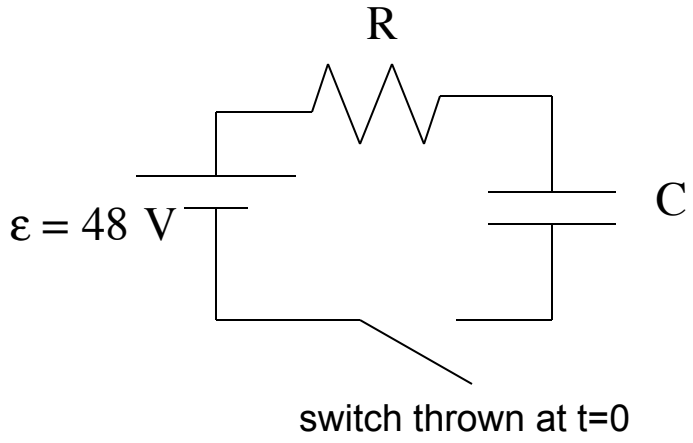
Problem 18.36

An RC circuit is powered by a 48 volt battery and has a maximum current of .5 mA. If the time constant is .96 seconds:



a.) What is the capacitance?

To begin with, the maximum current happen just as (after) the switch is thrown. Additionally, an uncharged capacitor provides no resistance to charge flow in a circuit, so just as the switch is thrown the only element that does provide resistance is the resistor. That means, according to Ohm's Law:

$$i_{max} = \frac{V}{R}$$

$$\Rightarrow \quad R = \frac{V}{i_{max}}$$

$$\Rightarrow \quad R = \frac{48\ V}{.5x10^{-3}\,A}$$

$$\Rightarrow \quad R = 96x10^{3}\ \Omega$$

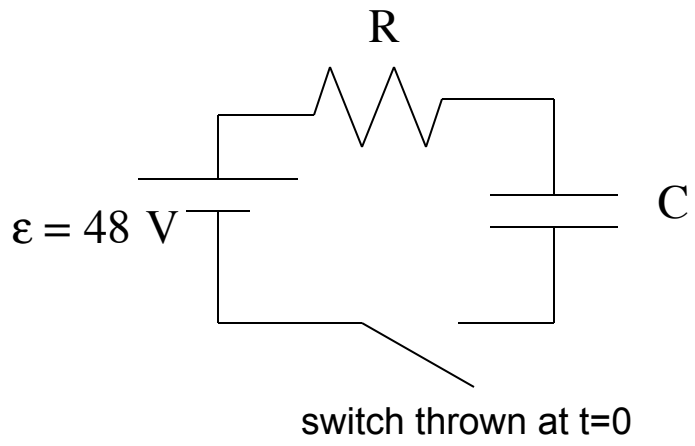
Using the time constant and the now known resistance, we can write:

$$\tau = RC$$

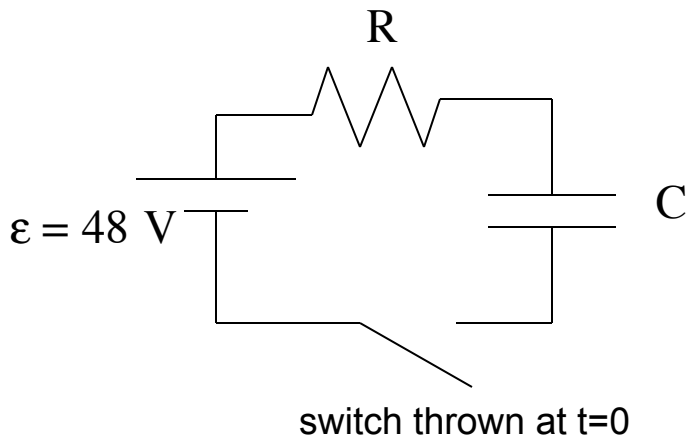
$$\Rightarrow \quad C = \frac{\tau}{R}$$

$$\Rightarrow \quad C = \frac{.96 \text{ sec}}{96 \text{x} 10^3 \ \Omega}$$

$$\Rightarrow \quad C = 10^{-5} \text{ farads}$$



b.) 1.96 seconds is the same as two time constants. After two time constants, the charge has increased to .87 times its maximum charge. In other words:



$$q(2\tau) = .87q_{max}$$
$$= .87CV_o$$
$$= .87\left(10^{-5}\ \text{farads}\right)(48\ \text{V})$$
$$= 41.76\text{x}10^{-5}\ \text{coulombs}$$