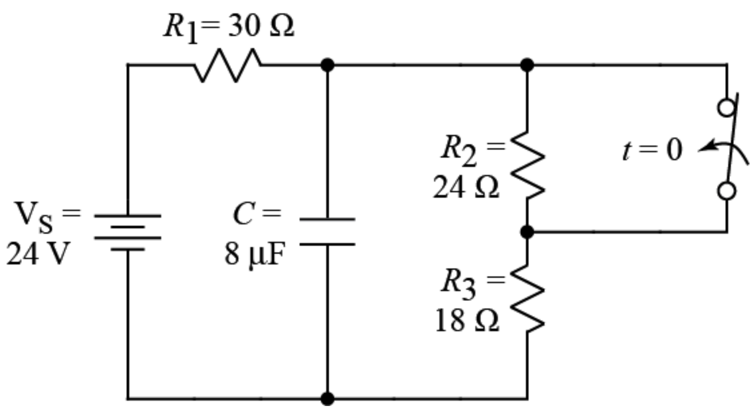
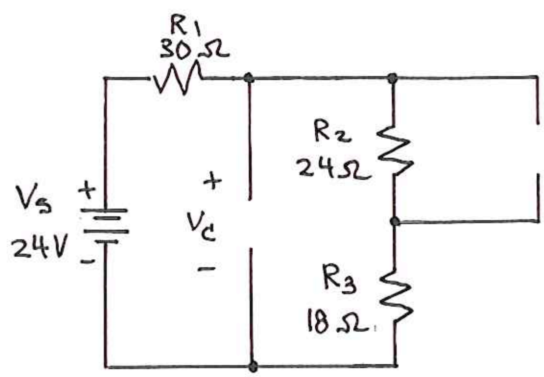
Ex:



a) The switch has been open for a long time and is closed (as shown) at $t = 0$.

b) Find the initial and final conditions and write the full expression for $v_C(t)$, including all the constants that you find.

sol'n: At $t = 0^-$, the switch is open and C = open:

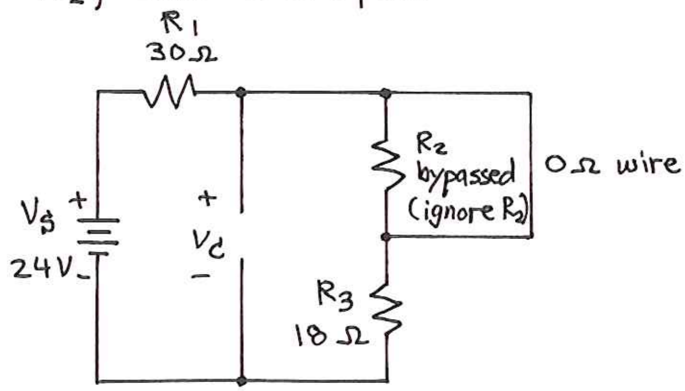


We find $V_C(0^-)$ = V across $R_2 + R_3$ by using a V-divider.

$$V_C(0^-) = V_S \frac{R_2 + R_3}{R_1 + R_2 + R_3} = 24V \cdot \frac{24\Omega + 18\Omega}{30\Omega + 24\Omega + 18\Omega}$$

$$V_C(0^-) = 24V \cdot \frac{42\Omega}{72\Omega} = 14V$$

For $t \to \infty$, the switch is closed, bypassing R_2, and C = open.

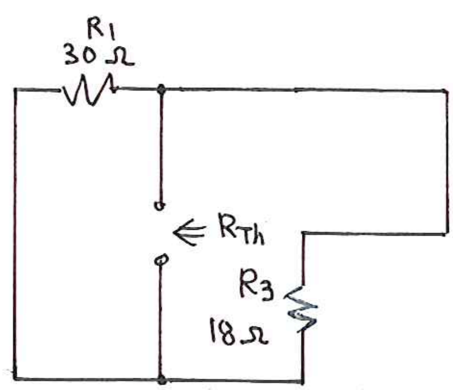


Again, we have a V-divider.

$$v_C(t\to\infty) = V_S \frac{R_3}{R_1+R_3} = 24V \frac{18\Omega}{30\Omega+18\Omega}$$

$$v_C(t\to\infty) = 24V \cdot \frac{18\Omega}{48\Omega} = 9V$$

For the time constant, $\tau = R_{Th}C$, we find R_{Th} looking into the circuit from the terminals where C is connected. We turn off V_S, which becomes a wire.



$$R_{Th} = 30\Omega \| 18\Omega = 6\Omega \cdot 5\|3 = 6\Omega \cdot \frac{15}{8} = \frac{90}{8}\Omega$$

$$\tau = R_{Th}C = \frac{90}{8}\Omega \cdot 8\mu F = 90\mu s$$

We now use the general soln for RC probs:

$$v_c(t) = v_c(t\to\infty) + \left[v_c(0^+) - v_c(t\to\infty)\right] e^{-t/\tau}$$

where $v_c(0^+) = v_c(0^-)$ (C voltage doesn't jump)

$$v_c(t) = 9V + (14V - 9V)\, e^{-t/90\mu s}$$

or

$$\boxed{v_c(t) = 9V + 5V e^{-t/90\mu s}}$$