The equivalent resistance in a series circuit is the sum of the circuit's resistances

As described in Section 1, the potential difference across the battery, ΔV, must equal the potential difference across the load, $\Delta V_1 + \Delta V_2$, where ΔV_1 is the potential difference across R_1 and ΔV_2 is the potential difference across R_2.

$$\Delta V = \Delta V_1 + \Delta V_2$$

According to $\Delta V = IR$, the potential difference across each resistor is equal to the current in that resistor multiplied by the resistance.

$$\Delta V = I_1R_1 + I_2R_2$$

Because the resistors are in series, the current in each is the same. For this reason, I_1 and I_2 can be replaced with a single variable for the current, I.

$$\Delta V = I(R_1 + R_2)$$

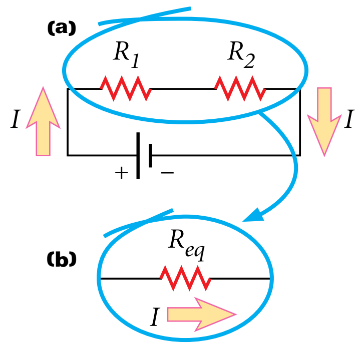

Figure 10
(a) The two resistors in the actual circuit have the same effect on the current in the circuit as **(b)** the equivalent resistor.

Finding a value for the equivalent resistance of the circuit is now possible. If you imagine the equivalent resistance replacing the original two resistors, as shown in **Figure 10,** you can treat the circuit as if it contains only one resistor and use $\Delta V = IR$ to relate the total potential difference, current, and equivalent resistance.

$$\Delta V = I(R_{eq})$$

Now set the last two equations for ΔV equal to each other, and divide by the current.

$$\Delta V = I(R_{eq}) = I(R_1 + R_2)$$

$$R_{eq} = R_1 + R_2$$

Thus, the equivalent resistance of the series combination is the sum of the individual resistances. An extension of this analysis shows that the equivalent resistance of two or more resistors connected in series can be calculated using the following equation.

RESISTORS IN SERIES

$$R_{eq} = R_1 + R_2 + R_3 \ldots$$

Equivalent resistance equals the total of individual resistances in series.

Because R_{eq} represents the sum of the individual resistances that have been connected in series, *the equivalent resistance of a series combination of resistors is always greater than any individual resistance.*

To find the total current in a series circuit, first simplify the circuit to a single equivalent resistance using the boxed equation above; then use $\Delta V = IR$ to calculate the current.

$$I = \frac{\Delta V}{R_{eq}}$$