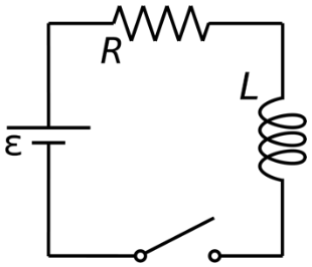
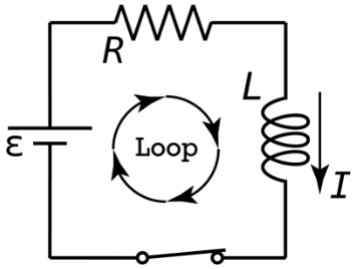
Flipping Physics Lecture Notes:
LR Circuit Basics
http://www.flippingphysics.com/lr-circuit.html



This LR circuit is a circuit with a battery, a resistor, an inductor, and a switch. Before time t = 0, the switch is open. At time t = 0, the switch is closed and remains closed. A few general things to realize:

- The initial current in the circuit, at time t = 0, is zero.
- The inductor opposes the change in current in the circuit which is what causes the current to change from its initial current of zero to its final steady state current.
- After a long time, the inductor behaves like any other ideal wire in a circuit and has zero resistance. In other words, after a long time the current has reached its maximum value and behaves as if the inductor is not there.



Let's determine equations for the limits. To do so, we use Kirchhoff's Loop Rule starting in the lower left-hand corner of the circuit:

$$\Delta V_{\text{Loop}} = 0 = \varepsilon - \Delta V_R - \Delta V_L = \varepsilon - IR - L\frac{dI}{dt}$$

We can use this equation to determine the remaining limits.

$$@\ t_i = 0; I_i = 0$$

$$\Rightarrow 0 = \varepsilon - L\frac{dI}{dt} \Rightarrow \varepsilon = L\frac{dI}{dt} \Rightarrow \frac{dI}{dt} = \frac{\varepsilon}{L} \Rightarrow \left(\frac{dI}{dt}\right)_{\text{initial}} = \frac{\varepsilon}{L}\ [\text{max value}]$$

$$@\ t_f \approx \infty; \left(\frac{dI}{dt}\right)_{\text{final}} = 0 \Rightarrow 0 = \varepsilon - IR \Rightarrow I_f = \frac{\varepsilon}{R}\ [\text{max value}]$$