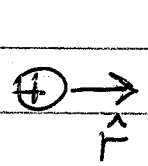
 Phys 2426 2017-07-17 Lec 8

Magnets! Generators of magnetic field.

E-Fields vs. B-Fields

- Vector fields - vector value @ every point.
- Generated by sources
  - Source of E is charge
  - Source of B is moving charge (i.e. current)
- Field is proportional to source.
- Direction of field related to relative position.

$\vec{E}$:

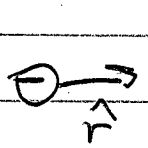


$\hat{r} = +\hat{x}$

from source toward p

For a ⊕ source, $\vec{E}$ is in $\hat{r}$ direction.

$$\vec{E} = \frac{kQ}{r^2}\hat{r}$$



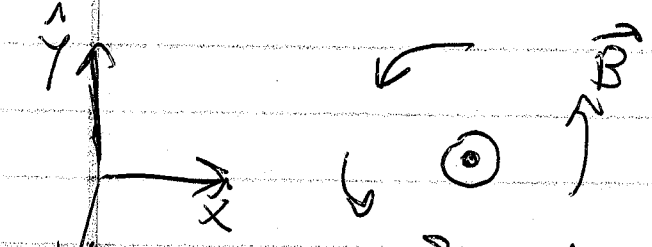
$$\hat{r} = \frac{\vec{r}}{|r|}$$

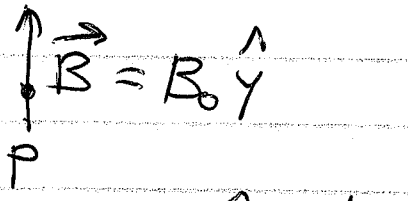
$$\vec{r} = (\vec{r}_P - \vec{r}_Q)$$

②

$\vec{B}$ is $\perp$ to $\hat{r}$

$\vec{B}$ is $\perp$ to $I\vec{\ell}$





$\hat{r} = \hat{x}$

$\hat{B} = \hat{I} \otimes \hat{r}$

Right-hand rule for current segment:

- Thumb along current.
- Fingers curl in dir of $\vec{B}$-field.

Vector Cross Product

$\vec{A} \otimes \vec{B} = \vec{C}$

$\vec{C} \perp \vec{A}$

$\vec{C} \perp \vec{B}$

$|C| = AB \sin \Theta_{AB}$

Analytical Method: $\hat{x} \otimes \hat{y} = \hat{z}$

Swap any two introduces $\ominus$ sign.

Ex: $\hat{x} \otimes \hat{z} = -\hat{y}$

Matrix Method

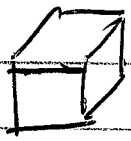
$$\vec{A} \otimes \vec{B} = \begin{vmatrix} \hat{x} & \hat{y} & \hat{z} \\ A_x & A_y & A_z \\ B_x & B_y & B_z \end{vmatrix}$$

RHR Method:

- Pointer = $\vec{A}$ = First vector
- Middle = $\vec{B}$ = second vector
- Thumb = $\vec{C}$ = result

Specifying 3D Directions

- Graphical



or ⊙ ⊗
"out" "in"

- In a captron?

R/L	+x/-x	E/W	R/L
Top=Up/Down=Bot	+y/-y	N/S	F/B
out/in	+z/-z	Up/Down	Up/Down
Page/Paper		World	Relative/Driving

- Be careful about Up/Down.

- $\vec{E}$ and $\vec{B}$ affect charges, also.
  - ↳ not the sources.
  - $\vec{E}$ pushes charges $\vec{F}_E = q\vec{E}$
  - $\vec{B}$ pushes moving charges $\vec{F}_B = q\vec{v} \otimes \vec{B}$
    and currents $\vec{F}_B = I\vec{\ell} \otimes \vec{B}$
  - $\vec{B}$ torques other magnets.