

Review and apply Investigation 7

Let's review

Pages 442-443

At the beginning of this investigation, a student was wondering why a heavy wooden log floats and lighter rocks sink.

- 1. If she was able to weigh a volume of water equal to the volume of the log, which would weigh more, the water or the log?**

The water will weigh more.

Explain your answer.

Since the log floats in water, the density of water must be greater than the density of the log. Density is a measure of mass divided by volume. If you weigh the same volume of water and log, the one that is more dense must weigh more.

- 2. When you compared the weight of wax to an equal volume of water on your ruler balance, you saw that the water weighed more than the wax. Which was more dense, the wax or the water?**

The water was more dense.

- 3. If you had an enormous piece of wax the size of a house, do you think it would float or sink if it was placed in water like in a lake or huge swimming pool?**

The giant piece of wax would float.

Explain your reasoning.

Wax is less dense than water, so it will float. Floating or sinking depends on the density of the object compared to the density of the liquid.

- 4. Each liquid has its own density. Let's say that you had two liquids and needed to know which one was more dense than the other. You could carefully pour both liquids into a cup and see if one layered on top of or beneath the other.**

What is another way to find out which liquid is more dense than the other?

Answers will vary. Students might place the same object in both liquids and compare the results. Students might also compare the weights of equal volumes of the different liquids.

5. A carrot slice sinks in fresh water and floats in salt water.

If you put a carrot slice on one end of a balance and an equal volume of water on the other end, what would you expect the balance to do?

Since the carrot slice sinks in water, carrot must be more dense than water. Since carrot is more dense, a slice of carrot weighs more than an equal volume of water. Therefore, the end of the balance with the carrot will go down and the end with the water will go up.

If you put a carrot slice on one end of a balance and an equal volume of salt water on the other end, what would you expect the balance to do?

Since the carrot slice floats in salt water, carrot must be less dense than salt water. Since carrot is less dense, a slice of carrot weighs less than an equal volume of salt water. Therefore, the end of the balance with the carrot will go up and the end with the salt water will go down.

6. Hot water is less dense than cold water. Let's say you had a sample of hot water and a sample of cold water and they had exactly the same weight. Which one would have more volume?

The hot water will have more volume.

Explain.

Since hot water is less dense than cold water to get the same mass or weight of both, you would have to have more hot water.

7. Explain why adding volume can make an object float that ordinarily sinks.

Density is a measure of mass compared to volume ($D=m/v$). By looking at the fraction, you can see that adding volume without adding much mass will make the fraction smaller which makes density smaller. If the volume of an object that ordinarily sinks is increased enough, its density can decrease enough to make it float. This is like activity 7.6 where bubble wrap was used to increase the volume of the soda can, making it float.

Science in action!

Pages 444-445

1. **Draw and label what you see in each cup. Be sure to compare the level the ice cube floats in each liquid.**

Students should draw the ice cube floating highest in water, a little lower in vegetable oil, and lowest in mineral oil.

2. **The level an ice cube floats in different liquids can help you compare the density of the liquids.**

What do you know about the density of the liquid if the ice cube floats high in the water?

If the ice cube floats highest in the water, this indicates that the water is more dense than the other two liquids.

3. **Based on your observations, rank the three liquids from most dense to least dense.**

The ice cube floats highest in the water indicating the water is the most dense. The ice cube floats lowest in the mineral oil indicating that the mineral oil is the least dense of the liquids. The ice cube floats at an intermediate height in the vegetable oil indicating that it is less dense than water but more dense than vegetable oil.

4. **Do you think that water, vegetable oil, and mineral oil could form layers if they were carefully poured in a cup? Yes.**

Why do you think that?

Since the liquids have different densities, there is a chance that they will form distinct layers when poured in a cup. It will help if the liquids are the type which do not readily mix with each other.

5. **In what order should water, vegetable oil, and mineral oil be poured to get them to form layers in a cup? Hint: In order to prevent mixing, the most dense should be poured first.**

The order should be: water, vegetable oil, and then mineral oil

Think about it

Pages 448-449

- 1. Which of the following is the best summary of this passage?**
 - a. Water wings and life jackets can help you float.
 - b. Life jackets increase your volume quite a bit without increasing your mass very much.
 - c. Fish, life jackets, and submarines all can float.
 - d. Density is a relationship between mass and volume, which explains how some things are able to float.
- 2. When kids wear water wings, their...**
 - a. mass increases quite a bit and volume increases quite a bit.
 - b. mass decreases slightly and volume increases quite a bit.
 - c. mass increases slightly and volume increases quite a bit.
 - d. both mass and volume stay the same.
- 3. Gas moves into or out of a fish's swim bladder to...**
 - a. help the fish swim faster.
 - b. help the fish stay at the right depth in the water.
 - c. help the fish get more worms from fishing hooks.
 - d. help the fish increase its mass.
- 4. In the first paragraph, the word *volume* refers to...**
 - a. how heavy something is.
 - b. how much space something takes up.
 - c. how dense you are in water.
 - d. how well you can float.
- 5. When you inhale and hold your breath, you float more easily because...**
 - a. your mass decreases.
 - b. your volume increases.
 - c. your volume and mass both decrease.
 - d. your volume stays the same.
- 6. Submarines take in or release sea water into their ballast tanks to...**
 - a. enable them to become more or less dense than the surrounding water.
 - b. bring water in for the people inside the submarine to drink.
 - c. clean the sea water of pollution.
 - d. move faster in the ocean.

- 7. Most wood floats in water, but samples of a type of wood called ebony can sink. Based on the reading, what would you say about the density of this sinking wood compared to the density of water?**

If the wood sinks, its density must be greater than the density of water.

- 8. Almost all rocks sink but a type of rock called pumice floats. Based on the reading, what would you say about the density of this floating rock compared to the density of water?**

If the rock floats, its density must be less than the density of water.

- 9. If a fish with a swim bladder needs to go deeper in the water, explain how the swim bladder helps the fish stay in deeper water.**

When the fish goes to deeper water, gas will leave the swim bladder and enter the blood. The volume of the fish will decrease so its density will increase. This added density helps the fish stay at the lower depth.

- 10. If a submarine is far under water and needs to rise toward the surface, explain how ballast tanks are used to help the submarine go up.**

If the submarine wants to go up, it expels water from the ballast tanks. This decreases the mass of the submarine but its volume stays the same. The decrease in mass decreases the density so the submarine can rise more easily.

What's going on here?

Page 452

1. Of the substances listed, which ones will float in water and which will sink?

- The ones that *float* have a density less than the density of water (1g/cm^3). These are: wood (pine), wax (tealight candle), and vegetable oil.
- The ones that *sink* have a density greater than the density of water. These are: clay, iron, and lead

2. Mineral oil has a density of about $.8\text{g/cm}^3$. What substances from the list on p. 451 will float in mineral oil?

Substances that float in mineral oil have a density less than the density of mineral oil. These are: wood (pine) and wax (tea light candle).

3. The metal iron has a density of about 7.9g/cm^3 .

What is the density of a solid cube of iron that is 2 cm long, 2 cm wide, and 2 cm high?

This is kind of a trick question because the answer is given in the question. The density of iron is given (7.9g/cm^3) so the density of the cube would be the same. There is no need to make any calculation of volume using the measurements given. The point of the question is to emphasize that density is a characteristic property of a substance and remains the same regardless of the size of the sample.

What is the density of a solid cube of iron that is 10 cm long, 10 cm wide, and 10 cm high?

This is a follow-up question to reinforce the idea that density is a characteristic property of a substance. The answer is 7.9g/cm^3 which is the same as the smaller cube in the question above.