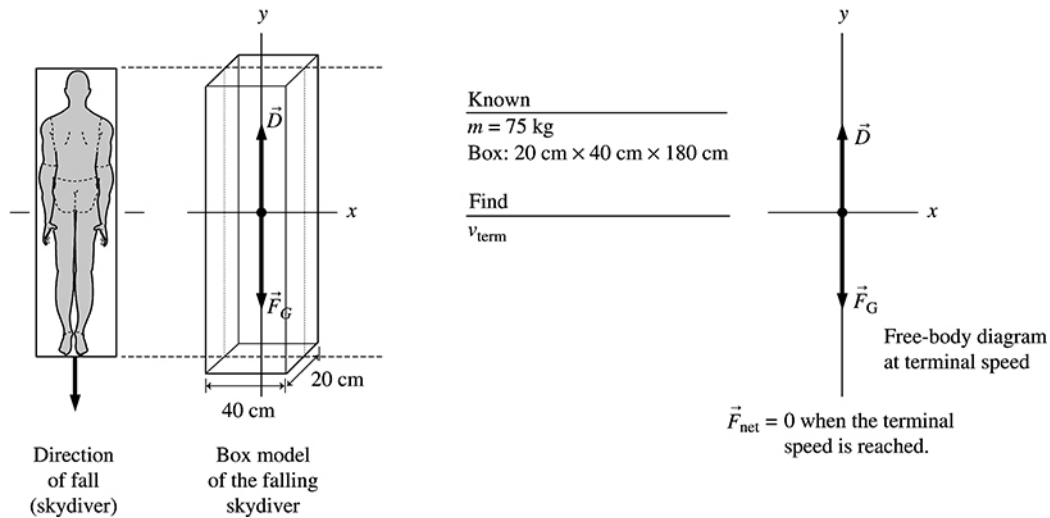


6.25. Model: We assume that the skydiver is shaped like a box and is a particle.

Visualize:

Pictorial representation



The skydiver falls straight down toward the earth's surface, that is, the direction of fall is vertical. Since the skydiver falls feet first, the surface perpendicular to the drag has the cross-sectional area $A = 20 \text{ cm} \times 40 \text{ cm}$. The physical conditions needed to use Equation 6.16 for the drag force are satisfied. The terminal speed corresponds to the situation when the net force acting on the skydiver becomes zero.

Solve: The expression for the magnitude of the drag with v in m/s is

$$D \approx \frac{1}{4} A v^2 = 0.25(0.20 \times 0.40) v^2 \text{ N} = 0.020 v^2 \text{ N}$$

The gravitational force on the skydiver is $F_G = mg = (75 \text{ kg})(9.8 \text{ m/s}^2) = 735 \text{ N}$. The mathematical form of the condition defining dynamical equilibrium for the skydiver and the terminal speed is

$$\begin{aligned} \vec{F}_{\text{net}} &= \vec{F}_G + \vec{D} = 0 \text{ N} \\ \Rightarrow 0.02 v_{\text{term}}^2 \text{ N} - 735 \text{ N} &= 0 \text{ N} \Rightarrow v_{\text{term}} = \sqrt{\frac{735}{0.02}} \approx 192 \text{ m/s} \end{aligned}$$

Assess: The result of the above simplified physical modeling approach and subsequent calculation, even if approximate, shows that the terminal velocity is very high. This result implies that the skydiver will be very badly hurt at landing if the parachute does not open in time.