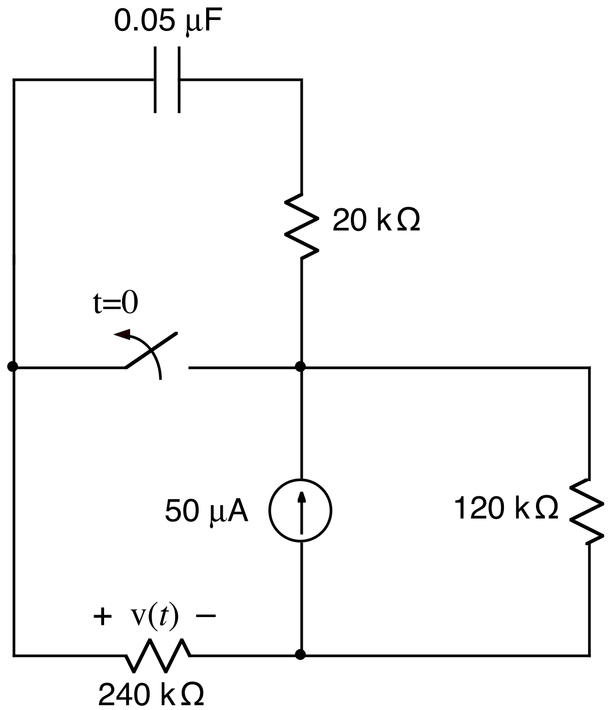
Ex:



Write a numerical expression for v(t) for $t > 0$.

Sol'n: We use general form of solution for RC circuits.

$$v(t>0) = v(t\to\infty) + \left[v(0^+) - v(t\to\infty)\right] e^{-t/R_{Th}C}$$

We find $v(0^+)$, $v(t\to\infty)$, and R_{Th}.

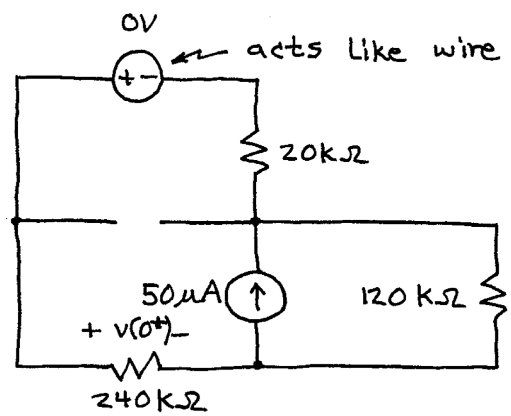
We start at $t=0^-$ to find voltage on C at $t=0^+$.

$t=0^-$: C acts like open circuit. Switch is closed.

Switch creates a short circuit, and $v_C(0^-) = 0V$.

$t = 0^+$: $v_C(0^+) = v_C(0^-) = 0V$ since v_C can't change instantly.

We model C as voltage source of 0V. Thus, it acts like a wire.



This is a current-divider circuit with $20k\Omega + 240k\Omega = 260k\Omega$ on one side and $120k\Omega$ on the other side.

The current thru the $240\,k\Omega$ is

$$i(0^+) = 50\mu A \cdot \frac{120k\Omega}{20k\Omega + 240k\Omega + 120k\Omega}$$

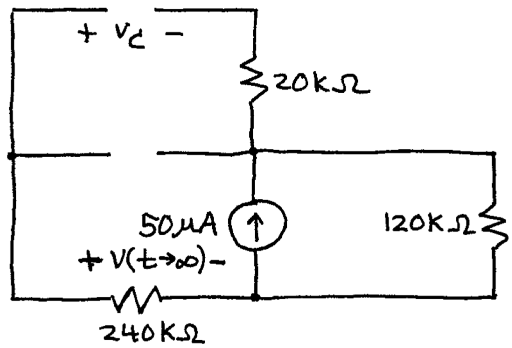
$$i(0^+) = 50\mu A \cdot \frac{120k\Omega}{380\,k\Omega}$$

$v(0^+)$ from Ohm's Law is

$$v(0^+) = 50\mu A \cdot \frac{120k\Omega}{380k\Omega} \cdot 240\,k\Omega$$

$$v(0^+) = 6V \cdot \frac{12}{19}$$

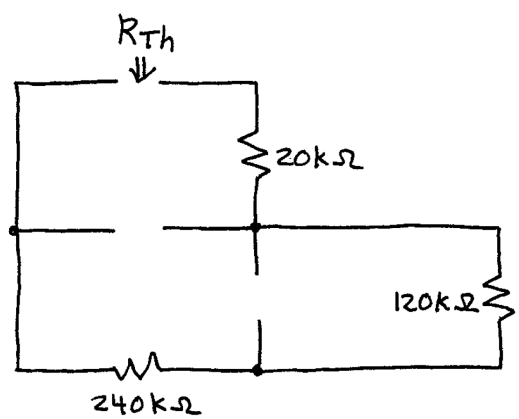
$t \to \infty$: Switch is open. C = open circuit.



No current can flow thru the 240 kΩ resistor.

$$\therefore\ v(t \to \infty) = 0V$$

R_{Th}: We look in from the terminals where C is connected, and we turn off the current source.



$$R_{Th} = 20k\Omega + 120k\Omega + 240k\Omega = 380k\Omega$$

The time constant is $R_{Th}C$:

$$\tau = 380\,\text{k}\Omega \cdot 0.05\,\mu\text{F} = 19\text{ ms}$$

Putting results together:

$$v(t>0) = 0\text{V} + \left(6\text{V} \cdot \frac{12}{19} - 0\text{V}\right) e^{-t/19\text{ms}}$$

or

$$v(t>0) = 6\text{V} \cdot \frac{12}{19}\, e^{-t/19\text{ms}} \doteq 3.8\text{V}\, e^{-t/19\text{ms}}$$