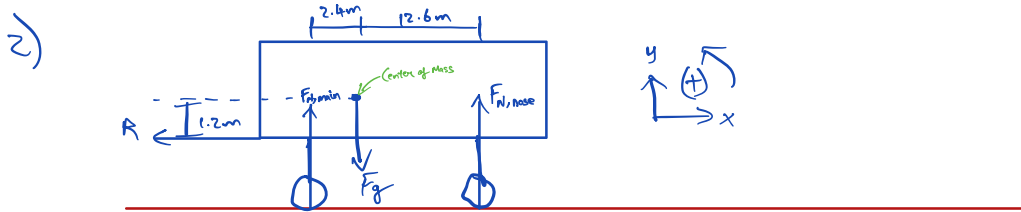


Vishnu Prasad
SIVAKUMAR



$$\sum F_x = -R = ma_x \quad (1)$$

$$\sum F_y = F_{N,main} + F_{N,nose} - F_g = 0 \quad (2)$$

$$\sum M @ \text{center of mass} = -R \times 1.2 - F_{N,main} \times 2.4 + F_{N,nose} \times 12.6 = 0 \quad (3)$$

Because of constant deceleration :

$$v^2 = u^2 + 2a_x s \quad (4)$$

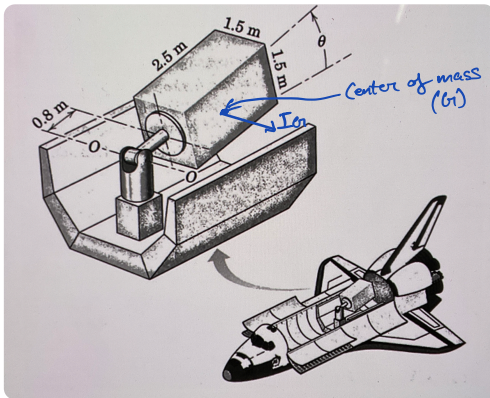
where, $u = \frac{60000}{60 \times 60} \text{ ms}^{-1}$, $v = \frac{200000}{60 \times 60} \text{ ms}^{-1}$, $s = 425 \text{ m}$

$$m = 140000 \text{ kg}, \quad g = 9.81 \text{ ms}^{-2}$$

$$F_{N,main} = 1.117 \times 10^6 \text{ N}, \quad R = 462600 \text{ N}, \quad a_x = -3.304 \text{ ms}^{-1}$$

$$F_{N,nose} = 256752 \text{ N}$$

3)



$$I_{G1} = \frac{m}{12} (1.5^2 + 2.5^2), \text{ where } m = \text{mass (kg)}$$

$$I_{O-O} = I_{G1} + m(\text{displacement between } G1 \& O)^2$$

$$I_{O-O} = \frac{m}{12} (1.5^2 + 2.5^2) + m(2.05)^2$$

By taking moments @ O:

$$\sum M = \alpha I_{O-O} = \alpha \left[\frac{m}{12} (1.5^2 + 2.5^2) + m(2.05)^2 \right] = \tau$$

Where α = angular acceleration (rad/sec^2)

$$m = 6000 \text{ kg}$$

$$\tau = 30 \text{ Nm}$$

$$\therefore \alpha = 0.00102 \text{ rad/sec}^2$$

Since α is constant:

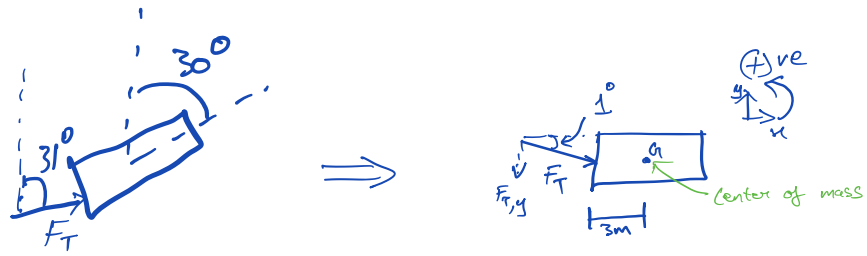
$$s = ut + \frac{1}{2} \alpha t^2, \text{ where } s = \pi/4 \text{ rad}, u = 0 \text{ rad/s}, \alpha = 0.00102 \text{ rad/sec}^2$$

$$t = 39.2783 \text{ sec to reach } 45^\circ$$

Since operation is identical in magnitude between 45° & 90°

$$\text{Total time} = 39.2783 \times 2 = 78.5566 \text{ sec}$$

5)



By taking moments at center of mass:

$$\sum \tau M = F_{T,y} \times 3 = \alpha I_G$$

$$F_{T,y} = F_T \sin(1^\circ), \quad I_G = m k^2 = m (1.5)^2$$

$$\therefore F_T \sin(1^\circ) \times 3 = \alpha m (1.5)^2$$

$$\text{Where, } F_T = 4000 \text{ N}, \quad m = 300 \text{ kg}$$

$$\therefore \alpha = 0.3103 \text{ rad/sec}^2$$