Test

3

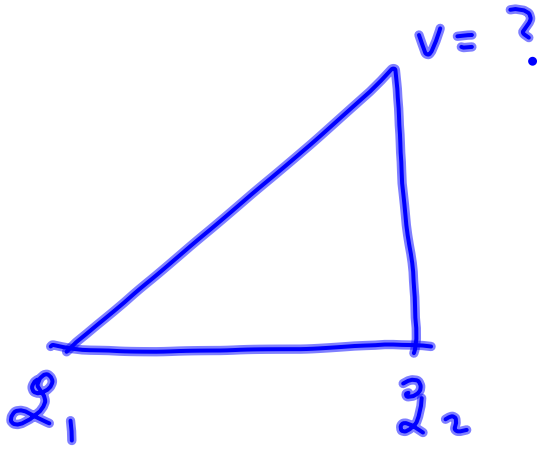
$$\vec{E} = -\left[\frac{\partial V}{\partial x}\hat{i} + \frac{\partial V}{\partial y}\hat{j} + \frac{\partial V}{\partial z}\hat{k}\right]$$

$$V = x^2 + y^2 + z^2$$

$$\vec{E} = -2x + z + \dots$$

$$\vec{E} = -2x\,\hat{i} - z\,\hat{j} - (y + 2z)\,\hat{k}$$

4



potential is a scalar

$$V = \frac{1}{4\pi\varepsilon_0}\frac{Q_1}{r}\overset{?}{=}\hat{i} + \frac{1}{4\pi\varepsilon_0}\frac{Q_2}{r}$$

Lorentz force law

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

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

$\vec{F} = q|\vec{v}||\vec{B}|\sin\theta$, direction determined by right hand rule

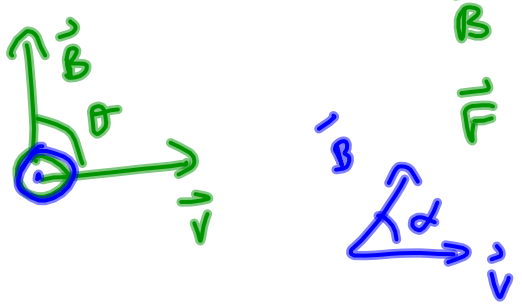
Let's look at magnetic part only

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

$\vec{v}$ thumb

$\vec{B}$ index finger

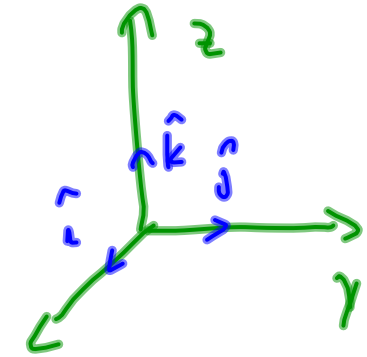
$\vec{F}$ middle finger



$$\vec{A} = 3\hat{i} + 2\hat{j} - 5\hat{k}$$

$$\vec{B} = 2\hat{i} - \hat{j} + 2\hat{k}$$

$$\vec{A} \times \vec{B} = \begin{vmatrix} \hat{i} & \hat{j} & \hat{k} \\ 3 & 2 & -5 \\ 2 & -1 & 2 \end{vmatrix}$$



$$\hat{i}\ \hat{j}\ \hat{k}\ \hat{i}\ \hat{j}$$

$$\vec{A} \times \vec{B} = (3\hat{i} + 2\hat{j} - 5\hat{k}) \times (2\hat{i} - \hat{j} + 2\hat{k})$$

$$\hat{i} \times \hat{j} = \hat{k} \qquad \hat{k} \times \hat{i} = \hat{j}$$

$$\hat{j} \times \hat{k} = \hat{i}$$

$$\vec{A} \times \vec{B} = -\vec{B} \times \vec{A}$$

$$\hat{i} \times \hat{j} = -\hat{j} \times \hat{i}$$

$$\vec{A} = 3\hat{i} + 2\hat{j} - 5\hat{k}$$

$$\vec{B} = 2\hat{i} - \hat{j} + 2\hat{k}$$

$$\vec{A} \times \vec{B} = (3\hat{i} + 2\hat{j} - 5\hat{k}) \times (2\hat{i} - \hat{j} + 2\hat{k}) =$$

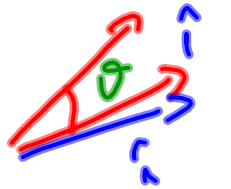
$$= -3\hat{k} - 6\hat{j}$$

$$-4\hat{k} + 4\hat{i}$$

$$-10\hat{j} - 5\hat{i}$$

$$= -\hat{i} - 16\hat{j} - 7\hat{k}$$

$= 0$ { $\hat{i} \times \hat{i}$, $\hat{j} \times \hat{j}$, $\hat{k} \times \hat{k}$



$\sin\theta$

i j k i j k

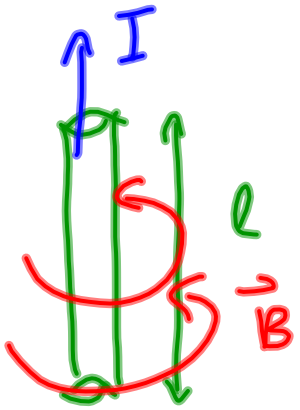
$$\begin{vmatrix} \hat{i} & \hat{j} & \hat{k} \\ 3 & 2 & -5 \\ 2 & -1 & 2 \end{vmatrix} = \hat{i}\cdot\left(4-(-5\cdot(-1))\right)$$

$$-\hat{j}\cdot\left(3\cdot 2-(-5\cdot 2)\right)$$

$$+\hat{k}\cdot\left(3\cdot(-1)-2\cdot 2\right)$$

$$= -\hat{i}-16\hat{j}-7\hat{k}$$

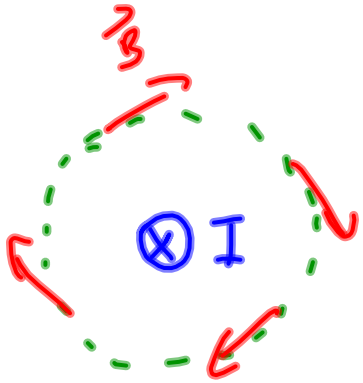
$$\vec{F}_{wire_{magnetic}} = I\vec{\ell} \times \vec{B}$$

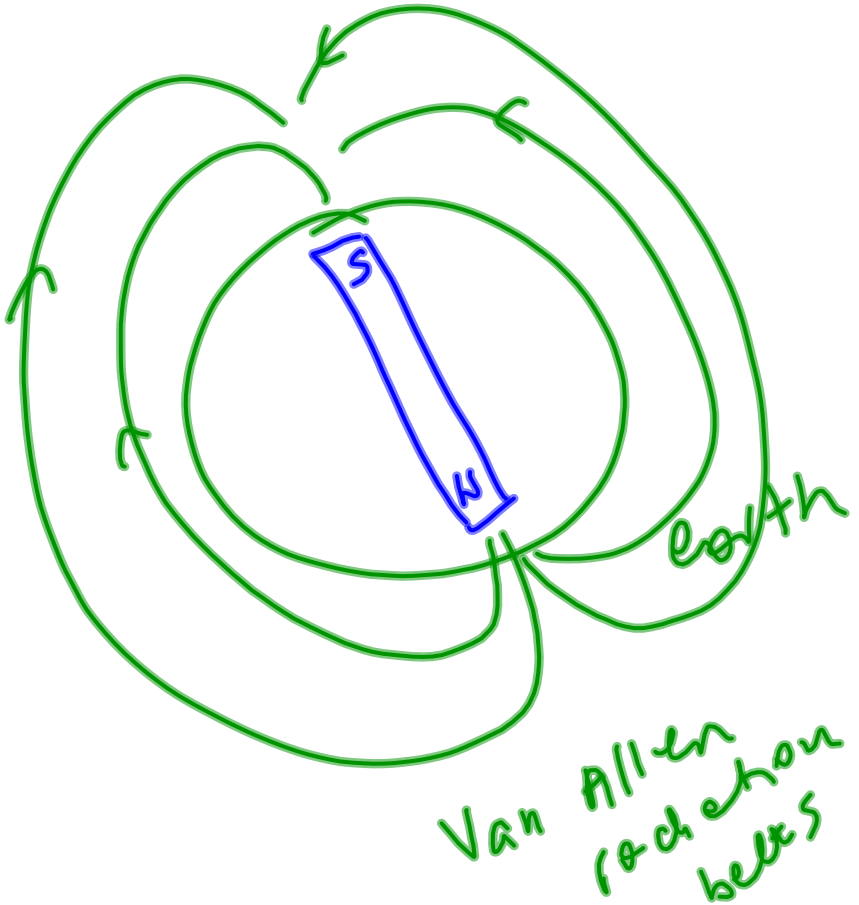


1) point your right thumb in the direction of the current

2) curl your fingers around the wire

3) your fingers point in the direction of $\vec{B}$ lines


B
I


S
N
Earth
Van Allen radiation belts