Chapter 27

Problem 1

Part a

Charge is

\[ q = it = 5 \times 4 \times 60 = 1200 \text{ C} \]

Part b

Number of electrons is

\[ n = \frac{q}{1.60 \times 10^{-19}} = 7.5 \times 10^{21} \]

Problem 7

Current is

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

where \( d \) is the diameter of the wire. So

\[ d = 2\sqrt{\frac{i}{\pi J}} = 2\sqrt{\frac{0.50}{440\pi}} = 3.8 \times 10^{-2} \text{ cm} \]

Problem 14

\[ R = \frac{\rho L}{A} = \frac{3 \times 10^{-7} \times 10 \times 10^3}{56 \times 10^{-4}} = 0.536 \Omega \]

Problem 16

Part a

\[ i = \frac{V}{R} = \frac{23}{15 \times 10^{-3}} = 1530 \text{ A} \]
Part b

\[ J = \frac{i}{A} = \frac{1530}{\pi (3 \times 10^{-3})^2} = 5.41 \times 10^7 \text{ A/m}^2 \]

Part c

\[ \rho = \frac{RA}{L} = 1.06 \times 10^{-7} \text{ \Omega m} \]

Hence, the material is platinum.

Problem 19

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 \( L' = 3L \). So

\[ A' = \frac{LA}{3L} = \frac{A}{3} \]

This gives

\[ R' = \frac{\rho L'}{A'} = \frac{\rho \times 3L}{A/3} = 9 \frac{\rho L}{A} = 9R = 54 \text{ \Omega} \]

Problem 32

The current is

\[ i = \frac{P}{V} = \frac{7}{9} = 0.78 \text{ A} \]

The charge is

\[ q = it = 0.78 \times 5 \times 60 \times 60 = 14000 \text{ C} \]
Problem 40

Part a

Energy used in 1 month is

\[ U = Pt = 100 \times 31 \times 24 \text{ Wh} = 74.4 \text{ kWh} \]

Hence,

\[ \text{Cost} = 74.4 \times 6 = 446 \text{ cents} = \$4.46 \]

Part b

As \( i = P/V \),

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

Part c

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

Part d

Resistance is lower when turned off as the filament is colder.