Stickin’ Together: Surface Tension, Cohesion, and

Adhesion

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| **FRAMEWORK** | | |  | |
| I. Scientific and Engineering Practices | | | | |
| II. Cross-Cutting Concepts | | | | |
| III. Physical Sciences | | | | |
| **SKILLS/OBJECTIVES** | | | |  |
| * Exploring water’s ability to “stick” to itself and other materials; seeing what amazing properties this produces; connecting these facts to everyday observations like the ability of objects to float on water, dew drops forming on plants, and the movement of water from root to stem in plants. | | | | |
| **MATERIALS** | |  | | |
| * Water * Plastic pipettes * Coins * Cups * Test tubes * Paper towels * Paper clips * Soap * Vegetable oil * Food dye | | | | |
| **NOTES** |  | | | |
| * The capillary action activity should be re-visited at the end of the lesson to examine its progress * The first activity should be done as a large group, but the rest can be in smaller groups if necessary. * These discussions can be modified to fit any age group | | | | |

**BACKGROUND**

* Water is all around us and is necessary for every kind of life on this planet!
* It has some really amazing properties that animals and plants can use to help them survive.
* It is actually “sticky,” even though it doesn’t feel that way. It is able to “grab” onto itself better than a lot of other materials. When it sticks to itself, water becomes strong enough to hold things. Have you ever seen a bug walking on water?
* For the older kids, if they’re interested: water has high **surface tension**, **cohesive properties**, and **adhesive properties**. This is because it can form a special, strong type of bond called an H-bond.
* The key idea in this lesson is that water “sticks” to things, especially itself, and this means it is very strong and can work against other forces like gravity.

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| Activity # 1 | **Hydrogen Bonding** |
| Materials | None |
| Worksheet | None |

* This is to show children how water can form stronger connections with itself than other liquids can.
* Have each of the kids be an individual molecule of water (or if they don’t understand that, maybe refer to them as “parts” or “pieces” of water).
* Water likes to hang out with friends, so everyone should try to hold hands with as many people as they can at once!
* In water, this kind of holding hands is a very strong connection, or bond, called an H-bond*.*
* Now everyone is going to be a different kind of liquid called vegetable oil. These liquids don’t like hanging out with each other as much as water does, so everyone can only hold hands with one other person and put the other hand behind their backs.
* Which of these liquids, water or ethanol/oil, is stronger? If we were to throw a stuffed animal on top of you, which group would prevent it from hitting the ground?
* Water is stronger because it likes to stick together!

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| Activity #2 | **Capillary Action Paper Towel Race!** |
| Materials | * 2 test tubes * 1 small Dixie cup filled with water * 1 small Dixie cup   filled with oil   * 2 empty Dixie cups * 2 pieces of twisted paper towel * Food dye |
| Worksheet | No |

* This activity shows how water may adhere to other surfaces to work against the force of gravity. This same principle, water’s ability to stick to non-water surfaces, is responsible for concave appearance of water’s meniscus. Similarly, adhesion allows water to flow up small-diameter tubes, the root-shoot system in plants.
* Pour water into one test tube and oil into another. The top of the liquid, where liquid meets the air, is called *the meniscus*. It looks different for different liquids. Examine the meniscus of the water and compare it to that of the oil.
  + This is because water is “stickier” than oil and can climb further and faster up the tube.
* Pour water into one cup and oil into another. Add food dye of the kids’ choice to the cup full of water and of oil so it is easier to see.
* Kids twist a piece of paper towel until it looks like a string. They then place one end of the paper towel in the full cup of water and one end in the empty glass. Do the same for the cup of oil.
* Examine progress at end of class.
* They should observe that the water can travel up the paper towel and into the empty cup faster/more than the oil.
* Have you seen this before? How does this relate to how plants get water from the ground?

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| Activity # 3 | **Droplet** |
| Materials | * Pipettes * Cup of water * Pennies |
| Worksheet | No |

* This activity looks at the ability of water to form large droplets due to cohesion/stickiness. When the droplet gets too large, the pressure inside it overwhelms the weaker forces of cohesion acting on the surface, so the droplet bursts
* Ask the kids to form a guess, or hypothesis, about how many drops of water they think a penny can hold.
* Then have them use the pipettes to drop water onto a penny
* How large can they get the water droplet before it bursts? What happens when the coin is already wet? Are there other factors that affect how large the droplet can get? Would you say the cohesive forces are strong?
* Make sure they compare this to their daily observations about water droplets on plants etc.

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| Activity # 4 | **Surface Tension** |
| Materials | * 1 glass filled with water * Paperclip * Paper towel * Soap |
| Worksheet | None |

* This activity examines surface tension by using this force to float a paperclip on the surface of water and seeing what kinds of things break surface tension.
* Have kids put a paperclip in the glass of water and see that it just sinks to bottom. Why couldn’t it float? Why can little water bugs float on top of the water and not this paperclip?
* Remove the paper clip and dry it
* Have kids tear off a small piece of dry paper towel to place underneath the paperclip. Put both towel and paperclip in the glass of water. The water will soak the paper towel, sinking it (you may want to push the paper towel down with your finger), leaving the dry paperclip to float on the surface of the water.
* What was different this time? Did the paperclip weigh any less?
* Then, put a few drops of soap into the water and watch as the paperclip sinks. What happened here? What is important to maintain surface tension?
* Answers: the paperclip did not sink the second time because it did not disturb the water’s surface tension; the paper towel did that job for it. The soap breaks the surface tension and the paperclip sinks.
* Try the same experiment with vegetable oil.