Solution to Problem 102C

Because all three fluids (water, glycerine, and oil) are assumed to be incompressible, we use the hydrostatic relation $dp = \rho g dy$. The density of water will be denoted by ρ_w, the density of glycerine by ρ_g, and the density of oil by ρ_o. First define the pressure at point 1 as p_1. Then the pressure at point 2, p_2, is

$$p_2 = p_1 + \rho_w g\,(y_1 + y_2)\,.$$

The pressure at point 3, p_3, is

$$p_3 = p_2 - \rho_g g y_2 = p_1 + \rho_w g\,(y_1 + y_2) - \rho_g g y_2.$$

Traversing from point 3 to point 1, the pressure at point 1 is found to be

$$p_1 = p_3 - \rho_o g y_1 = p_1 + \rho_w g\,(y_1 + y_2) - \rho_g g y_2 - \rho_o g y_1$$

and therefore

$$\rho_w g\,(y_1 + y_2) = \rho_g g y_2 + \rho_o g y_1$$

Finally,

$$\frac{y_1}{y_2} = \frac{\rho_g - \rho_w}{\rho_w - \rho_o} = \frac{1.26 - 1.0}{1.0 - 0.92} = \frac{0.26}{0.08} = 3.25$$