



H₂Olympics

Can you make water defy gravity?

■ Grade Level

Upper Elementary, Middle School

■ Subject Areas

Physical Science, Math

■ Duration

Preparation time: 40 minutes

Activity time: 50 minutes

■ Setting

Classroom

■ Skills

Analyzing (formulating questions, identifying components and relationships)

■ Charting the Course

Preceding this lesson, introduce the structure and behavior of the water molecule through "Molecules in Motion." This activity can be done in conjunction with "Hangin' Together" to help students understand the forces that contribute to water's properties. "H₂Olympics" supports concepts presented in "Get the Ground Water Picture" and "Aqua Notes." Finally, "Is There Water on Zork?" gives students an opportunity to apply their understanding of water and some of its unique characteristics.

■ Vocabulary

adhesion, cohesion, capillary action, surface tension, gravity, universal solvent

▼ Summary

Students compete in a Water Olympics to investigate two properties of water, adhesion and cohesion.

Objectives

Students will:

- demonstrate adhesive and cohesive properties of water.
- relate adhesion and cohesion to daily activities.

Materials

Warm Up

- Beaker or measuring cup with narrow spout
- Yarn (soaking wet)
- Container to hold water
- Colored water

The Activity

- Music from the Olympics or other sports programs (optional)
- Copies of **H₂Olympics Score Sheet** (one per team of two students) ©
- Water
- Paper and drawing materials

To simplify setting up the activity, materials for each event are listed separately. (Each event requires water.)

Event 1

- Clear plastic cups
- Two dollars in pennies

Event 2

- Eyedropper
- Penny

Event 3

- Boat pattern
- Stiff cardboard
- Scissors
- Soap chips (shaved from a bar of soap)
- Large aluminum trays
- Stopwatch

Event 4

- Paper clips
- Fork
- Magnifying glass
- Clear plastic cups

Event 5

- Several brands of paper towels
- Tall glasses
- Tape
- Ruler
- Scissors

Making Connections

Water is the universal solvent because of its unique chemical nature. Students see signs of water's adhesive and cohesive properties daily (e.g., water beading on the surface of a glass). However, they may not appreciate how life depends on these qualities. Relating to how a water strider skates over the surface of water or how water travels upward through soil through experimentation gives students opportunities to explore further the structure and behavior of the water molecule.



Water striders can skate on water because they do not break the surface tension.

PHOTO CREDIT: © iStockphoto—Thinkstock Photos

Background

The chemical nature of the water molecule is a wonder. Water's unique chemical structure causes it to behave in unique ways. For example, it can be attracted to other water molecules as well as to molecules of other substances, which is why water flows in rivers and streams. Because of these qualities, water can travel up the tallest Redwood Tree (379 feet) and can deliver nutrients and gases throughout the human body.

The attraction between water molecules is called cohesion. The attraction of the water molecule to other materials, like glass or soil, is called adhesion. An easy way to remember is that adhesive tape sticks things together.

Evidence of water's attraction to itself can be seen by simply observing its surface. If a glass is filled to the brim and more water is added gently, the level of the water will exceed the top of the glass, forming a dome. The cohesive force between water molecules causes the water surface to behave as though it is covered by a thinly stretched membrane. This phenomenon is called surface tension.

Water's surface is so strong it can even support paper clips and needles. Surface tension is important to the survival of many aquatic organisms, including insects. The water strider lives on the surface of fresh water. Compared to a piece of wood floating in the water, paper clips and water striders are not actually floating. Instead, they are held up by the surface tension made by the bonds between water molecules.

- Soap breaks surface tension. For example, when a small piece of cardboard cut into the shape of a boat is placed on water, it will stay in one place. This is because water is equally attracted to all sides of the cardboard. When soap is placed at the back end of the cardboard boat, water molecules are still pulling at the front end of the boat, but not the back end. (The soap reduces the pull of water molecules on the back end of the boat.) This causes the boat to move forward. (An analogy would be a tug of war. The rope is the boat and the people pulling on

each side are the water molecules. If several people on one end let go [representing the addition of soap], the rope [boat] would be pulled toward the opposite end.)

- The same positive and negative forces that cause water to be attracted to itself cause it to adhere to other substances. If this didn't happen, water would not flow.

Water appears to defy gravity as it moves up a paper towel, through spaces among soil particles or along a piece of yarn at an angle to the ground. This is called capillary action and results from water molecules being attracted to molecules of the towel (or soil or yarn) and to each other. However, the molecules can only travel so far before the force of gravity overcomes the attraction of water to itself and to other molecules.

Procedure

▼ Warm Up

- Show students a beaker partially filled with colored water, an empty container and the yarn. Tell them that you are going to make water defy gravity as it “walks a tightrope” from the beaker to the container.
- Hold beaker and yarn as indicated in the illustration, *Water Walks a Tightrope*. Slowly pour the water down the yarn. (You might want to practice first!) Can students explain how water moves along the yarn? Tell them they will conduct a series of events that will help them understand this demonstration and other feats of water.

▼ The Activity

1. Divide the classroom into sections; an Olympic event will take place in each area. Banners can be designed to identify each event.
2. Divide the class into small teams. Each team should represent a body of water (e.g., the Atlantic Ocean team, the Columbia River team, the Lake Travis team, etc.). Begin the games with each team presenting its members to the class.
3. Play the Olympics theme song. Tell students they will be participating in a Water Olympics to demonstrate some amazing feats of water.

4. Students complete the events in any order. Directions for the events are on the *H₂Olympics Score Sheet*. Results should be recorded on their score sheets and on a scoreboard posted in the front of the room.

▼ Wrap Up

- Have students compare the results of the different events. Ask them to explain the role of cohesion (water’s attraction to itself) and adhesion (water’s attraction to other materials) in each activity.
- Remind students of the water walking the tightrope during the *Warm Up*. Can they explain how water’s attraction to the yarn and to itself keeps water from falling toward the ground? If water is poured too quickly, gravity will overpower water’s cohesive and adhesive forces.
- Have students develop a system to hand out medals to the winners of each event. Students should be encouraged to make sure each team gets some type of medal (include criteria, such as teamwork, creativity, cooperation).



Water walks a tightrope.

H₂Olympics Scoreboard

	Event 1 Pole Vaulting (number of pennies)	Event 2 Balance Beam (number of drops)	Event 3 Sculling (number of seconds)	Event 4 Backstroke (number of paperclips)	Event 5 Slalom (height)	
					1st Towel	2nd Towel
Team:						
Team:						
Etc.						

▼ **Project WET Reading Corner**

Fink, Patricia A. 1997. *Animals that Walk on Water*. New York, NY: Franklin Watts.

Solves the mystery of surface tension, which allows some creatures to walk on water.

Goodstein, Madeline P. 2004. *Water Science Fair Projects: Using Ice Cubes, Super Soaks, and Other Wet Stuff*. Berkeley Heights, NJ: Enslow Publishers, Inc.

A fun and easy way to learn about the structure of water, adhesion, cohesion and surface tension.

Kampion, Drew. 2005. *Waves: From Surfing to Tsunami*. Layton, UT: Gibbs Smith.

A technical, yet easy-to-understand, analysis of wave action and influences.

Tocci, Salvatore. 2003. *Experiments with Soap*. Bel Air, CA: Children's Press.

How to use soap experiments to learn about surface tension and air currents.

Wick, Walter. 1998. *A Drop of Water: A Book of Science and Wonder*. New York, NY: Scholastic, Inc.*

Using photography, this author captures the properties of water on film.

Yolen, Jane. 2004. *Water Music*. Honesdale, PA: Boyds Mill Press.^

Combines photographs and text to detail water in various shapes and appearances.

*National Governors Association Center for Best Practices and Council of Chief State School Officers. "Texts Illustrating the Complexity, Quality, and Range of Student Reading K-5." And "Texts Illustrating the Complexity, Quality, and Range of Student Reading 6-12." Common Core State Standards Initiative. www.corestandards.org (June, 2009)

^Listed on one or more state reading lists.

Assessment

Have students:

- demonstrate water's cohesive and adhesive properties (step 4).
- draw a picture of water moving along yarn or of a water drop and identify where adhesion and cohesion occur (*Wrap Up*).

Extensions

Students can investigate how soil absorbs water to explore adhesion and cohesion further. Challenge students to concoct a soil that will absorb the most water. Have students collect soil samples and remove excess water by leaving the samples spread out in the sun for about six hours. Instruct them to describe their soil recipe and why they think it will absorb water well. After the samples are dried, provide students with the following instructions:

- Use a cup with tiny holes punched in the bottom. Record the weight of the cup: _____. Fill the cup with your soil; pack it tightly. Record the weight of the cup and the soil, and subtract the weight of the cup. How much does the dry soil weigh? _____. Place the cup in a pan filled with a shallow layer of water. After 30 minutes, remove the cup from the water and carefully wipe excess water from the sides and bottom. Weigh the cup and soil and subtract the weight of the cup and dry soil. How much water did your soil absorb? _____

Compare the surface tension of other liquids. Using a magnifying glass and safety glasses, investigate drops of water, hydrogen peroxide and alcohol. How do they differ? Can a paper clip be supported on the surface of each of these liquids?

Teacher Resources**Books**

Robertson, William C. 2005. *Air, Water, and Weather: Stop Faking It! Finally Understanding Science So You Can Teach It*. Arlington, VA: National Science Teacher Association.

SciGuides. 2005. *Properties and Changes of Properties in Matter*. Arlington, VA: National Science Teacher Association.

SciGuides. 2005. *Properties of Objects and Materials*. Arlington, VA: National Science Teacher Association.

Journals

Ansberry, Karen and Emily Morgan. 2008. "Teaching Through Trade Books: The Wonder of Water." *Science and Children*, 46 (4), 16-18.

Blake, Robert Jr., et al. 2010. "Inside-Out: Environmental Science in the Classroom and the Field, Grades 3-8." Arlington, VA: National Science Teacher Association.

The chapter entitled "Water" is a free download from the NSTA web site.

Cavallo, Ann M. L. and Pamela A. Dunphey. 2002. "Sticking Together." *Science Teacher*, 69 (8), 24-28.

Kessler, James. 2003. "Science 101: What Causes Water's Surface Tension?" *Science and Children*, 40 (8), 21.

McCarty, Robbie V. 2000. "Water: A Sticky Subject?" *Science and Children*, 37 (6), 44-47.



TEAM NAME: _____ Date: _____

Team member(s): _____

**Event 1.
Pole Vaulting:
Over the Top!**

Read the directions through before you begin this event. How many pennies do you think you'll be able to add before the water spills over? _____

Directions: Fill a clear plastic cup with water until it is even with the rim. Add pennies, one at a time. Keep track of the number of pennies added. Continue until the water spills over the side. Repeat for the other team member.

Describe or draw the surface of the water:

Number of pennies added,
team member 1: _____ team member 2: _____

**Event 2.
The Balance Beam:
A Penny for Your Thoughts!**

Read the directions before you begin this event. How many drops of water do you think you'll be able to put on the penny? _____

Directions: Using an eyedropper, place as many drops of water on the penny as possible without spilling over the edge. Keep track of the number of drops. Continue until water spills over or the water drop collapses. Repeat for the other team member. Record the scores. Describe or draw how the water appeared on the penny before the drop collapsed:

Number of drops,
team member 1: _____ team member 2: _____

**Event 3.
Sculling:
Bubble Power!**

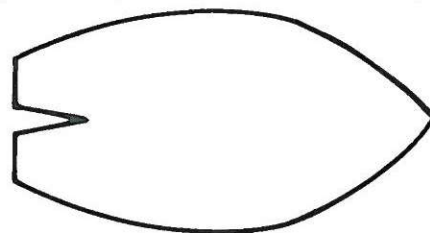
Directions: Cut out two boat shapes from a piece of cardboard (see pattern). In the rear of each boat, cut out a small notch. Place a soap chip in the notch of one boat. Place the boats in a tray of water and describe what happens.

What caused the boat to move? (Hint: Place a drop of water on the table. What happens to it when you put a soap chip in it?)

Design a better shape for the boat so that it will move faster and in a straight line. Experiment with different shapes of boats, placement of the soap chip and size of the soap chip. Be sure to change the water in between groups.

Choose the best design and place the boat at one end of the tray at the start line. Time it until it crosses the finish line.

How long did it take to cross the finish line?





Event 4. Backstroke: Clipping Along!

Read the directions before you begin this event. How many paper clips do you think your team can suspend on the surface of water?

Directions: Try placing a paper clip on the surface of water. (Hint: Lay the paper clip on the prongs of a fork and lower it into the water.) Use a magnifying glass to observe the surface of the water where it comes in contact with the paper clip. Draw a picture or describe what this looks like.

See how many paper clips you can suspend on the water's surface. Repeat for your other team member.

Number of paper clips suspended on the surface of water _____

Team member 1: _____

Team member 2: _____

Event 5. Slalom: Weaving In and Out!

Directions: Cut out strips of two brands of paper towels—one you think will absorb the most water and one you think will absorb the least. Explain your reasoning.

Tape one end of each towel to the middle of a pencil. Lay the pencil on top of a tall glass. Figure out how much water will need to be added to the container to immerse the ends of the paper towels ½ inch (1.5 cm) into the water. Remove the towels, fill the container to that level and put the towels back in. Let the paper towels absorb water until the water stops rising. Use a ruler to measure the height absorbed above the water for each towel.

Height for first towel: _____

Height for second towel: _____