National Aeronautics and Space Administration

Christa's Lost Lessons

Liquids in Microgravity

Grade: 5-8

For more of Christa's lessons and accompanying videos filmed in orbit, visit www.challenger.org/christa.

www.nasa.gov

Liquids in Microgravity

Background Guide

Grade Level:
5th-8th

Suggested Time:
55-60 minutes

Standards:

- 5-PS1-3: Make observations and measurements to identify materials based on their properties.
- 5-PS1-4: Conduct an investigation to determine whether the mixing of two or more substances results in new substances.

Key Vocabulary

- Density: How compact something is

Essential Questions

- How do liquids behave and mix in microgravity compared to Earth?
- What is density?
- How does density affect the interaction of different liquids?

Objective

- Compare how liquids behave and mix in microgravity with how they behave on Earth.

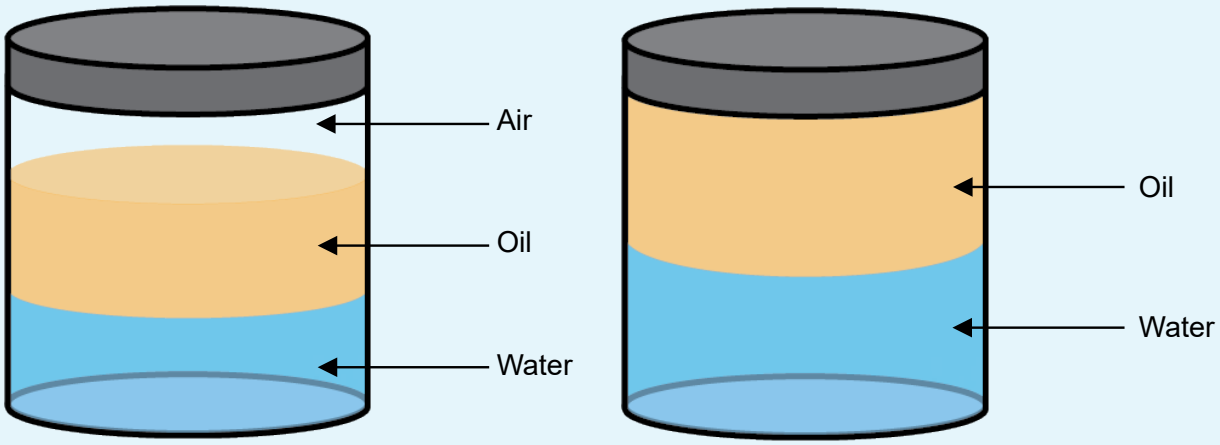
Materials (for each student/group)

- For opening activity:
  - A bottle of Italian salad dressing or other salad dressing with ingredients that separate from one another
- For experiment:
  - Clear containers with tightly secured lid, preferably a jar
  - Oil
  - Water
  - Spoon
  - Food coloring
- For extension:
  - Pipette
  - Jars or graduated cylinders
  - Food coloring
  - Multiple types of liquids (e.g. vinegar, honey, various oils, etc.)

Teacher Preparation

Containers should have equal parts of oil and water. The water should be dyed with food coloring to make it easier to differentiate between the liquids.
Provide enough materials for the experiment to be performed in groups of two to four.

The jars for each group will be filled as illustrated below.
*Note: If you wish to save time and materials, consider preparing the jars for each student group ahead of time.



PROCEDURE

ENGAGE (10 min)

Materials needed: Italian salad dressing or other salad dressing with ingredients that separate from one another.

Opening Demonstration: Mixing It Up!
As an opening activity, have students form small groups and provide each group with a bottle of salad dressing. Ask them not to pick up the bottles yet.

- Ask students to discuss, in their small groups, the ingredients that they might find in the dressing. Students should note that there are layers of liquids (ingredients) in the bottles of dressing. Challenge students to think about what the different layers are. Some might realize that they can look at the list of ingredients to identify some of the components.
- Ask students to briefly share their ideas with the class.
- Ask students to shake up the salad dressing, then set it back down and observe what happens. The contents will begin to settle again in layers. Ask the students to discuss in small groups or as a class, “Why do you think the ingredients separate again?”

EXPLORE (15 min)

Materials needed: Liquids in Microgravity video: Find at www.challenger.org/Christa, attached worksheet.

Video Viewing:

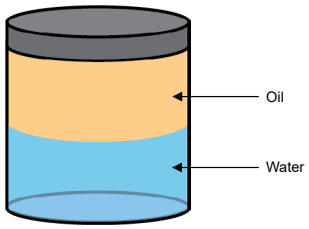
- At this time, show the designated video associated with the Liquids in Microgravity lesson.
- Students should observe/take notes on their handouts during the video.
- After viewing the video, discuss what students saw in the video and the key terms: density, hydrophilic and hydrophobic.

EXPLAIN (15-20 min)

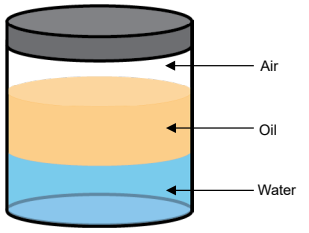
Materials needed: Clear jars with lids, oil, water, a spoon, food coloring and the attached worksheets.

In Class Experiment:

1. Direct students to form groups of 2-4.
2. Once at their stations (which should be set up ahead of time to include 2 clear jars with lids, water, oil and food coloring), students can begin to conduct the experiment themselves.
3. Instruct students to fill one jar halfway up with water and the rest of the way with oil.
    - Fill with water first and add a few drops of food coloring. Stir with a spoon.
    - Fill the rest of the way with oil.
4. The liquids should completely fill the jar, leaving as little room for air as possible. The lid needs to be screwed on tightly.



5. In the other jar, fill it ⅓ of the way with oil, ⅓ with water, and leave ⅓ of it empty with air.
6. Repeat the same process for adding the food coloring to the water.
7. Screw on the lids to the containers.
8. Shake the container with no/little air vigorously. Once done shaking, set it back on a flat surface and let the container sit until the liquids settle. Record observations.
9. Next, take the container with oil, water and air and repeat this process.
10. Did having more air affect the mixture in any way? Record observations.
11. Working in small groups, students should answer the questions on the final page of the student handout. Additional extensions are included to enhance this activity, time permitting.



ELABORATE and EVALUATE(15 min)

Materials needed: Student worksheets.

Apply Concepts to New Mixtures:

- Review student responses to questions on the final page of the student handout as a class. As students talk through their responses, they should note that water is more dense than oil. The experiments in space and on Earth look different, however, due to the presence of a strong gravitational pull on Earth. Gravity pulls the denser, heavier substances to the bottom of the container over time on Earth, but this does not happen in microgravity, which is why the air bubbles stay trapped in the water and oil.
- Ask students to examine the bottles of salad dressing that have been sitting on the desk. Challenge students to consider, “If you shook up salad dressing on the International Space Station, do you think the ingredients would settle into layers like they do on Earth? Why or why not?

EXTENSIONS AND ENRICHMENT

As an extension, give students the opportunity to mix new substances to determine which substances will combine with one another and which will separate. Provide students with additional jars or graduated cylinders in which they can try to layer liquids and/or mix them up. Students may want to add food coloring to substances. Encourage students to record what they add to their mixtures and observe which substances are more/less dense than others, and which substances combine mix with one another. Have students share these results with the class.

NASA astronaut Scott Kelly demonstrates effervescence in a high resolution video from the International Space Station. Watch here.

LIQUIDS in MICROGRAVITY

In this lesson, you are going to learn about density and how liquids interact. Look at the bottle of salad dressing at your table. Do not touch it yet! What do you observe in the bottle? What different types of substances do you think are in the bottle?

_____

_____

_____

Now shake up the bottle! After shaking the bottle for about five seconds, set the bottle back on the table. Observe what happens for a few minutes. What happened and why do you think it happened?

_____

_____

_____

Astronaut Ricky Arnold is going to perform an experiment that demonstrates how liquids interact on the International Space Station. Write down your observations, then answer the questions as you watch the video.

Liquids in Microgravity Experiment Video: Write down the definition of density as you watch the video.

Density: _____

_____

_____

How did the water and oil mixture with no air behave?

Observations: _____

_____

_____

How did the water and oil mixture with air behave?

Observations: _____

_____

_____

LIQUIDS in MICROGRAVITY

What did Ricky Arnold do to the liquids on the International Space Station that might be hard to accomplish on Earth?

Observations: _____
_____
_____

Now that you have seen what this experiment looks like in space, you are going to try it in your classroom! Just like Ricky Arnold, you are going to have one container with oil and water, and one with oil, water and air. In the space below, predict how these mixtures will interact in Earth's gravity.

Hypothesize: Make your prediction of what will happen to your two oil and water mixtures.

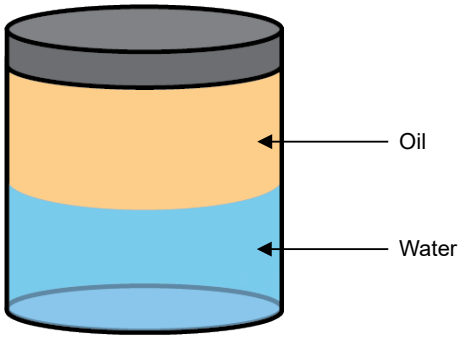
_____
_____
_____

Materials:

- Clear jars with lids
- Oil
- Water
- Spoon
- Food coloring

Directions:

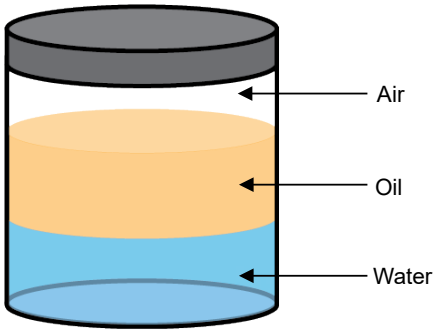
1. In one jar, fill it halfway up with water.
2. Add a few drops of food coloring to the liquid. Stir with a spoon.
3. Next, fill the rest of the jar with oil. Fill to the top so that almost no room for air is left in the jar.



5. Screw the lid on your container.
6. Shake the container. What do you see happening? After you have given it a good shake, set it down on a flat surface and watch as the liquids settle. Record your observations in the chart labeled "Container Observations" (next page). Take notes. Draw and label pictures that illustrate your findings.

LIQUIDS in MICROGRAVITY

7. In the other jar, fill it ⅓ of the way with water and add the food coloring the same way you did to the other jar.
8. Next, fill the jar ⅓ of the way with oil. The rest of the room in the jar is left open for air.



9. Screw the lid onto your container.
10. Shake the container. What do you see happening? After you have given it a good shake, set it down on a flat surface and watch as the liquids settle. Record your observations in the chart labeled “Container Observations”. Take notes. Draw and label pictures that illustrate your findings.

Data (include a drawing and a written explanation of what you see):

Container Observations	
Jar with No Air	**Jar with Air**

LIQUIDS in MICROGRAVITY

Conclusion:

What differences and similarities did you observe in the results of the in experiment in space versus the experiment in your classroom?

_____
_____
_____
_____

Why do you think the mixtures behaved differently in microgravity and in Earth's gravity?

_____
_____
_____
_____

Which is more dense: oil or water? Circle one.

Oil Water

How do you know?

_____
_____

What do you think would happen if you added a thicker substance like honey or syrup to the top of the mixture here on Earth? How would the mixture behave in microgravity?

_____
_____
_____
_____

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