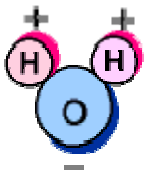
ES 106 Laboratory # 1
PROPERTIES OF WATER

Introduction

What are the physical and chemical properties of water that make it so unique and necessary for living things? When you look at water, taste and smell it – well, what could be more boring? Pure water is virtually colorless and has no taste or smell. But the hidden qualities of water make it a most interesting subject. In today's lab, you will explore some of the properties of water. You will also be introduced to the concept of density as a property of matter.

The Water Molecule's Properties



You probably know water's chemical formula is H_2O. As the diagram to the left shows, that is one atom of oxygen attached to two atoms of hydrogen. The hydrogen atoms are bonded to one side of the oxygen atom, resulting in a water molecule having a positive charge on the side where the hydrogen atoms are and a negative charge on the other side, where the oxygen atom is. Molecules with charge differences such as this are called polar molecules.

Since opposite electrical charges attract, water molecules are attracted to one another, making water kind of "sticky." As the right-side diagram shows, the side with the hydrogen atoms (positive charge) attracts the oxygen side (negative charge) of a different water molecule.

All these water molecules attracting each other mean they tend to clump together. This is why water drops are drops! If it wasn't for Earth's gravity, a drop of water would be ball shaped – a perfect sphere.

Water's Physical Properties

Here's a quick rundown of some of water's properties:

- Water is unique in that it is the only natural substance that is found in all three states – liquid, solid (ice), and gas (steam) – at the temperatures normally found on Earth. Earth's water is constantly interacting, changing, and in movement.
- Water is unusual in that the solid form, ice, it is less dense than the liquid form, which is why ice floats. Notice the density of water at various temperatures in the chart on the following page

Density of Water	Solid (ice)	Liquid
0° C (32° F)	0.917 g/cm^3	0.9998 g/cm^3
4° C (39.2° F)		1.0000 g/cm^3
100° C (212° F)		0. 95865 g/cm^3

- Water has a very high surface tension. It tends to clump together in drops rather than spread out in a thin film. The surface can support small objects that have greater density than water. Surface tension is also responsible for capillary action, which allows water (and its dissolved substances) to move through the roots of plants and through the tiny blood vessels in our bodies.

- The freezing and boiling points of pure water at sea-level pressure are the baseline with which Celsius temperature is measured:

Phase change temperature of pure water at various pressure	▪ Solid-liquid (freezing)	▪ Liquid-vapor (boiling)
Sea level	▪ 0° C (32° F)	▪ 100° C (212° F)
4265 m (14,000 ft) above sea level	▪ 0° C (32° F)	▪ 85.8° C (186.4° F)

- Pure water has a pH of 7, which is neutral, neither acidic nor basic.
- Water is called the “universal solvent” because it dissolves more substances than any other liquid. This means that wherever water goes, either through the ground or through our bodies, it takes along valuable chemicals, minerals and nutrients.
- Water has a high specific heat. This means that water can absorb a lot of heat energy before it gets hot. Water is valuable to industries and in your car’s radiator as a coolant because of this property. The high specific heat of water also helps regulate the rate at which air changes temperature, which is why the temperature change between seasons is gradual rather than sudden, especially near the oceans.

Goals and Objectives

- Be able to define specific heat, surface tension, and polar molecule.
- Be able to define and calculate density.
- Observe the effects of the polar nature of water on its properties.
- Apply the scientific method to identify materials based on their properties.

Useful Websites

- http://www.uni.edu/~iowawet/H_2OProperties.html
- http://www.simetric.co.uk/si_water.htm
- http://www.physicalgeography.net/fundamentals/8a.html

Name_____

Lab Day_____ Time_____

Pre-lab Questions – Complete these questions before coming to lab.

1. Define the following terms.
   A. Density

   B. Polar molecule

   C. Surface tension

   D. Specific heat

2. Calculate the following temperature conversions: Note: $F^0 = \frac{9}{5}C^0 + 32$
   A. 32ºF to ºC

   B. 100ºC to ºF

   C. 46ºF to ºC

   D. 25ºC to ºF

Part A – Exploring Some Properties of Water

For this part of the lab you will explore the surface tension of water.

Activity 1:
Predict the number of drops of water you can fit on a penny. _____
Use the dropper to place water, one drop at a time on the penny until it spills off the penny. How many drops did it hold? _____

Activity 2:
Place a piece of wax paper over a piece of newspaper. Place a few drops of water on the wax paper. Look at the newsprint. What happens to the appearance of the newsprint? Note your observations.

Activity 3:
Carefully place a dry pin on water in a watch glass so the water supports its weight (**Hint**: fill watch glass until the water bulges over the top and gently insert pin from side). While the pin is on the water, gently add a drop of detergent near the pin. What happened to the pin? Note your observations.

Does a pin "float" on water in the same way as a block of wood floats? Describe:

Activity 4:
Tie a piece of thread in a loop (> 1" in diameter) and float it on water in the watch glass. Add a drop of detergent inside the loop. What happened to the thread loop? Note your observations.

Thoroughly clean the watch glass to remove all traces of detergent. Float another loop of thread as before. Predict what will happen if you add a drop of detergent outside the loop.

Try it. Note your observations.

Part B – Which Clear Liquid Is Water? Using properties to identify it.

You are on the Planet WOU and are in need of water. The residents of Planet WOU – the WOLFIANS – do not speak any Earth languages, but you are trying to communicate with them. All that the Wolfians are able to understand is that you need a clear liquid. They do not understand the various properties and characteristics of water that you are trying to explain to them. They bring your group samples of 4 clear liquids that they have located on Planet WOU. You are now faced with a serious predicament. If you drink the wrong liquid, you could become violently ill or die. On the other hand, if you don't get any more water, you will also die. Hence, the conundrum: Which of these liquids is water?

Activity:

Your spacecraft has many testing materials onboard, including a known sample of water, which you can use to explore all the liquids. You check the spacecraft manual for situations of this nature, and identify a series of experiments, tests, or procedures that should enable you to distinguish water from the other liquids with a great degree certainty. In order to be extra sure of your identification of water (after all, your life is on the line), you must also design one other experiment, test, or procedure to confirm the other tests. Your group can use the data table on the following page to summarize your observations. Remember, there is no taste testing, smelling, or touching of the liquids allowed.

Do NOT put any other materials into the large test tubes labeled 1-5.
The samples that you receive in the numbered test tubes are all that you get to use. If you contaminate them or run out, you won't be able to continue your investigations. So read and follow the instructions below.

Carry out your experiments on the liquids in small test tubes, watch glasses, and beakers using as little of the unknown liquids as possible for each test.

After you have completed your experiments be sure to clean up completely, so the equipment is ready for another lab group to use.

Do NOT put any other materials into the large test tubes labeled 1-5.

TABLE 3: Liquid Investigation Data

Question asked:	Known Water sample	Unknown Liquid 1	Unknown Liquid 2	Unknown Liquid 3	Unknown Liquid 4
What is the pH of the liquid?					
Which materials float on the liquid (check: ice, toothpick, ~~oil,~~ and salt)					
Which materials dissolve in the liquid? Use small amount of solid! (check salt, sugar, and baking soda) Note any reactions.	Salt				
	Sugar				
	Soda				
How long does it take for 2.5 mL to evaporate? (Use a small beaker for this test and be very careful!) Is there a residue?					
Student designed test: (describe test in this space, and put results to the right)					

Questions

1. Based on your tests, which sample is most likely water?

2. Indicate which ones you know are not water, and why you know this.

3. How confident are you in your determinations? Briefly explain.

4. Briefly outline the procedure that you followed to solve this problem.

5. Which test was the most effective in addressing the needs of the problem? Explain why you think it was so effective.

6. Which test was the least effective in addressing the needs of the problem? Explain why you think it was so ineffective.

Name_____

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POST-LAB ASSESSMENT

1. Suppose that you are doing dishes after a greasy meal. You take a greasy pan and fill it with water. A thin film of grease completely covers the surface of the water in the pan. You place a drop of Dawn dishwashing liquid in the middle of the pan and the grease shoots away from the drop towards the sides of the pan. "Wow!" you exclaim to yourself "Dawn really does take grease out of the way, just like in the commercial." Using what you observed in today's lab, what actually happened? Do you think this behavior would only happen with Dawn, or would other dishwashing liquid produce this effect as well? (If you have never seen the Dawn commercial on TV, try this experiment at home with a greasy pan.)

2. Imagine that you have a 2 inch long, ½ inch diameter rod made of a clear material. Your goal is to determine what material makes up the rod. Your first guesses as to the composition of the rod are glass and ice. To test these hypotheses, you place the rod in a beaker of water and it sinks to the bottom.

a. Could the rod be made of ice?

b. Could the rod be made of glass?

c. After this experiment, have you uniquely determined the composition of the rod, or is there another clear material in addition to glass that would sink to the bottom of a beaker of water? What else could it be?

d. Can you think of a test to distinguish between this material and glass?