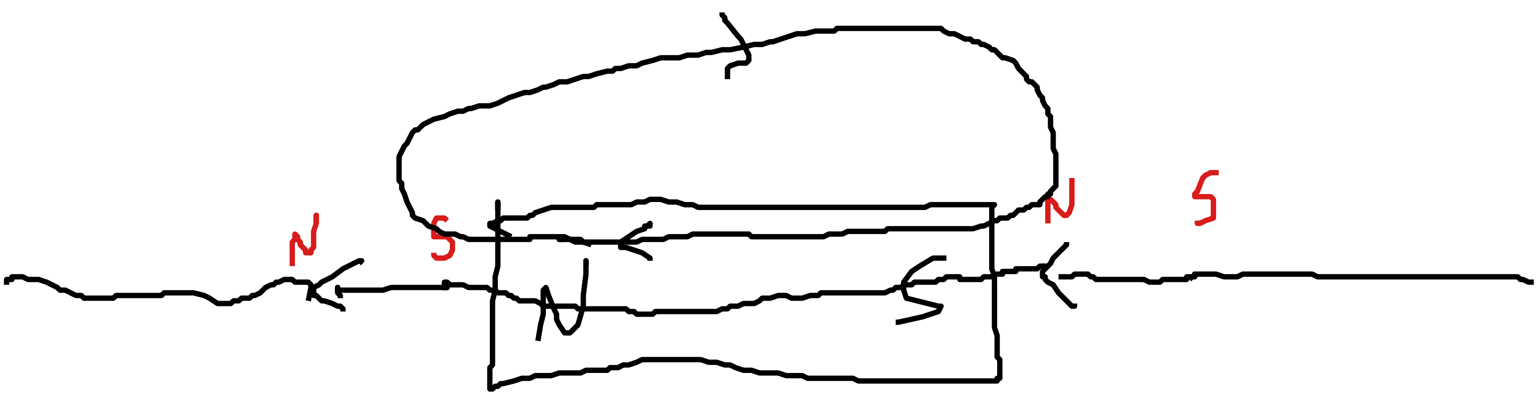
Magnets

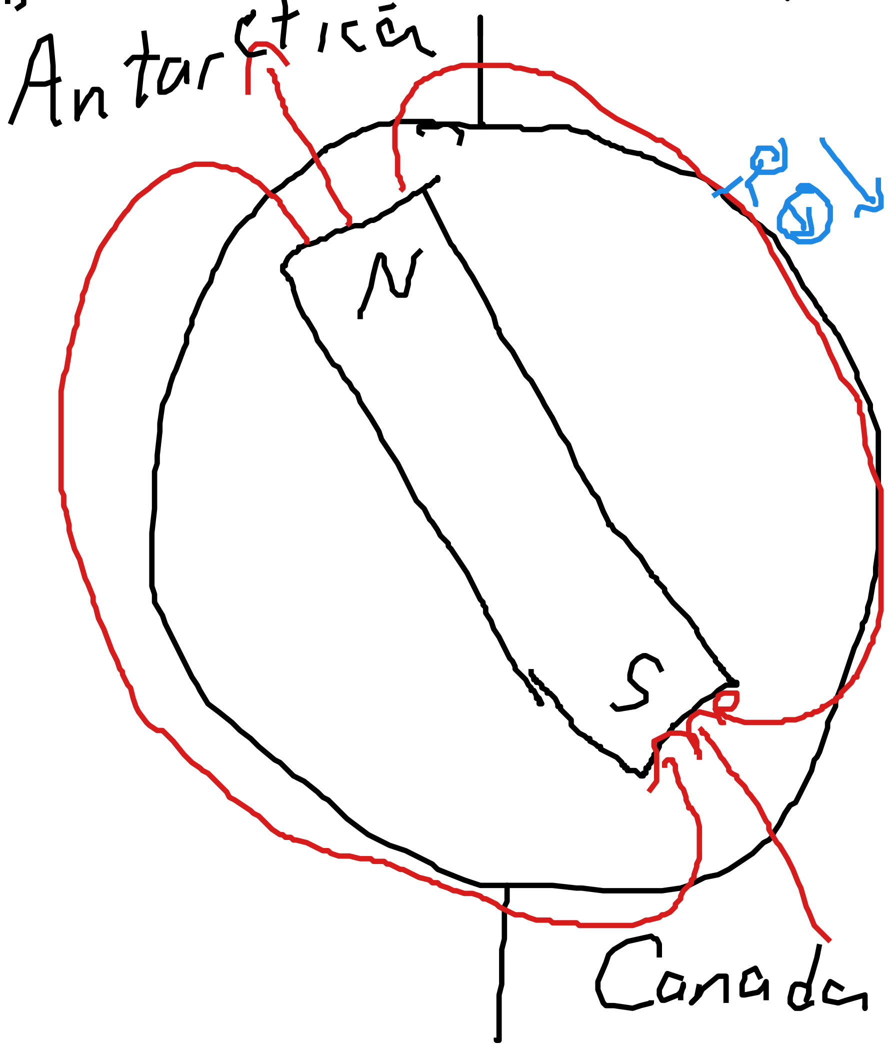
$\vec{B}$: magnetic field

points in direction a compass would point



Magnetic field lines never terminate

Earth has a magnetic field



Earth is not actually a giant bar magnet

Field is created by currents in the core.

The "north magnetic pole" (Canadian) is an S pole.

The "south magnetic pole" is an N pole.

What does $\vec{B}$ do?

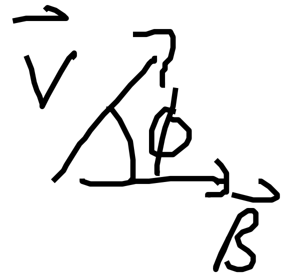
exerts a force on moving charge

$$\vec{F} = q\vec{V} \times \vec{B}$$

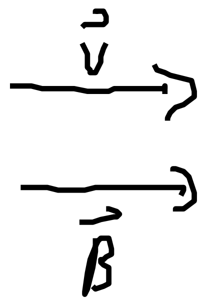
- $\vec{F}$: force
- q : charge
- $\vec{V}$: velocity of charge
- $\vec{B}$: magnetic field

Cross Product : vector

$$|\vec{v} \times \vec{B}| = |\vec{v}|\ |\vec{B}| \sin\phi$$

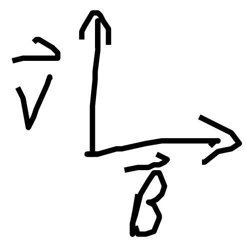


$\phi = 0$! parallel



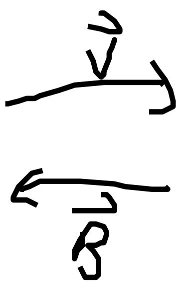
$\sin\phi = 0 \quad |\vec{v} \times \vec{B}| = 0$

$\phi = 90^\circ$



$\sin 90^\circ = 1 \quad |\vec{v} \times \vec{B}| = |vB|$

$\phi = 180^\circ$ anti parallel



$\sin 180^\circ = 0 \quad |v \times B| = 0$

$\vec{v} \times \vec{B}$ is perpendicular to $\vec{v}$ & $\vec{B}$.

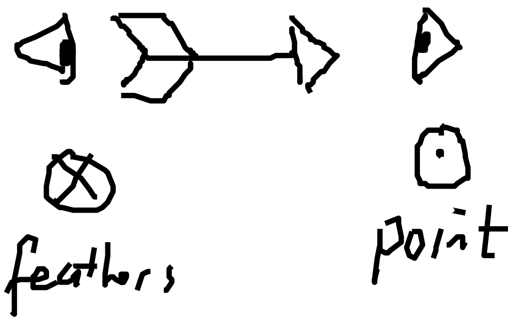
is perpendicular to the plane defined by $\vec{v}$ & $\vec{B}$

If $\vec{V}$ & $\vec{B}$ are on the screen

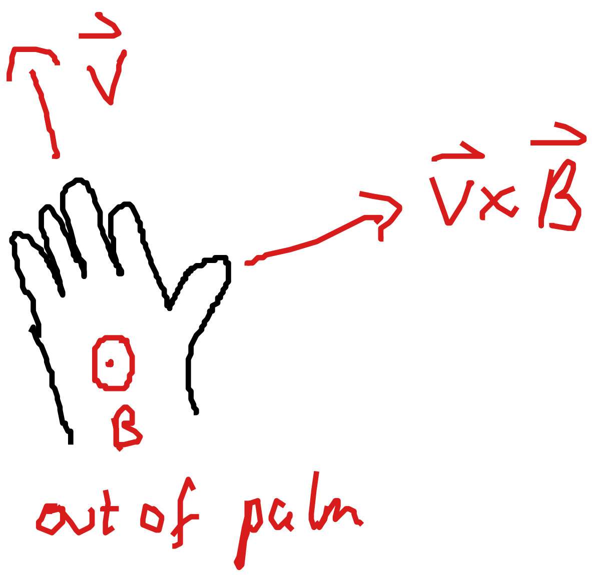
$\vec{V} \times \vec{B}$ is $\perp$ to screen

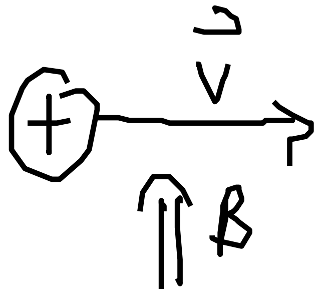
$\odot$ vector out of screen

$\otimes$ vector into screen



Right-Hand Rule #1

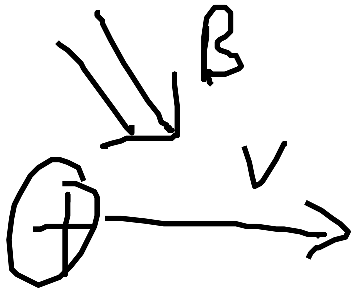




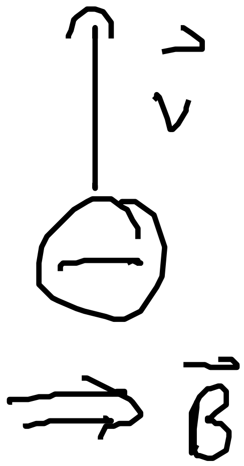
$\vec{F}$ points

A) $\otimes$

B) $\odot$



$\vec{F}$: $\otimes$

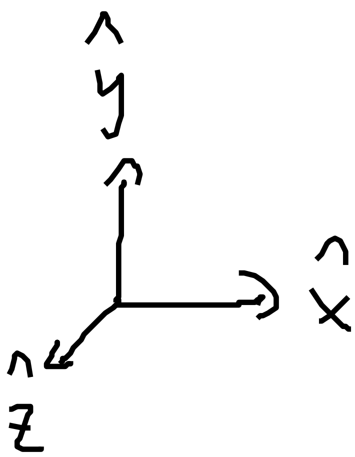


$$\vec{F} = q\vec{v}\times\vec{B}$$

$\vec{v}\times\vec{B}$ $\otimes$

negative → $q\,\vec{v}\times\vec{B}$ $\odot$

"electron twist"



right handed coordinate system

$$\hat{x}\times\hat{y} = \hat{z}$$
$$\hat{y}\times\hat{z} = \hat{x}$$
$$\hat{z}\times\hat{x} = \hat{y}$$
$$\hat{y}\times\hat{x} = -\hat{z}$$

$\boxed{\vec{A}\times\vec{B} = -\vec{B}\times\vec{A}, \text{ anticommutative}}$

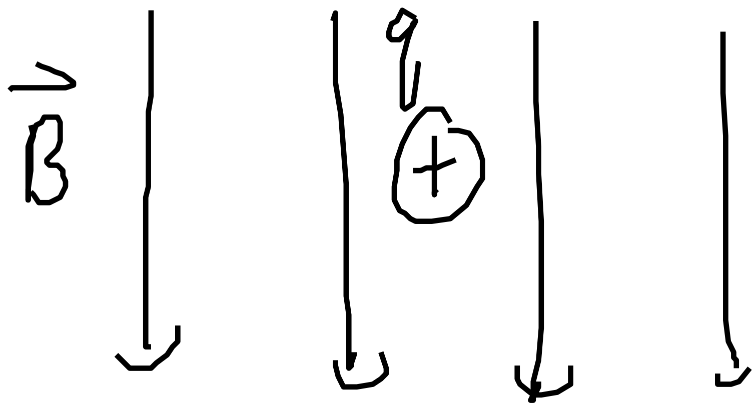
$$\hat{x} \times \hat{x} = 0 \qquad \hat{y} \times \hat{y} = 0 \qquad \hat{z} \times \hat{z} = 0$$

$$(3\hat{x} + 4\hat{y}) \times (\hat{y} - \hat{z})$$

$$3\hat{x} \times \hat{y} + 4\hat{y} \times \hat{y} - 3\hat{x} \times \hat{z} - 4\hat{y} \times \hat{z}$$

$$3\hat{z} + 0 - 3(-\hat{y}) - 4\hat{x}$$

$$-4\hat{x} + 3\hat{y} + 3\hat{z}$$



What direction must charge move to feel a downward force?

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

$\vec{F}$ is $\perp$ to $\vec{v}$ & $\vec{B}$

so this is impossible

$\vec{B}$: the direction the force <u>can't</u> point

$\vec{v}$ & $\vec{B}$ <u>can</u> be parallel but then $\vec{F} = 0$