

Module 4: The Wonder of Water

Vocabulary:

Cohesion: The phenomenon that occurs when individual molecules are so strongly attracted to each other that they tend to stay together, even when exposed to tension

Electrolysis: using electricity to break a molecule down into its constituent elements.

Hard water: water that has certain dissolved ions in it, predominately calcium ions.

Polar molecule: A molecule that has a slight positive and negative charges due to an imbalance in the way electrons are shared.

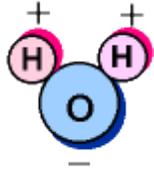
Solute: A substance that is dissolved in a solvent.

Solvent: A liquid substance capable of dissolving other substances.

Water is one of the most interesting molecular structure on our planet. Let's look at some of the Chemical and Physical properties of water that make it unique:

- *Water covers most of the earth's surface*
- *Without water human life, animal life and plant life would cease to exist*
- *Water is one of the most solvent properties on earth, described as the "universal solvent".*
- *It is neither an acid nor a base with a pH of 7*
- *On earth, it is the only substance found in all three states: liquid, solid and gas.*
- *It is the less dense in solid form than it is in liquid form.*
- *Freezing point is 32° Farenheit (0 ° Celcius); boiling point is 212° Farenheit (100 °Celcius)*
- *The heat index of water is high which means it takes a lot of heat to change the temperature of water.*
- *High surface tension is the property of water that a gives it elasticity and the ability to stick together in clumps. Water forms spherical drops instead of teardrops.*

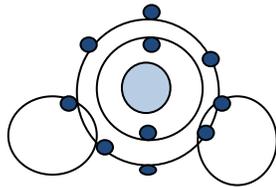
Measurements of water: 1 gallon=4 quarts=8 pints=128 fl. Ounces=231 cu. Inches



Hydrogen has a positive charge; Oxygen has a negative charge. They are attracted to one another because of their opposite charges.

Water is unique because of the bonding between the hydrogen and oxygen atoms. Because the oxygen atom needs another electron in its valence shell, the Hydrogen has one to give. They bond and become a stable molecule.

See the diagram below.



The first electron shell needs 2 electrons to be full. The second shell needs 8. Because an Oxygen atom has 8 electrons it needs 2 more to fill its outer valence shell. This is why the hydrogen bond in a water molecule is so strong.



The adhesive bonding property of water molecules allows for the formation of water droplets (Photo © 2004 [Edward Tsang](#)).

Below are 2 great websites about water:

<http://www.chem1.com/acad/sci/aboutwater.html>

<http://www.physicalgeography.net/fundamentals/8a.html>

Outline for Module 4:

- I. Introduction
 - Water is one of the most necessary substances for life on our planet.
- II. The Composition of Water
 - Molecule made of 2 Hydrogen Atoms and 1 Oxygen Atom
 - Electrolysis is a process we can use to break water down into its separate components. (note experiment)
 - Pay attention to experimental error when you are performing experiments. Be diligent to include all data.
 - Peer Review is a process in the scientific community which can prove or disprove a scientific conclusion.

➤ **What are the things that make a good experiment?** *It is measurable, reproducible, and has at least 1 constant vs. the variable(s).*
- III. Chemical Formulas
 - Chemical formulas are made up of the Chemical Symbols for the elements represented in the molecule.
 - Always capitalize the 1st letter of each element.
 - The subscript tells how many atoms exist in that molecule. No subscript means only 1 atom of that element is present.
- IV. Water's Polarity
 - Water is a polar molecule because it has opposite charges within the atoms that make up the structure of that atom. I.e: Oxygen has a negative charge and Hydrogen has a positive charge.
 - The way the electrons are shared, due to the outer valence shell in the Oxygen atom creates the difference in charges for the Hydrogen and Oxygen Atoms.
 - The chemical bond in the molecule affects the way the water molecule behaves.
 - Chemical bonds link atoms together to form a molecule.
 - Note the comment made about non-polar molecules which do not react to electrical charges.

V. Water as a Solvent

- Water's polarity creates the ability for it to be classified as a "universal solvent". The electrical charges attract the opposite charge in other substances which then causes the molecules to move apart and "dissolve".
- Note: if we used heat or electricity to change the state of the water we *should* see that dissolved particle back as it was to begin with.
- Water can not dissolve non-polar substances.
- Water can dissolve substances with polar molecules or ionic compounds.
- Table salt is an ionic compound. Study Figure 4.5 to understand this concept.
- ** In your experiment you should see that the oil dissolved in the oil, that is because non-polar substances can dissolve in non-polar substances.

VI. Hydrogen Bonding In Water

- Hydrogen bonds link molecules together, they only form between molecules.
- Hydrogen bonds are weaker than chemical bonds.
- This property of water keeps it liquid at room temperature.
- Water molecules are farther apart when in solid state, causing it to float on water in its liquid state. This is because of hydrogen bonding.

VII. Water's Cohesion

- The polarity of water and the existence of hydrogen bonding cause the molecules to be close to one another and stay attached.
- Cohesion causes surface tension, which allows water to have the ability to resist tension.
- Surface tension is necessary for plants, to receive water through the xylem tubes.



Picture of Water Cohesion with wax on glass found at :

http://cwx.prenhall.com/bookbind/pubbooks/hillchem3/medialib/media_portfolio/text_images/CH11/FG11_28.JPG

VIII. Hard and Soft Water

- Hard water has extracted the minerals from the location which it is taken from (or traveled to).—usually calcium and magnesium.
- Soft water is created by adding salt to water which produces an “ion exchange” where the sodium and chloride ions replace the calcium and magnesium ions.

Websites:

Hydrogen Bonding:

http://www.exploratorium.edu/ronh/bubbles/sticky_water.html

http://www.visionlearning.com/library/module_viewer.php?mid=57

Icebergs:

<http://express.howstuffworks.com/wq-iceberg.htm>

Hard Water:

<http://www.hardwater.org/>

http://www.qualitywatertreatment.com/city_water_guide.htm

Surface tension with the “Jesus Lizard”.

http://news.nationalgeographic.com/news/2004/11/1116_041116_jesus_lizard.html

Shape of a raindrop:

<http://www.ems.psu.edu/~fraser/Bad/BadRain.html>

Electrolysis of Water:

<http://www.ice.divched.org/JCEsoft/CCA/CCA3/MAIN/ELECH20/PAGE1.HTM>

Solvency:

http://www.chem4kids.com/files/matter_solution.html