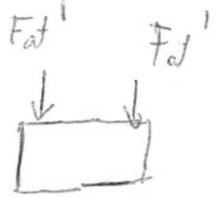
1)

$\underset{\sim}{\omega} = \frac{v_G}{r}\, z$ $\qquad$ $^R\underset{\sim}{z}^{*} = -v_G\, y$

$^R\underset{\sim}{a}^{*} = \frac{v_G^2}{r}\, \underset{\sim}{x}$



$\underset{\sim}{F} = m\, \underset{\sim}{a}$

$\frac{mg}{4} = N$

$F_{at} = F_{at}^{*}$

$F_{at}' = m \frac{v_G^2}{r}$

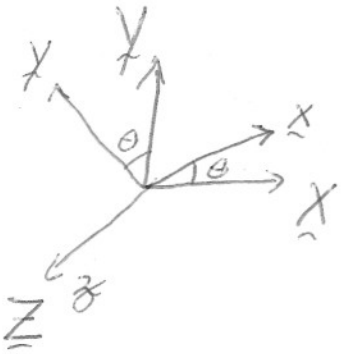
$\underset{\sim}{H} = I_{zz} \frac{v_G}{r}\, z$ $\qquad$ $\underset{\sim}{M} = \dot{\underset{\sim}{H}} \Rightarrow 0 = 0$

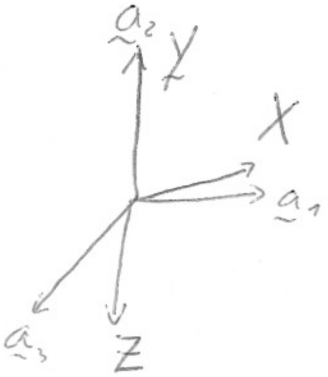
$\dot{\underset{\sim}{H}} = 0$

2)

$\underset{\sim}{\omega} = \dot\theta\, z + \omega\, \underset{\sim}{Y}$

$= \dot\theta\, z + \omega \cos\theta\, y + \omega \sin\theta\, \underset{\sim}{x}$





$M_x = \cancelto{0}{I_{xx}}\, \dot\omega_x + \cancelto{0}{(I_{zz} - I_{yy})}\, \omega_y \omega_z$

$M_y = I_{yy}\, \dot\omega_y + (\cancelto{0}{I_{xx}} - I_{zz})\, \omega_x \omega_z$

$M_z = I_{zz}\, \dot\omega_z + (I_{yy} - I_{xx})\, \omega_x \omega_y$

$I_{xx} = 0$

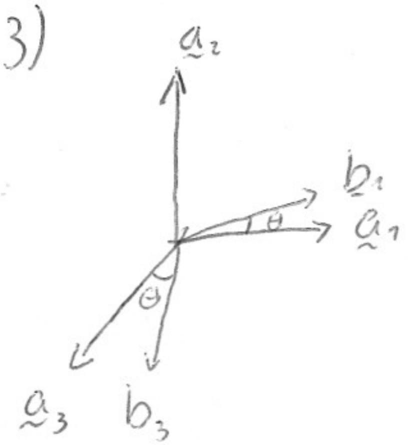
$I_{yy} = I_{zz} = \frac{1}{12} m L^2$

$M_x = 0\, \underset{\sim}{x}$

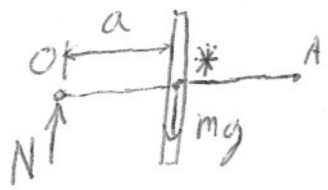
$M_y = -\frac{1}{12} m L^2 \omega \dot\theta \sin\theta - I_{zz} \dot\theta \omega \sin\theta = -\frac{1}{6} m L^2 \dot\theta \omega \sin\theta\, y$

$M_z = \frac{1}{12} m L^2 \cancelto{0}{\ddot\theta} + \frac{1}{12} m L^2 \omega^2 \sin\theta \cos\theta = \frac{1}{12} m L^2 \omega^2 \sin\theta \cos\theta\, z$

3)



onde $\underset{\sim}{b}_1$ acompanha a barra OA.



$N = mg \qquad \underset{\sim}{\omega} = \begin{bmatrix} \omega_r \\ \omega_p \\ 0 \end{bmatrix}$

$$[I^*] = \begin{bmatrix} mK_{OA}^2 & 0 & 0 \\ 0 & ma^2 & 0 \\ 0 & 0 & 0 \end{bmatrix} \qquad \underset{\sim}{H}^{c/*} = [I^*]\,\underset{\sim}{\omega}$$

$$\underset{\sim}{H}^{c/*} = \begin{bmatrix} m K_{OA}^2 \omega_r \\ m a^2 \omega_p \\ 0 \end{bmatrix}$$

$$\dot{\underset{\sim}{H}}^{c/*} = -m K_{OA}^2 \omega_r \omega_p \underset{\sim}{b}_3 \qquad M^{F/*} = r^{O/*} \times N$$

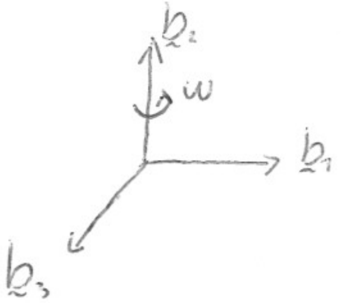
$$= -a\underset{\sim}{b}_1 \times N\underset{\sim}{a}_2 = a\underset{\sim}{b}_1 \times mg\underset{\sim}{b}_2$$

$$= -mga\underset{\sim}{b}_3$$

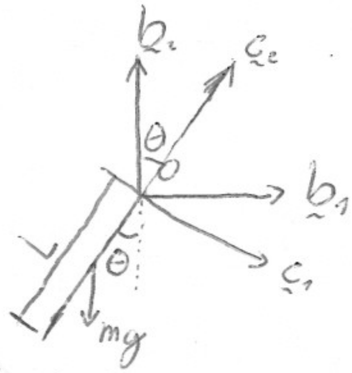
$$\dot{H}^{c/*} = M^{F/*}$$

$$m K_{OA}^2 \omega_r \omega_p = mga \Rightarrow \omega_r = \frac{ga}{K_{OA}^2 \omega_p} = 367{,}875 \text{ rad/s}$$

4)



De modo que a barra está sempre no plano de $\underset{\sim}{b}_1$ e $\underset{\sim}{b}_2$



$$p^{CM/O} = -\frac{L}{2}\cos\theta\,\underset{\sim}{b}_2 - \frac{L}{2}\operatorname{sen}\theta\,\underset{\sim}{b}_1 \qquad H^{b/O} = [I^O]\,\underset{\sim}{\omega}$$

$$^{R}v^{CM} = \frac{L}{2}\operatorname{sen}\theta\,\omega\,\underset{\sim}{b}_3$$

$$[I^O] = \begin{bmatrix} \frac{1}{3}mL^2 & 0 & 0 \\ 0 & 0 & 0 \\ 0 & 0 & \frac{1}{3}mL^2 \end{bmatrix}$$

$$^{R}a^{CM} = \frac{L}{2}\operatorname{sen}\theta\,\omega^2\,\underset{\sim}{b}_1$$

$$\underset{\sim}{\omega} = \omega\underset{\sim}{b}_2 = \omega\cos\theta\,\underset{\sim}{c}_2 - \omega\operatorname{sen}\theta\,c_1$$

$$\underset{\sim}{H} = -\frac{1}{3}mL^2\omega\operatorname{sen}\theta\,\underset{\sim}{c}_1$$

$$\underset{\sim}{H} = -\frac{1}{3} m L^2 \omega \, sen\,\theta \cos\theta \; \underset{\sim}{b}_1 + \frac{1}{3} m L^2 \omega \, sen^2\theta \; \underset{\sim}{b}_2$$

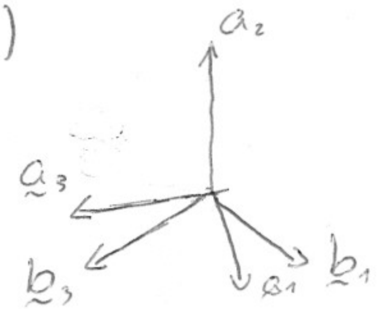
$$\dot{\underset{\sim}{H}} = \frac{1}{3} m L^2 \omega^2 \, sen\,\theta \cos\theta \; \underset{\sim}{b}_3$$

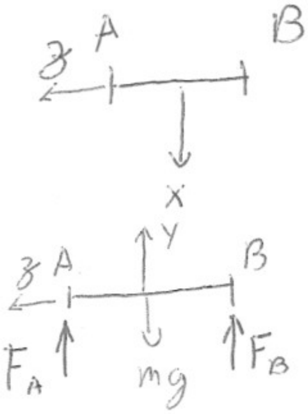
$$\underset{\sim}{M}^{FG} = \left(-\frac{L}{2}\cos\theta \; \underset{\sim}{b}_2 - \frac{L}{2} sen\,\theta \; \underset{\sim}{b}_1\right) \times \left(-m g \; \underset{\sim}{b}_2\right) = m g \frac{L}{2} sen\,\theta \; \underset{\sim}{b}_3$$

$$\dot{\underset{\sim}{H}} = \underset{\sim}{M} \Rightarrow \frac{1}{3} \cancel{m} L^2 \omega^2 \cancel{sen\,\theta} \cos\theta = \cancel{m} g \frac{L}{2} \cancel{sen\,\theta} \Rightarrow \cos\theta = \frac{3}{2}\frac{g}{L\omega^2}$$

$$\theta = \arccos\left(\frac{3g}{2L\omega^2}\right)$$

5)





$$\underset{\sim}{\omega} = \omega_s \; \underset{\sim}{b}_3 + \omega_y \; \underset{\sim}{b}_2$$

$$\underset{\sim}{H} = [I^0] \; \underset{\sim}{\omega}$$

$$\underset{\sim}{H} = I_{yy} \, \omega_y \; \underset{\sim}{b}_2 + I_{zz} \, \omega_s \; \underset{\sim}{b}_3$$

$$\dot{\underset{\sim}{H}} = I_{zz} \, \omega_s \omega_y \; \underset{\sim}{b}_1 = m K_z^2 \, \omega_s \, \omega_y$$

$$\underbrace{F_A \, a - F_B \, a}_{-M_1} = -m K_z^2 \omega_s \, \omega_y \Rightarrow M_1 = m K_z^2 \, \omega_s \, \omega_y$$