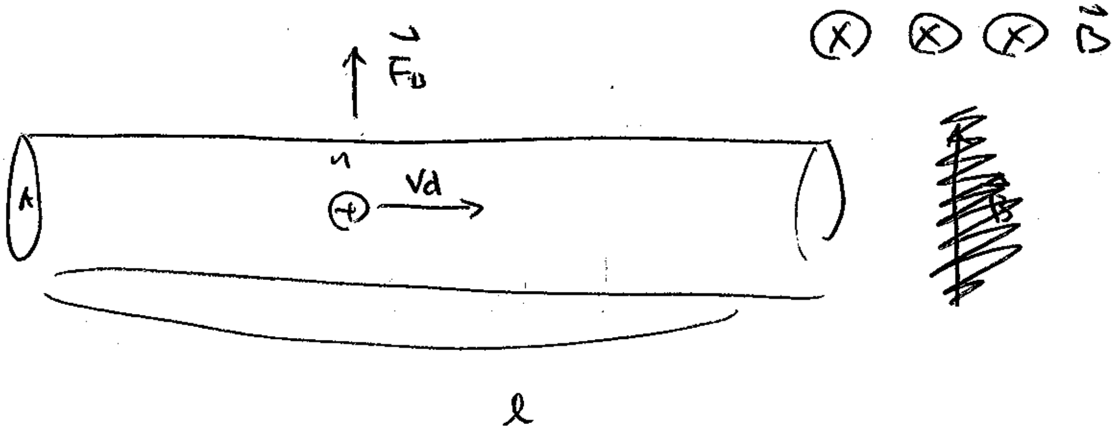
LECTURE 2VEB 2/27/09

FRIDAY

EM 396 — CURRENT CARRYING CONDUCTOR



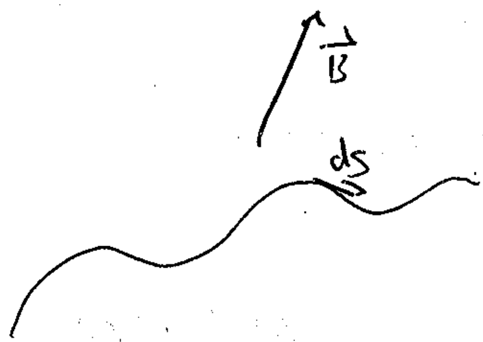
MAGNETIC FORCE ON ONE CHARGE $\vec{f}_B = q\vec{v}\times\vec{B}$

TOTAL MAGNETIC FORCE

$$\vec{F}_B = (q\,\vec{v}_d\times\vec{B})\; n\,(A\ell)$$

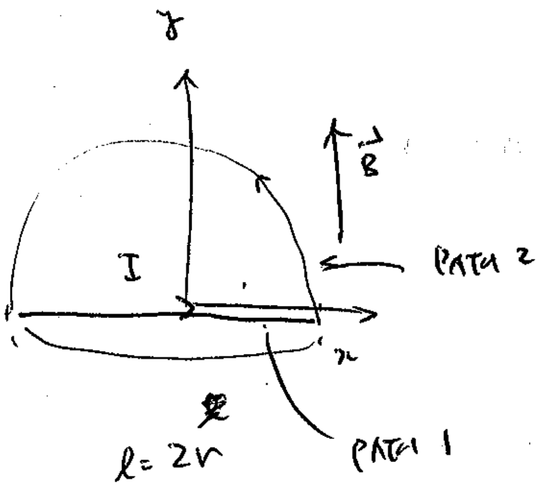
$$I = n q v_d A$$

$$\boxed{\vec{F}_B = I\vec{L}\times\vec{B}}$$



$$dF_B = I\, d\vec{s} \times B$$

$$\vec{F}_0 = I \int_a^b d\vec{s} \times \vec{B}$$



PATH 1

$$\vec{F}_B = I \int_{-l/2}^{l/2} dx \times \vec{B}$$

$$= I \int_{-l/2}^{l/2} \hat{z}\ B$$

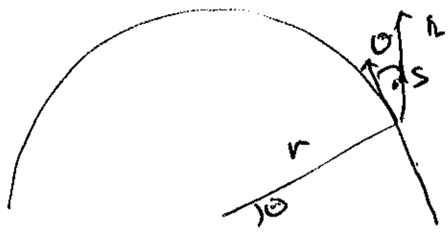
$$= \boxed{I\, l\, B}$$

PATH 2

~~$d\vec{s} \times \vec{B} = \hat{z} - B \sin\theta$~~

~~$\vec{F} = \int_0^{\pi} - B \hat{z}\, I \sin\theta$~~

~~$=$~~



$$ds = R\,d\theta$$

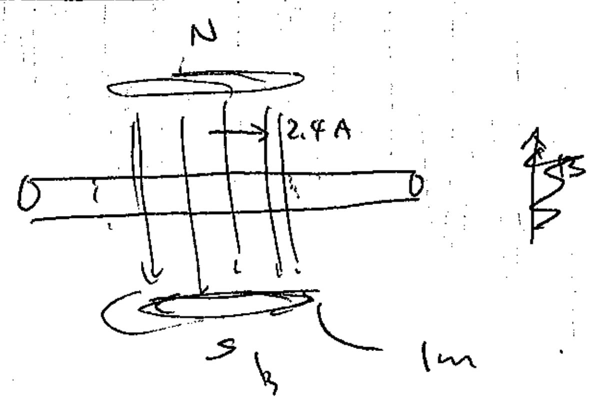
$$d\vec{s} \times \vec{B} = R\,d\theta \; - \hat{z} \sin\theta$$

$$\vec{F} = I \int_0^{\pi} - R \sin\theta \; d\theta \; \hat{z}$$

$$= IRB \cos\theta \Big]_0^{\pi} \hat{z} = -2IRB\,\hat{z}$$

PATH 1 + PATH 2 = 0

EXAMPLE:

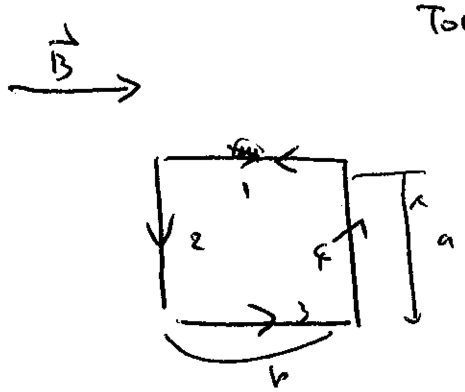


FORCE POINTS IN

$$F = I \vec{L} \times \vec{B}$$

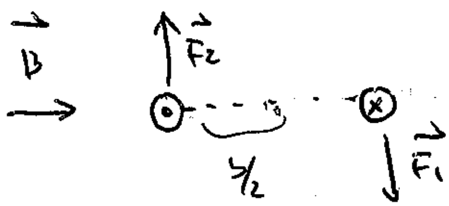
$$= I \; 1m \cdot 1T = \underline{2.4 \; N/m}$$

TORQUE ON A CURRENT LOOP



1, 3, $F = 0$

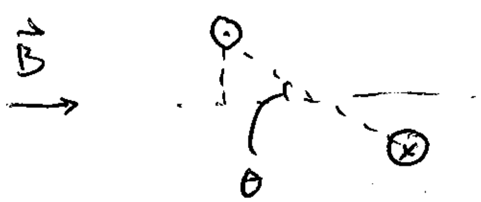
$\sum \vec{F} = 0$



$\sum \tau = \frac{b}{2} IaB + \frac{b}{2} IaB$

$= IabB$

$= IAB$



$\cdot F$

SECTION 1

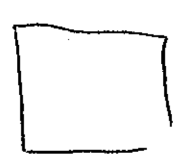
$\tau = \vec{r} \times \vec{F}$

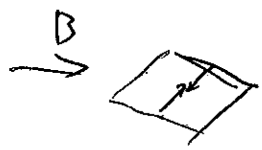
⊗ $\vec{F}_B$,

NO TORQUE

⊗ F_B

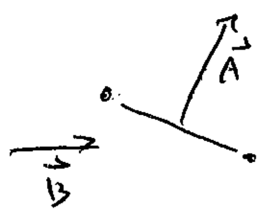
⊙



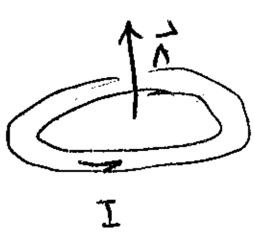


$$\therefore \tau = Ia\frac{b}{2}B\sin\theta + Ia\frac{b}{2}B\sin\theta = IabB\sin\theta$$

$$= IAB\sin\theta$$



$$\vec{\tau} = I\vec{A} \times \vec{B}$$



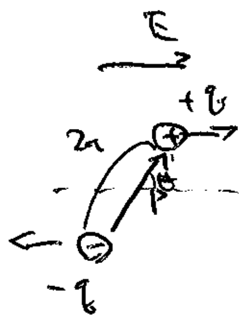
MAGNETIC DIPOLE MOMENT

$$\vec{\mu} = I\vec{A}$$

$$\vec{\tau} = \vec{\mu} \times \vec{B}$$

SIMILARITY TO ELECTRIC DIPOLE

$|\vec{p}| = 2aq$



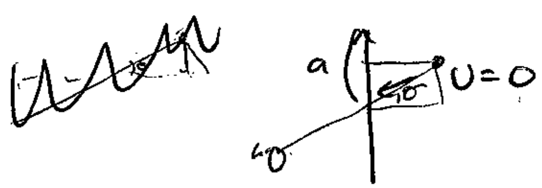
$\vec{\tau} = q\, a\, \sin\theta \times 2$

$= 2qa \sin\theta$

$\vec{\tau} = \vec{p} \times \vec{E}$

POTENTIAL ENERGY

$qEa\cos\theta \times 2 \Rightarrow \boxed{U = -\vec{p}\cdot\vec{E}}$

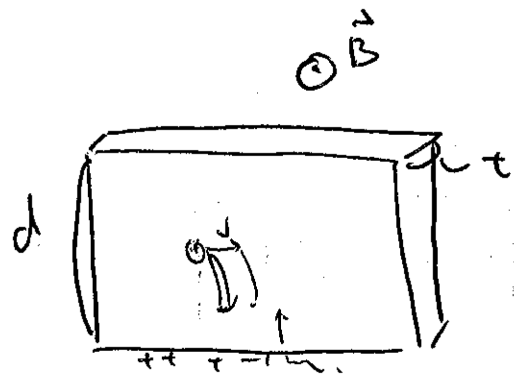


MAGNETIC DIPOLE

$$\vec{\tau} = \vec{\mu} \times \vec{B}$$

$$U = -\vec{\mu} \cdot \vec{B}$$

HALL EFFECT



$$\vec{E} \qquad q E_H = q V_d B$$

$$\Delta V_H = q E_H d$$

$$V_d = \frac{I}{nqA}$$

$$\Delta V_H = \frac{IBd}{nqA} = \frac{IB}{nqt} = \frac{R_H I B}{t}$$

$R_H = \frac{1}{nq}$: HALL COEFFICIENT