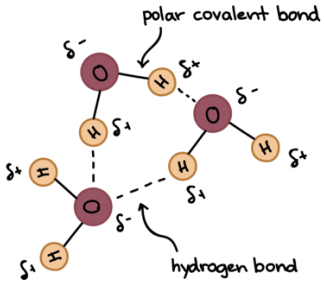
Water-Themed Lessons & Activities
from FAIRMOUNT WATER WORKS

Properties of Water - Polarity of H_2O

Introduction:

Water is an amazing molecule that behaves differently from most other molecules on earth. H_2O has atoms that are oriented so that positive hydrogen and negative oxygen are at opposite ends of the molecule. This arrangement produces an electrically charged polar molecule with hydrogen bonds and a bent shape. This shape and charge make water very attractive to itself and other substances. Students will experiment with water to detect some of its incredible properties.



Note: The drinking water treatment process depends on the properties of water to dissolve substances and cause coagulation and sedimentation. For more, click on the "Drinking Water Treatment Process" link that is part of this online series.

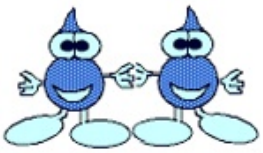
Learning Objectives:

Students will be able to

- **Experiment with the hydrophilic** (water loving) **and hydrophobic** (water fearing) **characteristics of water.**
- **Identify adhesion, cohesion, surface tension**

Materials:

- Sheet of paper; water
- Glass of water; food coloring (or substitute); eyedropper or straw
- Penny / coin; paper and pencil; paper towel
- Drop of detergent



Cohesion

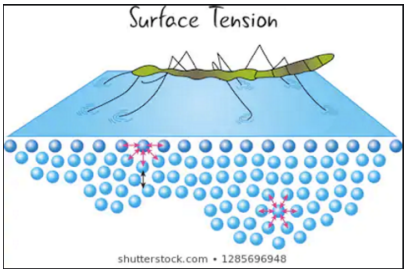
Adhesion

Definitions:

Cohesion - the attraction of molecules of the **same** substance, such as water adhering to water.

Adhesion - the attraction of molecules of **different** substances, such as water adhering to paper.

Surface Tension - As water interfaces with air, the water molecules (because of cohesion) are more attracted to each other and form a surface "skin".



Activity Procedure:

1. For a simple demonstration, tear a piece of paper in half. Hold the two sheets together and let go and watch them part. Next, sprinkle a little water in the middle of each sheet and press together. Hold up by one end and let go. Do they separate? Explain using some of the definitions above.

2. You will be adding a several drops of a dark food color to a glass of water. Before doing the activity, describe how you think the color will move through the water. You can use a substitute of dark juice and an eyedropper or straw. (*Hold the straw upright in a little juice and hold your finger to seal the top of the straw. Lift the straw over the glass of water, keeping your finger in place until you are ready to release.)* Did your prediction match what you saw? You can document by making a video or drawing what you see.

   Explanation: *Food color is hydrophobic. It is at first repelled by the water. Over time, the water is attracting and breaking the food color molecule bonds. As this happens, the color is being distributed throughout the water. When the attraction that water molecules have for food color molecules overcomes the attraction those molecules have for each other, the substance dissolves.*

3. You will be keeping count of drops of water added to a penny until it spills over the sides of the penny. First, write down your prediction of how many drops it will take before overflow. Next, rinse off a penny with water, dry, and place on a paper towel. Using an eyedropper, begin the count as you add drops to the center of the coin and stop when the water spills over the sides. How close was your prediction? Use the definitions to explain what you see.

Explanation: *When water molecules are surrounded on all sides by other water molecules, they create a sphere or ball (perfectly round if in outer space). On Earth, the effect of gravity flattens this ideal sphere into the elongated drop we see as it is dropping. Surface tension and adhesion are also a factor in the drops on the penny shape.*

4. Wipe off the penny, put it back on a paper towel, and spread a drop of detergent over its surface. Now repeat activity 3 adding drops and counting. Was there a difference? How did the water behave?

   Explanation: *Detergent-soap is polar at one end of the molecule and non-polar at the other. Water and anything that mixes with water is hydrophilic. Oil is hydrophobic and non-polar (electric charges are evenly distributed across the molecule). Oil attracts oil. Soap removes dirt and fats by making them soluble in water. Adding soap weakens the surface tension of the drops.*

References

USGS - water properties activities unit to supplement http://ga.water.usgs.gov/edu/waterproperties.html

http://www.stevespanglerscience.com/lab/experiments

Khan Academy for water molecules image
https://www.khanacademy.org/science/biology/water-acids-and-bases/hydrogen-bonding-in-water/a/hydrogen-bonding-in-water

Suggested Age Level: 6th - 9th
Suggested Subject Area (s): Chemistry/Science