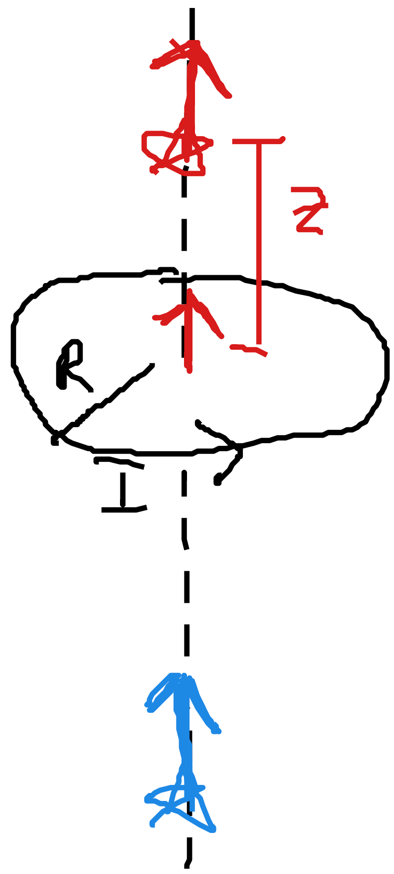
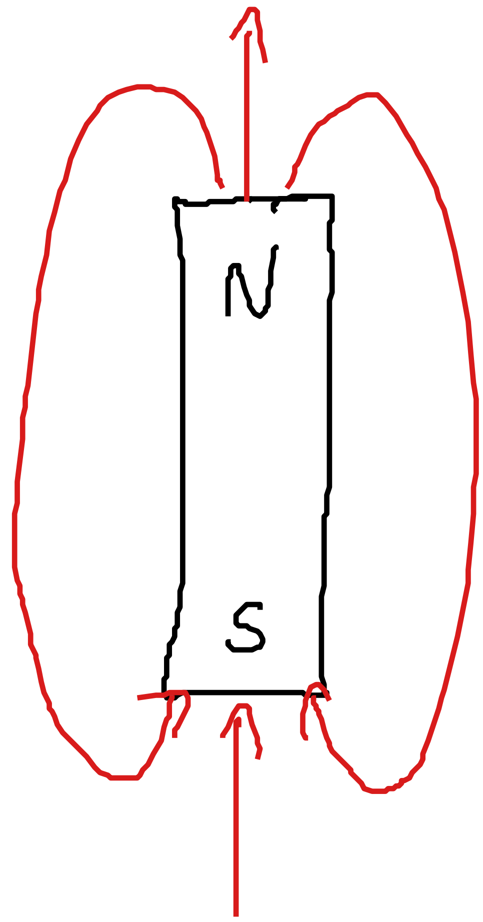




radius of loop

Along axis,

$$B = \frac{\mu_0 I}{2} \frac{R^2}{(R^2+z^2)^{3/2}}$$

distance from loop

no π in this equation

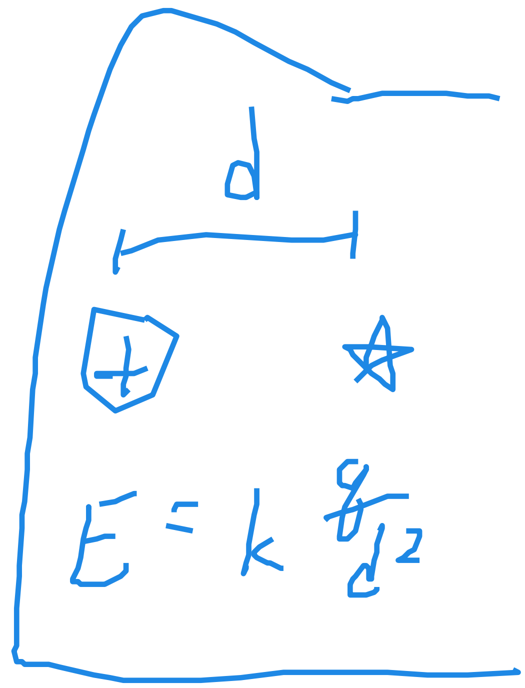
Very far away

$$z \gg R$$

$$R^2 + z^2 \approx z^2$$

$$B \approx \frac{\mu_0 I}{2} \frac{R^2}{(z^2)^{3/2}}$$

$$\approx \frac{\mu_0 I}{2} \frac{R^2}{z^3}$$



Fields of magnetic dipoles die away as $1/(\text{distance})^3$, faster than $\frac{1}{(\text{distance})^2}$

Current Loops are like Bar magnets — both dipoles

"Strength" of a Dipole

Magnetic Dipole Moment

$\vec{\mu}$

For a bar magnet

$\vec{\mu}$ points from S to N

Magnitude is just given

For a current loop

- direction from RHR circle: I

thumb: $\vec{\mu}$

$|\vec{\mu}| = IA = I\pi R^2$

A ↑ area; $I\pi R^2$ for circle

Far away on axis of a dipole

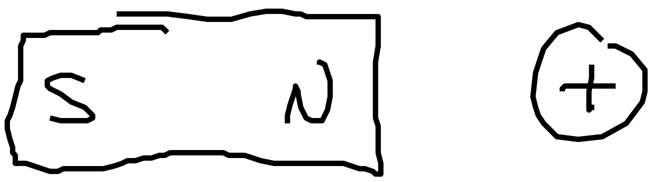
$$B = \frac{\mu_0 I \pi R^2}{2\pi z^3}$$

constant

$$\vec{B} = \frac{\mu_0 \vec{\mu}}{2\pi z^3}$$

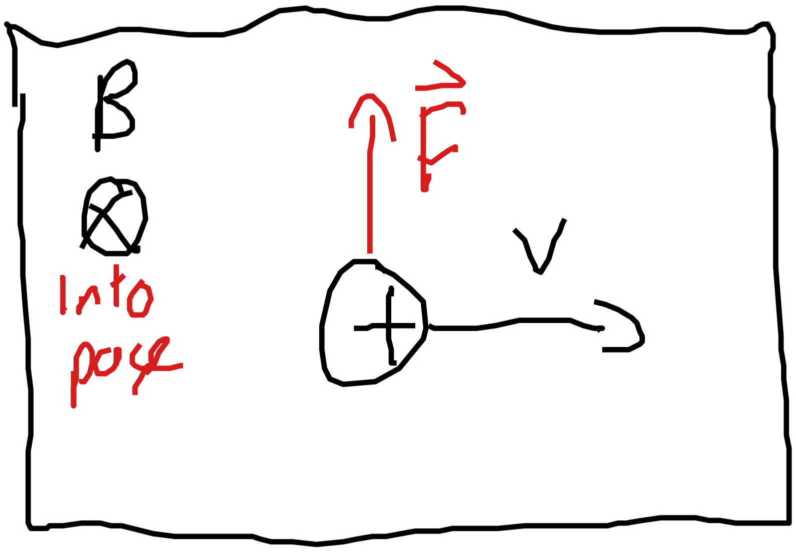
magnetic dipole moment

Static charges do not care about $\vec{B}$



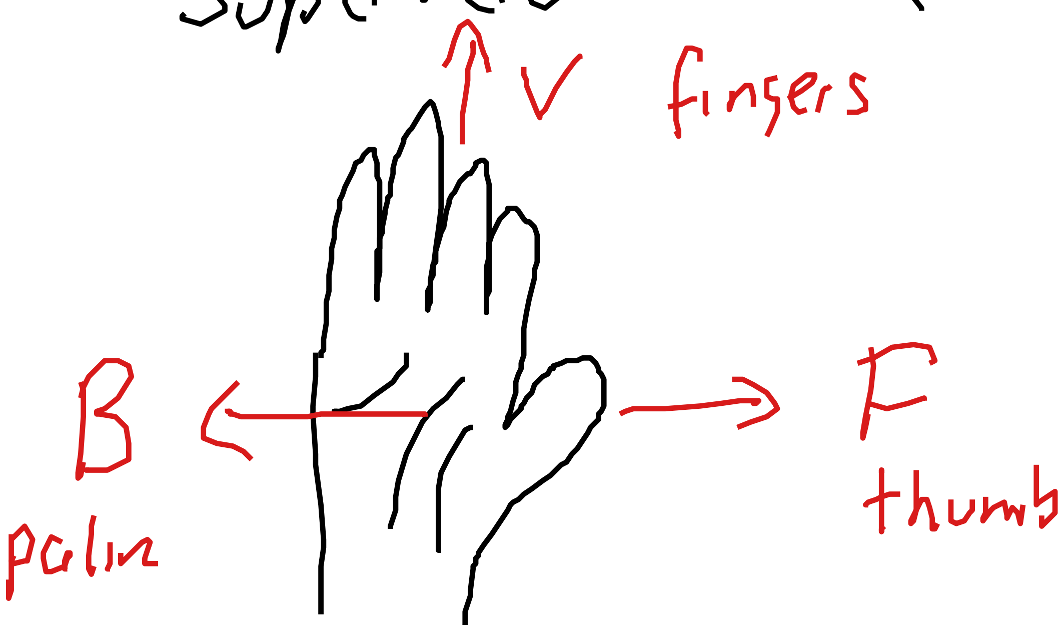
nothing happens

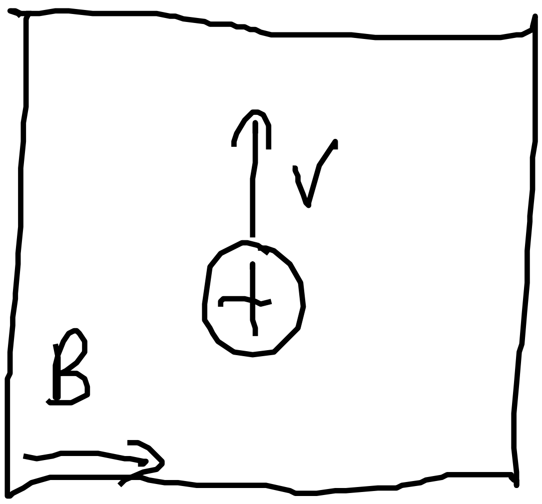
Moving charges fel a force in a $\vec{B}$ field



- $\vec{F}$ is always $\perp$ to $\vec{V}$ & $\vec{B}$ (up or down)
- To choose which direction

Superhero RHR



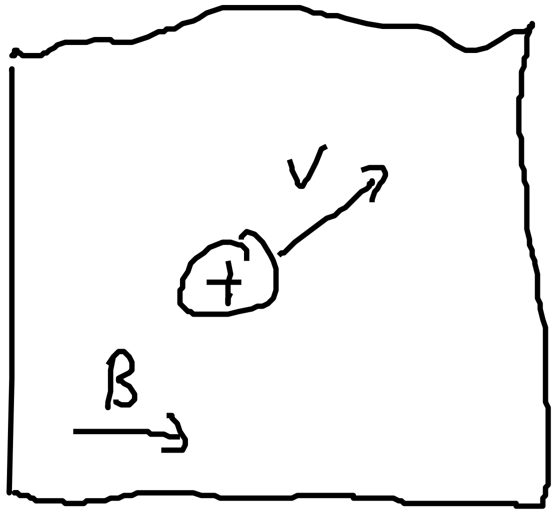


What is F?

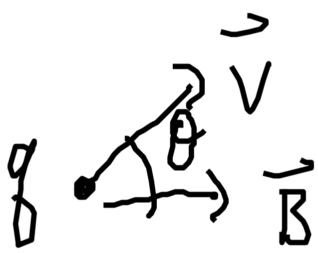
- can't be ↑ or ↓
  (b/c ⊥ to v)

- can't be → or ←
  (b/c ⊥ to B)

therefore ⊙ out or ⊗ in



- either $\odot$ or $\otimes$ (perpendicular to the plane of $\vec{v}$ & $\vec{B}$)
- $\vec{F}$ is still $\otimes$



$$|\vec{F}| = qvB\sin\theta$$

$\theta = 0$ $\sin\theta = 0$

v ⟶

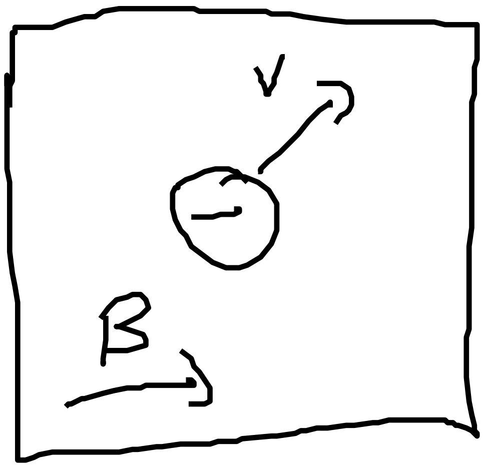
B ⟶

$F = 0$

$\theta = 90^\circ$ $\sin 90^\circ = 1$

B ⟂ v

$F = qvB$

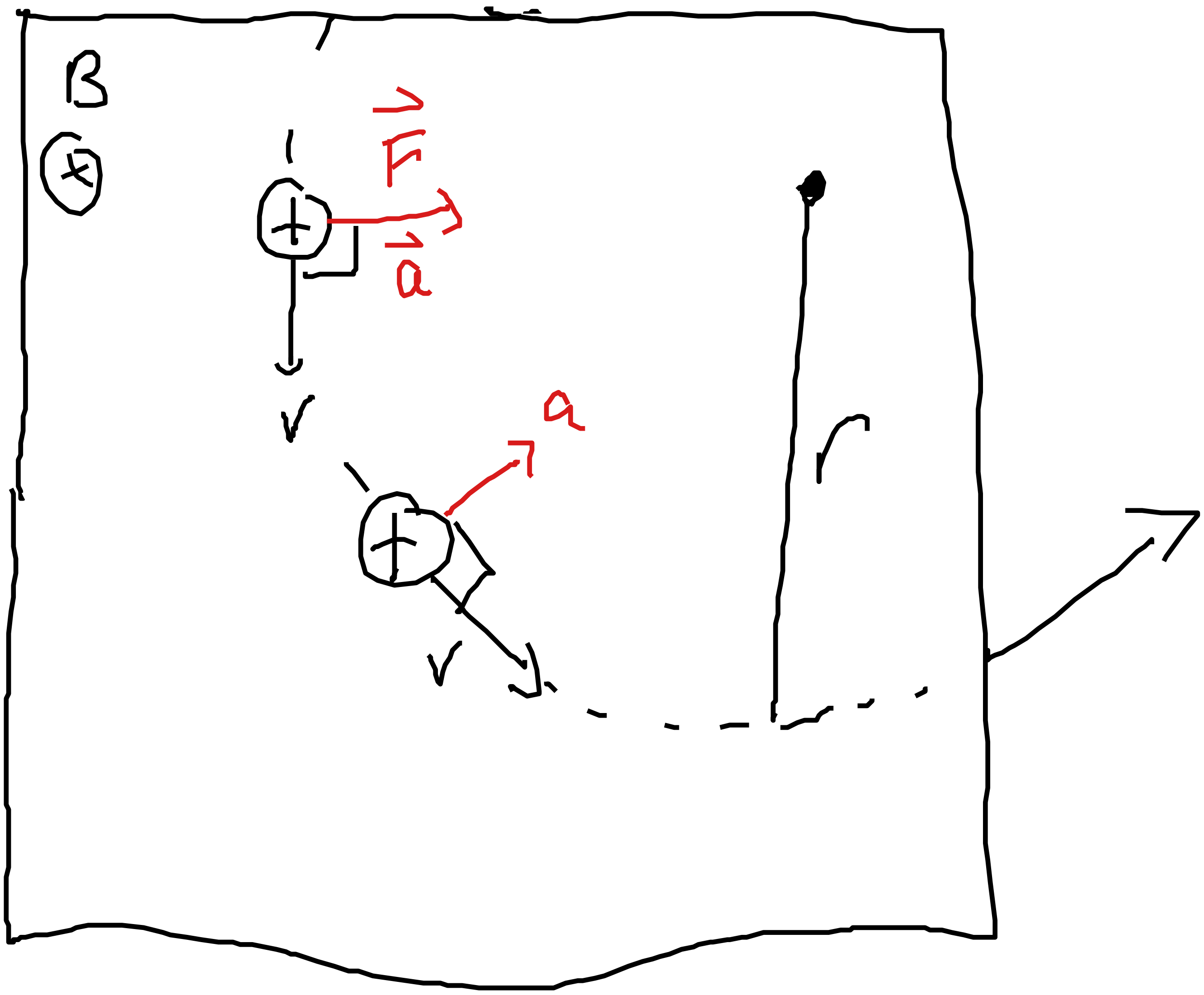


$\vec{F}$ ⊙ out of page

(opposite ⊕)

Negative charges feel force in opposite direction

- electron twist
- LHR



Uniform Circular Motion

$$r = \frac{mv}{qB}$$

radius