SOLUTION (*a*) Any given charge (or electron) can flow through only one or the other of the two resistors in Fig. 19–7a. Just as a river may break into two streams when going around an island, here too the total current I from the battery (Fig. 19–7a) splits to flow through each resistor, so I equals the sum of the separate currents through the two resistors:

$$I = I_1 + I_2.$$

The potential difference across each resistor is the battery voltage $V = 24.0\ \text{V}$. Applying Ohm's law to each resistor gives

$$I = I_1 + I_2 = \frac{V}{R_1} + \frac{V}{R_2} = \frac{24.0\ \text{V}}{100\ \Omega} + \frac{24.0\ \text{V}}{100\ \Omega}$$

$$= 0.24\ \text{A} + 0.24\ \text{A} = 0.48\ \text{A}.$$

The equivalent resistance is

$$R_{\text{eq}} = \frac{V}{I} = \frac{24.0\ \text{V}}{0.48\ \text{A}} = 50\ \Omega.$$

We could also have obtained this result from Eq. 19–4:

$$\frac{1}{R_{\text{eq}}} = \frac{1}{100\ \Omega} + \frac{1}{100\ \Omega} = \frac{2}{100\ \Omega} = \frac{1}{50\ \Omega},$$

so $R_{\text{eq}} = 50\ \Omega$.

(*b*) All the current that flows out of the battery passes first through R_1 and then R_2 since they lie along a single path, Fig. 19–7b. So the current I is the same in both resistors; the potential difference V across the battery equals the total change in potential across the two resistors:

$$V = V_1 + V_2.$$

Ohm's law gives

$$V = IR_1 + IR_2 = I(R_1 + R_2).$$

Hence

$$I = \frac{V}{R_1 + R_2} = \frac{24.0\ \text{V}}{100\ \Omega + 100\ \Omega} = 0.120\ \text{A}.$$

The equivalent resistance, using Eq. 19–3, is $R_{\text{eq}} = R_1 + R_2 = 200\ \Omega$. We could also get R_{eq} by thinking from the point of view of the battery: the total resistance R_{eq} must equal the battery voltage divided by the current it delivers:

$$R_{\text{eq}} = \frac{V}{I} = \frac{24.0\ \text{V}}{0.120\ \text{A}} = 200\ \Omega.$$

NOTE The voltage across R_1 is $V_1 = IR_1 = (0.120\ \text{A})(100\ \Omega) = 12.0\ \text{V}$, and that across R_2 is $V_2 = IR_2 = 12.0\ \text{V}$, each being half of the battery voltage. A simple circuit like Fig. 19–7b is thus often called a simple **voltage divider**.

Voltage divider

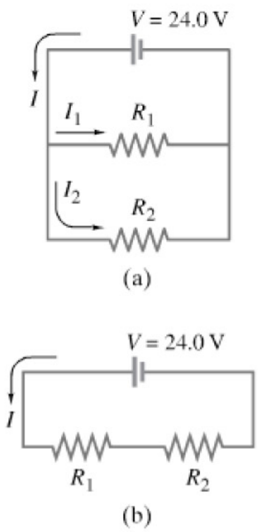

FIGURE 19–7 Example 19–3.

EXERCISE B Design a voltage divider that would provide one-fifth (0.20) of the battery voltage across R_2. What is the ratio R_1/R_2?

Note that whenever a group of resistors is replaced by the equivalent resistance, current and voltage and power in the rest of the circuit are unaffected.