1. A cylindrical wire has a radius r and a length l. If both r and l are doubled, what happens to the value of the resistance of the wire?

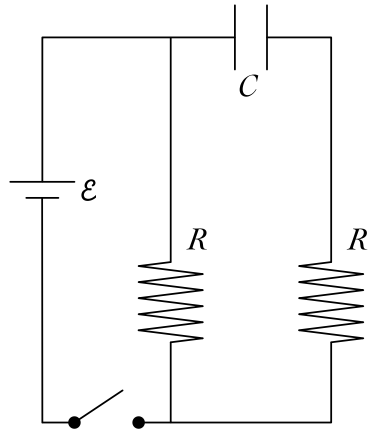
   Solution

   The relationship between the resistance of a segement of wire, its length and its cross sectional area is

$$
\begin{aligned}
R &= \rho \frac{l}{A} \\
&= \rho \frac{l}{\pi r^2},
\end{aligned}
$$

   which states that a doubling in length will result in a doubling of resistance. Meanwhile, a doubling in radius will reduce the resistance by a factor of four. The net result is a decrease in resistance by a factor of two.

   A response of "it decreases" is sufficient for full credit.



2. Consider the circuit above, and assume the battery has no internal resistance. Just after the switch is closed, what is the current in the battery? What is the current after a very long time?

   Solution

   The equation for the current $I(t)$ in an RC circuit during the charging phase is

   $$I(t) = \frac{\mathcal{E}}{R} e^{-t/RC}.$$

   At $t = 0$, this reduces to

   $$I(0) = \frac{\mathcal{E}}{R}.$$

   In this case, R is actually

   $$R_{\text{eq}} = \frac{R^2}{2R} = \frac{1}{2}R,$$

   and so

   $$I(0) = \frac{2\mathcal{E}}{R}.$$

   A response of "it is the current drawn by the two resistors in parallel" is sufficient for full credit. After the capacitor is fully charged, only the left hand loop has current, given by

   $$I = \frac{\Delta V}{R} = \frac{\mathcal{E}}{R}.$$

   A response of "it is the current drawn by one resistor" is sufficient for full credit.