

Assignment 4.2.

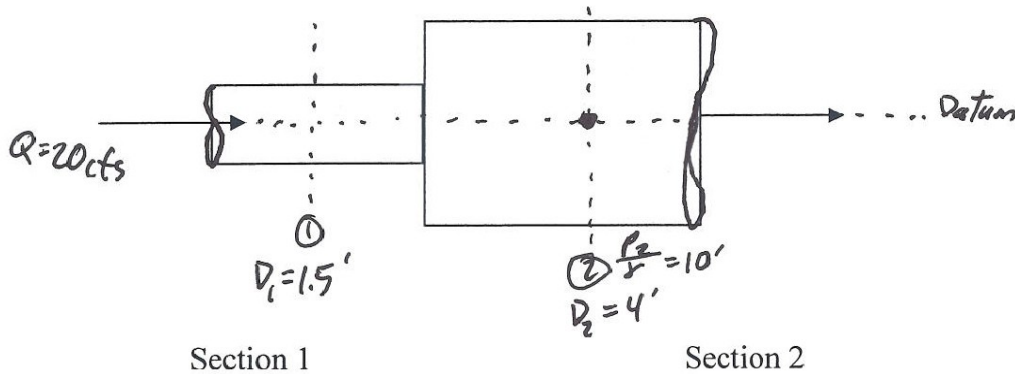
Determine the head loss at the Abrupt Expansion in the pipe shown below.

Find the pressure head at section 1.

Given: $D_1=1.5$ ft; $D_2=4$ ft; $Q=20$ cfs; $p_2/\gamma=10$ ft.

Assume: $\alpha_1=\alpha_2=1$; $\beta_1=\beta_2=1$, $h_f=\phi$

10



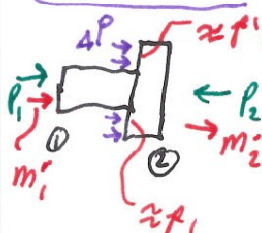
Apply Continuity

$$Q = V_1 A_1 = V_2 A_2$$

$$V_1 = \frac{Q}{A_1}; V_2 = \frac{Q}{A_2}$$

$$V_1 = \frac{20 \frac{\text{ft}^3}{\text{s}}}{\pi \frac{(1.5)^2}{4}} = 11.32 \frac{\text{ft}}{\text{s}} \quad V_2 = \frac{20}{\pi \frac{4^2}{4}} = 1.592$$

Apply Momentum



$$\sum F_x = p_1 + \Delta P - p_2 = M_2' - M_1' = \rho Q V_2 - \rho Q V_1$$

$$p_1 A_1 + p_1 (A_2 - A_1) - p_2 A_2 = \rho Q (V_2 - V_1)$$

$$\rightarrow p_1 A_2 - p_2 A_2 = \rho Q (V_2 - V_1)$$

$$\rightarrow p_1 = p_2 + \frac{\rho Q}{A_2} (V_2 - V_1) = 10' (62.4 \frac{\text{lb}}{\text{ft}^3}) + \frac{(62.4 \frac{\text{lb}}{\text{ft}^3})(20 \frac{\text{ft}^3}{\text{s}})}{12.57 \text{ft}^2} (1.592 \frac{\text{ft}}{\text{s}} - 11.32 \frac{\text{ft}}{\text{s}})$$

$$624 \frac{\text{lb}}{\text{ft}^2} + (-30) \frac{\text{lb}}{\text{ft}^2} = 594 \frac{\text{lb}}{\text{ft}^2}$$

$$h_{\text{press}} = \frac{p_1}{\gamma} = 9.519 \text{ ft}$$

Energy

$$H_{T_1} = H_{T_2} + h_L \rightarrow \frac{p_1}{\gamma} + \frac{V_1^2}{2g} + h_{z_1} = \frac{p_2}{\gamma} + \frac{V_2^2}{2g} + h_{z_2} + h_L = 10' + \frac{(1.592)^2}{64.4} + h_L$$

$$h_L = 1.46 \text{ ft}$$

compare above w/

$$h_L = \frac{(V_1 - V_2)^2}{2g} = 1.47 \text{ ft}$$

(for sudden expansion) of flow