FLUID PRESSURE AS A FUNCTION OF DEPTH

$$P = P_0 + \rho gh$$

absolute pressure = atmospheric pressure + (density × free-fall acceleration × depth)

This expression for pressure in a fluid can be used to help understand buoyant forces. Consider a rectangular box submerged in a container of water, as shown in **Figure 7.** The water pressure at the top of the box is $-(P_0 + \rho gh_1)$, and the water pressure at the bottom of the box is $P_0 + \rho gh_2$. From the definition of pressure, we know that the downward force on the box is $-A(P_0 + \rho gh_1)$, where A is the area of the top of the box. The upward force on the box is $A(P_0 + \rho gh_2)$. The net force on the box is the sum of these two forces.

$$F_{net} = A(P_0 + \rho gh_2) - A(P_0 + \rho gh_1) = \rho g(h_2 - h_1)A = \rho gV = m_f g$$

Note that this is an expression of Archimedes' principle. In general, we can say that buoyant forces arise from the differences in fluid pressure between the top and the bottom of an immersed object.

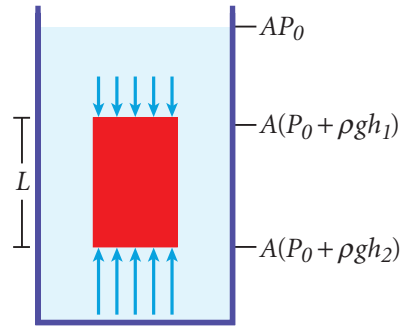

Figure 7
The fluid pressure at the bottom of the box is greater than the fluid pressure at the top of the box.

extension

Practice Problems

Visit go.hrw.com to find a sample and practice problems for pressure as a function of depth.

Keyword HF6FLUX

SECTION REVIEW

1. Which of the following exerts the most pressure while resting on a floor?
   - **a.** a 25 N cube with 1.5 m sides
   - **b.** a 15 N cylinder with a base radius of 1.0 m
   - **c.** a 25 N cube with 2.0 m sides
   - **d.** a 25 N cylinder with a base radius of 1.0 m

2. Water is to be pumped to the top of the Empire State Building, which is 366 m high. What gauge pressure is needed in the water line at the base of the building to raise the water to this height? (Hint: See **Table 1** for the density of water.)

3. When a submarine dives to a depth of 5.0×10^2 m, how much pressure, in Pa, must its hull be able to withstand? How many times larger is this pressure than the pressure at the surface? (Hint: See **Table 1** for the density of sea water.)

4. **Critical Thinking** Calculate the depth in the ocean at which the pressure is three times atmospheric pressure. (Hint: Use the value for the density of sea water given in **Table 1.**)