Answer on Question #55763, Physics Electric Circuits

A 2 micro farad capacitor is connected by closing a switch to a supply of 100 volts through a 1 mega ohm series resistor. Find the initial rate of rise of p.d across the capacitor and the time taken for the capacitor to be fully charged.

Solution

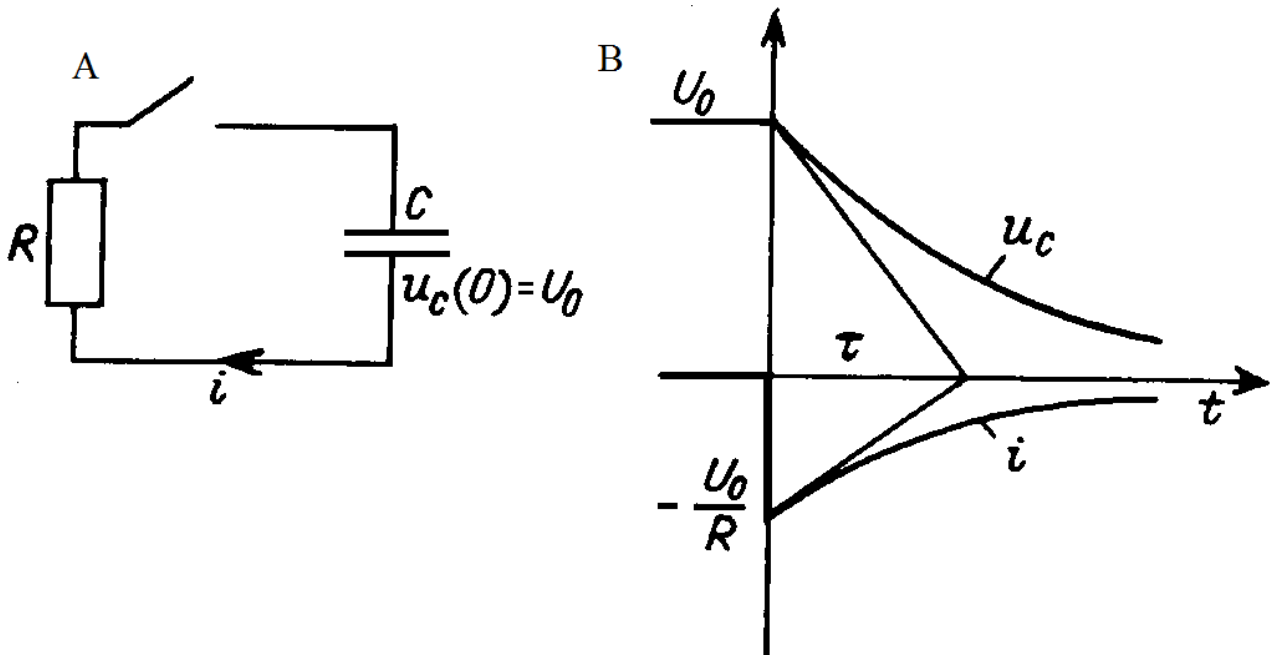

Fig.1

From the second Kirchhoff's law and Ohm's law

$$i_C(t)R + u_C(t) = 0 \tag{1}$$

where $i_C(t) = C\frac{du_C}{dt}$; $C = 2\cdot 10^{-6} F$; $R = 1MOhm$

Then

$$CR\frac{du_C}{dt} + u_C(t) = 0 \tag{2}$$

So,

$$u_C(t) = const \cdot \exp\left[-\frac{t}{CR}\right] \tag{3}$$

where $const$ is the integration constant.

So, $u_C(0) = const = U_0 = 100V$

Then

$$u_C(t) = U_0 \cdot \exp\left[-\frac{t}{CR}\right] = 100 \cdot \exp\left[-\frac{t}{2 \cdot 10^{-6} \cdot 1 \cdot 10^6}\right] = 100\exp[-0.5t] \tag{4}$$

$$u_C(t) = 0.01U_0 \left(u_C(t) \approx 0\right) \Rightarrow 0.01U_0 = U_0 \cdot \exp\left[-\frac{t}{CR}\right] \Rightarrow t = 2CR \cdot \ln 10 = 2 \cdot 2 \cdot 10^{-6} \cdot 1 \cdot 10^6 \cdot \ln 10 \approx 18.4s$$

Answer: $t \approx 18.4s$; $100\exp[-0.5t]V$.