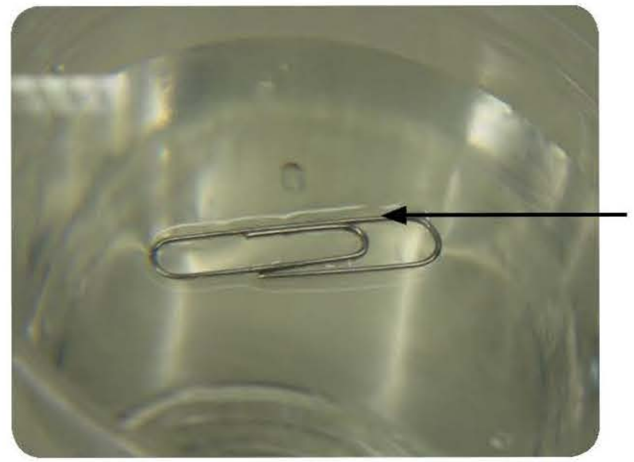
WRAP-UP

To wrap-up the investigation, bring your students together for a group discussion to help them understand why and how they achieved their results. It is important to share results so that everyone has a clear picture of what happened. To help you facilitate the discussion, review the explanation in "The Why and The How" using the Group Discussion questions as a guide.

Group Discussion
Explain to students that scientists learn from each other through discussion, and they build upon the work of others to make new discoveries. Just as scientists come to conclusions based on the findings of their experiments, they will now come together as a group to share their results and make conclusions about the investigations they've conducted. Have students record their final results and the explanation in their journals.

- What did you learn about water from this experiment?
- Did everyone have the same results?
- How were you able to float the paperclip?
- How did the detergent affect the water?
- What surprised you?
- What new questions do you have?

The "Why" and The "How"
Surface tension is the strength of the force that controls the shape and movement of water. Water molecules on the surface of water feel a strong force of attraction from all of the molecules under the water's surface. The molecules at the surface are attracted to each other. This attraction also contributes to the strength of the skin. The stronger the bonds are between the molecules in water, the greater the surface tension. However, the surface tension of water can be broken by adding certain substances such as detergents. Soaps and detergents are useful for cleaning because when they break water's surface tension, they are able to spread out onto dirty surfaces and soak into laundry, breaking up dirt and oil.



meniscus around floating paperclip

Adding detergent to water weakens the bonds between the surface molecules, making them spread apart. This causes the water's invisible skin to break and pull off to the sides, similar to the popping of a balloon. When the surface tension of water was broken in this experiment the weight of the paperclip floating on the surface could no longer be supported, causing it to immediately sink to the bottom.

Curriculum Match-Up

- Draw a water strider using surface tension to help it walk on water.
- Create a chart or graph for the results of different sized paperclips.
- Try the investigations again with different water solutions: saltwater or carbonated water, for example.

References:
www.coolscience.org/CoolScience/KidScientists/FloatDivePaperClip.htm
launchpadscience.com/experiments.htm
pbskids.org/zoom/activities/phenom/soappoweredboat.html

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Breaking the Tension: Surface Tension I

Learning Objectives

Students will:

1. Explain why certain objects are able to float on the surface of water.
2. Explain how detergents break the surface tension of water.
3. Observe that the attractive forces between water molecules cause an invisible "skin", known as surface tension, to form on the surface of water.

Vocabulary Ventures

atom
attraction
cohesion
elastic
hydrogen bonding
meniscus
molecule
sphere
surface area
surface tension
teddy bear molecule
water strider

Have you ever looked at a pond or a large rain puddle and wondered how some insects are able to walk on water? What enables these organisms to accomplish such an incredible feat? Have you ever thought about raindrops and wondered why they aren't square or triangular? These phenomena are actually due to an amazing property of water known as **surface tension**.

Aquarius sp. (Water Strider)

Everything on the planet is made of something smaller. The smallest unit of water is called a **molecule**. A molecule is made up of several small particles called **atoms** which are joined by a chemical attraction. Atoms are the building blocks of eveything on the planet. In a water molecule, opposites attract: two hydrogen atoms with a positive charge are attached to an oxygen atom with a negative charge, forming a shape that looks like the head of a teddy bear. The water molecule is known as the **"teddy bear molecule"**.

Water molecules behave like a magnet, with a positive end and a negative end. The oxygen atom in one molecule of water is attracted to the hydrogen atom in another water molecule, a process called **hydrogen bonding**. This force causes water molecules to be attracted to one another, a property called **cohesion**.

The **attraction** between water molecules also causes water to pull or curve itself inward into the shape with the smallest amount of **surface area** (the outside surface of the shape) which is a **sphere**, or on a flat surface, a dome shape called a **meniscus** (from the Greek word for "moon").

Within a body of water, water molecules are in a constant tug of war with other surrounding water molecules. A water molecule is constantly pulled in every direction by other water molecules, canceling out the forces and causing it to remain stationary. This is known as "no net force".

However, on the surface of the water, molecules are being pulled by other molecules everywhere except from above. This causes the surface molecules to be pulled down strongly and held together very tightly, creating an invisible "skin" on the water's surface known as surface tension.

This stretchy, **elastic** skin on the surface of water is strong enough to support some insects like **water striders**. If you look closely at an insect walking on water you will notice that the insect's feet make dents in the skin but do not break it. Amazing!

Time Needed to Conduct Investigation
This investigation has two parts.
Organize and set up materials: 10 minutes
Introduce the lesson: 5 minutes
Conduct the investigation: 25 minutes
Student journaling/Group reflection: 10 minutes
Total estimated time: 50 minutes

Investigation: Walk on Water

Materials

*For groups of two**
Student journals and writing tools
Picture of a water strider

Part 1
- ½ liter water bottle
- Pie tins or 16 oz clear plastic cups with a wide brim
- Paperclips of varying sizes
- Plastic fork
- Magnifying lenses
- Sponges for clean-up

Part 2
- Liquid dish detergent

*Students can each get their own set of materials if available.

Part 1
Floating Paperclips

GET READY!

In this investigation students will learn that attractive forces between water molecules cause an invisible "skin", known as surface tension, to form on the surface of water. Students will conduct an experiment to determine whether water can support a paperclip.

TIP
Gather all necessary materials prior to the start of the activity.

1. Break students up into groups of two.
2. Ask students if they have ever seen an insect, such as a water strider, walk across the surface of a pond. Show them a picture. Ask students how they think the water strider and other insects are able to walk across water without falling in?
3. Explain that the students will be doing a series of experiments to determine how this phenomenon is possible. Review any relevant concepts/vocabulary from previous investigations.

PREDICT

Invite students to predict whether they think a paperclip will float or sink in the water and why. Have students record their predictions and explanations in their student journals.

PROCEDURE

1. Students should pour water into the pie tin or cup.
2. Tell students they will next try to float a paperclip on the water, but they should first make some predictions.
3. Using the materials provided, try to get the paperclip to float on the surface of the water in the pie tin or cup. Start with the small paperclips first before trying paperclips of larger sizes.

TIP
Let the students experiment with different methods of floating the paperclip. If they are having difficulty, ask questions to help get them on the right track. An easy way to get the paperclip to float is to balance the paperclip on the prongs of the fork and then lower the fork into the cup or pie tin until the paperclip moves off the fork and rests on the water. This may take a bit of practice.

lowering paperclip into water

OBSERVE

Once students have been able to get their paperclips to float, invite them to examine the floating paperclip with a magnifying glass. Students may then experiment with different sizes of paperclips. Circulate around the room and ask students to make the following observations:
- Which methods were successful in getting the paperclip to float?
- Which methods were not effective?
- What do you think is keeping the paperclip afloat?
- How did the water around the paperclip look under the magnifying glass?
- How large of a paperclip can you float? (Students can measure them.)

Part 2
Sink to the Bottom

PREDICT

Next, ask students what they think will happen to the floating paperclip if they add some dishwashing detergent to the water?

OBSERVE

Have students place a drop of dish detergent onto the surface of the water, and make the following observations:
- What happened when you added the detergent to the water? Why do you think this occurred?
- Could you float another paperclip on the water after you added the soap? Why do you think this is?
- How do you think adding detergents or pollutants to a pond would affect organisms such as water striders that live in water environments?

TIP
Rinse all materials between investigations to remove soap residue.

leaf supported by surface tension