

Exercise 1.89

A 25.0-cm long cylindrical glass tube, sealed at one end, is filled with ethanol. The mass of ethanol needed to fill the tube is found to be 45.23 g. The density of ethanol is 0.789 g/mL. Calculate the inner diameter of the tube in centimeters.

Solution

The density ρ is mass m divided by volume V .

$$\rho = \frac{m}{V}$$

The volume of a cylinder is $\pi r^2 h$.

$$\rho = \frac{m}{\pi r^2 h}$$

The radius is half the diameter.

$$\rho = \frac{m}{\pi \left(\frac{d}{2}\right)^2 h} = \frac{m}{\pi \left(\frac{d^2}{4}\right) h} = \frac{4m}{\pi d^2 h}$$

Solve for d .

$$\begin{aligned}d^2 &= \frac{4m}{\pi \rho h} \\d &= \sqrt{\frac{4m}{\pi \rho h}} \\&= \sqrt{\frac{4(45.23 \text{ g})}{\pi \left(0.789 \frac{\text{g}}{\text{mL}} \times \frac{1 \text{ mL}}{1 \text{ cm}^3}\right) (25.0 \text{ cm})}} \\&\approx 1.71 \text{ cm}\end{aligned}$$