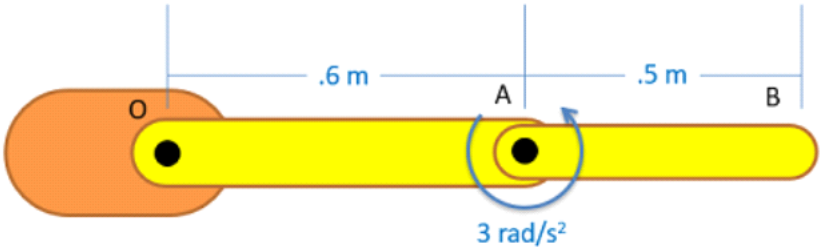
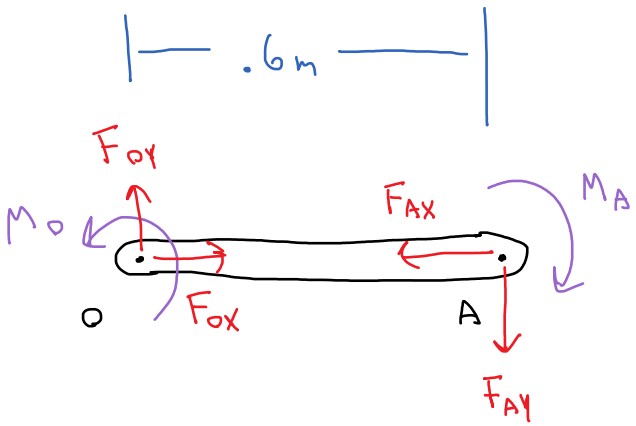
Problem 1

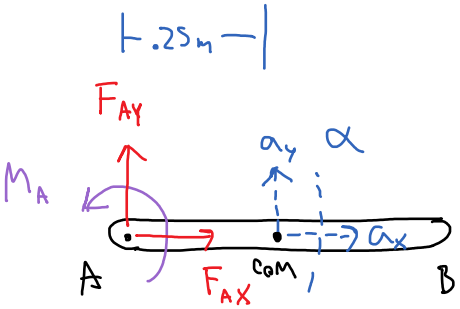
A robotic arm has two sections (OA and AB) with section OA having a mass of 10 kg and section AB having a mass of 7 kg. Treat each section as a slender rod. If we wish to accelerate member AB from a standstill at a rate of 3 rad/s2 and keep the right section stationary, what moments must we exert at joints O and A?



OA



AB



Start with kinematics of AB

$$a_x = -r\omega^2 = 0$$

$$a_y = r\alpha = (.25\,m)\left(3\,rad/s^2\right) = .75\,m/s^2$$

$$\alpha = 3\,rad/s^2$$

Kinetics of AB

$$\Sigma F_x = F_{AX} = 0$$

$$\Sigma F_y = F_{AY} = (7\,kg)(.75\,m/s^2)$$

$$F_{AY} = 5.25\,N$$

$$\Sigma M_{com} = M_A - (.25m)(F_{AY}) = I\,\alpha$$

(α: 3 rad/s²)

$$I = \frac{1}{12} m l^2$$

(m: 7 kg, l: .5 m)

$$M_A - 1.3125 = .4375$$

$$\boxed{M_A = 1.75\,N\,m}$$

Kinetics of OA

$$\Sigma F_x = F_{ox} - 0 = 0$$

$$F_{ox} = 0$$

$$\Sigma F_y = F_{oy} - 5.25 = 0$$

$$F_{oy} = 5.25\,N$$

$$\Sigma M_o = M_o - 1.75 - (.6)(5.25) = 0$$

$$\boxed{M_o = 4.9\,N\,m}$$