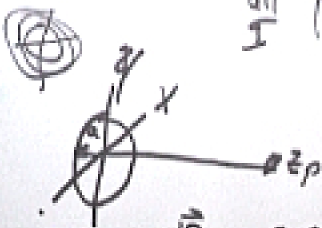
BB2

$$\vec{B} = \frac{\mu_0 I}{4\pi} \int_{\text{all } I} \frac{d\vec{L}_i \times \vec{r}_{ip}}{|\vec{r}_{ip}|^3}$$



$$\vec{r}_i = a\cos\phi_i \cdot \hat{x} + a\sin\phi_i \cdot \hat{y}$$

$$\vec{r}_p = z_p \hat{z}$$

$$\vec{r}_{ip} = -a\cos\phi_i \cdot \hat{x} - a\sin\phi_i \cdot \hat{y} + z_p \hat{z}$$

$$d\vec{L}_i = -a\sin\phi_i \cdot \hat{x} + a\cos\phi_i \cdot \hat{y}$$

$\bar{r}_p = z_p \hat{z}$

$\bar{r}_{ip} = -a\cos\phi_i \hat{x} - a\sin\phi_i \hat{y} + z_p \hat{z}$

$d\bar{l}_i = -a\sin\phi_i \hat{x} + a\cos\phi_i \hat{y}$

$d\bar{l}_i \times \bar{r}_{ip}$

$$= a^2 \begin{vmatrix} \hat{x} & \hat{y} & \hat{z} \\ -\sin\phi_i & \cos\phi_i & 0 \\ -\cos\phi_i & -\sin\phi_i & z_p \end{vmatrix}$$

$$= a^2 \left(+\sin^2\phi_i + \cos^2\phi_i\right) \hat{z}$$

$$= a^2 \hat{z}$$

$$|\bar{r}_{ip}|^3 = \left(a^2 + z_p^2\right)^{3/2}$$

$$\bar{B} = \frac{\mu_0 I}{4\pi} \int_{\phi=0}^{2\pi} \frac{a^2 \hat{z}}{\left(a^2 + z_p^2\right)^{3/2}} \, a \, d\phi$$

$$\bar{dl}_i \times \hat{r}_{ip}$$

$$= a^2 \begin{vmatrix} \hat{x} & \hat{y} & \hat{z} \\ -\sin\phi_i & \cos\phi_i & 0 \\ -\cos\phi_i & -\sin\phi_i & z_p \end{vmatrix}$$

$$= a^2 \left(+\sin^2\phi_i + \cos^2\phi_i \right) \hat{z}$$

$$= a^2 \hat{z}$$

$$|\bar{r}_{ip}|^3 = \left(a^2 + z_p^2\right)^{3/2}$$

$$\bar{B} = \frac{\mu_0 I}{4\pi} \int_{\phi=0}^{2\pi} \frac{a^2 \hat{z}}{\left(a^2+z_p^2\right)^{3/2}} \, a \, d\phi$$

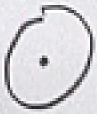
$$= \frac{\mu_0 I}{4\pi} \frac{a^3 \cdot 2\pi}{\left(a^2+z_p^2\right)^{3/2}} \hat{z}$$

$-a^2 \hat{z}$

$$|\bar{r}_{cp}|^3 = (a^2 + z_p^2)^{3/2}$$

$$\bar{B} = \frac{\mu_0 I}{4\pi} \int_{\phi=0}^{2\pi} \frac{a^2 \hat{z}}{(a^2+z_p^2)^{3/2}} \, a \, d\phi$$

$$= \frac{\mu_0 I}{4\pi} \frac{a^3 \cdot 2\pi}{(a^2+z_p^2)^{3/2}} \hat{z}$$



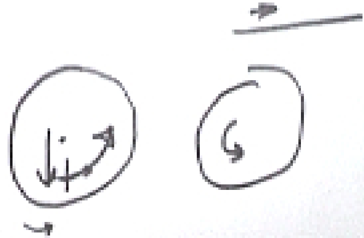
$z_p = 0$

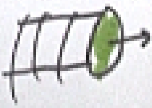
$$\bar{B} = \frac{\mu_0 I}{2} \frac{\cancel{a^3}}{\cancel{a^3}} \hat{z}$$

$z_p >> a$

$$= \frac{\mu_0 I}{2} \hat{z} \left[\frac{a^2/z_p^3}{\left[\left(\frac{a}{z_p}\right)^2 + 1\right]^{3/2}} \right]$$

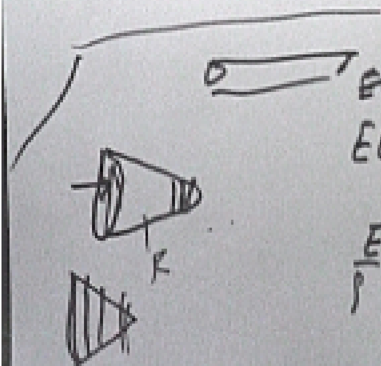
$$\simeq \frac{\mu_0 I}{2} \frac{a^2}{z_p^3} \hat{z}$$



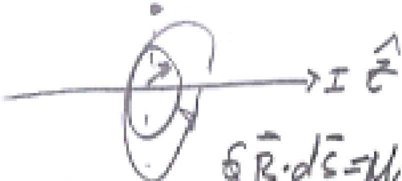


$I \rightarrow$ $\vec{J}$

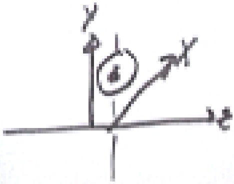
$$V = IR$$
$$= J \cdot A$$
$$\rho \cdot \frac{L}{A}$$



$$EL = J\rho \cdot L$$
$$EL = J\rho \cdot L$$
$$\frac{E}{\rho} = J \Rightarrow \vec{J} = \sigma \vec{E}$$



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



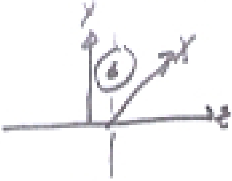
$$B(2\pi s) = \mu_0 I$$

$$\vec{B} = \frac{\mu_0 I}{2\pi s}\hat{\phi}$$

along +y,

$\vec{B}$: $(-\hat{x})$

$$\oint \vec{B}\cdot d\vec{s} = \mu_0 I_c$$



$$B(2\pi s) = \mu_0 I$$

$$\vec{B} = \frac{\mu_0 I}{2\pi s}\hat{\phi}$$

along $+y$,

$\vec{B}\cdot(-\hat{x})$

$$\vec{B}(y_p) = \frac{\mu_0 I}{4\pi}\int_I \frac{d\vec{l}_i \times \vec{r}_{ip}}{|\vec{r}_{ip}|^3}$$

$\vec{B}(-x)$

$$\vec{B}(\vec{r}_p) = \frac{\mu_0 I}{4\pi} \int_I \frac{d\vec{L}_i \times \vec{r}_{ip}}{|\vec{r}_{ip}|^3}$$

$$\vec{r}_i = z_i \hat{z}$$

$-\frac{a}{2}$ $+\frac{a}{2}$

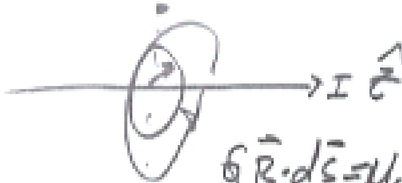
$$\vec{r}_p = y_p \hat{y}$$

$$\vec{r}_{ip} = \vec{r}_p - \vec{r}_i = 0\hat{x} + y_p \hat{y} - z_i \hat{z}$$

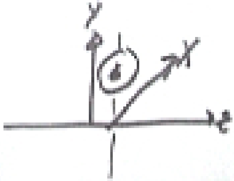
$$d\vec{L}_i = dz_i \hat{z}$$

$$\vec{B}(y_p) = \frac{\mu_0 I}{4\pi} \int_{-\frac{a}{2}}^{+\frac{a}{2}} \frac{d\vec{L}_i \times \vec{r}_{ip}}{|\vec{r}_{ip}|^3}$$

$$d\vec{L}_i \times \vec{r}_{ip} = \begin{vmatrix} \hat{x} & \hat{y} & \hat{z} \\ 0 & 0 & dz_i \\ 0 & y_p & -z_i \end{vmatrix}$$



$$\oint \vec{B}\cdot d\vec{s} = \mu_0 I_c$$



$$B(2\pi s) = \mu_0 I$$

$$\vec{B} = \frac{\mu_0 I}{2\pi s}\hat{\phi}$$

along $+y$,
$\vec{B}\cdot(-\hat{x})$

$$\vec{B}(r_p) = \frac{\mu_0 I}{4\pi}\int_I \frac{d\vec{l}_i \times \vec{r}_{ip}}{|\vec{r}_{ip}|^3}$$

$$\vec{r}_i = z_i \hat{z}$$

$$-\frac{a}{2} \qquad\qquad +\frac{a}{2}$$

$$\vec{r}_p = y_p \hat{y}$$

$$\vec{r}_{ip} = \vec{r}_p - \vec{r}_i = 0\hat{x} + y_p \hat{y} - z_i \hat{z}$$

$$d\vec{L}_i = dz_i \hat{z}$$

$$\vec{B}(y_p) = \frac{\mu_0 I}{4\pi} \int_{-a/2}^{+a/2} \frac{d\vec{L}_i \times \vec{r}_{ip}}{|\vec{r}_{ip}|^3}$$

$$d\vec{L}_i \times \vec{r}_{ip} = \begin{vmatrix} \hat{x} & \hat{y} & \hat{z} \\ 0 & 0 & dz_i \\ 0 & y_p & -z_i \end{vmatrix}$$

$$\hat{x}(-y_p\,dz_i) - \hat{y}(0) + \hat{z}(0)$$

$$\vec{B} = \frac{\mu_0 I}{4\pi}\int_{-a/2}^{+a/2} \frac{-y_p\,dz_i\,\hat{x}}{[y_p^2 + z_i^2]^{3/2}}$$

$$= \frac{\mu_0 I(-y_p)\hat{x}}{4\pi} \underbrace{\int_{-a/2}^{+a/2} \frac{dz_i}{[y_p^2 + z_i^2]^{3/2}}}_{K}$$

$$K = \frac{z_i}{y_p^2\sqrt{z_i^2 + y_p^2}}\Bigg|_{-a/2}^{+a/2}$$

$$\hat{x}(-y_p\, dz_i) - \hat{y}(0) + \hat{z}(0)$$

$\hat{\phi}$

$$\vec{B} = \frac{\mu_0 I}{4\pi}\int_{-a/2}^{+a/2} \frac{-y_p\, dz_i\, \hat{x}}{\left[y_p^2 + z_i^2\right]^{3/2}}$$

$$= \frac{\mu_0 I (-y_p)\hat{x}}{4\pi} \underbrace{\int_{-a/2}^{+a/2} \frac{dz_i}{\left[y_p^2 + z_i^2\right]^{3/2}}}_{K}$$

$$K = \left.\frac{z_i}{y_p^2\sqrt{z_i^2 + y_p^2}}\right|_{-a/2}^{+a/2}$$

$$B = \frac{\mu_0 I}{2\pi} \hat{\lambda} \quad \frac{1}{y_p\sqrt{5}} \qquad B = \frac{\mu_0 I}{2\pi y_p}$$

$$\frac{1}{\sqrt{5}}$$

$$\int_{-a}^{+a} \rightarrow \frac{2a}{y_p^2\sqrt{a^2+y_p^2}} \text{ Row } a \to \infty$$

$$K_{-a}^{+a} \rightarrow \frac{2}{y_p^2\sqrt{1}}$$

$$\rightarrow \frac{2}{y_p^2}$$

$$\vec{B} = \frac{\mu_0 I}{2\pi} \cdot \frac{2}{y_p^2}\left(-y_p\hat{x}\right) \Rightarrow$$

$$B = \frac{\mu_0 I}{2\pi} \cdot \frac{1}{y_p}$$

$$K = \frac{a}{r_p^2\sqrt{\left(\frac{a}{2}\right)^2 + r_p^2}}$$

$$= \frac{1}{r_p^2\sqrt{\frac{1}{4} + \left(\frac{r_p}{a}\right)^2}}$$

$$\lim a \to \infty \to K = \frac{1}{r_p^2\sqrt{\frac{1}{4} + 1}}$$

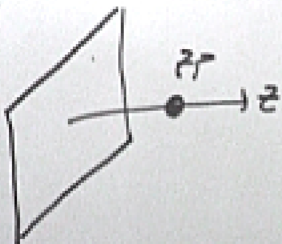
$$B = \frac{\mu_0 I}{4\pi} \cdot \frac{(-r_p \hat{r})}{r_p^2\sqrt{5/4}} = \frac{2\mu_0 I(-r_p\hat{r})}{4\pi\, r_p^2\sqrt{5}}$$

$$J_s = \frac{I}{L}$$

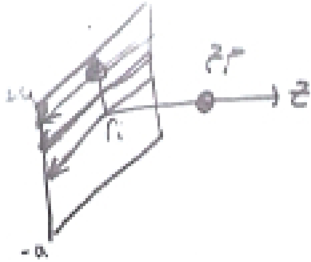
$$\oint \vec{B} \cdot d\vec{s} = \mu_0 I_c$$

$$B(2w) = \mu_0 (J_s \cdot w)$$

$$B = \frac{\mu_0 J_s}{2} \begin{cases} \hat{y}, & z>0 \\ -\hat{y}, & z<0 \end{cases}$$



$$\vec{B} = \frac{\mu_0 J_s}{2}\begin{cases}\hat{x}, & z>0\\ -\hat{x}, & z<0\end{cases}$$



$\mathcal{J}_s$. $\vec{J}_s = \frac{I}{2a}\hat{y}$

$$\vec{r}_i = x_i\hat{x} + y_i\hat{y}$$

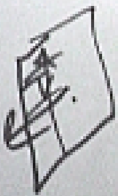
$$\vec{r}_p = z_p\hat{z}$$

$$\vec{r}_{ip} = -x_i\hat{x} - y_i\hat{y} + z_p\hat{z}$$

$$d\vec{l}_i = dx_i\hat{x} + dy_i\hat{y}$$

$$d\vec{l}_i \times \vec{r}_{ip} = \begin{vmatrix}\hat{x} & \hat{y} & \hat{z}\\ dx_i & dy_i & 0\\ -x_i & -y_i & z_p\end{vmatrix}$$

$$d\hat{l}_i \times \hat{r}_{i,p} = \hat{x}(z_p\, dy_i) - \hat{y}(z_p\, dx_i) + \hat{z}(-y_i\, dx_i + x_i\, dy_i)$$

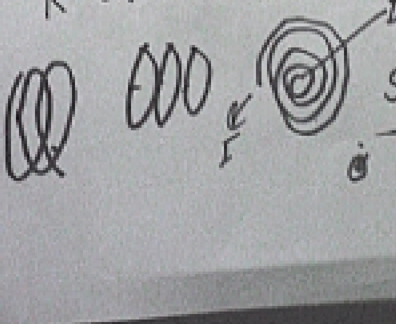


$$B = \frac{\mu_0}{4\pi}\int_S \frac{\vec{K}\times\vec{r}_{i,p}}{|r_{i,p}^3|}\, dA_i$$

$K = \sigma\vec{v}$

$\vec{v} = 0\hat{x} + v\hat{y} + 0\hat{z}$

$\vec{K} = \sigma\vec{v}$



$\vec{s} = a\cdot\phi\,\hat{\phi}$

$$\oint \bar{E}\cdot d\bar{A} = \frac{Q_{enc}}{\varepsilon_0}$$

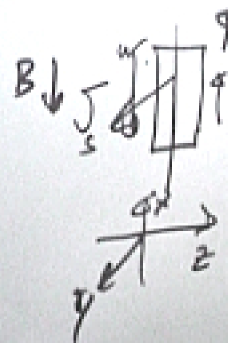
$$\bar{\nabla}\cdot\bar{E} = \frac{\rho}{\varepsilon_0}$$

$$\oint \vec{B}\cdot d\bar{s} = \mu_0 I_c$$

$$\oint\!\!\oint (\vec{\nabla}\times\vec{B})\cdot d\vec{A} = \oint \vec{B}\cdot d\vec{l}$$

$$= \int \mu_0 \vec{J}\cdot d\vec{A}$$

$$\Rightarrow \boxed{\vec{\nabla}\times\vec{B} = \mu_0 \vec{J}}$$

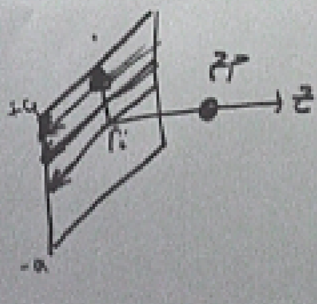


$$J_s = \frac{I}{L}$$

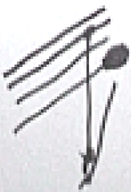
$$\oint \vec{B}\cdot d\vec{s} = \mu_0 I_c$$

$$B(2w) = \mu_0 (J_s \cdot w)$$

$$B = \frac{\mu_0 J_s}{2} \begin{cases} +\hat{y}, & z>0 \\ -\hat{y}, & z<0 \end{cases}$$



B_s: $\vec{J}_s = \frac{I}{2a}\hat{y}$



$$\vec{r}_i = x_i\hat{x} + y_i\hat{y}$$

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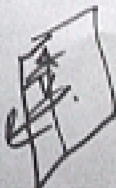
$$\vec{r}_{ip} = -x_i\hat{x} - y_i\hat{y} + z_p\hat{z}$$

$$d\vec{L}_i = dx_i\hat{x} + dy_i\hat{y}$$

$$d\vec{L}_i \times \vec{r}_{ip} = \begin{vmatrix} \hat{x} & \hat{y} & \hat{z} \\ dx_i & dy_i & 0 \\ -x_i & -y_i & z_p \end{vmatrix}$$

$$d\hat{l}_i \times \hat{r}_{ip} = \hat{x}(z_p dy_i) - \hat{y}(z_p dx_i) + \hat{z}(-y_i dx_i + x_i dy_i)$$

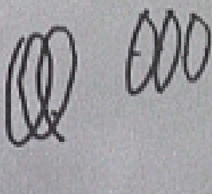


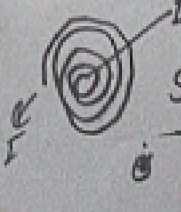
$$B = \frac{\mu_0}{4\pi}\int_I \frac{\vec{K}\times\vec{r}_{ip}}{|r_{ip}^3|} dA_i$$

$K = \sigma\vec{v}$

$\vec{v} = 0\hat{x} + v\hat{y} + 0\hat{z}$

$\vec{K} = \sigma\vec{v}$





$\vec{s} = a\cdot\phi\,\hat{\phi}$