Density of Liquids
Teacher Notes

Introduction:

In the second century BC, the great mathematician and scientist, Archimedes, observed and measured the behavior of various substances when immersed in water. *Archimedes' Principle* states that:

> *any body completely or partially submerged in a liquid is acted upon by an upward (buoyant) force which is equal to the weight of the liquid displaced by the body.*

A block of wood ter. If the block of wood t, and the block will rise o the weight of the b in. A rock sinks in ater. A rock immersed t force is less than the w t) than the liquid that they In this lab, you examine some real life

The story of Archimedes' method of determining the purity of the gold in the king's crown is probably not accurate. See

http://www.mcs.drexel.edu/~crorres/Archimedes/Crown/CrownIntro.html

for a nice discussion of the story and a simple and more likely method that Archimedes might have used.

Part I Procedure:

Observe the floating blocks of wood and Styrofoam in the display at the front of the room. Notice that the 2 blocks are about the same size - that they have the same volume.

1. In the space below, carefully sketch and label the 2 blocks in their observed positions relative to the surface of the water:

Water Su

2. Which block ed!)

3. Re-read the n block floats lower

A piece of 2x4 framing lumber about 4 inches (10 cm) long makes a suitable block of wood. Styrofoam insulation or packing can easily be cut to match the size of the wooden block. If you want to get really fancy, a few coats of polyurethane finish will prevent the block from soaking up too much water.

Fill an small aquarium about 2/3 full of water to float the blocks.

_____

_____

_____

4. If the water could somehow be made more dense, would the level at which the block of wood is floating change?_____ If so, how and why would it change?

_____

_____

_____

_____

_____

_____

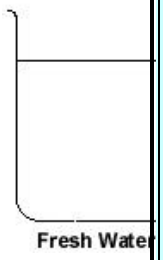
You might also want to prepare a few blocks of different kinds of wood: Oak is more dense than pine, for instance. Kids can predict what percentage of different blocks of wood will be submerged based upon their densities.

Part 2 Materials:

- 3 identical glass graduated cylinders
- balance (digital or triple beam)
- Salt water
- Fresh water

Part 2 Procedure:

1. From the supply area, pick up 3 glass graduates. Fill one about 3/4 full with fresh water, and another about 3/4 full with salt water. Leave the third graduate empty.
2. Notice the eggs that have been placed in the fresh and salt water containers, and sketch your observations on the cartoon b



about the
the fresh

Dissolve as much salt as you can into a 3/4 full, suitably large container (a 1000 ml beaker or one of those gigantic pretzel bottles from a warehouse store), and fill a second container 3/4 full of fresh water. Use raw eggs - brown ones contrast nicely.

Provide 2 turkey basters (labeled "fresh" and "salt") for students to use to fill their graduated cylinders.

Of course the larger the graduates the smaller the % error that will creep into kids' work. On the other hand, it's easier to read to the 1/10 of a ml on small graduates. It's a tradeoff, I guess.

3. Measure the
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answer includ
4. Measure the
he table
below. Again
5. Measure the
e table.
Include units.
6. For both fresh and salt water samples, subtract the mass of the empty graduate from the mass of the graduate and liquid to determine the mass of the liquid alone. Record the result on the table.
7. Very carefully and accurately read and record the volume of the water in each cylinder. Make sure you read to the bottom of the meniscus, and estimate the volume to the nearest 1/10 of a ml. (**Note:** 1 ml is by definition equal to 1 cm^3. ***report your results in cm^3 on the table***)
8. The density of a material can be obtained by the formula:

$$\text{Density} = \frac{\text{Mass}}{\text{Volume}}$$

Calculate the density of the fresh and salt water, and record the result (complete with units) on the table.

	Mass of liquid and graduate	Mass empty graduate	Mass of liquid	Volume of liquid	Density of liquid
Fresh Water					
Salt Water					

Answer the questions on the following page.

Density of Liquids
Questions

Name _____

Period _____

1. Refer back to the observations, conclusions, and explanations you made step 2 of the Part 2 Procedures. Explain how the densities you calculated in step 8 of the procedures supports or refutes (disagrees with) the observations and conclusions you made in step2.

_____

_____

_____

2. The Great Salt Lake in Utah is up to 6 times as salty as the oceans. In terms of your buoyancy, what do you suppose it is like to swim in the Great Salt Lake?

_____

_____

3. The air over the eastern Mediterranean Sea is both warm and dry. As a result, there is great deal of evaporation from the surface of the sea in that area.

   A. As evaporation occurs at the surface of a salty sea, what kind of molecules (what substances) are leaving the sea?_____

   B. As evaporation occurs at the surface of a salty sea, what kind of molecules (what substances) are left behind in the sea?_____

4. If water molecules are leaving the sea, and salt molecules are left behind, does the sea get ***saltier*** or ***less salty?*** (circle your choice!).

5. If the water at the surface of the eastern Mediterranean gets saltier as a result of evaporation, what happens to the density of that surface water?

_____

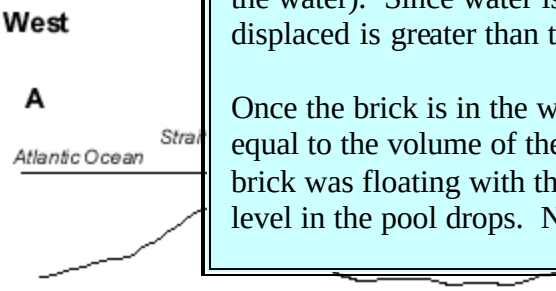
6. What must ha

_____

When the salty, ess salty
surface water fl currents
flowing into it fr never
seemed to rise

CHALLENGE !

Notice line A - B
to the right. The
floor from A to B



less salty
er - to
indicate the possible flow of water between the Mediterranean Sea and the Atlantic Ocean.

Here's another nice challenge question:

The Setup:

Imagine you are sitting in a boat in a swimming pool holding a brick in your lap. Now imagine that you drop the brick overboard and it sinks to the bottom of the pool.

The Question:

Does the level of the water in the pool rise, fall, or remain the same after the brick is dropped into the pool?

The Answer Explained:

The water level drops. When the brick is in your lap, it is essentially floating, and must displace a volume of water whose mass is equal to the mass of the brick (which is does by causing the boat to ride a little lower in the water). Since water is less dense than bricks, the volume of water displaced is greater than the volume of the brick.

Once the brick is in the water, it displaces a volume of water that is exactly equal to the volume of the brick - slightly less displacement than when the brick was floating with the boat. Since less water is being displaced, the level in the pool drops. Not much, but it drops!