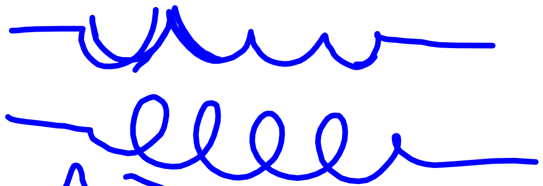
Inductance -

1) **Self-Inductance** appears in a single coil when the curent in the coil changes. The changing current produces a changing B-field in the coil, and



$$\frac{\Delta I}{\Delta t}$$

$$\frac{dI}{dt}$$ inst. rate of change of current

this induces a back emf in the coil. The back emf tends to retard the flow of current if the the current in the coil is increasing and

induces an emf in the same direction as the current flow if the current is decreasing. The average induced emf is

$$\mathcal{E} = -L\frac{dI}{dt}$$

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L is the proportionality constant measred in henries (H)

Units:

$V = IR$

$\frac{V}{I} = R$

$$V = H\frac{A}{s} \Rightarrow H = \frac{V}{A}\cdot s = \Omega \cdot s$$

The self-inductance (L) of a long coil, called a <u>Solenoid</u>, of length l, and cross-sectional area A which contains N turns is

$$L = \mu_0 N^2 \frac{A}{\ell}$$

$$\mu_0 = 4\pi \times 10^{-7}\ \frac{T\cdot m}{A}$$

(2) $L = \mu_0 N^2 \frac{A}{l}$

The energy stored in a coil of inductance L, carrying a c urrent I, is

energy = $\frac{1}{2} L I^2$

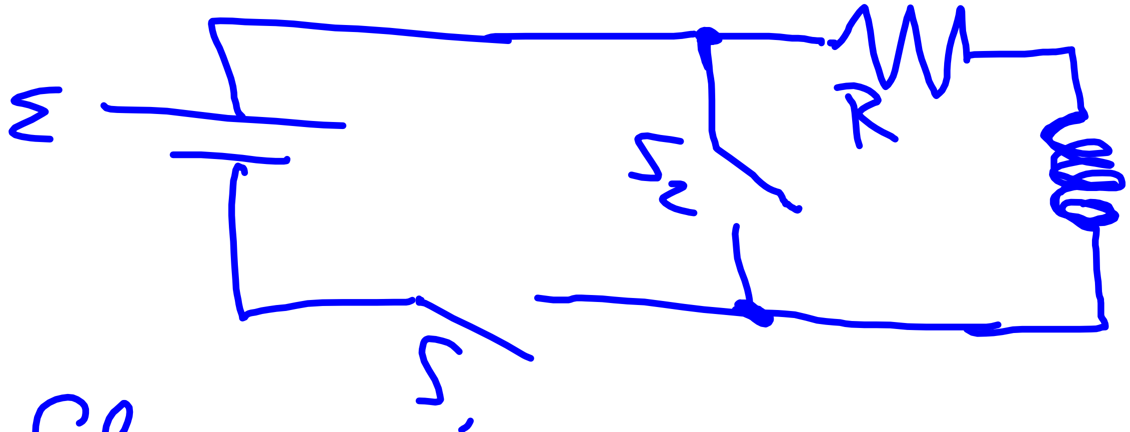
The stored energy in the inductor's B-field is

$$\text{energy} = \frac{1}{2} B^2 A l / \mu_0$$

The volume enclosed by the windings of the coil equals the product of A and l. The energy stored per unit volume or **energy density** is given by

$$\text{energy density} = \frac{1}{2} B^2 / \mu_0$$

③ LR circuit



Close switch 1

I increases

$$I = \mathcal{E}/R\left(1 - e^{-t/\tau}\right) \qquad \tau = L/R$$

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