PSI: PHYSICAL SCIENCE INVESTIGATION

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GREAT LAKES Science Center

Teacher's Lesson Description

Title	**Big Deal**
Brief Description of the Segment	Dante will carry out several demonstrations which will demonstrate unique properties of water, principally but not exclusively, surface tension. Classes who seek more depth in the topic may explore adhesion, specific heat, and the structure of the water molecule.
Time Needed	One class period for surface tension; one or two more for additional properties
Ohio Science Benchmarks Addressed	•Grades 6-8 PS Benchmark A •Grades 6-8 SI Benchmark B
Ohio Grade Level Indicators Addressed	•Grade 7 ES Indicators 1,3 •Grade 7 SI Indicator 1, 7
Concepts Developed	Water is unique among liquids in the natural environment. Surface tension is a property of water that can be investigated. OPTIONAL: adhesion, heat of fusion, heating curve, heat of vaporization
Lesson Rationale	Students use discrepant events embedded in the surface tension demonstrations to learn how water stands virtually alone with respect to its physical properties. Students who do the heating curve will see how graphing data can clearly display real life phenomena. Students who have the opportunity to see electrolysis in action will have a clear example of the difference between a compound (water) and its constituent parts (hydrogen and oxygen).
Background Knowledge for Teachers	Familiarity with the physical and chemical properties of water.

Classroom Procedures	1. SURFACE TENSION •Drops of water on a penny… Using a dropper and a clean penny, count how many drops of water you can add to the penny's surface until the surface tension is broken and the water flows off. 40 pr 50 drops are normal, and some students will have many more. As an extension, try it again, stop after perhaps 20 or 30 drops, and touch the water gently with a soapy surface. Soap destroys the surface tension and the water will stream off. •Pennies in a cup…. the same principle as above. Fill a paper cup with water all the way to the rim, perhaps a little above if you have a steady hand. Add pennies to the water, watch the bulge on top of the rim grow, and be sure to drop them in gently, edge first. See how many pennies you can add until the surface tension breaks. •Staple on surface…. Carefully place a single staple on the surface of water. Discuss why it does not sink. Note the relationship of this demonstration to the capabilities of some insects to walk on water. Now, add a drop of soap solution (dish detergent works well) to the water, but not on the staple. The staple will sink (it sometimes takes several seconds) because the soap destroyed the surface tension. •Inverted glass and screen…. Repeat the demonstration shown in the video. The screen will hold back the flow of the water from the glass. This may have to do with adhesion as well as surface tension. •Color streaming…. Place a teaspoon or so of corn starch into a dish of water and mix it in. Once the solution is homogeneous and still, spot three drops of food coloring in a widely spaced triangle on the surface. Now place some soap in the middle of the water's surface. The colors will stream rapidly in all directions as the surface tension is broken. 2. ADHESION •Use two small, identical, flat pieces of glass, Moisten the surface of one and place the two flat pieces together. It will be very difficult to pry them apart due to water's property of adhesion. •The toothpick star…. Use five flat wooden toothpicks. Snap each of them in half but not so much that the actually break in two. Work on a flat, non-porous surface. You should have five broken

	(but not separated) toothpicks. Make each of them into an acute "V" shape, and place them in a circle with the vertices close together, so that it looks like a wheel with spokes. Place several drops of water in the center of the circle so that each vertex is in contact with the water, then just leave it alone. Water's adhesion (as well as another property called capillary action) will result in the "V" shapes spreading out and you will have a five-pointed star. The water flows through the empty spaces in the wood, adhering to the sides of the spaces, and swelling the toothpick, opening the acute angles into a more obtuse form. Students will want to create their own shapes after everyone has tried the star. 3. HEATING CURVE OF WATER •Place a beaker of water (300 ml. or so) in a beaker with 3-4 ice cubes. Use a clamp to suspend a thermometer in the water near the surface. Allow the temperature to reach its minimum. Begin to heat the ice water, taking the temperature reading every 30 seconds. Students should record the data and create a graph of the results. Ideally, the heating curve graph will be flat at the start (as the ice melts), rise is a fairly linear pattern until boiling, and flatten out again as the steam escapes and the liquid water maintains a temperature of 99 - 100 degrees C. Opportunities abound for discussion as to why the result obtained experimentally does not seem exactly to match the theoretical outcome. 4. CHEMICAL COMPOSITION •If you have the setup to perform electrolysis of water (Hoffmann Apparatus is ideal), run DC current through the two sides. Add a few drops of acid (sulfuric works well) to increase the water's conductivity. Note the volumes of gases collected, which will be in a 2:1 ratio. Collect and test the gases. Hydrogen, collected from the side with the grater amount of gas, will remain in an inverted test tube and will explode when exposed to a lit match. The oxygen gas is a little more difficult to collect since you have to turn the test tube upright the test tube immediately after you collect the gas. If you place a glowing wood splint into the oxygen tube, it will burst into flame.
Materials Needed	**Part 1**. Medicine droppers, cups, pennies, staples, soap, screening material, food coloring **Part 2**. Flat, identical pieces of glass, dropper, flat wooden toothpicks **Part 3.** Heat source, beaker, ice, thermometer (with lab equipment to secure a thermometer in

	place at the surface of the heating water), graph paper or Excel software. **Part 4.** Hoffmann Apparatus, test tubes, matches, wood splint.
Science Connections	Water's unique properties are significant for the rise of life and human settlement in all parts of the earth: 1**. Expansion Upon Freezing**: allows for aquatic life to survive winters under ice sheets worldwide; 2. **High Specific Heat**: resulting in land areas near water having cooler summers and warmer winters than land areas without nearby water, due to the huge amount of energy required for water to change temperature; 3. **Surface Tension and Adhesion**: allows water to climb upward in plants, allows some life forms to exist on the surface of water; 4. **High Boiling Point**: means that, given average temperatures in most parts of the world, water usually remains in liquid form in temperate and tropical zones.
Additional Web Resources	Experiments with Water's Properties http://www.science-projects.com/CCwater.htm The New Mystery of Water http://www.livescience.com/environment/041201_water_bonds.html Water's Properties http://www.uni.edu/~iowawet/H2OProperties.html Physical Properties of Water http://www.physicalgeography.net/fundamentals/8a.html Drops Attract Each Other http://www.expertvillage.com/video/9867_surface-tension-demo.htm

	Surface Tension Boats http://www.madsci.org/experiments/archive/857512487.Ph.html Float a Needle http://www.iit.edu/~smile/ph9205.html

Ohio Science Standards Abbreviations:

ES – Earth/Space Science	LS – Life Sciences	PS – Physical Sciences
SI – Scientific Inquiry	ST – Science and Technology	SW – Scientific Ways of Knowing