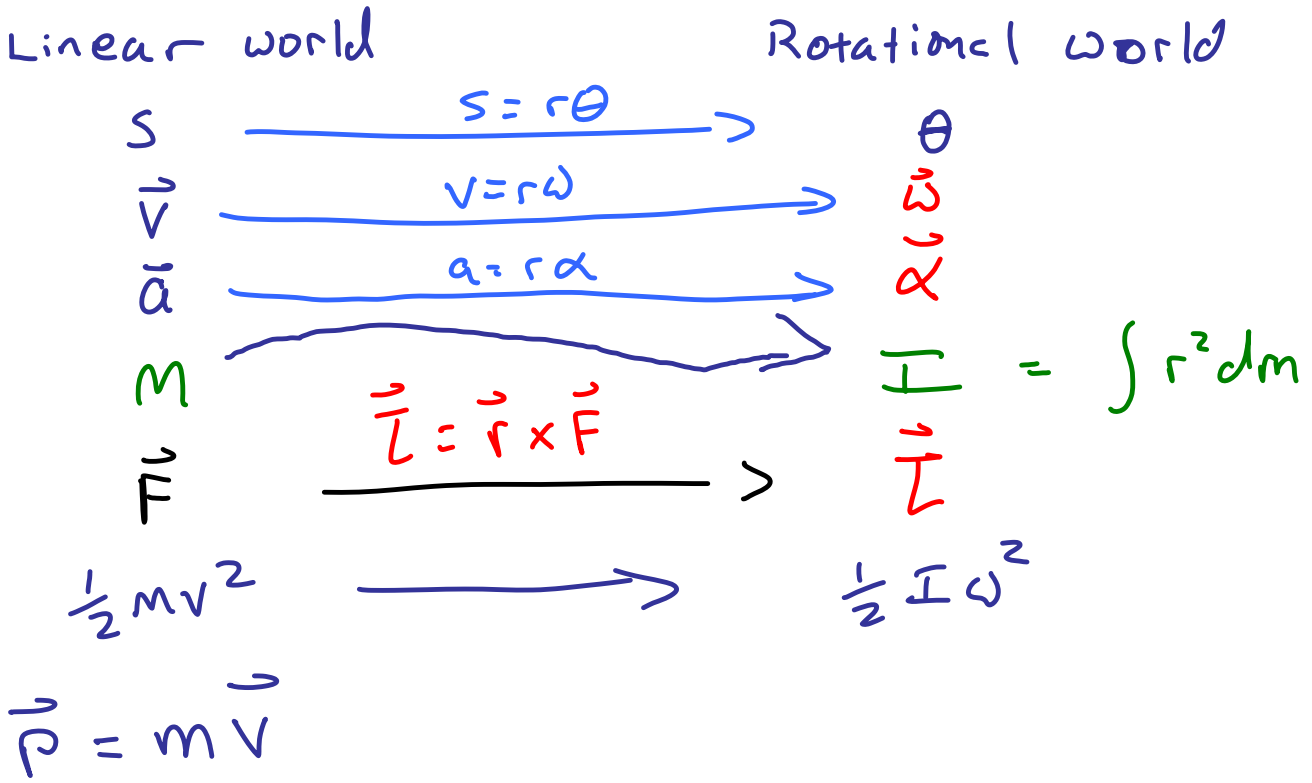
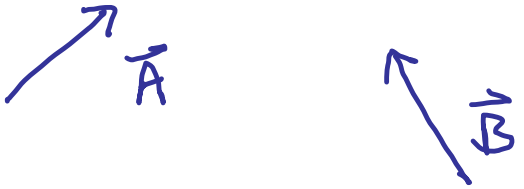
Physics 113 – November 12, 2013

Last Time

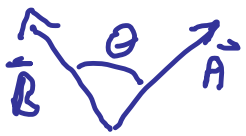
Rotational Dynamics



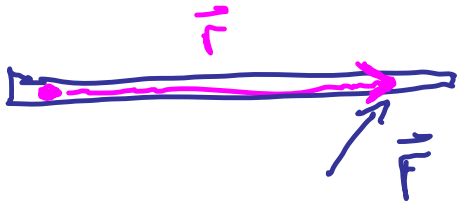
$\vec{p} = m\vec{v}$



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



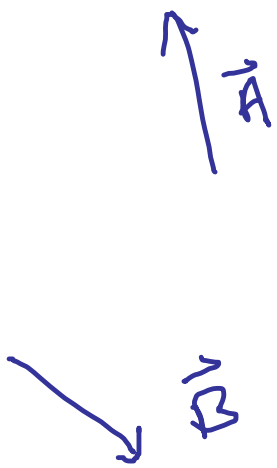
use RH Rule to get direction



$\vec{L} = \vec{r} \times \vec{F}$ ← out of board

$\vec{\tau} = I\vec{\alpha}$ gives $\vec{L}$ also

makes $\vec{\omega}$ be also out of board + rotation counter-clockwise



Direction of $\vec{B} \times \vec{A}$ is what?

(I) into board

(II) out of board ✓

(III) left

(IV) Right

(V) up

VI down

Direction of $\vec{B} \times \vec{A}$ is what?

(I) into board

(II) out of board

(III) left ✓

(IV) Right

(V) up

(VI) down

Direction of $\vec{A} \times \vec{B}$ is what?

(I) into board

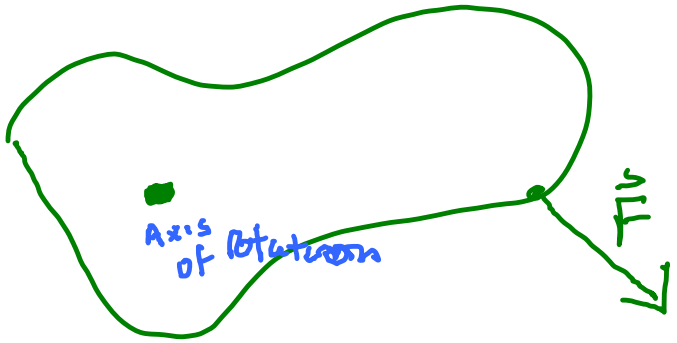
(II) out of board

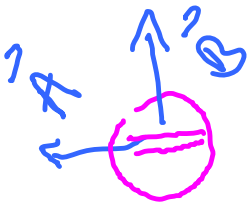
(III) left ✓

(IV) Right

(V) up

VI down





Direction of Torque is

(I) into board ✓

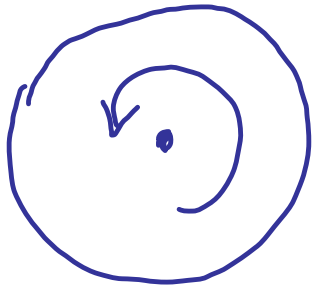
(II) out of board

(III) left

(IV) Right

(V) up

(VI) down



Slowing down

What is direction of $\vec{\omega}$?

What is direction of $\vec{L}$?

I into board ✓ $\vec{L}$

II out of board ✓ ω

III left

IV Right

V up

VI down

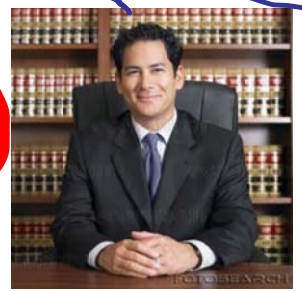
Angular Momentum $\equiv \vec{L} = I\vec{\omega}$ (recall linear momentum is $m\vec{v}$.)

$$\vec{F} = m\vec{a} = \frac{d\vec{p}}{dt} = m\frac{d\vec{v}}{dt}$$

$$\vec{\tau} = \frac{d\vec{L}}{dt} = \frac{d(I\vec{\omega})}{dt} = I\frac{d\vec{\omega}}{dt}$$

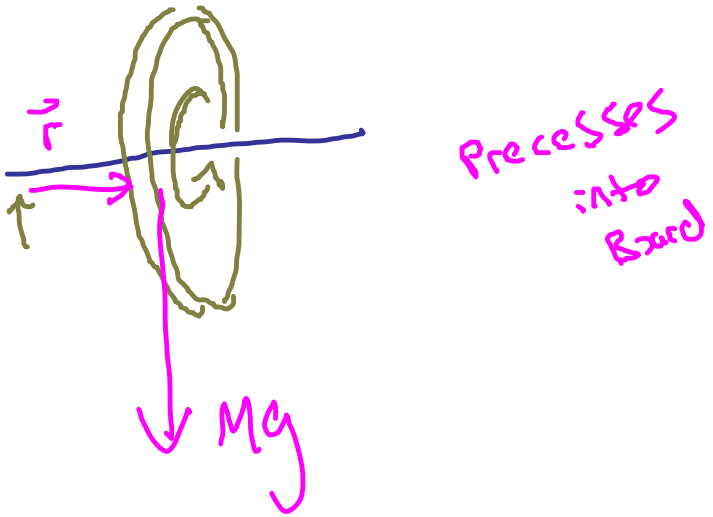
Angular Momentum is Conserved

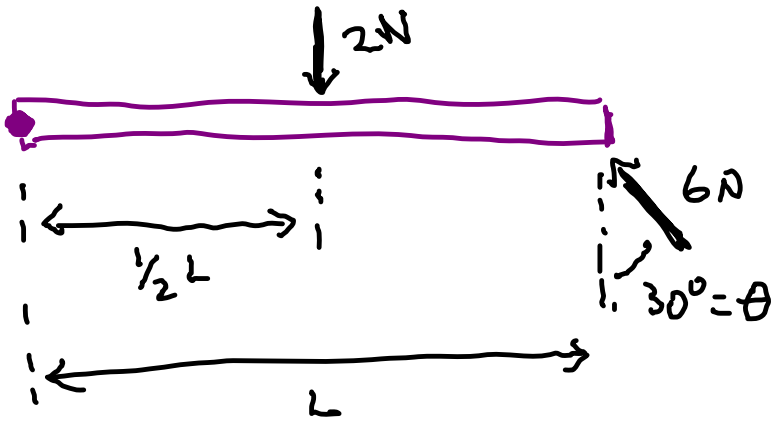
$$\vec{L}_{init} = \vec{L}_{final}$$



Precession

$$\vec{\tau} = \frac{d\vec{L}}{dt} = \frac{d(I\vec{\omega})}{dt} = I\frac{d\vec{\omega}}{dt}$$





Thin rod length L
Free to rotate abt
axis thru end

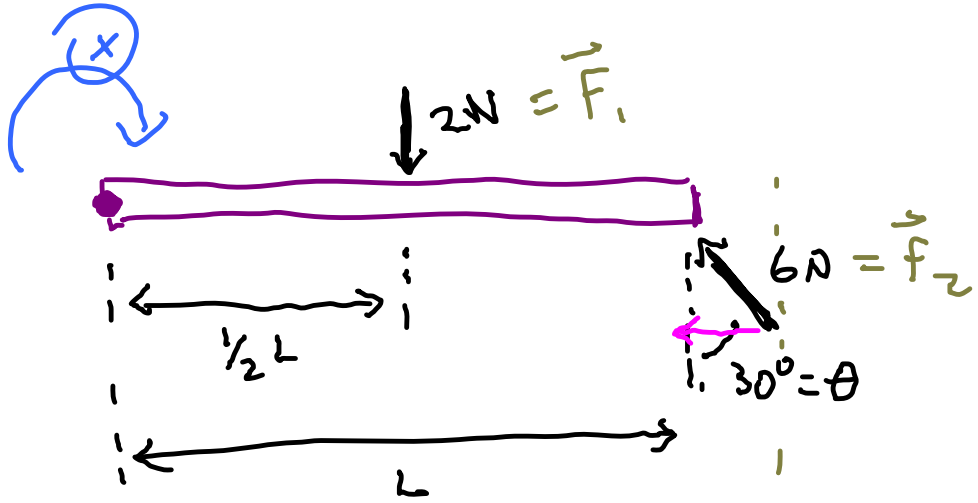
Mass rod is 3 kg

$L = 2m$

Find $\vec{\alpha}$ for rod
at moment shown

give $I_{rod} = \frac{1}{3} ML^2$

ignore all other forces



$$\Sigma \tau = I\alpha$$

$$\tau = \underbrace{\tfrac{1}{3}mL^2}_{I}\alpha$$

$$\vec{\tau}_2 = \vec{r}_2 \times \vec{F}_2 = |\vec{r}_2||\vec{F}_2| \sin 120^\circ$$

$$F_{2\perp} = F_2 \cos 30 \quad \sim$$

$$\Sigma\tau = |r_1||F_1| - |r_2||F_2|\cos 30$$

$$\tfrac{1}{3}mL^2\alpha = \tfrac{1}{2}L(2) - L(6)\cos 30$$

$$\alpha = -2.5\ \text{rad/s}^2$$