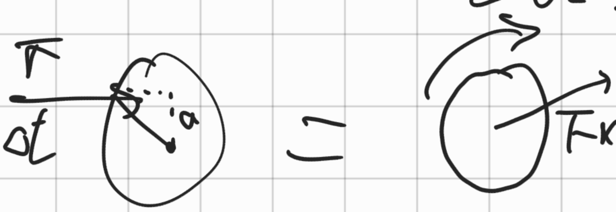
Physical Base

$I_{sphere} : \frac{2}{5} m R^2$

$\tau \Delta t = I\alpha \cdot \Delta t = I\omega = F \cdot a \Delta t$



$F \times \Delta t = m \Delta V$

For Coding:

Constants.

μ_k, μ_r, e

Bmass, Bradius

Cmass

Ball:

Current_Position. [P_x, P_y, P_z)

V[V_x, V_y, V_z]

ω[ω_x, ω_y, ω_z]

Projection angle

Hit point

Cue property

function

Hit_Ball (ϕ, a, b, V_0, θ)

Collide (Ball_pos, Coll_pos, v, ω)

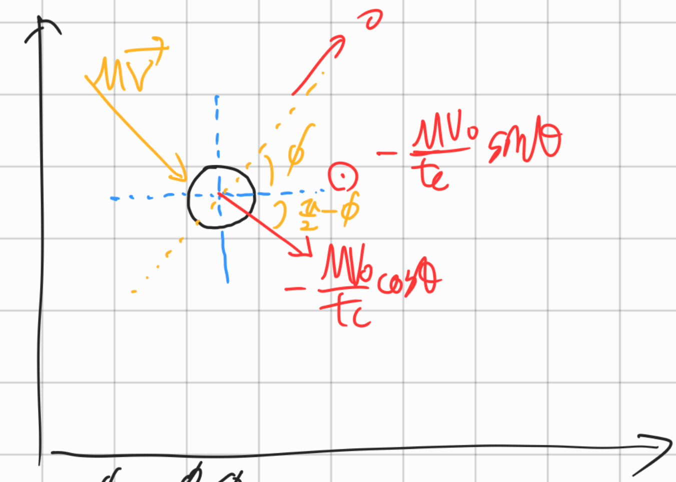
Proceed

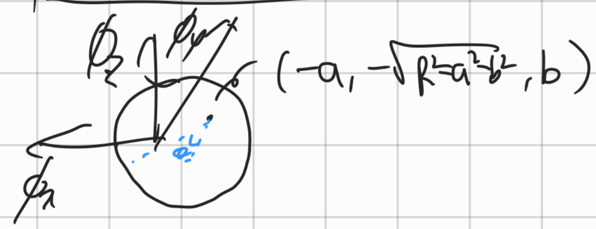
Physics.

· Impact

Cue property: V, M, θ, t_c

Impact point. (ϕ, a, b)





$$M\vec{V} = \vec{F}t_c = m\vec{v}$$

$$\vec{V} = \left(0,\ |\vec{V}|\cos\theta,\ -|\vec{V}|\sin\theta\right)$$

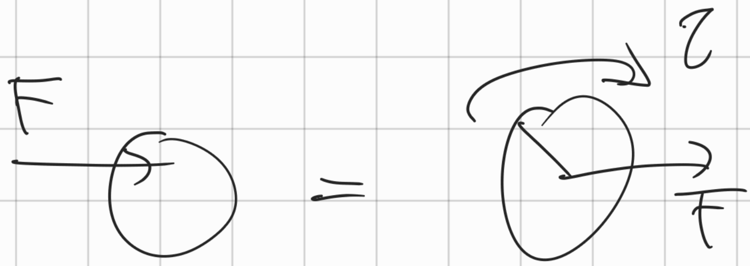
$$\vec{F} = \left(0,\ \frac{MV_0}{t_c}\cos\theta,\ -\frac{MV_0}{t_c}\sin\theta\right)$$

$$\Rightarrow \vec{F}_{conv} = \left(F_{\phi y}\cos\left(\frac{\pi}{2}-\phi\right),\ -F_{\phi y}\sin\left(\frac{\pi}{2}-\phi\right),\ F_{\phi z}\right)$$

$$= \left(F_{\phi y}\sin\phi,\ -F_{\phi y}\cos\phi,\ F_{\phi z}\right)$$

$$F_{\phi z} = \begin{cases} F_{\phi z} & \text{if } > 0 \\ 0 & \text{if } \le 0. \end{cases}$$

$$\Rightarrow \vec{v} = \frac{t_c}{m} \cdot \vec{F}_{com}$$



$$\vec{\tau} = \vec{r} \times \vec{F}$$

$$\vec{r} = \left(-a, -\sqrt{R^2-a^2-b^2}, b\right)$$

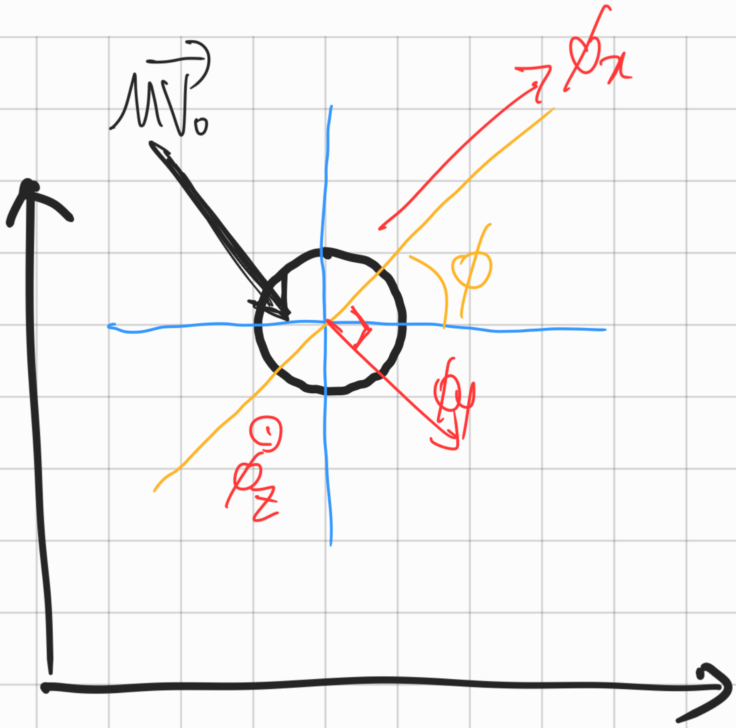
$$\vec{\tau}_{com} = \left(\tau_{\phi x}\cos\phi + \tau_{\phi y}\cos\left(\frac{\pi}{2}-\phi\right), \tau_{\phi x}\sin\phi - \tau_{\phi y}\sin\left(\frac{\pi}{2}-\phi\right), \tau_{\phi z}\right)$$

$$= \left(\tau_{\phi x}\cos\phi + \tau_{\phi y}\sin\phi, \tau_{\phi x}\sin\phi - \tau_{\phi y}\cos\phi, \tau_{\phi z}\right)$$

$$\vec{\tau}\, t_c = I\alpha \cdot t_c$$
$$= I\vec{\omega}$$

$$\Rightarrow \vec{\omega} = \frac{t_c}{I}\vec{\tau}$$

1. Hit the ball.

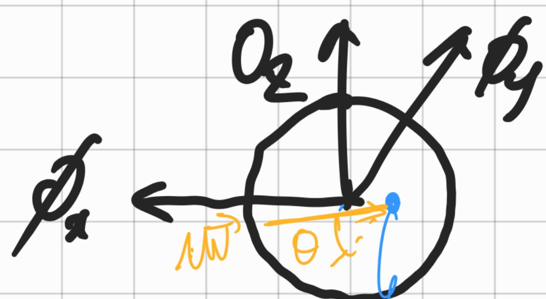


$$M\vec{V_0} = \vec{F} t_c = m\vec{v}$$

$$\vec{V_0} = (0, |V_0|\cos\theta, -|V_0|\sin\theta)$$

$$\vec{F} = \frac{M}{t_c}\vec{V_0}$$

$$= \left(0, \frac{M|V_0|}{t_c}\cos\theta, -\frac{M|V_0|}{t_c}\sin\theta\right)$$



$$\vec{F_{com}} = \left(F_{\phi_y}\cos\left(\frac{\pi}{2}-\phi\right), -F_{\phi_y}\sin\left(\frac{\pi}{2}-\phi\right), F_{\phi_z}\right)$$

$(a, -\sqrt{R_b^2-a^2-b^2}, b)$

$a^2+b^2 \le R_b^2$

$$= \left(F_{\phi_y}\cdot\sin\phi, -F_{\phi_y}\cdot\cos\phi, F_{\phi_z}\right)$$

$$\vec{v} = \frac{t_c}{m}\vec{F_{com}}$$

$$F_{\phi_z} = \begin{cases} F_{\phi_z} & \text{if } >0 \\ 0 & \text{if } \le 0 \end{cases}$$

$$\vec{\tau} = \vec{r} \times \vec{F}, \quad \vec{r} = \left(a, -\sqrt{l^2 - a^2 - b^2}, b\right)$$

$$\vec{\tau}_{conv} = \left(\tau_{\phi x}\cos\phi + \tau_{\phi y}\cos\left(\frac{\pi}{2} - \phi\right), \right.$$

$$\left. \tau_{\phi x}\sin\phi - \tau_{\phi y}\sin\left(\frac{\pi}{2} - \phi\right), \tau_{\phi z}\right)$$

$$= \left(\tau_{\phi x}\cos\phi + \tau_{\phi y}\sin\phi, \tau_{\phi x}\sin\phi - \tau_{\phi y}\cos\phi, \tau_{\phi z}\right)$$

$$\vec{\tau}\, t_c = I\alpha t_c = I\vec{\omega}$$

$$\therefore \vec{\omega} = \frac{t_c}{I}\vec{\tau}$$