Definition of $\vec{E}$: put charge q at rest at some point in space. Measure $\vec{F}$.

$$\vec{E} = \vec{F}/q$$

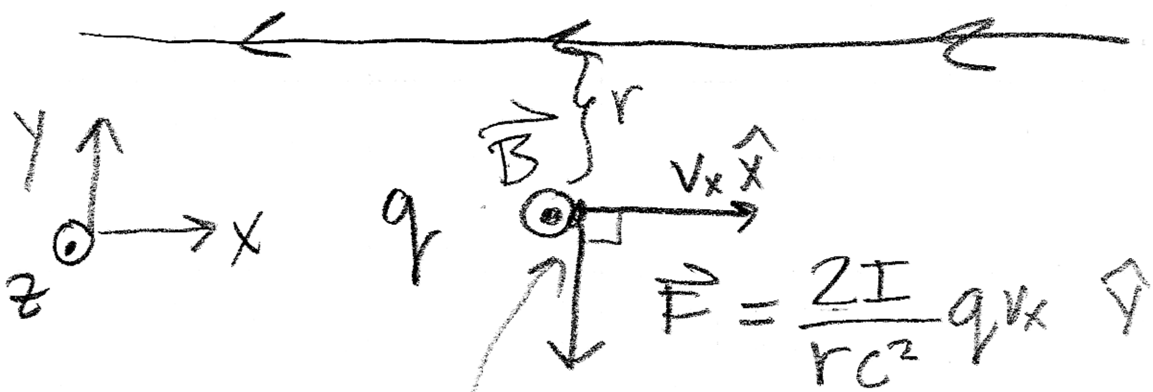
Definition of $\vec{B}$: (magnetic field) go to that same spot in space, Give q a velocity $\vec{v}$, measure $\vec{F}'$

$$\text{"magnetic force"} \equiv \vec{F}' - \frac{\vec{F}}{q}$$

$$\equiv \underbrace{q\frac{\vec{v}}{c} \times \vec{B}}_{} \quad \text{(by definition)}$$

presence of cross product makes solving for $\vec{B}$ a challenge!

$I < 0$



$$\vec{F} = \frac{2I}{rc^2} q v_x \hat{y} \quad \left(\begin{matrix}\text{note}\\ I<0\end{matrix}\right)$$

deduce $\vec{B}$ in $\hat{z}$ direction.

since right angles

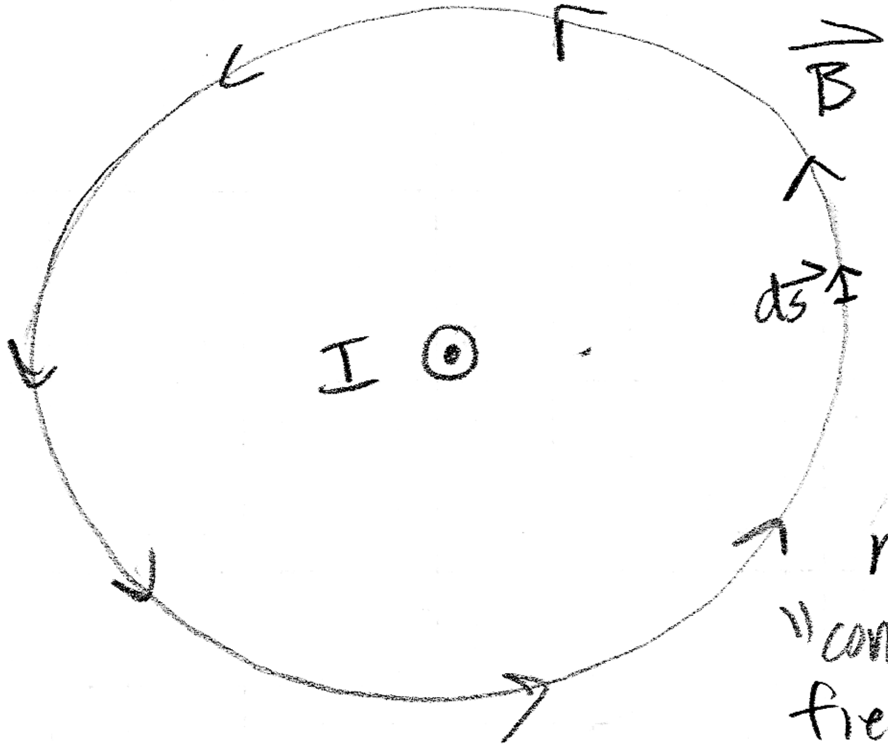
$$\frac{\cancel{q} v_x}{c} B = \frac{2I}{rc^2} \cancel{q v_x}$$

comes out in: Gauss, input esu/sec, cm, cm/s...

$$\boxed{B = \frac{2I}{rc}}$$

NOT radial!

remember E_r around wire? $2 \cdot \frac{\lambda}{r}$



$\oint \vec{B} \cdot d\vec{s} \neq 0$!!!

not a "conservative" field

MKS:

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

Newtons

Coulombs

no c

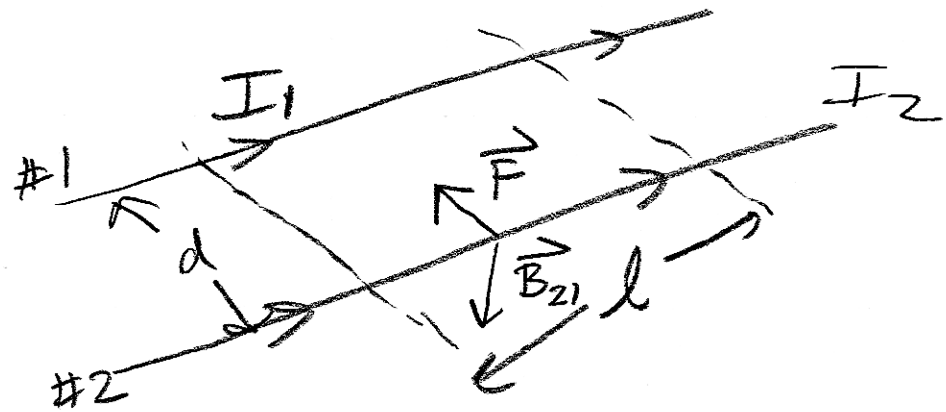
in Tesla...

The weird thing here is computing $\vec{B}$ from I.

$$B = \frac{\mu_0}{2\pi} \cdot \frac{I}{r} \qquad \mu_0 = 4\pi \cdot 10^{-7}$$

$$1 \text{ Tesla} = 10^4 \text{ Gauss}$$

Force/Length on Wires



$$\vec{B}_{21} = \frac{2I_1}{dc}$$

$$I_2 = n_2 q_2 v_2$$

n_2 = # charges/length
q_2 = charge of carriers
v_2 = velocity of carriers.

$$\text{force on one carrer} = B_{21} \frac{q_2 v_2}{c} \quad (\perp)$$

$$\text{force on } n_2 \text{ carriers/length} = n_2 B_{21} \frac{q_2 v_2}{c} = \frac{2 I_1 I_2}{dc^2}$$

$$\frac{\text{dynes}}{\text{cm}} \quad \boxed{\frac{F}{\ell} = 2\frac{I_1 I_2}{d c^2}} \quad 2\frac{\left(\frac{\text{esu}}{\text{sec}}\right)^2}{\text{cm}\left(\frac{\text{cm}}{\text{s}}\right)^2}$$

used to define 1 $\frac{\text{esu}}{\text{sec}}$ of current

$$\frac{\text{Newtons}}{\text{m}} \quad \boxed{\frac{F}{\ell} = \frac{\mu_0}{2\pi}\frac{I_1 I_2}{d}} \quad \frac{(\text{Amp})^2}{\text{m}}$$

$4\pi \cdot 10^{-7}$