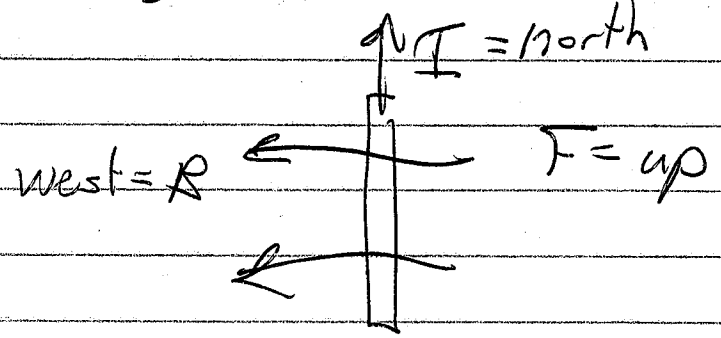
Phys 2426 2015-10-08 Lec 13

Read Ahead: Chap 31-32

A wire carries a current northward.
Gravity points down.
What $\vec{B}$ could levitate the wire?
(Ans: West)



E-Field Only $\vec{F}_E = q\vec{E}$

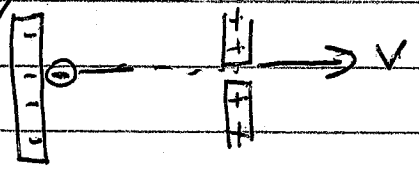
Particle accel in dir of $\vec{F}_E$
Force in the direction of motion does work.

Energy = Charge · Voltage

$\frac{1}{2}mv^2 = qV = qEl$

velocity ↑ ↑ voltage

This is a particle accelerator.

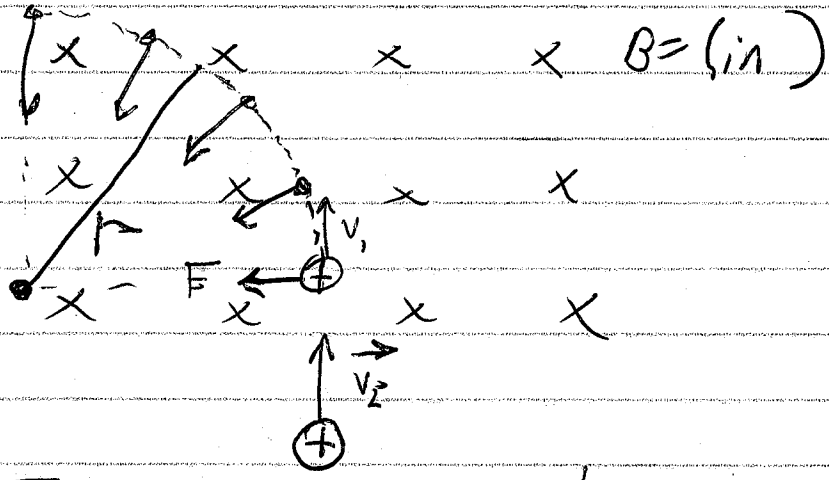


B-Field Only

$$\vec{F_B} = qvB\sin\theta$$

If $\vec{v}$ along $\vec{B}$, $\theta = 0$ $\quad F_B = 0$

If $\vec{v}$ perp $\vec{B}$, $\theta = 90°$ $\quad F_B = qvB$



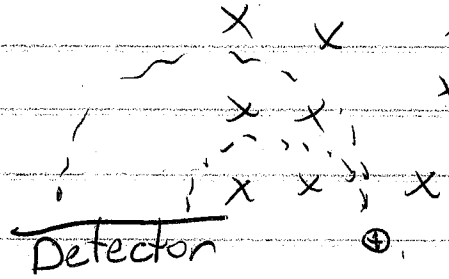
Force = m · accel

$$qvB = mv^2/r$$

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

Mass Spectrometer

- m different for each particle
- v, q, B the same



E and B simultaneously

$\vec{E}$ is uniform $\rightarrow$ $\vec{F}_E$ = uniform

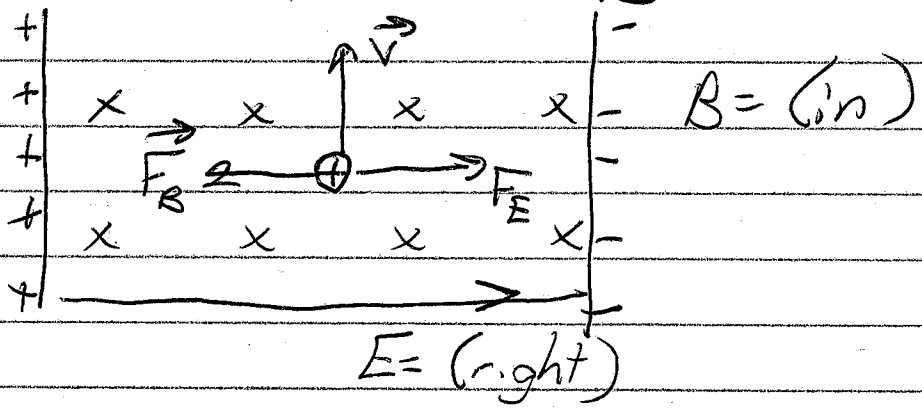
$\vec{B}$ is uniform $\rightarrow$ $\vec{F}_B$ = uniform?

$\vec{v}$ = constant

$\Sigma F = 0$ $\qquad F_E = F_B$

$qE = qvB$

$v = E/B$



What if the particle is going too slow?

F_B is weaker, F_E wins

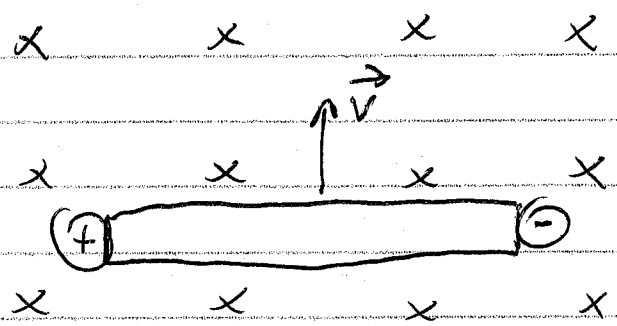
Particle is deflected to the right.

(4)

Mass Spec analysis $v = E/B$

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

Motional EMF



When the bar is moving across $\vec{B}$:

- Electrons Feel F_B. What dir?
  - ⊕ would Feel F_B = (left)
  - ⊖ feels F_B = (right)
- Built-up charge forms a capacitor.
- There is E in the metal now.
- Balance when $F_E = F_B$

$$qE = qvB$$

$$E = vB$$

$$V = El = vBl$$

V: voltage; v: velocity

Move wire in B Field → EMF

Hold wire and move magnet → EMF

What makes the stationary charges move? Fluctuating $\vec{B}$ makes $\vec{E}$