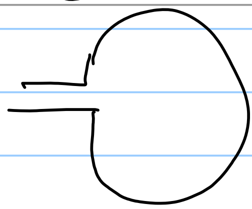
Note Title Question 1 4/13/2009



wire loop

Find self inductance of the loop.

Prin: Definition of L $\quad \Phi \propto I$

$\Phi \equiv L I$ ← defn

Method: find Φ but need a B for $\int \vec{B} \cdot d\vec{a}$

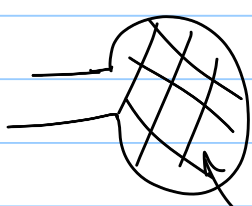
So assume current I in the loop that generates B

(J) given — Biot & Savart / Amp's Law → (B) find $\qquad$ (A)

Then use Biot & Savart to find $\vec{B}$. Then cal $\vec{B} \cdot d\vec{a}$ for each tile on surface & get

CHECK: let area → 0 then $L \to 0$

Details $\vec{B} = \frac{\mu_0}{4\pi} \int \frac{I \, d\vec{l} \times \hat{r}}{r^2}$ $\qquad \Phi = \int \vec{B} \cdot d\vec{a} = L I$



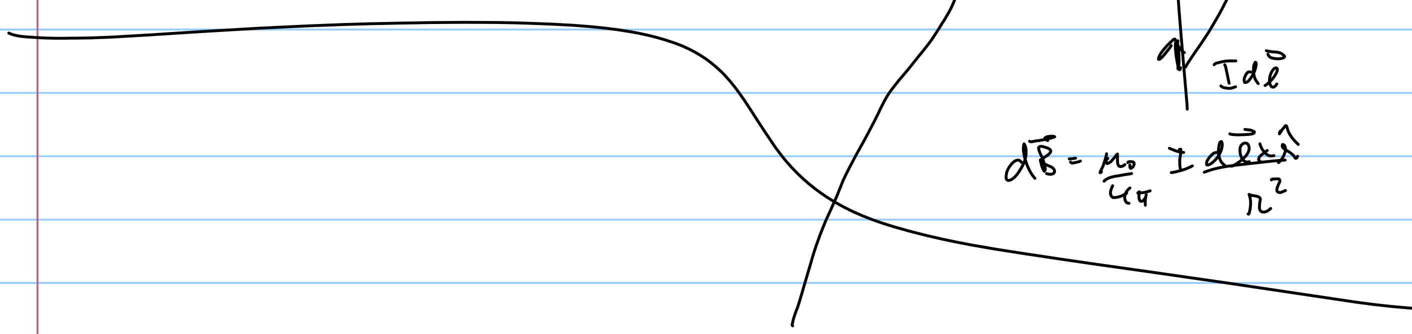
choose area

← amps law not useful here since hard to calculate $\oint \vec{B} \cdot d\vec{l}$

Amps law works well here

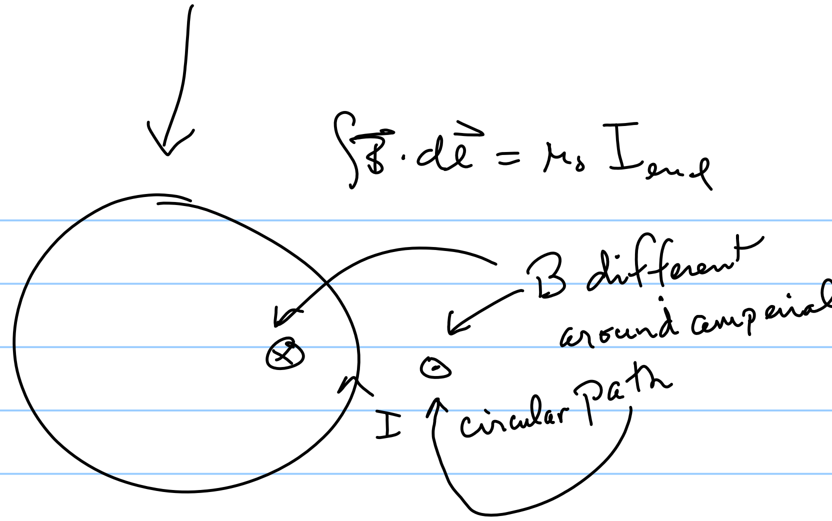
$I d\vec{l}$

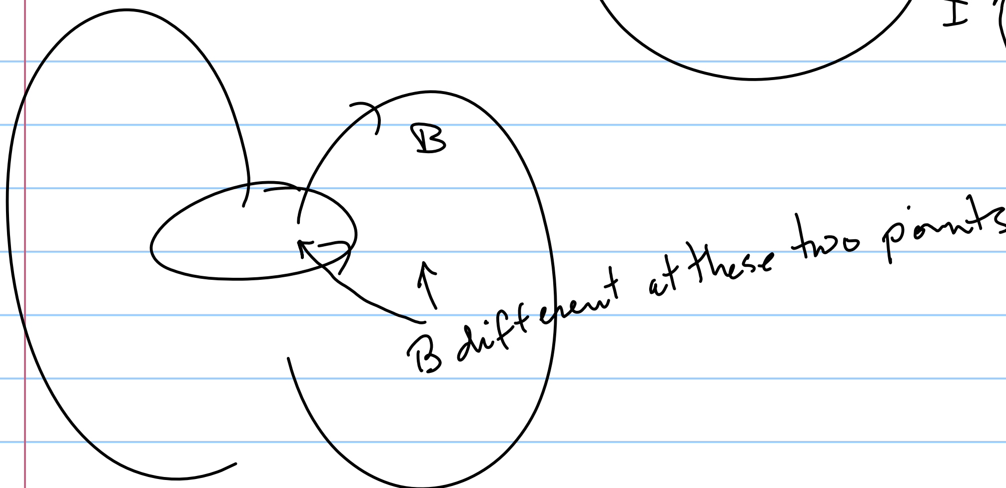
$d\vec{B} = \frac{\mu_0}{4\pi} \frac{I \, d\vec{l} \times \hat{r}}{r^2}$



Perfect circle

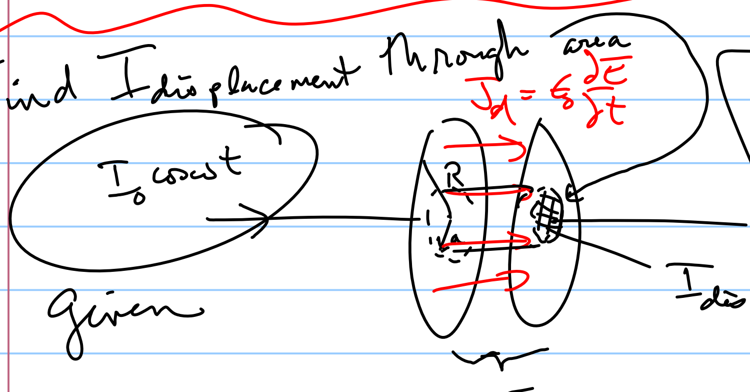
$$\oint \vec{B}\cdot d\vec{l} = \mu_0 I_{encl}$$





Assume low freq

Find $I_{displacement}$ through area



$$\boxed{I_{displacement} \text{ in } \pi a^2}$$

$$I_{displ} = \int \vec{J}_{displ} \cdot d\vec{a}$$

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

Prin:
$$J_{disp} \overset{\text{defn}}{\equiv} \epsilon_0 \frac{\partial E}{\partial t}$$

Gauss's Law to find E

Method: Find E using Gauss's law

$$E = \frac{\sigma(t)}{\epsilon_0}$$ then relate σ to I $\left(\frac{\text{Coul}}{s}\right)$

$\sigma = \epsilon_0 E$

using σA is charge ← to area of cap

$$\frac{d(\sigma A)}{dt} = \frac{dQ}{dt} = I_0 \text{ const}$$

$$A\frac{d\sigma}{dt} = A\,\underbrace{\epsilon_0 \frac{dE}{dt}}_{J} = \underline{I_0 \text{ const}}$$

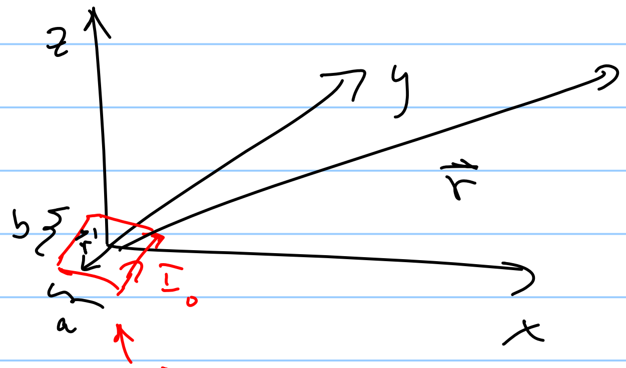
this gives $\frac{dE}{dt}$

and then $\epsilon_0 \frac{\partial E}{\partial t}$ is J_d

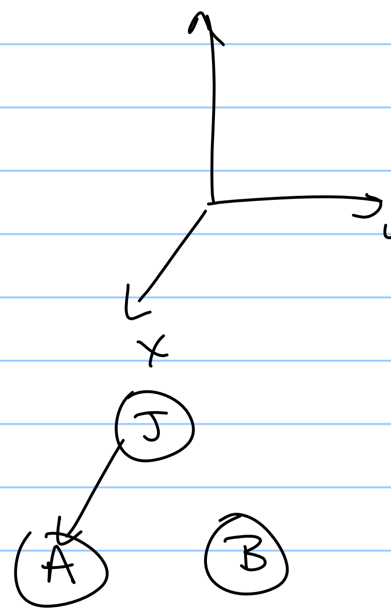
Then $\int \vec{J}_{displcm} \cdot d\vec{a}$

Check: $a \to R$ $\quad I_{displacm} = \omega I_0 \cos \omega t$

$$= \epsilon_0 \frac{\partial E}{\partial t} = \epsilon_0 \frac{\partial (\sigma A)}{\partial t}$$



in x-y plane



$\boxed{\text{Find } \vec{A} \text{ far from origin.}}$

Prin: $\quad \vec{A} = \frac{\mu_0}{4\pi} \int \frac{I_0 d\vec{l}}{\mathscr{r}}$

Method: $\quad A_x = \frac{\mu_0}{4\pi} I_0 \int_{-a}^{a} \frac{dx' \hat{x}}{\mathscr{r}}$ $\qquad$ find $\vec{r}'$ & $\vec{r} = x\hat{x} + y\hat{y} + z\hat{z}$

2 integrals $\to$

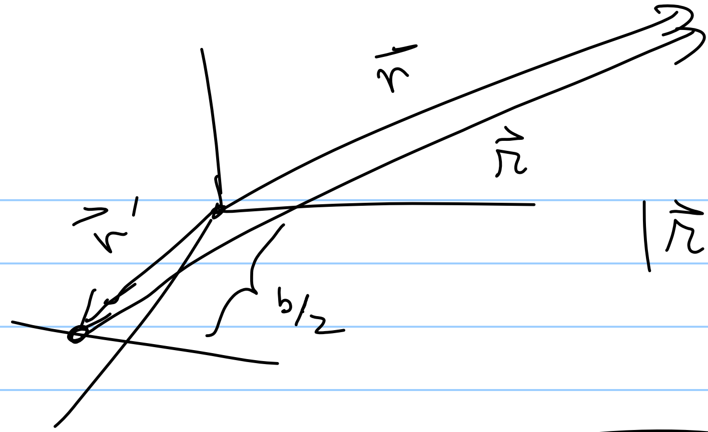
$$A_y = \frac{\mu_0}{4\pi} I_0 \int_{-b}^{b} \frac{dy' \hat{y}}{\mathscr{r}}$$

$A_z = 0$ $\qquad \vec{A} = A_x \hat{x} + A_y \hat{y} + 0 \hat{z}$

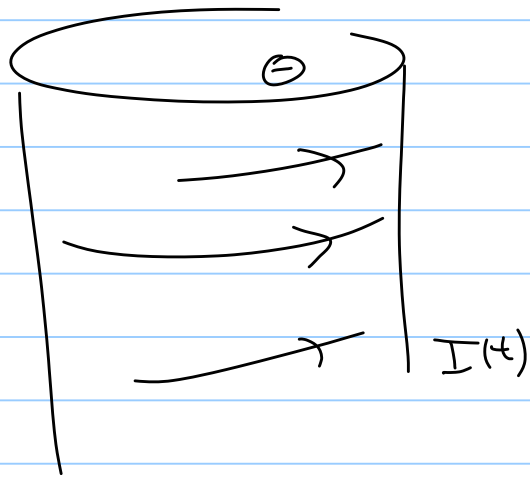
Check: $\quad a \to 0 \qquad \vec{A} = 0$

$b \to 0 \qquad \vec{A} = 0$

$A \to 0$ as $r \to \infty$



$|\vec{\mathscr{r}}| =$



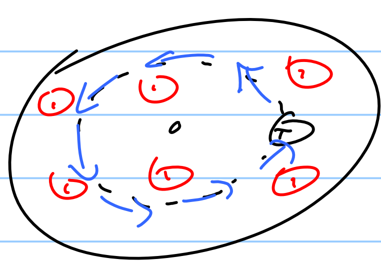
How does charge move if B varies slowly with time.

Prin: $\vec{F} = m\vec{a} = q\vec{E} + q\vec{v}\times\vec{B}$

Amp's law gives B

Faradays law gives E caused by changing B

Method: choose amp path $\frac{1}{\epsilon_i}$ $\oint \vec{B}\cdot d\vec{\ell} = \mu_0 I_{en}$



$$\oint \vec{E}\cdot d\vec{\ell} = -\frac{d\Phi_B}{dt}$$

gives E

Check: I is const $E \to 0$ just $q\vec{v}\times\vec{B}$ forces

zero

I is zero particle is unaffected