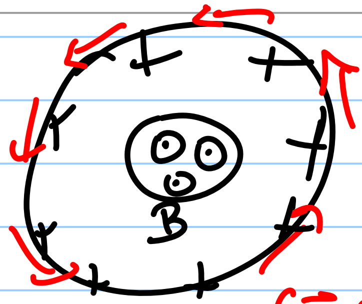
Note Title 4/14/2008



Calculate ΔL due ΔB

$$\oint \vec{E}\cdot d\vec{l} = \mathcal{E}mf = -\frac{d\Phi_m}{dt}$$

Changing B generates $\vec{E}$

$$\vec{\tau} = \frac{d\vec{L}}{dt} \qquad \vec{F} = \frac{d\vec{p}}{dt}$$

$$\vec{r}\times\vec{F} = \vec{r}\times q\vec{E}$$

Maxwell's Eqn

$$\vec{\nabla}\cdot\vec{E} = \frac{\rho}{\epsilon_0} \quad \text{Gauss Law} \qquad \vec{\nabla}\cdot\vec{B} = 0$$

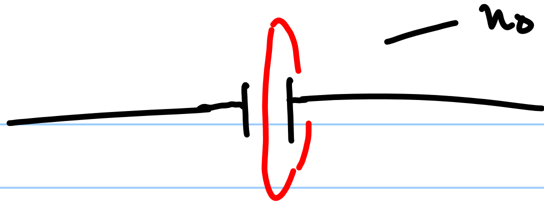
$$\vec{\nabla}\times\vec{E} = -\frac{\partial\vec{B}}{\partial t} \quad \text{Faraday's} \qquad \boxed{\vec{\nabla}\times\vec{B} = \mu_0\vec{J} \quad \text{Amps}}$$

$$\vec{F} = q\vec{E} + q\vec{v}\times\vec{B} \qquad \vec{\nabla}\cdot\vec{J} = -\frac{\partial\rho}{\partial t} \quad \text{cons charge}$$

$\oint \vec{B}\cdot d\vec{l} = \mu_0$

cal B: $\int \vec{\nabla}\times\vec{B}\cdot d\vec{a} = \oint \vec{B}\cdot d\vec{l}$

$\int \mu_0\vec{J}\cdot d\vec{a} = \mu_0 I_{encl}$



— no $I_{encl} \Rightarrow$ no B

Assumed magnetic static $\vec{\nabla}\cdot\vec{J} = -\frac{\partial \rho}{\partial t} = 0$

When current goes into cap $I = I_0 e^{-t/RC}$

So magnetic statics NOT valid

Fundamental principles NON STATIC

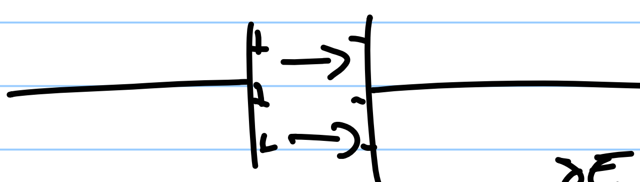
$$\vec{\nabla}\cdot\vec{J} = -\frac{\partial \rho}{\partial t} \qquad \vec{\nabla}\cdot\vec{E} = \frac{\rho}{\epsilon_0} \rightarrow \rho = \epsilon_0 \vec{\nabla}\cdot\vec{E}$$

$$\frac{\partial \rho}{\partial t} = \epsilon_0 \vec{\nabla}\cdot\frac{\partial \vec{E}}{\partial t}$$

Problem with $\vec{\nabla}\times\vec{B} = \mu_0 \vec{J}$ fixed

$$-\vec{\nabla}\cdot\vec{J} = \frac{\partial \rho}{\partial t} = \epsilon_0 \vec{\nabla}\cdot\frac{\partial \vec{E}}{\partial t}$$

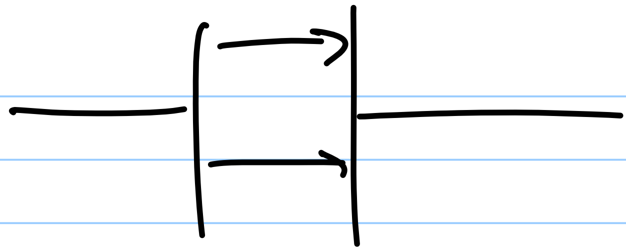
$$\vec{J}_{Disp} = +\epsilon_0 \frac{\partial \vec{E}}{\partial t}$$



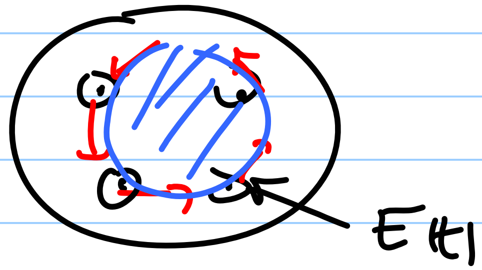
$E(t) \Rightarrow \frac{\partial E}{\partial t} \neq 0$

$$\vec{\nabla}\times\vec{B} = \mu_0 \vec{J} \rightarrow \mu_0 J_{charges} + \mu_0 J_{Disp}$$

$$\vec{\nabla}\times\vec{B} = \mu_0 \vec{J} + \mu_0 \epsilon_0 \frac{\partial \vec{E}}{\partial t}$$



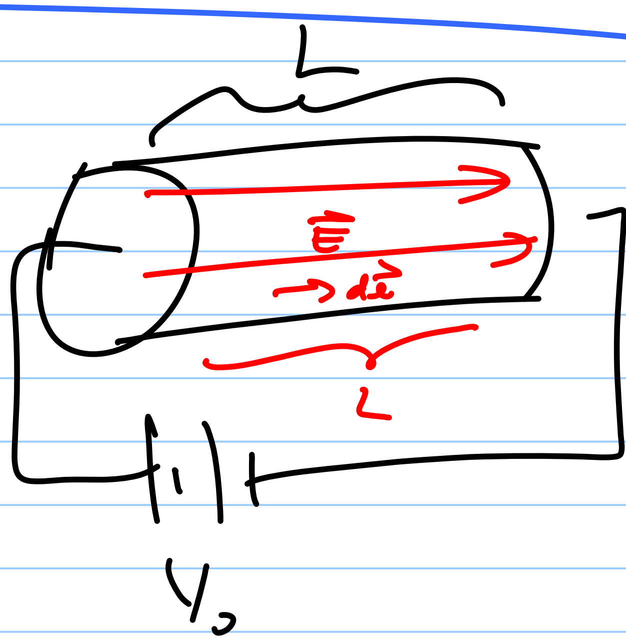
$$E = \frac{\sigma}{\epsilon_0}$$



$$\oint \vec{B}\cdot d\vec{l} = \mu_0 \int \underbrace{\vec{J}_{disp}}_{\epsilon_0 \frac{\partial \vec{E}}{\partial t}} \cdot d\vec{a} = \mu_0 \epsilon_0 \int \frac{\partial \vec{E}}{\partial t}\cdot d\vec{a}$$

$$= \mu_0 \epsilon_0 \frac{\partial}{\partial t} \underbrace{\int \vec{E}\cdot d\vec{a}}_{\Phi_E}$$

Derive $V = IR$



Principles

$J = \sigma E$ Ohm's

$\Delta V = -\int \vec{E}\cdot d\vec{l}$

$I = \int \vec{J}\cdot d\vec{a}$

Method: find I in terms J & V in terms of E

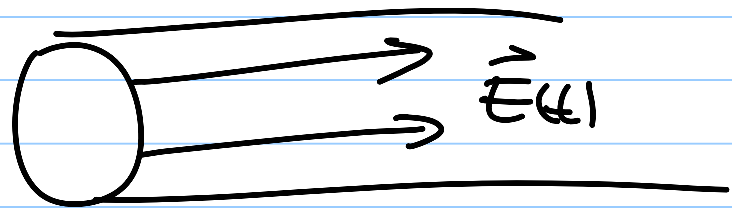
$$|\Delta V| = \left|-\int \vec{E}\cdot d\hat{l}\right| = EL \rightarrow E = \frac{V}{L}$$

$$I = \int \vec{J}\cdot d\vec{a} = \int \sigma E \, da = \sigma E A$$

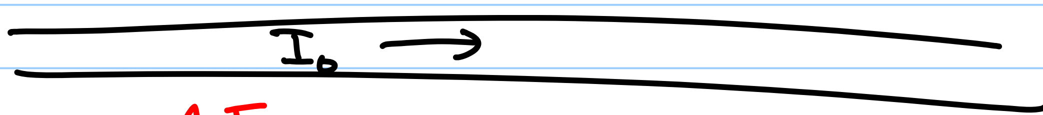
$$I = \sigma \frac{V}{L} A \Rightarrow V = I \underbrace{\left(\frac{L}{\sigma A}\right)}_{R}$$

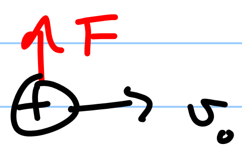
Check: $T \to 0$

E very large so thermal speed < speed due E



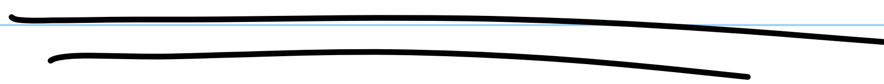
$J_{charge} + \epsilon_0 \frac{\partial E}{\partial t}$ both displ. & charge current





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

Go to the frame of the charge (move at speed v_0)



⊕ $\vec{F} =$