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Purpose: To learn about the surface tension of various liquids and how it can be changed.

Learning Objectives:

1. Understand that surface tension is a property of a liquid that helps things float on top of the surface.
2. Know that different liquids have different surface tensions
3. Learn that surface tension can be altered by adding other liquids or materials to the liquid

Next Generation Science Standards (est. 2013):

- PS1.A: Structure and Properties of Matter (partial)

Grade Level: 2-8

Time: 45 minutes

Materials:

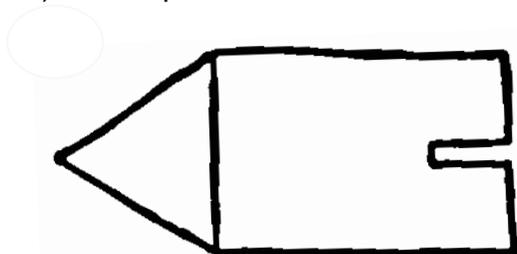
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| <ul style="list-style-type: none"> • Clear small plastic cups • Paper towel • Printer paper • Tissue paper • Notebook paper • Small paper clips • Heavy object that won't break if dropped • Pennies (3 per student) • Rulers • Water | <ul style="list-style-type: none"> • Salt water (salt water) • Isopropyl alcohol • Pepper • Plastic pipettes • Paper or plastic plates (1 per student) • Cotton swabs • Dish soap • Pre-cut aluminum foil boats • 1 bin for every group (needs to be at least 1ft long) |
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Preparation ahead of time:

Fill clear cups with the liquids. For each group: 3 water, 1 isopropyl alcohol, 1 salt water.

Trace and cut out aluminum foil boat. The boat below is the approximate size you should have (~0.5"x1.5"). It is important that the boats are symmetrical.

Introduction:



Surface tension is a characteristic of liquids that helps certain things float on the liquids. This tension created on the surface acts almost as if it were a skin on the liquid. It can be compared to a piece of paper that lets some things sit on top of but when the item gets too heavy the paper will break. Surface tension is affected the same way and will hold some items on the top of the liquid but others will sink if they are too heavy. Different liquids each have separate surface tensions, just like different types of paper can hold different things. These surface tensions can also increase or decrease by mixing in various materials, which will then change what is able to sit on the surface of the liquid.

Procedures:

1. Paper Analogy

- a. Have students pair up (or help the student if you are working one-on-one). Give each group one sheet of each of the different types of paper (printer, notebook, and tissue paper) and 3 different weight objects for dropping on the paper (i.e. baseball, penny, paper clip).
- b. Have students fill in predictions on the worksheet of what will happen when each item is dropped on the different types of paper.
- c. Have one student pick a piece of paper and hold it with both hands at least 10 cm above the table.
- d. Have the other student measure 20 centimeters above the paper and drop one of the objects onto the paper.
- e. Have students write the result of dropping the object.
- f. Repeat with each object on each type of paper.
- g. Ask students what type of object is more likely to fall through the paper (something heavier) and what is more likely to sit on the surface of the paper (something lighter).
- h. Compare the papers to the surface tension of a liquid. The papers were able to hold a few objects but some broke through the paper, same as surface tension of a liquid, it will hold a few objects but some items will break through.

2. Penny Drops

- a. Give each student a plate and place 3 pennies on it. Place the cup with water from the first experiment on the table.
- b. Ask the students what they think will happen if they put a drop of water on a penny.
- c. Using an eyedropper, have students do this and make observations about what they see.
- d. Have them continue to slowly add droplets of water onto the penny counting each drop.
- e. Once the entire surface is covered, have them stop and drop their heads so their eyes are level with the edge of the table.

Ask them what they see happening in the shape of the water on the penny.

- f. Have them draw this side view of the penny with the water on it on their worksheet.
- g. Let the students continue adding drops of water until they fall off. Have them write down how many of drops of water the penny was able to hold.
- h. Repeat parts b-g with the other liquids and have students continue filling out the worksheet.
- i. Ask them what differences they noticed between the numbers of drops held by the different liquids. What does this mean in terms of surface tension (higher surface tension means a liquid can hold itself together better, therefore the liquid that allowed for the most drops on the penny has the highest surface tension).
- j. Remove the eyedroppers and cups of liquids (do not pour out the liquids as you need it for the next activity).

3. Pepper Scatter

- a. Pour a small amount of pepper on a dry part of each of the student's plates (if plates are completely wet, you can pour a small amount onto their hand or a paper towel).
- b. Set out the 2 additional glasses of water (so there are a total of 3 on the table).
- c. Have students scatter a little pepper on the top of the water in both glasses of water.
- d. Ask them why they think the pepper floats on the water. Encourage them to think about what happened when they dropped light objects on the paper. If they don't say it, remind them this is called surface tension.
- e. Ask students what they think will happen if they added a little isopropyl alcohol or another substance to the water
- f. Give students the cups of isopropyl alcohol and salt water as well as a dropper for each. Have them add a drop of isopropyl alcohol to one of the cups of water. Ask them what they see happening (the pepper scatter throughout the water and begin sinking). Add a drop of salt water to the other cup. Have students compare what happened in this cup to the other (the pepper will again scatter and sink).
- g. Give students a cotton swab and have them dip it in the dish soap so the swab is coated. Then have them dip the swab into the water (the pepper will scatter even more quickly).
- h. Ask students why they think this is happening. Encourage them to think about the difference in surface tension between the two liquids. Ask them what happens when you combine 2 colors of paint. Is it the same color or something in between the 2 colors? That's what is happening to the surface tension, a higher and

lower surface tension combine to make something in the middle. This new surface tension is not strong enough to hold all of the pepper.

- i. If time allows, have students continue adding isopropyl alcohol and salt water to the cups, observing each time how this impacts the pepper. More and more pepper will sink.
- j. Remove the cotton swab and cups with pepper.

4. Aluminum Foil Boats

- a. Give each student an aluminum foil boat, a new pipette, and a cup of water and place a tub with water on the table for the students to share.
- b. Ask them to make a hypothesis of what will happen when they put the boat in the water. They should answer that the boat will float and you should follow up by asking them what makes the boat float (surface tension and density are both accurate answers).
- c. Ask them to hypothesize what will happen if they use the pipette to put a drop of water on the end boat where the slit is cut. The boat may move a little but otherwise there won't be much of a chance.
- d. Ask students to hypothesize what will happen if they use the pipette to add a few drops of isopropyl alcohol on the back of the boat. Get them to think about what happened with the pepper flakes to help them make their hypothesis.
- e. Test their hypothesis (you can do this test multiple times). Reinforce the idea of reduced surface tension.
- f. Ask students to hypothesize what will happen if they use the pipette to add a few drops of soap on the back of the boat. Get them to think about what happened with the pepper flakes to help them make their hypothesis.
- g. Test their hypothesis (you can only do this test once or twice before you'll need to replace the water to get it to continue to work). Reinforce the idea of reduced surface tension.

Discussion:

You can use the examples of rain drops and soap bubbles to describe real life examples of surface tension that the students would be familiar with. Throughout the last 3 parts of the activity, you can compare surface tension to the paper which will help students visualize what is actually happening on the surface of the fluid. Every type of liquid has a different surface tension which just like the different types of paper were able to hold different weights of objects. Students

should see these differences when they test the different liquids on the pennies. When liquids with different surface tensions are combined, the mixture has a new surface tension value somewhere between the surface tension of the two ingredients. Then they will see this first hand when the paper clip floats when you add the paper towel and also when the isopropyl alcohol is added and they see the pepper scatter. The isopropyl alcohol lowers the surface tension while the paper towel helps you gently place the paper clip in the water so that it doesn't break the surface tension.

Evaluation:

Which liquid used in this activity has a greater surface tension?

What does the isopropyl alcohol do to the surface tension of the water?

What is an example of surface tension that you have seen before?



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