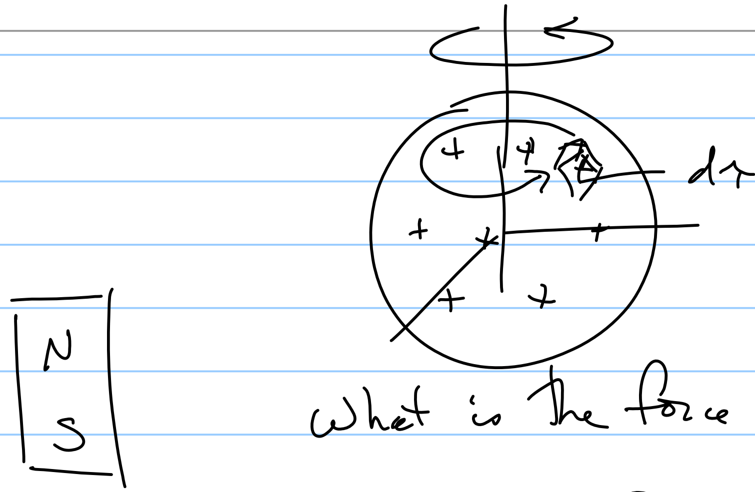
Note Title 4/16/2009

1)



charged sphere rotates

What is the force on the sphere?

Principles: $\vec{F} = q\vec{v}\times\vec{B} + \cancel{q\vec{E}}^{\,0} \rightarrow I\,d\vec{l}\times\vec{B} \rightarrow \vec{K}\times\vec{B}\,da$

Method: $\rightarrow \vec{J}\times\vec{B}\,d\tau$

$\vec{F}_{net} = \int \vec{J}\times\vec{B}\,d\tau$ find $\vec{J} = \rho\vec{v} = \rho\,\vec{\omega}\times\vec{r}$

↖ vol sphere ↖ charge/vol

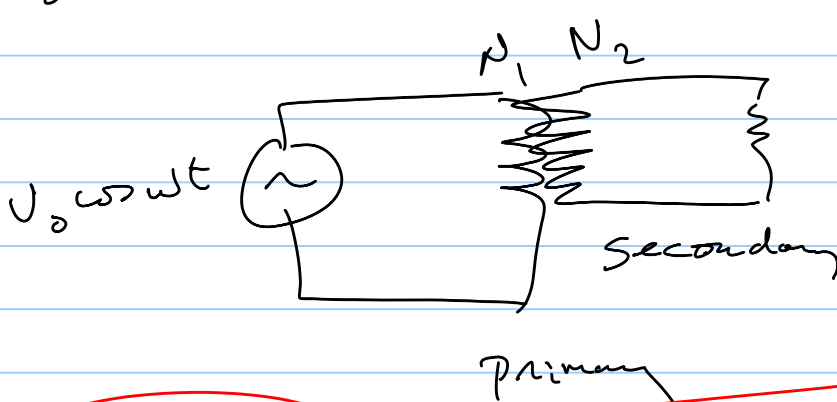
find $\vec{B}$ dipole field

Check: $\omega \rightarrow 0$ $F \rightarrow 0$

$R \rightarrow 0$ $F \rightarrow 0$

$\rho \rightarrow 0$ $F \rightarrow 0$

Transformer



each loop of primary coil has flux Φ
each loop of secondary coil has flux Φ

What is The Emf & current in secondary?

Prin: $\mathcal{E}mf = -\frac{d\Phi}{dt}$ $\quad V = IR$

Method: Find Φ_{tot} for each circuit

$$\underline{\underline{\Phi_1}} = N_1 \overline{\Phi} = L_1 I_1 + M I_2$$

flux thru one loop

$$\underline{\Phi_2} = N_2 \overline{\Phi} = L_2 I_2 + M I_1$$

$\mathcal{E}mf$ in $1 = -N_1 \frac{d\overline{\Phi}}{dt}$ $\qquad$ $\mathcal{E}mf$ in $2 = -N_2 \frac{d\overline{\Phi}}{dt}$

$V_0 \cos\omega t = V_1 = -N_1 \frac{d\overline{\Phi}}{dt}$

$V_2 = -N_2 \frac{d\overline{\Phi}}{dt}$ $\qquad$ $L_1 \frac{dI_1}{dt} + M \frac{dI_2}{dt}$

Kirch: primary $\qquad V_0 \cos\omega t - V_{coil} = 0$

sec $\qquad V_{coil} - I_2 R = 0$

$$L_2 \frac{dI_2}{dt} + M \frac{dI_1}{dt} - I_2 R = 0$$

Solve 2 ODE for I_1 & I_2

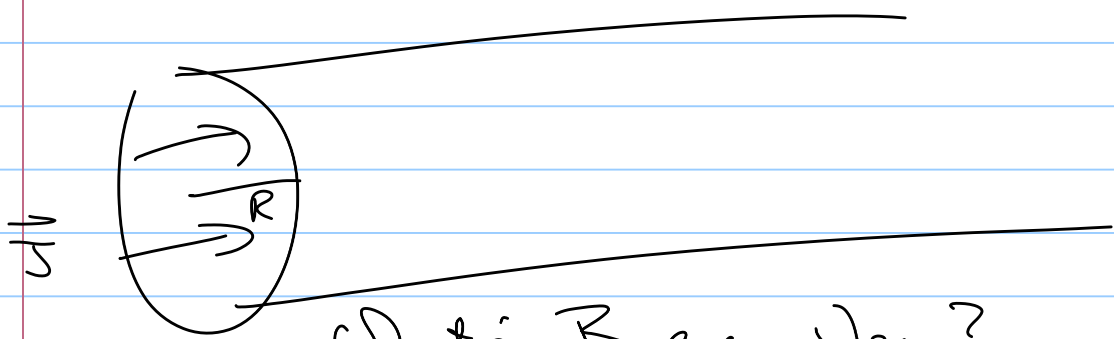
Check: $\omega \to 0$ $\qquad V_2 \to 0$

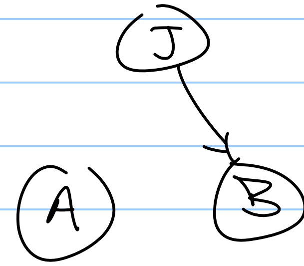
$N_1 \to N_2$ $\qquad \mathcal{E}mf_1 = \mathcal{E}mf_2$

$R_0 \to \infty$ $\qquad I_2 \to 0$

$M \to 0$ $\qquad I_2 \to ?$

A wire of radius R has $J = \alpha r$



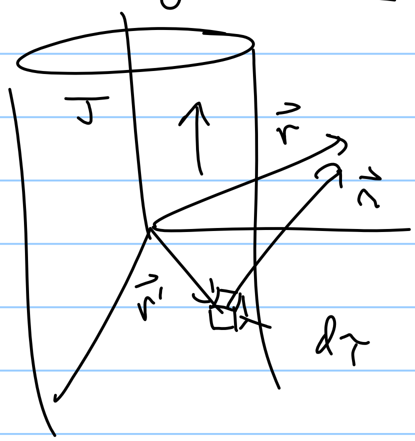


What is B everywhere?

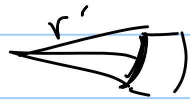
Prin: Ampere's law Biot-Sav

Method: (1) B-S $\vec B = \frac{\mu_0}{4\pi}\int \frac{\vec J \times \hat{\mathscr{r}}}{\mathscr{r}^2}\, d\tau$

<u>$d\tau$ cylindrical</u> $\vec J = \alpha r \hat z$ $\vec{\mathscr{r}} = \vec r - \vec r\,'$



$$\int_0^R \int_{-\infty}^{\infty} \int_0^{2\pi} r' d\phi' dz' dr'$$



$$\begin{vmatrix} \hat x & \hat y & \hat z \\ J_x = 0 & J_y = 0 & J_z \\ \hat{\mathscr{r}}_x & \hat{\mathscr{r}}_y & \hat{\mathscr{r}}_z \end{vmatrix}$$

$\vec{\mathscr{r}}$ in $\mathscr{r}_x \hat x + \mathscr{r}_y \hat y + \mathscr{r}_y \hat z$

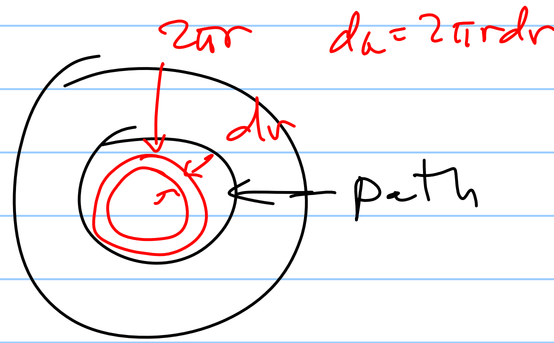
Amp's law $\oint \vec B \cdot d\vec l = \mu_0 I_{enc}$

need to know direction of B to find amperian path
we know from symmetry B is $\hat\phi$ so path

is circular $\Rightarrow$ $\underbrace{\oint \vec{B}\cdot d\vec{l}}_{B\,dl\cos\phi} = \underline{B\,2\pi r}$

cal $I_{enc} = \int_0^r \vec{J}\cdot d\vec{a}$

$\vec{J} = \alpha r$



Check: $\alpha \to \phi$ $\quad B \to \phi$ $\quad$ and

$B_{in}\Big|_{r=R} = B_{outside}\Big|_{r=R}$