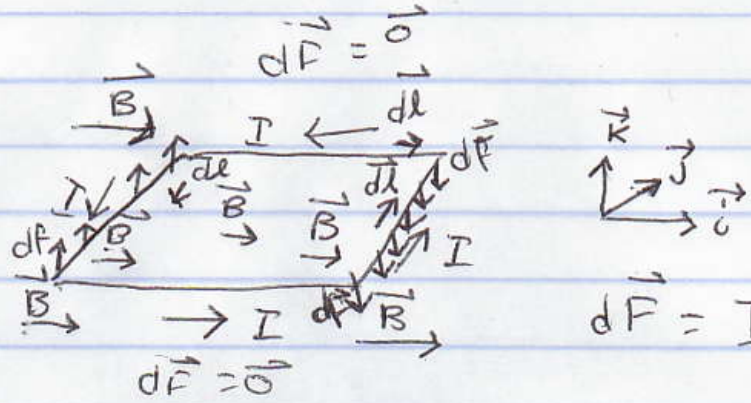
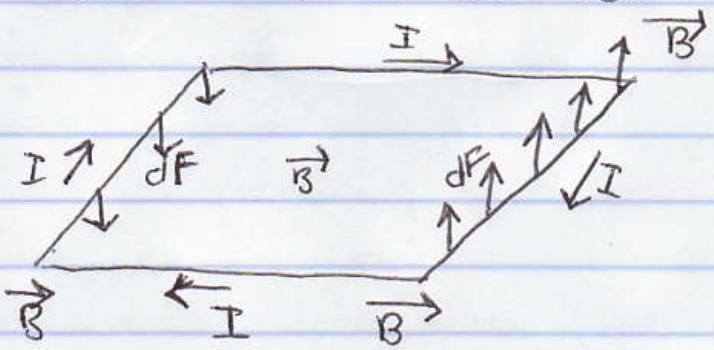
9/27/10



- Planer loop of wire with uniform current.
- uniform magnetic field.

* loop rotates 180°



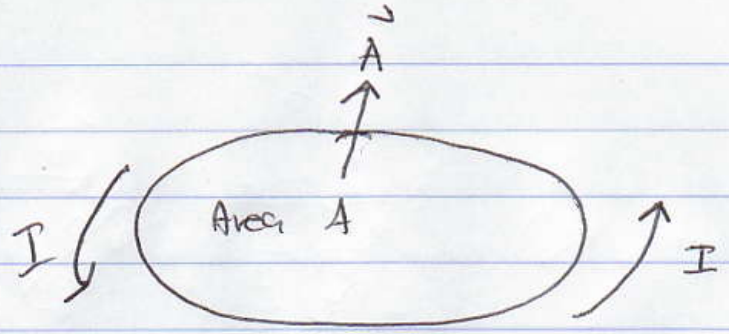
opposite torque

Recall from physics I

$\vec{P}$ = linear momentum

$\vec{L}$ = angular momentum

$\vec{F} = \frac{d\vec{P}}{dt}$ torque $= \vec{\tau} = \frac{d\vec{L}}{dt}$



planar loop

$|A| = A$ = area

direction of $\vec{A}$:

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

N loops: $\vec{\mu} = NI\vec{A}$

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

Biot - Savart Law:

Moving charges make magnetic fields:

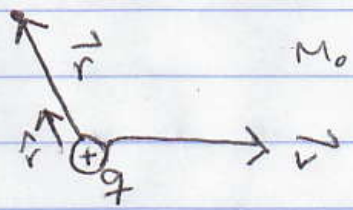
$$\vec{B} = \frac{\mu_0}{4\pi} \cdot \frac{q\vec{v} \times \hat{r}}{r^2}$$

↑ at point P

μ_0 = "Permeability of free space"

$\mu_0 = 4\pi \cdot 10^{-7} (T/A) \cdot m$

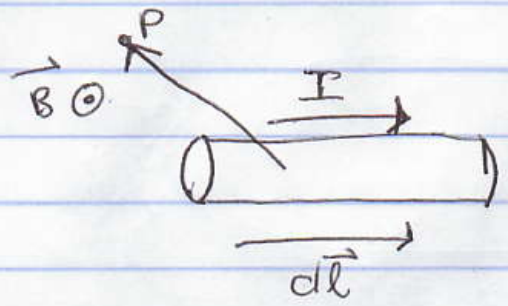
$= 4\pi \cdot 10^{-7}\ T \cdot m/A$



$\vec{r}$: arrow from q to P

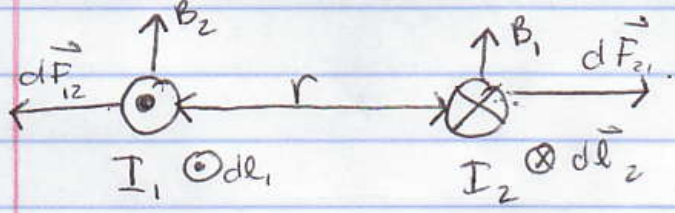
$r = |\vec{r}|$ = distance from q to P

$$\hat{r} = \frac{\vec{r}}{r} = \frac{\vec{r}}{|\vec{r}|}$$



"current" version of Biot-Savart law:

$$\underbrace{d\vec{B}}_{\text{at point } P} = \frac{\mu_0 I}{4\pi} \cdot \frac{d\vec{\ell} \times \hat{r}}{r^2}$$



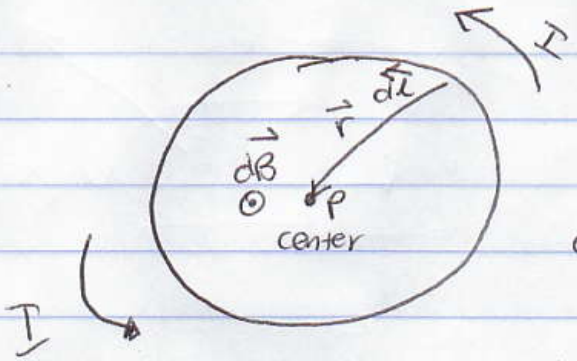
$$d\vec{F} = I\, d\vec{\ell} \times \vec{B}$$

Antiparallel currents repel.

$$\frac{dF_{12}}{d\ell} = I_1 B_2 = I_1 \cdot \frac{\mu_0 I_2}{2\pi r}$$

$$\frac{dF_{21}}{d\ell} = I_2 B_1 = I_2 \cdot \frac{\mu_0 I_1}{2\pi r}$$

$$\frac{\mu_0 I_1 I_2}{2\pi r}$$



$d\vec{B}$ always points out

$d\vec{l} \times \vec{r}$

$$B = \int_{\text{circle}} \frac{\mu_0 I}{4\pi} \cdot \frac{(dl)\,1}{r^2} = \underbrace{\frac{\mu_0 I}{4\pi r^2}}_{\text{circle}} \int dl$$

$$= \frac{\mu_0 I}{4\pi r^2} \cdot 2\pi r = \frac{\mu_0 I}{2r}$$