Physics 142 - October 30, 2008

- Presentations start Dec. 2
- Meet w/ group, do a bit of planning + select a spokesperson to contact me + negotiate a meeting time.
- Exam 2 — Nov. 13, Hoyt, Regular class time

Happy Halloween

Induction

$$\mathcal{E} = \int_{loop} \vec{E} \cdot d\vec{l} = -\frac{d\Phi_M}{dt}$$

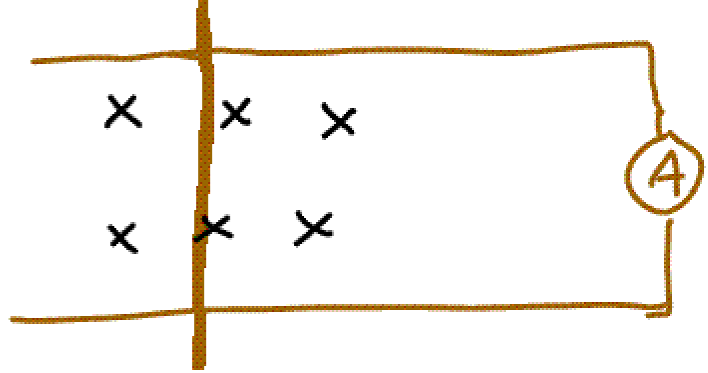
induced EMF

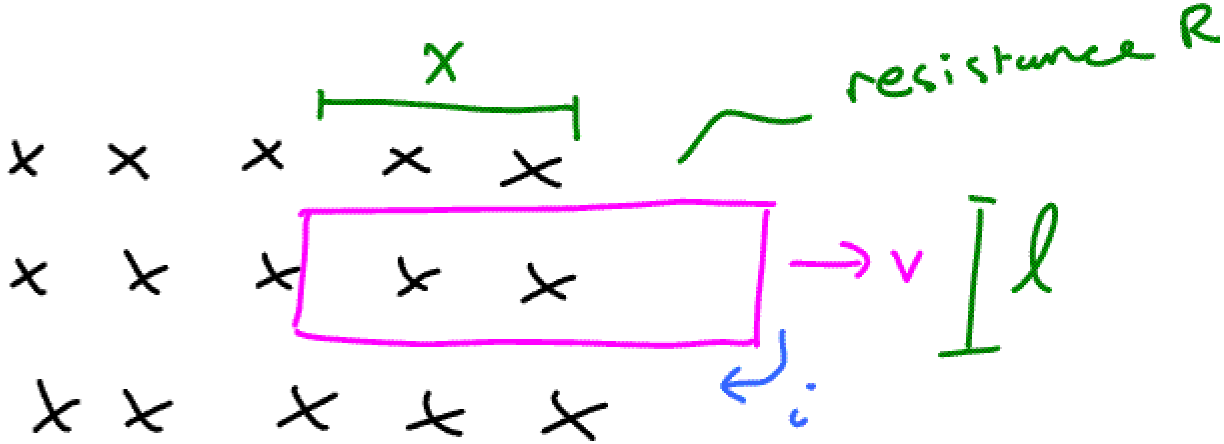
$$\Phi_M = \int_{loop} \vec{B} \cdot d\vec{A}$$

All very Important

<u>Lenz's</u> <u>Law</u> - An induced current in a closed conducting loop will appear in such a way as to oppose the change that created it

Gives the direction of induced effect

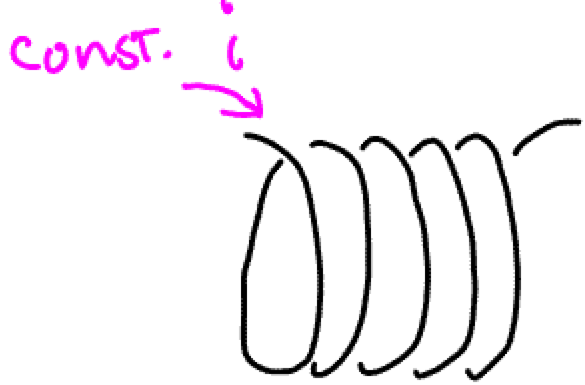




$\vec{B}$

$$\mathcal{E} = -\frac{d\Phi_M}{dt} = -\frac{d(Bx\ell)}{dt}$$

$$\mathcal{E} = -B\ell v \qquad |i| = \frac{B\ell v}{R}$$



Solenoid

Each turn has Area A

n turns/length

$$\underset{\text{single turn}}{\phi_M} = BA = \mu_0 n i A$$

length ℓ of solenoid

$n\ell$ turns

$$\phi_M = \underbrace{n\ell}_{\#\ \text{turns}}\left(\mu_0 n i A\right)$$

$n^2 \mu_0 i \ell A$

$L = n^2 \mu_0 \ell A$

$$\underset{\text{single turn}}{\phi_m} \propto i \qquad \underset{n\ell\ \text{turns}}{\phi} \propto i$$

$$\Phi_m = \underbrace{L}_{\text{constant of self-inductance}} i$$

change $i \rightarrow$ change $\Phi_m \rightarrow \frac{d\Phi_m}{dt} \rightarrow \mathcal{E}$

$$\mathcal{E} = -\frac{d\Phi_m}{dt} = -L\frac{di}{dt}$$

$$\boxed{\mathcal{E} = -L\frac{di}{dt}}$$

geometry

units Henrys (MKS)

Δi in I $\longrightarrow$ ΔB in II

induces ε in II

(+ vice versa)

sometimes M

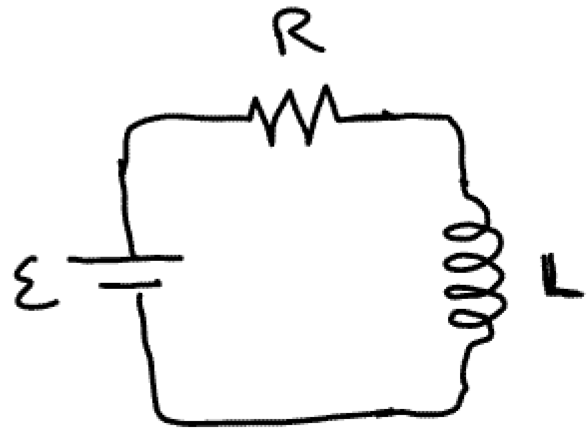
ϕ_M in II $\propto i_I$

$\phi_M = L i$

$$\boxed{\varepsilon = -L \frac{di}{dt}}$$

Constant of Mutual inductance

Energy + Magnetic field



$$\sum \mathcal{E} = 0$$

$$\mathcal{E} - iR - L\frac{di}{dt} = 0$$

$$\mathcal{E} = iR + L\frac{di}{dt}$$

mult by i

$$\mathcal{E}i = i^2R + Li\frac{di}{dt}$$

All "power" terms

Rate of change of E stored in B field

E stored in B field

$$\frac{dU_B}{dt} = Li\frac{di}{dt}$$

$$dU_B = Li\,di$$

$$U_B = \int_0^I Li\,di = \frac{Li^2}{2} = \frac{1}{2}LI^2$$

Analogous to capacitor $U_{cap} = \frac{1}{2}CV^2$

Solenoid w/ i, n $\frac{\text{turns}}{\text{length}}$, length l

$\rightarrow$ find Energy density of magnetic field

$B = \mu_0 n i$ (inside)

$= 0$ (outside)

From earlier

$u_B \equiv$ Energy density in B

$$u_B = \frac{U_B}{Al} = \frac{\frac{1}{2} L i^2}{Al} = \frac{i^2 n^2 \mu_0 l A}{2Al}$$

$$u_B = \frac{1}{2} \mu_0 i^2 n^2 = \frac{|B|^2}{2\mu_0}$$

$B = \mu_0 n i$

$$u_B = \frac{(B)^2}{2\mu_0}$$

Similar to

$$u_E = \frac{\varepsilon_0}{2} E^2$$