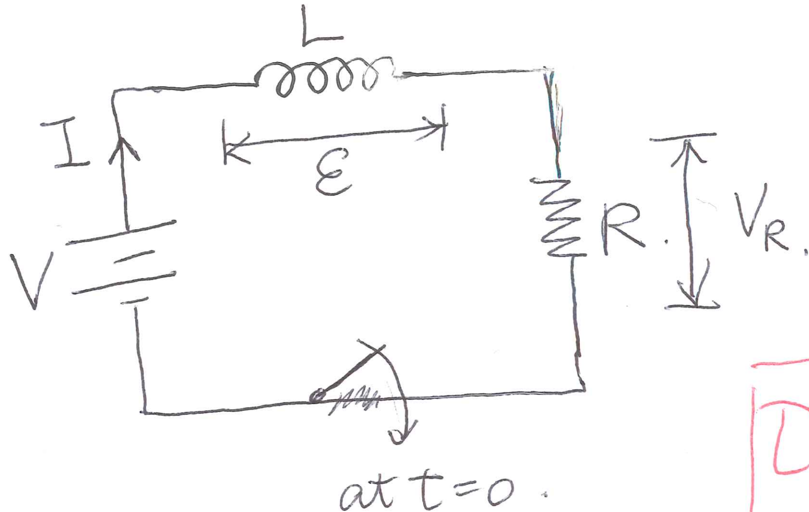
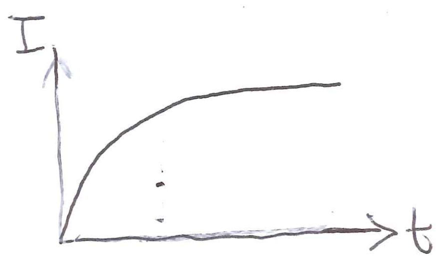
Charging RL



$$\boxed{\tau = \frac{L}{R}}$$



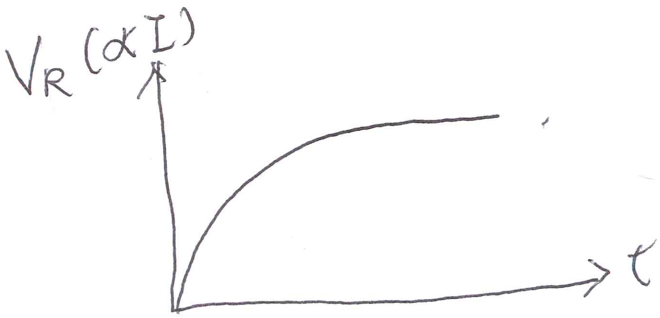
$$\cancel{A}\; I = I_0\left(1 - e^{-t/\tau}\right)$$

?

$$= \frac{V}{R}\left(1 - e^{-t/\tau}\right).$$

$$\varepsilon = \varepsilon_0 e^{-t/\tau}.$$

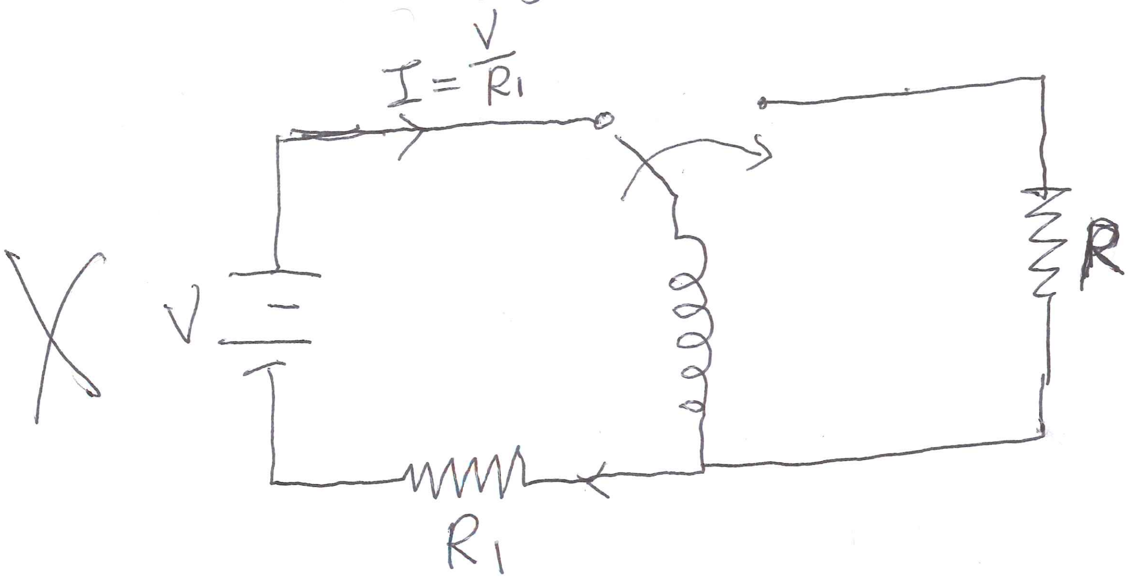
$$= V e^{-t/\tau}.$$

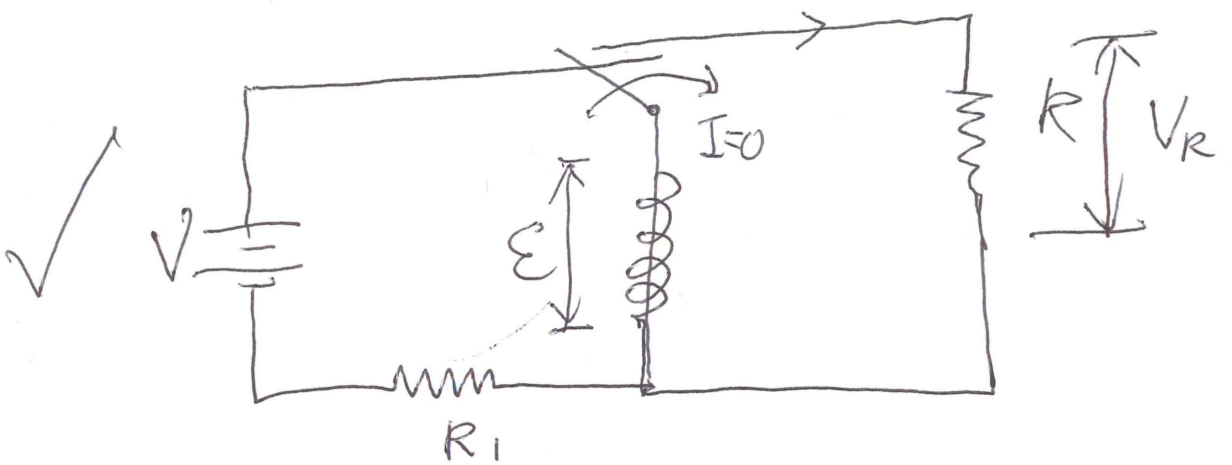


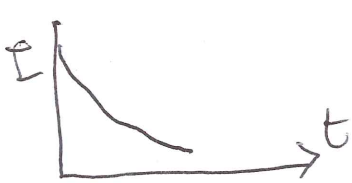
$$V = V_0\left(1 - e^{-t/\tau}\right)$$

$$= V\left(1 - e^{-t/\tau}\right).$$

Charging Discharging







$$I = I_0 e^{-t/\tau} = \frac{V}{R} e^{-t/\tau}$$

$$\varepsilon = V_R = \varepsilon e^{-t/\tau}$$

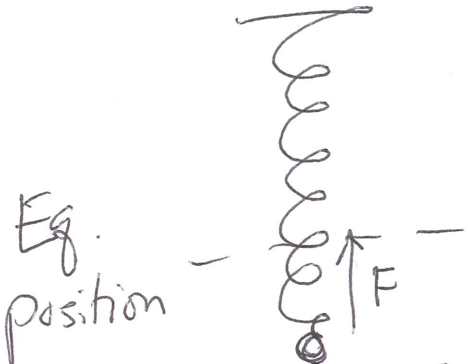
$$\uparrow$$

$$\varepsilon = V$$

RC Circuit ✓ RL circuit ✓.

LC Circuit now.

Newton's viewpoint:



$$-kx = ma$$

$$\Rightarrow \boxed{-kx = m\frac{d^2x}{dt^2}.}$$

$\frac{d^2x}{dt^2} = v\frac{dv}{dx}$

Energy view point:

Constant

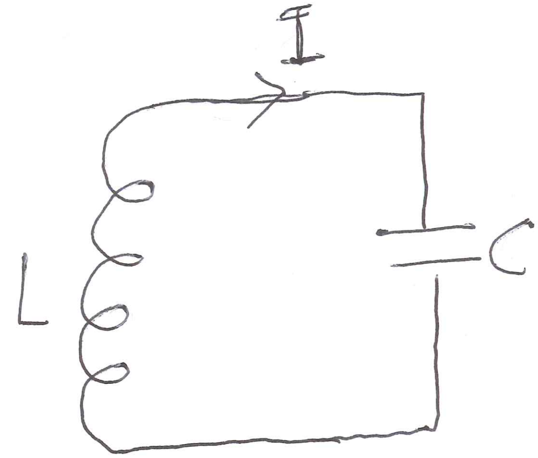
$$\underbrace{\frac{1}{2}mv^2}_{KE} + \underbrace{\frac{1}{2}kx^2}_{PE} = \text{Total Energy}$$

$\frac{1}{2}kA^2$ or $\frac{1}{2}mV_{max}^2$

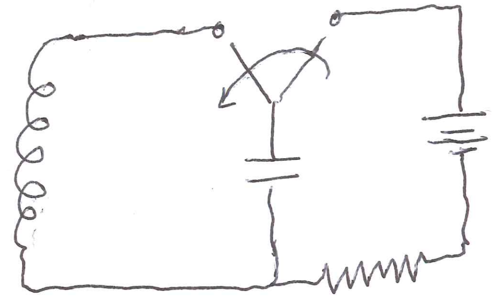
$$\omega = \sqrt{\frac{k}{m}}$$

$$x = A\cos(\omega t + \phi).$$

Integration constants to be determined by initiation condition.



Details:



$$L\frac{dI}{dt} + \frac{Q}{C} = 0. \leftarrow$$

differentiation:

$$\cancel{L\frac{d^2I}{dt^2} + \frac{I}{C} = 0}$$ ~~Equation of motion.~~

$$I = \frac{dQ}{dt}.$$

$L \Leftrightarrow m$

$Q \Leftrightarrow x, \; I \Leftrightarrow v$

$C \Leftrightarrow \frac{1}{k}.$

$$\boxed{L\frac{d^2Q}{dt^2} + \frac{Q}{C} = 0}.$$

$$m\frac{d^2x}{dt^2} + kx = 0.$$

$$\omega = \sqrt{\frac{k}{m}} \Longrightarrow \sqrt{\frac{1}{LC}}.$$

Conservation of Energy:

$$\frac{1}{2} m v^2 + \frac{1}{2} k x^2 = \text{Total Energy.}$$

$$\frac{1}{2} L I^2 + \frac{1}{2C} Q^2 = \text{Total Enery.}$$