STEAM Subject: Physics
Lab: Buoyancy

Grades: 3-8

Learning objective: Students will learn about the relationship between mass and volume, called density, and determine when and which objects will sink or float.

ENGAGE:
Ask students the following question:
What is the name of the force that causes an object to float? Have you ever heard the word buoyancy before?

EXPLORE:
Activity 1: Sink or Float
Students will participate in an activity where they will drop various items into a tub of water and make predictions on whether an object will sink or float. Students will discover the relationship between mass and volume, and change an object's buoyancy.

Materials needed per student:

- A plastic bin
- Water
- A piece of paper
- A pencil
- 5-6 various objects of the student's choice (make sure they are water-proof!)
- A kitchen scale (optional). Google can be used to determine the approximate mass of the objects chosen
- Aluminum foil

Directions:

1. Fill the plastic bin with water until it is approximately 2/3rd full. Ask for help from a parent or guardian.
2. Choose 5-6 small objects from around your home that can get wet. For example, I chose: a highlighter, a metallic bracelet, a quarter, a tennis ball, a plastic spoon, and a marble.
3. Create a table on the paper that looks like the following:

Name of Object	Mass (grams)	Prediction: Sink or Float	Result: Sink or Float	Density of Object (g/ml) or (g/cm^3)	Density of Water
Object 1					1 g/ml
Object 2					1 g/ml
Object 3					1 g/ml
Object 4					1 g/ml
Object 5					1 g/ml

4. Use a kitchen scale (optional) to measure the mass of the objects. Without a kitchen scale, students can use Google to search for the approximate mass in grams. Write down the mass of the object in the table.
5. Make a prediction based on the mass whether Object 1 will sink or float in the tub of water. Drop Object 1 into water and record the result.
6. Repeat Step 5 until all five or six objects have been dropped into the water.
7. Use Google to look up the approximate density of the objects chosen, and record it in your table. Compare to the density of water.

Activity 1: Sink or Float
Explain:
Some of the objects you have chosen may have sunk to the bottom of the bin, while others stayed afloat at the top. The heaviest objects usually sink to the bottom, while the lightest objects stay at the top. While mostly all objects have more mass than water, some of the objects can still stay afloat. This is due to their **volume**. *The more volume an object has, compared to its mass, the more likely it is to float on water.* An object that can easily float on water is described as having **buoyancy** or a strong buoyant force. Compare the density of the objects to the density of water. Is the density of the objects that sunk bigger or smaller than the density of water? What about the objects that float?

Activity 2: Aluminum Foil Boats.

Use a sheet of aluminum foil and fold into a small boat. (Watch video here and here). Record the length, width, and height of your boat to calculate the volume of your boat. Record this volume onto your piece of paper. Place the boat in the tub of water, and select the objects that sunk in your first activity. First, drop the objects, one by one, into the water and
observe that they sink. Next, place one object into your aluminum foil boat. What happens? Record the results onto your piece of paper. Repeat this experiment with the other objects that sunk.

Explain:

Objects that once sank now appear to float, with the help of the aluminum foil boat; what has happened? When we calculated the volume of the boat, and placed an object onto it, we added the volume of the boat to the volume of the object. We increased the volume of the object, while keeping the mass of the object the same. When we divide the mass of the object by its new volume, we have made the object *less dense* than the water. The aluminum foil boat distributes the mass of the object across a wider volume of space. We have decreased the amount of water displaced by the object, increasing the buoyancy of the object, and helping the heavy object float.

Review Science Vocabulary

- **Mass**: the measure of amount of matter in an object. Scientists use the metric of "grams" (g)
- **Volume**: the amount of space occupied in an object. Scientists use the metric of "milliliters" (ml) or centimeters cubed (cm^3)
- **Density**: the mass divided by the volume of an object.
  The density of an object (mass/volume) compared to the density of water (1 gram/milliliter or 1 gram/centimeter cubed) will determine whether an object sinks or floats.
- **Buoyancy**: the force that causes an object to float. In a liquid, when this force is greater than the force of gravity, an object will float. Buoyancy is equal to the amount of water displaced by an object. When we increase the volume of the object, we decrease its density, decrease the amount of water it displaces, and can increase the buoyant force.

ELABORATE:

- Watch videos about Density and Buoyancy
  Why different objects sink or float?
  - SciShow Kids:https://www.youtube.com/watch?v=eQuW8G2QV_Q
  - Buoyancy: https://www.youtube.com/watch?v=nMlXU97E-uQ

EVALUATE:

Have you ever seen cruise ships or boats cross the San Diego Bay? Think back to our "sink or float" experiment, and how density affects whether an object will sink or float in water. Steel is denser than water, can you explain how a steel ship, like a cruise ship can float? Think about our aluminum foil boat experiment, and how we made our heavy objects float by changing their volume. How does changing an object's volume affect density and the strength of an object's buoyant force?

Fun Extension Project: Ellie the Engineer Elephant wants to cross a pond to meet with her friend, Stella the Stork. Unfortunately, she doesn't own a boat, and doesn't have the tools to make one. Can you design a new vehicle to carry her across the pond? (Hint: Brainstorm how to change the density and buoyancy of Ellie the Elephant).

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