

Problem 22

Gold, which has a density of 19.32 g/cm^3 , is the most ductile metal and can be pressed into a thin leaf or drawn out into a long fiber. (a) If a sample of gold, with a mass of 27.63 g , is pressed into a leaf of $1.000 \mu\text{m}$ thickness, what is the area of the leaf? (b) If, instead, the gold is drawn out into a cylindrical fiber of radius $2.500 \mu\text{m}$, what is the length of the fiber?

Solution

Start with the given mass of gold and use conversion factors to obtain the volume of the leaf.

$$27.63 \text{ g} \times \frac{1 \text{ cm}^3}{19.32 \text{ g}} \times \left(\frac{1 \text{ m}}{100 \text{ cm}} \right)^3 \approx 1.430 \times 10^{-6} \text{ m}^3$$

Part (a)

Volume is area times thickness, so

$$\text{Area} = \frac{\text{Volume}}{\text{Thickness}} \approx \frac{1.430 \times 10^{-6} \text{ m}^3}{1.000 \mu\text{m} \times \frac{1 \text{ m}}{10^6 \mu\text{m}}} = 1.430 \text{ m}^2.$$

Part (b)

The volume of a cylinder is $V = \pi r^2 l$, so

$$l = \frac{V}{\pi r^2} \approx \frac{1.430 \times 10^{-6} \text{ m}^3}{\pi \left(2.500 \mu\text{m} \times \frac{1 \text{ m}}{10^6 \mu\text{m}} \right)^2} \approx 7.284 \times 10^4 \text{ m}.$$