

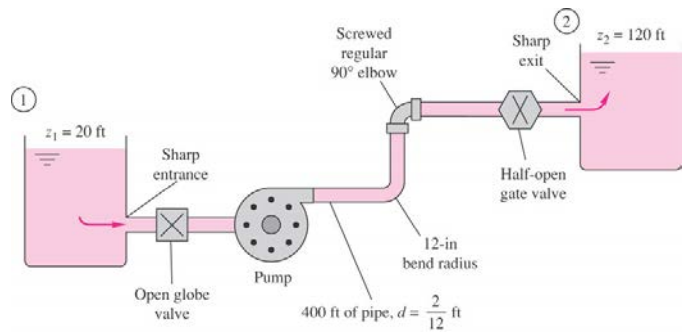
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NAME \_\_\_\_\_

Fluids-ID \_\_\_\_\_

## Quiz 13.

Water is pumped between two reservoirs at a flow rate  $Q = 0.2 \text{ ft}^3/\text{s}$  through a pipe with a total length  $\ell = 400 \text{ ft}$  and a diameter  $d = 2 \text{ in}$ . The roughness ratio is  $\varepsilon/d = 0.001$ . Compute the pump horsepower,  $P$ , required. Minor losses are not negligible. ( $P = \rho g Q h_p$ ;  $\rho = 1.94 \text{ slugs}/\text{ft}^3$ ;  $\nu = 0.000011 \text{ ft}^2/\text{s}$ ;  $g = 32.2 \text{ ft}/\text{s}^2$ ;  $1 \text{ hp} = 550 \text{ ft}\cdot\text{lbf}/\text{s}$ )



- **Energy Eq.:**

$$\frac{p_1}{\rho g} + \frac{V_1^2}{2g} + z_1 + h_p = \frac{p_2}{\rho g} + \frac{V_2^2}{2g} + z_2 + \frac{V^2}{2g} \left( \frac{f\ell}{d} + \sum K_L \right)$$

- **Friction factor,  $f$ :**

$$\frac{1}{\sqrt{f}} = -1.8 \log \left[ \left( \frac{\varepsilon/d}{3.7} \right)^{1.11} + \frac{6.9}{Re} \right]$$

Loss	$K_L$
Sharp entrance	0.5
Open globe valve	6.9
12-in bend	0.25
Regular 90° elbow	0.95
Half-closed gate valve	2.7
Sharp exit	1.0

Note: Attendance (+2 points), format (+1 point)