• Chapter 1:

1.6, 1.7, 1.9, 1.11, 1.17

1.25, 1.32, 1.38, 1.42, 1.43

P1.6 (a) A conductor is analogous to a frictionless pipe.
(b) An open switch is analogous to a closed valve.
(c) A resistance is analogous to a constriction in a pipe or to a pipe with friction.
(d) A battery is analogous to a pump.

P1.7* The reference direction for i_{ab} points from *a* to *b*. Because i_{ab} has a negative value, the current is equivalent to positive charge moving opposite to the reference direction. Finally, since electrons have negative charge, they are moving in the reference direction (i.e., from *a* to *b*).
For a constant (dc) current, charge equals current times the time interval. Thus, $Q = (3\ A) \times (3\ s) = 9\ C$.

P1.9* $$Q = \int_0^\infty i(t)dt = \int_0^\infty 2e^{-t}dt = -2e^{-t} \Big|_0^\infty = 2 \text{ coulombs}$$

P1.11* $Q = \text{current} \times \text{time} = (10 \text{ amperes}) \times (36{,}000 \text{ seconds}) = 3.6 \times 10^5 \text{ coulombs}$
$\text{Energy} = QV = (3.6 \times 10^5) \times (12.6) = 4.536 \times 10^6 \text{ joules}$

P1.17 The number of electrons passing through a cross section of the wire per second is

$$N = \frac{15\sqrt{2}}{1.6 \times 10^{-19}} = 1.326 \times 10^{20} \text{ electrons/second}$$

The volume of copper containing this number of electrons is

$$\text{volume} = \frac{1.326 \times 10^{20}}{10^{29}} = 1.326 \times 10^{-9} \text{ m}^3$$

The cross sectional area of the wire is

$$A = \frac{\pi d^2}{4} = 3.301 \times 10^{-6} \text{ m}^2$$

Finally, the average velocity of the electrons is

$$u = \frac{\text{volume}}{A} = 401.7 \ \mu\text{m/s}$$

P1.25* $$\text{Energy} = \frac{\text{Cost}}{\text{Rate}} = \frac{\$60}{0.12 \ \$/\text{kWh}} = 500 \text{ kWh}$$

$$P = \frac{\text{Energy}}{\text{Time}} = \frac{500 \text{ kWh}}{30 \times 24 \text{ h}} = 694.4 \text{ W} \qquad I = \frac{P}{V} = \frac{694.4}{120} = 5.787 \text{ A}$$

$$\text{Reduction} = \frac{60}{694.4} \times 100\% = 8.64\%$$

P1.32* At the node joining elements A and B, we have $i_a + i_b = 0$. Thus, $i_a = -2$ A. For the node at the top end of element C, we have $i_b + i_c = 3$. Thus, $i_c = 1$ A. Finally, at the top right-hand corner node, we have $3 + i_e = i_d$. Thus, $i_d = 4$ A. Elements A and B are in series.

P1.38 We are given $i_a = 2$ A, $i_c = -3$ A, $i_g = 6$ A, and $i_h = 1$ A. Applying KCL, we find

$$i_b = i_c + i_a = -1 \text{ A} \qquad i_e = i_c + i_h = -2 \text{ A}$$
$$i_d = i_f - i_a = 5 \text{ A} \qquad i_f = i_g + i_h = 7 \text{ A}$$

P1.42* Summing voltages for the lower left-hand loop, we have $-5 + v_a + 10 = 0$, which yields $v_a = -5$ V. Then for the top-most loop, we have $v_c - 15 - v_a = 0$, which yields $v_c = 10$ V. Finally, writing KCL around the outside loop, we have $-5 + v_c + v_b = 0$, which yields $v_b = -5$ V.

P1.43 We are given $v_a = 10$ V, $v_b = -3$ V, $v_f = 12$ V, and $v_h = 5$ V. Applying KVL, we find

$$v_d = v_a + v_b = 7 \text{ V} \qquad v_c = -v_a - v_f - v_h = -27 \text{ V}$$
$$v_e = -v_a - v_c + v_d = 24 \text{ V} \qquad v_g = v_e - v_h = 19 \text{ V}$$