H_2Olympics

Students will learn about properties of water: cohesion, adhesion and surface tension, through a series of experiments while using the steps of the scientific method.

Grade Level: 4th

Phenomena:
How does conducting experiments help scientists answer questions?

Objectives:
- Students will conduct experiments following the steps of the scientific method
- Students will explain the difference between adhesion and cohesion
- Students will relate adhesion and cohesion to daily activities.

Materials:
- Beaker or measuring cup with narrow spout
- Yarn (soaking wet)
- Container to hold water
- Colored water
- Music taped from the Olympics or other sports programs (optional)
- Pennies
- Pipette
- Record sheet for each group
- Water

Appendixes:
- Record sheet: Page 6-7

Time Considerations:
Preparations: 40 minutes
Lesson Time: 55-65 minutes
Introduction: 10-15 minutes
Activity 1: 35-40 minutes
Conclusion: 10 minutes

Related Lesson Plans:
Flubber, Yellow/Blue Switcheroo, Mentos Super Fountain, Eggs-plosion, Blood-Typing, Mystery Box, Freezing Point

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Next Generation Science Standards

3-5-ETS1-2. Generate and compare multiple possible solutions to a problem based on how well each is likely to meet the criteria and constraints of the problem.

Science and Engineering Practices (SEP):
Constructing Explanations and Designing Solutions

Disciplinary Core Ideas:
Developing Possible Solutions

Crosscutting Concepts:
Influence of Science, Engineering, and Technology on Society and the Natural World

Excellence in Environmental Education Guidelines

Strand 1—Questioning, Analysis and Interpretation Skills

A) Learners are able to develop questions that help them learn about the environment and do simple investigations.

B) Learners are able to design simple investigations.

C) Learners are able to locate and collect information about the environment and environmental topics.

G) Learners can develop simple explanations that address their questions about the environment.

This lesson has been adapted from The Watercourse and the Council for Environmental Education's *H_2Olympics*:

The Watercourse and the Council for Environmental Education. (1995). H_2Olympics. In *Project WET* (pp. 30-34).

Background

A water molecule's shape gives it a number of unique properties including the ability to stick to both nearby water molecules and other surfaces. The attraction between water molecules is called cohesion. The attraction of the water molecules to other materials, like glass or soil, is called adhesion. Without these properties, plants could not get water and blood would have difficulty traveling through the body.

Evidence of water's attraction to itself can be seen by simply looking at its surface. If a glass is filled to the brim and more water is added gently, the level of the water rises above the rim of the glass without flowing over. The cohesive force between water molecules causes the water surface to behave as though it is covered by a thinly stretched membrane that is always trying to contract. This phenomenon is called surface tension. In many ways, surface tension is like water's skin.

Surface tension is a phenomenon in which the surface of a liquid, where the liquid is in contact with gas, acts like a thin elastic sheet. An example of surface tension is drops of water. Water does not flow in a continuous stream, but rather in a series of drops. The shape of the drops is caused by the surface tension of the water. The only reason the drop of water isn't completely spherical is because of the force of gravity pulling down on it. (*Zimmerman, A.Z.*)

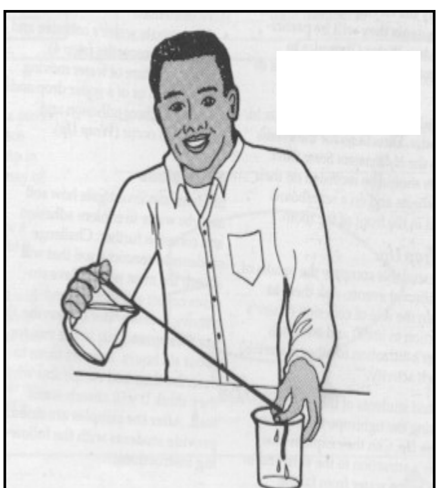
Water's surface tension is so strong it can even support paper clips and needles. Surface tension is important to the survival of many aquatic organisms, including insects. The water strider lives on the surface of fresh water. However, rather than floating in the water due to buoyancy, water striders walk over the surface without breaking the bonds between molecules.

Water striders walk on water using surface tension

Soap also 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 game of 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 forces that cause water to be attracted to itself cause it to adhere to other substances. If this didn't happen, water would slide off everything.

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, 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.



Water walks a tightrope

Before presenting to students, practice the demonstration, Water Walks a Tightrope.

Preparation

Set Up Stations

Event 1: Pole Vaulting – Fill a clear plastic cup with water until it is even with the rim. Students will be adding pennies to the water, so be sure to leave enough by the cup.

Event 2: Balance Beam – Set up a penny, eyedropper and a cup of water. Be sure there is enough water in the cup for each group. Students will be using the eyedropper to place as many drops of water on the penny as possible without spilling over the edge.

Introduction

Put the word "water" up on the board and ask the students to brainstorm what they know about water and record their ideas.

Show students a beaker partially filled with colored water, an empty container and a piece of damp yarn.

Doing the Activity

Ask the students the following question: Do you think I can make water walk a tightrope from one cup to another? The students should make a hypothesis as to whether they think that water will move down the yarn instead of falling directly below the cup due to gravity.

Paper clip the yarn to one of the cups. Hold the cup with the paper clip higher, at an angle to the second cup. Slowly pour the water down the yarn. Why did the water "walk a tightrope" instead of falling directly below the pour cup?

Tell students that we are going to be scientists studying water today. As scientists, we will use the scientific method to conduct experiments to learn more about the different properties of water.

Whenever scientists do experiments they follow certain steps to ensure they are finding quality results. Does anyone know what this group of steps or process is called?

Put the steps on the board and go over what each one entails.

1. Question: When scientists do experiments, they always begin with a question.

2. Hypothesis/Prediction: After asking the question scientists then try to guess the answer.

3. Research: Randomly combining things from around the house is dangerous so scientists have to do some research by reading, looking on the internet or asking other scientists.

4. Experiment: This is generally the fun part. Scientists do an experiment by following the directions and they have fun! But they are always safe and careful.

5. Results: Scientists keep accurate records of results of their experiment.

6. Conclusion: Examine the meaning of your results; speculate why certain data resulted from your experiment.

Tell the students during today's lesson they are going to be scientists and follow the scientific method (*Science Buddies).*

Activity 1: The Olympics!

Introduce the H2Olympics activities. Stress that the students will be scientists and therefore must be precise, accurate and safe.

It is important to demonstrate the different activities so students know the correct procedure for each of the experiments. For the pole vault, students should take turns gently placing pennies in a cup filled completely with water while keeping track of how many pennies have been added.

Students doing the balance beam should take turns carefully placing droplets of water on a penny to see how many it will hold.

Stress that students should conduct the same experiment more than once to ensure they are finding consistent results. Before beginning the experiments have the students formulate a hypothesis for each.

Break students into groups of three or four and hand out student worksheets. Have half the students begin with the Balance Beam event and the other half begin with the Pole Vaulting event. Remind students to make careful observations of the experiments at eye level. After about five minutes of experimenting have students wrap up their last trial and then switch event stations. After another five minutes, come back as a class and discuss what was discovered. Ask the students to report on their results and conclusions.

Balance beam station

Have students draw on the board what they observed while conducting their experiment so the rest of the class can compare results.

Use this discussion to introduce and define new vocabulary words the concepts of surface tension, adhesion and cohesion. Explain to the students that both adhesion and cohesion are caused by the shape of water molecules. Have the students put their arms out in front of them forming a “V” that mimics the bent shape of a water molecule. Tell the class that each of their hands represents a positively charged hydrogen atom while their shoulders are the negatively charged oxygen. Remind the students that opposite charges attract and have them arrange themselves so their hands are touching someone else’s shoulders. This demonstrates how cohesion causes surface tension in water.

Conclusion

Ask the students where else they would see examples of surface tension. (water striders, hair sticking together when it’s wet)

Explain to the students how water walks a tightrope. The best explanation for this is that water is moving by capillary action, which results from water molecules being attracted to molecules of the yarn and 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. Plants soak up water by the same process within their tissues.

Assessment

Review with the students what they learned about the properties of water. Ask them what they learned about water that they did not know before the lesson. What surprised them the most?

Extensions

Ask the students if there are any other types of experiments they could do to find out more about the properties of water.

Have the students reflect on the lesson in their notebooks by answering the following questions:

What are some interesting things you learned? Did you learn anything new? What was your favorite part of the lesson? Why? What did you learn about water?
Have the students test the strength of surface tension by attempting to “float” objects like pins and paperclips.

Have a surface tension race by placing a drop of soap behind paper boats.

Vocabulary

Adhesion: the force of attraction between unlike molecules or the attraction between the surfaces of contacting bodies

Cohesion: the force of attraction by which the molecules of a solid or liquid tend to remain together

Conclusion: a decision or answer, based on facts

Hypothesis: an educated guess

Materials: the tools and other things needed to perform a particular task

Procedure: a way of doing something, especially by a series of steps

Results: the outcome(s) of a certain task or procedure

Scientific Method: the system of advancing knowledge by formulating a question, collecting data about it through observation and experimentation, and testing a hypothetical answer

Surface Tension: The property of liquids that gives their surfaces a slightly elastic quality and enables them to form into separate drops. It is caused by the interaction of molecules at or near the surface that tend to cohere and contract the surface into the smallest possible area.

Sources

- Science Buddies. (2010). *Steps of the Scientific Method.* Retrieved Aug. 26, 2010, from http://www.sciencebuddies.org/science-fair-projects/project_scientific_method.shtml
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Pole Vaulting - Record Sheet

Question: How many pennies can you fit into the cup before it overflows?

Hypothesis (guess):____________________

Materials:____

Procedure:
1. Fill a clear plastic cup with water until it is even with the rim.
2. Add one penny at a time. Count how many pennies you add.
3. Continue until the water spills over the side.

Results:
# of pennies in the cup _______

Draw a side-view of the top of the cup:

Pole Vaulting - Record Sheet

Question: How many pennies can you fit into the cup before it overflows?

Hypothesis (guess):____________________

Materials:____

Procedure:
1. Fill a clear plastic cup with water until it is even with the rim.
2. Add one penny at a time. Count how many pennies you add.
3. Continue until the water spills over the side.

Results:
# of pennies in the cup _______

Draw a side-view of the top of the cup:

Balance Beam - Record Sheet

Question: How many drops of water can you place on a penny, before it spills over?

Hypothesis (guess):___________________

Materials:____

Procedure:
1. Place a penny on a flat surface (desk or floor).
2. Dip a pipette in water, squeeze the bulb and suck water into the pipette.
3. Gently squeeze the pipette and let drop one drop of water onto the penny.
4. Count the number of drops of water you drop on the penny until it spills over.

Results:
# of water drops on penny _______

Draw a side-view of the top of the penny:

Balance Beam - Record Sheet

Question: How many drops of water can you place on a penny, before it spills over?

Hypothesis (guess):___________________

Materials:____

Procedure:
1. Place a penny on a flat surface (desk or floor).
2. Dip a pipette in water, squeeze the bulb and suck water into the pipette.
3. Gently squeeze the pipette and let drop one drop of water onto the penny.
4. Count the number of drops of water you drop on the penny until it spills over.

Results:
# of water drops on penny _______

Draw a side-view of the top of the penny: