83. The current through the 20-Ω resistor in Fig. 19–68 does not change whether the two switches S_1 and S_2 are both open or both closed. Use this clue to determine the value of the unknown resistance R.

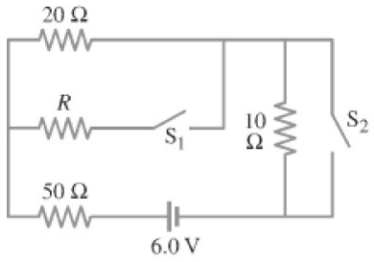

FIGURE 19–68 Problem 83.

84. In the circuit shown in Fig. 19–69, the 33-Ω resistor dissipates 0.50 W. What is the battery voltage?

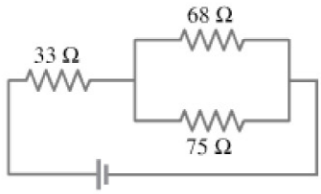

FIGURE 19–69 Problem 84.

85. (*a*) What is the equivalent resistance of the circuit shown in Fig. 19–70? (*b*) What is the current in the 18-Ω resistor? (*c*) What is the current in the 12-Ω resistor? (*d*) What is the power dissipation in the 4.5-Ω resistor?

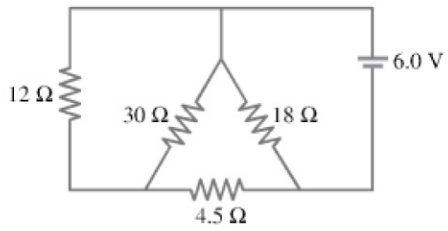

FIGURE 19–70 Problem 85.

*** 86.** (*a*) A voltmeter and an ammeter can be connected as shown in Fig. 19–71a to measure a resistance R. If V is the voltmeter reading, and I is the ammeter reading, the value of R will not quite be V/I (as in Ohm's law) because some of the current actually goes through the voltmeter. Show that the actual value of R is given by

$$\frac{1}{R} = \frac{I}{V} - \frac{1}{R_V},$$

where R_V is the voltmeter resistance. Note that $R \approx V/I$ if $R_V \gg R$. (*b*) A voltmeter and an ammeter can also be connected as shown in Fig. 19–71b to measure a resistance R. Show in this case that

$$R = \frac{V}{I} - R_A,$$

where V and I are the voltmeter and ammeter readings and R_A is the resistance of the ammeter. Note that $R \approx V/I$ if $R_A \ll R$.

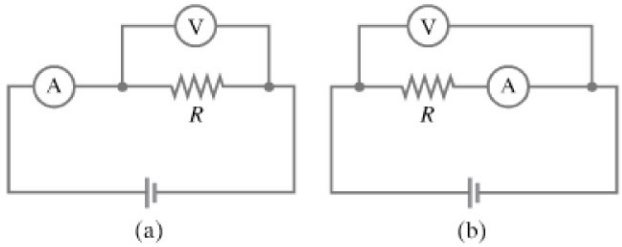

FIGURE 19–71 Problem 86.

87. A flashlight bulb rated at 2.5 W and 3.0 V is operated by a 9.0-V battery. To light the bulb at its rated voltage and power, a resistor R is connected in series as shown in Fig. 19–72. What value should the resistor have?

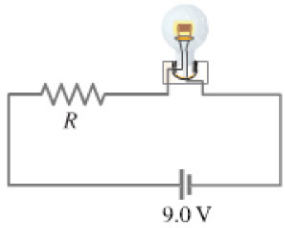

FIGURE 19–72 Problem 87.

Answers to Exercises

A: (*a*) 1.14 A; (*b*) 11.4 V; (*c*) $P_R = 13.1$ W, $P_r = 0.65$ W.
B: Series with $R_1/R_2 = 4.0$.
C: $41I_3 - 45 + 21I_2 - 80 = 0$.
D: 180 A; this high current through the batteries could cause them to become very hot: the power dissipated in the weak battery would be $P = I^2r = (180\text{ A})^2(0.10\,\Omega) = 3200$ W!
E: 12 kΩ.
F: The voltmeter will consist of a resistance $R_{ser} = 300\,\text{k}\Omega$ in series with the galvanometer.