32.37. Visualize: Please refer to Figure P32.77.

Solve: Bulb A is in parallel with the battery and experiences the full potential difference $\mathcal{E}$ whereas the other 5 bulbs divide up the potential into smaller pieces. So A will be brightest. Stated another way, the resistance of the right path, with bulb D in series with several other bulbs, is greater than the resistance of the middle path, with only bulb A. Both paths experience the full potential difference of the battery, so the current starting down the middle path is larger than the current starting down the right path, causing A to be brighter than D (A > D).

All of the current in the right path passes through D, then it divides up. So D is brighter than B, C, E, or F (D > B, C, E, F). C and E are in parallel and have the same potential difference. Because they are identical bulbs with equal resistances, they have the same current and are equally bright (C = E). The current through F is the sum of the currents through C and E, so it is brighter than they are (F > C = E).

The three-resistor combination C + E + F is in parallel with B. The combination C + E + F has more resistance than B, so more current will flow through B than through C + E + F. Consequently, B is brighter than F (B > F). Putting all these pieces together, the final result is A > D > B > F > C = E.

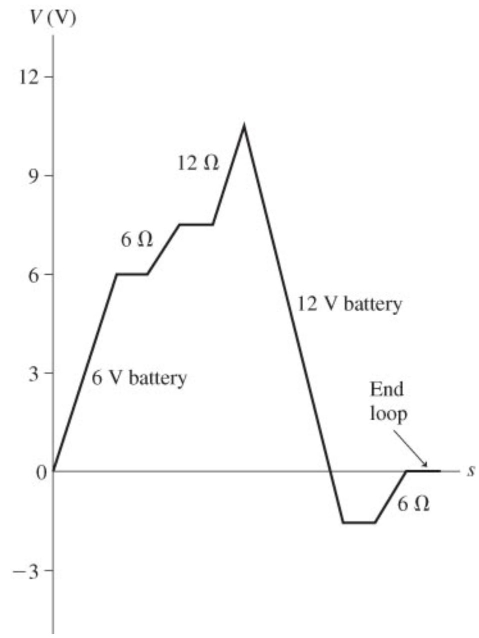
32.43. Model: Assume the batteries and the connecting wires are ideal.
Visualize: Please refer to Figure P32.43.
Solve: **(a)** The two batteries in this circuit are oriented to "oppose" each other. The curent will flow in the direction of the battery with the greater voltage. The direction of the current is counterclockwise because the 12 V battery is greater.
(b) There are no junctions, so the same current I flows through all circuit elements. Applying Kirchhoff's loop law in the *counterclockwise* direction and starting at the lower right corner,

$$\sum \Delta V_i = 12\text{ V} - I(12\ \Omega) - I(6\ \Omega) - 6\text{ V} - IR = 0$$

Note that the IR terms are all negative because we're applying the loop law in the direction of current flow, and the potential *decreases* as current flows through a resistor. We can easily solve to find the unknown resistance R:

$$6\text{ V} - I(18\ \Omega) - IR = 0 \Rightarrow R = \frac{6\text{ V} - (18\ \Omega)I}{I} = \frac{6\text{ V} - (18\ \Omega)(0.25\text{ A})}{0.25\text{ A}} = 6\ \Omega$$

(c) The power is $P = I^2R = (0.25\text{ A})^2(6\ \Omega) = 0.38$ W.
(d)



The potential difference across a resistor is $\Delta V = IR$, giving $\Delta V_6 = 1.5$ V, and $\Delta V_{12} = 3$ V. Starting from the lower left corner, the graph goes around the circuit *clockwise*, opposite from the direction in which we applied the loop law. In this direction, we speak of potential as *lost* in the batteries and *gained* in the resistors.

32.47. Model: Assume that the connecting wire and the battery are ideal.
Visualize: Please refer to Figure P32.47.
Solve: The middle and right branches are in parallel, so the potential difference across these two branches must be the same. The currents are known, so these potential differences are

$$\Delta V_{\text{middle}} = (3.0\text{ A})R = \Delta V_{\text{right}} = (2.0\text{ A})(R + 10\ \Omega)$$

This is easily solved to give $R = 20\ \Omega$. The middle resistor R is connected directly across the battery, thus (for an ideal battery, with no internal resistance) the potential difference ΔV_{middle} equals the emf of the battery. That is

$$\mathcal{E} = \Delta V_{\text{middle}} = (3.0\text{ A})(20\ \Omega) = 60\text{ V}$$

32.73. Model: The battery and the connecting wires are ideal.

Visualize: Please refer to Figure P32.73.

Solve: **(a)** A very long time after the switch has closed, the potential difference ΔV_C across the capacitor is $\mathcal{E}$. This is because the capacitor charges until $\Delta V_C = \mathcal{E}$, while the charging current approaches zero.

(b) The full charge of the capacitor is $Q_{max} = C(\Delta V_C)_{max} = C\mathcal{E}$.

(c) In this circuit, $I = +dQ/dt$ because the capacitor is charging, that is, because the charge on the capacitor is increasing.

(d) From Equation 32.36, capacitor charge at time t is $Q = Q_{max}(1 - e^{-t/\tau})$. So,

$$I = \frac{dQ}{dt} = C\mathcal{E}\frac{d}{dt}\left(1 - e^{-t/\tau}\right) = C\mathcal{E}\left(\frac{1}{\tau}\right)e^{-t/\tau} = C\mathcal{E}\left(\frac{1}{RC}\right)e^{-t/\tau} = \frac{\mathcal{E}}{R}e^{-t/\tau}$$

A graph of I as a function of t is shown below.