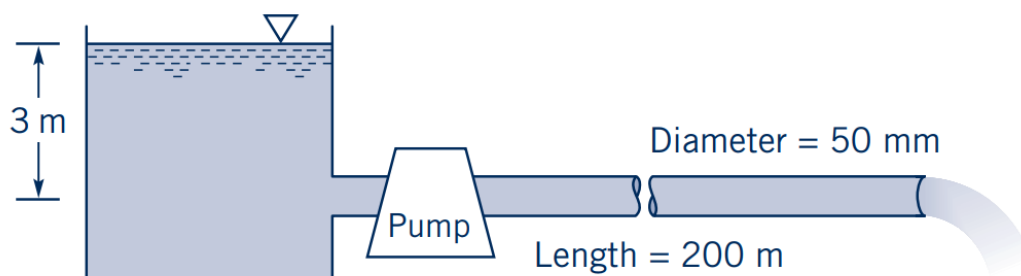




1- Water at 40°C is pumped from an open tank through 200 m of 50 mm diameter smooth horizontal pipe as shown in the figure and discharges into the atmosphere with a velocity of 3 m/s. Assume standard atmospheric pressure and negligible minor losses.

(a) If the efficiency of the pump is 70%, how much power is being supplied to the pump?

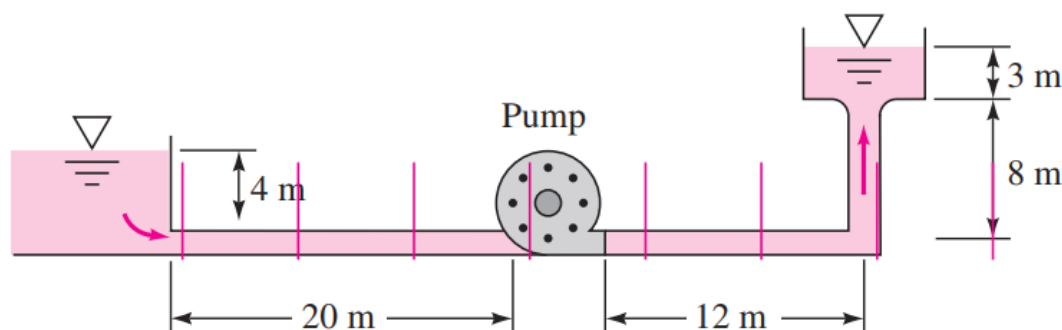
(b) What is the NPSHA at the pump inlet? Neglect losses in the short section of pipe connecting the pump to the tank.



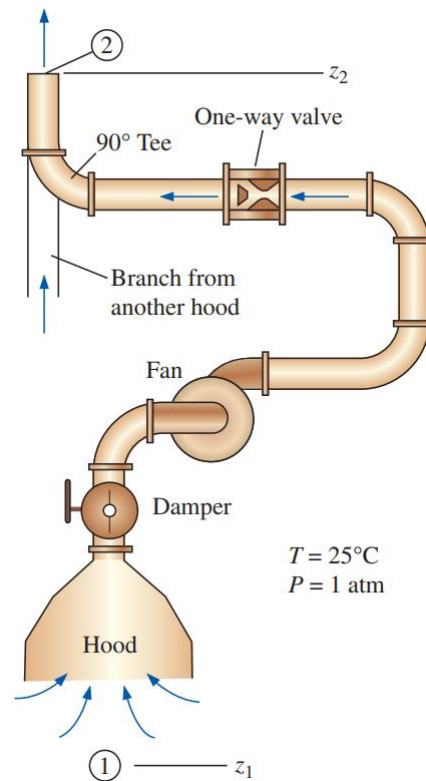
2- An 18-in-diameter centrifugal pump, running at 880 r/min with water at 20°C , generates the following performance data:

$Q \text{ m}^3/\text{s}$	0	0.1262	0.2524	0.3785	0.5047	0.631
$H \text{ m}$	28.04	27.13	25.6	23.77	20.73	15.24

It is proposed to run this pump through the system shown in the figure. The pipe is 20-cm-diameter commercial steel ($\varepsilon = 0.046 \text{ mm}$). What flow rate in ft^3/min will result?(use $Q = 0.3 \text{ m}^3/\text{s}$ as a first guess)



- 3- A local ventilation system is used to remove air and contaminants from a pharmaceutical lab. The inner diameter of the duct is $D = 150 \text{ mm}$, its average roughness is 0.15 mm , and its total length is $L = 24.5 \text{ m}$. There are three elbows along the duct, each with a minor loss coefficient of $K_L = 0.21$. Literature from the hood manufacturer lists the hood entry loss coefficient as 3.3 based on duct velocity. When the damper is fully open, its loss coefficient is 1.8 . The minor loss coefficient through the 90° tee is 0.36 . Finally, a one-way valve is installed to prevent contaminants from a second hood from flowing “backward” into the room. The minor loss coefficient of the (open) one-way valve is 6.6 . The performance data of the fan fit a parabolic curve of the form $H_{\text{available}} = H_0 - aQ^2$, where shutoff head $H_0 = 60 \text{ mm}$ of water column, coefficient $a = 2.50 \times 10^{-7} \text{ mm of water column per } (Lpm)^2$, available head $H_{\text{available}}$ is in units of mm of water column, and capacity Q is in units of Lpm of air. Estimate the volume flow rate in Lpm through this ventilation system. (neglect the elevation difference)



- 4- Two identical pumps and three hydraulic resistances are used in a circuit as shown in the following figure. Determine the equivalent Head-Capacity relation for the following circuit.

$$H_p(Q) = -0.0259Q^2 + 59.14$$

$$H_{R1}(Q) = 2.222 \times 10^{-2}Q^2$$

$$H_{R2}(Q) = 3.125 \times 10^{-3}Q^2$$

$$H_{R3}(Q) = 4 \times 10^{-3}Q^2$$

