31.10. **Model:** The batteries and the connecting wires are ideal.

Visualize: Please refer to Figure Ex31.10.

Solve: **(a)** Choose the current I to be in the clockwise direction. If I ends up being a positive number, then the current really does flow in this direction. If I is negative, the current really flows counterclockwise. There are no junctions, so I is the same for all elements in the circuit. With the 9 V battery being labeled 1 and the 6 V battery being labeled 2. Kirchhoff's loop law is

$$\sum \Delta V_i = \Delta V_{\text{bat 1}} + \Delta V_{\text{R}} + \Delta V_{\text{bat 2}} = +\mathcal{E}_1 - IR - \mathcal{E}_2 = 0$$

$$\Rightarrow I = \frac{\mathcal{E}_1 - \mathcal{E}_2}{R} = \frac{9 \text{ V} - 6 \text{ V}}{30 \text{ }\Omega} = 0.100 \text{ A}$$

Note the signs: Potential is gained in battery 1, but potential is lost both in the resistor and in battery 2. Because I is positive, we can say that $I = 0.100$ A flows from left to right through the resistor.

(b) The graph shows 9 V gained in battery 1, $\Delta V_{\text{R}} = -IR = 3$ V *lost* in the resistor, and another 6 V lost in battery 2. The final potential is the same as the initial potential, as required.