**Properties of Water – Teacher’s guide**

**Purpose:**

Water is everywhere. It is used in every single science from Physics to Astronomy, Biology and beyond. Understanding the fundamental properties of water is a key component to understanding details in future classes.

The amazing properties of water are taken for granted every day. Learning about how precious water is can also allow students to see that we are an extremely fortunate planet to have so much of this rare resource. There is no substitute for water in daily life, and without it life would not exist. If students can understand this and how unique water is, it could help open up their eyes to water management and conservation as well.

**Objectives:**

Students will be able to define, identify and explain the properties of cohesion, adhesion, and capillary action as seen with water. Students will also be able to understand the term “surface tension”

Students will be able to apply this knowledge to the outside world. Examples: How these properties allow tall trees to grow leaves at the very top.

Students will understand the difference between polar and non-polar molecules.

Students will be able to experimentally discover that mixing water with other substances can change it’s density.

**State Standards:**

• 11.A.4b – Conduct controlled experiments or simulations to test hypotheses.

• 11.A.4c – Collect, organize and analyze data accurately and precisely.

• 12C – 3 – 3.Apply scientific inquiries or technological designs to examine the chemical and physical characteristics of matter, constructing and discussing models and charts that explain these properties, investigating the relationships among atoms, molecules, elements, and compounds, classifying objects and mixtures based on these properties, explaining the organization of elements in the Periodic Table, or investigating the properties of gases at varying temperatures and pressures.

**Materials:**

**FOR TEACHER:**

* 3-4 long magnets to show cohesion and adhesion

**FOR LAB STATIONS:**

1. **Surface tension of water**
   1. 2 shallow dishes (agar plates work). One dish half filled with normal tap water. The other dish half filled with heavy salt water
   2. Paper clips
   3. Paper towels
2. **Water as a solvent**
   1. 8 empty 150 ml beakers
   2. At least 50 ml of veg oil
   3. Pure tap water in a large beaker (300-400 ml)
   4. Table salt (1 cup)
   5. 2 stir rods
   6. 2 graduated cylinders
   7. ½ tsp measuring spoon
   8. Paper towels
3. **Cohesion**
   1. 2-3 pennies
   2. 2-3 eye droppers
   3. 150 ml beaker filled with tap water
   4. 150 ml beaker filled with salt water
   5. Paper towels
4. **Adhesion**
   1. Small dish. A watchglass or empty agar dish can work
   2. Either capillary tubing (if able) or a very thin clear straw
   3. Lightly colored water (green is preferred).
   4. Paper towels
5. **Density**
   1. 3 colors of dye, blue, red and yellow
   2. Pure water (dyed yellow)
   3. Lightly salted water (dyed red)
   4. Heavily salted water (dyed blue)
   5. 2-3 small tubes to place experiment in.
   6. 3, 150 ml beakers for storage of dyed water
   7. Paper towels
   8. Clay
   9. 3 droppers

**Length of lab:**

|  |  |
| --- | --- |
| Portion of lab | Time allotted |
| “What do you know” worksheet | 3 min |
| Lecture/ class participation | 10-12 min |
| Lab station exercise | 5 min each station. Approx 25 min total |
| Wrap-up | 5 min |

**Safety issues:**

The only safety issues that are in this lab are beakers breaking or minor eye irritation if salt water gets splashed. For this reason students need only to wear eye goggles.

**Prelab questions/ postlab questions:**

Pre-lab discussion outline:

We will begin today by talking about a few different properties of water. What are the three states that we find water in naturally? Ice, liquid, water vapor.

What are the temperatures associated with these? What is the freezing point in both Celsius and Fahrenheit? 32 F, 212 F, 0 C, 100 C

Alright, so we know the freezing point of water. What happens to water when it freezes? Does it become more or less dense than the surrounding liquid water? Less. Why do you think that is? As the water freezes, H2O molecules spread out slightly from each other and form extremely small air pockets. This is a very rare ability. Normally atoms spread out as they heat up, and get closer together as they cool down. How do you think this ability is important to life on earth? Think about a lake, or a stream when it freezes over in winter.

Now lets look at the water atoms themselves. Does anyone know how to draw a water atom? Have student come up to the board. Good. Now water atoms are special, they are what we call *polar*, meaning they have a positively charged end and a negatively charged end. Can anyone come up here and draw which end is positive and which end is negative? Have student come up to the board. Good. Now, if I have more than one water molecule… say 4 or 5 of them, how would they arrange themselves together? Can I have a volunteer? Have student come up to the board. Great! This is a property that is extremely useful for water. Can you think of any other common objects that are polar? Magnets. Correct.

We will now move on to a quick review of cohesion and adhesion, and we will use magnets to help us understand these concepts. For this part of the lecture I want you to imagine that each one of these magnets is 1 water molecule. Which end represents north, if north is positive? Which end is south (negative)? Lets look at the word co-hesion.

*Cohesion*. What do we think this word means? Well let’s dissect it. What does the prefix co- mean? What does co-operation mean? CO- means “together” or “likeness”. “hesion” means….”to stick”. So the word cohesion means to stick together, but more specifically it means to stick together to like objects. So if I take these two “water molecules” and stick them together that shows cohesion. They are two alike compounds that are sticking together.

Adhesion means close to the same thing, however instead of the same kind of objects sticking together, different objects are sticking together. So, if I stick a “water molecule” onto a chair or the board, that is adhesion because there are two different compounds or objects sticking together.

Are there any questions so far? Please feel free to ask before we begin lab. You now have all the tools needed to start experimenting! Please get into groups of 2 and I will assign you to a lab station. You will have 5 minutes at each station so make good use of your time and don’t dilly-dally.

Post-lab discussion:

These questions will be review of some of the more difficult concepts that were addressed during the lab, particularly why the paper-clip could not float in salt water.  
\*\*\*The reason is because once sodium chloride dissolves into water, the sodium and chloride begin to bind to the positive and negative areas of water molecules keeping them from binding to one another, therefore decreasing surface tension.

**Lab set up:**

Students will work in groups of two. At each station they will have 5 minutes to complete the experiment and answer the questions. I will have lab set up before students come to class. In the laboratory room here is where each station will be located:

Center table

DO

O

R

DOOR

Station 1

Station 5

Station 4

Station  
3

Station  
2