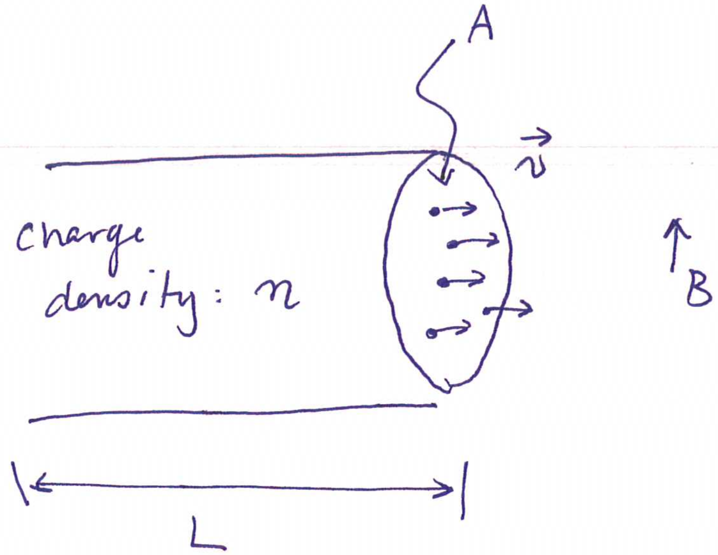


$$\vec{F} = q\,\vec{v} \times \vec{B}$$

$$\vec{F}_{Tot} = \sum_{i=1}^{N} q_i \vec{v}_i \times \vec{B}$$

$$= q\underbrace{n}_{\#\text{ density}} \overbrace{AL}^{\text{volume}}\, \vec{e}_v\, v \times \vec{B}$$

$$= \underbrace{qnvA}_{I}\ \underbrace{L\vec{e}_v}_{\vec{L}} \times \vec{B}$$

this is defined as a current I.

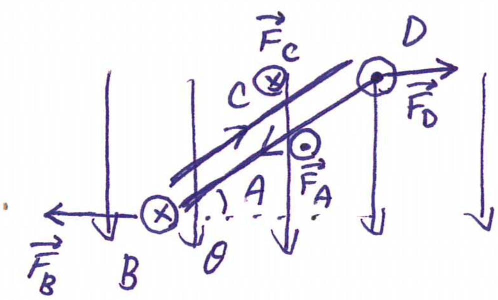
$$\vec{F} = I\,\underbrace{\vec{L}}_{\text{end-to-end distance}} \times \overbrace{\vec{B}}^{\text{uniform.}}$$

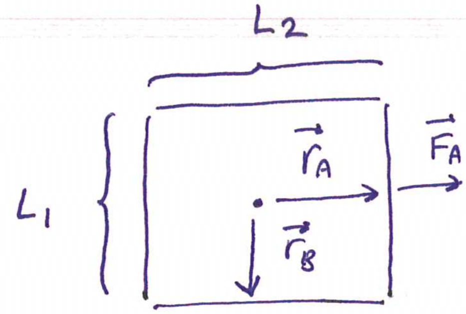
Application :

Closed loop + jumping wires.

Compute torque on loop.

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





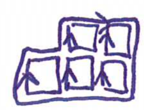
$$\vec{\tau}_{Tot} = \underbrace{\cancel{\vec{r}_A \times \vec{F}_A}}_{0} + \vec{r}_B \times \vec{F}_B + \underbrace{\cancel{\vec{r}_C \times \vec{F}_C}}_{0} + \vec{r}_D \times \vec{F}_D$$

$$|\vec{L}_B| = L_2 \qquad |\vec{r}_B| = \frac{L_1}{2}$$

$$\vec{F}_B = I B L_2 (-\hat{\imath}) \qquad \vec{F}_D = B I L_2 (\hat{\imath})$$

$$\vec{\tau}_{Tot} = \left(\frac{L_1}{2}\right)(I L_2 B)\left(\hat{r}\times\hat{\imath} + (-\hat{r})\times(-\hat{\imath})\right) = L_1 L_2 I B \sin\theta\, \hat{k}$$

$$= A I B \sin\theta \cdot \hat{k}$$

* Arbitrary shape constructed from  differential loops

$$\vec{\tau} = \oint \vec{r} \times I\, d\vec{l} \times \underset{\text{constant}}{\vec{B}} = I\left(\underset{\text{loop normal}}{\hat{n}} \int d^2A\right) \times \vec{B}$$

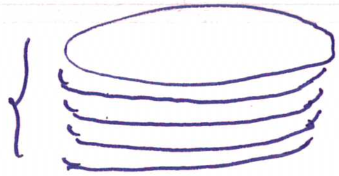
$$= (\hat{n} A I) \times \vec{B}$$

Phys 122 D Wi 15 Lecture 18

Define $\vec{\mu} \equiv$ Magnetic Dipole Moment

$$\equiv \hat{n} A I$$

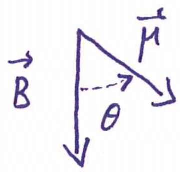
for multiple loops

N=5 

$$\vec{\mu} = \hat{n} A I N$$

N = number of loops

Work + Potential energy



$$\Delta W = -\int_{\theta_0}^{\theta_1} d\theta\, \tau = -\mu B \int_{\theta_0}^{\theta_1} d\theta \sin\theta$$

Note... (−) of def from X.

$$= +\mu B \cos\theta \Big]_{\theta_0 = \frac{\pi}{2}}^{\theta_1} = \mu B \cos\theta_1$$

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

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