Solutions
Chapter 5

Problem 1

Part a

Charge is

$$q = it = 2.00 \times 4.00 \times 60 = 480 \text{ C}$$

Part b

Number of electrons is

$$n = \frac{q}{1.60 \times 10^{-19}} = 3.00 \times 10^{21}$$

Problem 2

Current is

$$i = JA = J\pi(d/2)^2$$

where d is the diameter of the wire. So

$$d = 2\sqrt{\frac{i}{\pi J}} = 2\sqrt{\frac{2.00}{500\pi}} = 7.14 \times 10^{-2} \text{ cm}$$

Problem 3

$$R = \frac{\rho L}{A} = \frac{3.00 \times 10^{-7} \times 200}{50.0 \times 10^{-4}} = 1.20 \times 10^{-2} \ \Omega$$

Problem 4

Part a

$$i = \frac{V}{R} = \frac{25}{41.8 \times 10^{-3}} = 598 \text{ A}$$

Part b

$$J = \frac{i}{A} = \frac{598}{\pi(2 \times 10^{-3})^2} = 4.76 \times 10^7 \text{ A/m}^2$$

Part c

$$\rho = \frac{RA}{L} = 5.25 \times 10^{-8} \ \Omega\text{m}$$

Hence, the material is tungsten.

Problem 5

Let the initial length of the wire be L and its initial cross-sectional area be A. Then the initial resistance is

$$R = \frac{\rho L}{A}$$

If the final length is L' and the final cross-sectional area is A', then the final resistance is

$$R' = \frac{\rho L'}{A'}$$

As the density does not change, the volume does not change. So

$$LA = L'A'$$

and hence,

$$A' = \frac{LA}{L'}$$

But $L' = 2L$. So

$$A' = \frac{LA}{2L} = \frac{A}{2}$$

This gives

$$R' = \frac{\rho L'}{A'} = \frac{\rho \times 2L}{A/2} = 4\frac{\rho L}{A} = 4R$$

Problem 6

The current is

$$i = \frac{P}{V}$$

The charge is

$$q = it = \frac{Pt}{V} = \frac{0.50 \times 12 \times 60 \times 60}{9} = 2400 \text{ C}$$

Problem 7

Part a

Energy used in the month of June (in Watt.hour=Wh)

$$U = Pt = 100 \times 30 \times 24 \text{ Wh} = 72000 \text{ Wh} = 72 \text{ kWh}$$

Hence,

$$\text{Cost} = 72 \times \$0.10 = \$7.20$$

Part b

As $i = P/V$,

$$R = \frac{V}{i} = \frac{V^2}{P} = \frac{120^2}{100} = 144 \ \Omega$$

Part c

$$i = \frac{P}{V} = \frac{100}{120} = 0.83 \text{ A}$$