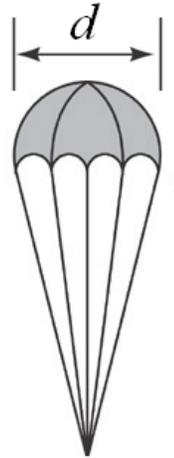


November 7, 2016

NAME _____

Quiz 11. Flow characteristics for a 30-ft-diameter prototype parachute are to be determined by tests of a 1-ft-diameter model parachute in a water tunnel. Some data collected with the model parachute indicate a drag of 17 lb when the water velocity is 4 ft/s. (a) Use the dimensional analysis and find a suitable pi parameter for this problem. (b) Use the model data to predict the drag on the prototype parachute falling through the air at 10 ft/s. Assume the drag to be a function of the velocity, V , the fluid density, ρ , and the parachute diameter, d . ($\rho_{\text{water}} = 1.94 \text{ slugs/ft}^3$ and $\rho_{\text{air}} = 2.38 \times 10^{-3} \text{ slugs/ft}^3$)



Note: Attendance (+2 points), format (+1 point)

Solution:

(a) Pi parameter

$$D = f(V, \rho, d)$$

Where, $D \doteq F$, $V \doteq LT^{-1}$, $\rho \doteq FL^{-3}$, $d = L$, and $4 - 3 = 1$ pi parameter.

Thus,

$$\Pi = DV^a \rho^b d^c = (F)(LT^{-1})^a (FL^{-3})^b (L)^c = F^0 L^0 T^0$$

or

$$\Pi = \frac{D}{\rho V^2 d^2} \quad (+4 \text{ points})$$

(b) For similarity between model and prototype,

$$\frac{D}{\rho V^2 d^2} = \frac{D_m}{\rho_m V_m^2 d_m^2} \quad (+2 \text{ points})$$

So that

$$D = \left(\frac{\rho}{\rho_m} \right) \left(\frac{V}{V_m} \right)^2 \left(\frac{d}{d_m} \right)^2 D_m$$

$$= \left(\frac{2.38 \times 10^{-3} \frac{\text{slugs}}{\text{ft}^3}}{1.94 \frac{\text{slugs}}{\text{ft}^3}} \right) \left(\frac{10 \frac{\text{ft}}{\text{s}}}{4 \frac{\text{ft}}{\text{s}}} \right)^2 \left(\frac{30 \text{ ft}}{1 \text{ ft}} \right)^2 (17 \text{ lb}) = 117 \text{ lb} \quad (+1 \text{ points})$$