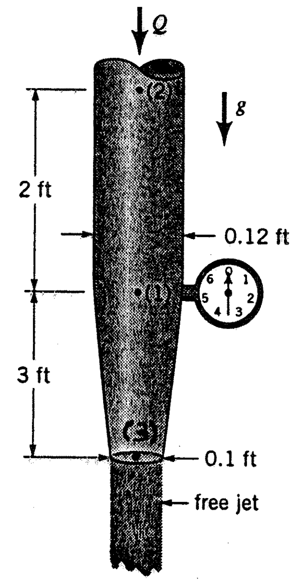
3.25

3.25 Water flows steadily downward through the pipe shown in Fig. P3.25. Viscous effects are negligible, and the pressure gage indicates the pressure is zero at point (1). Determine the flowrate and the pressure at point (2).



■ FIGURE P3.25

$$\frac{p_1}{\gamma} + z_1 + \frac{V_1^2}{2g} = \frac{p_3}{\gamma} + z_3 + \frac{V_3^2}{2g}$$

where $z_1 = 3\ ft,\ z_3 = 0,\ p_1 = p_3 = 0$
and

$$V_1 = \frac{A_3}{A_1} V_3 = \left(\frac{\frac{\pi}{4}(0.1\ ft)^2}{\frac{\pi}{4}(0.12\ ft)^2} \right) V_3 = 0.694\ V_3$$

Thus,

$$\frac{(0.694)^2 V_3^2}{2(32.2\ ft/s^2)} + 3\ ft = \frac{V_3^2}{2(32.2\ ft/s^2)} \quad \text{or} \quad V_3 = 19.3\ \frac{ft}{s}$$

so that

$$Q_3 = A_3 V_3 = \frac{\pi}{4}(0.1\ ft)^2 \left(19.3\ \frac{ft}{s}\right) = \underline{\underline{0.152\ \frac{ft^3}{s}}}$$

Also,

$$\frac{p_2}{\gamma} + z_2 + \frac{V_2^2}{2g} = \frac{p_1}{\gamma} + z_1 + \frac{V_1^2}{2g}$$

where $p_1 = 0$ and since $A_1 = A_2$ it follows that $V_2 = V_1$

Thus,

$$z_2 - z_1 = -\frac{p_2}{\gamma} \quad \text{or} \quad \frac{p_2}{\gamma} = -2\ ft$$

or

$$p_2 = -2\ ft\left(62.4\ \frac{lb}{ft^3}\right) = \underline{\underline{-125\ \frac{lb}{ft^2}}}$$