Physics 142 – October 30, 2007

Happy Halloween Tomorrow

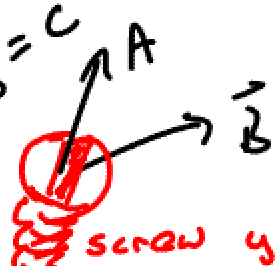
- Last week
  - → survey
- Exam 2 scheduled for Nov. 8, 2007

  yikes!
- Presentations

Right Hand Rule (s)

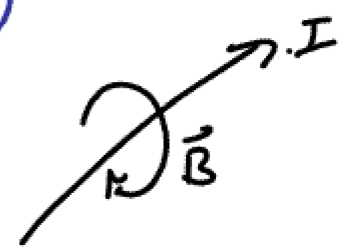
Be sure you can do these

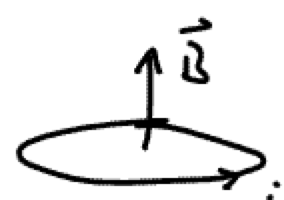
$\vec{A} \times \vec{B} = \vec{C}$



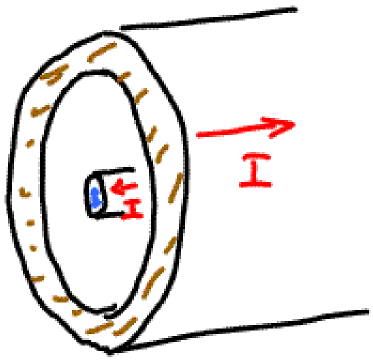
screw goes in direction of $\vec{A} \times \vec{B}$

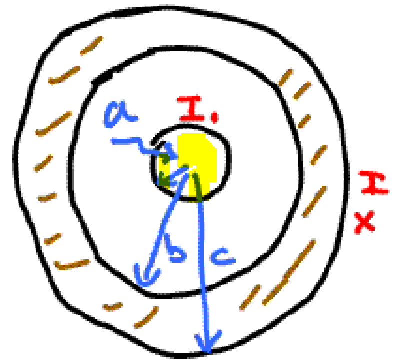
$q \vec{v} \times \vec{B} = \vec{F}$





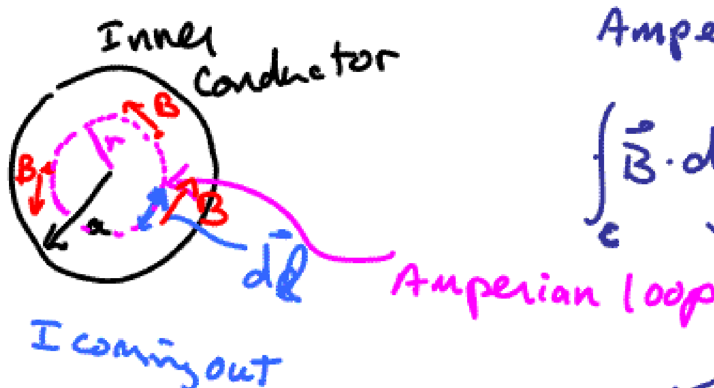
Coaxial cable (long)





Assume I uniform across both inner + outer conductors. Find $\vec{B}$ in all space

$r < a$



Ampere's law

$$\oint_C \vec{B}\cdot d\vec{l} = \mu_0 I_{encl}$$

$$\oint_C \vec{B}\cdot d\vec{l} = \oint_C |\vec{B}|\, dl = |\vec{B}| \int_0^{2\pi r} dl = B\, 2\pi r = \mu_0 I_{encl}$$

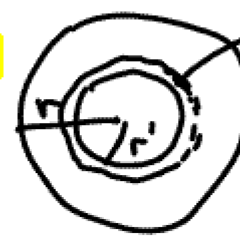
Symmetry + choice of loops

Current density $= \vec{j}(\vec{r})$

$|\vec{j}|$ is const $= \dfrac{I}{\pi a^2}$

I_{enc} = I inside r

$$I_{encl} = \int j \, dA$$



$dA = 2\pi r' dr'$

$$I_{enc} = \int_0^r j \, 2\pi r' dr' = \frac{I}{\pi a^2} 2\pi \int_0^r r' dr' = \frac{r^2}{2} \frac{I \, 2\pi}{\pi a^2}$$

$j \rightarrow \dfrac{I}{\pi a^2}$

Fast way to do calc.

$$I_{enc} = j \pi r^2 = \frac{I}{\pi a^2} \pi r^2 = \frac{I r^2}{a^2}$$

$$I_{encl} = \frac{I r^2}{a^2}$$

$B \, 2\pi r = \mu_0 I_{encl}$

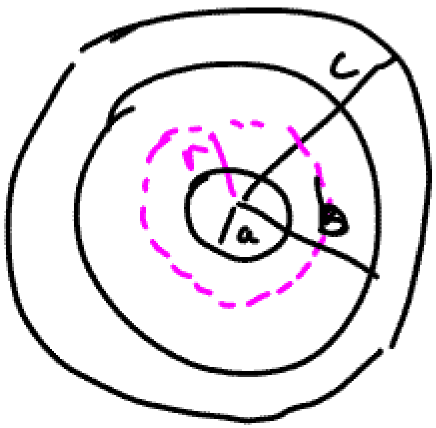
$$B \, 2\pi r = \mu_0 I \frac{r^2}{a^2}$$

$$B = \frac{\mu_0 I r}{2\pi a^2} \quad \text{for } r < a$$

counterclockwise

at $r = a$ $\quad B = \frac{\mu_0 I}{2\pi a}$

right limit



$a < r < b$

$$\oint_c \vec{B} \cdot \vec{dl} = \mu_0 I_{encl}$$

$$B \, 2\pi r = \mu_0 I$$

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

counterclockwise

$b<r<c$

$$\int_c \vec{B}\cdot d\vec{l} = \mu_0 I_{encl}$$

$$B\,2\pi r = \mu_0 I_{encl}$$

$I_{encl} = \underline{I}$ (inner conductor) $-$ i (outer cond enclosed)

get $i_{outer\,encl}$

easy

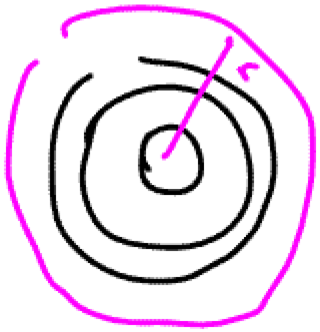
$$i_{encl\,in} = j\,(\pi r^2 - \pi b^2) = I\left(\frac{\pi r^2 - \pi b^2}{\pi c^2 - \pi b^2}\right) = I\left(\frac{r^2-b^2}{c^2-b^2}\right)$$

$j = I / (\pi c^2 - \pi b^2)$

$b<r<c$

$$B = \frac{\mu_0}{2\pi r}\left[I - I\frac{(r^2-b^2)}{(c^2-b^2)}\right]$$ counterclockwise

$r > c$ $\quad I_{encl} = 0 \Rightarrow \boxed{B = 0}$ $\quad r > c$



$$\oint \bar{B} \cdot d\bar{l} = \mu_0 I_{enc}$$

The obvious way to make problem a bit more difficult is to give current density that varies w/ r

$$j \longrightarrow j(\vec{r})$$

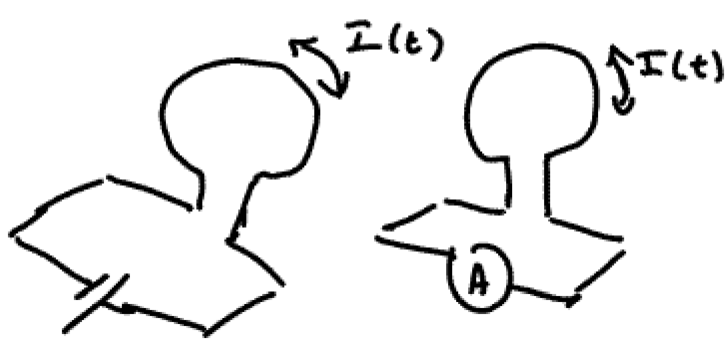
MUST Evaluate

$$\oint B \cdot dl = B 2\pi r = \mu_0 I_{encl}$$

$$I_{encl} = \int_{r_1}^{r_2} j(r)\, 2\pi r\, dr$$

Magnetic Induction

1830's Michael Faraday (England)
Joseph Henry (US)



Induction ≡ a changing magnetic field "Induces" a changing electric field