Problem 2.30

Suppose we wish to approximate the skydiver of Problem 2.29 as a sphere (not a very promising approximation, but nevertheless the kind of approximation physicists sometimes like to make). Given the mass and terminal speed, what should we use for the diameter of the sphere? Does your answer seem reasonable?

Solution

From Problem 2.29, the terminal velocity of a skydiver in a medium with quadratic air resistance is

$$v_{\text{ter}} = \sqrt{\frac{mg}{c}}.$$

For a sphere, by Equation (2.4) on page 44, $c = \gamma D^2$.

$$v_{\text{ter}} = \sqrt{\frac{mg}{\gamma D^2}}$$

$$= \frac{1}{D}\sqrt{\frac{mg}{\gamma}}$$

Solve for D, the sphere diameter.

$$D = \frac{1}{v_{\text{ter}}}\sqrt{\frac{mg}{\gamma}}$$

In Problem 2.29, the skydiver's mass is 70 kg, the terminal velocity is 50 m/s, and $\gamma = 0.25\ \text{N} \cdot \text{s}^2/\text{m}^4$ at STP. Using these data gives a diameter of

$$D = \frac{1}{50}\sqrt{\frac{(70)(9.81)}{0.25}}\ \text{m}$$

$$\approx 1.05\ \text{m}.$$

This is roughly 3 feet, which is reasonable for a person in the fetal position.