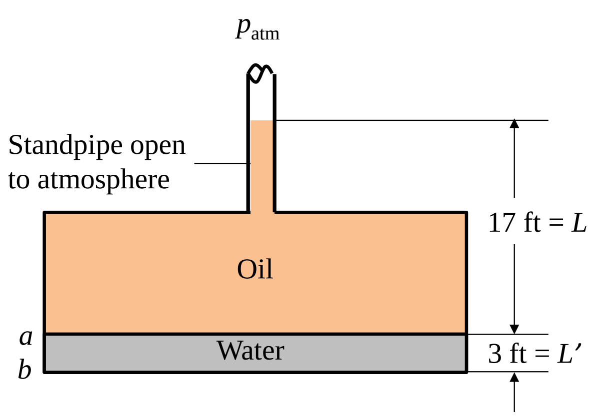
1.40 Because of a break in a buried oil storage tank, ground water has leaked into the tank to the depth shown in Fig. P1.40. Determine the pressure at the oil-water interface and at the bottom of the tank, each in lbf/in.^{2} (gage). The densities of the water and oil are, respectively, 62 and 55, each in lb/ft^3. Let g = 32.2 ft/s^2.

KNOWN: Ground water has leaked into a buried oil storage tank. Densities of the water and oil are known.

FIND: the pressure at the oil-water interface and at the bottom of the tank.

SCHEMATIC AND GIVEN DATA:



ENGINEERING MODEL:
1. The acceleration of gravity is 32.2 ft/s^2.

ANALYSIS: With Eq. 1.11, the pressure at the oil-water interface is,

$$p_a = p_{atm} + \rho_o g L$$

Expressed as a gage pressure, this is

$$p_a\,(\text{gage}) = [p_a - p_{atm}] = \rho_o g L$$

Calculating,

$$p_a\,(\text{gage}) = \left(55\frac{\text{lb}}{\text{ft}^3}\right)\left(32.2\frac{\text{ft}}{\text{s}^2}\right)(17\text{ ft})\left|\frac{1\,\text{lbf}}{32.2\frac{\text{lb}\cdot\text{ft}}{\text{s}^2}}\right|\left|\frac{1\,\text{ft}^2}{144\,\text{in}^2}\right| = \underline{\mathbf{6.49\ lbf/in^2\ (gage)}}$$

The pressure at the bottom of the tank is

$$p_b = p_a + \rho_w g L' = [p_a - p_{atm}] + \rho_w g L'$$

$$p_b\text{ (gage)} = [p_b - p_{\text{atm}}] = \rho_{\text{o}} g L + \rho_{\text{w}} g L'$$

$$p_b\text{ (gage)} = 6.49\,\frac{\text{lbf}}{\text{in}^2} + \left(62\,\frac{\text{lb}}{\text{ft}^3}\right)\left(32.2\,\frac{\text{ft}}{\text{s}^2}\right)(3\text{ ft})\left|\frac{1\text{ lbf}}{32.2\,\frac{\text{lb}\cdot\text{ft}}{\text{s}^2}}\right|\left|\frac{1\text{ ft}^2}{144\text{ in}^2}\right| = \underline{\mathbf{7.78\ lbf/in^2\ (gage)}}$$