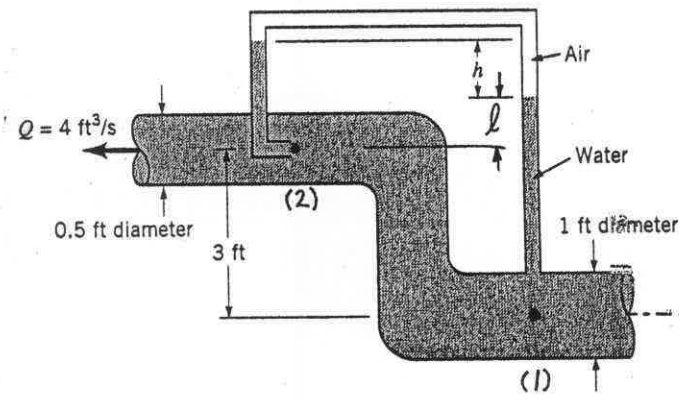
3.99

3.99 Water, considered an inviscid, incompressible fluid, flows steadily as shown in Fig. P3.92. Determine h.



■ FIGURE P3.92

$$p_1 + \gamma z_1 + \tfrac{1}{2}\rho V_1^2 = p_2 + \gamma z_2 + \tfrac{1}{2}\rho V_2^2$$

where $z_1 = 0$, $z_2 = 3\,ft$, $V_2 = 0$, and $V_1 = \frac{Q}{A_1} = \frac{4\,\frac{ft^3}{s}}{\frac{\pi}{4}(1\,ft)^2} = 5.09\,\frac{ft}{s}$

Thus,

$$p_1 + \tfrac{1}{2}\left(1.94\,\tfrac{slugs}{ft^3}\right)\left(5.09\,\tfrac{ft}{s}\right)^2 = p_2 + 62.4\,\tfrac{lb}{ft^3}(3\,ft)$$

or

$$p_1 - p_2 = 162\,\tfrac{lb}{ft^2} \qquad (1)$$

But from the manometer,

$$p_1 - \gamma(\ell + 3\,ft) + \gamma(h + \ell) = p_2$$

or

$$p_1 - 62.4\,\tfrac{lb}{ft^3}(3\,ft) + 62.4\,\tfrac{lb}{ft^3}h = p_2$$

Hence,

$$p_1 = p_2 + 187 - 62.4h$$ which when combined with Eq. (1) gives

$$p_2 + 187 - 62.4h - p_2 = 162$$

or

$$h = \underline{\underline{0.400\,ft}}$$