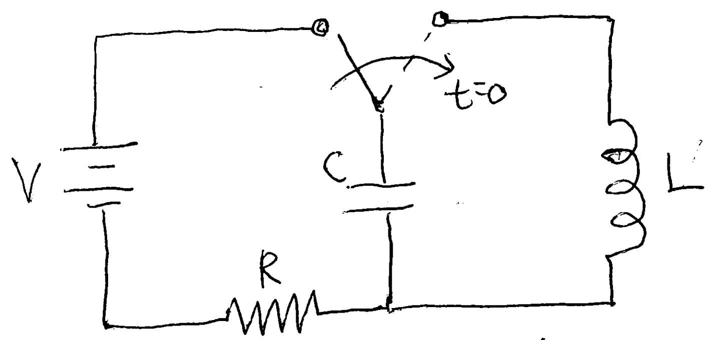
Example.

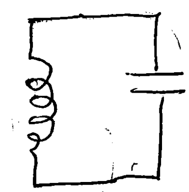


$$Q_0(\text{at } t=0) = CV$$

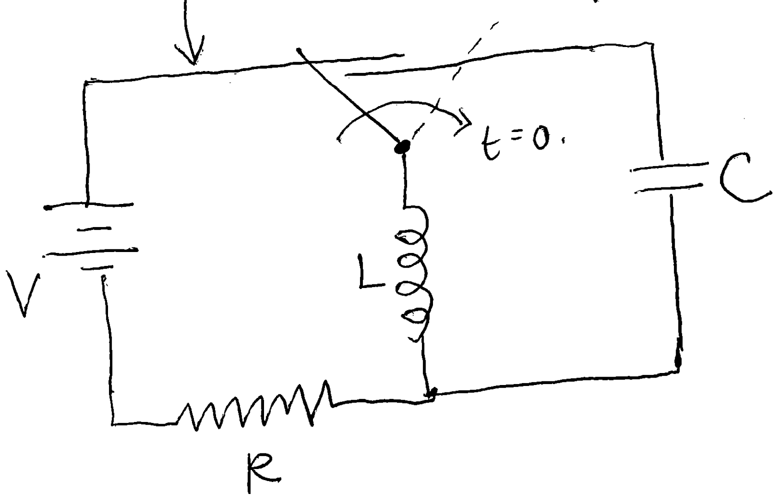
$$I_0(\text{at } t=0) = 0.$$

LC resonance circuit.

Charging circuit (Define initial condition).

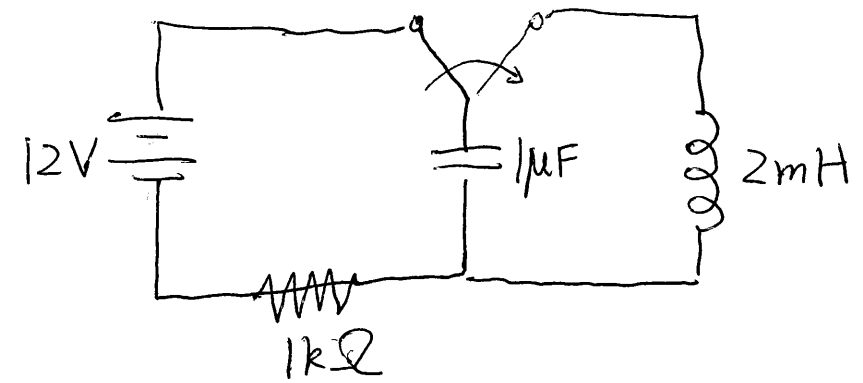


or



$$Q_0(\text{at } t=0) = 0.$$

$$I_0(\text{at } t=0) = \frac{V}{R}.$$



At t=0.

$$I_0 = 0.$$

$$Q_0 = (1\,\mu F)(12V) = 12\times10^{-6}\,C.$$

$$U = \frac{1}{2}CV^2 = \frac{1}{2}\cancel{(12)}(1\times10^{-6})(12)^2.$$

$$= 7.2\times10^{-5}\,J.$$

$$\omega = \frac{1}{\sqrt{LC}} = \frac{1}{\sqrt{2\times10^{-3}\times1\times10^{-6}}}$$

$$= \frac{1}{\sqrt{2\times10^{-9}}}$$

$$= 2.236\times10^{4}\ \text{rad/s}.$$

$$f = \frac{\omega}{2\pi} = 3558.8\ \text{Hz}.$$

$$T = \frac{1}{f} = 2.81\times10^{-4}\,s \text{ or } 0.281\,ms$$

What are I and Q at $t = 0.05\,ms$?

$$Q = A\sin(\omega t + \phi)$$

At $t=0$. $Q_0 = 12\times10^{-6}\,C$.

$$12\times10^{-6} = A\sin\phi. \quad \text{—(1)}$$

At $t=0$. $I_0 = 0$.

$$I = \frac{dQ}{dt} = A\omega\cos(\omega t+\phi).$$

$$\therefore A\omega\cos\phi = 0. \quad \text{—(2)}$$

$$\Rightarrow \cos\phi = 0. \Rightarrow \phi = \frac{\pi}{2}.$$

$$\therefore A\sin\frac{\pi}{2} = 12\times10^{-6}.$$

$$\Rightarrow A = 12\times10^{-6}$$

$$Q = (12\times10^{-6})\sin\left(2.236\times10^{4}t + \frac{\pi}{2}\right).$$

At $t = 0.05$ ns.

$$Q = (12\times10^{-6})\sin(2.236\times10^{4}\times \cancel{0}.5\times10^{-5} + \tfrac{\pi}{2}),$$

$$= \underline{\underline{5.250\times10^{-6}\,C}}.$$

$$I = \frac{dQ}{dt} = (12\times10^{-6})(2.236\times10^{4})\cos(2.236\times10^{4}t + \tfrac{\pi}{2}),$$

$$= \cancel{2.} \cancel{3.00\times10^{-11}}\ \underline{\underline{0.241\ A}}$$

$$U_E = \cancel{\tfrac{1}{2}C}\ \frac{1}{2}\frac{Q^2}{C} = \frac{1}{2}\frac{(5.25\times10^{-6})^2}{1\times10^{-6}}$$

$$= 1.378\times10^{-5}\,J.$$

$$U_B = \frac{1}{2}LI^2 = \frac{1}{2}(2\times10^{-3})(0.241)^2$$

$$= 5.808\times10^{-5}\,J.$$

$$U_{Total} = 1.378\times10^{-5} + 5.808\times10^{-5}$$

$$= \cancel{7.186\times10^{-5}\,J.} \sim 7.2\times10^{-5}\,J.$$