A wire carries a current northward. Gravity points down. What \( B \) could levitate the wire?

(Ans: West)

\[ \mathbf{F} = \text{up} \]

\[ \mathbf{T} = \text{north} \]

\[ \text{West} = \mathbf{F} \]

E-Field Only \( \Rightarrow \)

\[ \mathbf{F}_E = q \mathbf{E} \]

Particle accel in dir of \( \mathbf{F}_E \)

Force in the direction of motion does work.

\[ \text{Energy} = \text{Charge} \times \text{Voltage} \]

\[ \frac{1}{2} m v^2 = q V = q E l \]

This is a particle accelerator.
**B-Field Only**

\[ \vec{F}_B = q \vec{v} \times \vec{B} \sin \theta \]

- If \( \vec{v} \) along \( \vec{B} \), \( \theta = 0 \) \( \Rightarrow \vec{F}_B = 0 \)
- If \( \vec{v} \) perpendicular \( \vec{B} \), \( \theta = 90^\circ \) \( \Rightarrow \vec{F}_B = q \vec{v} \vec{B} \)

\[ \text{Force} = m \cdot \text{accel} \]

\[ q \vec{v} \vec{B} = m \vec{v}^2 / r \]

\[ r = \frac{m \vec{v}}{q \vec{B}} \]

**Mass Spectrometer**

- \( m \) different for each particle
- \( v, q, \vec{B} \) the same

Detector
E and B simultaneously

\[ E \text{ is uniform } \rightarrow F_E = \text{ uniform} \]
\[ B \text{ is uniform } \rightarrow F_B = \text{ uniform?} \]
\[ \frac{\vec{v}}{v} = \text{ constant} \]

\[ \sum F = 0 \quad F_E = F_B \]

\[ qE = qvB \]
\[ v = \frac{E}{B} \]

What if the particle is going too slow?
\[ F_B \text{ is weaker, } F_E \text{ wins} \]
Particle is deflected to the right.
Mass Spec analysis  \( v = \frac{E}{B} \)

\[ r = \frac{mv}{eB} \]

**Motional EMF**

\[ \rightarrow \]

When the bar is moving across \( B \):
- Electrons feel \( F_e \). What dir.?
  - \( + \) would feel \( F_e = \text{(left)} \)
  - \( - \) feels \( F_e = \text{(right)} \)
- Built-up charge forms a capacitor
- There is \( E \) in the metal now.
- Balance when \( F_e = F_B \)
  \[ qE = qvBR \]
  \[ E = vR \]
  \[ V = EL = vBL \]

Voltage \( \rightarrow \) velocity
Move wire in B Field $\rightarrow$ EMF

Hold wire and move magnet $\rightarrow$ EMF

What makes the stationary charge move? Fluctuating $B$ makes $E$