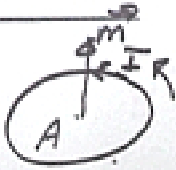
(382)

$$\vec{H} = \frac{1}{\mu_0}\vec{B} - \vec{M} \qquad M : \frac{A\,m^2}{m^3} = \frac{A}{m}$$

m :



$\underline{m}$ M_R $\frac{\underline{m}}{\text{volume}}$

$$\vec{\tau} = \vec{m}\times\vec{B} \rightarrow B = \frac{\tau}{m}$$

$$\vec{F} = q\vec{E} + q\overset{\vec{\mu}}{\vec{v}}\times\vec{B}$$

$$\oint \vec{H}\cdot d\vec{l} = \frac{1}{\mu_0}\oint \underline{\vec{B}\cdot d\vec{l}} - \underline{\oint \vec{M}\cdot d\vec{l}}$$

$$= \frac{1}{\mu_0} I_{Total} \cdots \quad I_B$$

$$\oint \vec{H}\cdot d\vec{A} = \frac{1}{\mu_0}\oint \vec{B}\cdot d\vec{A} - \oint \vec{M}\cdot d\vec{A}$$

Φ

0

$H_1^{\parallel}$

$H_2^{\parallel}$

$$H_1^{\parallel} - H_2^{\parallel} = \vec{K}_f \times \hat{n}$$

$$\frac{\sigma}{\varepsilon_0} = E$$

$\vec{\tau} = \vec{m} \times \vec{B}$ → $B = \frac{\text{torque}}{\text{unit dipole}}$

also $\vec{F} = \vec{\nabla}(\vec{m} \cdot \vec{B})$

whe $\vec{m} = I A$
curr Area

Ideal Dipole: $A \to 0$, $I \to \infty$
keeps IA constant

$$\oint \mu_0 \vec{H} \cdot d\hat{A} = \oint (B - \mu_0 M)$$

Gauss $\Rightarrow \oint \vec{B} \cdot d\hat{A} = 0$

$B = \mu_0(H + M)$

or $H = \frac{B}{\mu_0} - M$

$\therefore \oint \mu_0 \vec{H} \cdot d\hat{A} = -\int \vec{M} \cdot d\hat{A}$

$\oint \vec{H} \cdot d\hat{l} = \oint \left(\frac{\bar{B}}{\mu_0} - \bar{M}\right) d\hat{l}$ does not dep on free curr

line int $= I_{total} - I_{bound} = I_{free}$

line int of H does not dep on bound currents

$H_1^{\parallel} - H_2^{\parallel} = \vec{K}_f \times \hat{n}$

surf integ

$\oint \mu_0 \vec{H} \cdot d\hat{A} = q_m$ ← magnt charge

So— $H = H_0 + H_d$

H_0: free

H_d: demag field due to BC

$$\vec{A}(\vec{r}_p) = \frac{\mu_0}{4\pi}\,\frac{\vec{m}\times\vec{r}_{ip}}{r_{ip}^3}$$

$I \to \infty$

$A \to 0$

IA

$$\vec{A} = \frac{\mu_0}{4\pi}\iiint \frac{\vec{M}(\vec{r}_i)\times\vec{r}_{ip}}{r_{ip}^3}\,d\tau_i$$

$$\vec{\nabla}_i\left(\frac{1}{r_{ip}}\right) = \frac{\vec{r}_{ip}}{r_{ip}^3}$$

$$\vec{A} = \frac{\mu_0}{4\pi}\iiint \vec{M}(\vec{r}_i)\times\left(\vec{\nabla}_i\left(\frac{1}{r_{ip}}\right)\right)d\tau_i$$

$$\vec{A} = \frac{\mu_0}{4\pi} \oiiint \frac{1}{r_{ip}} \underbrace{(\vec{\nabla} \times \vec{M})}_{= \vec{J}_b} d\tau_i$$

$$+ \frac{\mu_0}{4\pi} \oiint \frac{1}{r_{ip}} \left[\vec{M}(r_i) \times d\vec{a}_i\right]$$

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

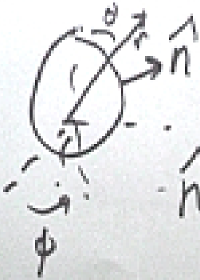
$$\rho_b = -\vec{\nabla} \cdot \vec{P} \; ; \; \sigma_b = \vec{P} \cdot \hat{n}$$

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

$J_{b,z}$

$$\vec{J}_b = \begin{vmatrix} \hat{r} & \hat{\varphi} & \hat{z} \\ \frac{\partial}{\partial x} & \frac{\partial}{\partial y} & \frac{\partial}{\partial z} \\ 0 & 0 & M \end{vmatrix} = 0$$

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



$$\hat{n} = \sin\theta\cos\phi\,\hat{x} + \sin\theta\sin\phi\,\hat{y} + \cos\theta\,\hat{z}$$

$$\vec{K}_b = \begin{bmatrix} \hat{x} & \hat{y} & \hat{z} \\ 0 & 0 & M \\ s\theta c\phi & s\theta s\phi & c\theta \end{bmatrix}$$

$$= \hat{x}(-M\sin\theta\sin\phi) - \hat{y}(-M\sin\theta\cos\phi) + 0\hat{z}$$

$B \quad [\mu_0] \quad \dfrac{\frac{A}{m}\cdot m}{m^2}\cdot m^2$

$\cancel{\frac{A}{m}[\mu_0]}$

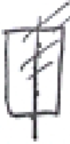
$[B]=[\mu_0]\,\dfrac{A}{m}$

Φ

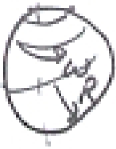
$\oint B\cdot dl=\mu_0 I$

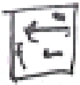
$[B] = [\mu_0]\dfrac{[I]}{m}$

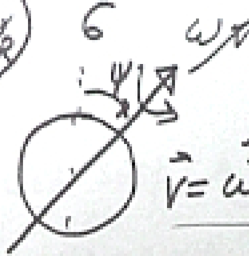
$\vec{K}_b = M \sin\theta \, \hat{\phi}$



J_s







$\vec{v} = \vec{\omega} \times \vec{r}$

$A = \frac{C}{s}$

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

$\vec{\omega} = \omega \sin\psi \, \hat{x} + 0 \hat{y} + \omega \cos\psi \, \hat{z}$

$\boxed{\frac{A}{m^2}}$

$\uparrow$

$\frac{A}{m}$

$\vec{K}_s = \sigma \cdot \vec{v} = C(\vec{\omega} \times \vec{r})$

$\frac{C}{m^2} \cdot \frac{m}{s}$

$\vec{\omega} \times \hat{r_i}$

$$= \omega R \begin{bmatrix} \hat{x} & \hat{y} & \hat{z} \\ s\theta\psi & 0 & \cos\psi \\ \sin\theta c\phi & s\theta s\phi & c\theta \end{bmatrix}$$

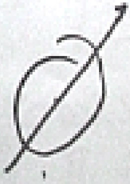
$$= \omega R \left[-s\theta s\phi c\psi \hat{x} + 0 \hat{y} + s\psi s\theta s\phi \hat{z} \right]$$

$$\vec{K}_s = 6\omega R [\sin\theta] [s\phi \cos\psi \hat{x} + s\psi s\phi \hat{z}]$$

$$\vec{K}_s = 6\omega R\, s\theta s\phi [\cos\psi \hat{x} + \sin\psi \hat{z}]$$

$$\int_{\phi} \frac{K\vec{J}_0 \times \vec{r}_{ip}}{|\vec{r}_{ip}|^{\frac{3}{2}}} \, dA_i$$

$$\phi z_p \quad d\vec{A}_i = R^2 \sin\theta \, d\theta \, d\phi \, \hat{r}$$



$$\vec{r}_p = 0\hat{x} + 0\hat{y} + z_p \hat{z}$$

$$\vec{r}_i = s\theta c\phi \hat{x} + s\theta s\phi \hat{y} + c\theta \hat{z}$$

$$\vec{r}_{ip} = -Rs\theta c\phi \hat{x} - Rs\theta s\phi \hat{y} + (z_p - Rc\theta)\hat{z}$$

$$(z_p - Rc\theta)\hat{z}$$

$$\vec{K}_s \times \vec{r}_{ip}$$

$$= \begin{bmatrix} \hat{x} & \hat{y} & \hat{z} \\ c\psi & 0 & s\psi \\ -RS\theta C\phi & -RS\theta S\phi & (z_p - RC\theta) \end{bmatrix}$$

$$\left[\sigma \omega R S\theta S\phi \right]$$

$$\int_{\theta=0}^{\pi} \int_{\phi=0}^{2\pi} \left[\quad \right] R^2 \sin\theta \, d\theta \, d\phi$$

$$\vec{B}(\vec{r}_p) = \frac{\mu_0}{4\pi}\int \frac{\vec{J} \times \vec{r}_{ip}}{r_{ip}^3}\, dA_i$$

$$\oint(\vec{\nabla}_p \times \vec{B}_p) \cdot d\vec{A} = \oint \vec{B} \cdot d\vec{L} = \oint \underline{\vec{J} \cdot d\vec{A}}$$

$$\frac{\vec{r}_{ip}}{r_{ip}^3} \rightarrow \vec{\nabla}\left(\frac{1}{r_{ip}}\right)$$

$B \cdot m = \mu_0 I$

$B = \frac{\mu_0 I}{m}$ [T]

$$\mu_0 \oint \vec{J} \cdot d\vec{A} \rightarrow$$

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

$[J] = \frac{T}{\mu_0 \cdot m} : \frac{[\mu_0 I}{m}$

$\frac{I}{m} = [\mu_0][J]$

$[J] : \frac{I}{m^2}$

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

$$\vec{J} = \frac{dI}{dA_\perp} \qquad \frac{A}{m^2}$$

$$\vec{J} = \rho\vec{v} \qquad \frac{C}{m^3}\cdot\frac{m}{s} \quad \frac{C/s}{m^2}$$

$$I = \oiint \vec{J}\cdot d\vec{A}$$

$$\oiint \vec{J}\cdot d\vec{A} = \iiint (\vec{\nabla}\cdot\vec{J})\cdot d\tau$$

$$= -\frac{\partial}{\partial t}\iiint \rho \, d\tau$$

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