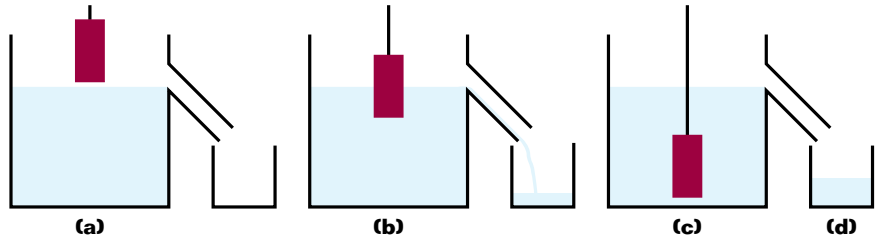

Figure 2
(a) A brick is being lowered into a container of water. **(b)** The brick displaces water, causing the water to flow into a smaller container. **(c)** When the brick is completely submerged, the volume of the displaced water **(d)** is equal to the volume of the brick.

extension

Integrating Biology

Visit go.hrw.com for the activity "How Fish Maintain Neutral Buoyancy."

Keyword HF6FLUX

Did you know?

Archimedes was a Greek mathematician who was born in Syracuse, a city on the island of Sicily. According to legend, the king of Syracuse suspected that a certain golden crown was not pure gold. While bathing, Archimedes figured out how to test the crown's authenticity when he discovered the buoyancy principle. He is reported to have then exclaimed, "Eureka!" meaning "I've found it!"

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Archimedes' principle describes the magnitude of a buoyant force

Imagine that you submerge a brick in a container of water, as shown in **Figure 2.** A spout on the side of the container at the water's surface allows water to flow out of the container. As the brick sinks, the water level rises and water flows through the spout into a smaller container. The total volume of water that collects in the smaller container is the *displaced volume* of water from the large container. The displaced volume of water is equal to the volume of the portion of the brick that is underwater.

The magnitude of the buoyant force acting on the brick at any given time can be calculated by using a rule known as *Archimedes' principle.* This principle can be stated as follows: *Any object completely or partially submerged in a fluid experiences an upward buoyant force equal in magnitude to the weight of the fluid displaced by the object.* Everyone has experienced Archimedes' principle. For example, recall that it is relatively easy to lift someone if you are both standing in a swimming pool, even if lifting that same person on dry land would be difficult.

Using m_f to represent the mass of the displaced fluid, Archimedes' principle can be written symbolically as follows:

BUOYANT FORCE

$$F_B = F_g\,(displaced\ fluid) = m_f g$$

magnitude of buoyant force = weight of fluid displaced

Whether an object will float or sink depends on the net force acting on it. This net force is the object's apparent weight and can be calculated as follows:

$$F_{net} = F_B - F_g\,(object)$$

Now we can apply Archimedes' principle, using m_o to represent the mass of the submerged object.

$$F_{net} = m_f g - m_o g$$

Remember that $m = \rho V$, so the expression can be rewritten as follows:

$$F_{net} = (\rho_f V_f - \rho_o V_o) g$$

Note that in this expression, the fluid quantities refer to the *displaced* fluid.