8.022 Lecture Notes Class 18 - 10/17/2006

Magnetostatics

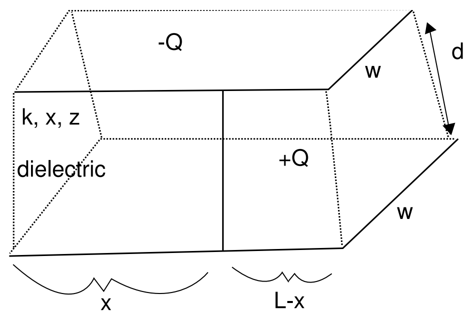
What is Magnetism?

- attraction of the opposite
- $\vec{F}$ on moving charges $\vec{F} \perp \vec{d}$ of charges
- $|\vec{F}| \alpha |\vec{v_+}|$

$$\Rightarrow \vec{F_B} = q(\vec{v} \times \vec{B})$$

In fact, $\vec{F_{E,B}} = q(\vec{E} + (\vec{v} \times \vec{B}))$ (Lorentz Force Law)

H is to B as D is to E



- Find capacitance
- Find energy
- Find force on middle dielectric

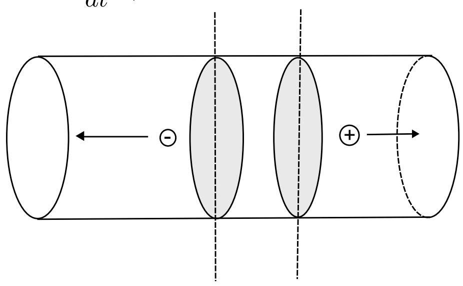
- $$C = \frac{wx\epsilon}{d} + \frac{w(L-x)\epsilon_0}{d}$$

- $$E = \frac{1}{2}\frac{Q^2}{C} = \frac{Q^2}{\frac{2}{d}(wx\epsilon + w(L-x)\epsilon_0)}$$

- $$F = \frac{dE}{dx} = \frac{d}{dx}\left(\frac{Q^2}{\frac{2}{d}(wx\epsilon + w(L-x)\epsilon_0)}\right) = \frac{Q^2}{\frac{2w}{d}}\frac{d}{dx}\left(\frac{1}{x\epsilon + w(L-x)\epsilon_0}\right)$$
  $$= \frac{Q^2}{\frac{2w}{d}}\frac{d}{dx}\left(\frac{1}{wL\epsilon_0 + x(\epsilon - w\epsilon_0)}\right)$$
  $$= -\frac{Q^2 d}{2w} \cdot \frac{\epsilon - w\epsilon_0}{[wL\epsilon_0 + w(\epsilon - w\epsilon_0)]}$$

Moving Charges

$I = \frac{dQ}{dt}$, current



$$\begin{cases} \text{charges q} \\ \text{linear density } n_L \\ \text{velocity v} \end{cases}$$

I has no direction, but J does!

$$I = q \cdot n_L v$$
$$dI = \vec{J} \cdot d\vec{A}$$
$$\vec{J} = q \cdot n \cdot \vec{v} \quad \text{where } \vec{J} \text{ is the current density}$$