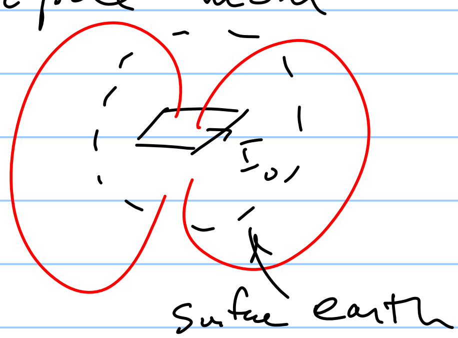
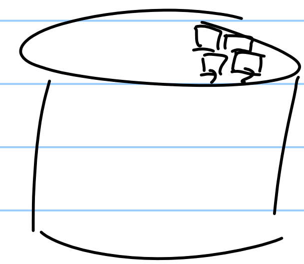
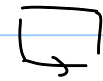
Mag materials

Note Title 4/20/2009

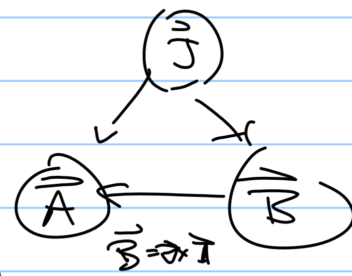
Dipole mom

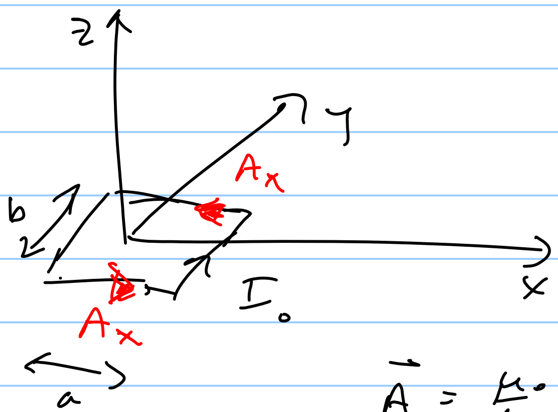






Find $\vec{A}_{dipole}$ $\vec{B}_{dipole} = \nabla \times \vec{A}_{dipole}$

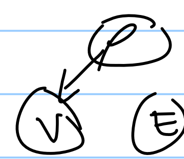


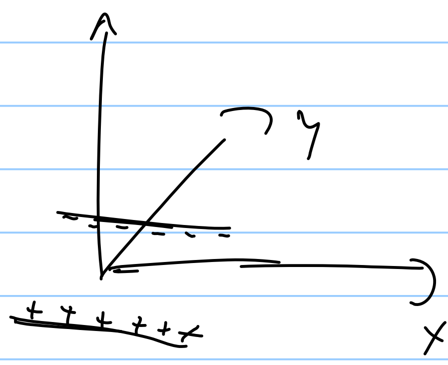


$$\vec{A} = \frac{\mu_0}{4\pi}\int \frac{\vec{J}(r')}{r} d\tau'$$

$$\vec{r} = \vec{r} - \vec{r}'$$

$$\vec{A} = \frac{\mu_0}{4\pi}\int \frac{I(\vec{r}')\,d\vec{l}}{r}$$





$$V = \frac{1}{4\pi\epsilon_0}\int \rho \frac{d\tau}{r}$$

$$V = \frac{\lambda}{4\pi\epsilon_0}\int \frac{dl}{r}$$

$$A_x = \frac{\mu_0 I_0}{4\pi}\int \frac{dl}{r} \quad (dl \to dx)$$

$$A_y = \frac{\mu_0 I_0}{4\pi}\int \frac{dl}{r} \quad (dl \to dy)$$

$$\lambda = I_0 \mu_0 \epsilon_0$$

$$V_{dipole} = \frac{1}{4\pi\epsilon_0} \frac{\vec{p} \cdot \hat{\mathscr{r}}}{\mathscr{r}^2}$$

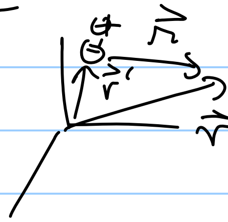
$$\vec{p} = \int \rho \vec{r} \, d\tau$$

$$= \lambda a b$$

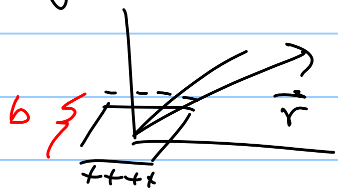
$$p = q b = \lambda a b$$

$\updownarrow$ $\lambda = I \mu_0 \epsilon_0$

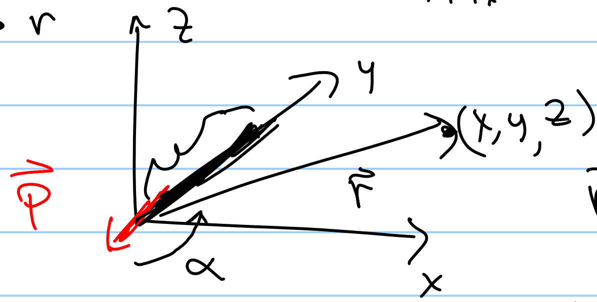
A_x



In our geometry $\vec{\mathscr{r}} = \vec{r} - \vec{r}'$



need $\vec{p} \cdot \hat{r}$



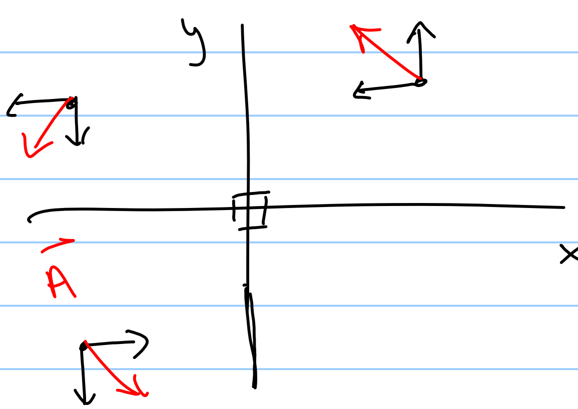
$$\vec{r} = x\hat{x} + y\hat{y} + z\hat{z}$$

$$\cos\alpha = \frac{y}{r} = \frac{y}{\sqrt{x^2+y^2+z^2}}$$

$$\vec{p} \cdot \hat{r} = |\vec{p}||\hat{r}| \cos\alpha = -p \frac{y}{r}$$

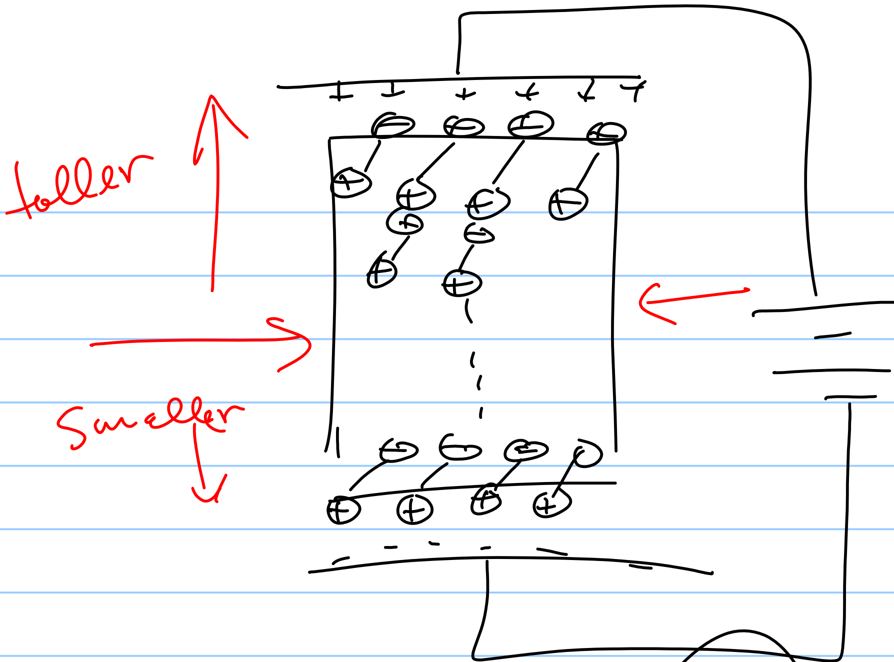
($|\hat{r}| = 1$)

$$A_x = -\frac{I a b \mu_0 \epsilon_0}{4\pi\epsilon_0} \frac{y}{r^3} \qquad A_y = \frac{I a b \epsilon_0 \mu_0}{4\pi\epsilon_0} \frac{x}{r^3}$$



$A_x \propto -y$

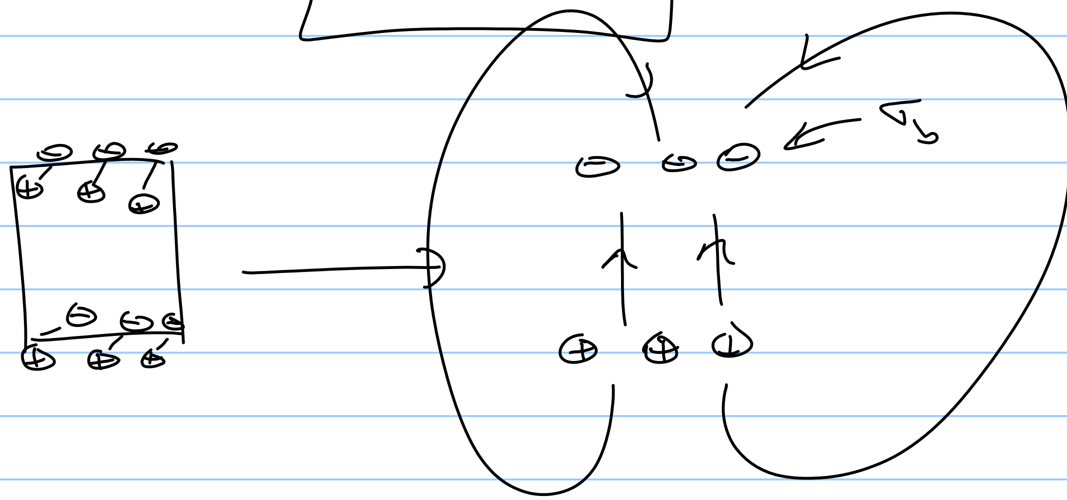
$A_y \propto x$

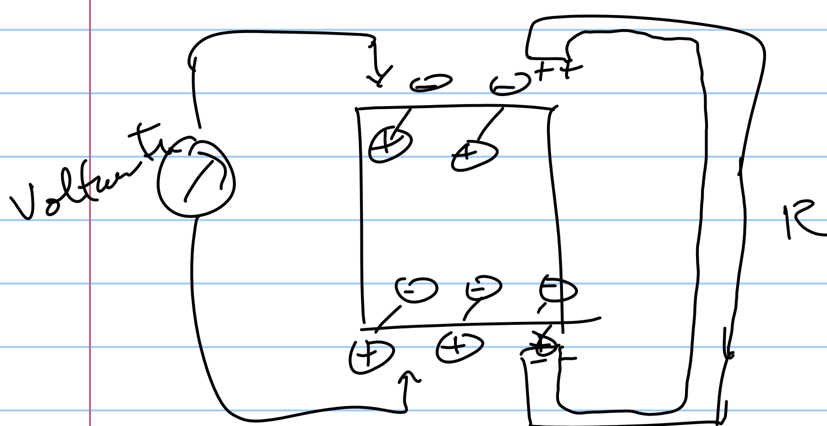


$\vec{P}$ permanent

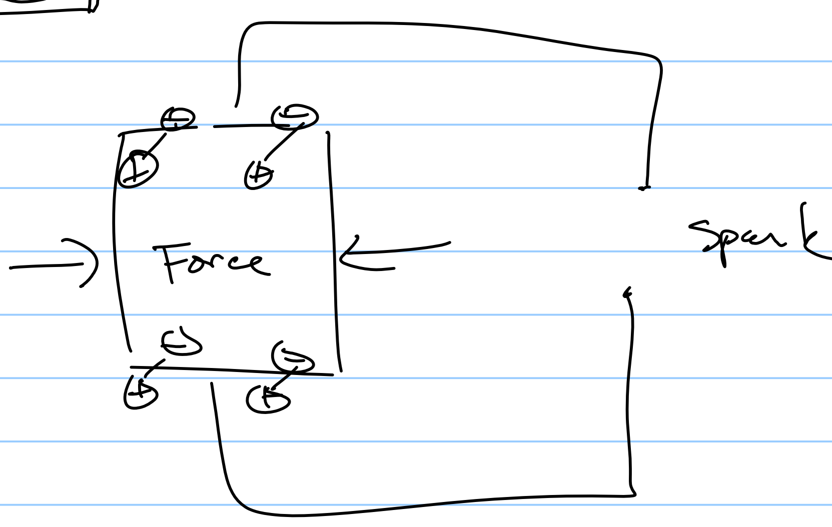
$\sigma_b = \vec{P} \cdot \hat{n} = |\vec{P}| \cos\theta$

10^{-6} m change for 1000 V



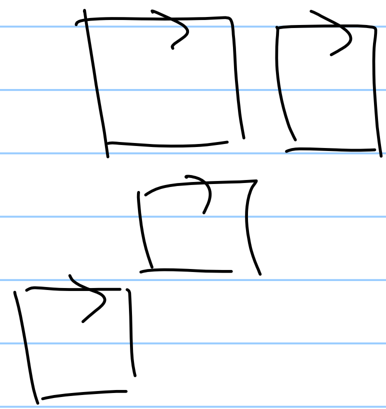


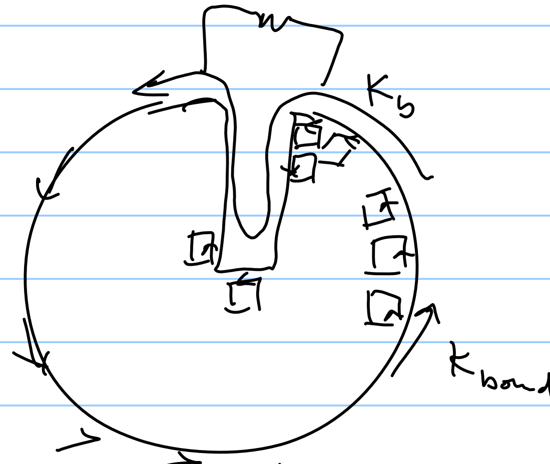
Application



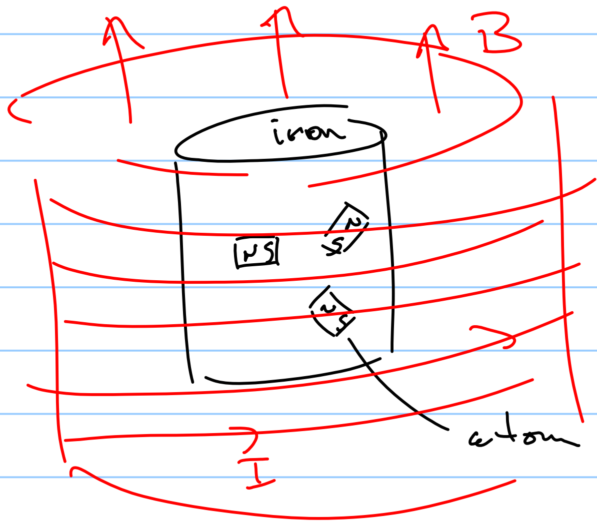
Can't access bnd charge

" " bnd current

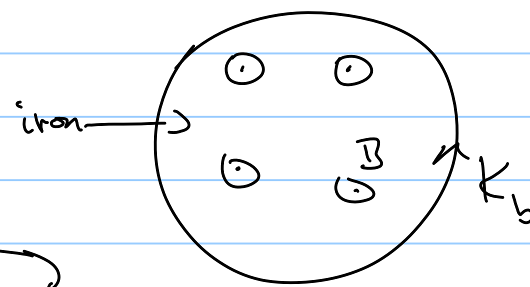


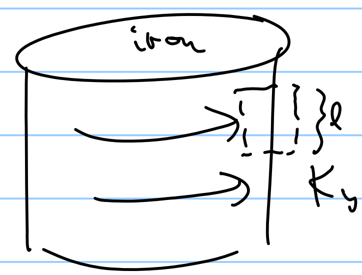


$\vec{K}_b = \vec{M} \times \hat{n}$



$\vec{M}$ $\frac{\text{mag dipole mom}}{\text{vol}}$





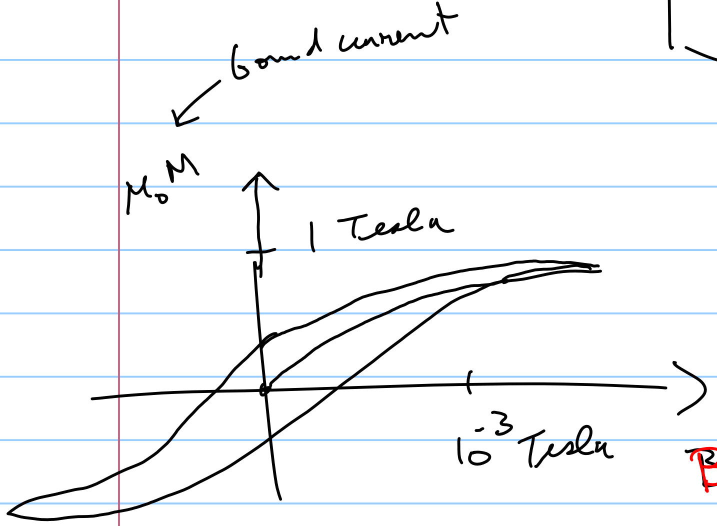
$\oint B \cdot dl = \mu_0 I_{encl}$

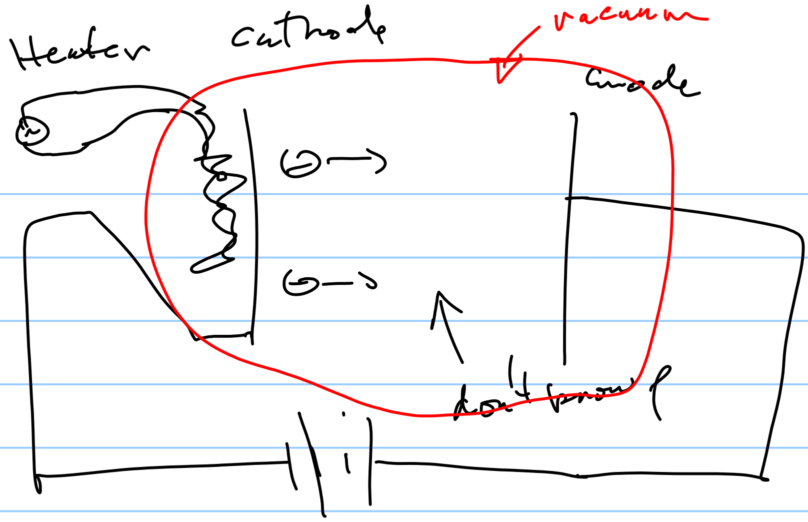
$B l = \mu_0 n I_0 l \Rightarrow$

n: $\frac{\text{turns}}{\text{length}}$, I_0: $\frac{\text{current}}{\text{turn}}$

$B = \mu_0 \underbrace{n I_0}_{K = M}$

$B_{bound} = \mu_0 M$





Find E ?

V ?

I ?

ρ ?

$\vec{E} = -\vec{\nabla} V$

$\vec{\nabla} \cdot \vec{E} = \rho / \epsilon_0 \qquad \nabla^2 V = -\rho / \epsilon_0$

Newtons laws $\quad \vec{F} = m\vec{a} = q\vec{E} + q\vec{v} \times \vec{B}$

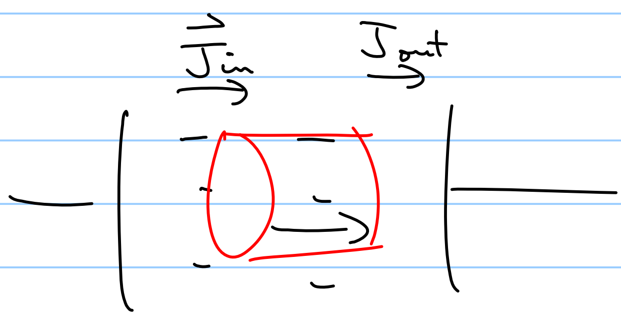
Conservation of Energy

$\Delta(KE + PE) = W_{nc} \to 0$

$PE = q\Delta V$

Cons charge

$\vec{\nabla} \cdot \vec{J} = -\frac{\partial \rho}{\partial t} \to 0$ steady state



$J_{in} = J_{out}$

$\rho_{in} v_{in} = \rho_{out} v_{out}$