5.19

5.19 Various types of attachments can be used with the shop vac shown in Video V5.2. Two such attachments are shown in Fig. P5.19 —a nozzle and a brush. The flowrate is 1 ft^3/s. **(a)** Determine the average velocity through the nozzle entrance, V_n. **(b)** Assume the air enters the brush attachment in a radial direction all around the brush with a velocity profile that varies linearly from 0 to V_b along the length of the bristles as shown in the figure. Determine the value of V_b.

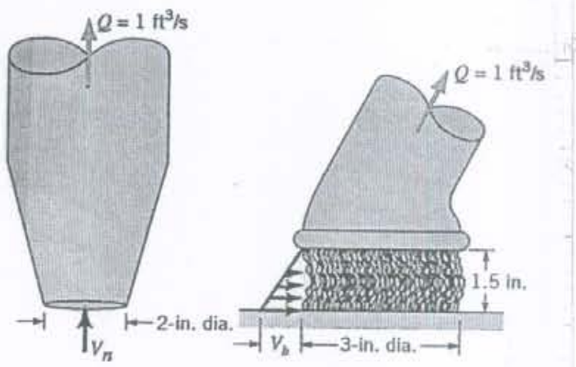

FIGURE P5.19

(a) $Q_1 = Q_2$ where $Q_2 = 1 \frac{ft^3}{s}$

Thus,

$A_1 V_1 = Q_2$ or $V_1 \equiv V_n = \dfrac{1 \frac{ft^3}{s}}{\frac{\pi}{4}\left(\frac{2}{12} ft\right)^2}$

so

$V_n = \underline{\underline{45.8 \frac{ft}{s}}}$

(b) $Q_3 = Q_4$ where $Q_4 = 1 \frac{ft^3}{s}$ and $Q_3 = \overline{V}_3 A_3$ where

$\overline{V}_3$ = average velocity at (3) = $\frac{1}{2} V_b$ and

$A_3 = \pi D_3 h_3$

Thus,

$\frac{1}{2} V_b \left[\pi \left(\frac{3}{12} ft\right)\left(\frac{1.5}{12} ft\right)\right] = 1 \frac{ft^3}{s}$, or

$V_b = \underline{\underline{20.4 \frac{ft}{s}}}$