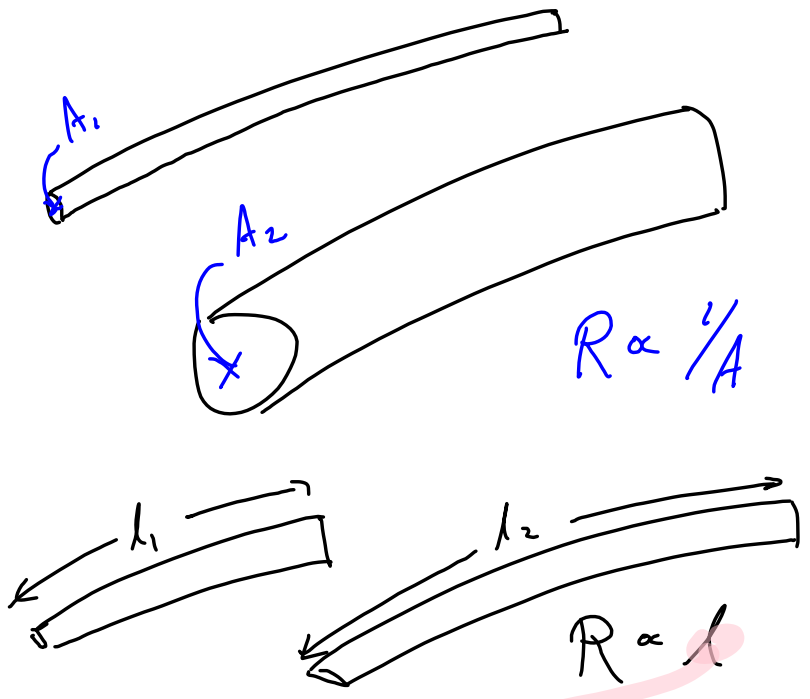


17.5 Resistivity



$$R = \rho l / A \quad \rho$$

$\rho =$ resistivity = a property of the conducting material

Table 17.1, p 576, has some resistivities.

$$[\rho] = \Omega \cdot m$$

17.6 Temperature Variation of Resistance

For most substances, there is at least some temperature range where the variation of resistivity is proportional to the temperature change:

$$\Delta \rho \propto \Delta T$$

or

$$\Delta \rho = \rho_0 \alpha \Delta T$$

$$\Delta R = R_0 \alpha \Delta T$$

$$R = R_0 [1 + \alpha \Delta T]$$

ρ_0 is the resistivity at a reference temp., T_0

$$\Delta \rho = \rho - \rho_0 ; \Delta T = T - T_0$$

α = "temperature coefficient of resistivity"

$$[\alpha] = \frac{1}{\text{temp.}} = \frac{1}{^\circ\text{C}}, \text{ } ^\circ\text{C}^{-1}$$

Example: The nichrome wire in a space heater has a resistance of 14.4 ohms at 800 °C. What is its resistance at room temp. (20.0°C)?

For nichrome, $\alpha = 0.4 \times 10^{-3} / ^\circ\text{C}$

$$\left(\begin{array}{l} \Delta R = R_0 \alpha \Delta T \\ R - R_0 \\ 14.4 \Omega \end{array} \right) \quad T - T_0 = 800^\circ\text{C} - 20.0^\circ = 780^\circ\text{C}$$

$$R - R_0 = R_0 (\alpha \Delta T)$$

$$R = R_0 + R_0 (\alpha \Delta T)$$

$$\rightarrow R = R_0 (1 + \alpha \Delta T)$$

$$R_0 = \frac{R}{1 + \alpha \Delta T} = \frac{14.4 \Omega}{1 + (0.4 \times 10^{-3} / ^\circ\text{C})(780^\circ\text{C})}$$

$$= \frac{14.4 \Omega}{1.312}$$

$$1 + \frac{.312}{1.312} = 1.312$$

$$R_0 = 11 \Omega$$

If the diameter of the wire is 0.80 mm, how long is the wire?

$$R = \rho l / A$$

$$\text{@ } 20^\circ\text{C} : R = 11 \Omega ; \rho = 150 \times 10^{-8} \Omega \cdot \text{m}$$

$$A = \pi r^2 = \pi (0.0004 \text{ m})^2 = 5.027 \times 10^{-7} \text{ m}^2$$

$$R = \rho l / A \left] \frac{A}{\rho} \rightarrow l = \frac{RA}{\rho}$$

$$l = \frac{(11 \Omega)(5.027 \times 10^{-7} \text{ m}^2)}{(150 \times 10^{-8} \Omega \cdot \text{m})} = 3.68 \text{ m}$$

$$= 3.7 \text{ m}$$

$$k_e = 8.99 \times 10^9 \text{ N}\cdot\text{m}^2/\text{C}^2 ; \quad \epsilon_0 = 1/4\pi k_e$$

$$E = k_e q / r^2 ; \quad \vec{F} = q \vec{E}$$

$$\Phi_E = EA \cos \theta = Q_{in} / \epsilon_0$$

$$\Delta V = \Delta PE / q_0 ; \quad \Delta V = k_e q / r ; \quad \Delta V = -E_x \Delta x$$

$$C = Q / \Delta V ; \quad C = \frac{\kappa \epsilon_0 A}{d} ; \quad \frac{1}{C_s} = \frac{1}{C_1} + \frac{1}{C_2}$$

$$PE = \frac{1}{2} C (\Delta V)^2 ; \quad R = \rho L / A ; \quad R = R_0 [1 + \alpha \Delta T]$$

17.8 Electrical Energy & Power

$$P_{\text{power}} = P = \frac{\Delta W}{\Delta t} = \left(\frac{Q \cdot \Delta V}{\Delta t} \right)$$

$$P = I \cdot \Delta V \quad \text{for any circuit element}$$

With $R = \Delta V / I \rightarrow \Delta V = R I$
or $I = \Delta V / R$

$$P = R I^2 \leftrightarrow P = (\Delta V)^2 / R$$

Example: What are the resistance of and the current through a "100 watt" light bulb? The "100 W" would be at 120 V.

$$P = I \Delta V \rightarrow I = \frac{P}{\Delta V} = \frac{100 \text{ W}}{120 \text{ V}} = 0.833 \text{ A}$$

$$R = \frac{\Delta V}{I} = \frac{120 \text{ V}}{0.833 \text{ A}} = 144 \Omega$$

HW, pp 588-589
P 11, 15, 17, 23, 28, 31, 33

