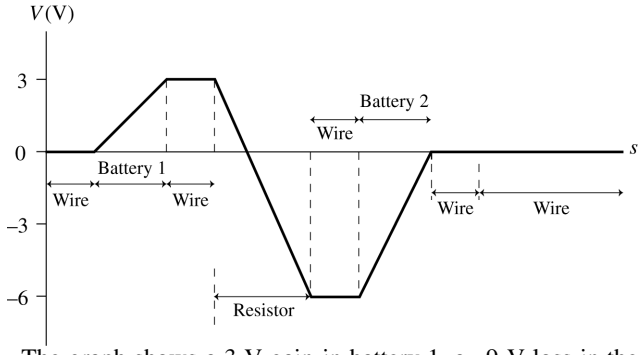
**31.11. Model:** Assume ideal connecting wires and an ideal battery for which $\Delta V_{\text{bat}} = \mathcal{E}$.
**Visualize:** Please refer to Figure Ex31.11. We will choose a clockwise direction for $I$. Note that the choice of the current's direction is arbitrary because, with two batteries, we may not be sure of the actual current direction. The 3 V battery will be labeled 1 and the 6 V battery will be labeled 2.
**Solve:** **(a)** Kirchhoff's loop law, going clockwise from the negative terminal of the 3-V battery is

$$\Delta V_{\text{closed loop}} = \sum_i (\Delta V)_i = \Delta V_{\text{bat 1}} + \Delta V_{\text{R}} + \Delta V_{\text{bat 2}} = 0$$

$$\Rightarrow +3\text{ V} - (18\ \Omega)\, I + 6\text{ V} = 0 \Rightarrow I = \frac{9\text{ V}}{18\ \Omega} = 0.50\text{ A}$$

Thus, the current through the 18 Ω resistor is 0.50 A. Because $I$ is positive, the current is left to right (i.e., clockwise).
**(b)**




**Assess:** The graph shows a 3 V gain in battery 1, a –9 V loss in the resistor, and a gain of 6 V in battery 2. The final potential is the same as the initial potential, as required.