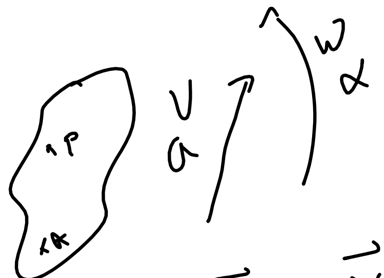
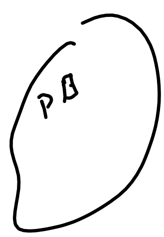
$\tau = I\alpha$



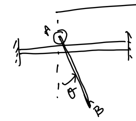
$$\vec{v}_P = \vec{v}_A + \vec{\omega} \times \vec{r}_{P/A}$$

$$\vec{a}_P = \vec{a}_A + \vec{\alpha} \times \vec{r}_{P/A} - \omega^2 \vec{r}_{P/A}$$



1) Draw FBD
2) Choose a point 'P' to compute torque/moment about
3) Compute $\vec{a}_G$
4) $\vec{F} = m\vec{a}_G$ (2-eqns for planar case)

$\vec{M}_P = \sum \vec{r}_{i/P} \times \vec{F}_i = I\vec{\alpha}_G + \vec{r}_{P/G} \times m\vec{a}_G$ (1-eqn for planar)



$I_G = \frac{mL^2}{12}$

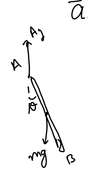
$a_A = ?$ $\alpha_{AB} = ?$ Right after release.

$$\vec{a}_G = \vec{a}_A + \vec{a}_{G/A}$$
$$= \vec{a}_A + \vec{\alpha}_{AB} \times \vec{r}_{G/A} - \omega_{AB}^2 \vec{r}_{G/A}$$
$$= a_{A_x}\hat{i} + \alpha_{AB}\hat{k} \times \left(\frac{L}{2}\sin\theta\,\hat{i} - \frac{L}{2}\cos\theta\,\hat{j}\right) - \omega_{AB}^2\left(\frac{L}{2}\sin\theta\,\hat{i} - \frac{L}{2}\cos\theta\,\hat{j}\right)$$

$$\vec{a}_G = a_x\hat{i} + \alpha_{AB}\frac{L}{2}\sin\theta\,\hat{j} + \frac{\alpha_{AB}L}{2}\cos\theta\,\hat{i} - \frac{\omega_{AB}^2 L}{2}\sin\theta\,\hat{i} + \frac{\omega_{AB}^2 L}{2}\cos\theta\,\hat{j}$$
$$= \left(a_x + \frac{\alpha_{AB}L}{2}\cos\theta - \frac{\omega_{AB}^2 L}{2}\sin\theta\right)\hat{i} + \left(\frac{\alpha_{AB}L}{2}\sin\theta + \frac{\omega_{AB}^2 L}{2}\cos\theta\right)\hat{j}$$

As AB is released from rest, $\omega_{AB} = 0$.

$$\vec{a}_G = \left(a_x + \frac{\alpha_{AB}L}{2}\cos\theta\right)\hat{i} + \frac{\alpha_{AB}L\sin\theta}{2}\hat{j}$$



$\sum \vec{F} = m\vec{a}_G$ in x & y dxn

$\vec{M}_A = I_G\vec{\alpha}_{AB} + \vec{r}_{G/A} \times m\vec{a}_G$ ✓

$\vec{M}_G = I_G\vec{\alpha}_{AB}$ ✓

$\vec{M}_P = \sum_{i=1}^{n} \vec{r}_{i/P} \times \vec{F}_i$

x: $\sum F_x = ma_x$

$\Rightarrow$ $0 = m\left(a_x + \frac{\alpha_{AB}L}{2}\cos\theta\right)$ — ①

y: $\sum F_y = ma_y$

$A_y - mg = m\left(\frac{\alpha_{AB}L}{2}\sin\theta\right)$ — ②

$\hat{k}$: $\vec{M}_A = \sum \vec{r}_{i/A} \times \vec{F}_i$
$$= \left(\frac{L}{2}\sin\theta\,\hat{i} - \frac{L}{2}\cos\theta\,\hat{j}\right) \times (-mg\hat{j})$$
$$= -\frac{mgL}{2}\sin\theta\,\hat{k}$$

$$I_G\vec{\alpha}_G + \vec{r}_{G/A} \times m\vec{a}_G$$
$$= \frac{mL^2}{12}\alpha_{AB}\hat{k} + \left[\left(\frac{L}{2}\sin\theta\,\hat{i} - \frac{L}{2}\cos\theta\,\hat{j}\right) \times m\left[\left(a_x + \frac{\alpha_{AB}L}{2}\cos\theta\right)\hat{i} + \frac{\alpha_{AB}L}{2}\sin\theta\,\hat{j}\right]\right]$$
$$= \frac{mL^2}{12}\alpha_{AB}\hat{k} + m\left[\frac{L^2}{4}\alpha_{AB}\sin^2\theta\,\hat{k} + \frac{a_x L}{2}\cos\theta\,\hat{k} + \frac{L^2\alpha_{AB}}{4}\cos^2\theta\,\hat{k}\right]$$
$$= \left[\frac{mL^2\alpha_{AB}}{12} + \frac{mL^2\alpha_{AB}}{4} + \frac{ma_x L}{2}\cos\theta\right]\hat{k}$$
$$= \left(\frac{mL^2\alpha_{AB}}{3} + \frac{ma_x L}{2}\cos\theta\right)\hat{k}$$

$$-\frac{mgL}{2}\sin\theta = \frac{mL^2}{3}\alpha_{AB} + \frac{ma_xL}{2}\cos\theta$$

$$A_y - mg = \frac{m\alpha_{AB}L}{2}\sin\theta$$

$$0 = m\left(a_x + \frac{\alpha_{AB}L}{2}\cos\theta\right)$$

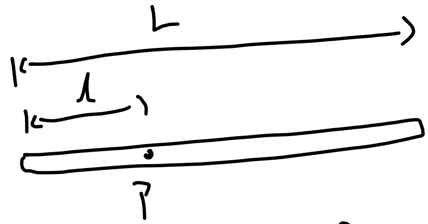
$$a_x = -\frac{\alpha_{AB}L}{2}\cos\theta$$

$$-\frac{mgL}{2}\sin\theta = \frac{mL^2\alpha_{AB}}{3} + \frac{mL}{2}\cos\theta \times \left(-\frac{\alpha_{AB}L}{2}\cos\theta\right)$$

$$-6g\sin\theta = 4L\alpha_{AB} - 3L\alpha_{AB}\cos^2\theta$$

$$\alpha_{AB} = \frac{-6g\sin\theta}{L(4-3\cos^2\theta)} \quad //$$

$$a_x = \frac{6g\sin\theta\cos\theta}{2(4-3\cos^2\theta)} \quad //$$



m, L

release from rest.

compute 'l' so α_{bar} is maximum.