

Surface Tension in Zero-G: It's about Adhesion and Cohesion!

Introduction

Have you ever wondered why water forms drops? Or why it sticks to the side of a glass? Surface tension is the ability of a liquid's surface to resist external forces like gravity. This results in holding the surface of a liquid together, and is caused the forces of cohesion and adhesion.

Cohesion is a force between the molecules in the liquid, which attract each other, causing water molecules to stick together. It is why a cup of water or a raindrop has a rounded surface.



Adhesion on the other hand, is when a liquid comes into contact with a solid surface, causing the liquid to adhere, or stick, to the surface. This is due to the attraction between the molecules of the liquid and the molecules of the solid.

Surface tension is most obvious and interesting in microgravity, where liquids will form a sphere. The spherical shape is due to cohesion between the water molecules:

[Water Spheres in Space](#)

However, once the liquid touches a surface, such as a wash rag, the adhesive force causes the water to stick to that surface:

[Wringing Out Water on the International Space Station](#)

A surfactant reduces surface tension, causing water molecules to spread out. Dish soap is a good example of a surfactant. When dish soap is added to water, it reduces the surface tension of the water by disrupting the cohesive force between molecules. This causes the soapy water to spread out and more easily adhere to another surface, such as a dirty dish... making it easier to clean!

Target Grade Level: 5th-8th

Suggested Time Frame: 45 minutes (class time)

NGSS Standards:

MS-PS1-1: Develop models to describe the atomic composition of simple molecules and extended structures.

MS-PS2-2: Plan an investigation to provide evidence that the change in an object's motion depends on the sum of the forces on the object and the mass of the object.

MS-ETS1-2: Evaluate competing design solutions using a systematic process to determine how well they meet the criteria and constraints of the problem.

Objective:

Demonstrate the properties of surface tension, adhesion, and cohesion in microgravity.

Materials

Small, plastic cups

Water

Food coloring

Sealable containers of varying shapes and types

Plastic syringes (5-20 mL)

Duct tape

Glue (assorted, leak proof)

Ziplock bags

*Students may come up with their own material ideas

Engage

Tik Tok Water Cup Challenge!

Have groups of 3-5 students take turns pouring water in a cup.

Goal: Don't spill the water!

<https://www.facebook.com/watch/?v=4723223551120447>

Students will really get into this challenge, and will notice that the water forms a dome above the rim of the cup due to surface tension.

Discuss the concepts of surface tension, adhesion, and cohesion based on the water cup challenge.

Student Design Challenge

Design and build an apparatus to demonstrate the properties of adhesion and cohesion of water.

Criteria and Constraints:

- Max size: 2000, cm³
- Max volume of water (total): 50 mL
- Container must be fully sealed and leak-proof.
- A secondary containment system while in flight is required

Students need to ground test carefully to ensure that design is leak proof.

Choose the most appropriate design for flight on-board G-Force One to demonstrate cohesion and adhesion. Be sure to use colored water for better visibility.

Try water with and without a surfactant!

Procedures- In flight

At Initiation of weightlessness:

1. Start video (slow motion) or take photos! *Be sure that the side of the container is clear for the shots!
2. Slowly inject colored water into the container to form a sphere of water, demonstrating the adhesive properties of water. Hold the container through 2 parabolas.
3. During the next parabola, continue filming so students can see the adhesive properties of water. Shake the canister. Where is the water?
4. Repeat with water + surfactant, for example soapy water.

In class: Students will view flight video and make observations

Results- Post flight

Show video of cohesive and adhesive properties of water
Students should write down observations

Surface tension of water in microgravity

	Observations
What did you see that is an example of cohesion?	
What did you see that is an example of adhesion?	
Explain surface tension	
How did adding a surfactant change the results? Explain	
How would you build on this experiment?	

How can the properties of adhesion and cohesion be useful in space flight?

How do they make space flight difficult?

Resources

Video: Adhesion

[Water Spheres in Space](#)

Video: Cohesion

[Wringing Out Water on the International Space Station](#)