Phys 1402 2014-10-14

HW Questions?

#6 & #7 : B of a wire (Sec 19.7)

$$B_{wire} = \frac{\mu_0 I}{2\pi r} \qquad \mu_0 = 4\pi \times 10^{-7} = \pi\, 4\times 10^{-7}$$

r = our dist from wire

Ex: $B = 50\,\mu T = 5\times 10^{-5}\,T$

$I = 0.2\,A$

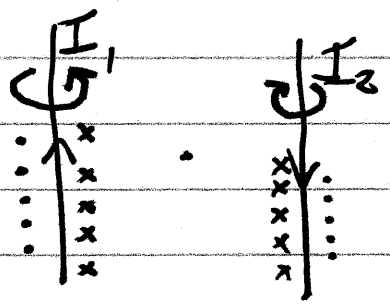
$$B = \frac{\mu_0 I}{2\pi r} \qquad r = \frac{\mu_0 I}{2\pi B}$$

$$= \frac{\mu_0 (0.2A)}{2\pi (5\times 10^{-5} T)}$$

$$= 8\times 10^{-4}\ m$$

$$= 0.8\ mm$$

Ex: Two wires



B_1 is out

B_2 is in

$B = B_1 - B_2$

B_1 = in

B_2 = in

$B = B_1 + B_2$

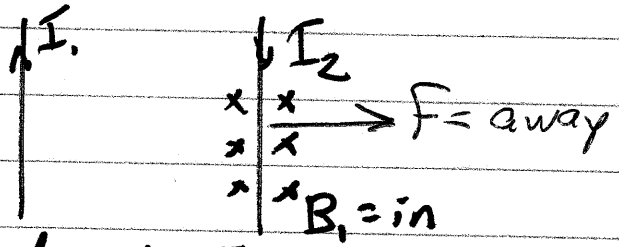
B_1 = in

B_2 = out

$B = B_2 - B_1$

(2)

#8



Force on I_2 due to I_1.

1. Calculate B_1 @ position of I_2.

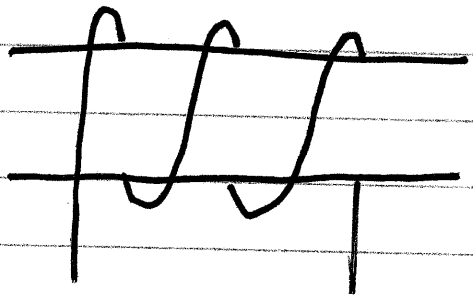
$$B_1 = \frac{\mu_0 I_1}{2\pi d} \qquad \text{(inward)}$$

2. Force on I_2

$$F_B = I \ell B$$

$$\frac{F}{\ell} = I_2 B_1$$

#14 Solenoid generates B.



$B = \mu_0 I N / \ell$

Ex: $N = 430$ turns

$\ell = 40$ cm

$I = 5.1$ A

$$B = \mu_0 (5.1A)(430)/(0.4m) = 6.89 \times 10^{-3} T$$

Magnetic Flux thru the cross section

$\Phi_B = BA$ $\quad A = \pi r^2$ $\quad r = 3.3$ cm

$= (6.89 \times 10^{-2} T)\pi (0.033 m)^2$

$= 2.36 \times 10^{-5} \ T \cdot m^2$

Lenz's Law - which way does the induced voltage point?

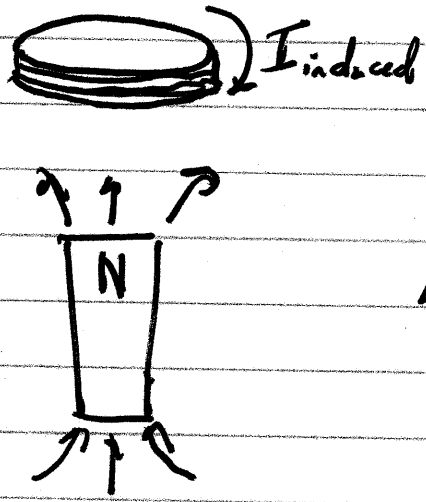
EMF caused by change in Flux.
↕ voltage

$$\Phi_B = BA\cos\theta$$

PhET: Faraday's Electromagnetic Lab

Lenz's Law: When the flux changes, the direction of the EMF pushes a current that opposes the change in flux.

Ex: Drop a ring onto a magnet



As the ring falls
- B points up
- B is getting stronger

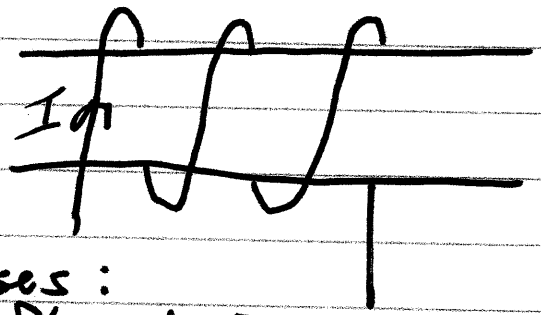
Lenz's Law
- Induced B is down.
- I goes CW as viewed from the top.

As the ring falls off the bottom:
- B points up
- B decreases

} Induced B is up, I is CCW

(5)

Solenoid



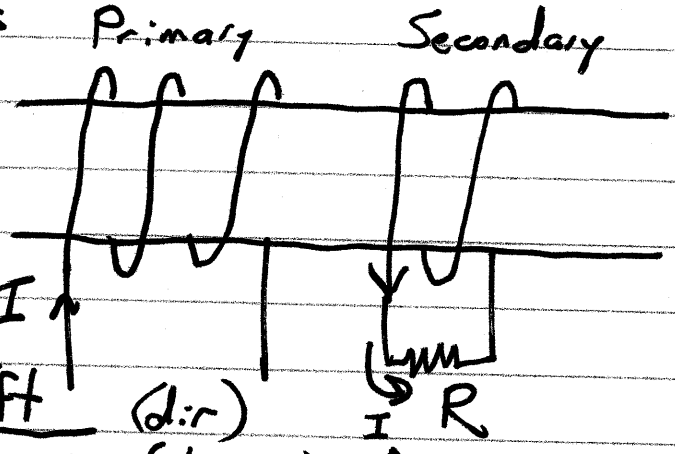
As I decreases:

- B is leftward
- B is decreasing

} Induced B is leftward
Induced I is up the front.

A coil opposes changes in current because of Lenz's Law.
This is inductance.

Two Solenoids



I is increasing.

- B is left (dir)
- B is increasing (change)

Induced current.

So:

- Induced B is rightward
- Induced I is down the front.
- Thru R, I is rightward

Example of motor w/ Back EMF

120 V motor with 20Ω resistance.

$\mathcal{E} = NBA\omega$

$\mathcal{E}$ proportional to ω

@ Full Speed, $I = 2.0\,A$

$$V_{Net} = V_1 + V_2 \quad \text{(Series)}$$

$$V_{in} = \mathcal{E} + V_R$$

@ Full Speed,

$$V_R = IR = (2.0A)(20\Omega) = 40v$$

$$(120v) = \mathcal{E} + (40v)$$

$$\mathcal{E} = 80\ v$$

What if we stop the motor?

$$(120v) = 0 + V_R$$

$$I = \frac{V_R}{R} = \frac{120v}{20\Omega} = 6.0\,A$$

Why do we care?

$$P_1 = VI = (120v)(2A) = 240\ W$$

$$P_2 = VI = (120v)(6A) = 720\ W$$