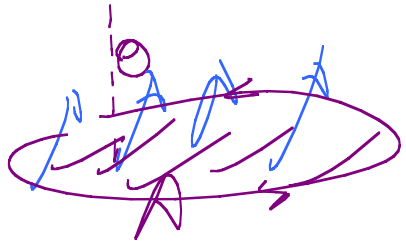
Phys 2120-4 10/19/12

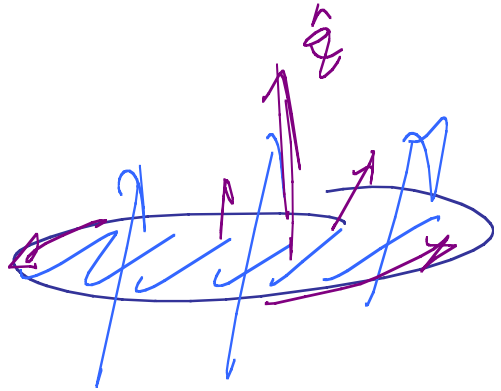
Note Title 10/19/2012

EM Induction

$$\Phi_B = \int \vec{B} \cdot d\vec{A}$$



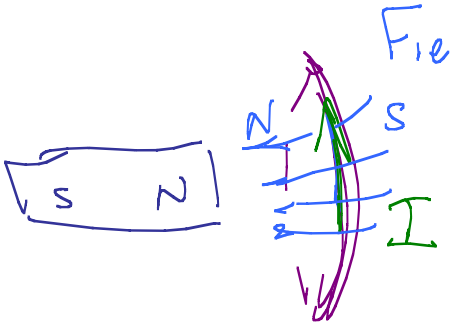
$$= BA\cos\theta$$



$$\int \vec{E} \cdot d\vec{s} = \mathcal{E} = -\frac{d\Phi_B}{dt}$$

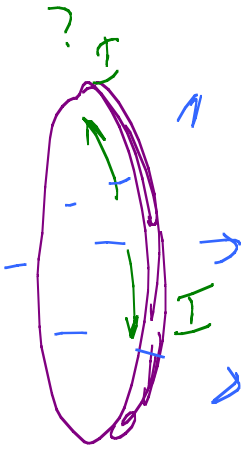
Which way does current go when flux changes

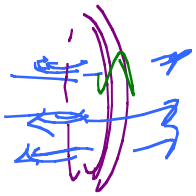
Can reason it out w/ energy.

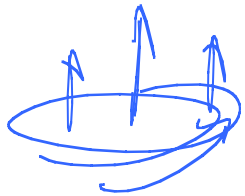


Field opposes magnet

Work done oppose flux



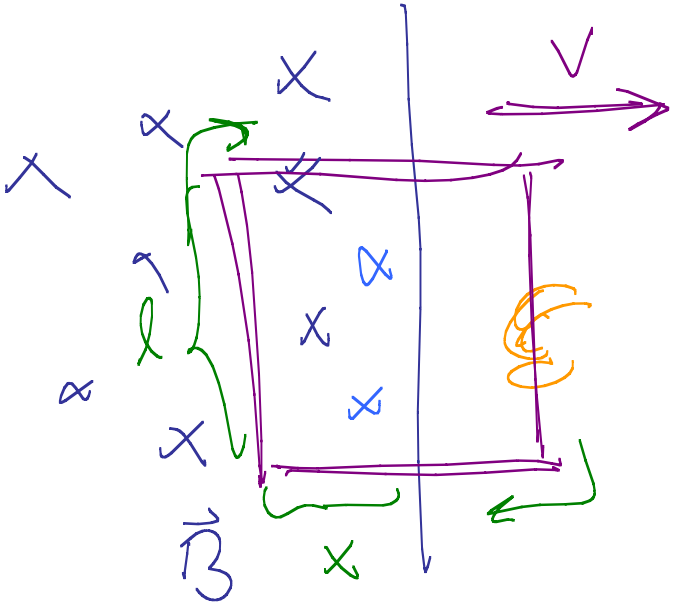




Lenz Law

The direction of an induced emf or current is such that the mag. field created by induced current opposes change in magnetic flux

Lenz's Law, Currents

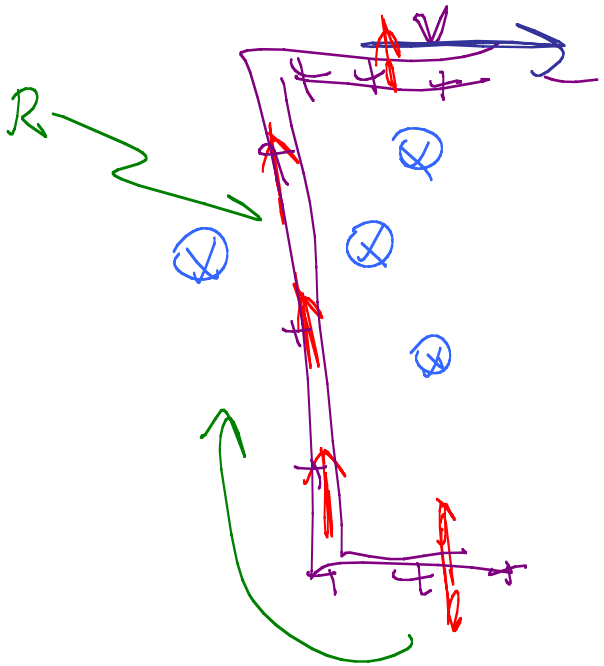


Flux into page, decreases

Oppose this by more flux into page

Clockwise current

Another way:



$$\Phi_B = Blx$$

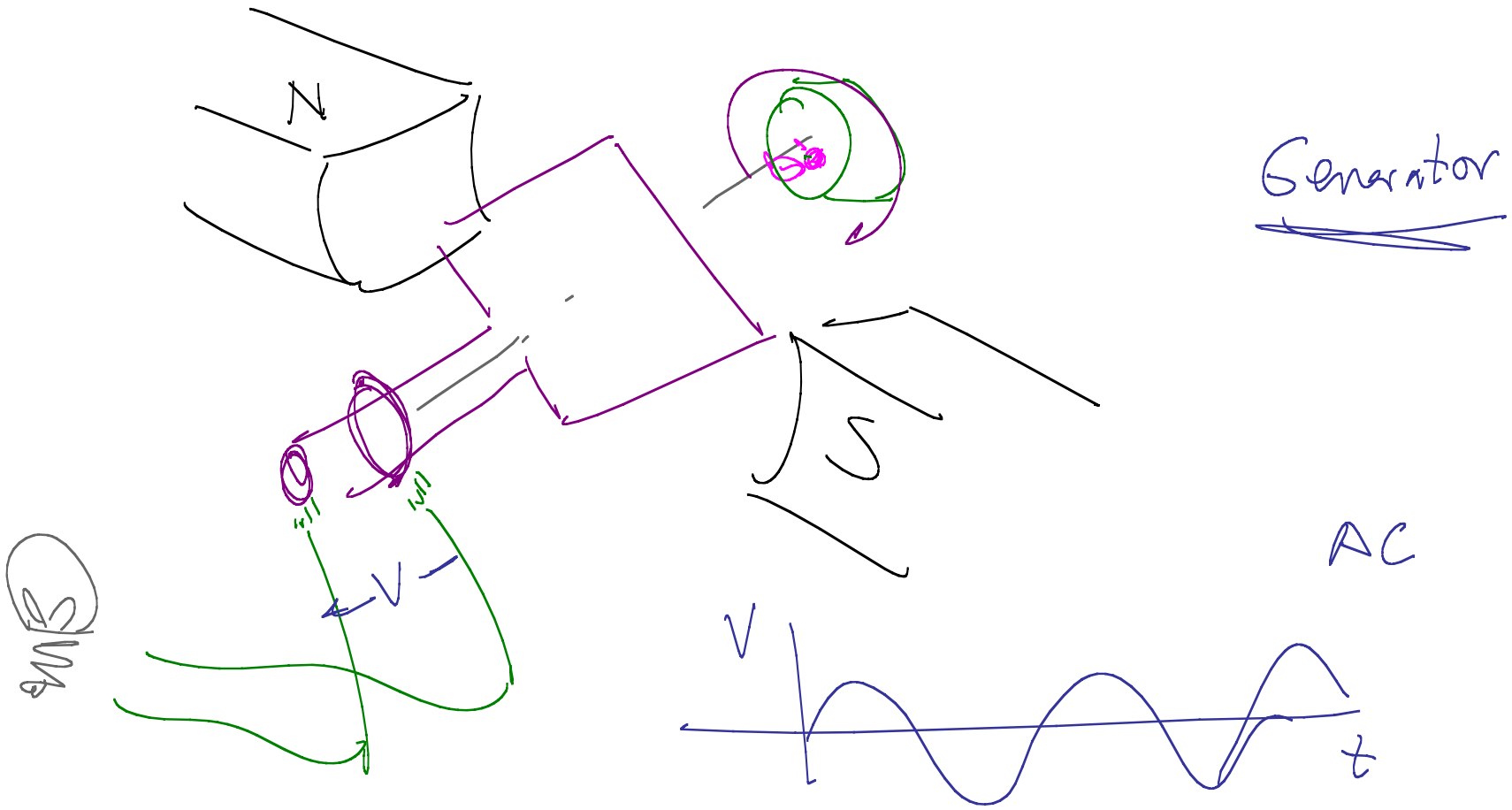
$$\frac{d\Phi_B}{dt} = Bl\frac{dx}{dt}$$

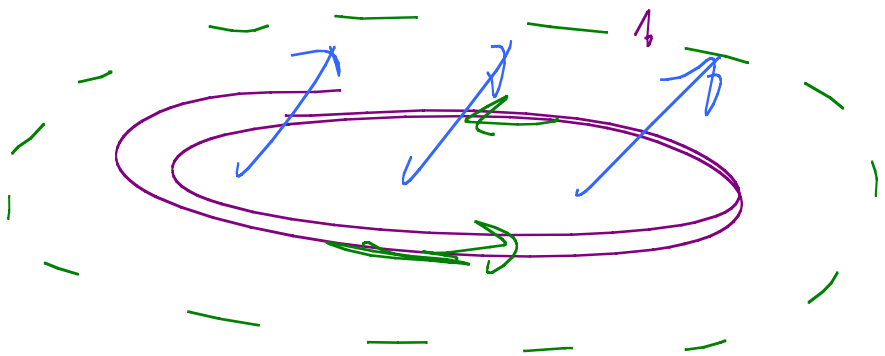
$$= -Blv$$

$$\mathcal{E} = -\frac{d\Phi}{dt} = Blv \qquad P = I\mathcal{E} = \mathcal{E}^2/R$$

$$= B^2l^2v^2/R$$

$$I = \mathcal{E}/R \qquad P = Fv = IlBv = B^2l^2v^2/R$$


N
S
V
Generator
AC
V
t

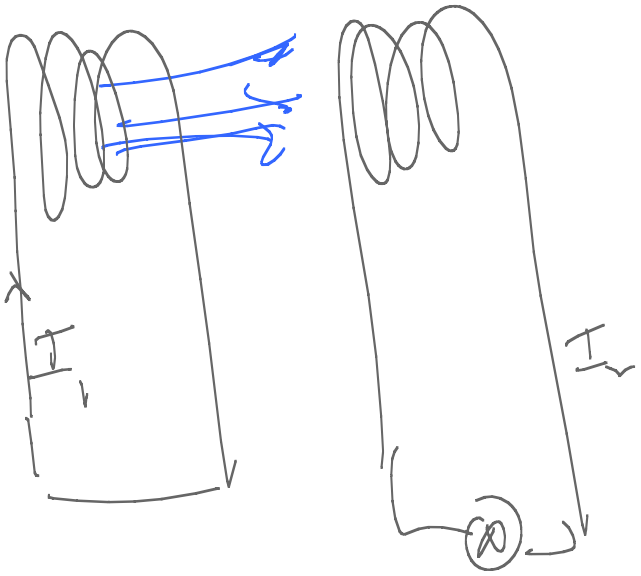


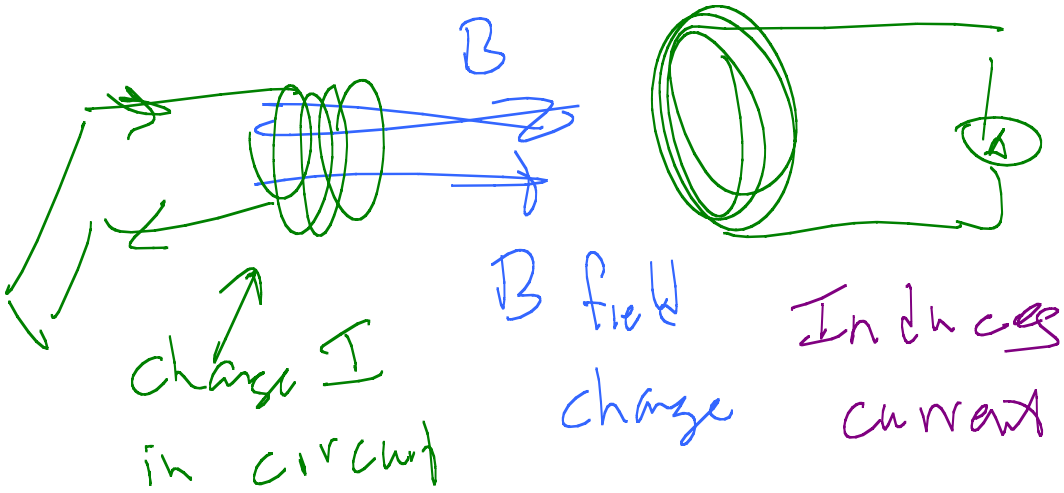
$$\int \mathcal{E} \cdot d\vec{r} = \mathcal{E}$$

Also curls in solid piece of metal

Eddy Currents

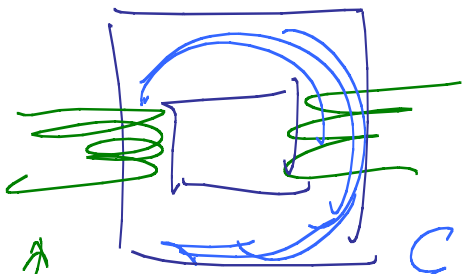
Inductance





If $\frac{dI_1}{dt}$ is nonzero, set emf in 2.

Mutual Inductance



$\mathcal{E}$

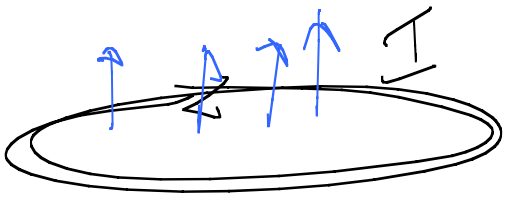
$\frac{dI_1}{dt}$

Transformers

$$\mathcal{E}_2 = -M \frac{dI_1}{dt} = -\frac{d\Phi_2}{dt}$$

M — Coeff of mutual induc

$$\Phi_2 = M I_1$$



$\frac{dI}{dt}$ produces $\mathcal{E}$ opposes the change

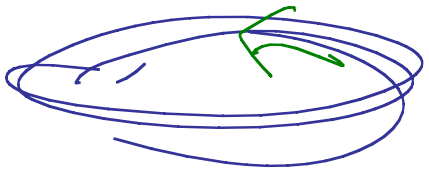
$\Phi_B = L I$

↑ geometry

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

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

L = coefficient of self-inductance



A voltage which opposes change in I.

"Back" emf.

$\Phi = LI$

Solenoid

$L = \mu_0 n^2 A l$

$n = \text{turn}/\text{length}$

$n = N/l$

L self inductance $\quad \Phi = LI$

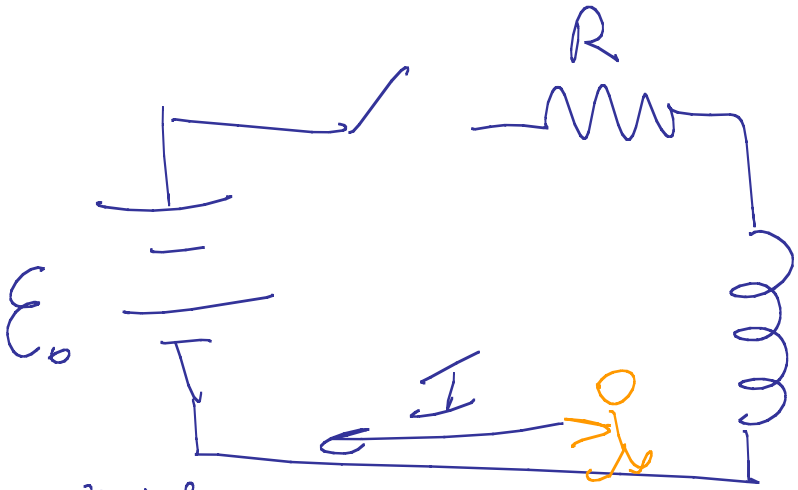
Units $\dfrac{[\Phi]}{[I]} = \dfrac{T\,m^2}{A}$ $\quad$ Henry (American) $\quad \mu H \quad -H$

Very useful.

Inductor L  $\quad$ condensor

"choke"

Inductors in Circuits



Kirchhoff

$$\mathcal{E} - IR - L\frac{dI}{dt} = 0 \qquad (1)$$