KE of rotation. Torque.

Note Title 10/28/2011

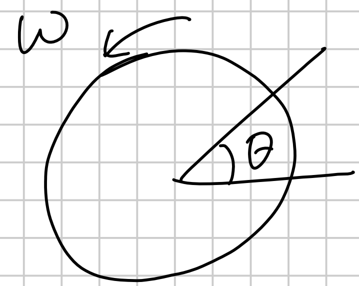
x — θ

v — ω

a — α

m — $I = \sum_i m_i r_i^2$

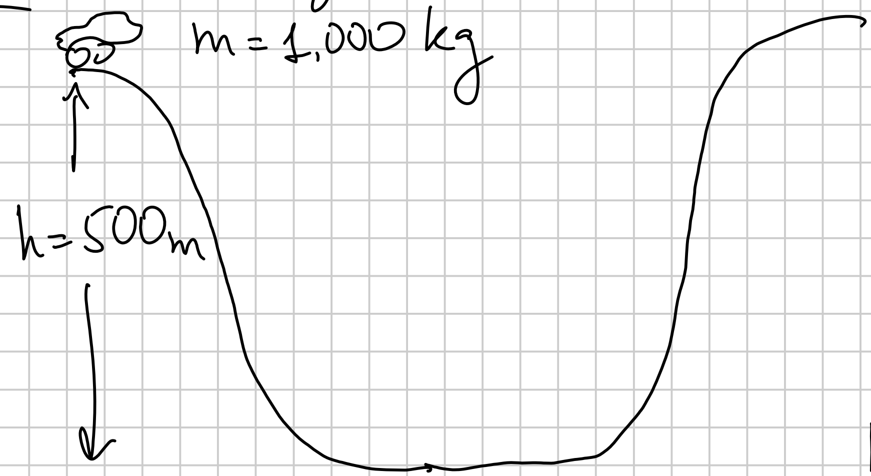
$KE = \frac{1}{2} m v^2$ — $KE = \frac{1}{2} I \omega^2$



EX

$PE = mgh$

$m = 1{,}000\ kg$



$PE = mgh = 1000 \cdot 10 \cdot 500 =$

$= 5{,}000{,}000\ J$

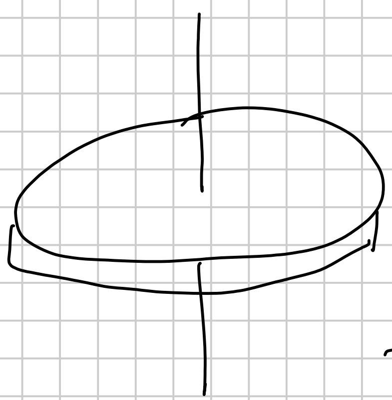
$v = 10\ mph \approx 4\ m/s$

$KE = \frac{1}{2} m v^2 = 8{,}000\ J$

$20\ mph \rightarrow 32{,}000\ J$

$40\ mph \rightarrow 128{,}000\ J$

$80\ mph \rightarrow 512{,}000\ J$



$R = 0.5 m$

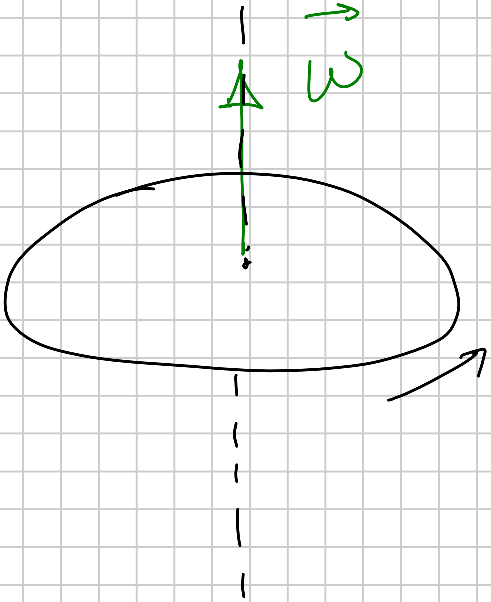
$M = 200\ kg$

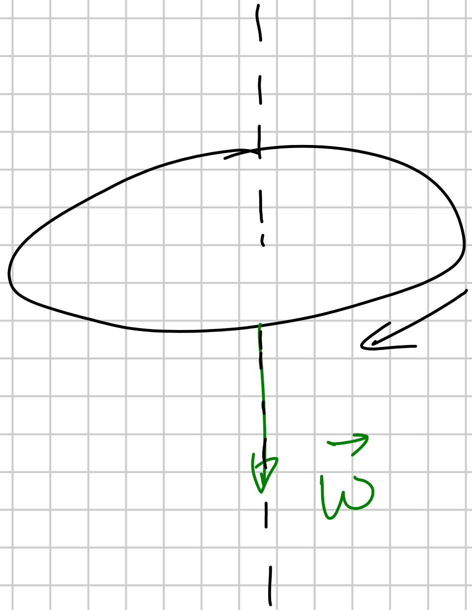
$I = \frac{1}{2} M R^2 = 25\ kg \cdot m^2$

$KE = \frac{1}{2} I \omega^2 = 5 \cdot 10^6\ J$

$\omega = \sqrt{\frac{2 \cdot 5 \cdot 10^6}{25}} = 632\ rad/s$

$f = \frac{\omega}{2\pi} \approx 100\ Hz$



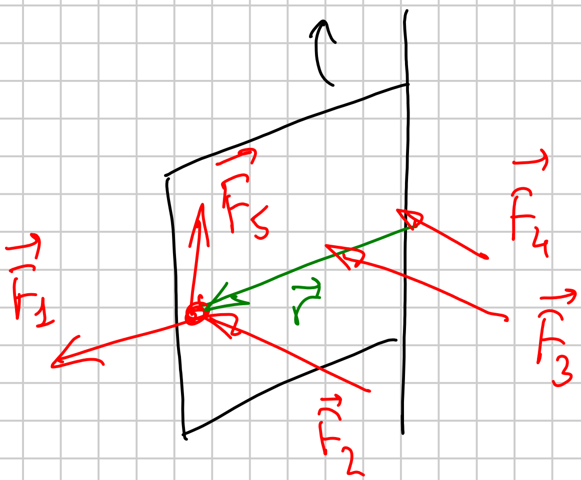


$$\frac{d\vec{\omega}}{dt} = \vec{\alpha}$$

$\downarrow \vec{\alpha}$ if ω increases

$\uparrow \vec{\alpha}$ if ω decreases

Torque

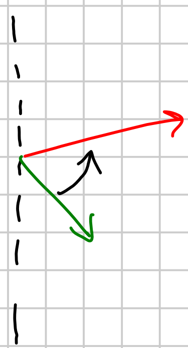


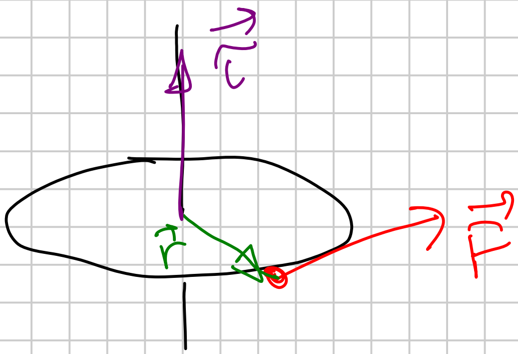
$\vec{F} \perp \vec{r}$

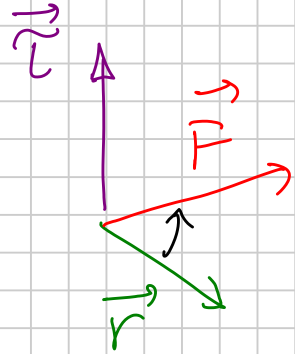
$\boxed{\vec{\tau} = \vec{r} \times \vec{F}}$ – torque

$|\vec{r}||\vec{F}| \sin\theta$

$N \cdot m$



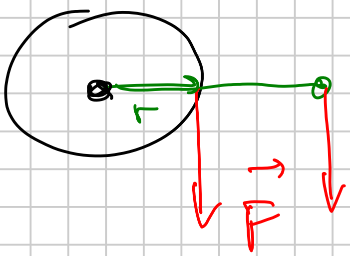




$$\vec{\tau} = \vec{r} \times \vec{F}$$

$$\vec{F} = m\vec{a}$$

$$\boxed{\vec{\tau} = I\vec{\alpha}}$$



$$\vec{\alpha} = \frac{\vec{\tau}}{I}$$

$$v = \omega \cdot R$$

$$a = R \cdot \alpha$$

$$x = \frac{1}{2} a t^2$$

$$t = \sqrt{\frac{2x}{a}}$$

$$r_2 = \frac{1}{2} r_1$$

$$\tau_2 = \frac{1}{2} \tau_1$$

$$\alpha_2 = \frac{1}{2} \alpha_1$$

$$a_2 = \frac{1}{2} r_1 \cdot \frac{1}{2} \alpha_1 = \frac{1}{4} a_1$$

$$t_2 \sim \sqrt{\frac{1}{1/4\, a_1}} = 2 t_1$$