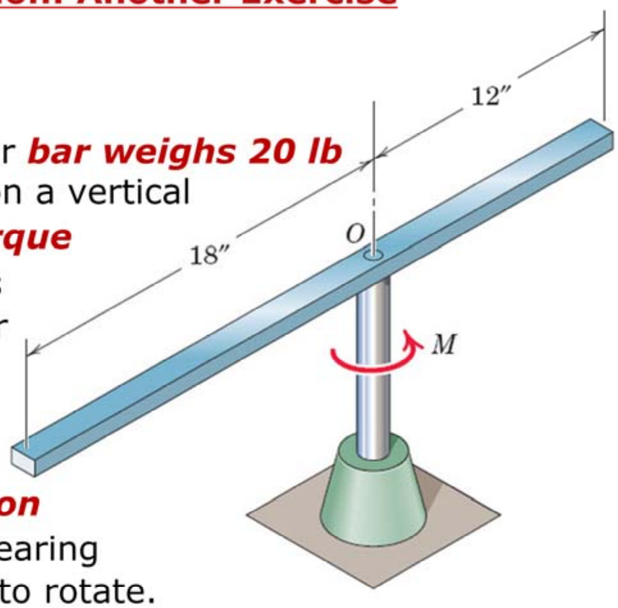
Fixed-Axis Rotation: Another Exercise

The ***30-in*** slender ***bar weighs 20 lb*** and is mounted on a vertical shaft at ***O***. A ***torque M = 100 lb-in*** is applied to the bar through its shaft.



Determine the horizontal ***reaction force R*** on the bearing as the bar starts to rotate.

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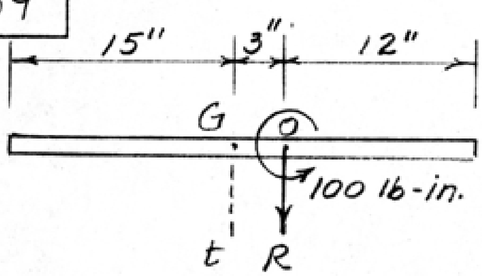

$$I_O = I_G + md^2$$

$$I_G = \frac{1}{12}ml^2 = \frac{1}{12}\,\frac{20}{32.2}\left(\frac{30}{12}\right)^2 = 0.323 \text{ lb-ft-sec}^2$$

$$I_O = 0.323 + \frac{20}{32.2}\left(\frac{3}{12}\right)^2 = 0.3623 \text{ lb-ft-sec}^2$$

$\Sigma M_O = I_O\alpha$; $\frac{100}{12} = 0.3623\,\alpha$, $\alpha = 23.0 \text{ rad/sec}^2$

$\bar{a}_t = \bar{r}\alpha$; $\bar{a}_t = \frac{3}{12}(23.0) = 5.75 \text{ ft/sec}^2$

$\Sigma F_t = m\bar{a}_t$; $R = \frac{20}{32.2}(5.75) = \underline{3.57 \text{ lb}}$