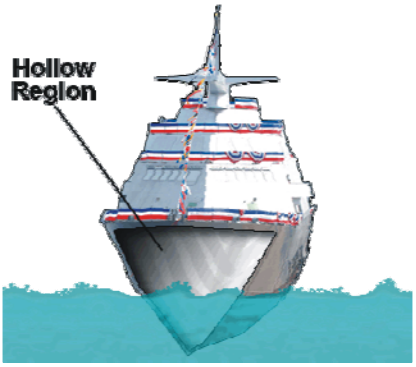
Archimedes' Principle

Archimedes' principle says the buoyant force on an object is equal to the weight of the fluid displaced. This is because when an object is dropped in water, the object sinks and the water rises. The force exerted by the displaced water flowing back down into place is equal to the weight of the water. If the force is equal to the weight of the object, the object floats. If the density of the object is less than water, then the displaced water weighs at least as much as the object ($m = D \times V$). As a result, if the density of the object is less than water, it floats. Even heavy objects can float if they displace enough water. The right shape can give a heavy object a very large volume and, consequently, a very small density ($D = m \div V$). Ships are heavy, but they float because of their shapes. A ship is hollow inside, so its volume is large compared to its mass. This is what enables it to float.



Archimedes' Principle ruins a great invention.

The density of water is 1 $^{g}/_{mL}$ or 1 $^{kg}/_{L}$. Anything with a lower density floats. Anything with a higher density doesn't. It is possible to determine if an object will float if you know its mass and volume, because you can determine its density.

Sample Problem

Some scouts hollow out a log to make a boat. The hollowed log has a mass of 100. kg and a volume of 50.0 L. Will it float?

Step 1: Determine the density

$$D = \frac{m}{V} = \frac{100.\,kg}{50.0\,L} = 2\,{}^{kg}/_{L}$$

Step 2: Compare to the density of water

$2\,{}^{kg}/_{L} > 1\,{}^{kg}/_{L}$. The boat won't float

Answer the questions below based on your reading above and you knowledge of physics.

1. Determine the density of each of the following objects, and state whether or not they will float. Find the volume first [$V = L \times W \times H$]. Show your work. (*Note:* 1 cm^3 = 1 mL)
   a. A 35.0 g plastic container has the following dimensions: 3.0 cm × 5.0 cm × 6.0 cm

   b. A 1.38 g piece of aluminum foil is folded to the following dimensions: 5.0 cm × 5.0 cm × 10.0 cm

   c. The same 1.38 g piece of foil is squeezed into a cube 0.8 cm on a side

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2. Two objects the same size (volume) are floating in the water. One of them is submerged halfway. The other is three fourths under water. Explain. _____

3. Two boats appear identical (same volume and shape), but one does not have a hollow hull. One floats and one sinks. Which does what? Explain. _____

4. A cup is filled with crushed ice. Then water is added, filling the cup to the top. The ice floats. When the ice melts, will the cup overflow? How do you know? _____

5. A beach ball floats on the water's surface. After the air is let out, it actually has a smaller mass, but it sinks. Why? ____

6. An empty row boat is tied to a pier. You step in. What happens to the boat's height in the water? Why? _____