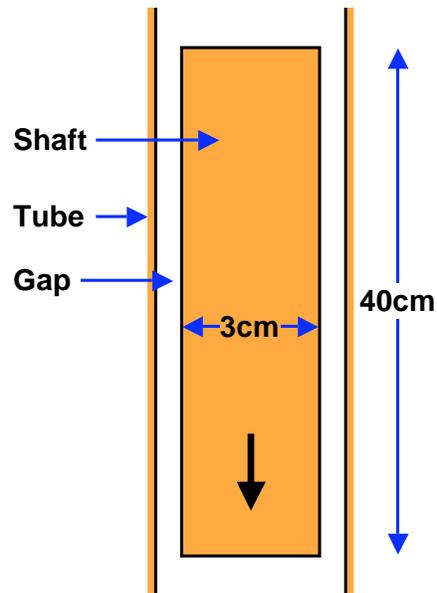


**Problem 109B**

A steel ( $7850 \text{ kg/m}^3$ ) shaft which is  $3 \text{ cm}$  in diameter and  $40 \text{ cm}$  long falls under its own weight inside a vertical open tube whose internal diameter is  $3.02 \text{ cm}$ :



The small gap between the shaft and the tube (assumed uniform) is filled with oil whose specific gravity is  $0.9$  and whose kinematic viscosity is  $0.005 \text{ m}^2/\text{s}$ . What is the terminal velocity of the shaft? Neglect any complications associated with the ends of the shaft.