11. (a) The current resulting from this nonuniform current density is

$$i=\int_{\text{cylinder}} J_a\,dA=\frac{J_0}{R}\int_0^R r\cdot 2\pi r dr=\frac{2}{3}\pi R^2 J_0=\frac{2}{3}\pi(3.40\times10^{-3}\text{m})^2(5.50\times10^4\,\text{A/m}^2)\,.$$
$$=1.33 \text{ A.}$$

(b) In this case,

$$i=\int_{\text{cylinder}} J_b\,dA=\int_0^R J_0\left(1-\frac{r}{R}\right)2\pi r dr=\frac{1}{3}\pi R^2 J_0=\frac{1}{3}\pi(3.40\times10^{-3}\text{m})^2(5.50\times10^4\,\text{A/m}^2)$$
$$=0.666 \text{ A.}$$

(c) The result is different from that in part (a) because J_b is higher near the center of the cylinder (where the area is smaller for the same radial interval) and lower outward, resulting in a lower average current density over the cross section and consequently a lower current than that in part (a). So, J_a has its maximum value near the surface of the wire.

17. We find the conductivity of Nichrome (the reciprocal of its resistivity) as follows:

$$\sigma=\frac{1}{\rho}=\frac{L}{RA}=\frac{L}{(V/i)A}=\frac{Li}{VA}=\frac{(1.0\text{ m})(4.0\text{ A})}{(2.0\text{ V})(1.0\times10^{-6}\text{ m}^2)}=2.0\times10^6\,/\,\Omega\cdot\text{m.}$$

18. (a) $i = V/R = 23.0 \text{ V}/15.0 \times 10^{-3}\ \Omega = 1.53 \times 10^3$ A.

(b) The cross-sectional area is $A=\pi r^2=\frac{1}{4}\pi D^2$. Thus, the magnitude of the current density vector is

$$J=\frac{i}{A}=\frac{4i}{\pi D^2}=\frac{4\left(1.53\times10^{-3}\text{ A}\right)}{\pi\left(6.00\times10^{-3}\text{ m}\right)^2}=5.41\times10^7\text{ A/m}^2.$$

(c) The resistivity is

$$\rho=\frac{RA}{L}=\frac{(15.0\times10^{-3}\Omega)\pi(6.00\times10^{-3}\text{ m})^2}{4(4.00\text{ m})}=10.6\times10^{-8}\ \Omega\cdot\text{m.}$$

(d) The material is platinum.

23. We use $J = E/\rho$, where E is the magnitude of the (uniform) electric field in the wire, J is the magnitude of the current density, and ρ is the resistivity of the material. The electric field is given by $E = V/L$, where V is the potential difference along the wire and L is the length of the wire. Thus $J = V/L\rho$ and

$$\rho = \frac{V}{LJ} = \frac{115 \text{ V}}{(10 \text{ m})(1.4 \times 10^4 \text{ A/m}^2)} = 8.2 \times 10^{-4} \,\Omega \cdot \text{m}.$$

25. Since the mass density of the material does not change, the volume remains the same. If L_0 is the original length, L is the new length, A_0 is the original cross-sectional area, and A is the new cross-sectional area, then $L_0A_0 = LA$ and $A = L_0A_0/L = L_0A_0/3L_0 = A_0/3$. The new resistance is

$$R = \frac{\rho L}{A} = \frac{\rho 3L_0}{A_0/3} = 9\frac{\rho L_0}{A_0} = 9R_0,$$

where R_0 is the original resistance. Thus, $R = 9(6.0\ \Omega) = 54\ \Omega$.

31. (a) The current in each strand is $i = 0.750$ A/125 $= 6.00 \times 10^{-3}$ A.

(b) The potential difference is $V = iR = (6.00 \times 10^{-3}\text{ A})\ (2.65 \times 10^{-6}\ \Omega) = 1.59 \times 10^{-8}$ V.

(c) The resistance is $R_{\text{total}} = 2.65 \times 10^{-6}\ \Omega/125 = 2.12 \times 10^{-8}\ \Omega$.

45. (a) The power dissipated, the current in the heater, and the potential difference across the heater are related by $P = iV$. Therefore,

$$i = \frac{P}{V} = \frac{1250 \text{ W}}{115 \text{ V}} = 10.9 \text{ A}.$$

(b) Ohm's law states $V = iR$, where R is the resistance of the heater. Thus,

$$R = \frac{V}{i} = \frac{115 \text{ V}}{10.9 \text{ A}} = 10.6\ \Omega.$$

(c) The thermal energy E generated by the heater in time $t = 1.0$ h $= 3600$ s is

$$E = Pt = (1250\,\text{W})(3600\,\text{s}) = 4.50 \times 10^6 \text{ J}.$$

46. (a) Using Table 26-1 and Eq. 26-10 (or Eq. 26-11), we have

$$|\vec{E}| = \rho |\vec{J}| = (1.69 \times 10^{-8}\,\Omega \cdot \text{m})\left(\frac{2.00\,\text{A}}{2.00 \times 10^{-6}\,\text{m}^2}\right) = 1.69 \times 10^{-2} \text{ V/m}.$$

(b) Using $L = 4.0$ m, the resistance is found from Eq. 26-16:

$$R = \rho L/A = 0.0338\ \Omega.$$

The rate of thermal energy generation is found from Eq. 26-27:

$$P = i^2 R = (2.00\text{ A})^2(0.0338\ \Omega) = 0.135\text{ W}.$$

Assuming a steady rate, the amount of thermal energy generated in 30 minutes is found to be $(0.135\text{ J/s})(30 \times 60\text{ s}) = 2.43 \times 10^2$ J.

68. We use Eq. 26-17: $\rho - \rho_0 = \rho\alpha(T - T_0)$, and solve for T:

$$T = T_0 + \frac{1}{\alpha}\left(\frac{\rho}{\rho_0} - 1\right) = 20°\text{C} + \frac{1}{4.3\times10^{-3}/\text{K}}\left(\frac{58\,\Omega}{50\,\Omega} - 1\right) = 57°\text{C}.$$

We are assuming that $\rho/\rho_0 = R/R_0$.