

31.72. Model: Assume ideal wires. The capacitor discharges through the resistor.

Solve: (a) The capacitor discharges through the resistor R as $Q = Q_0 e^{-t/\tau}$. For $Q = Q_0/2$,

$$\frac{Q_0}{2} = Q_0 e^{-t/10 \text{ ms}} \Rightarrow \ln\left(\frac{1}{2}\right) = -\frac{t}{0.010 \text{ s}} \Rightarrow t = -(0.010 \text{ s})\ln(0.5) = 6.93 \text{ ms}$$

(b) If the initial capacitor energy is U_0 , we want the time when the capacitor's energy will be $U = U_0/2$. Noting that $U_0 = Q_0^2/2C$, this means $Q = Q_0/\sqrt{2}$. Applying the equation for the discharging capacitor,

$$\frac{Q_0}{\sqrt{2}} = Q_0 e^{-t/10 \text{ ms}} \Rightarrow \ln\left(\frac{1}{\sqrt{2}}\right) = -\frac{t}{0.010 \text{ s}} \Rightarrow t = -(0.010 \text{ s})\ln\left(\frac{1}{\sqrt{2}}\right) = 3.47 \text{ ms}$$