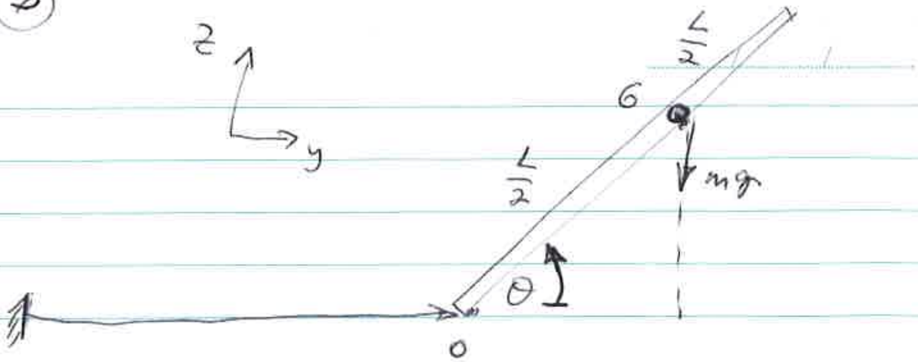
3



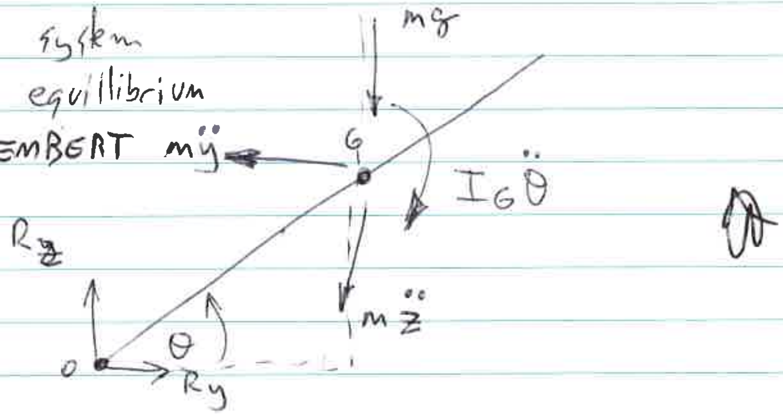
$$y_G = y_0 + \frac{L}{2}\cos\theta \qquad z_G = \frac{L}{2}.\sin\theta$$

$$\dot{y}_G = \dot{y}_0 + -\dot{\theta}\,\frac{L}{2}.\sin\theta \qquad \dot{z}_G = \dot{\theta}\,\frac{L}{2}.\cos\theta$$

$$\ddot{y}_G = \ddot{y}_0 + -(\dot{\theta})^2\frac{L}{2}.\cos\theta + -\ddot{\theta}\,\frac{L}{2}.\sin\theta \qquad \ddot{z}_G = -(\dot{\theta})^2\frac{L}{2}\sin\theta + \ddot{\theta}\,\frac{L}{2}\cos\theta$$

Put system into equilibrium

D'ALEMBERT



$$\therefore \sum M_o = 0 = -\frac{L}{2}\cos\theta\left(mg + m\ddot{z}\right) + \frac{L}{2}\sin\theta\, m\ddot{y} - I_G\ddot{\theta}$$

Note:–

$$-\ddot{z}\cos\theta + \ddot{y}\sin\theta$$
$$= \cos\theta\sin\theta\,\frac{L}{2}(\dot{\theta})^2 - \ddot{\theta}\,\frac{L}{2}\cos^2\theta$$
$$+ \ddot{y}_o\sin\theta + -\cos\theta\sin\theta\,\frac{L}{2}(\dot{\theta})^2 + -\ddot{\theta}\,\frac{L}{2}\sin^2\theta$$
$$= \ddot{y}_o\sin\theta + -\ddot{\theta}\,\frac{L}{2}$$

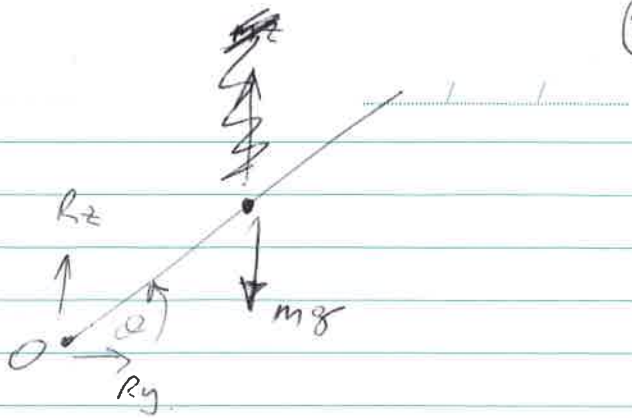
$$\therefore \sum M_o = 0 = -I_G\ddot{\theta} + -\frac{L}{2}mg\cos\theta + \frac{mL}{2}\left(-\ddot{z}\cos\theta + \ddot{y}\sin\theta\right)$$

$$\therefore 0 = -I_G\ddot{\theta} + -mg\frac{L}{2}\cos\theta + \frac{mL}{2}\left(\ddot{y}\sin\theta - \ddot{\theta}\frac{L}{2}\right)$$

$$\therefore \left(I_G + \frac{mL^2}{4}\right)\ddot{\theta} = -mg\frac{L}{2}\cos\theta + \frac{mL}{2}\ddot{y}_o\sin\theta$$

$$\therefore I_o\ddot{\theta} = -mg\frac{L}{2}\cos\theta + \frac{mL}{2}\sin\theta\,\ddot{y}_o$$

ALTERNATE.



$$m\ddot{y}_G = \sum F_y = R_y \quad — (1)$$

$$m\ddot{z}_G = \sum F_z = R_z - mg. \quad — (2)$$

$$\cancel{I_G\ddot{\theta} = \sum M_G = -mg\frac{L}{2}\cos\theta \quad — (3)}$$

$$I_G\ddot{\theta} = \sum M_G. = R_y.\sin\theta\frac{L}{2} - R_z\frac{L}{2}\cos\theta.$$

$$\therefore I_G\ddot{\theta} = m\ddot{y}_G\sin\theta\frac{L}{2} - \cos\theta\frac{L}{2}\left(m\ddot{z}_G + mg\right)$$

what we had <u>before</u>!