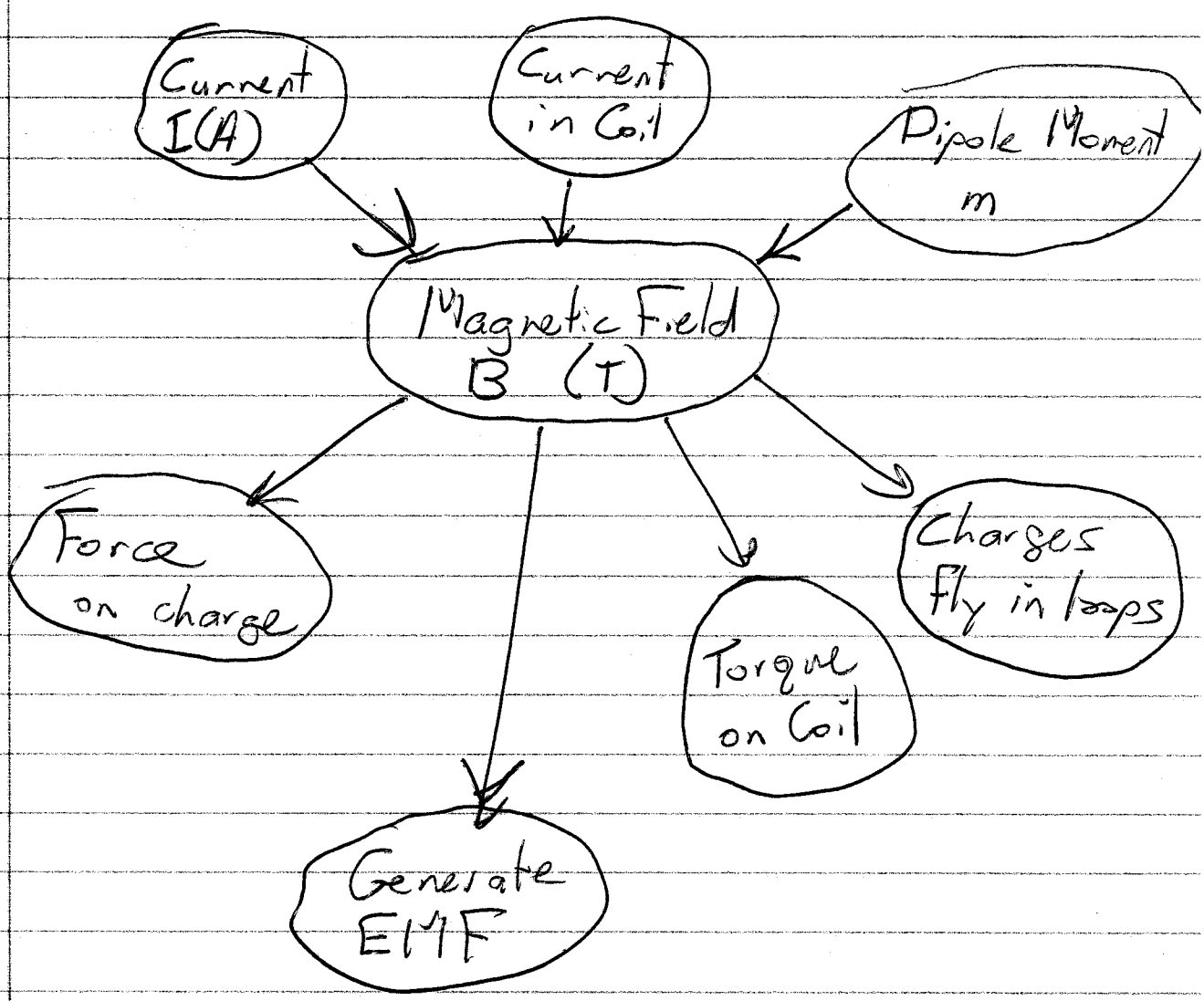
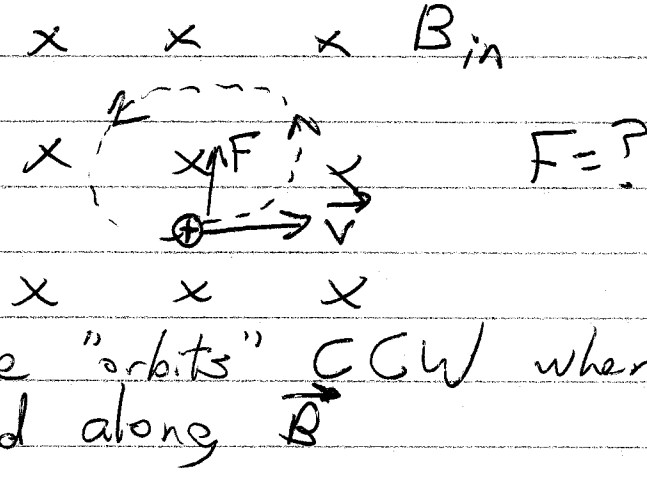
 Phys 1402 2015-10-13 Lec 14



$F = qv_\perp B$

Review:



⊕ particle "orbits" CCW when viewed along $\vec{B}$

Induced EMF

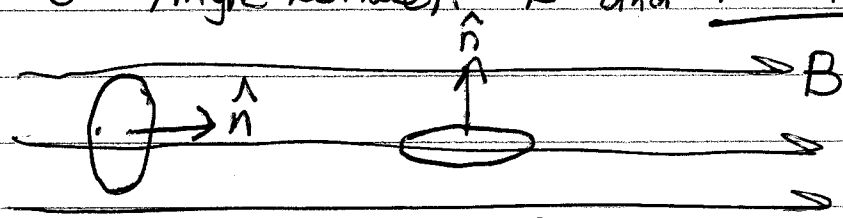
$$\mathcal{E} = -\frac{\Delta \Phi_B}{\Delta t}$$

EMF is caused by changing magnetic flux

What is flux? "Total amount" of B pointing through a coil.

$\Phi_B = NBA\cos\theta$ Total flux of coil

N = # of turns of wire
B = mag field strength
A = Area of coil ($A = \pi r^2$)
θ = Angle between $\vec{B}$ and normal ($\hat{n}$)

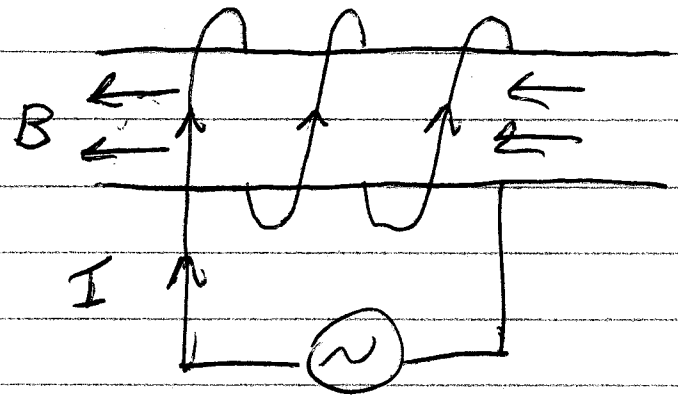


$\theta = 0$	$\theta = 90°$
$\cos\theta = 1$	$\cos\theta = 0$
$\Phi = NBA$	$\Phi = 0$

How can we change Φ_B?

- Change B – move a magnet into place
  – change current in coil
- Change θ – rotate the coil
- Change A – move one edge of coil

$\mathcal{E} = Bvl$



I is changing but known
I causes magnetic field

$$B = \mu_0 N I / \ell$$

B forms flux in coil

$$\Phi_B = NBA \cos\theta = \underbrace{\frac{\mu_0 N^2 A}{\ell}} I$$

L = Inductance in henries (H)

$$\Phi_B = L I$$

Change $I \Rightarrow$ changes $\Phi \Rightarrow$ makes $\mathcal{E}$

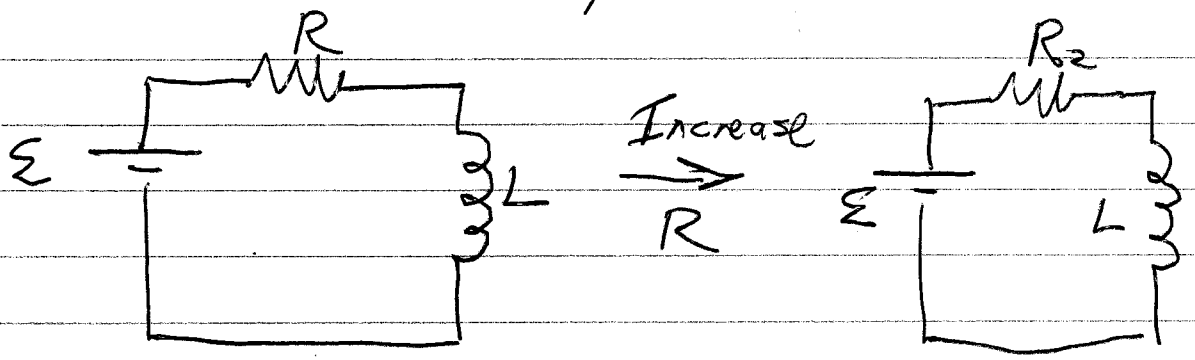
This is an inductor.

$$\mathcal{E} = \frac{\Delta \Phi}{\Delta t} = \frac{\Delta (LI)}{\Delta t} = L \frac{\Delta I}{\Delta t}$$

Lenz's Law - tells us direction of $\mathcal{E}$.

Coils hate change.

- Try to decrease I in an inductor. The coil reacts by trying to boost the current back up to its old value.



$$I = \frac{V_R}{R} = \frac{\mathcal{E}}{R} \qquad I = \frac{V_R}{R_2}$$

Same I, Bigger R } V_R must be bigger

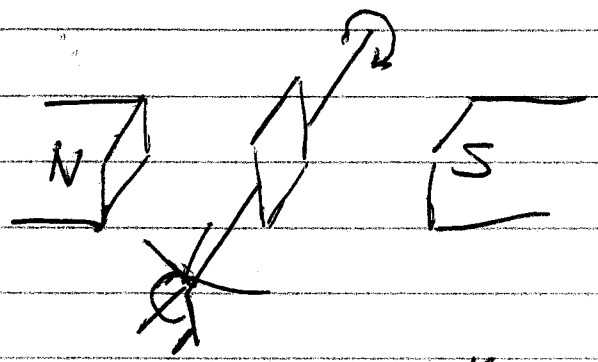
$$\mathcal{E} = V_R + V_L$$

$$V_R = \mathcal{E} - V_L \Rightarrow V_L \text{ must be big}$$

"Inductive Kick" - motor briefly generates high voltage when shut off.

(5)

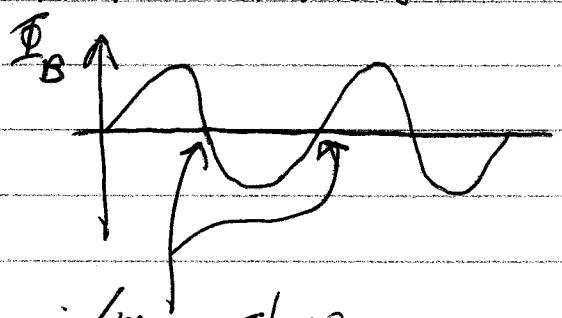
Electric Generators



Maximum Flux in coil $\Phi_{max} = NBA$

Spinning changes θ

Minimum Flux $\Phi_{min} = -NBA$



$$\mathcal{E} = -\frac{\Delta\Phi}{\Delta t}$$

$$\mathcal{E}_{max} = NBA\,\omega$$

ω = angular speed in radians per second.

$$1\ RPM \Rightarrow \omega = \frac{2\pi}{(60s)} = 0.105\ s^{-1}$$

Ex: $B = 0.004\ T$

$A = 0.0013\ m^2$ (20m radius)

$N = 130$

$$\omega = 3600\ RPM \left(\frac{0.105\ s^{-1}}{1\ RPM}\right) = 377\ s^{-1}$$

$$\mathcal{E}_{max} = 0.25\ V$$