

18.5 (a) In order to compute the resistance of this aluminum wire it is necessary to employ Equations 18.2 and 18.4. Solving for the resistance in terms of the conductivity,

$$R = \frac{\rho l}{A} = \frac{l}{\sigma A} = \frac{l}{\sigma \pi \left(\frac{d}{2}\right)^2}$$

From Table 18.1, the conductivity of aluminum is $3.8 \times 10^7 (\Omega\text{-m})^{-1}$, and

$$\begin{aligned} R &= \frac{l}{\sigma \pi \left(\frac{d}{2}\right)^2} = \frac{5 \text{ m}}{\left[3.8 \times 10^7 (\Omega\text{-m})^{-1}\right] \left(\pi \left(\frac{5 \times 10^{-3} \text{ m}}{2}\right)^2\right)} \\ &= 6.7 \times 10^{-3} \Omega \end{aligned}$$

(b) If $V = 0.04 \text{ V}$ then, from Equation 18.1

$$I = \frac{V}{R} = \frac{0.04 \text{ V}}{6.7 \times 10^{-3} \Omega} = 6.0 \text{ A}$$

(c) The current density is just

$$J = \frac{I}{A} = \frac{I}{\pi \left(\frac{d}{2}\right)^2} = \frac{6.0 \text{ A}}{\pi \left(\frac{5 \times 10^{-3} \text{ m}}{2}\right)^2} = 3.06 \times 10^5 \text{ A/m}^2$$

(d) The electric field is just

$$E = \frac{V}{l} = \frac{0.04 \text{ V}}{5 \text{ m}} = 8.0 \times 10^{-3} \text{ V/m}$$