

# Properties of Water Rotation Lab

<b>Grade Level:</b>	9 <sup>th</sup> grade	<b>Subject:</b>	PreAP Biology	<b>Prepared by:</b>	Jessica Svoboda, Modified from Jennifer Giannou
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Objective	Warm Up	Reminders	Key Concepts
Investigate the properties of water	Draw a food chain with 3 trophic levels and label the secondary consumer, heterotrophs and autotrophs (See Critical thinking for explanation)	Homework: Finish reading/analytical questions in water lab  Test corrections: start next week, end on 10/2  Next Exam: 10/23 Turn in: Predator Prey	Read about the different characteristics of water and answer questions to retain information Introduce the biological molecules most common in life Perform comparative experiments to explore the properties of water that make it different from other compounds Explain how water is important to life

TEKS: B.9.A. compare the structures and functions of different types of biomolecules, including carbohydrates, lipids, proteins, and nucleic acids;

Materials:

Every station: A reading about that particular property of water

Station 1: Two water molecule building sets

Station 2: two vials with caps containing colored salt and water, two vials with caps containing colored salt and vegetable oil

Station 3: Two Dixie cups – one filled with water, the other with rubbing alcohol, two pennies, pipettes and paper towels

Station 4: A beaker filled with ice, a cup half-way full of water and a cup of vegetable oil with a polymer ball inside

Station 5: 6 graduated cylinders filled with 20mL of water, paper towels cut into 1in, 2in, and 3in strips

Station 6: 4 bowls – 2 filled with water, the other two filled with soapy water, paper clips, plastic forks, paper towels

Station 7: Q-tips, one cup with rubbing alcohol, one cup with water, a timer/stopwatch

Activities: **Independent Practice** – Modeling – **Group Practice** – **Check for Understanding**

(5 min – before bell)

Students have their binders out and are writing down the objective and warm up for the day.

(3 min)

Students are writing down their objective and warm up and turning in their homework from the day before.

(5 min): Pass out calendars

"We are starting a new unit on Biomolecules! Please take out your new calendar so we can highlight a few important dates." Put the calendar on the over head document cam and review the important dates for the unit as well as a simple overview of what we will be doing this next month. **Modeling** and **Group practice**. "Does anyone have questions about what we are doing this month or how the test will be set up next time?" (Students will want to know when they have to come to school on PSAT day. They will also ask a lot about the previous test).

(15 min): Pass out notes sheet

"Today we will be taking some notes on biomolecules, both organic and inorganic. Please open your iPads and log into joinme so you can see my screen." Wait for everyone to get their iPads. "What kind of biomolecules have we explored in previous units?" **Check for understanding** (Students should be able to link the carbon and nitrogen cycles to biomolecules). Go through the notes with the students, explaining important features BEFORE they start writing. Interject with examples and comparisons

(5 min): Prepare for water lab

"Close the iPads and please return them to the center of your table. Also, clear everything off your desks so they don't get ruined or wet during the lab. Keep a pen or pencil out to write on the water lab sheet. I am going to put a bin of materials on your desk, please leave them alone until I give you instructions."

Gather the iPads and place materials on each table.

(5 min): Explain rotation lab

We are going to go through 7 stations to explore each individual characteristic of water that makes it different to other molecules. You will start at the station that is at your table. You will be working with your shoulder partners. The first thing you do at your station is read the yellow sheet and answer the reading questions on your handout. Do not start any experiments until you have completed your reading and reading questions. Next, you will move on to the experiment which includes very specific instructions on your yellow sheet. There are also supplemental tips at certain stations to make sure you are completing the experiment successfully and not ruining any variables for the next group who performs the same experiment": GIVE AN EXAMPLE. "There are also questions that you will need to answer when completing the experiment. These questions should be filled as you do the experiment or after completing the experiment. Finally, you will clean up your station and return it as you found it. Put any used paper towels in the trash bin. When you finish the station, you have analytical questions to complete. If you have time, do these after each station. If you do not complete them now, you may finish them for homework. For now, focus mainly on reading the description, answering the reading

questions, completing the experiment and answering the experiment questions and then cleaning your stations before you move to the next one. The analytical questions can be completed at a later time if necessary.” **Modeling**

Have each shoulder partner explain to the other the instructions of the lab. **Check for understanding**

(56 min): Station rotations

Students move through the stations and complete the instructions. There will be 8 minutes for each station, 7 station rotations total. **Group Practice**

(4 min): Clean up and recap

Students are required to clean up their lab area and finish any questions they missed. The student with the longest hair will throw away any used paper towels in the trash bin.

Guiding Critical Thinking:

The warm up question is an attempt to spiral information from the last unit. A lot of students missed questions on the last test involving the identification of heterotrophs and consumers. By requiring the students to draw a food chain and identify the appropriate heterotrophs and consumers, they are combining synthesis with classification to better understand the concepts.

Students are asked to think critically about the properties of water and how they apply to the maintenance and improvements of life. Instead of simply giving the students the information about water, they are required to work in groups to discover the properties of water with hands-on manipulatives that accompany a short reading.

Differentiation:

Learning Style	Accommodations
Students get the visual from the notes and readings	Students have the iPads for note taking if they cannot see the board  We have special “zoom in” options for those who cannot use the microscopes effectively
Students get the verbal from reading the notes aloud and conversations with shoulder partners	
Students get the kinesthetic from moving through the stations and performing comparative experiments	

Assessment:

Students will turn in their water rotation lab the next day, after completing the analysis questions.

Formative assessment comes from completing individual sections of the lab before moving to the next station.

## Reflection:

There are a lot of things we needed to change in terms of the lab set up and the stations themselves.

First, we need to give the students more time at each station. Perhaps this was not the best day to have notes AND stations. On the “B” day classes, we switched to give students two days to finish the lab and that seemed to work out a lot better. We concluded that the students could complete the stations with about 10 – 12 minutes at each station. However, the time limits should not be a problem since we plan to remove and combine some stations.

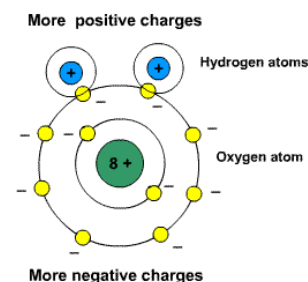
Next we needed to combine or completely remove some stations. This problem arose because some stations required information from other stations and the rotation schedule was not conducive to applying the information to other stations. For example, some students had not visited the cohesion/adhesion station before getting to the capillary action station. Cohesion and adhesion are the two properties responsible for capillary action and if the students had not yet been to the cohesion/adhesion station, they were unable to answer any of the questions relating to capillary action. We concluded that it would be best to combine the cohesion, adhesion and capillary action stations. To accomplish this efficiently, we would use fragile capillary tubes inside small cups instead of paper towel strips in graduated cylinders. The tubes would cut down the time needed for the water to travel up the tube and could be sitting aside while the students interacted with the pennies in the cohesion and adhesion section.

Finally, we chose to remove the station materials for the station explaining that water is less dense as a solid than as a liquid. The materials became messy and hard to clean up before the next group arrived to the station. The students were also very confused about the polymer ball inside the vegetable oil. For this reason, we chose to remove the materials associated with the station but keep the readings and the questions.

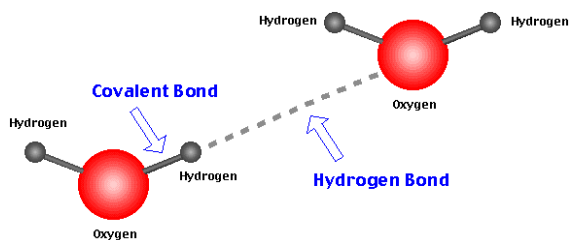
## STATION 1 – Water is a polar molecule and has a very unique structure.

A water molecule, because of its shape, is a polar molecule. That is, it has one side that is positively charged and one side that is negatively charged. The molecule is made up of two hydrogen atoms and one oxygen atom. The bonds between the atoms are called covalent bonds, because the atoms share electrons. The hydrogen atoms have one electron each. Because they share those electrons with the oxygen

atom, the electrons tend to stay close to the oxygen atom and the outside of the hydrogen atom tends to be positively charged. The oxygen atom has eight electrons. Most of those tend to stay away from the hydrogen atoms, and cause the outside of the oxygen atom to have a negative charge.



When two water molecules get close together, the polar forces work to draw the molecules together. The oxygen atom of one water molecule will bond with hydrogen atoms of other water molecules. These bonds are called hydrogen bonds.



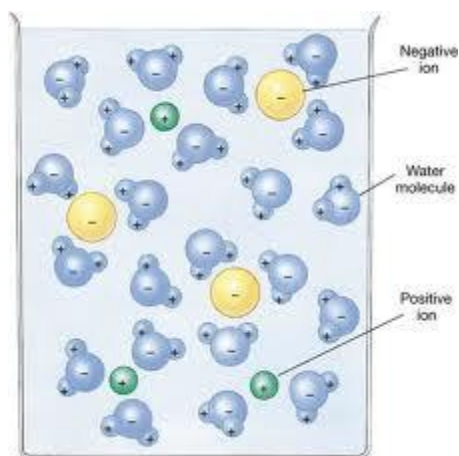
Hydrogen bonds are not as strong as covalent bonds, but they are strong enough to bind water molecules together and give water its unique characteristics. (An analogy concerning the bonds is that the covalent bonds are like a strong glue bond while the hydrogen bonds are like the bond between two toy magnets).

### Activity: Read all instructions before conducting the activity

1. Observe the model of a molecule of water and complete the questions that pertain to the model on your student worksheet.

## STATION 2 – Water is the universal solvent.

**Solutions and suspensions:** Water is not always pure – it is often found as part of a mixture. A mixture is a material composed of two or more elements or compounds that are physically mixed together but not chemically combined. Salt and pepper stirred together constitute a mixture. So do sugar and sand. Earth's atmosphere is a mixture of gases. Living things are in part composed of mixtures involving water. Two types of mixtures that can be made with water are solutions and suspension.



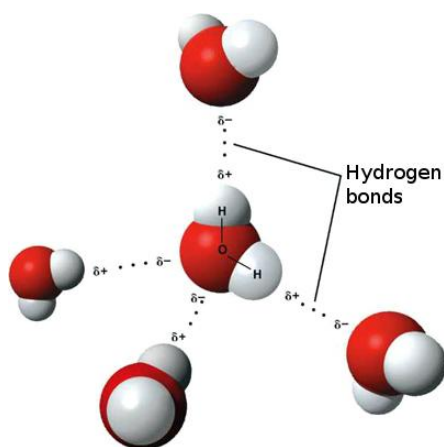
If a crystal of table salt is placed in a glass of warm water, sodium and chloride ions on the surface of the crystal are attracted to the polar molecules. Ions break away from the crystal and are surrounded by water molecules. The ions gradually become dispersed in the water, forming a type of mixture called a solution. All the components of a solution are evenly distributed throughout the solution. In a salt-water solution, table salt is the solute, the substance that is dissolved. Water is the solvent – the substance in which the

solute dissolves. Water's polarity gives it the ability to dissolve both ionic compounds and other polar molecules, such as sugar. Without exaggeration, water is the greatest solvent on Earth.

### **Activity: Read all instructions before conducting the activity**

1. Shake and observe the test tube that has oil plus salt.
2. Shake and observe the test tube that has water plus salt.
3. Answer the questions on your student worksheet.

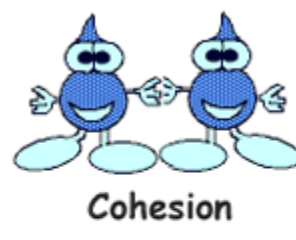
## STATION 3 – Water has the properties of adhesion and cohesion.



A single water molecule may be involved in as many as four hydrogen bonds at the same time. The ability of water to form multiple hydrogen bonds is responsible for many of water's properties. Cohesion is an attraction between molecules of the same substance. Because of hydrogen bonding, water is extremely cohesive. Water's cohesion causes molecules on the surface of water to be drawn inward, which is why drops of water form beads on a smooth surface. Cohesion also explains why some insects and spiders can walk on a pond's surface.

Adhesion is an attraction between molecules of different substances.

Have you ever been told to read the volume in a graduated cylinder at eye level? The surface of the water in the graduated cylinder dips slightly in the center because the adhesion between water molecules and glass molecules is stronger than cohesion between water molecules. Adhesion between water and glass also causes water to rise in a narrow tube against the force of gravity. This effect is called capillary action. Capillary action is one of the forces that draw water out of the roots of a plant and up into its stems and leaves. Cohesion holds the column of water together as it rises.



### Activity: Read all instructions before conducting the activity

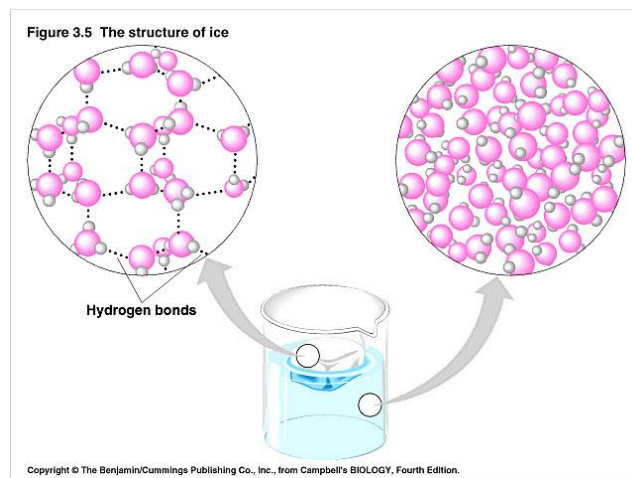
1. Obtain a clean penny.
2. Using the appropriate pipette, count how many drops of **water** can fit on a penny before spilling over. Record in your data table.
3. Make a drawing of the penny + water on your student sheet (before it spilled over – you may have to repeat the experiment).
4. Clean off the penny.
5. Using the appropriate pipette, count how many drops of **rubbing alcohol** can fit on a penny before spilling over. Record in your data table.
6. Make a drawing of the penny + rubbing alcohol on your student sheet (before it spilled over – you may have to repeat the experiment).
7. Clean off the penny.

## STATION 4 – Water is less dense as a solid than a liquid.

Water is one of the few substances that are less dense as a solid than as a liquid. In other words, ice (water's solid form) has the ability to float on liquid water. While other materials contract and become more dense when they solidify, water expands into an evenly distributed crystalline structure. This is due to the hydrogen bonds inside water molecules. The hydrogen bonds keep the molecules at "arms-length," far enough apart to make ice just dense enough to float on the liquid surface. When ice absorbs enough heat

for its temperature to rise above 0°C, hydrogen bonds between molecules are disrupted and changed from "arms-length" to shorter, more easily breakable bond formations.

The ability of ice to float due to its lower density is an important factor in making the environment suitable for life. If ice sank, then eventually all ponds, lakes and even oceans would freeze solid, making life as we know it impossible on Earth. During summer, only the upper few inches of the ocean would thaw. Instead, when a deep body of water cools, the floating ice insulates the liquid water below, preventing it from freezing and allowing life to exist below the frozen surface. Besides insulating the water below, ice also provides a solid habitat for animals such as polar bears and seals.



### Activity: Read all instructions before conducting the activity

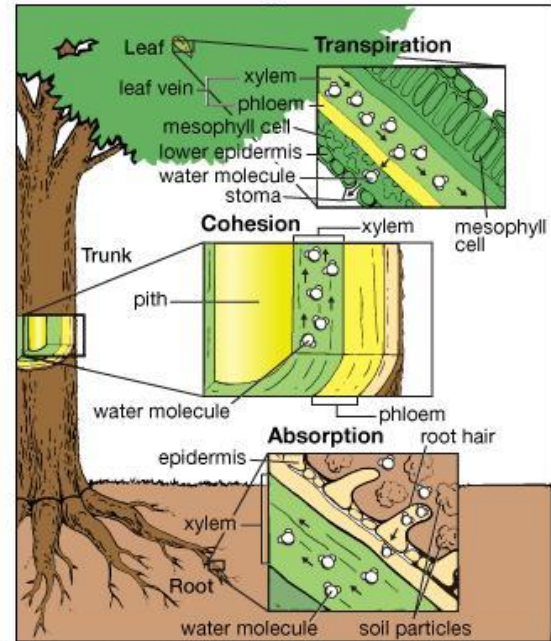
1. Observe the cup with vegetable oil and the polymer ball.
2. Observe the cup with the water and the ice.



## STATION 5 – Water is important for capillary action.

Water molecules are attracted to one another by a force called cohesion. Because of cohesion, water molecules have a tendency to form hydrogen bonds with each other. Water molecules can also form hydrogen bonds with other substances. This results in a force called adhesion, which is the attraction between unlike molecules. The tendency of water to rise in a thin tube is called capillary action. Water is attracted to the walls of the tube, and the water molecules are attracted to each other. The thinner the tube, the higher the water will rise inside it. Plants use capillary action in their xylem to suck water from the ground against the force of gravity.

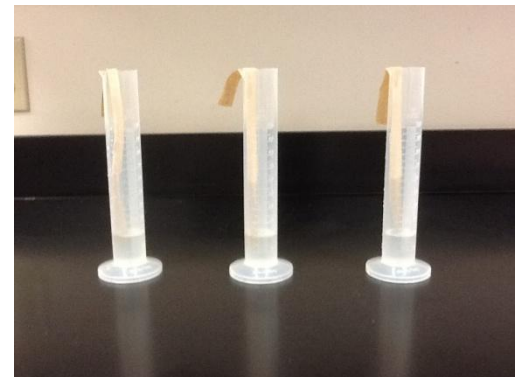
How water moves through a tree



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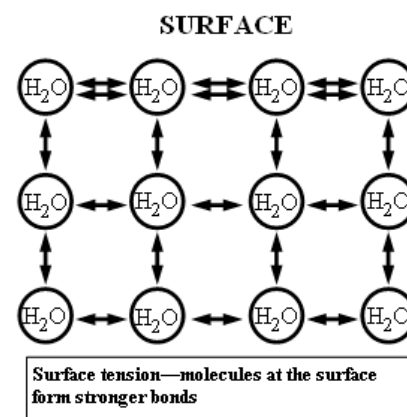
### Activity: Read all instructions before conducting the activity

1. Cut a paper towel into three different widths: 1cm, 2cm, 3cm. Keep the length the same for all the paper towels, and make sure there are no folds in the towel.
2. Fill three graduated cylinders with 20 mL of water.
3. Place the paper towels in separate graduated cylinders just until the towel touches the water, and fold it over the edge of the graduated cylinder.
4. Time the movement of water up the paper towel for **one minute**.
5. Take out the strips of paper and measure (in centimeters) how far the water moved up each towel.



## STATION 6 – Water has a strong surface tension.

The cohesive property of water gives it a high surface tension. Surface tension describes the “stickiness” of water molecules on the surface of water. The attraction of the water molecules creates a strong film on the water’s surface. Surface tension allows water to hold up materials heavier and denser than itself. For example, the high surface tension of water enables a paper clip to float on the surface of water, and also allows some insects to walk on the surface of water.



**Activity: Read all instructions before conducting the activity**



**Figure 5**



**Figure 5a**



**Figure 5b**

1. Take a paperclip, and using the fork, place it gently on the surface of the water.
2. Continue adding paper clips and record the maximum number of paperclips you and your partner were able to add without any of the clips falling to the bottom.
3. Repeat the same procedure above, but instead use soapy water.
4. Answer the questions on your student worksheet.

## STATION 7 – Water has a high heat of vaporization

The heat of vaporization is the quantity of heat a liquid must absorb for 1 gram to be converted from a liquid to a gas. It can take twice as long for water to evaporate than liquids such as ammonia. This property is the result of hydrogen bonds, which must be broken in order to turn water into a gas.

As a liquid evaporates, the surface of the liquid that remains behind cools down. This evaporative cooling occurs because the “hottest” molecules are the most likely to leave as a gas. Evaporative cooling of water contributes to the stable temperature of lakes and rivers and also provides a mechanism that prevents terrestrial organisms from overheating. For example, evaporation of sweat from human skin dissipates body heat and helps prevent overheating on a hot day when excess heat is generated by lots of activity. High humidity on a hot day makes one feel uncomfortable because the high amount of water vapor in the air prevents the evaporation of sweat from the body.



### Activity: Read all instructions before conducting the activity

1. At your station you will find two containers with a cotton swab soaking in a liquid.
2. Have your partner swab a small area on the inside of your left arm with the cotton swab soaked in water.
3. Time how long it takes for the water to evaporate.
4. Have your partner swab a small area on the inside of your right arm with the cotton swab soaked in rubbing alcohol.
5. Time how long it takes for the alcohol to evaporate.
6. Repeat the above procedures on the other partner.

Name \_\_\_\_\_ Date \_\_\_\_\_ Per \_\_\_\_\_  
preAP Biology

## Properties of Water

Write everything you know about water this box.

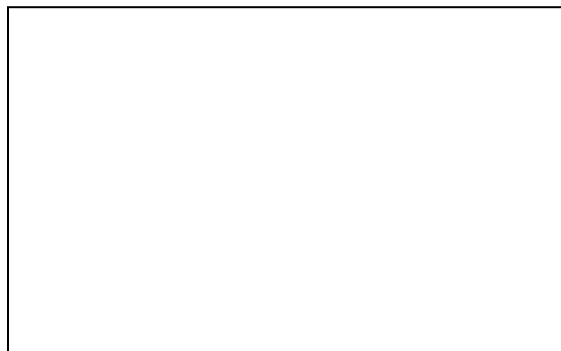
### **STATION 1 – Water is a polar molecule and has a very unique structure.**

Answer the following questions from the reading provided.

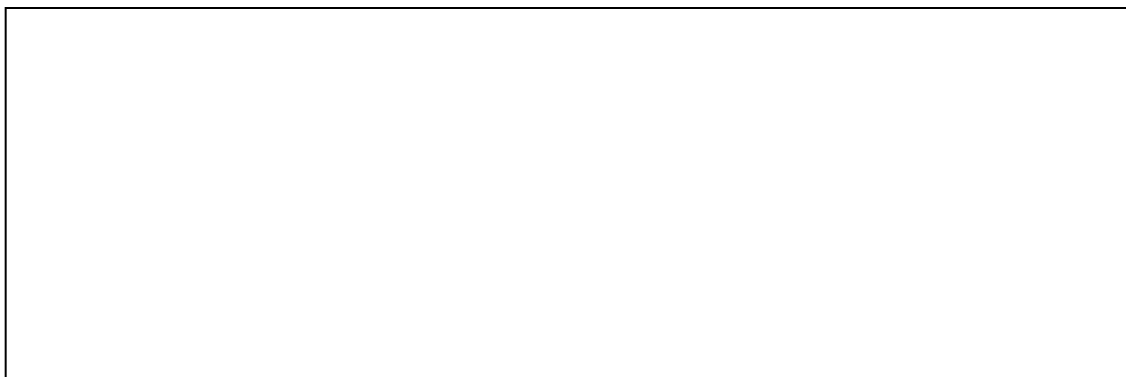
1. What is a polar molecule?
2. Name the elements that make up water.
3. What charge does the hydrogen atoms have in a molecule of water?
4. What charge does the oxygen atom have in a molecule of water?
5. The \_\_\_\_\_ atom of one water molecule will bond with \_\_\_\_\_ atoms of other water molecules.
6. What are the bonds called between two hydrogen atoms?

Answer the following questions after completing the activity.

1. Draw one molecule of water and label the hydrogen and oxygen atom. Label the positive (+) region of the molecule and the negative (-) region of the molecule.



2. Draw 5 molecules of water bonded together with hydrogen bonds. Label one hydrogen bond, oxygen atom, and hydrogen atom.



### **Analysis Questions**

Explain why it is important for hydrogen bonds to be weak bonds instead of strong bonds.

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## **STATION 2 – Water is the universal solvent.**

**Answer the following questions from the reading provided.**

1. Define mixture.
2. What are the two types of mixtures?
3. Define solute.
4. Define solvent.
5. Why is water considered the greatest solvent on Earth?

**Answer the following questions after completing the activity.**

1. Describe the appearance of the test tube with oil and salt. (Use complete sentences and be detailed)

2. Describe the appearance of the test tube with water and salt. (Use complete sentences and be detailed)

### Analysis Questions

Up to 60% of our body is made up of water. Describe the significance of water being a universal solvent in our bodies.

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### **STATION 3 – Water has the properties of adhesion and cohesion.**

Answer the following questions from the reading provided.



1. How many hydrogen bonds can a single water molecule have?
2. Define cohesion.
3. Define adhesion.

Answer the following questions after completing the activity.

How many drops can fit on a penny?

	Water	Rubbing Alcohol
Number of Drops that Fit on a Penny		

What does the solution look like on the penny?

Water	Rubbing Alcohol
	

1. Explain why more water drops could fit on a penny when compared to rubbing alcohol.

2. What property of water allows the water to stick to the penny?
3. What property of water allows the water to form a dome-like structure on top of the penny?

### **Analysis Questions**

Describe an example of cohesion and adhesion that you might observe during your daily life.

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## **STATION 4 – Water is less dense as a solid than a liquid.**

**Answer the following questions from the reading provided.**

1. Why can solid ice float on liquid water?
2. When a lake freezes, how does the density of water prevent all of the living organisms in the lake from freezing as well?

**Answer the following questions after completing the activity.**

1. Describe why the polymer ball is at the bottom of the vegetable oil.
2. Describe why the ice floats on the water.

### **Analysis Questions**

Imagine a world where ice was more dense than liquid water. What would this world be like? What would the consequences be for life in your local freshwater streams and lakes.

## **STATION 5 – Water is important for capillary action.**

**Answer the following questions from the reading provided.**

1. What two properties of water contribute to capillary action?
2. How does water move up the thin walls of a tube? Specifically, what is it sticking to?

**Answer the following questions after completing the activity.**

	Distance the Water Moved (centimeters)
1cm Paper Towel	
2cm Paper Towel	
3cm Paper Towel	

### **Analysis Questions**

Explain why the vessels that transport water in trees must be very small in diameter.

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## **STATION 6 – Water has a strong surface tension.**

**Answer the following questions from the reading provided.**

1. How does water hold up materials that is heavier than itself?
2. What property of water gives it a high surface tension?



**Answer the following questions after completing the activity.**

	Plain Water	Soapy Water
Number of Paperclips that floated		

1. What property of water allows the paper clips to be attracted to the plain water?
2. How did the soap affect the paper clip's ability to float?

**Analysis Questions**

Explain why this property of water is essential for organisms like water bugs.

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**STATION 7 – Water has a high heat of vaporization**

**Answer the following questions from the reading provided.**

1. Define heat of vaporization.
2. What causes water to have a high heat of vaporization?
3. What happens to the surface when water evaporates?

**Answer the following questions after completing the activity.**

	<b>Time (seconds)</b>
<b>Water</b>	
<b>Rubbing Alcohol</b>	

**Analysis Questions**

1. How does water's high heat of vaporization help you feel cooler when you sweat?
2. Describe the importance of high heat of vaporization to ecosystems.

**Tips:**

Keep the pipets in their designated solutions.

Do NOT use the pipet for anything other than its original use

Mixing solutions will cause inaccurate results and ruin the station

Dry the penny after each use with provided paper towels

Dispose of paper towels in Trash bin provided

**Tips:**

Only put the ice in the water cup, DO NOT put ice in the oil cup

Keep the table and materials dry with paper towels

Dispose of paper towels in Trash bin provided

**Tips:**

Use the strips provided, one in each cylinder

Place the strip in the cylinder so that only the base of the strip is touching the very top of the water

Throw away the strips in the Trash bin provided

DO NOT put used strips in with unused strips

**Tips:**

Make sure forks and paper clips are completely dry before testing the experiment

Make sure the fork is completely flat and level when entering the water

Make sure the fork is completely vertical when exiting the water

Dry forks and paper clips after every use

Put used paper towels in Trash bin provided