



Mission: How can we build stronger boundaries between materials?

Age: 8+

Materials: \$9

Time: 45 min

(Set-up: 5 min Activity: 30 min Clean-up: 10 min)

What you need:

Materials:

- Water
- Vegetable oil (about 1 cup)
- 1 tube gel food coloring (standard food coloring/egg dye will not work)
- 16 oz. bottle corn syrup

Equipment:

- 3-5 small clear glasses (glass works better than plastic)
- 1-cup liquid measuring cup
- Spoon for mixing
- Data sheet
- (Optional) Ruler
- (Optional) Smartphone or camera for recording video

What to do:

Observing Boundaries

1. Prepare your glasses by rinsing them with water to wet the sides. This will help you build a smooth boundary without unwanted bubbles.
2. In your first glass, add about 1 inch of water (use a ruler if you like, but no need to be exact). Next, add a layer of oil above (a ~1/2 inch layer is plenty), pouring slowly down the side of the cup to help prevent those bubbles from forming. Look closely at where the oil and water meet - that's a boundary!
3. Hold the gel food coloring tube close to (but not touching) the surface of the oil, and very carefully release one drop near the center of the cup. Observe the boundary and the drop closely as it falls. What happens? Write your observations on the data sheet. Keep watching for 3-5 minutes to look for any changes over time. [Optional: Take a close-up picture of the drop at the boundary to compare later with other boundaries. Or record a time-lapse video to capture any interesting changes.]
4. In a second glass, add about one inch of corn syrup (we'll call this a 100% corn syrup solution). As before, add a layer of oil. Observe the boundary where the corn syrup and oil meet. Does it look any different from the water-oil boundary?
5. Repeat step 3, adding a drop to your second glass. Observe. What happens to the drop this time? Write your observations on the data sheet. Wait a while and see if anything changes.
6. Compare your two boundaries. Which do you think is stronger? Why?

What to do:

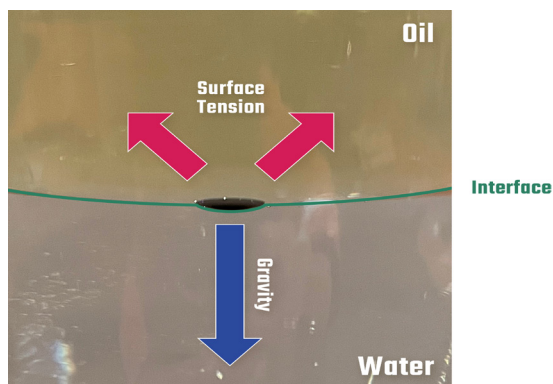
Testing Boundaries

7. Prepare a 50% corn syrup solution (half water, half corn syrup): In your measuring cup, measure 1/2 cup corn syrup. Then add 1/2 cup water. Mix thoroughly with a spoon, until the liquid is clear and you can't see any more swirls of corn syrup.
8. In a third glass, build another boundary with your 50% corn syrup solution and oil above it. Based on your earlier observations, predict what will happen when you add a drop of food coloring. Record your prediction on the data sheet.
9. Test your prediction! Repeat step 3 to add a drop to your third glass. Was your prediction correct?
10. Explore further! Try building boundaries with 25% corn syrup and 75% corn syrup solutions. Predict what will happen to the drop in each glass and test it out. Record your predictions and observations on the data sheet.
11. Experiment with building other boundaries too! Oil is the best choice for the upper liquid, but what variations could you try below? What other liquids might you try - maybe vinegar, or even egg whites? How about changing the temperature of the bottom liquid with warm or cold solutions? Every pair of liquids builds a different boundary!

Clean-up:

Dispose of all liquids down the drain with plenty of soap and water, and wash your dishes!

What's Happening?



Oil does not mix with liquids like water or corn syrup. When you combine them, they remain separate, creating a boundary where they touch. Scientists call this boundary an “interface.” Interesting and important things happen at interfaces.

In this activity, you observed how an interface can act like a net holding a drop of food coloring. The properties of the materials forming the interface determine how strong the net is -- a property called surface tension. If the net is weaker than the force of gravity pulling the drop down, the net will stretch until it breaks and the drop falls through. If the net is strong, the interface can support the weight of the drop without stretching and eventually breaking. Because corn syrup is a thicker liquid than water, it makes a stronger interface with oil. Just as you tested different solutions of corn syrup, scientists experiment -- predict, build, and test! -- with different materials to create stronger interfaces.

So What?

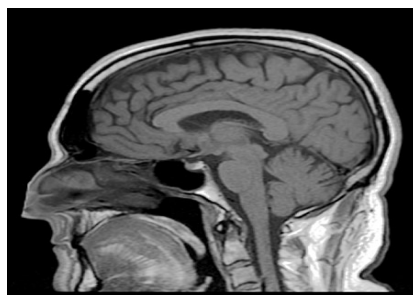


Image credit: Reigh LeBlanc

Your body is filled with interfaces between different materials. For example, think about the boundary between the air and your skin, or where your lung tissue touches the air that you breathe in. Another important interface in our bodies is the boundaries between our cells and the liquids that surround them. This interface has interesting effects on the organization and structure of molecules at the boundary. Sometimes the organization of these molecules changes and goes wrong. These changes play a role in brain disorders like Alzheimer’s disease and Parkinson’s disease. By studying interfaces that exist in the brain, we can better understand these diseases and try to find a cure.

Other than the human body, can you think of other important examples of interfaces that affect us every day? Look around. They are everywhere.

OBSERVING BOUNDARIES

What happens to the drop as it falls into the cup?
 How does the drop behave at the boundary?
 Does the drop's behavior, position, or shape change over time?

BOUNDARY

OBSERVATIONS

water — oil	
100% corn syrup — oil	
Which boundary do you think is stronger? Why?	

TESTING BOUNDARIES

Prepare corn syrup

Will the drop fall? (yes/no)

Was your prediction correct?

BOUNDARY

MIXTURE

PREDICT

TEST

50% corn syrup — oil	1/2 cup corn syrup 1/2 cup water		
25% corn syrup — oil	1/4 cup corn syrup 3/4 cup water		
75% corn syrup — oil	3/4 cup corn syrup 1/4 cup water		

NGSS Alignment of Building Boundaries Activity

The information below may not include every area that this activity can be linked to NGSS concepts

Disciplinary Core Ideas

PS1.A: Structure and Properties of Matter

- **Grade 5**

- ◇ Measurements of a variety of properties can be used to identify materials.
- ◇ Different kinds of matter exist and many of them can be either solid or liquid, depending on temperature. Matter can be described and classified by its observable properties.

- **Middle School**

- ◇ Each pure substance has characteristic physical and chemical properties (for any bulk quantity under given conditions) that can be used to identify it.

Performance Expectations

2-PS1-1: Plan and conduct an investigation to describe and classify different kinds of materials by their observable properties.

2-PS1-2: Analyze data obtained from testing different materials to determine which materials have the properties that are best suited for an intended purpose.

5-PS1-3: Make observations and measurements to identify materials based on properties.

MS-PS1-2: Analyze and interpret data on the properties of substances before and after the substances interact to determine if a chemical reaction has occurred.

Crosscutting Concepts:

Patterns

- Grade 3-5
 - ◇ Similarities and differences in patterns can be used to sort, classify, communicate and analyze simple rates of change for natural phenomena and designed products.
 - ◇ Patterns of change can be used to make predictions.
- Middle School
 - ◇ Macroscopic patterns are related to the nature of microscopic and atomic-level structure.

Cause and Effect

- Grade 3-5
 - ◇ Cause and effect relationships are routinely identified, tested, and used to explain change.
- Middle School
 - ◇ Cause and effect relationships may be used to predict phenomena in natural or designed systems.

Engineering and Science Practices

Analyzing and Interpreting Data

- Grade 3-5
 - ◇ Analyze and interpret data to make sense of phenomena, using logical reasoning, mathematics, and/or computation.
- Middle School
 - ◇ Analyze and interpret data to provide evidence for phenomena.
 - ◇ Analyze and interpret data to determine similarities and differences in findings.

Planning and Carrying Out Investigations

- Grade 3-5
 - ◇ Plan and conduct an investigation collaboratively to produce data to serve as the basis for evidence, using fair tests in which variables are controlled and the number of trials considered.
 - ◇ Make observations and/or measurements to produce data to serve as the basis for evidence for an explanation of a phenomenon or test a design solution.
- Middle School
 - ◇ Conduct an investigation and/or evaluate and/or revise the experimental design to produce data to serve as the basis for evidence that meet the goals of the investigation.