**SC.912.L.18.12: Discuss the special properties of water that contribute to Earth's suitability as an environment for life: cohesive behavior, ability to moderate temperature, expansion upon freezing, and versatility as a solvent.**

**Water** has polarity, in other words, it is a polar molecule, because there is a separation of positive and negative charges in the molecule. This is key to the universality of water as a solvent. Water has a bent shape to it, at one end (the oxygen end) it has a slightly negative charge and at the hydrogen end, it has a slightly positive charge. This is because the oxygen and hydrogen atoms in the water molecule do not share the electrons equally. Since water has this polarity it is able to form **hydrogen bonds**. This is the attraction of the partial positive part of one molecule to the partial negative part of another molecule. Hydrogen bonds are not true bonds. They are weak electrostatic attractive forces between hydrogen and other atoms such as oxygen, nitrogen, or carbon. Compared to covalent and ionic bonds, they are very weak, but due to the sheer number of them, water has some special properties. One water molecule can make as many as 4 hydrogen bonds at one time. This allows water to have the property of cohesion. This is when there is an attraction of molecules of the same substance. Since water has so many hydrogen bonds with itself, it is very cohesive. **Cohesion means “sticking together”**, in this case referring to the water molecules clinging to each other by hydrogen bonds. The bonds pull the outer molecules inward, causing the water to be drawn inward. This allows water to form beads on a surface or allow some insects to walk on water. This is also important in the transfer of water up a tree. The water molecules pull on each other all the way up the tree (in the xylem). Water is considered the “universal solvent”; because of its polarity, it is able to dissolve both ionic compounds (like table salt) as well as some polar molecules such as sugar.

Cohesion also causes water to have a very high heat capacity, the ability to absorb more heat without changing its temperature very much. It takes a lot of heat to evaporate water. The oceans absorb a lot of heat during the day and release it slowly at night. This property of water helps to maintain the Earth’s temperature more stable. Without the water of the oceans, the planet’s temperature would get very high during the day (over 150 degrees Celsius) and extremely cold at night (-100 degrees Celsius), making it impossible for most life forms to survive on Earth.

In addition to the properties listed above, water, unlike all other compounds, water expands when it freezes, making it less dense. This means that ice will float instead of sink. This is extremely important to survival on earth. Imagine a frozen lake; the fish are able to live under the frozen surface. What about the icebergs and polar ice caps, they float on the surface, providing a location for life.

In a solution, all parts are evenly distributed throughout the solution. A **solution** is a uniform mixture of two or more substances evenly dispersed. It is made of two parts, the dissolved substance, called the **solute**, and the **solvent** is what the solute dissolves in. A solution can be:

1. **concentrated** – there is a lot of solute (solid) in relation to the amount of solvent (liquid)
2. **diluted** – there is a small amount of solute in relation to the amount of solvent
3. **saturated** – this is the point that the most solute is dissolved, without being unable to dissolve. If any more solute was added, then it would form a solid.

**Properties of Water Graphic Organizer**

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| **Property of Water** | **Explanation of Property** | **Importance for Life** |
| **Cohesion** |  |  |
| **Universal Solvent** |  |  |
| **Property of Water** | **Explanation of Property** | **Importance for Life** |
| **Less dense as solid** |  |  |
| **High specific heat** |  |  |

1. Plants use water to move vital dissolved nutrients from the roots to the leaves. Which physical property of water allows the water to rise through the plant?
	1. Water expands as it freezes.
	2. Water is an excellent solvent.
	3. Water exhibits cohesive behavior.
	4. Water is able to moderate temperature.
2. Water is essential for life due to its unusual bent polar structure. Which of the following best describes a result of the polar nature of water molecules?
	1. Ionic compounds dissolve easily in water.
	2. The volume of water decreases by nearly half when it is frozen.
	3. Water molecules repel most other substances.
	4. Water molecules repel each other.
3. Water has a much higher specific heat than most other covalent compounds. What do you predict might happen if water had a low specific heat instead?
	1. Flooding would occur and animals would be forced to migrate.
	2. Harmful organisms living in water would reproduce at a rapid rate.
	3. Organisms that are sensitive to changes in temperature would die.
	4. Plants would not have enough water to effectively carry out photosynthesis.
4. Many fish and aquatic plants can survive a cold winter because the layer of ice that forms at the top of the lake insulates the water below and prevents the lake from freezing solid. What unique property of water contributes to this effect?
5. Water absorbs heat when it evaporates and forms a gas
6. Water expands and becomes less dense when it freezes.
7. Water molecules completely separate into ions in solutions.
8. Water forms hydrogen bonds with ions and other polar substances.