P1.12* $Q = \int_0^{\infty} i(t)dt = \int_0^{\infty} 2e^{-t}dt = -2e^{-t} |_0^{\infty} = 2 \text{ coulombs}$

P1.14* The charge flowing through the battery is

$$Q = (5 \text{ amperes}) \times (24 \times 3600 \text{ seconds}) = 432 \times 10^3 \text{ coulombs}$$

The stored energy is

$$\text{Energy} = QV = (432 \times 10^3) \times (12) = 5.184 \times 10^6 \text{ joules}$$

(a) Equating gravitational potential energy, which is mass times height times the acceleration due to gravity, to the energy stored in the battery and solving for the height, we have

$$h = \frac{\text{Energy}}{mg} = \frac{5.184 \times 10^6}{30 \times 9.8} = 17.6 \text{ km}$$

(b) Equating kinetic energy to stored energy and solving for velocity, we have

$$v = \sqrt{\frac{2 \times \text{Energy}}{m}} = 587.9 \text{ m/s}$$

(c) The energy density of the battery is

$$\frac{5.184 \times 10^6}{30} = 172.8 \times 10^3 \text{ J/kg}$$

which is about 0.384% of the energy density of gasoline.

P1.36* 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.

P1.37* We are given $i_a = 2$ A, $i_b = 3$ A, $i_d = -5$ A, and $i_h = 4$ A. Applying KCL, we find

$$i_c = i_b - i_a = 1 \text{ A} \qquad i_e = i_c + i_h = 5 \text{ A}$$

$$i_f = i_a + i_d = -3 \text{ A} \qquad i_g = i_f - i_h = -7 \text{ A}$$

P1.41* 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.

P1.42* Applying KCL and KVL, we have

$i_c = i_a - i_d = 1$ A $\qquad i_b = -i_a = -2$ A

$v_b = v_d - v_a = -6$ V $\qquad v_c = v_d = 4$ V

The power for each element is

$P_A = -v_a i_a = -20$ W $\qquad P_B = v_b i_b = 12$ W

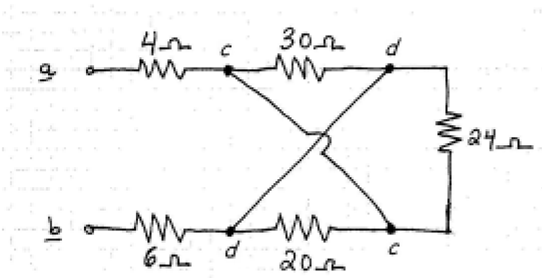
$P_C = v_c i_c = 4$ W $\qquad P_D = v_d i_d = 4$ W

Thus, $P_A + P_B + P_C + P_D = 0$

P2.1* (a) $R_{eq} = 20\,\Omega$ (b) $R_{eq} = 23\,\Omega$

P2.6 (a) $R_{eq} = 22\,\Omega$ (b) $R_{eq} = 20\,\Omega$

(c)



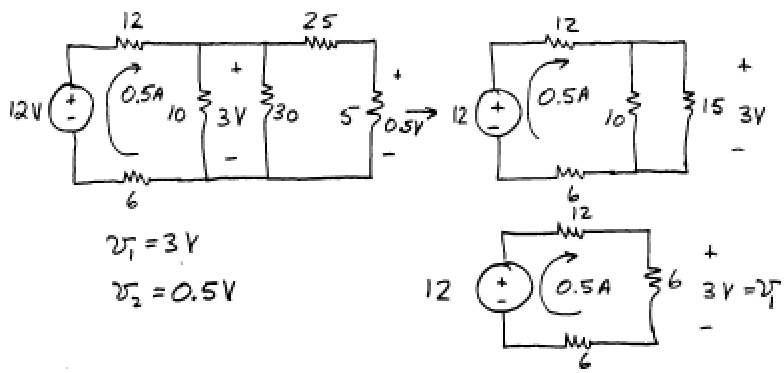
Notice that the points labeled *c* are the same node and that the points labeled *d* are another node. Thus, the 30-Ω, 24-Ω, and 20-Ω resistors are in parallel because they are each connected between nodes *c* and *d*. The equivalent resistance is 18 Ω.

P2.23* $i_1 = \frac{10}{R_{eq}} = \frac{10}{10} = 1\ A$

$v_x = 4\ V$

$i_2 = \frac{v_x}{8} = 0.5\ A$

P2.24* We combine resistances in series and parallel until the circuit becomes an equivalent resistance across the voltage source. Then, we solve the simplified circuit and transfer information back along the chain of equivalents until we have found the desired results.



P2.27 The equivalent resistance seen by the current source is $R_{eq} = 8 + \frac{1}{1/6 + 1/12} + \frac{1}{1/20 + 1/30} = 24\ \Omega$. Then, we have $v = 3R_{eq} = 72$ V, $i_2 = 1$ A, and $i_1 = 1.2$ A.