ACTIVITY 19

KEEPING YOUR HEAD ABOVE WATER

DO THINGS THAT FLOAT OR SINK BEHAVE DIFFERENTLY IN SALT AND FRESH WATER? WHAT LETS THEM FLOAT? WHEN DO THEY SINK?

SCIENCE SKILLS:
- observing
- measuring
- organizing
- predicting
- experimenting.
- communicating

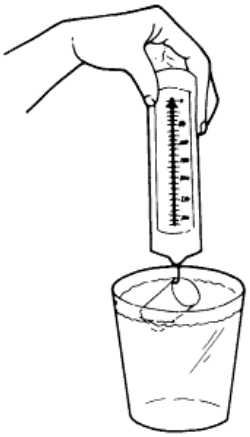
CONCEPTS:
- Because salt water weighs more than fresh (is more dense), it buoys things up more than fresh water.
- Things that float displace a weight of water equal to their own weight.

MATH AND MECHANICAL SKILLS PRACTICED:
- use of scale
- measuring liquid volume

SAMPLE OBJECTIVES:
- Students will be able to demonstrate why some objects float and others sink.
- Students will be able to compare the relative buoyancy of fresh and salt water.

INTRODUCTION:

BUOYANCY is a very difficult concept. The idea that some things sink and others float is straightforward, but the reasons behind these observations are not so easy to accept. This exercise is designed to demonstrate why things float differently in different solutions. It also allows you to introduce the idea of DISPLACEMENT as it relates to floating or sinking. If you have younger students, do this as a demonstration or delete the part that measures displacement. If you delete some sections, some of the materials are not required.



MATERIALS:

For each group:

- four 35 mm plastic film cans
- 50 pennies
- rubber bands to hook to the scale
- small hand-held spring scale with a pan (100 or 250 gram size)
- two clear plastic cups
- two small pans or trays from "TV" dinners or frozen meat pies
- 100 ml graduated cylinder calibrated in metric volume
- "plastic" modeling clay
- cafeteria tray or baking pan to catch spills
- plastic funnel

For class:

- fresh water in plastic jugs at room temperature with 1 tbs. liquid detergent to prevent surface tension
- very salty water (1 cup table salt per quart) in plastic jugs at room temperature with 1 tbs. liquid detergent

LESSON PLAN:

BEFORE CLASS: Decide if this lesson is to be done by groups, learning centers or demonstration. Demonstration interspersed with discussion may be best for younger students. Mix the salt water the day before using hot tap water. Let it cool to room temperature. The detergent should help reduce surface tension which causes the water to round up on the cups.

DURING CLASS:

METHODS: Start with a discussion of your students' own perceptions of floating and sinking. Have they ever been swimming in salt water? Fresh water? Which was easier to float in? Have they ever been to the Great Salt Lake or seen people floating in it in pictures? How about the Dead Sea (really also a salt lake)? In your class you should 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.

Start with a challenge: can the students design an object that floats in salt water and sinks in fresh water? Let them experiment with film cans and pennies. (13 to 14 pennies in a plastic Kodak film can generally works.) Now the problem is why?

What do they know about fresh and salt water from previous experiments? Salt water weighs more than an equal volume of fresh water. Can they design an experiment to test whether or not this might be important in floating and sinking? Consider the equipment and items available. Use pennies and film cans to make objects that are the same size, but have different weights. Film cans with 5, 10, 15, and 20 pennies make a nice series. Here are several tests they might try:

Put two clear plastic glasses in shallow pans to catch the overflow. Fill them absolutely full, one with salt and one with fresh water. Holding it by a wire or string, lower a heavy film can (20 pennies) into the fresh water. Observe what happens. The water that flows over into the pan is

DISPLACED by the object. Try the same thing with salt water. Does it look like the same volume of water spilled over? Measure both and record the volume. The volumes should be the same. Do they weigh the same? Weigh the water samples. (The fresh water weighs about 40 gm and the salt, about 60 gm.) The same volume of salt water weighs more. Compare the weights of the water with that of the object that sank. It weighed more than either amount of water displaced. Record the results. From this they can conclude that objects displace water, but that the weight of the water was less than the object in both cases.

2. Try an object that is light and floats in both (8-10 pennies). Does it displace the same volume of water? Check to see. No, it will displace more fresh water than salt water. It floats higher in the salt water.

Does it displace the same weight of water? Yes. What does the object weigh? It should weigh the same as the displaced water from both salt and fresh water.

Repeat this for several floating objects. Can the students formulate a rule based on their observations? An object that floats displaces a volume of water which weighs the same as the object.

3. Attach the 10 penny can to the spring scale and lower it into the water. Can the students observe the water supporting the weight of the object? It should become "weightless" on the scale when supported by the water.

4. What about a film can weighted to float in salt water but sink in fresh water? Can the students make one? Repeat the tests. Students should find that the volume of salt water displaced is equal to the weight of the object while the displaced fresh water weighs less than the object. Hence, it sinks in fresh water.

5. Now for a challenge! Does a ball (about 1 1/2 inches in diameter) of clay sink or float? It sinks. If the students change its shape, will it still sink? Try it flat or elongated. It still sinks. Compare its weight with that of the fresh water it displaces. Can the students figure out how to make it float? Forming it into a boat is the easy answer. Making it into a hollow ball is sneakier and much harder. (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 changed? Measure it. No. What has changed? Its displacement or volume. Gently push the hollow ball under and compare its displacement with that of the original ball of clay. It displaces a greater volume, enough to more than equal its weight.

CONCLUSIONS:

If an object displaces a volume of water whose weight is equal to its own weight, it will float. If it does not, it will sink

EXTENSIONS:

1. If you have older and/or gifted students, you may also introduce the concept of DENSITY by having the students calculate the weight per unit volume of the objects you have. You can find the volume of the objects by filling a measuring cup part way with water. 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. When all the objects' densities have been calculated, arrange them in order. What is the density of the fresh water? The salt water? Weigh a measured volume to find out. Where do they fit in the series of densities of the objects? Can you make a statement about density of an object versus density of a fluid with regard to whether it sinks or floats? If the object is less dense than the fluid, it will float. If it is more dense, it will sink.

2. If you have great students who like to think about space travel and planetary science, you may have your students calculate SPECIFIC GRAVITY for each object. Weight depends on gravity. Things weigh less on the moon where the gravity is less, but they have the same MASS. Specific gravity generally uses distilled water at 4°C as a standard and sets it equal to 1. Since water does not change, 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 2 gm/cubic centimeter (milliliter) and water is 1 gm/cubic centimeter (milliliter), then the specific gravity of the object is 2. The units cancel out. Anywhere in the universe the specific gravity will always be 2 although the object's weight will change with gravity.

3. Specific gravity of liquids is measured with an instrument called a hydrometer. There are many activities which have the students make a hydrometer: a thumbtack in the end of a pencil; clay and sand in a soda straw. Once they have made one, students can compare the specific gravity of other liquids to water. They can also compare salt water or hot water. If liquids are used that are dangerous (i.e. methyl alcohol), be sure that students are aware of the possible danger. Household products like cooking oil, pancake syrup and corn syrup should do.

ACTIVITY 19 Name Possible answers

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Use this sheet to record each test that you did and the results.

answers vary

Can you make a general conclusion about things that float based on your tests?

Things that float are less dense than water.

Things that sink weight more than the volume of water they displace.