OH, THE TENSION (1 Hour)

In this activity, students carefully add drops of liquids to the surface of a penny to help them understand the concept of surface tension.

OVERVIEW

Topic: Surface tension

Real World Science Topics:

- An exploration of how various substances change the physical properties of a solution
- An exploration of surface tensions of different solutions and liquids

Objective

Students will gain an understanding of how water and other solutions have similar or different surface tensions.

Materials Needed for Student Activity

Materials Needed for Teacher Demonstration

- nonstick baking sheet
- glass of water
- 2 paperclips

Materials Needed for Each Group

- several pennies
- eyedropper or syringe
- cookie sheet (alternatively, several paper towels)
- bowls with pre-prepared solutions (see Teacher Preparation)

Teacher Notes

Use your discretion on the best way to conduct this activity based on the individual level of your class. For some of the younger K-1 classes, you may wish to perform some or all of the steps of the activity, encouraging children to make predictions and observations. If the group is older or more advanced in their abilities, students can take a more hands-on role in performing the related tasks. Leveled methodologies for K-1 and 2-3 grade levels are provided, where appropriate, throughout the activity. Use your knowledge of each class to determine what the best option is for your particular group.

Teacher Preparation

Prior to teaching this lesson, prepare several different solutions for your students to test on the pennies. Younger students should receive at least two different solutions (such as water and salt water), and older students should receive at least three different solutions (soapy water, sugar water, salt water, water, etc). Prepare large batches of your chosen solutions, then divide them into small bowls or cups, labeling each container. These bowls or cups can then be easily passed out to the groups during the activity. To create solutions, use a 1:4 ratio (1/4 cup of salt to one cup of water, for example). Use the same ratio for all of the solutions that you mix.

OH, THE TENSION

STEPS FOR *OH, THE TENSION*

1. **Warm-Up Activity:** Ask students if they have ever observed beads of water on the surface of a new car or a window. You can reinforce the idea with a visual image. Ask them to think about how water forms in little beads. Then, have students gather around you as you slowly pour a glass of water onto the baking sheet, without allowing it to splash. Have students look at the water, keeping their eyes level with the top of the table on which the baking sheet rests. Ask students to describe what they see. Students should see that the water spreads out to a uniform thickness and that the surface of the water seems rounded.

   Next, refill the glass of water (fill it to the very top) and hold a paper clip or straight pin above it. Ask students to predict what will happen when you drop the paper clip into the glass. Students will most likely predict that it will sink. Drop the clip into the glass from several inches above. Explain that the clip pierces through the surface of the water and then sinks to the bottom. Then, tell students that you will do it again, but this time, you will carefully set the paper clip on top of the water.

   Grades K-1 Ask students to make a prediction about what will happen to the paper clip this time. Write several predictions on the board.

   Grades 2-3 Instruct students to make a prediction about what will happen to the paper clip this time, and have them write their predictions on the Student Handout.

   Now, carefully set the paper clip horizontally onto the surface of the water. The paper clip should float because the surface tension is strong enough to support the clip.

2. Next, explain to students that they just observed surface tension at work. Explain the concept as needed to your students. Tell them that they will now explore the surface tension of various liquids.

   Grades K-1 Pass out materials and Student Handouts to each group. Students at this level should test at least two different solutions.

   Grades 2-3 Pass out the materials and Student Handouts to each group. Students at this level should test at least three different solutions.

3. Next, model for your students the proper method for dropping individual drops of liquid onto a penny. Fill an eyedropper with water and carefully drop water, one drop at a time, onto the penny. Tell your students to count out loud with you as each drop is added to the penny. Continue until the penny can't hold any more water and the liquid spills off of the penny. Before having your students drop water for themselves onto a penny, have them practice making drops with their eyedroppers. They can put drops directly onto the baking sheet or paper towels. Only when they are comfortable with making drops should they continue.

4. Instruct students to place the first penny on the baking sheet and slowly count how many drops they can add to it. Tell students to all use the same side of the penny (either heads or tails). This way, you are helping to eliminate a possible variable.

   Grades K-1 Circulate as students work, offering tips or help as needed. Have students share how many drops they added. Record these numbers on the board.

   Grades 2-3 Circulate as students work, offering tips or help as needed. Have students share how many drops they added. Instruct students to write this number in the appropriate location on the Student Handout.

STEPS FOR *OH, THE TENSION*

5. Repeat this process (once more for grades K-1, twice more for grades 2-3) until students have tested all of the solutions you have given them. Record the numbers for each round on the board (and, for older students, instruct them to record their answers on the Student Handout).

6. **Wrap-up Activity:** Bring the class back together as a group and discuss the results. Review the number of drops each penny could hold. Ask if students could observe differences in the surface tension. Then, encourage students to think about why some solutions might have different surface tension. It is okay if students do not have fully formed answers to these questions. Be sure to wrap up your class discussion with an explanation of the ways that different solutions can have different surface tensions. Explain that water on its own has a high surface tension. Adding soap to the water can cause the molecules of water to break apart. This makes the surface tension of soapy water less than that of plain water. Answer any lingering student questions to help ensure comprehension.

   Grades K-1 Discuss the questions in the Student Handout.

   Grades 2-3 Have students answer the remaining questions in the Student Handout.

Oh, the Tension Extension Activity

Have students repeat their investigation using different surfaces, such as different coins or paper. Students can also alter the investigation by changing the temperature of the different solutions in order to investigate the role of temperature on surface tension.

What is surface tension?

Surface tension results from the attraction of molecules to other molecules. This attraction is called a cohesive force. Cohesive forces cause molecules at the surface of a liquid to be more attracted to other liquid molecules than they are to surrounding molecules. Liquids form "beads" (like water droplets) because of this cohesive force. Cohesive forces also cause liquids to develop a strong, sheet-like bond at the surface of the liquid (like at the surface of a lake or a glass of water).

What are some examples of surface tension?

The surface tension at the surface of a body of water is strong enough to support objects that are denser than water. For example, a pin (which is many times more dense than water) will float on the surface of water when it is placed gently onto the surface. Some insects, such as water striders, are able to skim across the surface of water because the surface tension is strong enough to support their weight.

Why do different solutions have different surface tensions?

The cohesive forces that attract molecules to each other within materials differ depending on the chemical makeup of a substance. This means that surface tension differs for different substances. For example, water and liquid mercury both readily form beads because surface tension binds the molecules of those liquids together, but other liquids have a lower surface tension and will spread out more easily. When an additive, like soap, is added to water, the surface tension changes. Soap reduces the cohesive forces between the molecules of water, and it allows water to penetrate the pores of surfaces more easily (thus allowing it to clean a surface better).

The temperature of a solution may also affect its surface tension. Hot water, for example, has less surface tension than cold water because the molecules in hot water are spread farther apart than in cold water, and this reduces the attractive forces between the molecules. Also, the molecules in hot water have more energy, and the attractive forces between molecules are not able to overcome this energy, so the molecules are not bound together as strongly. This explains why hot water is more effective at cleaning surfaces than cold water.

Key Vocabulary

tension: the state of being stretched or strained

cohesion: the force that holds particles or substances together

1. Make a prediction about what you think will happen when your teacher gently sets the paper clip on top of the water.

I think the paper clip will sink just like the first paper clip.

2. How many drops of plain water were you able to place on a penny?

[Answers will vary.]

3. Write down the second liquid/solution you tested, and the number of drops you were able to drop on a penny.

[Answers will vary]

4. Write down the third liquid/solution you tested, and the number of drops you were able to drop on a penny.

[Answers will vary]

5. If you tested additional liquids/solutions, write your results below. Be sure to note what solutions you tested.

[Answers will vary]

6. Which liquid/solution required the most drops before the surface tension was broken?

plain water

7. Which liquid/solution required the least amount of drops before surface tension was broken?

soapy water

8. What are some ways that adding things (like salt, water, or soap) can change the surface tension of water?

Adding things to the water seems to reduce the surface tension.

OH, THE TENSION STUDENT HANDOUT

Name:

Date:

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