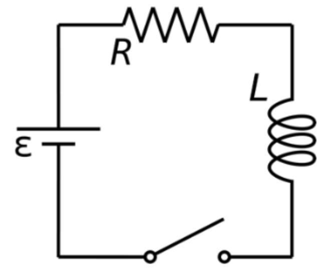
Flipping Physics Lecture Notes:
Time Constant - LR Circuit
http://www.flippingphysics.com/lr-circuit-time-constant.html

I'm not gonna lie, you really do need to have learned from these two previous lessons of mine in order to understand this:

- LR Circuit Basics
- LR Circuit Equation Derivations



LR Circuit:

- At $t_{initial} = 0$; $I_{initial} = 0$ & $\left(\frac{dI}{dt}\right)_{initial} = \frac{\varepsilon}{L}$ [max value]
- At $t_{final} \approx \infty$; $I_f = \frac{\varepsilon}{R}$ [max value] & $\left(\frac{dI}{dt}\right)_{final} = 0$

$$I(t) = \frac{\varepsilon}{R}\left(1 - e^{\left(-\frac{Rt}{L}\right)}\right) = I_{max}\left(1 - e^{\left(-\frac{Rt}{L}\right)}\right) \ \& \ \frac{dI}{dt}(t) = \frac{\varepsilon}{L}e^{\left(-\frac{Rt}{L}\right)} = \left(\frac{dI}{dt}\right)_{max} e^{\left(-\frac{Rt}{L}\right)}$$

$$I(t) = \frac{\varepsilon}{R}\left(1 - e^{\left(-\frac{t}{\tau}\right)}\right) \ \& \ \frac{dI}{dt}(t) = \frac{\varepsilon}{L}e^{\left(-\frac{t}{\tau}\right)} \Rightarrow \tau = \frac{L}{R}$$

One time constant, τ, is the time it takes for a 63.2% change.