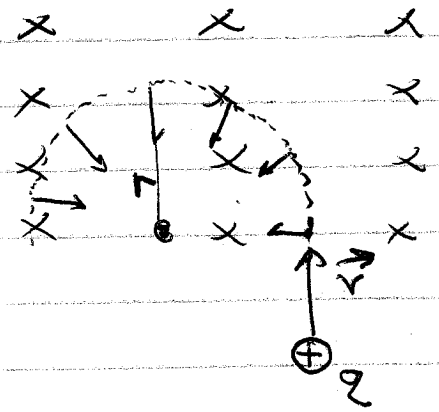
 Phys 2426 2016-10-06 Lec 13

Applications of $\vec{F}_B$

Particle moving in a magnetic Field.



$\vec{B} = B$ (in)

$\vec{F}_B = q\vec{v} \otimes \vec{B}$

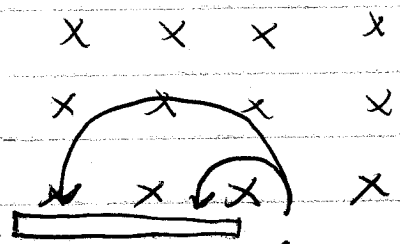
$= qvB$ (Left)

$$F = ma$$

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

$$r = \frac{mv}{qB}$$

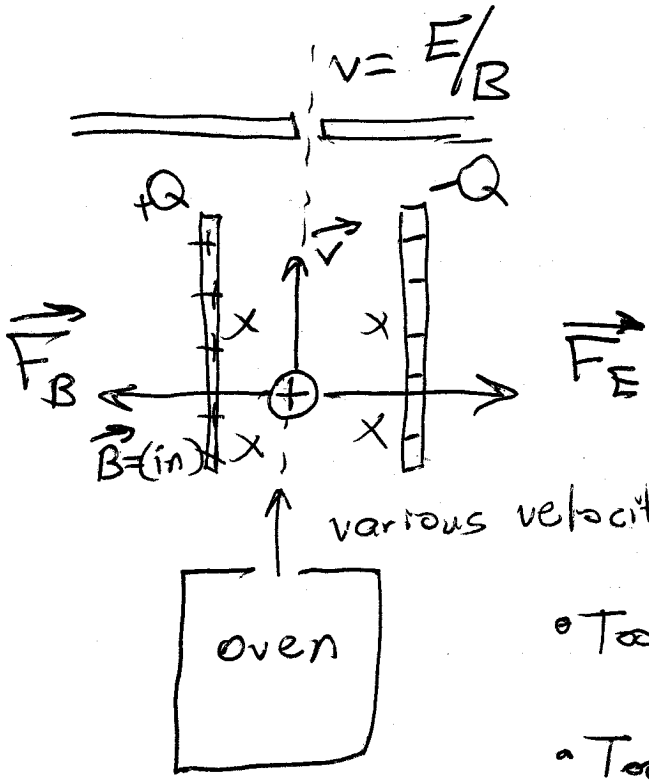
Mass Spectrometer



v = same
m = various

q = same

How do we make a beam of particles?



$F_E = F_B$

$qE = qvB$

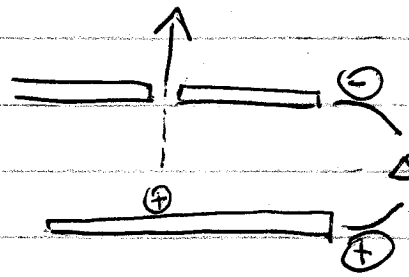
- Too Fast? F_B bends it.
- Too slow? F_E bends it.

Note: $E = 4\pi k\sigma = \dfrac{4\pi k Q}{A}$ ← charge of one plate; ↳ Area of one plate

$E = \dfrac{\Delta V}{d}$ ~ voltage; ~ spacing between plates

③

Linear Accelerator



Energy gain = $\boxed{q\Delta V = \frac{1}{2}mv^2}$

voltage — velocity

$$v^2 = \frac{2q\Delta V}{m} \qquad v = \sqrt{\frac{2q\Delta V}{m}}$$

In this beam, heavier particles go slower.

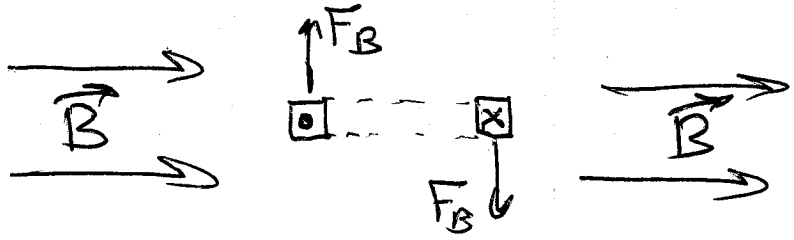
$$r = \frac{mv}{qB} = \frac{m}{qB}\sqrt{\frac{2q\Delta V}{m}}$$

$$r = \sqrt{\frac{2m\Delta V}{qB^2}}$$

If we use an accelerator beam, $r \propto \sqrt{m}$

④

Forces on a current:

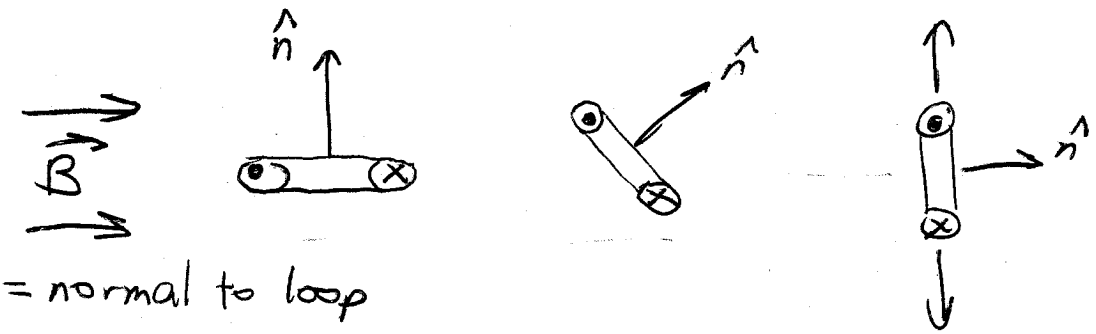


$$\vec{F} = \vec{I}\vec{\ell} \otimes \vec{B}$$

The two F_B's generate a torque:

$$\tau_{max} = NBAI$$

N = #loops of wire



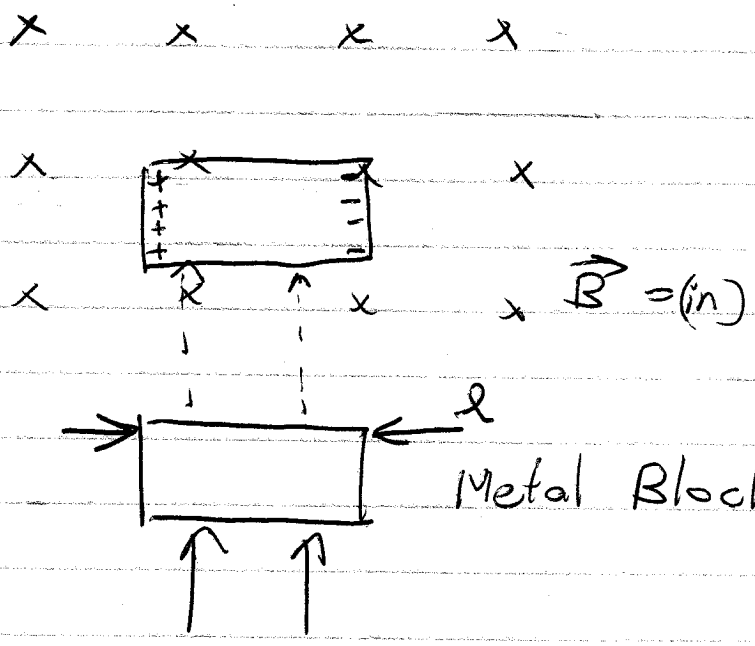
$\hat{n}$ = normal to loop

$\tau = \tau_{max}$ $\qquad$ $\tau = \tau_{max} \sin\theta$ $\qquad$ $\tau = 0$

$\theta = 90°$ $\qquad$ $\theta = 0°$

(5)

Motional EMF



$E = vB$

$\frac{\mathcal{E}}{\ell} = vB$

$\mathcal{E} = \ell v B$

- $\mathcal{E}$ — EMF
- ℓ — width of metal
- v — velocity