19. Refer to Figure 21-10 in the book, with all switches closed. The current through each bulb is found from $P = IV$. Since each branch sees the same voltage, the currents are, starting with the left bulb,

I_1 = (60 W)/(110 V) = 0.545 A,
I_2 = (100 W)/(110 V) = 0.909 A,
I_3 = (100 W)/(110 V) = 0.909 A,
I_4 = (40 W)/(110 V) = 0.364 A.

The current through the fuse is the sum of currents in all the parallel branches. Thus,
I_{total} = 0.545 + 0.909 + 0.909 + 0.364 = 2.73 A.

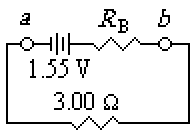
21. Each 75-watt bulb takes a current of I = (75 W)/(120 V) = 0.625 A. Therefore, the number of bulbs that can be on at the same time is (20 A)/(0.625 A per bulb) = 32 bulbs. If a 1200-watt iron is on, the iron takes I = (1200 W)/(120 V) = 10 A. Since half of the 20 A line

current supplies the iron, only 10 amps is available to supply the bulbs and not blow the circuit. A limit of 16 bulbs can be lighted.

24. The figure shows the battery circuit, including a 3.0-ohm resistor. The points "a" and "b" are the real battery terminals, and R_B is the internal resistance of the battery itself. When no current flows, the terminal voltage is indeed 1.55 V. However, when current flows, there is a voltage drop across the internal resistance R_B of the battery. Consequently, the terminal voltage is reduced by this internal loss. We are given that when the battery is hooked across a 3-ohm resistor, only 0.120 A flows. This implies that the terminal voltage is only

    V_{ab} = (0.12 A)(3.0 ohms) = 0.36 V.

    The voltage drop across the internal resistance is 1.55 V – 0.36 V = 1.19 V. This drop at a current of 0.12 A tells us R_B = (1.19 V)/(0.12 A) = 9.9 ohms.



26. If I = 3.0 A, the 80 A-hour battery is "drained" in (80 A-hour)/(3.0 A) = 26.7 hours. The total energy expended may be determined once the power expended by the battery is known. But

    $P = IV$ = (3.0 A)(12.0 V) = 36 watts = 36 Joules/s.
    Energy expended = (36 J/s)(27.6 hours)(3600 s/hr) = 3.5 x 10^6 J.

39. You draw the circuit this time and define the currents as follows (so that your equations agree with mine):

    Let I_1 go through R_1 to the right.
    Let I_2 go through R_2 to the right.
    Let I_3 go through R_3 and R_4 to the left.

    Now write the junction equation for the right-hand node, the loop equation for the upper loop, and the loop equation for the outside loop. You should get the following three equations.

I_1	$+ I_2$	$- I_3 =$	0
$- 7I_1$	$+ 3I_2$	=	–1.0
$- 7I_1$		$- 6.0I_3 =$	+1.0

    Now multiply equation (1) by 3 and subtract your result from equation (2), thereby eliminating I_2. This result, along with equation (3) forms a pair of simultaneous equation in I_1 and I_3. Solving this pair leads to the result I_3 = –0.21 A.

45. An energy of 10 J expended in 4 seconds implies a power of (10 J)/(4 s) = 2.5 watts.
    Since $P = I^2R$, the current through the 2-ohm resistor can be found
    I^2 = (2.5 W)/(2 ohms) = 1.25 A^2, or I = 1.118 A.
    Finally, since the total resistance of the three series resistors is 6 ohms, the voltage driving the known current 1.118 A is $E = IR_{eff}$ = (1.118 A)(6 ohms) = 6.7 V.