P27.6 $q = 4t^3 + 5t + 6$

$$A = \left(2.00\ \text{cm}^2\right)\left(\frac{1.00\ \text{m}}{100\ \text{cm}}\right)^2 = 2.00 \times 10^{-4}\ \text{m}^2$$

(a) $$I(1.00\ \text{s}) = \left.\frac{dq}{dt}\right|_{t=1.00\ \text{s}} = \left.\left(12t^2 + 5\right)\right|_{t=1.00\ \text{s}} = \boxed{17.0\ \text{A}}$$

(b) $$J = \frac{I}{A} = \frac{17.0\ \text{A}}{2.00 \times 10^{-4}\ \text{m}^2} = \boxed{85.0\ \text{kA/m}^2}$$

P27.13 $$I = \frac{\Delta V}{R} = \frac{120\ \text{V}}{240\ \Omega} = 0.500\ \text{A} = \boxed{500\ \text{mA}}$$

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

$$R = \frac{\Delta V}{I} = \frac{15.0\ \text{V}}{4.00 \times 10^{-3}\ \text{A}} = 3\,750\ \Omega = \boxed{3.75\ \text{k}\Omega}.$$

(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

$$\ell = \frac{RA}{\rho} = \frac{\left(3.75 \times 10^3\ \Omega\right)\left(5.00 \times 10^{-6}\ \text{m}^2\right)}{\left(3.50 \times 10^{-5}\ \Omega \cdot \text{m}\right)} = \boxed{536\ \text{m}}.$$

P27.17 (a) Given $M = \rho_d V = \rho_d A\ell$ where ρ_d = mass density,

we obtain: $A = \frac{M}{\rho_d \ell}$. Taking ρ_r = resistivity, $R = \frac{\rho_r \ell}{A} = \frac{\rho_r \ell}{M/\rho_d \ell} = \frac{\rho_r \rho_d \ell^2}{M}$.

Thus, $$\ell = \sqrt{\frac{MR}{\rho_r \rho_d}} = \sqrt{\frac{\left(1.00 \times 10^{-3}\right)(0.500)}{\left(1.70 \times 10^{-8}\right)\left(8.92 \times 10^3\right)}}$$ $\ell = \boxed{1.82\ \text{m}}$.

(b) $V = \frac{M}{\rho_d}$, or $\pi r^2 \ell = \frac{M}{\rho_d}$.

Thus, $$r = \sqrt{\frac{M}{\pi \rho_d \ell}} = \sqrt{\frac{1.00 \times 10^{-3}}{\pi\left(8.92 \times 10^3\right)(1.82)}}$$ $r = 1.40 \times 10^{-4}\ \text{m}$.

The diameter is twice this distance: diameter $= \boxed{280\ \mu\text{m}}$.

P27.21 Originally, $R = \dfrac{\rho\ell}{A}$. Finally, $R_f = \dfrac{\rho(\ell/3)}{3A} = \dfrac{\rho\ell}{9A} = \boxed{\dfrac{R}{9}}$.

P27.22
$$\frac{\rho_{\text{Al}}\ell}{\pi(r_{\text{Al}})^2} = \frac{\rho_{\text{Cu}}\ell}{\pi(r_{\text{Cu}})^2}$$
$$\frac{r_{\text{Al}}}{r_{\text{Cu}}} = \sqrt{\frac{\rho_{\text{Al}}}{\rho_{\text{Cu}}}} = \sqrt{\frac{2.82\times 10^{-8}}{1.70\times 10^{-8}}} = \boxed{1.29}$$

P27.24
$$R = \frac{\rho_1\ell_1}{A_1} + \frac{\rho_2\ell_2}{A_2} = \frac{\rho_1\ell_1 + \rho_2\ell_2}{d^2}$$
$$R = \frac{(4.00\times 10^{-3}\ \Omega\cdot\text{m})(0.250\ \text{m}) + (6.00\times 10^{-3}\ \Omega\cdot\text{m})(0.400\ \text{m})}{(3.00\times 10^{-3}\ \text{m})^2} = \boxed{378\ \Omega}$$