Clay Ball Challenge

Educator Lesson Plan

About This Activity

Subject: Physical Science

Topic: Buoyancy

Grade Level: 3 – 8

Lesson Duration: Approximately 25-45 minutes

Focus Question

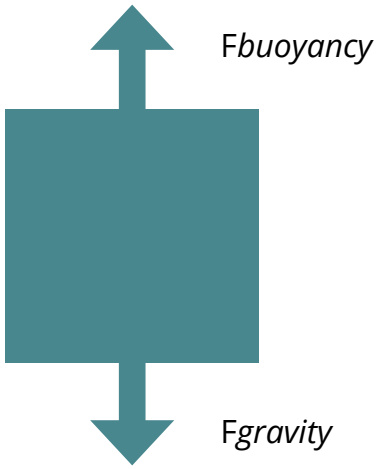
What makes an object buoyant?

Objectives

- Students will be able to formulate a scientific hypothesis.
- Students will be able to identify 3 things that float and hypothesize what properties make these objects float.
- Students will engage in science and engineering practices as outlined in the Next Generation Science Standards.
- Students will modify the design of a dense material to float using the principle of buoyancy.

Educator Background Information

This set of activities explores the concept of buoyancy. Buoyancy is the tendency of an object to float or sink in a fluid as a result of the balance between the force applied to that object by the fluid it displaces and the force of gravity as a result of the object's mass. This concept is depicted in the following free body diagram:



Objects can be positively, negatively, or neutrally buoyant. Objects with positive buoyancy experience a greater buoyant force than the force of gravity and are able to float. Objects with negative buoyancy sink, because the force exerted on them by the fluid is not enough to counteract the weight of the object. Neutral buoyancy occurs when these two forces are equal. The buoyancy of an object can be influenced by the volume and the density of the object.

Whether working with data collected by positively buoyant weather buoys, using neutrally buoyant remote operated vehicles, or mooring a research vessel to the sea floor with a negatively buoyant anchor, marine scientists rely on the principles of buoyancy to help them explore the ocean.

Introductory Buoyancy Exploration *(optional)*

This activity is a good introduction to the concept of buoyancy that can be used to lead into the clay ball challenge. If you are limited on either time or supplies, you can proceed directly to the clay ball activity.

Materials Needed

- Clementine or other easy-to-peel orange
- Container of water – large bowl, cooking pot, or a full sink
- Golf ball
- Ping pong ball
- Water bottle

Procedure

1) Present students with a golf ball. Ask them to predict if it will sink or float. Test prediction by placing ball in water. Students can record their predictions by either using the student worksheet included in this lesson plan or by creating their own chart in a science journal.
2) Next, present students with a ping pong ball. Ask students to predict if it will sink or float. Test prediction by placing ball in water.
3) Task students with comparing and contrasting the two types of ball. What was similar about the two balls? What was different? Why did the ping pong ball float while the golf ball sank?
4) Ask the students to predict whether an orange will sink or float. Test prediction.
5) Remove the peel of the orange making sure to remove all of the white pith. Make and test prediction if the peeled orange will sink or float.
6) Ask the students if mass was added or taken away from the orange when you peeled it. Why did taking away mass make the orange sink? (Often, students are under the impression that the lighter an object is, the more positively buoyant it is. This exercise demonstrates that the buoyancy of an object depends more on its physical features, such as form and design of the object, than its mass.)
7) Continue on to clay ball challenge.

Clay Ball Challenge Activity

Materials Needed

- Golf-ball-sized ball of clay or other pliable material that can be placed in water
- Container of water – kitchen bowl, cooking pot, or a full sink
- Weights – marbles, glass beads for vases, pennies, or similar items

Step 1

2 minutes

Instructor: Present the clay ball to the student and ask the student to write down 3-5 observations about the ball.

Student: Student will observe the clay ball and write observations.

Step 2

3 minutes

Instructor: Ask the student to use their own words to define “hypothesis” in scientific investigations. (It is alright if the student doesn’t know what a hypothesis is!)

Expand/elaborate on the student’s definition. A hypothesis is a testable prediction of what will happen in a given situation.

Student: Give best definition of “hypothesis.”

Step 3

2 minutes

Instructor: Ask the student to make a hypothesis about the behavior of the clay ball when placed in a container of water – Will it sink? Will it float? Will it stay in the middle of the water column and neither float nor sink?

Give clay ball to the student and ask them to test their hypothesis.

Student: Make a hypothesis of what will happen when the ball is placed in the water in an “if… then…” statement, i.e., “If I eat blue raspberry Jolly Ranchers, then my tongue will turn blue.”

Place ball in water and determine if hypothesis was correct.

Step 4

10-15 minutes

Instructor: Tell the student that they are going to be an engineer today. To be an engineer, you

have to define a problem, model a solution, test this solution, and improve the design until you have solved the defined problem.

Their engineering problem is that the ball of clay is not floating. They must change the ball of clay in some way to make it float for ten seconds. They must use all of the material given to them in their design! Allow the student to design and test their clay creations in the water. Most students will struggle with this challenge initially, but you should let the student work on their design with minimal help or instruction.

If the student is getting frustrated and needs assistance, you can give them hints after they have made several attempts on their own.

Possible hints:

- Think of something that you know of that floats. What makes that object float? Can you make the clay ball similar in some way?
- What is making your clay ball sink? How can you solve that problem?

Student:

1) Draw a diagram of a design that they believe will make the ball of clay float for 10 seconds.
2) Mold the clay into their design and test if it can float for 10 seconds.
3) Modify design based on observations as many times as needed in order to make the clay float.

Step 5

2 minutes

Instructor: Ask the student what they changed about the clay ball in order to make it float. Did they change how much the clay weighed?

Tell the student that they changed the buoyancy of the clay by changing the design. Buoyancy is the way that the water pushes back on the clay to hold it up and make it float. Give the example of a belly flop in the pool – when their body hits the water, the water pushes back on them, similar to the way water pushes up on the bottom of a boat. When they changed the surface of the clay, they changed how the water could push back on it and keep it afloat.

Student: Describe the changes they made to their clay ball.

Step 6

Optional - length of time varies by student

Instructor: Once the student has made the clay float for 10 seconds, you can repeat this process with an added challenge. Now instead of just making the clay float on its own, you are going to see how much weight can be added to your design before it starts to sink.

When the student has a design they believe will hold weight, add glass beads one at a time until the clay begins to take on water. Ask the student to improve their design to hold more weight. You can make this a competition between students in your class to see who can hold the most weight in their design. In order to make this a fair challenge, each student will need to use the same amount of material for their design and the same type of weights.

Student: Use the iterative engineering process to design a clay model that will hold the most weight possible.

Engineering Challenge: Neutral Buoyancy (Extension Activity)

Materials Needed

- Household items of varying buoyancy – clay, aluminum foil, sponges, paper clips, corks, metal washers, pipe cleaners, straws, etc.

Procedure

To further engage students in a more complex engineering problem, you can task them with making an object that is neutrally buoyant. A neutrally buoyant object does not sink or float – it "hovers" in the middle of the water. For this challenge, students can use any household materials provided.

This task is significantly more challenging than the clay ball challenge and will likely take students quite a while to achieve. To successfully make a neutrally buoyant object, it should not be touching the bottom of the water container at all.

Practical applications for neutral buoyancy can be seen in ocean exploration technology.

Submersibles like the ones used on the research vessel NOAA Ship Okeanos Explorer need to be able to control buoyancy and hover just off of the ocean floor without disturbing delicate ocean habitats. This allows scientists to gather samples and take amazing videos of the inhabitants of the deep seas to better communicate marine science to the public.

Clay Ball Challenge

Student Worksheet

Name _____

Date _____

Float or Sink?

Directions

For each object, make a prediction if it will Float (F) or Sink (S).

Object	Prediction (F or S)	Observed (F or S)
Ping pong ball		
Golf ball		

Object	Prediction (F or S)	Observed (F or S)
Water bottle filled		
Water bottle empty		

Object	Prediction (F or S)	Observed (F or S)
Orange with peel		
Orange w/o peel		

Questions

1) Name one quality (NOT COLOR) that is the same about the golf ball and ping pong ball:

2) Did the golf ball or ping pong ball float? What helped this one to float?

3) What happened to the orange when the peel was removed? Why?

Clay Ball Challenge

Draw your clay ball design below or on a separate sheet of paper.

Questions

1) Did your initial design make the clay ball float? What can you change to improve your design?

2) What did you change about the piece of clay to make it float? What about the clay remained the same?

3) How many pennies were you able to float in your design? _____