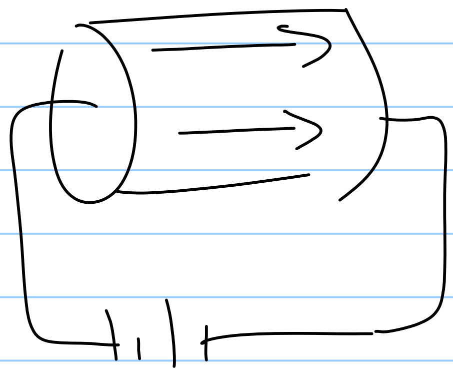
Note Title 3/27/2009

Ohm's Law

$\vec{v}_{drift} \propto \vec{E}$



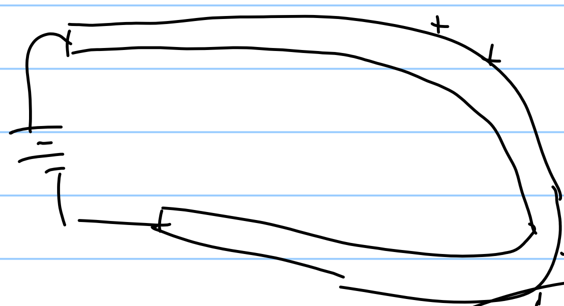
$\vec{J} = \rho\vec{v} = \sigma\vec{E}$

$\vec{E} = \frac{\vec{J}}{\sigma}$

$\vec{\nabla}\cdot\vec{E} = \frac{1}{\sigma}\vec{\nabla}\cdot\vec{J} = -\frac{\partial\rho}{\partial t} = 0$

$\vec{\nabla}\cdot\vec{E} = -\nabla^2 V = 0$

bndry $J_{\perp\,\text{bndy}} = 0$
&
$E_{\perp\,\text{bndy}} = 0$



Tablet problem: $\vec{J} = \sigma\vec{E}$ OHM's

$\vec{\nabla}\cdot\vec{E} = \frac{1}{\sigma}\vec{\nabla}\cdot\vec{J} = 0$

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

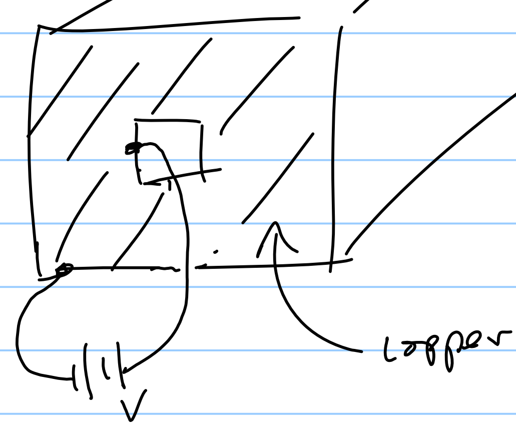
Principles

$\vec{\nabla}\cdot\vec{E} = 0$

$\boxed{\nabla^2 V = 0}$ & bndy of V on surface

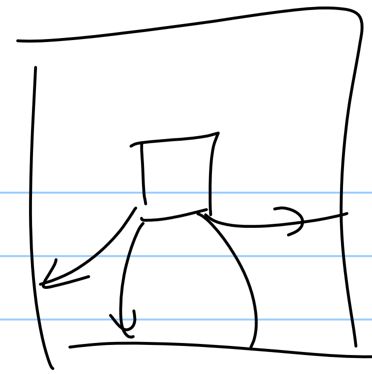
Find V then

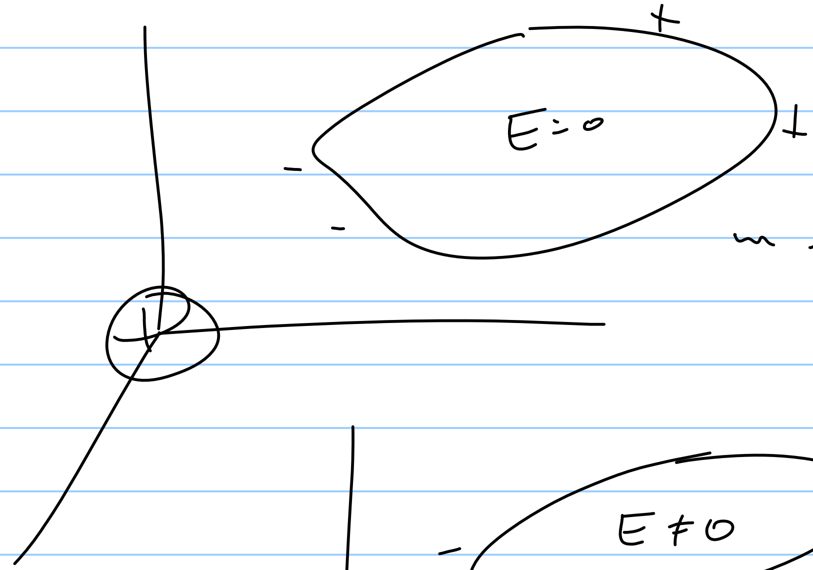
$\vec{E} = -\vec{\nabla} V = \frac{\vec{J}}{\sigma}$



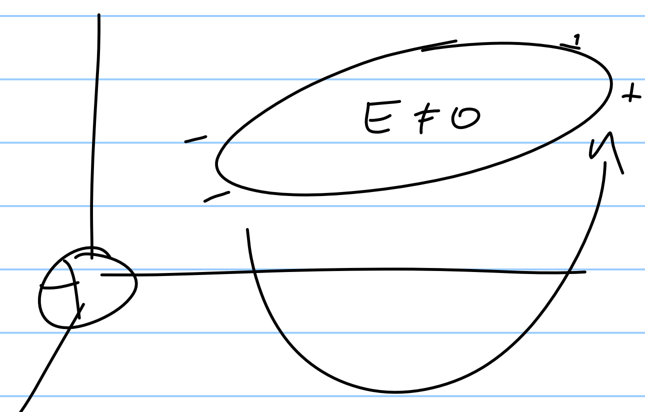
method: Sep. var.

$\boxed{\text{relaxation method}}$



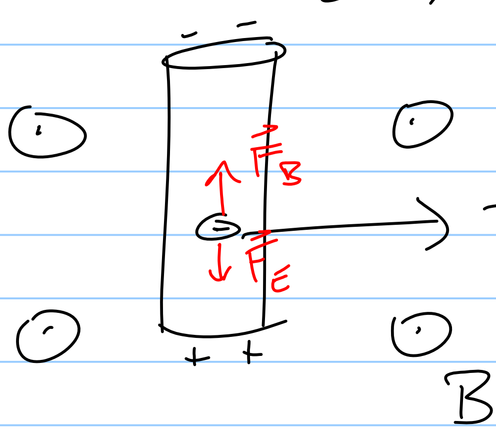


in electrostatics



tweezers

tweezers



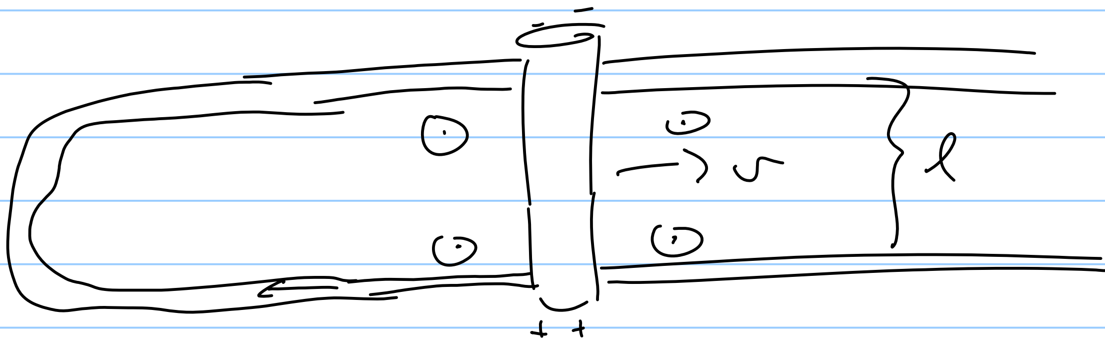
F_{ne} causes v

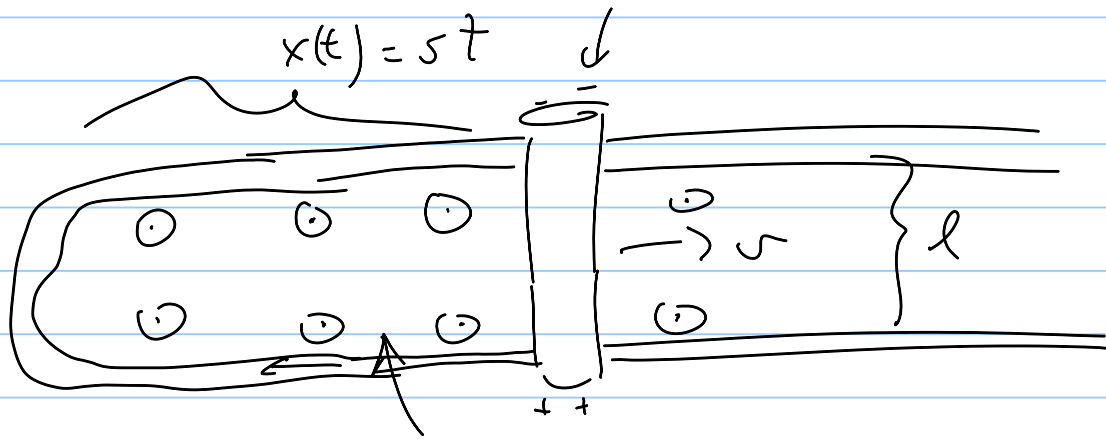
B

$\cancel{q} v B = \cancel{q} E$

"battery" with voltage $= \int \vec{E} \cdot d\ell = vB\ell$

vB



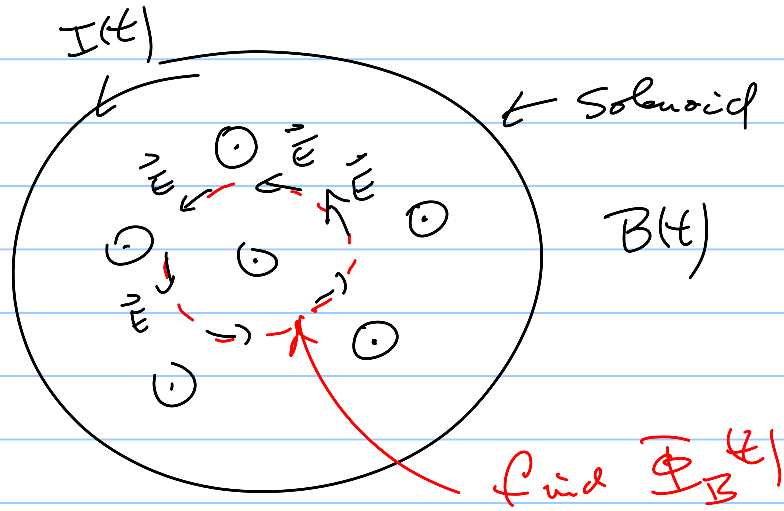


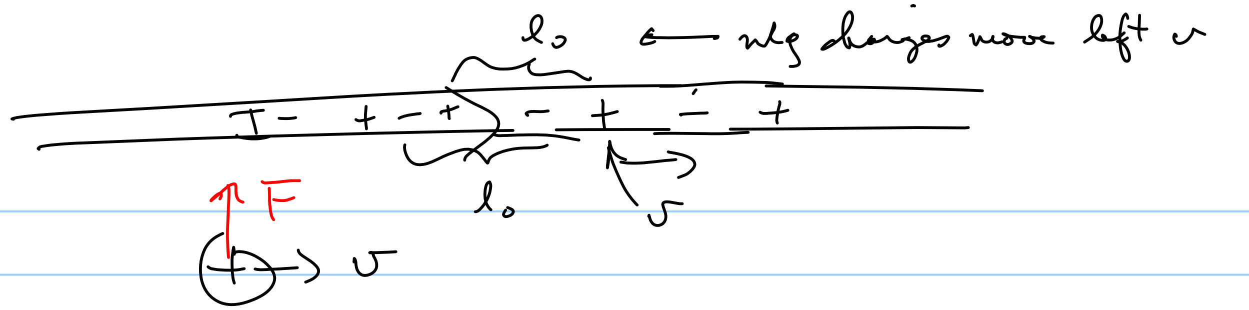
$$\Phi_B = \int \vec{B} \cdot d\vec{a} = B\ell vt$$

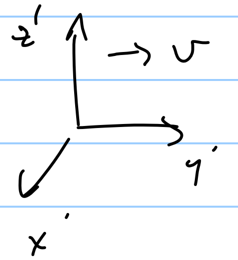
$$-\frac{d\Phi_B}{dt} = \mathcal{E}mf$$

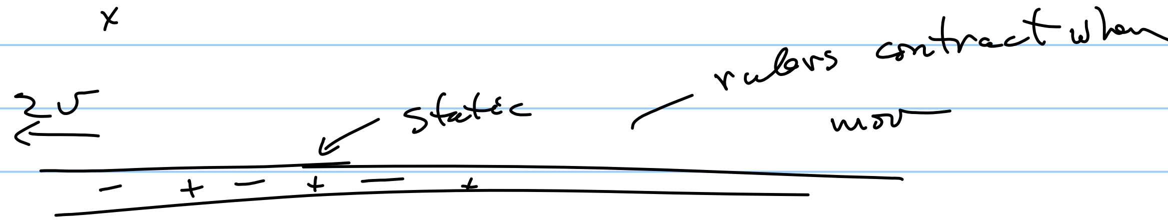
$$\frac{d\Phi_B}{dt} = \mathcal{E}mf = \oint \vec{E} \cdot d\ell \neq 0$$

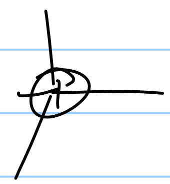
Ex:







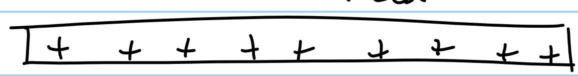




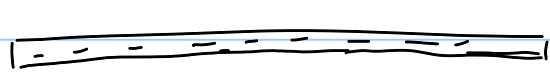
$$\vec{F} = q\vec{E} + q\underbrace{\vec{v}}_{=0}\times\vec{B}$$

$$\lambda_- > \lambda_+$$

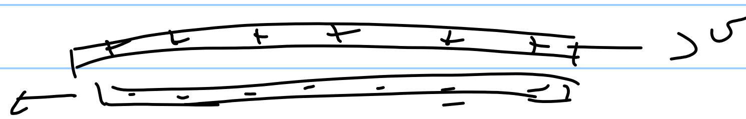
1 m ruler



λ_0



$-\lambda_0$

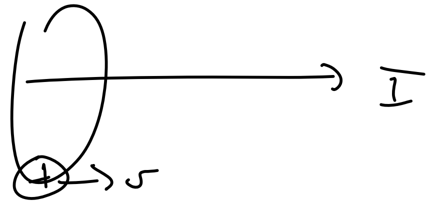


$$I = 2\lambda' v$$

$$\lambda' = \frac{\lambda_0}{\sqrt{1 - v^2/c^2}}$$

in lab current carrying wire is neutral no $\vec{E}$ just qvB

Go back lab frame



$2\pi r B = \mu_0 I$

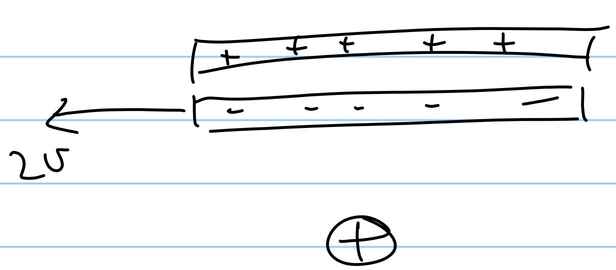
$B \propto \frac{I}{r}$

$$\vec{F} = q\underset{\overset{\shortparallel}{0}}{\vec{E}} + q\vec{v}\times\vec{B} = q\underline{vB}$$

$B \propto \frac{I}{r} \propto \frac{\lambda v}{r}$

$$F \propto \frac{v^2}{r}$$

Go to charge frame



$\underline{\lambda_0}$

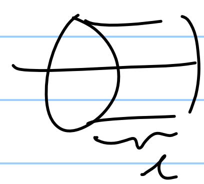
$$\frac{-\lambda_0}{\sqrt{1-v^2/c^2}} = -\lambda_0\left(\underline{1} - \frac{4}{2}v^2/c^2 + \cdots\right)$$

$$\vec{F} = q\underset{\overset{\shortparallel}{0}}{\vec{v}}\times\vec{B} + q\vec{E}$$

Net charge of wire $\propto v^2$

Gauss's Law $\Rightarrow$ $E\, 2\pi r \ell = \lambda \ell$

$E \propto \frac{1}{r}$



$$F = qE \propto \frac{\lambda}{r} \propto \frac{v^2}{r}$$