31.57. **Model:** The batteries are ideal, the connecting wires are ideal, and the ammeter has a negligibly small resistance.

Visualize: Please refer to Figure P31.57.

Solve: Kirchhoff's junction law tells us that the current flowing through the 2.0 Ω resistance in the middle branch is $I_1 + I_2 = 3.0$ A. We can therefore determine I_1 by applying Kirchhoff's loop law to the left loop. Starting clockwise from the lower left corner,

$$+9.0\text{ V} - I_1(3.0\ \Omega) - (3.0\text{ A})(2.0\ \Omega) = 0\text{ V} \Rightarrow I_1 = 1.0\text{ A} \Rightarrow I_2 = (3.0\text{ A} - I_1) = (3.0\text{ A} - 1.0\text{ A}) = 2.0\text{ A}$$

Finally, to determine the emf $\mathcal{E}$, we apply Kirchhoff's loop law to the right loop and start counterclockwise from the lower right corner of the loop:

$$+\mathcal{E} - I_2(4.5\ \Omega) - (3.0\text{ A})(2.0\ \Omega) = 0\text{ V} \Rightarrow \mathcal{E} - (2.0\text{ A})(4.5\ \Omega) - 6.0\text{ V} = 0\text{ V} \Rightarrow \mathcal{E} = 15.0\text{ V}$$