Properties of Water Station Lab: Station 1

SB1.d. Explain the impact of water on life processes (i.e., osmosis, diffusion).

Water is everywhere. It makes up about 3/4ths of the surface of the earth. It makes up 50-95% of the weight of living organisms. It is in the air we breathe, the sinks we use and in every cell of the body. Water has special properties that make it unusual and complex. Water has the ability to be a liquid, solid or gas depending on the temperature at which it is found. Each molecule of water is made up of 2 hydrogen molecules and 1 oxygen molecule joined together by a **covalent bond**. Water is a **polar molecule** because the oxygen molecule has a slightly negative charge and the hydrogen molecules have a slightly positive charge. This polarity results in **hydrogen bonds** forming between the slightly negative oxygen and the slightly positive hydrogen among water molecules.

Questions:

1. Illustrate several water molecules connected through hydrogen bonds (check textbook).
2. Explain how the presence of hydrogen ions and hydroxide ions determine the pH in aqueous solutions. Again, you will need to reference your textbook.
3. Draw the pH scale and label the range for acids, bases and neutral substances.

Take a piece of pH testing paper and rip it in half. Dip half into "solution A" and compare to the color of the pH paper to the color of the label (on the vial) to determine the approximate pH. Repeat this process for "solution B"

4. What were the pH values for solutions A and B? Label these on your pH scale from #3.
5. How can buffers influence the pH of a solution?

Next, use a LabQuest 2 digital probe technology to again find the pH values for solutions A and B. Remember to carefully follow the "LabQuest 2 Probe Instructions" sheet when using the probe.

6. How do the pH values compare between the pH testing paper and the digital probe? Calculate the percentage change for <u>each</u> value to make this comparison.

(original value – new value) / original value x 100 = % change

Properties of Water Station Lab: Station 2

SB1.d. Explain the impact of water on life processes (i.e., osmosis, diffusion).

Because of hydrogen bonds, water is attracted to other water molecules like magnets. This is called **cohesion**. Related to cohesion is **surface tension**, a measure of how difficult it is to stretch or break the surface of a liquid.

Part 1: How Many Drops? Materials: Penny, Water, Transfer pipette

1. Predict how many drops you will be able to put on the penny before it overflows by having each person at your table guess. Use the hypothesis format.

Now, let's see how many drops of water you can place on the surface of the penny before it overflows. Drop water from the dropper onto the penny, keeping a careful count of each drop.

2. How many total drops did you get on the penny?
3. Explain your results in terms of cohesion and polarity.

Part 2: How Many Drops with Detergent? Materials: Penny, Water, Pipette, Detergent

With your finger, spread one drop of detergent on the surface of a dry penny.

4. Predict how many drops you think this penny will hold after being smeared with detergent. Will it be more or less than part one and WHY?

Using the same dropper as before, add drops of water to the penny surface. Keep a careful count of each drop.

5. Identify the dependent variable and independent variable in this station's experiment.

6. Propose a hypothesis for how the detergent affects the water? Again, you will need to consider the chemical properties of water in your proposed hypothesis.

7. Describe three examples of cohesion that you would observe in your daily life.

Properties of Water Station Lab: Station 3

SB1.d. Explain the impact of water on life processes (i.e., osmosis, diffusion).

Water has a **high heat of vaporization** - the energy required to convert liquid water to a gas. Unlike other substances, when water is heated, much of the thermal energy that is absorbed breaks hydrogen bonds before heating the water. Water's high heat of vaporization helps moderate the earth's climate. Water also has a **high specific heat capacity**. Specific heat is the heat required to raise the temperature of 1 gram of water 1°C. This also contributes to water's ability to moderate temperatures.

Part 1: Heat of Vaporization

Let's examine the relative heats of vaporization of water and ethanol as follows:

Simultaneously stick one cotton swab into a beaker of water while doing the same with a second cotton swab in a beaker of ethanol. Gently draw thin lines of liquid (a few cm long) with each swab on your bench top and record in your lab notebook how long it takes for each to evaporate.

Questions:

1. Which substance had the higher heat of vaporization?
2. Based on your results explain why water is a much more effective coolant than alcohol for the body. Be sure to use the concept of hydrogen bonds in your answer.

Part 2: Specific Heat Capacity

Let's examine the specific heat capacity of water and ethanol as follows:

Obtain two labeled 20 ml beakers and fill each with 5 ml of either alcohol or water (depending on label). Place both beakers on the hotplate side by side and have a timer ready. Turn the hotplate to "High" and immediately begin timing. You want to record the amount of time it takes for each substance to boil vigorously (i.e., a rolling boil). TURN OFF hotplate and return all items to homeostasis before leaving station.

3. How long did it take for each substance to boil vigorously? Explain this disparity.

Properties of Water Station Lab: Station 4

SB1.d. Explain the impact of water on life processes (i.e., osmosis, diffusion).

Because of its high polarity, water is called the **universal solvent**. A **solvent** is a substance that dissolves, or breaks apart, another substance (known as a solute). A general rule that determines whether a substance will dissolve in a solvent depends upon its polarity. Polar solvents dissolve polar solutes and nonpolar solvents dissolve nonpolar solutes to form a solution.

Part 1: Solubility of Various Solutes in Water

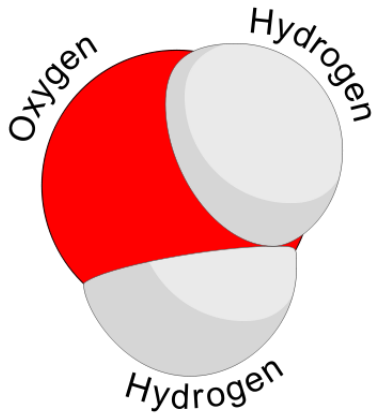
To observe how water behaves as a solvent, you will attempt to dissolve a variety of substances in liquid water. To do so, measure 50 ml of water into each of four 100 ml beakers and attempt to dissolve each substance by thoroughly stirring or swirling. Record the results, noting whether each substance is polar, non-polar or ionic:

Beaker #1 – 0.5 grams of NaCl, also known as “table salt” (ionic)

Beaker #2 – 0.5 grams of sucrose, also known as “table sugar” (polar)

Beaker #3 – 1 ml from a transfer pipet of vegetable oil (non-polar)

Beaker #4 – 1 ml from a transfer pipet of ethanol (polar)



RINSE and return all items before you leave station.

Questions:

1. Which substance(s) did not dissolve completely in water? Why?
2. Compare and contrast the terms polar and non-polar.
3. Explain the importance of water as the main solvent in cells. In your answer be sure to include a detailed description of how the negative and positive ions of water and the solutes interact to “dissolve” substances.

Properties of Water Station Lab: Station 5

SB1.d. Explain the impact of water on life processes (i.e., osmosis, diffusion).

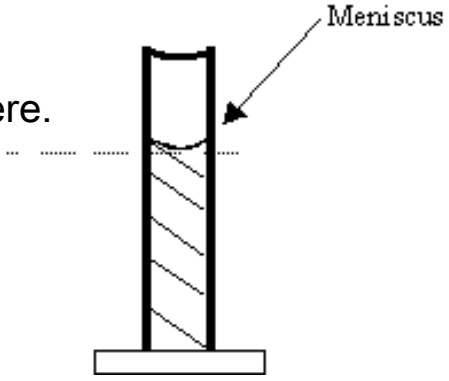
Density: Density is the amount of matter in a given volume (D = M/V). Water is one of the few substances that are less dense as a solid than as a liquid. While most substances contract when they solidify, water expands. This property is once again due to the hydrogen bonding between water molecules.

Examine the block of ice floating in the beaker of water.

1. If ice has a density of 0.92 g/cm^3 then what must be true about the density of the liquid? Draw two schematic diagrams that differentiate between the solid and liquid phases of water. Be sure to label the hydrogen bonds in each diagram.
2. Explain why this property of water is so important to aquatic organisms.

A Comparison: Devise a method to determine the density of the steel rod using the equipment at this station. Hint you will need to use water displacement and remember to always read below the meniscus. You will need to know that 1 ml = 1 cm^3.

3. Explain your method and record your calculations here.



Properties of Water Station Lab: Station 6

SB1.d. Explain the impact of water on life processes (i.e., osmosis, diffusion).

Adhesion: Water clings to non-polar molecules and substances other than water.

Examine the drink and the straw carefully.

1. Describe what happens when you place a straw in a drink.
2. Relate this phenomenon to the water property of adhesion.
3. What organism(s) depend on this property of water? Why?

Next, observe the celery stalks that have been placed in a solution of food coloring and water.

4. Describe any observations that can make about the celery and colored water.
5. Thoroughly explain which two properties of water have caused this phenomenon.

Next, use the computer to navigate to http://ga.water.usgs.gov/edu/adhesion.html.
Read the information on this webpage carefully.

6. Describe the chemical and physical properties that are exhibited on the water clinging to the pine needles.
7. Why is water considered "sticky"?
8. What shape would a drop of water take in outer space and why?

Properties of Water Station Lab: Station 7

COMPLETE THIS STATION LAST!

SB1.d. Explain the impact of water on life processes (i.e., osmosis, diffusion).

Summary

Pulling it all Together

1. List three things that you discovered about water?

2. How do the characteristics of water help the body?

3. Review your answers to the questions from Station 1. Which property of water is represented by each of the following questions? Justify your answers.

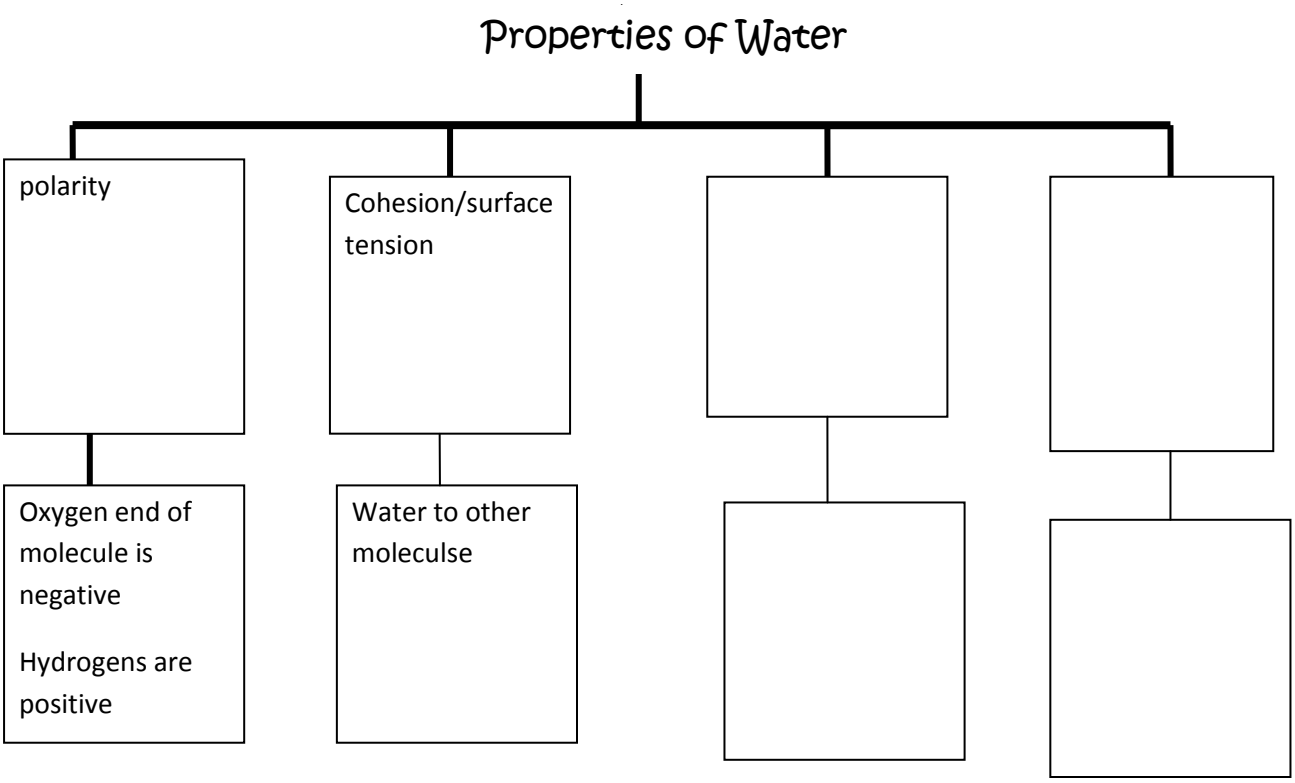
a. How does water rise from the roots of a tree to the very top?

b. How do insects walk on the water?

c. Why does ice float rather than sink?

d. Why do people become seriously ill, or die, if they go without liquid for a long time?

e. How would life in a lake be affected if ice sank and lakes froze from the bottom up?


Properties of Water
polarity
Cohesion/surface tension
Oxygen end of molecule is negative
Hydrogens are positive
Water to other moleculse