water is an excellent **solvent** (capable of dissolving another substance) of many **solutes** (the substance being dissolved). Water can dissolve ionic and polar molecules due to the attraction of opposite charges. Non-polar molecules are not dissolved in water because there are no opposite charges.

Water Freezes at 0°C
(becomes ice, a solid)

Water Evaporates at 100°C
(becomes steam, a gas)

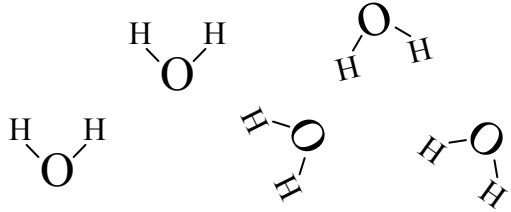


1. ___ Covalent Bond	A. Outer most electrons of an atom	1. ___ Cohesion	A. Measure of difficult it is to break the surface of a liquid
2. ___ Polar Molecule	B. Weak interaction between slightly charged molecules	2. ___ Adhesion	B. Amount of energy required to raise 1 gram of a substance 1°C
3. ___ Hydrogen Bond	C. Molecule with slightly charged ends	3. ___ Density	C. Attraction of similar molecules
4. ___ Valence Electrons	D. A bond formed when atoms share electrons	4. ___ Surface Tension	D. Attraction of dissimilar molecules
5. ___ Ionic Bond	E. A bond formed when atoms transfer electrons	5. ___ Specific Heat	E. Grams per volume

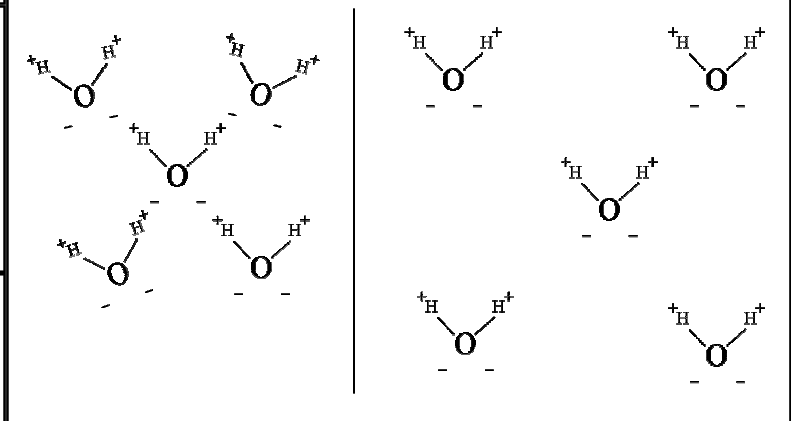
Draw a water molecule.
Label each atom.
Label the covalent bonds.
Label the charges.

Why is water a polar molecule?

Draw in and label the hydrogen bond.



Ice (solid water) is less dense than liquid water due to an increase in spacing between molecules cause by hydrogen bonds. Label one picture solid and the other liquid.



Hydrogen bonds cause water molecules to pull on each other, therefore, if one water molecule moves another behind it will follow. If the top molecule above is pulled to the right which direction will the bottom molecule move?

When a lake freezes where will the ice be found? Top or Bottom? Why?

How does adhesion and cohesion work together to pull water from the roots to the leaves of plants?

Water is a *nearly* universal solvent. Draw a picture that shows salt being dissolved by water.

The temperatures of lakes in Texas changes very little through the year. Explain in terms of specific heat.