P27.11 We use $I = nqAv_d$ n is the number of charge carriers per unit volume, and is identical to the number of atoms per unit volume. We assume a contribution of 1 free electron per atom in the relationship above. For aluminum, which has a molar mass of 27, we know that Avogadro's number of atoms, N_A, has a mass of 27.0 g. Thus, the mass per atom is

$$\frac{27.0\text{ g}}{N_A} = \frac{27.0\text{ g}}{6.02\times10^{23}} = 4.49\times10^{-23}\text{ g/atom}.$$

Thus, $$n = \frac{\text{density of aluminum}}{\text{mass per atom}} = \frac{2.70\text{ g/cm}^3}{4.49\times10^{-23}\text{ g/atom}}$$

$$n = 6.02\times10^{22}\text{ atoms/cm}^3 = 6.02\times10^{28}\text{ atoms/m}^3.$$

Therefore,
$$v_d = \frac{I}{nqA} = \frac{5.00\text{ A}}{\left(6.02\times10^{28}\text{ m}^{-3}\right)\left(1.60\times10^{-19}\text{ C}\right)\left(4.00\times10^{-6}\text{ m}^2\right)} = 1.30\times10^{-4}\text{ m/s}$$

or, $$v_d = \boxed{0.130\text{ mm/s}}.$$

P27.14 (a) Applying its definition, we find the resistance of the rod,

$$R = \frac{\Delta V}{I} = \frac{15.0\text{ V}}{4.00\times10^{-3}\text{ A}} = 3\,750\ \Omega = \boxed{3.75\text{ k}\Omega}.$$

(b) The length of the rod is determined from the definition of resistivity: $R = \frac{\rho\ell}{A}$. Solving for ℓ and substituting numerical values for R, A, and the value of ρ given for carbon in Table 27.1, we obtain

$$\ell = \frac{RA}{\rho} = \frac{\left(3.75\times10^3\ \Omega\right)\left(5.00\times10^{-6}\text{ m}^2\right)}{\left(3.50\times10^{-5}\ \Omega\cdot\text{m}\right)} = \boxed{536\text{ m}}.$$

P27.16 $$J = \frac{I}{\pi r^2} = \sigma E = \frac{3.00\text{ A}}{\pi(0.012\,0\text{ m})^2} = \sigma(120\text{ N/C})$$

$$\sigma = 55.3(\Omega\cdot\text{m})^{-1} \qquad \rho = \frac{1}{\sigma} = \boxed{0.018\,1\ \Omega\cdot\text{m}}$$

P27.42

$$R=\frac{(110\text{ V})^2}{(500\text{ W})}=24.2\ \Omega$$

(a) $R=\frac{\rho}{A}\ell$ so $\ell=\frac{RA}{\rho}=\frac{(24.2\ \Omega)\pi\left(2.50\times10^{-4}\text{ m}\right)^2}{1.50\times10^{-6}\ \Omega\cdot\text{m}}=\boxed{3.17\text{ m}}$

(b) $R=R_0[1+\alpha\Delta T]=24.2\ \Omega\left[1+\left(0.400\times10^{-3}\right)(1\,180)\right]=35.6\ \Omega$

P27.43 $R=\frac{\rho\ell}{A}=\frac{\left(1.50\times10^{-6}\ \Omega\cdot\text{m}\right)25.0\text{ m}}{\pi\left(0.200\times10^{-3}\text{ m}\right)^2}=298\ \Omega$

$\Delta V=IR=(0.500\text{ A})(298\ \Omega)=149\text{ V}$

(a) $E=\frac{\Delta V}{\ell}=\frac{149\text{ V}}{25.0\text{ m}}=\boxed{5.97\text{ V/m}}$

(b)

(c) $R=R_0[1+\alpha(T-T_0)]=298\ \Omega\left[1+\left(0.400\times10^{-3}/°\text{C}\right)320°\text{C}\right]=337\ \Omega$

P27.44 (a) $\Delta U=q(\Delta V)=It(\Delta V)=(55.0\text{ A}\cdot\text{h})(12.0\text{ V})\left(\frac{1\text{ C}}{1\text{ A}\cdot\text{s}}\right)\left(\frac{1\text{ J}}{1\text{ V}\cdot\text{C}}\right)\left(\frac{1\text{ W}\cdot\text{s}}{1\text{ J}}\right)=660\text{ W}\cdot\text{h}=\boxed{0.660\text{ kWh}}$

(b) $\text{Cost}=0.660\text{ kWh}\left(\frac{\$0.060\,0}{1\text{ kWh}}\right)=\boxed{3.96¢}$