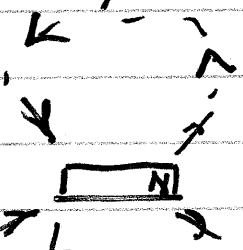
Phys 1402 2014-10-07

Magnetic Sources

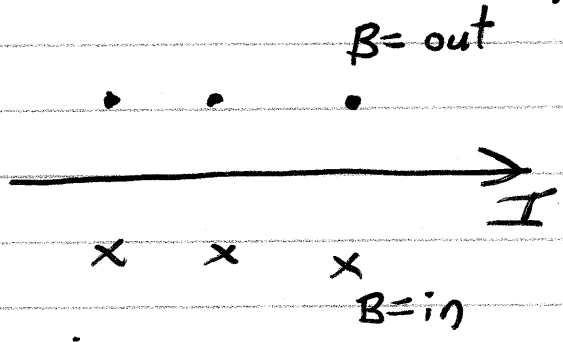
Magnet



B= strong near poles
weakens as you get further away

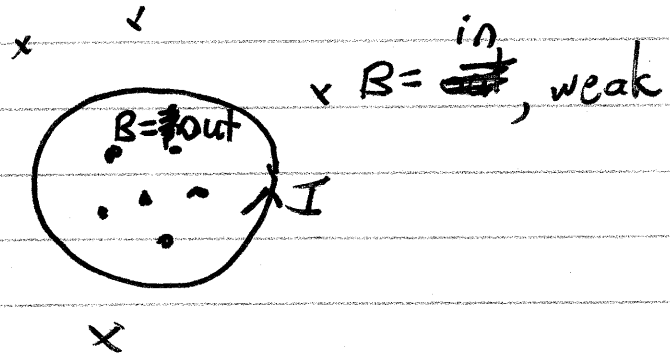
Wire

$$B = \frac{\mu_0 I}{2\pi r}$$



r= our dist from wire

Coil



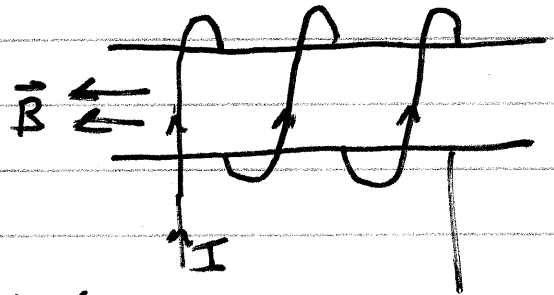
② Center:

$$B = \frac{\mu_0 I}{2r}$$

r= radius of coil.

Solenoid

Inside:



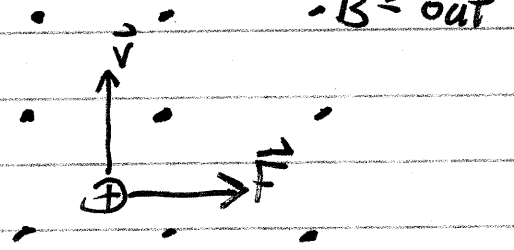
$$B = \mu_0 NI/\ell$$

$\mu_0 = 4\pi \times 10^{-7}$ T·m/A

Magnetic Force

- A moving charge experiences a sideways force due to $\vec{B}$.
- $\vec{B}$ must have some component $\perp$ to the velocity to cause a force.

Ex: $\vec{B}$ pointing out
$\vec{v}$ pointing up
$q = \oplus$



RHR for magnetic force

$$F = qvB_{\perp}$$

Thumb — index — middle

① Index finger in dir of $\vec{v}$.
② Middle finger bent inward in dir of $\vec{B}$
③ Thumb points in dir of $\vec{F}$ on $\oplus$

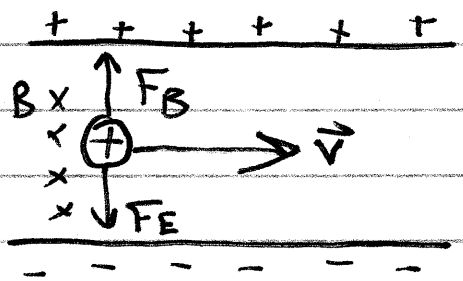
Ex: $\vec{B}$ points N. Drop a proton.
Which way does it deflect?
$\vec{F}$ is East ward.

N
W E
S

Ex: $\vec{B}$ points toward Left.
An electron is moving into the page.
$\vec{F}$ is toward bot of page.

(3)

Velocity Selector



Positive charge in a capacitor

$\vec{F}_E = q\vec{E}$ is downward.

Have the charge move toward the right.
We want the charge to go in a straight line.
We will make F_B oppose F_E.
Which way does B point?
B must point into the page.

$$F_B = qvB$$

$$F_E = F_B$$

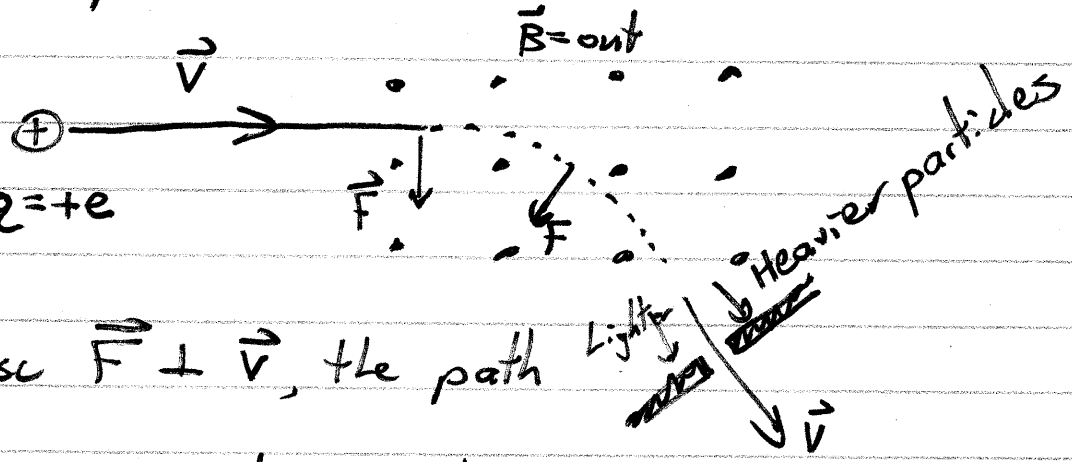
$$qE = qvB$$

$$E = vB$$

$$v = E/B$$

(4)

Mass Spectrometer



Because $\vec{F} \perp \vec{v}$, the path has a <u>circular</u> shape.

The path has a radius given by

$$F = ma$$

$$qvB = mv^2/r$$

$$r = \frac{mv^2}{qvB} = \boxed{\frac{mv}{qB}}$$

- Heavier particles follow a larger radius.
- How can we detect heavier particles?
  - decrease v
  - increase B
  - Move the detecton