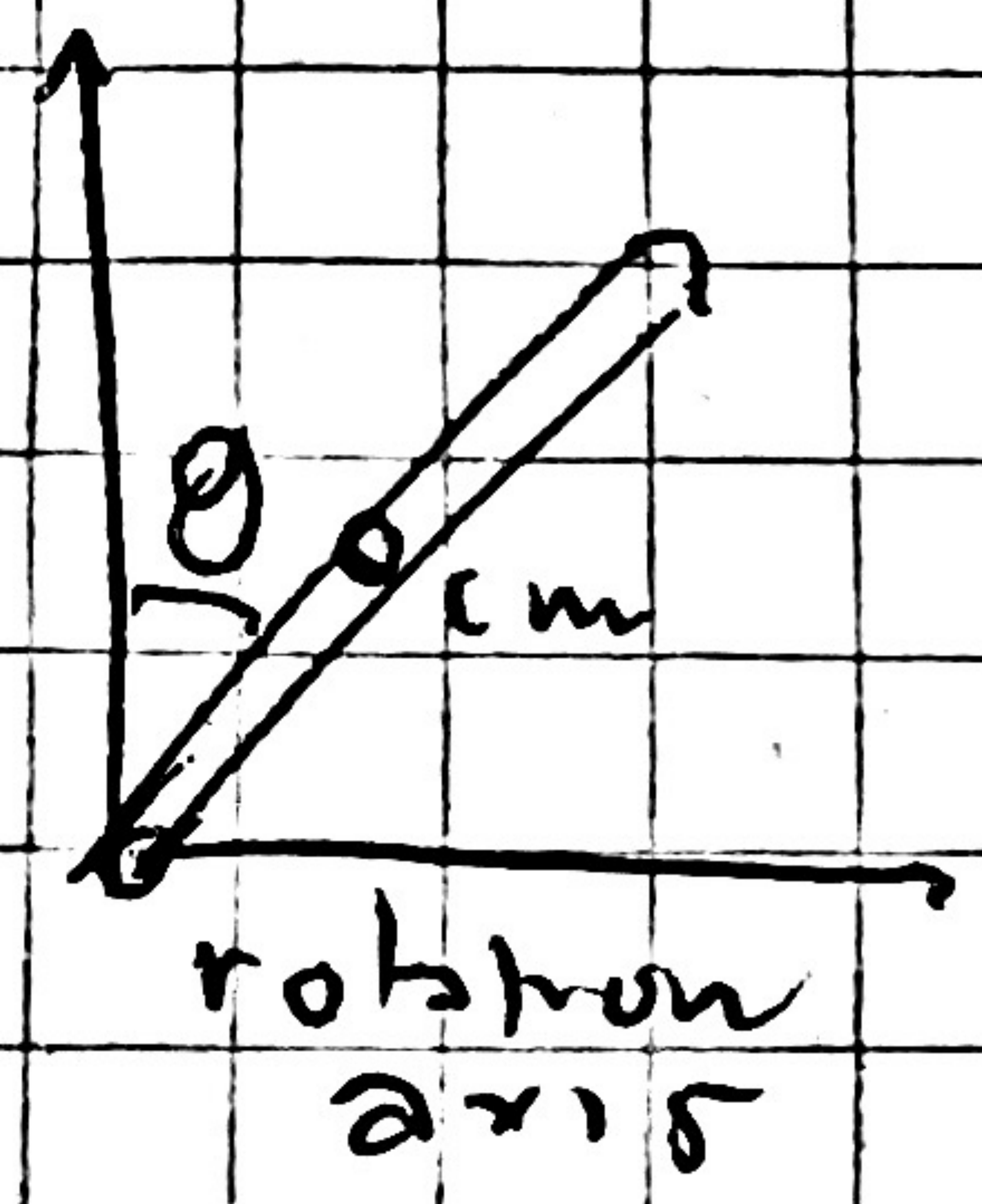
4a)

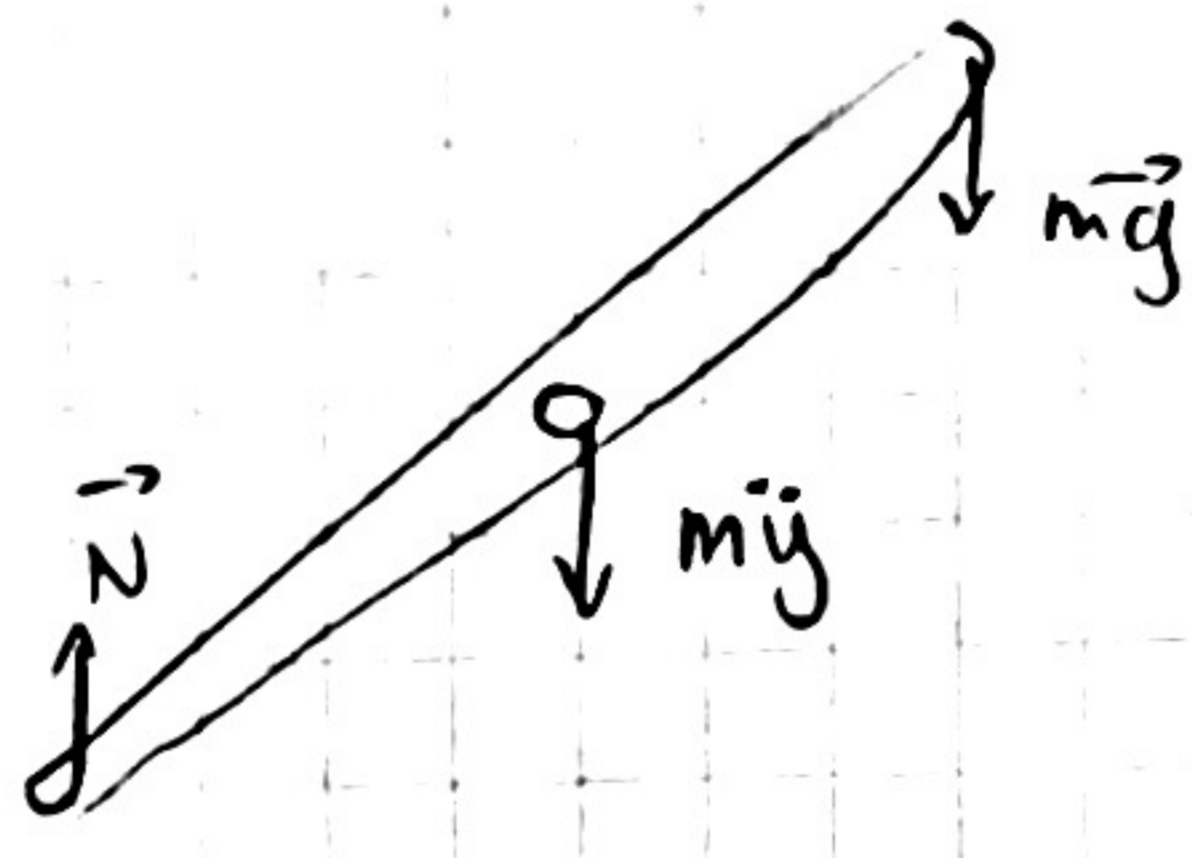


El torque actúa sobre la dirección y ya que el cm la barra no se desplaza en x

$$\dot{x} = 0$$

$$\dot{y} = \vec{v}_y$$

$$\ddot{y} = \vec{a_y}$$



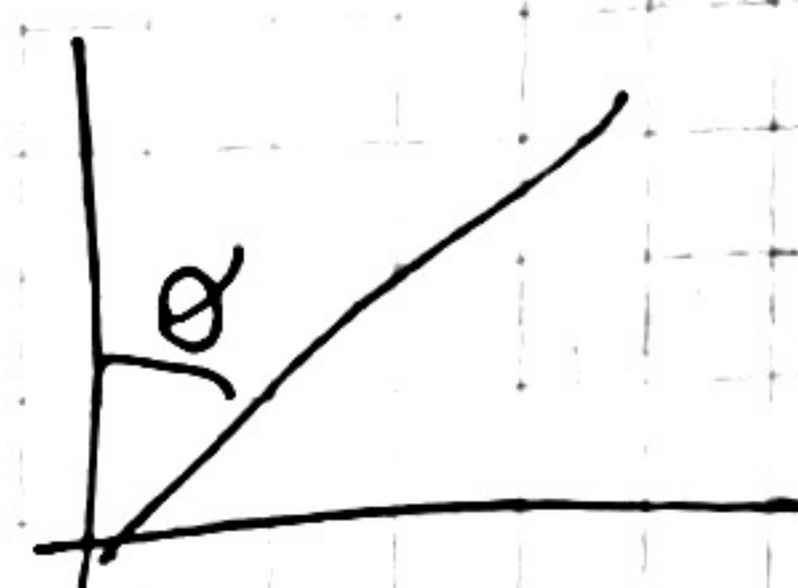
$$\sum \vec{F_y} = \vec{N} - m\vec{g}$$

$$m\ddot{y} = \vec{N} - m\vec{g}$$

b)

$$I\alpha = \sum \tau$$

$$I\ddot{\theta} = \tau_N$$



$$\vec{L_o} = I\vec{w} = I\dot{\theta}\hat{k}$$

$$\vec{M_o} = \vec{OC} \times \vec{P} = \left(\frac{1}{2} l \sin\theta\, \hat{i} + \frac{1}{2}\cos\theta\, \hat{j}\right) \times (-Mg\,\hat{j}) = -\frac{Mgl}{2}\sin\theta\,\hat{k}$$

$$\vec{M_o} = -\frac{NL}{2}\sin\theta\,\hat{k}$$

$$I\ddot{\theta}\hat{k} = \vec{M_o}$$

$$I\ddot{\theta}\hat{k} = \frac{NL}{2}\sin\theta\,\hat{k}$$

c) $\ddot{y} = -L/2 \cos\theta$

$$-m\frac{L}{2}\cos\theta = N - mg$$

$$N = mg - m\frac{L}{2}\cos\theta$$

$$I\ddot{\theta} = \left(mg - m\frac{L}{2}\cos\theta\right)\frac{L}{2}\sin\theta$$

$$\ddot{\theta} = \frac{\frac{12}{1}\cdot\frac{L}{2}\sin\theta\left(mg - m\frac{L}{2}\cos\theta\right)}{mL^2}$$

$$\ddot{\theta} = \frac{6}{L}\sin\theta\left(g - \frac{L}{2}\cos\theta\right)$$

$$\dot{\theta}^2 = \frac{2g}{L} - \ddot{\theta}\cos\theta$$

$$\sin^2\theta + \cos^2\theta = 1$$

$$\ddot{\theta} = \sin\theta\left(\frac{6g}{L} - \frac{\cos\theta}{3}\right)$$

$$\frac{6g}{L} - \frac{\cos\theta}{3} = \frac{\frac{2g}{L} - \dot{\theta}^2\cos\theta}{1/3 + \sin^2\theta}$$

$$\ddot{\theta} = \frac{\left((2g/L) - \dot{\theta}^2\cos\theta\right)\sin\theta}{1/3 + \sin^2\theta}$$