① Phys 1402 2015-10-08 Lec 13

Read Ahead Chap 20.

A wire carries a current toward the top of the page. (N)
Gravity points into the page (Down)

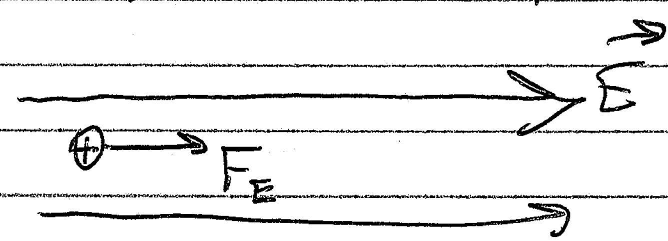
What magnetic field could levitate the wire?

$$F = I l B \sin\theta$$

F ↑ up (out) — l ↑ Top — B ↖ ? (middle finger)

B = left = West

Particle in Electric Field



Start at rest, force along $\vec{E}$
Force does work = Energy

Energy = Charge · Voltage

$\frac{1}{2}mv^2 = qV$ — little v = velocity

$\frac{1}{2}mv^2 = qEl$ — Big V = Voltage

$1\,eV = 1.6 \times 10^{-19}\,J$

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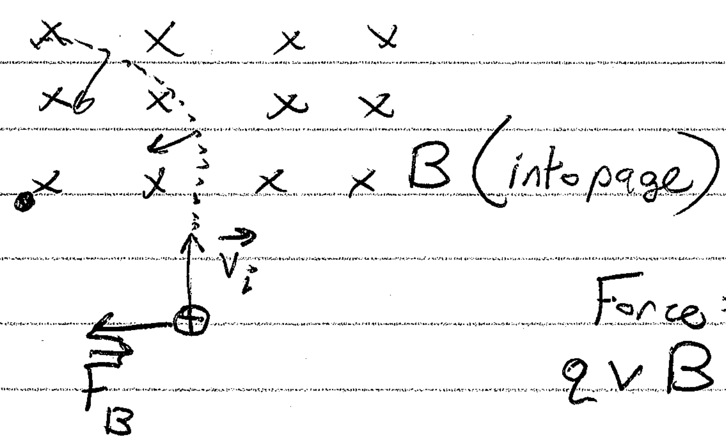
Mass Spectrometer (B only)

v along B $\quad F = qvB\sin\theta = 0$

v perp B $\quad F = qvB\sin\theta = qvB$



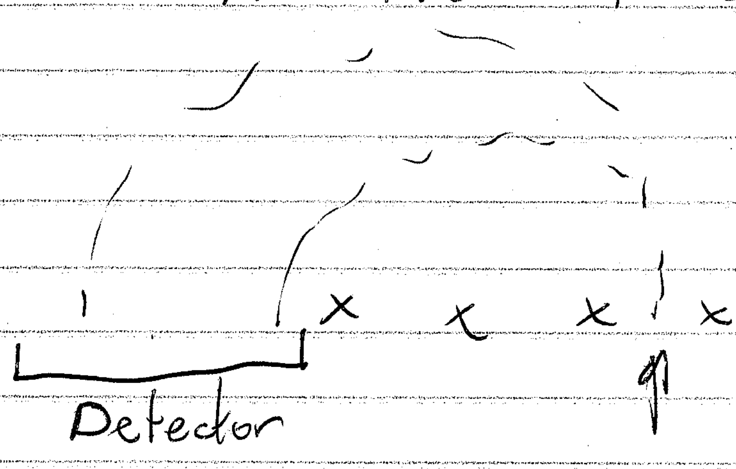
Force = m · accel

$$qvB = mv^2/r$$

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

In a mass spec:

- v = same for every particle
- q = +e
- B = shared by all
- m = different for each particle



E and B simultaneously

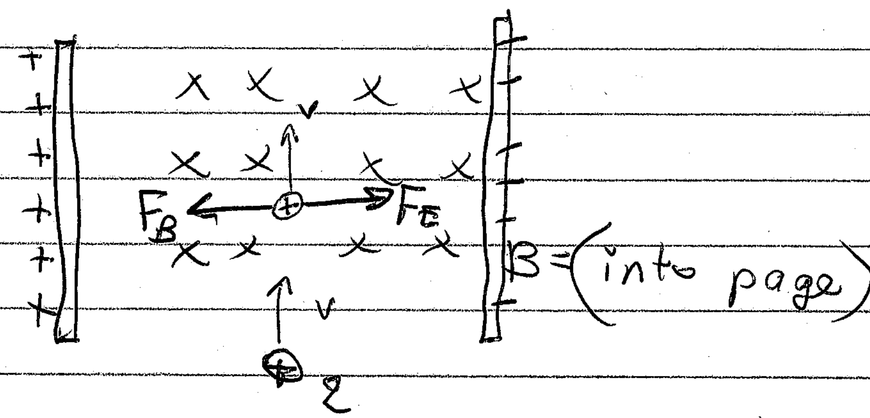
The only "easy" situation is if F_B = const
$\vec{v}$ = const

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

$$qE = qvB$$
$$E = vB$$

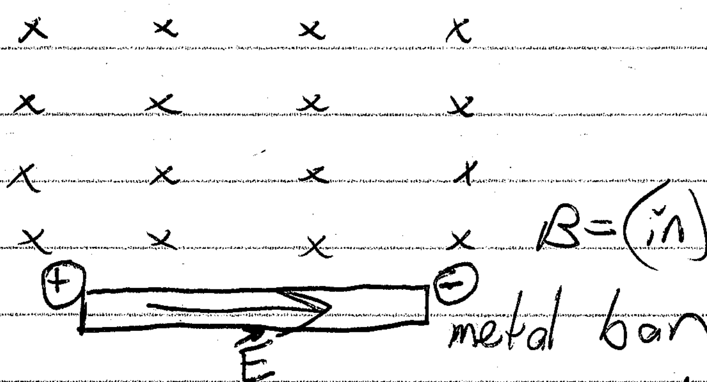
Velocity Selector $\quad v = E/B$

Dir? $\quad \vec{F_B} \perp \vec{B}$ $\quad$ therefore $\vec{E} \perp \vec{B}$
$\quad \vec{F_B} \perp \vec{v}$ $\qquad\qquad \vec{E} \perp \vec{v}$



What if the particle is going too slow?
F_B is weaker so F_E "wins"
Particle ~~goes~~ bends right.

Motional EMF



When the bar enters the B-Field,

- Electrons Feel F_B. What direction?
  - ⊕ would Feel F_B = (left)
  - ⊖ Feels F_B = (right)

- Many ⊖ gather at right edge.
  - ⊕ charge remains at left.
- They make $\vec{E}$ pointing to right
- How strong is E?

$$E = v \cdot B$$

- This E in a long bar makes voltage.

$$\Delta V = E\ell = Bv\ell$$

Practical