

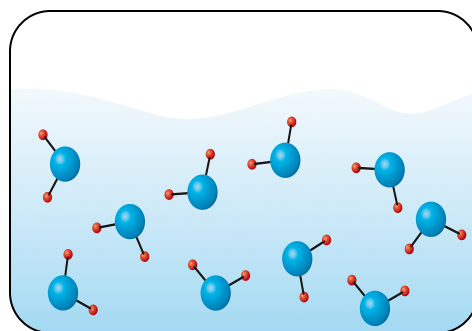
Getting to Know: Properties of Water

We are all aware of the importance of water. You know that we need it for drinking, for industry, and for recreation. You also know that all living things need water. You probably know many different facts about the water cycle and could describe how water moves through the planet. But how much do you know about the water molecule? Water has many unique properties that help make it such an essential substance. In this lesson, you will learn more about the interesting properties of water and how they are related to its unique chemical structure.

What makes the water molecule so unique?

Water is a molecule made of one oxygen atom bonded to two hydrogen atoms. Water molecules always form in the same way. The hydrogen atoms, which are really just positively charged protons, bond to the oxygen atom at a 105° angle. On the other side of the oxygen molecule, there are two pairs of unbonded electrons. This angle is what helps give water its polarity. A *polar* molecule has a positive charge on one side and a negative charge on the other. This polarity allows water molecules to form strong bonds with other water molecules.

The negative side of one molecule is attracted to the positive side of another water molecule in a hydrogen bond. Hydrogen bonds are much weaker than the bonds inside a molecule or ionic compound, but they are still pretty strong, as you will see in this lesson.



The water molecule has many interesting properties.



Misconception 1: *Because water is a renewable resource, that means there is an unlimited supply of it, right?*

It is true that there is a lot of water on our planet and that it can be used over and over again, which is why we call it renewable. However, when pollution enters the water cycle, it can permanently destroy water resources. Just because water is renewable does not mean we do not need to be careful with how it is used.

What are some of the interesting properties of water?

First, water is the only substance on our planet that can be found in all three states of matter at normal surface temperatures. Water vapor (a gas) is in the air around you. Liquid water is running through the pipes in your school and is found in rivers, lakes, oceans, and so on. Solid water (ice) is found in polar ice sheets, snowflakes, and perhaps in your glass of juice! Another property of water is its strong surface tension. Have you ever noticed a water bug moving across the surface of the water? It does not sink to the bottom of the water because the

molecules of water at the surface of the substance behave slightly differently than other molecules and form a type of film at the surface. The hydrogen bonds in water give it strong cohesion (it can stick to itself) and adhesion (it can stick to other things).

The next interesting property of water you have probably seen in action thousands of times. Whenever you stir sugar into your tea or use water to clean something, you are experiencing water's ability to dissolve, well, just about everything. Water is sometime called the "universal solvent" because it can solve most polar or charged substances.

One other interesting property of water is that it has a high heat capacity. This means water is able to absorb a lot of thermal energy before its temperature changes. This is important for life on Earth because the water vapor in Earth's atmosphere and the huge amounts of water in the oceans protect our planet from becoming too hot. If the Earth's surface were not mostly water, it would probably be too hot for life to have evolved.

I have heard that water expands when it freezes. Is that correct?

That is correct, and it is just one other way that water is unique. Typically, when substances lose thermal energy, the molecules in them slow down and take up less space. Water also contracts as it cools, but only to a point. When it reaches 4° C, it starts to form a highly organized crystal: ice. The water molecules in frozen water have more space between them than the molecules in liquid water, so ice expands as it freezes. As a result, solid water is less dense than liquid water, so ice floats! Usually, the solid form of a substance is denser than its liquid form, so this is a rare phenomenon.



Ice is less dense than liquid water.

Luckily, this rare phenomenon is just what aquatic organisms need to survive the winter. When the air above a body of water gets cold, it will cause the ice at the top of the water to cool. However, once some of the water reaches the freezing point, it will float to the top and create a protective covering over the top. Because water is a thermal insulator (its high heat capacity means that it does not pick up heat easily), the ice cover keeps the water below at a warmer temperature. Living things may hibernate under water or even swim around if there is enough dissolved oxygen, but at least they will not freeze!



Misconception 2: *Is it true that water always has a freezing point of 0° C and a boiling point of 100° C?*

This is true at the "standard pressure," which is found outside at sea level on Earth's surface. However, changing the pressure of the environment—for example, by going to the top of a mountain or putting a tight lid on a pan—can alter the freezing and boiling points of water significantly. Water with other substances dissolved in it usually has a much higher boiling point and a much lower freezing point.