

60. The volume rate of flow is $R = vA$ where $A = \pi r^2$ and $r = d/2$. Solving for speed, we obtain

$$v = \frac{R}{A} = \frac{R}{\pi(d/2)^2} = \frac{4R}{\pi d^2} .$$

- (a) With $R = 7.0 \times 10^{-3} \text{ m}^3/\text{s}$ and $d = 14 \times 10^{-3} \text{ m}$, our formula yields $v = 45 \text{ m/s}$, which is about 13% of the speed of sound (which we establish by setting up a ratio: v/v_s where $v_s = 343 \text{ m/s}$).
- (b) With the contracted trachea ($d = 5.2 \times 10^{-3} \text{ m}$) we obtain $v = 330 \text{ m/s}$, or 96% of the speed of sound.