Adhesion and Cohesion of Water

Adhesion and cohesion are water properties that affect every water molecule on earth and also the interaction of water molecules with molecules of other substances. Essentially, cohesion and adhesion are the "stickiness" that water molecules have for each other and for other substances. One example of this is a water droplet sticking to the end of a leaf. The water drop is composed of water molecules that like to stick together, an example of the property of cohesion. The water drop is stuck to the end of the leaf, which is an example of the property of adhesion.

Cohesion makes a water drop a drop

It is easy to see that the drop seems to have a "skin" holding it into a sort of flattened sphere (although there is nothing flat about a drop of water in outer space.). It turns out that this surface tension is the result of the tendency of water molecules to attract one another. The natural form of a water drop occurs in the "lowest energy state," the state where the atoms in the molecule are using the least amount of energy. For water, this state happens when a water molecule is surrounded on all sides by other water molecules, which creates a sphere or ball (perfectly round if it was in outer space). On Earth, the effect of gravity flattens this ideal sphere into the drop shape we see. Although you may have heard of a "skin" where water meets the air, this is not really an accurate description, as there is nothing other than water in the drop.

Why is water sticky?

Water is highly cohesive—it is the highest of the non-metallic liquids. Water is sticky and clumps together into drops because of its cohesive properties, but chemistry and electricity are involved at a more detailed level to make this possible. More precisely, the positive and negative charges of the hydrogen and oxygen atoms that make up water molecules makes them attracted to each other. If you've played with bar magnets you will know that the positive (+) side of one magnet will repel the other positive side, while a negative (-) side of one magnet will attract the positive side of the other magnet. Positive charges attract negative charges.

In a water molecule, the two hydrogen atoms align themselves along one side of the oxygen atom, with the result being that the oxygen side has a slight negative charge and the side with the hydrogen atoms has a slight positive charge. Thus when the positive side on one water molecule comes near the negative side of another water molecule, they attract each other and form a hydrogen bond. This polar nature of water molecules gives water its cohesive nature, and thus, its stickiness.

Some examples of Cohesion/ Adhesion

- Cohesion: Droplet of water on a oily surface; dew drop of water
- Adhesion: Dew drop sticking to blade of grass; water droplet falling off a melting icicle.

Surface Tension and Water

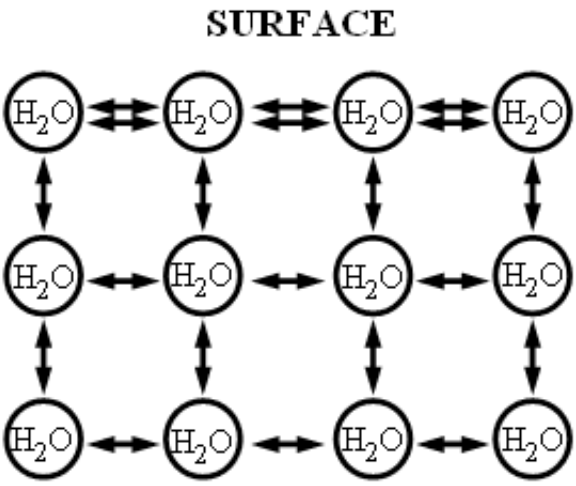
The cohesive forces between liquid molecules are responsible for the phenomenon known as surface tension. The molecules at the surface of a glass of water do not have other water molecules on all sides of them and consequently they cohere more strongly to those directly associated with them (in this case, next to and below them, but not above). It is not really true that a "skin" forms on the water surface; the stronger cohesion between the water molecules as opposed to the attraction of the water molecules to the air makes it more difficult to move an object through the surface than to move it when it is completely submersed.

Cohesion and Surface Tension

The cohesive forces between molecules in a liquid are shared with all neighboring molecules. Those on the surface have no neighboring molecules above and, thus, exhibit stronger attractive forces upon their nearest neighbors on and below the surface. **Surface tension** could be defined as the property of the surface of a liquid that allows it to resist an external force, due to the cohesive nature of the water molecules.

Surface tension at a molecular level

Water molecules want to cling to each other. At the surface, however, there are fewer water molecules to cling to since there is air above (thus, no water molecules). This results in a stronger bond between those molecules that actually do come in contact with one another, and a layer of strongly bonded water (see diagram). This surface layer (held together by surface tension) creates a considerable barrier between the atmosphere and the water. In fact, other than mercury, water has the greatest surface tension of any liquid.



Surface tension—molecules at the surface form stronger bonds

Due to the surface tension, small objects will "float" on the surface of a fluid, as long as the object cannot break through and separate the top layer of water molecules. When an object is on the surface of the fluid, the surface under tension will behave like an elastic membrane.

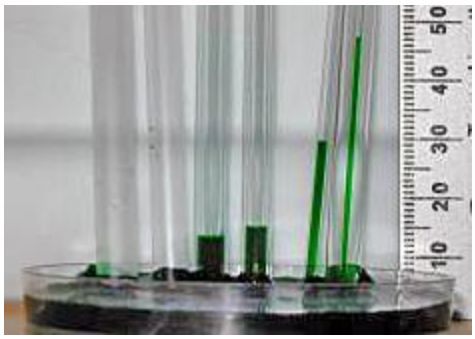
Some examples of surface tension:

Walking on water: Small insects such as the water strider can walk on water because their weight is not enough to penetrate the surface.

Floating a needle: A carefully placed small needle can be made to float on the surface of water even though it is several times as dense as water. If the surface is agitated to break up the surface tension, then needle will quickly sink.

Surface Tension and Droplets: Surface tension is responsible for the shape of liquid droplets. Although easily deformed, droplets of water tend to be pulled into a spherical shape by the cohesive forces of the surface layer.

Capillary action



Even if you've never heard of capillary action, it is still important in your life. Capillary action is important for moving water (and all of the things that are dissolved in it) around. It is defined as the movement of water within the spaces of a porous material due to the forces of **adhesion, cohesion, and surface tension**.

Capillary action occurs because water is sticky; thanks to the forces of cohesion (water molecules like to stay close together) and adhesion (water molecules are attracted and stick to other substances). Adhesion of water to the walls of a vessel will cause an upward force on the liquid at the edges and result in a meniscus which turns upward. The surface tension acts to hold the surface intact. Capillary action occurs when the adhesion to the walls is stronger than the cohesive forces between the liquid molecules. The height to which capillary action will take water in a uniform circular tube is limited by surface tension and, of course, gravity.

Not only does water tend to stick together in a drop, it sticks to glass, cloth, organic tissues, soil, and, luckily, to the fibers in a paper towel. Dip a paper towel into a glass of water and the water will "climb" onto the paper towel. In fact, it will keep going up the towel until the pull of gravity is too much for it to overcome.

Capillary action is all around us every day

- Plants and trees couldn't thrive without capillary action. Plants put down roots into the soil, which are capable of carrying water from the soil up into the plant. Water gets inside the roots and starts climbing up the plant tissue. As water molecule #1 starts climbing, it pulls along water molecule #2, which, of course, is dragging water molecule #3, and so on.

- A familiar example of capillary action is the tendency of a dry paper towel to absorb a liquid by drawing it into the narrow openings between the fibers of the paper towel.