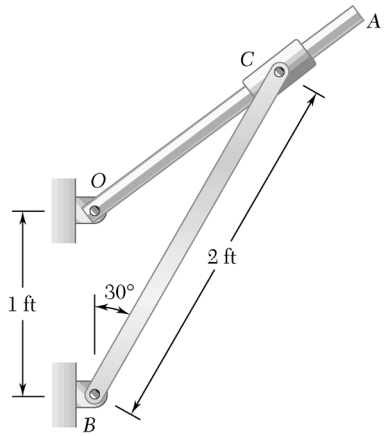
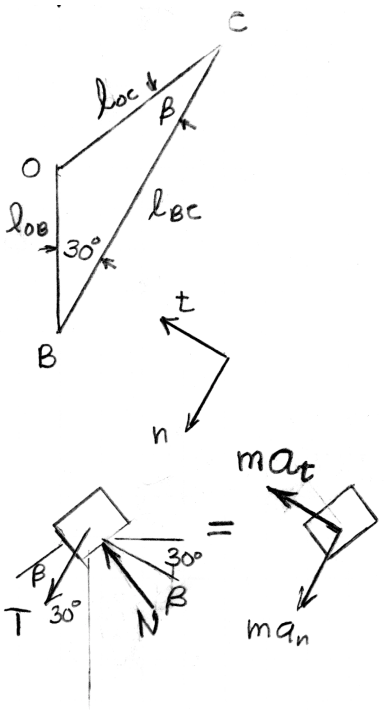


PROBLEM 12.39

A 2-lb collar C slides without friction along the rod OA and is attached to rod BC by a frictionless pin. The rods rotate in the horizontal plane. At the instant shown BC is rotating counterclockwise and the speed of C is 3 ft/s, increasing at a rate of 4 ft/s^2. Determine at this instant, (*a*) the tension in rod BC, (*b*) the force exerted by the collar on rod OA.

SOLUTION



Geometry

$$\ell_{OC}^2 = \ell_{OB}^2 + \ell_{BC}^2 - 2\ell_{OB}\ell_{OC}\cos 30°$$

$$= (1)^2 + (2)^2 - (2)(1)(2)\cos 30° = 1.5359 \text{ ft}^2$$

$$\ell_{OC} = 1.2393 \text{ ft}$$

$$\frac{\ell_{OC}}{\sin 30°} = \frac{\ell_{OB}}{\sin \beta}$$

$$\sin\beta = \frac{\ell_{OB}\sin 30°}{\ell_{OC}} = \frac{(1)\sin 30°}{1.2393} = 0.40345$$

$$\beta = 23.79°$$

Acceleration components: $a_t = 4$ ft/s^2

$$a_n = \frac{v^2}{\rho} = \frac{v_C^2}{\ell_{BC}} = \frac{(3)^2}{2} = 4.5 \text{ ft/s}^2$$

Mass $m = \dfrac{w}{g} = \dfrac{2}{32.2} = 0.06211 \text{ lb} \cdot \text{s}^2/\text{ft}$

$$+\nwarrow \Sigma F_t = ma_t: \; N\cos\beta = (0.06211)(4) = 0.2484$$

$$N = \frac{0.2484}{\cos 23.79°} = 0.2715 \text{ lb.}$$

$$+\swarrow \Sigma F_n = ma_n: \; T - N\sin\beta = (0.06211)(4.5) = 0.2795$$

(*a*) $T = 0.2795 + 0.2715 \sin 23.79°$ $\qquad T = 0.389$ lb. ◀

(*b*) Force exerted by rod on collar is $0.248 \text{ lb} \measuredangle (30° + \beta) = 53.8°$

Force exerted by collar on rod: $\qquad 0.248 \text{ lb.} \measuredangle 53.8°$ ◀