11/3/15

Magnetism

$\vec{B} \rightarrow$ moving q, $\vec{F} = q(\vec{v} \times \vec{B})$, apply right hand rule

① Power $= \underset{\substack{\downarrow \\ \text{always } \perp \vec{v}}}{\vec{F}} \cdot \vec{v} = 0$!!, so $W = 0$.

② $\vec{F} \perp \vec{v}$, $\vec{F} = m\vec{a}$ → $\boxed{\text{change } \vec{v}}$ ✓ / change $|\vec{v}|$ × $\Rightarrow \Delta KE = 0$

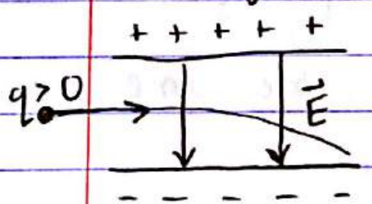
③ $F(v) \rightarrow$ non conservative force, cannot define potential e.

if $\vec{v} \perp \vec{B}$, $F = Bqv$, so $[B] = \left[\frac{F}{qv}\right]$ $[\text{Tesla}] = [B]$

$1 \text{ Tesla} = \frac{1 \text{ Newton}}{1 \text{ Coulomb} \cdot 1 \text{ m/s}}$

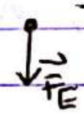
$= 10^4$ Gauss

Velocity Filter

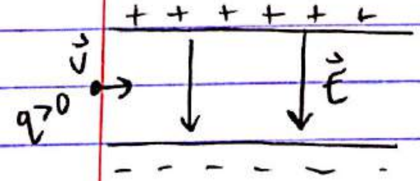


$\vec{F}_E = q\vec{E}$

- acts like projectile motion



Let's add a B (inside page)

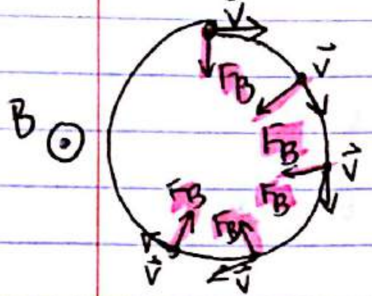


⊗ Due to the right hand rule, the force due to the magnetic field is up. $(\vec{F}_B = q(\vec{v} \times \vec{B}))$

(q>0) Faster particles are deflected upwards

Particles that have no deflection will have a calculable velocity. $(\vec{F}_{LORENTZ} = \vec{F}_E + \vec{F}_B)$ - straight when $F_{LORENTZ} = 0$ and $v = E/B$

$\vec{v} \perp \vec{B}$, much like centripetal motion



$\vec{F}_B = q(\vec{v} \times \vec{B}) \Rightarrow$ circular motion!

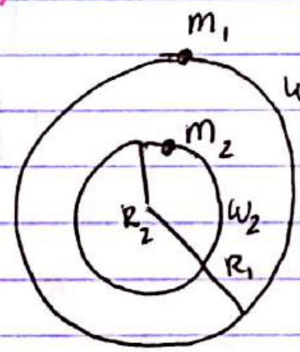
$qvB = \frac{mv^2}{R}$

$\boxed{R = \frac{mv}{qB}}$ can rearrange for m, v, q, B.

$v = \frac{RqB}{m}$

$\boxed{\omega = \frac{v}{R} = \frac{qB}{m}}$

$m_1 > m_2$, because $R_1 > R_2$.



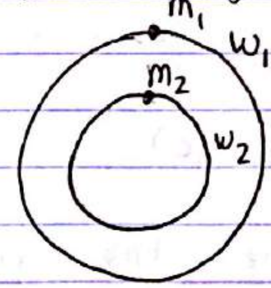
$T = \frac{2\pi}{\omega}$

$= \frac{2\pi m}{qB}$ not dependent on radius

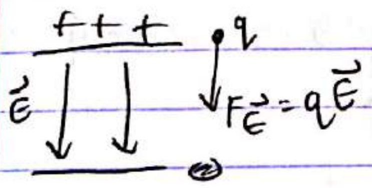
Depending on $\vec{v}$, R changes, but T is the same.

$m_1 = m_2$

$q_1 = q_2$

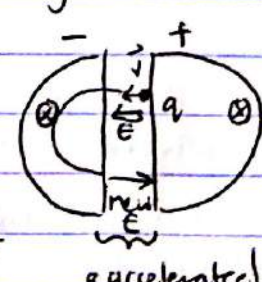


1932 - Lawrence's cyclotrone



$qV = \frac{1}{2}mv^2$ (chg. is accelerated)

B to trap charge



q accelerated

$\vec{E} \rightarrow$ switchable (radio freq.) so particle keeps speeding up

$KE = \frac{1}{2}mv^2 = \frac{1}{2}\frac{q^2B^2R^2}{m}$

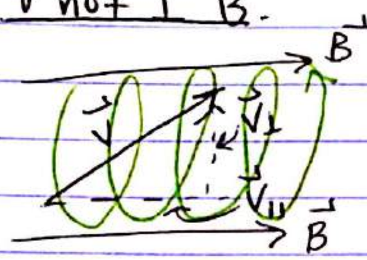
$R = \dfrac{m v}{q B}$

$m v \rightarrow$ change ΔV

$q B \rightarrow$ change current

*Look at Mass Spectrometer example in book

<u>$\vec{v}$ not $\perp$ $\vec{B}$.</u>

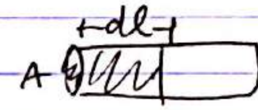


$\vec{F}_B \rightarrow q v_\perp B$

You get a spiral motion (circular + linear motion)

Force on wire-carrying current

$i \quad \vec{F}_i = q_i(\vec{v}_i \times \vec{B})$



$\vec{F}_{TOT} = \sum_i \vec{F}_i$ # charges = $neA\,dl$

$d\vec{l} \parallel \vec{v}$

So $\vec{F}_{TOT} = neA\,d\vec{l}(\vec{v} \times \vec{B}) = \underbrace{neAv}_{I}(d\vec{l} \times \vec{B})$

so $\vec{F}_T = I(\vec{L} \times \vec{B})$

$\downarrow$

direction given by current