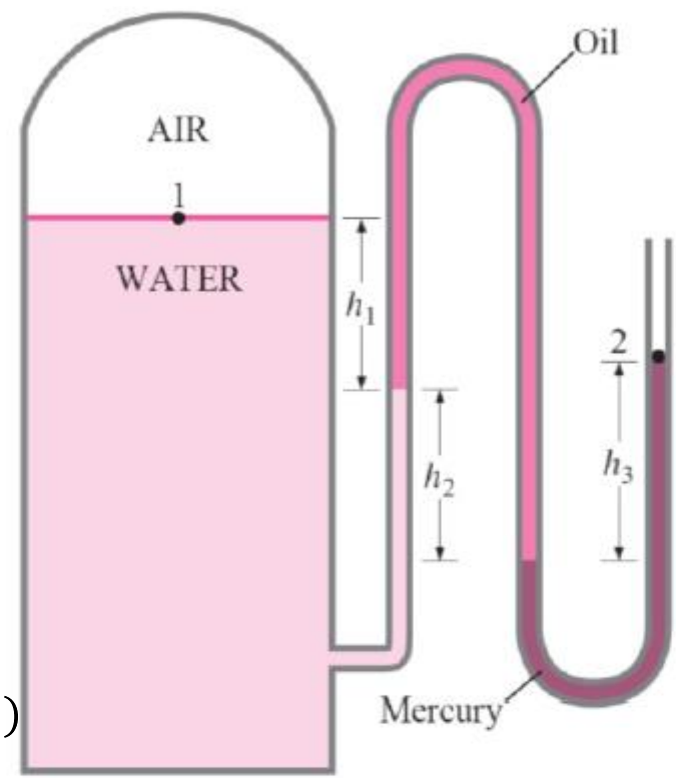
The water in a tank is pressurized by air, and the pressure is measured by a multi-fluid manometer as shown in the Figure. Determine the gage pressure of air in the tank if $h_1 = 0.2$ m, $h_2 = 0.3$ m, and $h_3 = 0.46$ m. Take the densities of water, oil, and mercury to be 1000 kg/m^3, 850 kg/m^3, and 13,600 kg/m^3, respectively.

Assumption The air pressure in the tank is uniform (i.e., its variation with elevation is negligible due to its low density), and thus we can determine the pressure at the air-water interface.

Analysis Starting with the pressure at point 1 at the air-water interface, and moving along the tube by adding (as we go down) or subtracting (as we go up) the $\rho g h$ terms until we reach point 2, and setting the result equal to p_{atm} (the tube is open to the atmosphere) gives



$$p_{atm} = p_1 + \rho_W g h_1 + \rho_O g h_2 - \rho_M g h_3$$

$$p_1 = p_{atm} + \rho_M g h_3 - \rho_O g h_2 - \rho_W g h_1$$

$$\begin{aligned} p_{1,gage} = p_1 - p_{atm} &= \rho_M g h_3 - \rho_O g h_2 - \rho_W g h_1 \\ &= g(\rho_M h_3 - \rho_O h_2 - \rho_W h_1) \\ &= 9.81 \times (13{,}600 \times 0.46 - 850 \times 0.3 - 1{,}000 \times 0.2) \\ &= 56.9 \text{ kPa} \end{aligned}$$