Fluids

This format for this experiment will be a little different from what you're used to. Instead of spending all your time at one station interacting with a single apparatus you'll be spending 10-15 minutes at each of six different stations doing a number of shorter activities. It does not matter what order you do these in, so you can start with whichever one you would like, but once you pick a place to start you should proceed in order from there (e.g., if you start with activity E you would then move on to F, followed by A, etc.).

PROCEDURE

Activity A: A floating block. For this activity you should have a block of wood, a beaker of water, and a scale. Start with nothing on the scale.

1. Record the mass of the block of wood. _______________
2. Record the mass of the beaker of water (without the block). ________________
3. After removing the beaker from the scale, place the block in the water. Estimate how much of its volume is below the water surface.
4. Predict what the scale will read when you find the mass of the beaker of water with the block floating in it.
5. Record the mass of the beaker with the block floating in it, and compare it to your prediction.
6. What, if anything, have you learned by doing this?

Activity B: Two floating blocks. For this activity you should have two block of the same type of wood, with one block being noticeably larger than the other. You will also have a beaker of water.

1. Take the small block of wood and place it in the beaker of water. Estimate how much of its volume is below the water surface.

2. Estimate how much larger the larger block of wood is, compared to the smaller block.

3. Predict what will happen when you place the larger block of wood into the beaker.

4. Were you correct? Does this tell you anything about what the upward buoyant force exerted by the water on the block depends on?

5. Push the smaller block further under water and then let go. What happens? Is this consistent with your conclusions above?

6. Pull up a bit on the smaller block so it sits a little higher in the water and then let it go. What happens? Is this consistent with your conclusions above?

7. Sketch a free-body diagram for one of the blocks. How does the buoyant force compare to the force of gravity exerted on the block by the Earth?

Activity C: Aluminum vs. wood. In this case you should have one object made from aluminum and another made from wood, a scale, and a beaker of water.

1. Find the mass of the block of wood. _______________

2. Place the block of wood in the beaker of water. What happens?

3. Find the mass of the aluminum object. How does it compare to the mass of the block of wood?

4. Predict what will happen when you place the aluminum object into the beaker. What do you base your prediction on?

5. Place the aluminum object into the beaker. Is your prediction correct? What, if anything, can you conclude from this?

Bonus Question 1: Determine the density of the aluminum cylinder and the block of wood.

Bonus Question 2: A Japanese yen, which is a solid disk of aluminum, can be placed carefully on a water surface and remain there without sinking. Is this consistent with what you observed in activity C? How can you explain this?

Activity D: Tossing an anchor overboard. In this activity you get to answer a classic conceptual question in physics, which is generally posed something like the following. You are in your boat floating around a reservoir when you notice that the water in the reservoir is dangerously close to spilling over the dam that holds the water back from flooding the village in the valley below. You have a heavy anchor in your boat. If you throw the anchor overboard into the water will the water level in reservoir go up, down, or remain the same?

1. Start with the heavy weight (the anchor) inside the container (the boat) floating in the tub of water (the reservoir). Predict what will happen to the water level in the reservoir when you carefully lift the anchor out of the boat and place it at the bottom of the reservoir.

2. Try this and watch carefully what happens to the water level in the process. What happened? Was your prediction correct?

3. When the anchor is submerged in the reservoir how much water does it displace? We're not looking for a number here, just a qualitative statement. Complete the following statement: The amount of water displaced by the anchor has a volume equal to ….

4. When the anchor is inside the boat, and the boat is floating, how much water does it displace? Again, we're after a qualitative statement: The amount of water displaced by the anchor has a weight equal to …

5. Based on the answers to parts 3 and 4, in which case does the anchor displace more water?

Activity E: A Cartesian Diver. A Cartesian diver is an object (like a toy squid, an eye-dropper, or a sealed ketchup or soy sauce packet from a fast food restaurant) of an appropriate density that it just floats in water that is at atmospheric pressure. This object is then placed into a plastic bottle and the bottle is sealed.

1. Predict what will happen to the diver when you squeeze the bottle (or pressurize it with the special fizz-keeper pump).

2. Observe what happens to the diver when you increase the pressure on the bottle.

3. Can you explain what is going on? If you can, carefully observe what happens inside the Cartesian diver when you squeeze the bottle. Try to explain this in terms of Archimedes' principle, which says that the buoyant force is equal to the volume of fluid displaced by the object.

4. Can you make the diver come to a stop in the middle of the bottle? What does this tell you about how the density of the diver when it is at rest at the center compares to the density of the water?

Activity F: A ping-pong ball in a funnel.

1. Place the ping-pong ball in the funnel and hold the funnel upright so the narrow stem points vertically down.

2. Predict what the ball will do when you turn on the air supply, bringing air up through the funnel from under the ball. Will the ball shoot out of the funnel, shoot out but remain in mid-air in the airstream, or will it remain in the funnel?

3. Turn on the air supply and see what happens. Can you explain this?

4. With the air still going invert the funnel slowly. What happens to the ball? Does this make sense in terms of the explanation you came up with in part 3?

5. Now hold the ping-pong ball in your hand and, with the air blowing through the funnel, try to place the ball into the airstream so that the ball hovers in the air. If you can do this slowly vary the angle of the funnel and airstream to see how far off vertical these can be and still support the ball. Roughly what angle, measured from the vertical, can you get to?

Additional Questions

These are the same questions we used for the pre-lab, but your answers may be different now that you have done the experiment.

Question 1: Object A sinks in a container of fluid. If the mass of object B is larger than the mass of object A, what will object B do when you put it in the container?

[ ] Sink [ ] Float

[ ] There is not enough information given to answer this question

Briefly justify your answer:

Question 2: A block of wood floats partly submerged in a beaker of water. A block of lead, of exactly the same dimensions as the block of wood, is placed in the same beaker and sinks to the bottom. Which block experiences the largest buoyant force?

[ ] The wooden block [ ] The lead block [ ] The forces are equal

[ ] There is not enough information given to answer this question

Briefly justify your answer:

Question 3: A large beaker of water is placed on a scale, and the scale reads 40 N. A block of wood with a weight of 10 N is then placed in the beaker. It floats with exactly half of its volume submerged. Assuming that none of the water spilled out of the beaker when the block was added, what does the scale read now?

[ ] 40 N [ ] 45 N [ ] 50 N

Briefly justify your answer: