Ex:

The switch has been open for a long time and is closed at $t = 0$.
Write the full numerical expression for $v_C(t)$ for $t > 0$.

**sol'n:** Time $t=0^-$ yields the initial value of $v_C$.
The circuit has reached equilibrium, and the $C$ acts like an open circuit because it has ceased charging.

$t=0^-$ model:

$v_C$ is the same as the voltage across $R_2$. 
A voltage divider formula gives the voltage across $R_2$.

$$V_C = V_{R2} = -120 \text{V} \frac{R_2}{R_1 + R_2 + R_3}$$

$$= -120 \text{V} \frac{20 \text{k} \Omega}{10 \text{k} \Omega + 20 \text{k} \Omega + 30 \text{k} \Omega}$$

$$= -120 \text{V} \frac{20 \text{k}}{60 \text{k}}$$

$$V_C(t^-) = -40 \text{V}$$

Time $t \to \infty$ yields the final value of $V_C$. Again, the circuit reaches equilibrium and $C$ acts like an open circuit.

The switch is closed, bypassing $R_1$.

The voltage divider formula for $V_C$ now excludes $R_1$.

$$V_C(t \to \infty) = -120 \text{V} \cdot \frac{20 \text{k} \Omega}{20 \text{k} \Omega + 30 \text{k} \Omega} = -48 \text{V}$$

The time constant is $\tau = R_{Th}C$. 
$R_{Th}$ is the resistance seen looking into the terminals where $C$ is connected, with $V_S$ set to zero and the switch closed.

$$R_{Th} = R_2 \parallel R_3 = 20 \text{k}\Omega \parallel 30 \text{k}\Omega$$

or

$$R_{Th} = 10 \text{k}\Omega \cdot 2 \parallel 3 = 10 \text{k}\Omega \cdot \frac{2 \cdot 3}{2 + 3} = \frac{12 \text{k}\Omega}{2}$$

$$\tau = R_{Th} C = 12 \text{k}\Omega \cdot (300 \text{pF}) = 3.6 \mu\text{s}$$

The values found above are placed in the general form of solution for $RC$ problems:

$$V_c(t \geq 0) = V_c(t \to \infty) + [V_c(0^-) - V_c(t \to \infty)] e^{-t/\tau}$$

or

$$V_c(t \geq 0) = -48V + \left[-40V - -48V\right] e^{-t/3.6\mu\text{s}}$$

or

$$V_c(t \geq 0) = -48 + 8e^{-t/3.6\mu\text{s}}$$