

31.24. Model: Assume ideal connecting wires but not an ideal battery.

Visualize: Please refer to Figure 31.23.

Solve: From Equation 31.25, the potential difference across the battery is

$$\Delta V_{\text{bat}} = \frac{\mathcal{E}R}{R+r} \Rightarrow r = R \left(\frac{\mathcal{E}}{\Delta V_{\text{bat}}} - 1 \right) = (20 \, \Omega) \left(\frac{9.0 \, \text{V}}{8.5 \, \text{V}} - 1 \right) = 1.18 \, \Omega$$

Assess: $1 \, \Omega$ is a typical internal resistance for a battery. This causes the battery's terminal voltage in the circuit to be $0.5 \, \text{V}$ less than its emf.