18.2 For this problem, given that an aluminum wire 10 m long must experience a voltage drop of less than 1.0 V when a current of 5 A passes through it, we are to compute the minimum diameter of the wire. Combining Equations 18.3 and 18.4 and solving for the cross-sectional area A leads to

$$A = \frac{Il}{V\sigma}$$

From Table 18.1, for aluminum $\sigma = 3.8 \times 10^7\ (\Omega\text{-m})^{-1}$. Furthermore, inasmuch as $A = \pi\left(\frac{d}{2}\right)^2$ for a cylindrical wire, then

$$\pi\left(\frac{d}{2}\right)^2 = \frac{Il}{V\sigma}$$

or

$$d = \sqrt{\frac{4Il}{\pi V\sigma}}$$

When values for the several parameters given in the problem statement are incorporated into this expression, we get

$$d = \sqrt{\frac{(4)(5\text{ A})(10\text{ m})}{(\pi)(1.0\text{ V})\left[3.8\ \times 10^7\ (\Omega - \text{m})^{-1}\right]}}$$

$$= 1.3 \times 10^{-3}\text{ m} = 1.3\text{ mm}$$