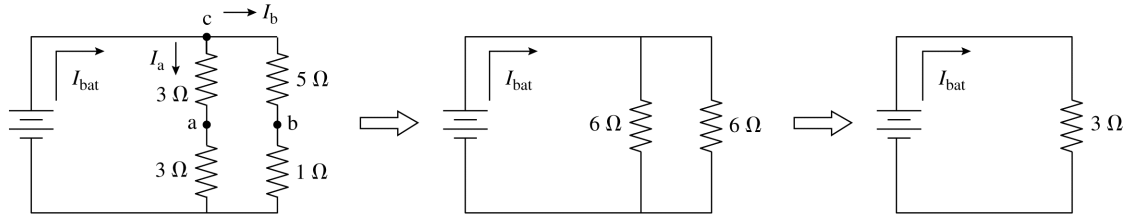
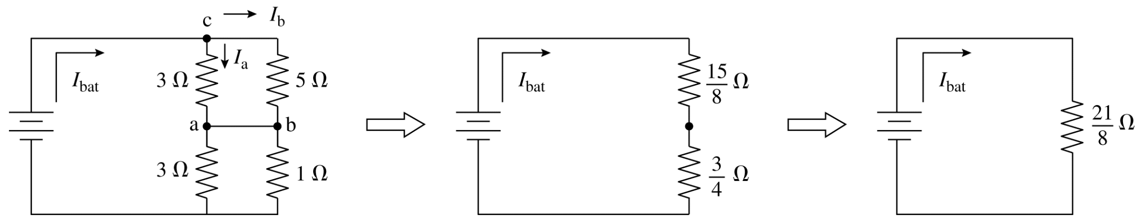
31.63. Model: The battery and the connecting wires are ideal.
Visualize:



(a)



(b)

The figure shows the two circuits formed from the circuit in Figure P31.63 when the switch is open and when the switch is closed.

Solve: (a) Using the rules of series and parallel resistors, we have simplified the circuit in two steps as shown in figure (a). A battery with emf $\mathcal{E} = 24$ V is connected to an equivalent resistor of 3 Ω. The current in this circuit is $24\text{ V}/3\ \Omega = 8\text{ A}$. Thus, the current that flows through the battery is $I_{bat} = 8$ A. To determine the potential difference ΔV_{ab}, we will find the potentials at point a and point b and then take their difference. To do this, we need the currents I_a and I_b. We note that the potential difference across the 3 Ω-3 Ω branch is the same as the potential difference across the 5 Ω-1 Ω branch. So,

$$\mathcal{E} = 24\text{ V} = I_a(3\ \Omega + 3\ \Omega) \Rightarrow I_a = 4\text{ A} = I_b$$

Now, $V_c - I_a(3\ \Omega) = V_a$, and $V_c - I_b(5\ \Omega) = V_b$. Subtracting these two equations give us ΔV_{ab}:

$$V_a - V_b = I_b(5\ \Omega) - I_a(3\ \Omega) = (4\text{ A})(5\ \Omega) - (4\text{ A})(3\ \Omega) = +8\text{ V}$$

(b) Using the rules of the series and the parallel resistors, we have simplified the circuit as shown in figure (b). A battery with emf $\mathcal{E} = 24$ V is connected to an equivalent resistor of $\frac{21}{8}\Omega$. The current in this circuit is $24\text{ V}/\frac{21}{8}\ \Omega = 9.143\text{ A}$. Thus, the current that flows through the battery is $I_{bat} = 9.14$ A. When the switch is closed, points a and b are connected by an ideal wire and must therefore be at the same potential. Thus $V_{ab} = 0$ V.