

51. (a) The volume of water (during 10 minutes) is

$$V = (v_1 t) A_1 = (15 \text{ m/s})(10 \text{ min})(60 \text{ s/min}) \left(\frac{\pi}{4} \right) (0.03 \text{ m})^2 = 6.4 \text{ m}^3 .$$

- (b) The speed in the left section of pipe is

$$v_2 = v_1 \left(\frac{A_1}{A_2} \right) = v_1 \left(\frac{d_1}{d_2} \right)^2 = (15 \text{ m/s}) \left(\frac{3.0 \text{ cm}}{5.0 \text{ cm}} \right)^2 = 5.4 \text{ m/s} .$$

- (c) Since $p_1 + \frac{1}{2} \rho v_1^2 + \rho g h_1 = p_2 + \frac{1}{2} \rho v_2^2 + \rho g h_2$ and $h_1 = h_2$, $p_1 = p_0$ (= atmospheric pressure),

$$\begin{aligned} p_2 &= p_0 + \frac{1}{2} \rho (v_1^2 - v_2^2) \\ &= 1.01 \times 10^5 \text{ Pa} + \frac{1}{2} (1.0 \times 10^3 \text{ kg/m}^3) [(15 \text{ m/s})^2 - (5.4 \text{ m/s})^2] \\ &= 1.99 \times 10^5 \text{ Pa} = 1.97 \text{ atm} . \end{aligned}$$

Thus the gauge pressure is $1.97 \text{ atm} - 1.00 \text{ atm} = 0.97 \text{ atm} = 9.8 \times 10^4 \text{ Pa}$.