Learn BRIGHT

VISCOSITY AND DISPLACEMENT

S T E M

GRADE 5-6

Classroom Procedure:

1. Introduce the lesson by asking students to think about pouring water and pouring glue into separate containers. Which container will fill up faster? Why? (Glue is thicker than water; therefore, it will pour slower.)
2. Distribute Viscosity and Displacement content pages.
3. Distribute the Activity Page. Have students work in groups. Determine if students will pour their liquids or have them pre-poured for each group.
4. Distribute the Practice Page. As students complete each section of the Practice Page, have students record their observations in a journal. Then, discuss their observations and results, and ask students to explain what happened in scientific language.
5. Distribute the Homework Page. Review them with students' observations. How do the results on the Homework Page correlate with the experiments in class?
6. In closing, ask students to name a liquid that can benefit from having a low viscosity and a liquid that helps from having a high viscosity. What are some practical applications of knowing about viscosity (i.e., lubrication in a car engine)? How does displacement explain how large ships float?

Lesson Title: **Viscosity and Displacement: A STEM Activity**

Subject: **Science**

Approximate Grade Level: **5 – 6**

Objectives: The student will explain viscosity and displacement. In addition, the student will understand how certain materials displace others (i.e., oil and water). Finally, students will know that a fluid with low viscosity flows easily because its molecular makeup results in very little friction in motion. Conversely, a fluid with high viscosity flows less easily at its molecular makeup, resulting in increased friction in the movement.

State Educational Standards*
NGSS.5-PS1-1, NGSS.5-PS1.A,
AND NGSS.5-PS1.B

Class Sessions (45 minutes):
2 – 3 Class Sessions

Teaching Materials/Worksheets:
Content Pages (2), Activity Page (1), Practice Pages (2), Homework Pages (2)

Student Supplies:
Activity: For each group - ruler, stopwatch, 2 – 6 graduated cylinders, marble or steel ball, calculator
Practice: Piece of tin foil, a large bowl or bucket of water (water can be for each group or one for the class to use)
Homework: Cup, water, plate, about 20 pennies

Prepare Ahead of Time:
Copies of worksheets

Options for Lesson: The homework page could be used as another in-class lesson for students to complete individually or in small groups. For example, have students explore the construction of large battleships for a more in-depth look at displacement. Students can also explore various types of machines to see how viscosity helps in engineering, from cars to electronics.

*Lessons are aligned to meet the education objectives and goals of most states. For more information on your state objectives, contact your local Board of Education or Department of Education in your state.

Teacher Notes

In this lesson, students will explore the scientific concepts of viscosity and displacement through several hands-on activities. Forget worksheets, as this lesson will have students dropping, measuring, and timing a variety of liquids to investigate viscosity. Students will also make small canoes to explain how displacement can keep a large steel battleship afloat. There will never be a dull moment in this class!

VISCOSITY

Viscosity comes from the Latin word *viscum,* meaning 'sticky.' It is a physical property of fluids. Think about pouring a glass of water. Now think about pouring a glass of honey. The water and honey will **flow** at different rates. Most fluids will offer some resistance to motion, in this case, pouring. This resistance is called **viscosity.** Viscosity is defined as the measure of a fluid's resistance to flow. It can be considered a measure of a fluid's thickness or resistance to objects passing through it.

Water has a low viscosity. Water flows easily because its molecular makeup results in very little friction when it is in motion. Honey has a high viscosity. It resists motion because it has strong intermolecular forces, which creates a lot of internal friction.

The viscosity of a liquid decreases when the temperature of the fluid increases. That means when you heat a liquid, it will generally flow much easier. For example, think about putting honey in the microwave for 15 seconds. The honey gets 'thinner,' and the viscosity increases, making it much more like pouring water.

Two ways to measure viscosity

1. Dynamic viscosity – resistance to flow when an external force is applied
2. Kinematic viscosity – resistance to flow under the weight of gravity

The basic way to measure viscosity is to drop a sphere through a fluid and time the fall of the sphere. The slower it falls, the greater the viscosity.

While this works great, scientists wanted a more accurate way to measure viscosity, so they invented a **viscometer**. A U-tube or Ostwald viscometer consists of two reservoir bulbs and a capillary tube.

Think about it for a moment. Can you think of examples where knowing the viscosity of a fluid is important? (For example, different kinds of oils are used for cooking.)

DISPLACEMENT

Here is something to think about. Maybe you have seen an aircraft carrier up close or on television. The largest aircraft carriers in the U.S. fleet are larger than four football fields. The deck space is approximately 4.5 acres in surface space. They have room for 4,500 sailors to live for multiple months of deployment. According to the Navy Museum, an aircraft carrier weighs more than 220,462,280 pounds or 100,000 tons! The planes typically weigh about 32,000 pounds each, and the sailors aboard can weigh as much as 900,000 pounds. Amazing, right? So, the question is, how does something that large not sink? How is it able to float?

When an object enters water or another liquid, it pushes out the water to make room for itself. Therefore, the object always pushes out a specific volume of water equal to its volume. This is called **displacement**. Remember, in science, **volume** measures how much space an object takes up. Because of this, you can measure the object's volume by measuring the displacement.

The scientific explanation for how a huge aircraft carrier can float is this: the aircraft carrier can float on water because the bottom of the ship, the hull, is designed to displace a large amount of water. The volume of water the ship displaces weighs more than the weight of the entire ship. Therefore, the buoyant force of the water is greater than the gravitational force of the aircraft carrier.

A simpler example is adding ice cubes to a liquid like a soda. The ice cubes float on top of the soda. As a result, they displace more liquid than the cubes weigh.

Name ______________________ Date ________

Instructions: With a partner, follow the directions to complete the chart.

3. Fill up the graduated cylinder to the same mark each time using each liquid.
4. Have one person hold/drop the sphere and another person start/stop the stopwatch.
5. Record each trial in the chart below.

Liquid	Time 1	Time 2	Time 3	Average Time
Shampoo				
Corn syrup				
Water				
Olive oil				
Cream				
Honey				

- **Put liquids in order of viscosity from lowest to highest.**

1. ______________________________

2. ______________________________

3. ______________________________

4. ______________________________

5. ______________________________

6. ______________________________

Instructions: Follow the instructions to prove displacement. Use different materials to make your canoe. Make several in various sizes and try other liquids (vegetable oil, salt water, etc.).

- Shape your tinfoil into a canoe.
- Fill up the bowl with water.

Will the tinfoil canoe sink or float? ____

- Place the canoe in the water.

Did the canoe sink or float? ____

- Crumple the tinfoil canoe into a ball.

Will the tinfoil ball sink or float? ____

- Place the ball in the water.

Did the ball sink or float? ____

How is this similar to how large ships float? ____

____

____

____

____

Why does the shape of the tinfoil make a difference? ____

____

____

____

____

____

____

Practice

Name Answer Key Date ________

Instructions: Follow the instructions to prove displacement. Use different materials to make your canoe. Make several in various sizes and try other liquids (vegetable oil, salt water, etc.).

- Shape your tinfoil into a canoe.
- Fill up the bowl with water.

Will the tinfoil canoe sink or float? Answers will vary.

- Place the canoe in the water.

Did the canoe sink or float? Float

- Crumple the tinfoil canoe into a ball.

Will the tinfoil ball sink or float? Answers will vary.

- Place the ball in the water.

Did the ball sink or float? Sink

How is this similar to how large ships float? An object that displaces its weight in water will float, regardless of how heavy it is. As long as it pushes aside its weight in water, it will stay on top.

Why does the shape of the tinfoil make a difference?

The canoe acts like a wedge, pushing water aside as you lower it into the water. The crumpled ball has the wrong shape. All of the mass is compressed together, so it has a high density and displaces very little water.

Homework Name ____________________ Date ________

Learn BRIGHT

Instructions: Follow the instructions to complete the chart.

- Fill a plastic cup with water all the way to the brim without overflowing and place it on a plate.
- Very slowly, add one penny into the water. Add another penny into the water.
- Continue to add pennies and note what happens on the chart below. Observe the cup at eye level to the brim. Use the terms flat, dome, and overflow in the chart.

Number of Pennies	Water in the cup	Number of Pennies	Water in the cup
1		11	
2		12	
3		13	
4		14	
5		15	
6		16	
7		17	
8		18	
9		19	
10		20	

Draw a picture of what happened at the beginning, middle, and end of the experiment.

Beginning	Middle	End

Homework Name Answer Key Date ________

Instructions: Follow the instructions to complete the chart.

- Fill a plastic cup with water all the way to the brim without overflowing and place it on a plate.
- Very slowly, add one penny into the water. Add another penny into the water.
- Continue to add pennies and note what happens on the chart below. Observe the cup at eye level to the brim. Use the terms flat, dome, and overflow in the chart.

Number of Pennies	Water in the cup	Number of Pennies	Water in the cup
1	(Answers will vary.)	11	
2		12	
3		13	
4		14	
5		15	
6		16	
7		17	
8		18	
9		19	
10		20	

Draw a picture of what happened at the beginning, middle, and end of the experiment.

Beginning	Middle	End