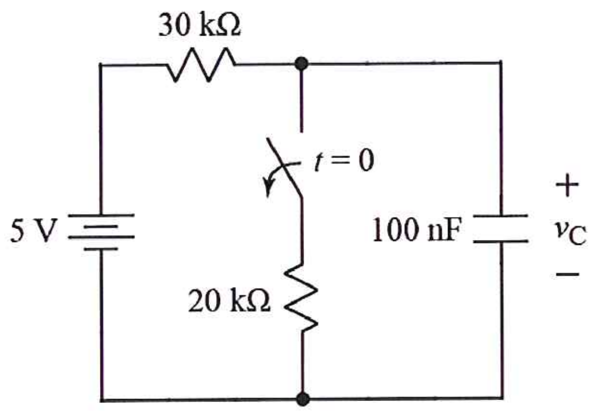
**Ex:**



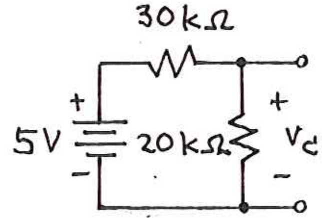

The switch is closed for a long time before opening at $t = 0$.

a) Find the energy stored by the capacitor at $t = 0$.

b) Find an expression for $v_C(t > 0)$.

c) If the switch is closed again at $t = 4\tau$ and left in that position forever, find the value of $v_C(t \to \infty)$.

soln a) We consider $t = 0^-$. C = open circuit
C is in parallel with 20kΩ resistor.




We have a V-divider.

$$v_c(t=0^-) = 5V \cdot \frac{20k\Omega}{20k\Omega + 30k\Omega} = 5V\left(\frac{2}{5}\right) = 2V$$

Energy is $w_c = \frac{1}{2} C v_c^2(0^-) = \frac{1}{2}(100nF)(2V)^2 = 200nJ.$

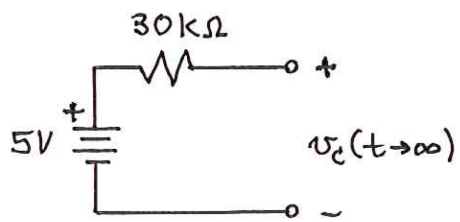
b) We use the general form of solution.

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

where $\tau = R_{Th}C$

From (a) we know $v_C(t=0^+)$ since $v_C(0^+) = v_C(0^-)$.

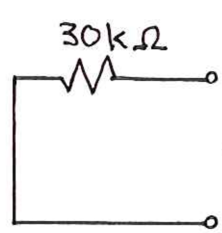
For $v_C(t\to\infty)$, the switch is open and $C$ acts like an open circuit.




Since no current flows in the 30kΩ R, the voltage drop across it is 0V. The $v_C(t\to\infty)$ value will be 5V.

$$v_C(t\to\infty) = 5V$$

To find $R_{Th}$, we turn off the 5V source and look into the circuit from the terminals where $C$ is attached.




$\Leftarrow R_{Th} = 30k\Omega$

$\tau = 30\,k\Omega \cdot 100nF$

$\tau = 3\,ms$

So $v_C(t>0) = 5V + [2V - 5V]e^{-t/3ms}$

c) If the switch is closed and the circuit stays in that configuration forever, we have the same situation as at $t=0^-$.

So $v_c(t \to \infty) = 2\,V$.