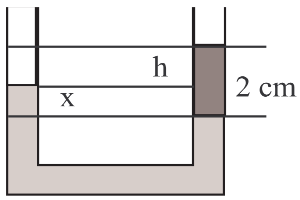
Chapter 15 Problem 43 †



Given

$\rho_{oil} = 0.82\rho_{water}$

Solution

Find the height difference between the tops of the fluids.

From the hydrostatic equation we know that the pressure at the oil-water interface is the same as the pressure in the other arm of the tube at the same height. If this were not so, the fluids would not be in hydrostatic balance and they would flow. The pressure at each of these points is the result of the fluid lying above this level. The pressure in the left side is

$$P = P_a + \rho_{water} g x$$

where P_a is the atmospheric pressure, the density is that of water and the height of the water column is x. The pressure in the right side is

$$P = P_a + \rho_{oil} g(x + h)$$

Since the pressure on each side must be equal, we can combine these equations by eliminating P.

$$P_a + \rho_{water} g x = P_a + \rho_{oil} g(x + h)$$

From the diagram we know that $x + h$ is 2 cm. Solving for x gives us

$$x = \frac{\rho_{oil} g}{\rho_{water} g}(x + h)$$

$$x = \frac{\rho_{oil}}{\rho_{water}}(x + h)$$

Substituting in the known values give

$$x = \frac{0.82\rho_{water}}{\rho_{water}}(2\ cm) = 0.82(2\ cm) = 1.64\ cm$$

Therefore, the value h is

$$h = 2.00\ cm - x = 2.00\ cm - 1.64\ cm = 0.36\ cm$$

†Problem from Essential University Physics, Wolfson