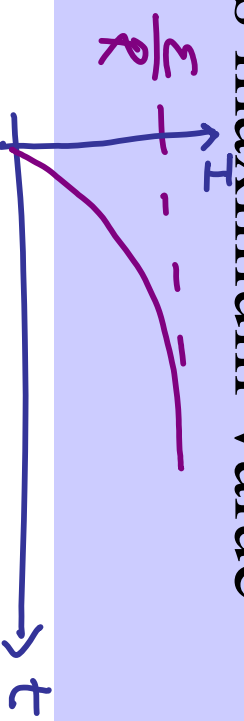
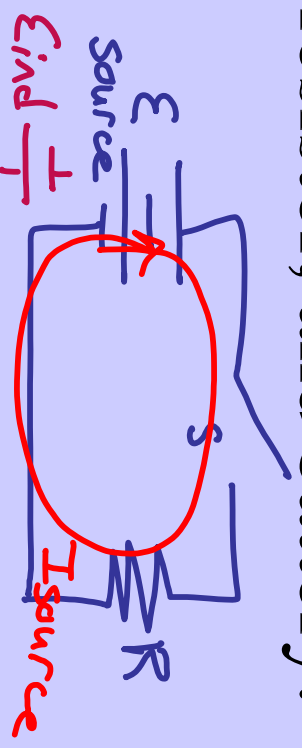


Self-Inductance

"Louis Pasteur's theory of germs is ridiculous fiction." Pierre Pacht, Professor of Physiology at Toulouse, 1872.

Self-Inductance

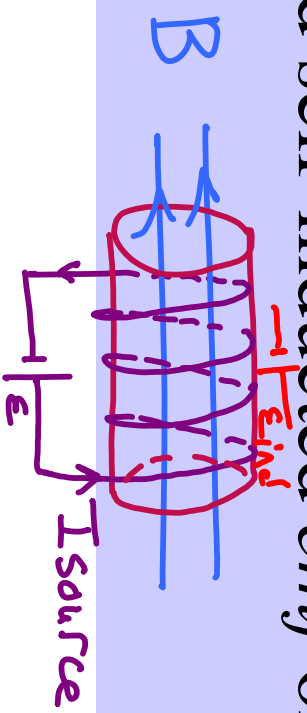
- We need to clearly distinguish between currents caused by a battery or other sources and currents induced by changing magnetic fields.
- We will use Source *emf* for those associated with a physical source and induced *emf* for those caused by changing magnetic fields.
- Draw a circuit with a switch, resistor, and battery.
- The maximum current is
$$I_{MAX} = \frac{\mathcal{E}}{R}$$
- The current does not reach its maximum value instantaneously.




- As the source current increases, what happens to the magnetic flux through the loop? *increasing inward*
 \vec{B} into \uparrow , loop opposes the $d\vec{B}$ \Rightarrow I_{induced} is *ccw*
to create *B-field outward*
- This flux creates an induced *emf*. What is the direction of the induced *emf*? *opposite*

- Thus the direction of the induced *emf* is opposite the source *emf*. This results in a gradual rather than instantaneous increase in the source current.

- This is called self-induced *emf* or back *emf*.



- Draw a coil wound around a cylindrical iron core.
- If the current increases, draw the polarity of the induced *emf*?
- If the current decreases, draw the polarity of the induced *emf*? 
- Use Faraday's Law to derive an equation for the induced emf.
- The inductance, L, is equal to
- The units of inductance are **henrys**, $H = \frac{V \cdot s}{A}$
- **Example:** Find the inductance of a uniformly wound solenoid having N turns and ℓ length. Assume that ℓ is much longer than the radius of the windings and that the core of the solenoid is air.

$$L = \frac{N \Phi_B}{I}$$

$$\mathcal{E}_L = -N \frac{d\Phi_B}{dt} = -L \frac{dI}{dt}$$

$b \propto \mathcal{E}_L \propto dB \propto dI$

$$-N \int d\Phi_B = -L \int \frac{dI}{dt}$$

$$L = \frac{N\Phi_B}{I}$$

L - inductance (H)
 R is a measure of opposition to I.

$$L = \frac{-\mathcal{E}_L}{\left(\frac{dI}{dt}\right)}$$

L is a measure of opposition of dI

Example

$$L = ?$$

$$B = \mu_0 \frac{N}{l} I$$

$$\Phi_B = \mu_0 \frac{NA}{l} I$$

$$L = \frac{N \left(\mu_0 \frac{NA}{l} I \right)}{I} = \frac{\mu_0 N^2 A}{l}$$

