Grade 8 Activity

# Keep Your Head Above Water

Do things that float behave differently in salt and fresh water? What lets them float, and when do they sink?

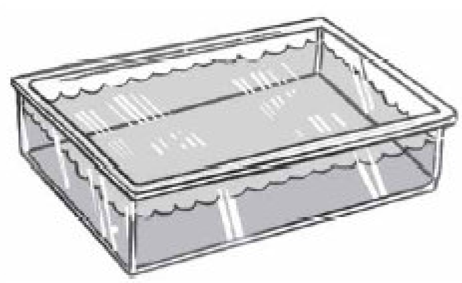
## Concepts
- Water has physical properties of density and buoyancy.

## Objectives
Students will observe the way things float or sink in fresh and salt water.

## Duration
One class period

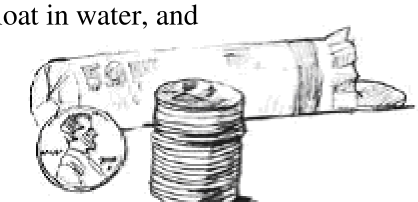
## Method
Teacher directed group work, followed by hands on experiments.

## California Science Content Standards
**8. Density and Buoyancy**
All objects observe a buoyant force when immersed in a fluid. As a basis for understanding this concept:
8.a. Students know density is mass per unit volume.
8.b. Students know how to calculate the density of substances (regular and irregular solids and liquids) from measurements of mass and volume.
8.c. The buoyant force on an object in a fluid is an upward force equal to the weight of the fluid the object has displaced.
8.d. Students know how to predict whether an object will float or sink.

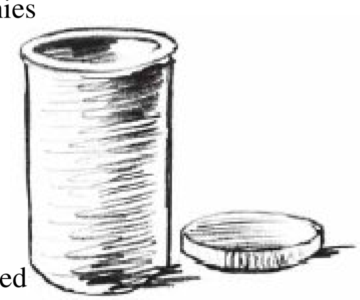


## Background
At a salt marsh there is mix of salt and fresh water. Salt and fresh water have different degrees of density, and can mix and blend in specials ways as a result of tidal inflow. Density is also a challenging concept: the weight per unit volume of objects. Buoyancy, which relates to the density of water, can be a difficult concept to understand. The idea that some things sink and others float is straightforward, but the reasons behind these observations are not so easy to accept. This activity uses an experimental approach in which students don't formally identify the concepts, but observe them in action.

## Activity
1. Begin a discussion of students' own perceptions of floating and sinking. Have they ever been swimming in salt water? Fresh water? Which was easier to float in? In your class you may be able to find at least one student who has made the observation that it is easier to float in salt water than in fresh water. Explore students' ideas of what makes things float in water, and why it might be difficult in salt water.



2. Tell students they will have an opportunity to conduct experiments with buoyancy and density. Hand out "Float or Sink?" worksheet. Begin with a challenge: can the students design an object that floats in salt water and sinks in fresh water? Let them experiment with film canisters and pennies (13 to 14 pennies in a plastic film canister usually works) in salt and fresh water in measuring cups. To catch spills, place the cups in aluminum pans first. Does a film canister holding the same number of pennies behave differently in two different solutions? How many pennies in a film canister will float in fresh water? How many will salt water support?



3. Does a ball (about 1 inch diameter) of clay sink or float? It sinks. If the student changes its shape, will it still sink? Try it flat or elongated in a bucket of water. It still sinks. Can the students figure out how to make it float? (Forming in into a boat, or clay might be shaped around a ping-pong ball to make a hollow clay ball. It takes a great deal of trapped air to make the clay float.) Has the weight of the clay changed? Measure it. What has changed? Its volume. Its weight per unit volume has changed with the addition of air space.

## Materials

**For each student or small group:**

1. "Float or Sink?" worksheet
2. Four 35 mm film canisters
3. 50 pennies
4. Two clear plastic two-cup measuring cups or large drink cups
5. One inch chunk of modeling clay (sold in sticks like butter)
6. Two pans to catch drips
7. One ping pong ball
8. 250 gm Ohaus spring scale (optional)
9. Rubber bands to hook to the scale
10. Optional: "Shipping in Dangerous Waters – Buoyancy Matters!" handout

**For entire class:**

1. Fresh water in gallon plastic milk containers at room temperature (1.5 cups per student or group)
2. Very salty water (6 cups table salt or kosher salt per gallon) on plastic milk containers at room temperature (about 1 ½ cups per student or group).
3. Bucket of fresh water

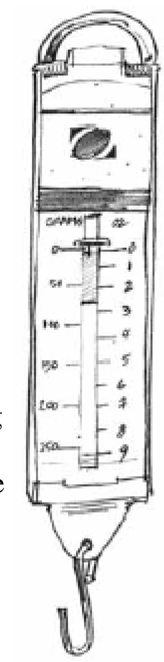
**For extension activities:**

1. Graduated cylinders
2. Accurate top-loading balance

## Preparation

Gather materials, photocopy worksheet. Mix salt water the day before, using hot water to dissolve the salt. Let solution sit to room temperature.

4. You may have conducted previous experiments with fresh and salt water where students learned that a volume of salt water weighs more than an equal volume of freshwater; the salt water is more dense than the fresh water. If you have a spring scale, attach the canister holding 13 pennies to the scale with a rubber band and lower it into each kind of water. What happens to the apparent weight in each kind of water? Can the students observe the water supporting the weight of the object? It should be "weightless" on the scale when it floats. If it sinks, it will still weigh less than then measured in air. The water is supporting the canister. The fact that objects weigh less in water is why water had been used to transport heavy things throughout human history, from logs to oil tankers. Salt water can support heavier objects because it is more dense than fresh water.



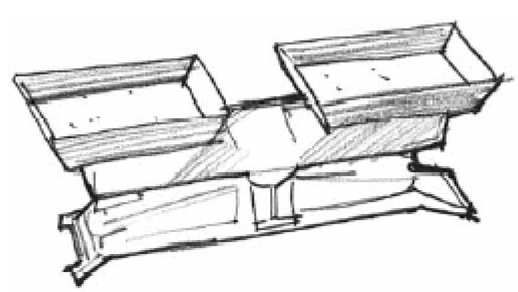
## Results and Reflections

1. Have students predict what would happen to a very heavily loaded boat as it sails from the ocean up into a river, and write their predictions on their worksheet. *It would sink lower and lower as the water became fresher.* Where harbors and shallow areas have fresh water input, boats have to be partially unloaded out to sea (a process called lightering) to keep them from getting stuck on the bottom as they sail up from the ocean. Have the students noticed marks painted on big ships that tell how low the ships are sitting in the water? *Salt water can float a heavier object of the same size than fresh water.* **Optional:** Pass out to students a copy of "Shipping in Dangerous Waters – Buoyancy Matters!" Students may read this article and hold a classroom discussion on the practical aspects of understanding buoyancy?

2. What happens when fresh water hits salt water, as when a river empties into the sea? How might this affect the plants and animals in salt water and fresh water? How might this affect the transport of pollutants carried in the fresh water?

## Conclusions

Objects weigh less in water than on dry land because of water's buoyant properties. Salt water is more dense than fresh water, and because of this, buoyant properties of salt water are different than fresh water.



## Extensions and Applications

1. You may introduce the concept of *density* by having the students calculate the weight per unit volume of objects. Density equals mass divided by volume:

   a. Weigh each object on a balance to find the mass.

   b. Find the volume of the objects by filling a larger graduated cylinder part way with water and a bit of detergent to break the surface tension. Record the level. Then sink the object below the surface and record the new volume. Subtract the volume of the water from the volume of the water plus object to find the volume of the object

   c. Mass divided by volume equals density.

   d. When all the objects' densities have been calculated, arrange them in order on a list.

2. What is the density of the fresh water? The salt water? To find out, weigh a measured volume (mass divided by volume equals density, so weigh it first, then divide by the volume, or mls.). Where do fresh water and salt water fit in the list of densities? Can students make a statement about density of an object versus density of a fluid with regard to whether it sinks of floats? (If the object is less dense than the fluid, it will float. If it is more dense, it will sink.)

3. Students may calculate the *specific gravity* of each object. Weight depends on gravity. Things weigh less on the moon where the gravity is less than on Earth, but they have the same specific gravity. Specific gravity generally uses distilled water at 4ºC as a standard and sets it equal to 1. Everything is compared to it. You could use cold tap water without being too far off. Divide the density of an object by the density of the fresh water to get the object's specific gravity. For example, if the object were 2g/cubic centimeter (millimeter) and water is 1 g/cubic centimeter (millimeter), then the specific gravity of the object will always be 2 although the object's weight will change with gravity.

4. Interested students can investigate the Dead Sea. Why is it called the Dead Sea? Is it really dead? If not, what lives in it? How did it become the way that it is now?

# Float or Sink?

| Object | Salt water: Float or Sink? | Fresh water: Float or Sink? |
|---|---|---|
| 1. Canister with 13 pennies | | |
| 2. Canister with ___ pennies | | |
| 3. One inch ball of clay | | |
| 4. Clay ball flattened out | | |
| 5. Clay ball different shape | | |
| 6. Other objects<br>(i.e., clay boat with pennies): | | |

1. Draw a clay shape that floats successfully in both freshwater and salt water.

2. **Predict:** Knowing what you know about how to float differently in salt water and fresh water, answer this question: What would happen to a very heavily loaded boat as it sails from the ocean up into a river? Draw a picture of a boat traveling from the ocean as it sails up a river.

# Shipping in Dangerous Waters – Buoyancy Matters!

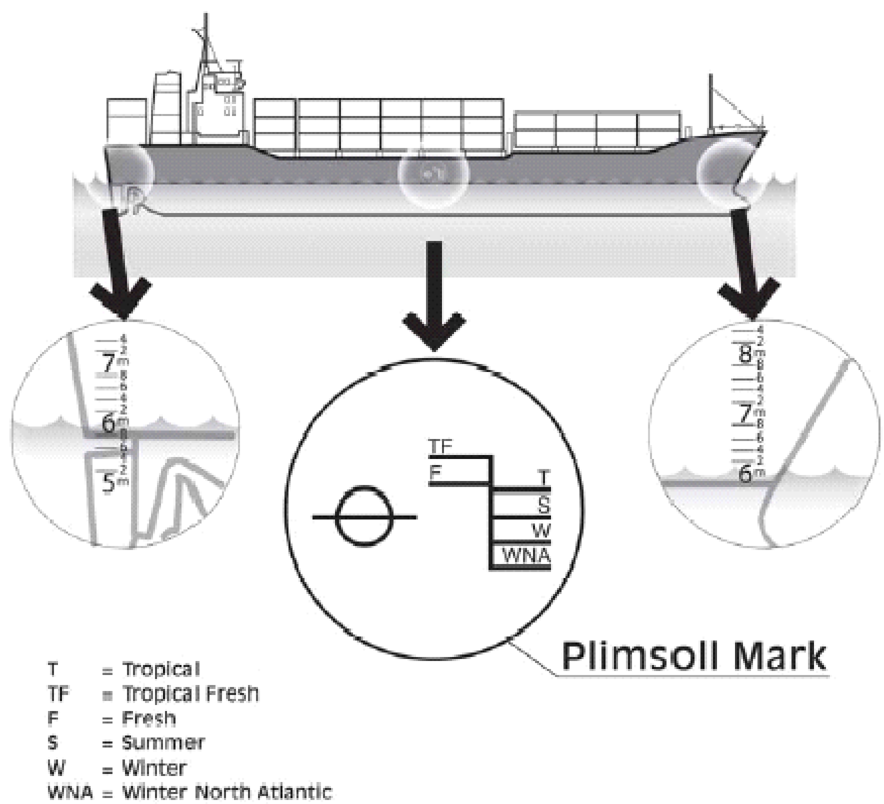
California's bays and harbors can be treacherous places for container ships and oil tankers with heavy loads. Why? These ships go great distances, from the tropics to the arctic, sometimes all in one trip. Due to the expense, harbors and bays are often dredged to just a certain depth to accommodate big ships, and not an inch more. Also, depending on tides, underwater features such as rocks and sand bars become obstacles to avoid. If a ship is loaded in a salt eater port, say, in Japan, and then comes across the ocean to unload in a fresh water port, such as the San Joaquin Delta, they could run into serious problems if the ship was loaded too heavily at the beginning. Ships can run aground, spill their cargo, or even worse, break a hole in the hull and leak fuel and oil. How do captains of these ships know when their ships are properly loaded? It has been an issue since the seas were first sailed, and, luckily, someone had a plan.

Samuel Plimsoll (1824-1898) was a member of the British Parliament. Plimsol was concerned with the loss of ships and crews due to overloading. He called them "coffin ships." To save sailors' lives, he persuaded Parliament to amend the 1871 Merchant Shipping Act to provide for the marking of a line on a ship's sides that would disappear below the water line if the ship was overloaded. Samuel Plimsoll developed the Plimsoll Mark now used by the shipping industry internationally.

The Plimsoll Mark is a reference mark located on the midship of a vessel hull indicating the depth to which it can be loaded, depending on the destination and the route. The Plimsoll Mark evolved into internationally recognized load lines. Load lines show the maximum draft (in terms of the amount of freeboard, or distance from the waterline to the main deck) to which the vessel may load in different zones and seasons around the world. Draft marks are indicated in meters and are at the forward, midship, and aft of the ship. The Plimsoll Mark is located midship only.

The difference in salinity between loading a ship in fresh water and than proceeding to sea causes an increase in freeboard of about 8.5 inches, called the FWA (fresh water allowance). The ship will rise in the salt water that much or sink that much if proceeding from sea to a fresh water dock. The actual FWA is a little different for each situation, and calculations used by computers on ships are much more exacting. The calculations use the actual water density, displacement of the ship, and other factors that take into account the shape of the vessel.

Next time you see a container ship of an oil tanker, look for the Plimsoll Mark and draft lines. Is the ship in fresh water or salt water? Is it safely loaded? Now you'll know!

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