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 activity?
- What surprised you?
- What new questions do you have?
- What did you like about this activity?

The "Why" and the "How"
There are several things working together to make each object float or sink. The surface of a liquid acts like an elastic band or skin, caving in slightly when an object touches the surface. When a high-density object (like a marble) is placed in or on water, it breaks the surface tension of the water. Some of the water is then pushed aside or "**displaced**". Because no two objects can occupy the same space at the same time, the water has to make room for the marble by moving out of the way, so the water level rises. If you weigh the marble that sank to the bottom of the container, you will find that it weighs more than the water it displaced.

All objects, whether they sink or float, experience an upward **force** when they are placed in liquid. This force is known as the buoyant force, and it is equal to the weight of the liquid displaced by the object. The properties of buoyancy and density work together, helping an object sink or float.

Density measures how compact (how crowded together) matter is packed into a certain space. If an object is less dense than the surrounding water, the object floats. But, if an object is more dense than the surrounding water, it sinks.

Buoyancy helps low-density objects float and causes them to resist being submerged under water. This is why the sealed bottle of air floats instead of sinking. Air is less dense than water, causing it to float above water.

References:
Adapted from information from the U.S. Office of Naval Research
Encyclopedia Britannica

Think about it: air floats above all the Earth's water, including lakes, rivers and the ocean! If you release air from the bottle while it is under water, water will fill the container, causing it to sink. Every day, you can see examples of some objects that float while others sink. Cornflakes can float in milk because they are less dense than the milk. A raisin may sink because it is denser than milk. Ice is actually less dense than water – this is why icebergs float on water.

Another example is submarines: a submarine floats because the weight of water that it displaces or moves is equal to its weight. When a submarine is placed in the water, **gravity** pulls the submarine downward. But, as water is displaced, it creates the upward (buoyant) force. This buoyant force acts opposite to gravity, which tries to pull the ship down. A submarine can control its buoyancy, allowing it to sink and rise to the surface as it needs. To control its buoyancy, the submarine has tanks that can be filled with water or air. When the submarine is on the surface of the water, the tanks are filled with air, making the submarine less dense than the surrounding water. When the submarine wants to dive, its tanks are filled with water until its density is greater than the surrounding water, causing the submarine to sink.

submarine

Curriculum Match-Up

- Make a chart of the items that sink and float in this investigation.
- Repeat the investigation using a ball of aluminum foil, cornflakes, paperclips or pennies in place of marbles and clay. Predict whether or not these items will sink or float. How many will it take to sink the bottle?
- Add ½ cup of salt to the water and try the investigations again. What do you observe?

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Uplifting Force: Buoyancy & Density

Learning Objectives

Students will:

1. Investigate different kinds of force and motion, including buoyancy and other properties of water.
2. Identify the relationship between physical properties of water, specifically buoyancy, **surface tension** and displacement.
3. List common examples of displacement, buoyancy and surface tension in action.

Vocabulary Ventures

buoyancy
density
displacement
force
gravity
mass
surface tension

An ancient Greek mathematician named Archimedes first discovered the law of **buoyancy**. Also known as Archimedes' principle, it states, "the buoyant force is equal to the weight of the displaced fluid".

Archimedes had a gift for making machines, and he served as an advisor to King Hiero of the Greek colony of Syracuse. King Hiero had gold sent to a goldsmith for a new crown. When the king received the finished crown, he thought something was wrong -- it didn't appear as if all the gold was used to make the crown. The king told Archimedes about his problem.

Archimedes went home and filled his tub with water. When he sat in the tub of water, it overflowed. Archimedes realized that the **mass** of the water that spilled out of the tub was equal to the mass of his body.

boy using inner tube float to stay buoyant in water

Archimedes tried the same experiment with the crown, placing it in a bucket filled with water and watching water spill out of the bucket. He observed that the amount of gold that was supposed to be used for the crown was equal to the amount of water that spilled out of the bucket. Archimedes later found out that the amount of gold sent to the goldsmith weighed more than the crown.

Archimedes concluded that the goldsmith didn't use all of the gold he was given to make a new crown. Why? Because the crown had less mass than the amount of gold sent to the goldsmith. The goldsmith was punished when King Hiero found out that the gold was missing from the crown. The legend is told that when Archimedes discovered the property of buoyancy, he ran through the streets yelling "Eureka!" which means "I found it!"

Time Needed to Conduct Investigation
This investigation has five parts.
Organize and set up materials: 10 minutes
Introduce the lesson: 5 minutes
Conduct the investigation: 15 minutes
Student journaling/group reflection: 10 minutes
Total estimated time: 40 minutes

Investigation: Sink or Float?

Materials

For groups of three
Student journals and writing tools

- Marbles (15 per group)
- Medium to large (shoebox-sized or larger) plastic container with a wide open top, filled with water
- ½ stick of clay (from a 1 lb. package)
- Small airtight jar or bottle (like a baby food jar or a ½ liter water bottle with cap)
- Pan balance or scale

Part 1
Marble vs. Clay

GET READY!

Review the concept of physical properties with students. Physical properties can be observed using at least one of our five senses (sight, smell, taste, touch, hearing), or they can be measured (using a tool like a scale) without changing the chemical make-up of matter. We use physical properties to describe and understand different objects. Physical properties include observations such as color, texture (rough or smooth), odor, melting point, boiling point, density, solubility (if and when a material dissolves in liquid) and several others.

PROCEDURE

1. Divide students into groups of two or three.
2. Ask students to mold a small piece of modeling clay into a ball the same size as the marble in their supplies.
3. Have students make observations about the properties of the clay ball and the marble. Students should then describe the differences and similarities between the clay and the marble.
4. Next, have students weigh the marble and the ball of clay using the pan balance.

PREDICT

Ask students to make predictions and record them in their student journals:

- What will happen when you put the marble in the water?
- What will happen when you put the ball of clay in the water?

OBSERVE

Ask students to place the marble into the water. Then have them place the clay in the water. Make the following observations:

- What happened to each object after you placed it in the water?
- Did the object sink quickly or take a long time to sink?
- Why do you think that this happened?

Part 2
Bottle Basics

Distribute the small airtight jar or bottle, and have students seal the lid tightly. Have students weigh the bottle using the pan balance.

PREDICT

Ask students to make a prediction about what will happen when they place the bottle in the water. Students should record their predictions in their journals.

OBSERVE

Ask students:

- What happened to the bottle after you placed it in the water?
- Why do you think that this happened?
- What do you notice about the shape of the bottle?
- What's inside the bottle? (HINT: It's something that you breathe. ANSWER: Air!)

Part 3
Marble in a Bottle

Have students take the bottle out of the water, remove the lid and place a marble in the bottle. Students should re-seal the bottle tightly and weigh it using the pan balance. Before the students place the bottle back in the water, have them make some predictions about what will happen to the bottle with the marble in it.

OBSERVE

Ask students:

- What happened to the bottle after you placed it in the water?
- How do you explain what happened?
- How many marbles can you add before you get the bottle to sink?

Part 4
Clay in a Bottle

Have students take the bottle out of the water, remove the lid and the marble, and place the ball of clay in the bottle. Students should re-seal the bottle tightly and weigh it using the pan balance. Students should predict again what will happen before they place the bottle back in the water.

OBSERVE

Ask students:

- What happened to the bottle after you placed it in the water?
- How do you explain what happened?
- How many balls of clay can you add to the bottle before you get it to sink?

Part 5
A Bottle Full of Water

Have students take the bottle out of the water, remove the lid and the ball of clay from the bottle. Students should fill the bottle with water and re-seal the bottle tightly. If you have enough gram counter weights, have the students weigh the bottle of water using the pan balance. Ask students to predict what will happen when the bottle is placed in the water.

OBSERVE

Ask students:

- What happened to the bottle after you placed it in the water?
- How do you explain what happened?

floating bottle with marble