3-4-2019: Magnetism

Monday, March 4, 2019 9:03 AM

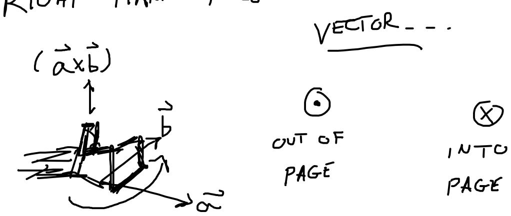
Is there a magnetic monopole?

- While some theories predict the existence of a magnetic monopole, we have yet to see one in practice.

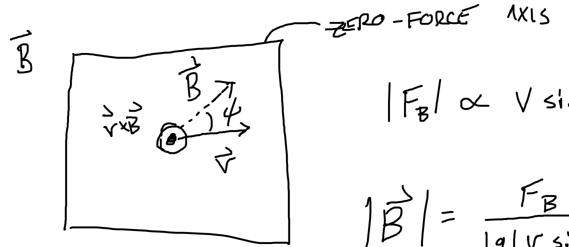
What are some examples of magnetism in our daily lives?

- The Earth itself has a magnetic field.
- The Sun is magnetic.
- Fridges, credit cards, etc. all magnetic!

RIGHT-HAND RULE



$\vec{B}$



$$|F_B| \propto v\sin\phi$$

$$\vec{F}_B \perp \vec{v}$$

$$|\vec{B}| = \frac{F_B}{|q|v\sin\phi}$$

$$\vec{F}_B = q(\vec{v}\times\vec{B})$$

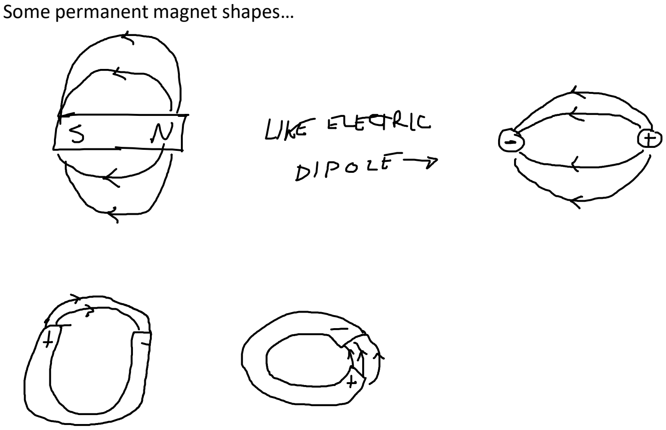
$$|F_B| = |q|vB\sin\phi$$

$$|B| = \frac{|F_B|}{|q|v\sin\phi}$$

$$[B] = \frac{N}{C\ m/s} = \frac{N}{A\cdot m} = T\ (\text{Tesla})$$

$$1\ T = 10^4\ \text{Gauss}\ (G)$$

Some permanent magnet shapes...



What's the magnetic field on the surface of Earth due to...

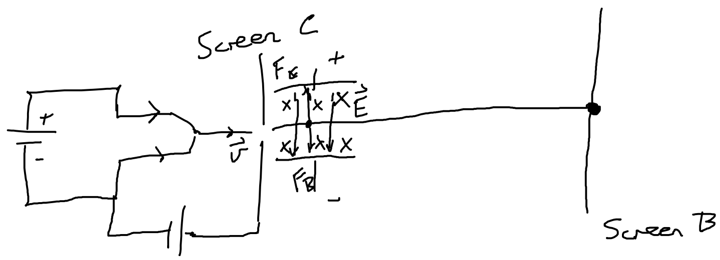
- Earth's magnetic pole?

$$B:\ 25 \sim 65\ \mu T$$

- The Sun?

$$\sim 1\ G$$

Cross Field: $\vec{E} \perp \vec{B}$



$$|F_E| = |F_B| \qquad 90^\circ$$

$$\cancel{q}E = \cancel{q}vB\sin\phi = \cancel{q}vB$$

$$E = vB \Rightarrow v = \frac{E}{B}$$

① $E_i = 0$; $B_i = 0$

$$\frac{m}{|q|}$$

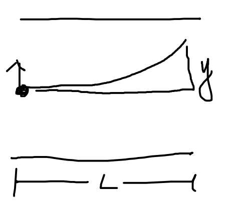
$$\vec{F}_B = q(\vec{v}\times\vec{B})$$

② $E \neq 0$; $B = 0$

$$y = \frac{1}{2}(|q|E)\left(\frac{L}{v}\right)^2$$

② $E \neq 0$ & $B = 0$

$F = qE$

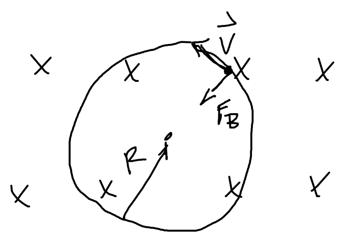


$$y = \frac{1}{2} a_y t^2 = \frac{1}{2}\left(\frac{qE}{m}\right)\left(\frac{L}{v}\right)^2$$

$$\vec{F}_B = q(\vec{v} \times \vec{B})$$

$$y = \frac{1}{2}\left(\frac{|q|E}{m}\right)\left(\frac{L}{v}\right)^2 = \frac{1}{2}\left(\frac{|q|E}{m}\right)\left(\frac{L}{\frac{E}{B}}\right)^2$$

$$y = \frac{|q|\cancel{E} B^2 L^2}{2m E^{\cancel{2}}} \Rightarrow \boxed{\frac{m}{|q|} = \frac{B^2 L^2}{2Ey}}$$



$$\vec{F}_B = q(\vec{v} \times \vec{B})$$

$$F_B = m\left(\frac{v^2}{R}\right) = qvB \Rightarrow R = \frac{mv}{|q|B}$$

$$\text{period} \quad T = \frac{2\pi R}{v} = \frac{2\pi\left(\frac{mv}{|q|B}\right)}{v} = \frac{2\pi m}{|q|B}$$

$$f = \frac{1}{T} = \frac{|q|B}{2\pi m} \Rightarrow \omega = 2\pi f = \frac{q|B|}{m}$$

What if this field is not perfectly in the plane of the velocity vector?

$\vec{v}_\perp \perp \vec{B}$