

Buoyancy

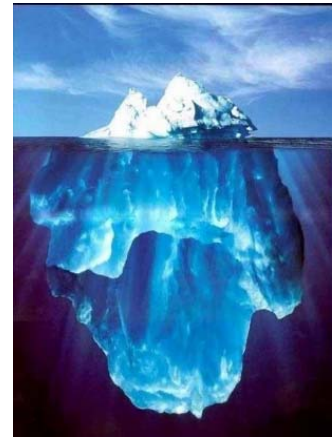
During the last couple weeks we've learned about different types of forces. Today we are going to learn about a different force called **buoyancy**. Buoyancy is the force that makes things float. It keeps boats, icebergs, and fish, among other things, from sinking.

The buoyancy of an object is related to its **density**. The density of an object is defined as —, its mass divided by its volume.

Because of this, something that is small but heavy for its size (a coin for example) has a high density. Something that is light for its size (a box full of Styrofoam peanuts, for example) has low density. Things that have high density sink, while things with low density float. Would the coin sink or float? How about the box?

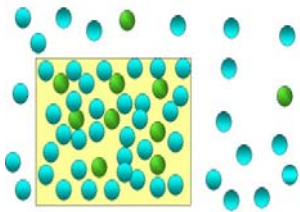
So how does a big, heavy boat float on the ocean? Obviously the metal that the boat is made out of is denser than the water. A boat floats because it is hollow: it is held up by the buoyant force. The buoyant force happens because water is pushed out of the way, or displaced. The more water is displaced, the stronger the buoyant force. Imagine pushing a beach ball under water at the swimming pool. As more of the ball is pushed under water, it gets harder to keep pushing it down. That is because more water gets pushed out of the way as the ball is submerged, and the buoyant force is increased. The greater the *volume* of water pushed out of the way, the greater the *buoyant force*. This is the same reason a boat floats.

Now think about a boat. If you put something heavy on it, does it rise or sink? Is more or less water displaced? If more water is displaced, is the buoyant force stronger or weaker? Does this make sense (remember that the boat is heavier now)? Talk about this with your mentor.

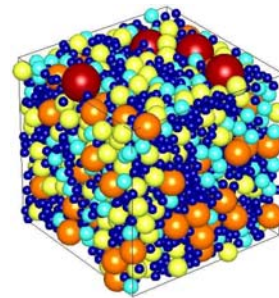


Questions

1. Why does a rock sink but a piece of wood floats?
2. Why does a material sink when it is crushed, but floats if it is shaped like a boat?
3. Why does a boat sink if you add too many materials?



Density Practice Problems



The density of a substance is a measure of how much mass is packed into a certain volume of the substance. Substances with a high density, like steel, have molecules that are packed together tightly. Substances with a low density, like cork, have fewer molecules packed into the same amount of space.

The density of a substance can be found by dividing its mass by its volume. As long as a substance is homogeneous, the size or shape of the sample doesn't matter. The density will always be the same. This means that a steel paper clip has the same density as a steel girder used to build a bridge.

$$\text{Density} = \text{Mass} \div \text{Volume} \qquad D = \frac{m}{V}$$

Use the density formula to solve the following problems. Show all work and the answer must have the correct units. Remember that volume can have different forms. A block of ice with a volume of 3 cm³ would be 3 mL of liquid after being melted.

1. What is the density of CO gas if 0.196 g occupies a volume of 100 ml?

Answer _____

2. A block of wood 3 cm on each side has a mass of 27 g. What is the density of the block? (Hint, don't forget to find the volume of the wood.)

Answer _____

3. An irregularly shaped stone was lowered into a graduated cylinder holding a volume of water equal to 2 ml. The height of the water rose to 7 ml. If the mass of the stone was 25 g, what was its density?

Answer _____

4. A 10.0 cm^3 sample of copper has a mass of 89.6 g. What is the density of copper?

Answer _____

5. Silver has a density of 10.5 grams/cm^3 and gold has a density of 19.3 g/cm^3 . Which would have the greater mass, 5cm^3 of silver or 5cm^3 of gold?

Answer _____

6. Five mL of ethanol has a mass of 3.9 g, and 5.0 mL of benzene has a mass of 44 g. Which liquid is denser?

Answer _____

7. A sample of iron has the same dimensions of 2 cm x 3 cm x 2 cm. If the mass of this rectangular-shaped object is 94 g, what is the density of iron?

Answer _____

Physical Science

QUIZ: DENSITY AND BUOYANCY

Name _____ Date: _____ Period: _____

Calculate each problem. Use the spaces provided for your solution. Good luck!


$$\frac{m}{D} = v$$

density = $\frac{\text{mass}}{\text{volume}}$

UNITS OF DENSITY solids (g/cm ³) liquids (g/mL)
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1. Find the unknown quantity:

a) d = 3 g/mL V = 100 mL M = ?	b) d = ? V = 950 mL M = 95 g	c) d = 0.5 g/cm ³ V = ? M = 20 g
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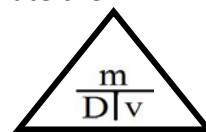
2. Find the unknown quantity (CONVERT FIRST to g or mL)

a) d = 24 g/mL V = 1.2 L = _____ mL M = ?	b) d = ? V = 100 mL M = 1.5 kg = _____ g	c) d = V = 0.52 L = _____ mL M = 500 mg = _____ g
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WORD PROBLEMS

1. A block of aluminum occupies a volume of 15.0 mL and weighs 40.5 g. What is its density?

2. Mercury metal is poured into a graduated cylinder that holds exactly 22.5 mL. The mercury used to fill the cylinder weighs 306 g. From this information, calculate the density of mercury.



3. What is the mass of the ethanol that exactly fills a 200.0 mL container? The density of ethanol is 0.789 g/mL.

4. A rectangular block of copper metal weighs 1896 g. The dimensions of the block are 8.4 cm x 5.5 cm x 4.6 cm. From this data, what is the density of copper? (hint: find the volume of a block first)

5. What volume of silver metal will weigh exactly 2500 g. The density of silver is 10.5 g/cm³.

6. A block of lead has dimensions of 4.5 cm x 5.2 cm x 6 cm. The block weighs 1587 g. From this information, calculate the density of lead. Will it float or sink?

7. 28.5 g of iron shot is added to a graduated cylinder containing 45.5 mL of water. The water level rises to the 49.10 mL mark. From this information, calculate the density of iron. Will it sink or float?

8. An empty graduated cylinder has a mass of 50 g. When 60 mL of an unknown liquid is placed in the cylinder, the mass increases to 110 g. What is the density of the liquid? What substance could the liquid be?