

20. To organize the calculation, we introduce the notion of density (which the students have probably seen in other courses):

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

- (a) We take the volume of the leaf to be its area A multiplied by its thickness z . With density $\rho = 19.32 \text{ g/cm}^3$ and mass $m = 27.63 \text{ g}$, the volume of the leaf is found to be

$$V = \frac{m}{\rho} = 1.430 \text{ cm}^3 .$$

We convert the volume to SI units:

$$(1.430 \text{ cm}^3) \left(\frac{1 \text{ m}}{100 \text{ cm}} \right)^3 = 1.430 \times 10^{-6} \text{ m}^3 .$$

And since $V = A z$ where $z = 1 \times 10^{-6} \text{ m}$ (metric prefixes can be found in Table 1-2), we obtain

$$A = \frac{1.430 \times 10^{-6} \text{ m}^3}{1 \times 10^{-6} \text{ m}} = 1.430 \text{ m}^2 .$$

- (b) The volume of a cylinder of length ℓ is $V = A\ell$ where the cross-section area is that of a circle: $A = \pi r^2$. Therefore, with $r = 2.500 \times 10^{-6} \text{ m}$ and $V = 1.430 \times 10^{-6} \text{ m}^3$, we obtain

$$\ell = \frac{V}{\pi r^2} = 7.284 \times 10^4 \text{ m} .$$