Title: Floating and Sinking

Subject Area: Environmental/Water Science

Classroom Set-up:
Groups of 4 or 5
Inside

Objective: To explore what makes objects float or sink

Summary: Students use the scientific method to approach the topic of what makes some things float and others sink, measure properties of various objects, and observe what floats and what sinks in fresh water and salt water.

Vocabulary:
Gravity
High Density
Low Density
Buoyancy
Salinity
Tides

Relevant DC Standards:

4.1.6 Identify better reasons for believing something than citing comments such as, "everybody knows that," "I just know," or "because they say," and discount such reasons when given by others
5.1.5 Read and follow step-by-step instructions when learning new investigations
8.4 All objects experience a buoyant force when immersed in a fluid.
6.1.1 Give examples of different ways scientists investigate natural phenomena, and identify processes all scientists use, such as collection of relevant evidence, the use of reasoning, the development and testing of hypotheses, and the use and construction of theory to make sense of the evidence
6.1.4 Recognize and explain that hypotheses are valuable even if they turn out not to be true, but that many investigations are not hypothesis driven.
8.4.2 Know that density is mass per unit volume
8.4.3 Investigate and explain that equal volumes of different substances usually have different masses and, therefore, different densities
8.4.4 Determine and explain that the buoyant force on an object in a fluid is an upward force equal to the weight of the fluid the object has displaced; this principle can be used to predict whether an object will float or sink in a given fluid.

Materials:

Description	Quantity	Can be bought at
Baseballs	1 per team	Sports Store like Mo's

Diet scales	1 per team	Bed, Bath and Beyond
Golf balls	1 per team	Sports Store
Lacrosse balls	1 per team	Grocery store
Aluminum foil sheets (10" x 6")	2 per team	Grocery store
Large plastic cups	1 per team	Grocery store
Food coloring	1 per team	Grocery store
Table salt	1 pound	Grocery store
Paint stirring sticks	1 per team	Lowe's, Home Depot
8 oz. transparent cups	1 per team	Grocery store
Eye dropper	1 per team	
Plastic water basin	1 per team	

Procedure:

Use the scientific method to approach the subject:
- The question: why do some things float and some things sink
- What do we know: Students identify things that float and sink (in bathtubs, sinks, swimming pools, lakes and ponds)
- Hypothesis: Ask students to make an informed guess about what makes things float or sink (they may hypothesize weight or size)
- Conduct experiments (below)
- Record results and draw conclusions

Experiment 1: Each team weighs a golf ball and a baseball (you can use a hanger as a balance, attaching a plastic bag with a baseball at the same point on each end of the hangar. It balances. Replace one of the baseballs with a golf ball and the tilt is caused because the baseball weighs more. Add two more golf balls, which balances because a baseball (about 150 grams) weighs 3 times as much as a golf ball (about 50 grams). Each ball is then placed in the tumbler 2/3 filled with water. Students observe the heavier baseball floats while the lighter golf ball sinks.
Discussion: Weight is not the only thing that affects whether an object floats or sinks, because in this case the heavier object floats and the lighter object sank. Ask what force is pulling the balls down (gravity). But something must also be pushing the balls up (the force of the water on the balls, called buoyancy. It helps to draw on the board a cross section of a ball in water (like if the students look at their bowl from the side), with an arrow on the ball pointing down depicting gravity and an arrow up depicting buoyancy. The size and shape of objects determines the size of the buoyancy forces. If the gravity force pulling down is larger than the buoyancy force pushing up, the thing will sink. If the buoyancy force is larger than the gravity force pulling down, the thing will float. The gravity force on the golf ball is larger than the buoyancy force, so it sinks. But because the baseball has a larger area below the water, there is more room for the buoyancy force to push up, and it floats even though it weighs more than the golf ball. So some larger objects will float even when they weigh more than some smaller objects. Whether an object floats and sinks is affected by both its size and weight, and this is called density. An object that is heavy even when pretty small is said to be dense or to have high density

(for example a rock, which sinks, as did the golf ball). An object that is light even when pretty large is said to have a low density (e.g. a large bag of cotton candy, which floats). If you have a bag filled with marbles, it will have a higher density and will sink. If you have a bag the same size full of popped popcorn, it will have a lower density and will float. Water has a density as well. Anything with a density higher than water will sink; anything with a density less than water will float.

Experiment 2: Place lacrosse ball in large plastic cup. Observe it sinks. Take ball out and add 1/3 cup of table salt to tumbler. Stir for a full minute. Place lacrosse ball again in tumbler and observe it floats (if it doesn't add more salt and stir more). Discussion: Salt water pushes up on an object more than unsalted (fresh) water. Lakes, ponds, swimming pools, and tap water are fresh water. The ocean is salt water. So it's easier for a swimmer to stay on top in the ocean than in a lake (if the waves are the same size and don't make a difference in how hard it is to float). Gravity is pulling down the same on both swimmers, but the salt water in the ocean is pushing up more on the swimmer, so it's easier to stay on top. The buoyant force of salt water is stronger than the buoyant force of fresh water.

Experiment 3. Pour out a small about ½ oz. of salt water in the tumbler from experiment 3 into a small container (maybe a 3 oz cup) and add 5 drops of food coloring. Fill the transparent 8 ounce cup with fresh water to a level of ½ inch from the top with fresh water. Using the eyedropper, students slowly and gently transfer dyed saltwater down the inside surface of the 8 ounce cup. Observe it sinks to the bottom of the cup. Discussion: The salt adds weight to the water and an amount of salt water will weigh more that the same amount of fresh water. Therefore salt water has a higher density than fresh water, and it sinks in freshwater. The higher density of salt water is the reason it has more buoyancy that made the lacrosse ball float. Oceans are salt water and rivers are fresh water. In places where rivers flow into the oceans, like in Chesapeake Bay, heavier salt water (with higher density) is on the bottom and lighter water with less salt (fresh water is on top). As time allows, explain that the moon pulls ocean water up the bays and rivers (tides), and the heavier ocean water moves along the bottom of the bay or river, forming a "salt wedge."
If time and availability allow, a different color food coloring can be added to very warm water and it can be gently eyedropped into the same cup. It will float because warm water has a lower density than the cooler water.

Experiment 4: Shape a rectangle of aluminum foil into the shape of a canoe (folding over the ends so it's watertight). One at a time each team places the canoe in the basin of water and gently places the golf ball in it. Observe it floats (depending on the boat). Discussion: The air around the golf ball in the canoe does not weigh much and the canoe provides a larger area for the water to push up on. So the buoyancy of the water pushes up more than gravity pulls down and the canoe floats. If we placed something heavier around the golf ball in the canoe, like sand, gravity would pull down more than the water pushes up and the canoe would sink. This science learning is used by engineers who design boats and ships. They leave a lot of space for air inside the part of the boat that's

below the water line, so they float, even when made of heavy steel and carrying heavy items like cars.
If there's time, have each student shape a canoe and float it for two minutes. If not, have a single student do this task and see which of the group's canoes stays afloat the longest.

Note: If students will understand it, the buoyant force is equal to the weight of the water displaced by the object

3/12/12