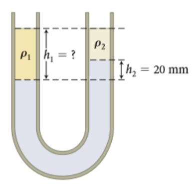
58. After pouring some water into the U-tube of Figure P18.58, you pour a volume V1 of oil of mass density r1 = 800 kg>m3 into the left side of the tube and a volume V2 of oil of mass density r2 = 700 kg>m3 into the right side. Once the two oils have been added, the levels on the left and right sides are the same, and the water level on the right side is a height h2 = 20 mm higher than the water level on the left side. What is the height h1 of the oil on the left side?

Figure P18.58




The pressure in the water in the two legs of the tube is the same at any horizontal level. In particular, at the level of the bottom of the oil in the left leg, the pressures are the same and they are sufficient to support the fluids above them against the force of gravity. That is,

$$\rho_1 V_1 g = \rho_2 V_2 g + \rho_{\text{water}} V_{\text{water}} g$$

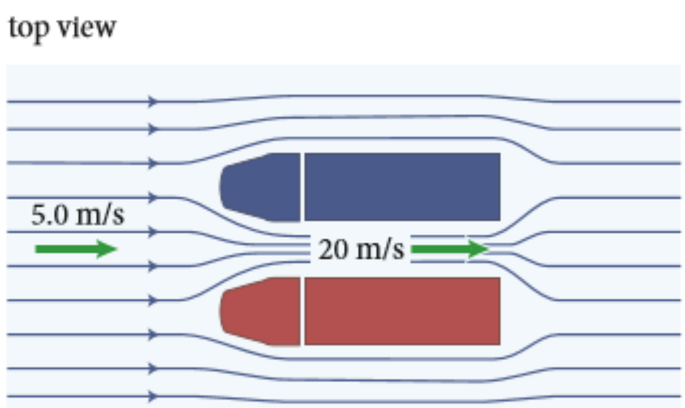
$$\rho_1 h_1 A g = \rho_2 (h_1 - h_2) A g + \rho_{\text{water}} h_2 A g$$

$$h_1(\rho_1 - \rho_2) = h_2(\rho_{\text{water}} - \rho_2)$$

$$h_1 = \frac{h_2(\rho_{\text{water}} - \rho_2)}{\rho_1 - \rho_2}$$

$$h_1 = \frac{(20\text{ mm})\left[(1000\text{ kg/m}^3) - (700\text{ kg/m}^3)\right]}{(800\text{ kg/m}^3) - (700\text{ kg/m}^3)} = 60\text{ mm}$$

70. Two tractor trailers, each 16 m long and 4.0 m tall, are parked next to each other as shown in Figure P18.70. A light wind that is blowing at 5.0 m>s in the parking lot but at 20 m>s between the trailers causes the air pressure between them to drop. What is the magnitude of the force exerted by the air on each trailer? (Use 1.0 kg>m3 for the air mass density.)




**18.70.** Because the air flows more quickly between the tractor trailers than along their other sides, the pressure is less than atmospheric between them, so the air exerts a force on each equal to the product of its area times the pressure difference. Because the air speeds are not too large, we can assume the mass density of the air is constant, so we can use Bernoulli's equation to calculate the pressure difference. The air does not change height, so Bernoulli's equation reduces to $P_1 + \frac{1}{2}\rho v_1^2 = P_2 + \frac{1}{2}\rho v_2^2$ or $P_1 - P_2 = \frac{1}{2}\rho(v_2^2 - v_1^2)$, and the magnitude of the force exerted on either of the tractor trailers is $F = (P_1 - P_2)A = \frac{1}{2}\rho(v_2^2 - v_1^2)A.$ Substituting numerical values gives $F = \frac{1}{2}(1.0\text{ kg/m}^3)\left[(20\text{ m/s})^2 - (5.0\text{ m/s})^2\right](16\text{ m})(4.0\text{ m}) = 1.2\times10^4\text{ N}.$