Physics 113 - November 9, 2006

Rotational Dynamics

I'll be out of Town Nov. 12-26

Hopefully will be in email Contact

In P113, Life goes on as usual ... including exam 3 on Nov 21 at 12:30 in Hoyt

Last Time

$$\tau = I\alpha$$

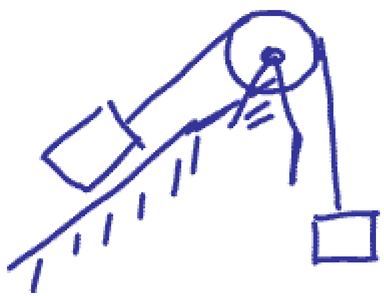
$\sim rF$

$$\int_{vol} r^2\,dm = \int_{vol} r^2 \rho\,dv$$

Can get I From table usually

Sometimes need Parallel axis Theorem

$$KE_{Rot} = \frac{1}{2} I \omega^2$$



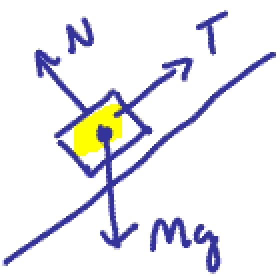
In problems w/ massive pulleys

$I \neq 0$

usually solve using

Rotational form of Newton's law

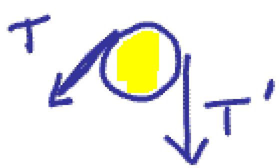
$$\tau = I\alpha$$



do

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

as usual



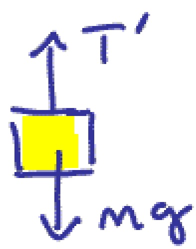
new

do

$\Sigma \tau = I\alpha$

$I\alpha = rT' - rT$

↳ Additional eqn



do $\Sigma \vec{F} = ma$

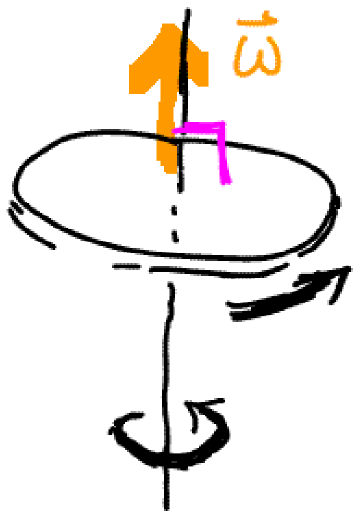
as usual

Solve eqns simultaneously

Rotational dynamics

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

$\vec{\omega} \rightsquigarrow \perp$ to plane of rotation



vector $\vec{\omega}$ defines

plane of rotation

speed of rotation

direction of rotation

Right hand rule

grasp axis of rotation w/ fingers pnted along rotation direction

$\Rightarrow$ Thumb pointed along $\vec{\omega}$

$\vec{\tau}$ is along $\vec{\alpha}$

If $\vec{\omega}$ is increasing w/ time

$\vec{\alpha}$ is vector along $\vec{\omega}$

if $\vec{\omega}$ is decreasing

$\vec{\alpha}$ is vector opposite direction of $\vec{\omega}$

⊥ To line joining Axis of rotation to Point of Application of the force

Only ⊥ piece of F rotates object

$$\vec{\tau} \sim |\vec{r}| \underbrace{F_{\perp}}_{\text{what we want}}$$

$$\boxed{\vec{\tau} = |\vec{r}|\,|\vec{F}| \sin\theta}$$

if $\theta = 0$ $\quad \vec{r}$ along $\vec{F}$

$\vec{\tau} = 0$

if $\theta = 90^\circ$ $\quad \vec{r} \perp \vec{F}$

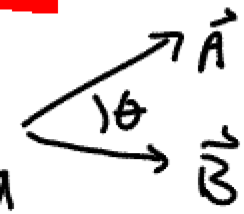
$\vec{\tau} = rF$

recall work ~ $\vec{F}\cdot\vec{s} = |\vec{F}||\vec{s}|\cos\theta$

Cross product

$$\vec{A}\times\vec{B} = |\vec{A}||\vec{B}|\sin\theta$$

dir given by another Right HAND Rule



$\vec{A}\times\vec{B}$ into board

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

$$\vec{A}\times\vec{B} = -\vec{B}\times\vec{A}$$

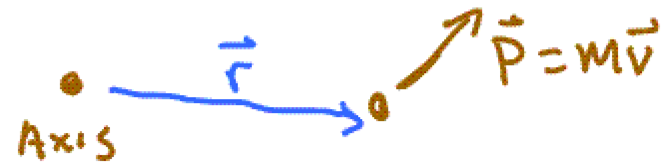
$$\vec{F} = \frac{d\vec{p}}{dt}$$

$$\vec{\tau} = \frac{d\,\vec{r}\times\vec{p}}{dt}$$

$$\boxed{\vec{\tau} = \frac{d\vec{L}}{dt}}$$

Angular Momentum

$$\vec{L} = \vec{r} \times \vec{p} = |\vec{r}||\vec{p}|\sin\theta$$



L out of board

$$\boxed{\vec{L} = I\vec{\omega}}$$