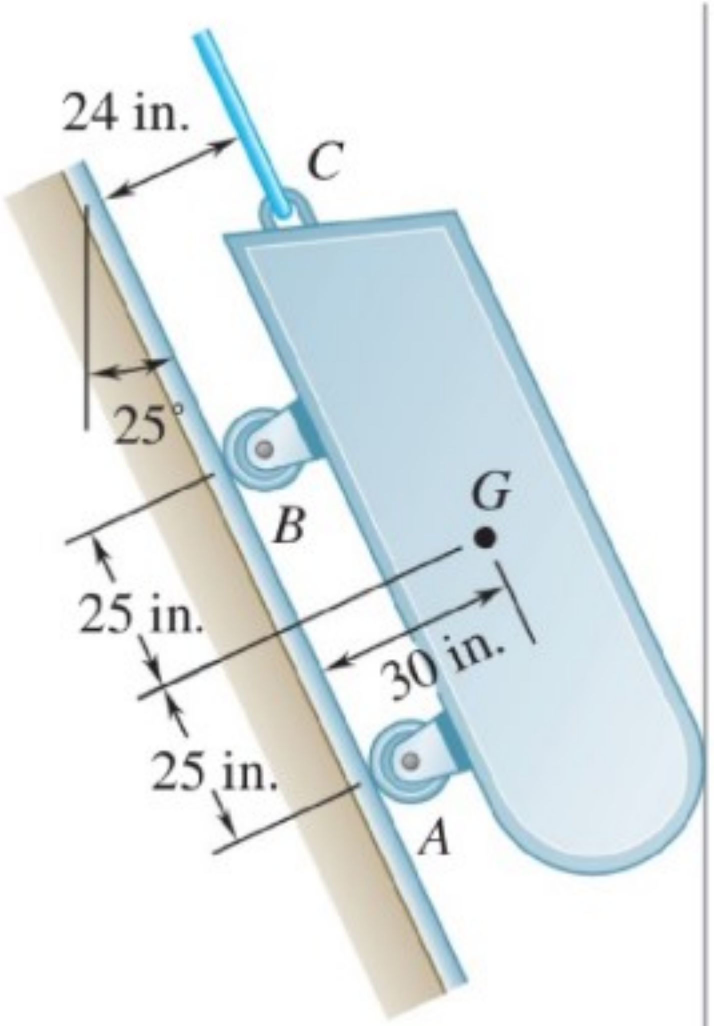
A loading car is at rest on a track forming an angle of 25° with the vertical. The gross weight of the car and its load is 5500 lb, and it acts at point G. Knowing the tension in the cable connected at C is 3000 lb, determine (a) the acceleration of the car, (b) the reaction at each pair of wheels.



$$R_A + R_B - W_{Gx} = 0$$

$$R_A + R_B - 2324 = 0$$

$$720 + R_B + R_B - 2324 = 0$$

$$2R_B = 2329 - 720 = 1604$$

$$\boxed{R_B = 802 \text{ lb}}$$

$$-6 \cdot 3000 - 25 R_B + 25 R_A = 0$$

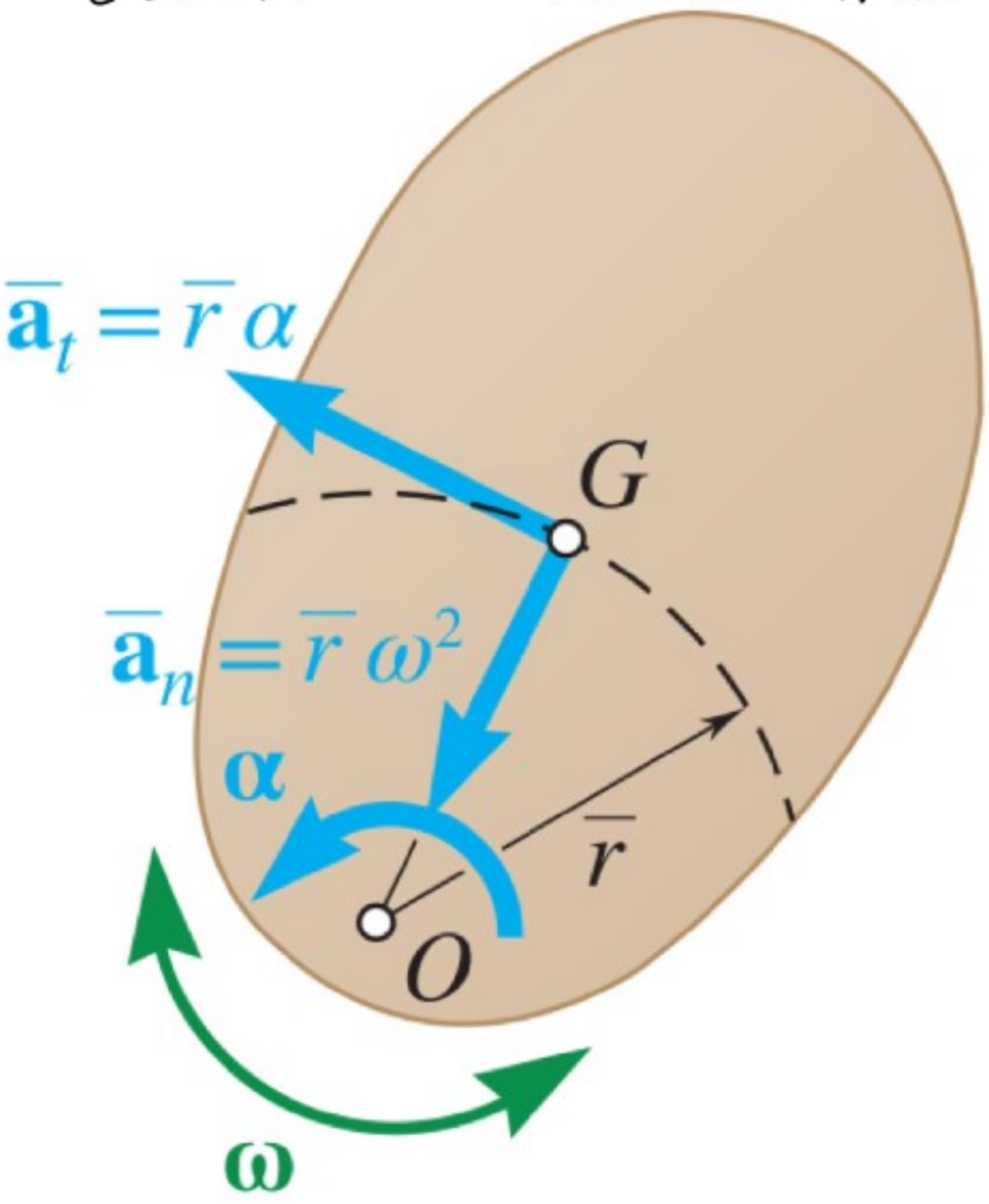
$$-18000 - 25 R_B + 25 R_A = 0$$

$$25 R_A = 18000 + 25 R_B$$

$$R_A = 720 + R_B$$

$$= 720 + 802 = \boxed{1522 \text{ lb}}$$

Constrained Plane Motion



O center of rotation

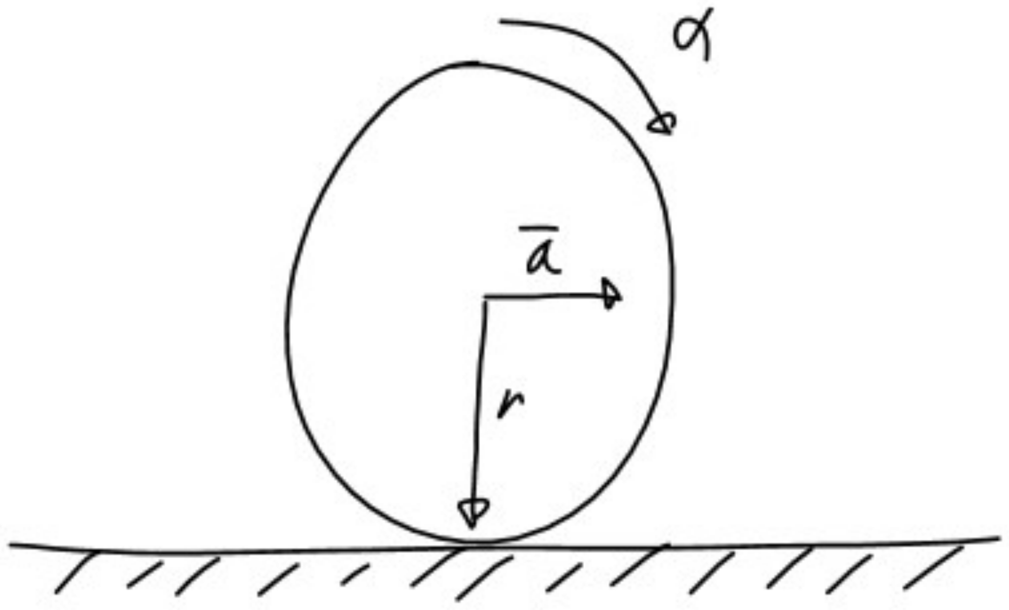
G center of mass

$\bar{a}_t = \bar{r}\alpha$

$\bar{a}_n = \bar{r}\omega^2$

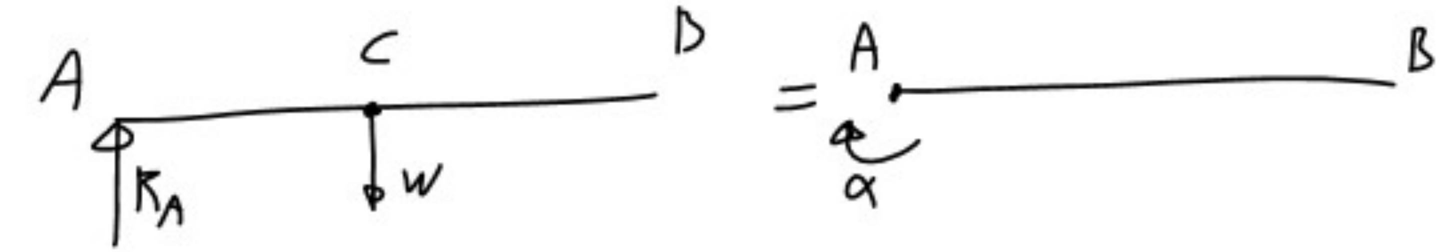
$\Sigma M_0 = I_0 \alpha$

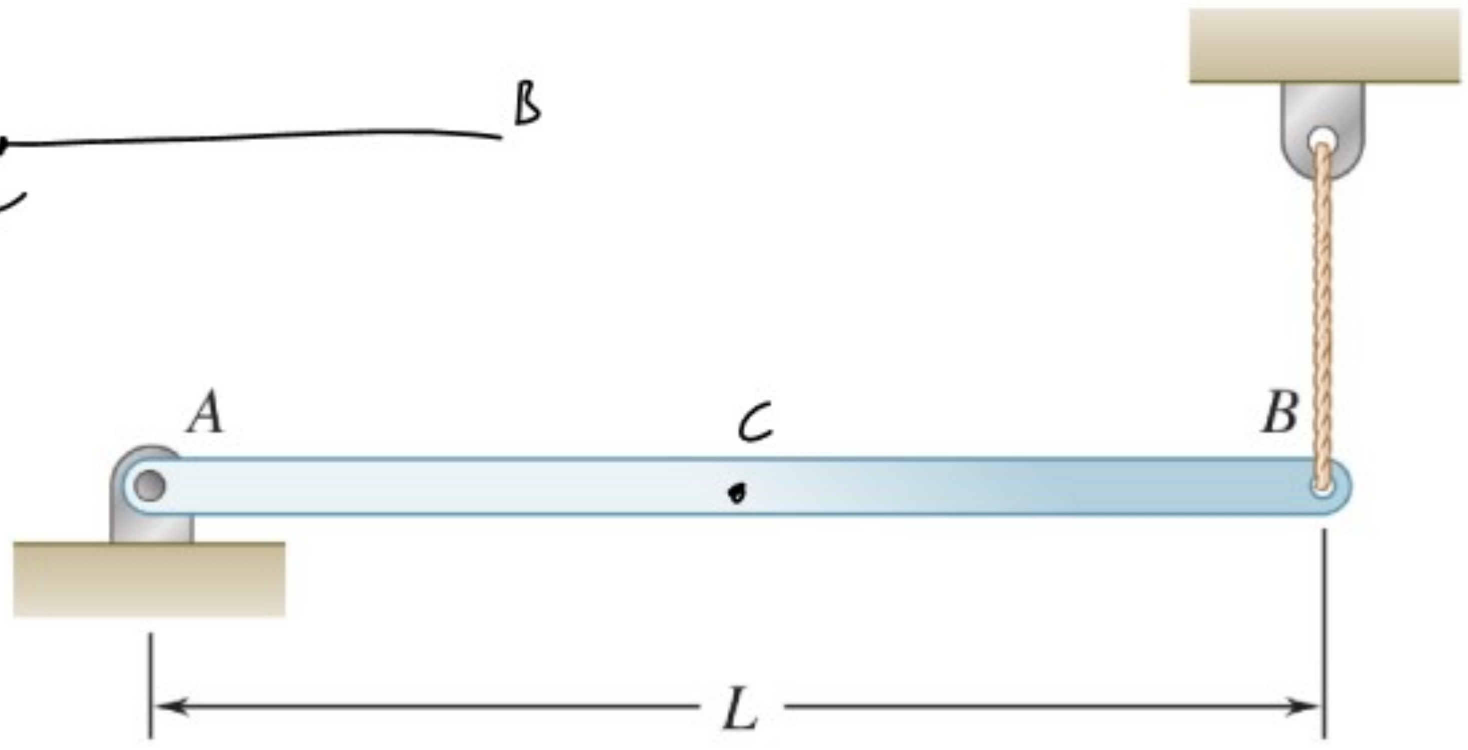
Rolling



$\bar{a} = r\alpha$

A uniform rod of length L and mass m is supported as shown. If the cable attached at end B suddenly breaks, determine (a) the acceleration of end B, (b) the reaction at the pin support.





$$I_c = \frac{1}{12} mL^2$$

$$I_A = I_c + d^2 m$$

$$= \frac{1}{12} mL^2 + \left(\frac{L}{2}\right)^2 m$$

$$= \frac{1}{12} mL^2 + \frac{1}{4} mL^2$$

$$= \frac{16}{48} mL^2 = \frac{1}{3} mL^2$$

$$\Sigma M_A = I_A \alpha$$

$$-\frac{L}{2} W = I_A \alpha$$

$$-\frac{\cancel{L}}{2} \cancel{m} g = \frac{1}{3} \cancel{m} L^{\cancel{2}} \alpha$$

$$\alpha = \frac{-3}{2} \frac{g}{L}$$

$$a_B = \cancel{a_A}^{\,0} + a_{B/A} = \alpha k \times r_{B/A} - \cancel{\omega^2 r_{B/A}}^{\,0}$$

$$= \alpha L = \frac{-3}{2} \frac{g}{L} L = \boxed{-\frac{3}{2} g}$$

$$\Sigma M_c = I_c a$$

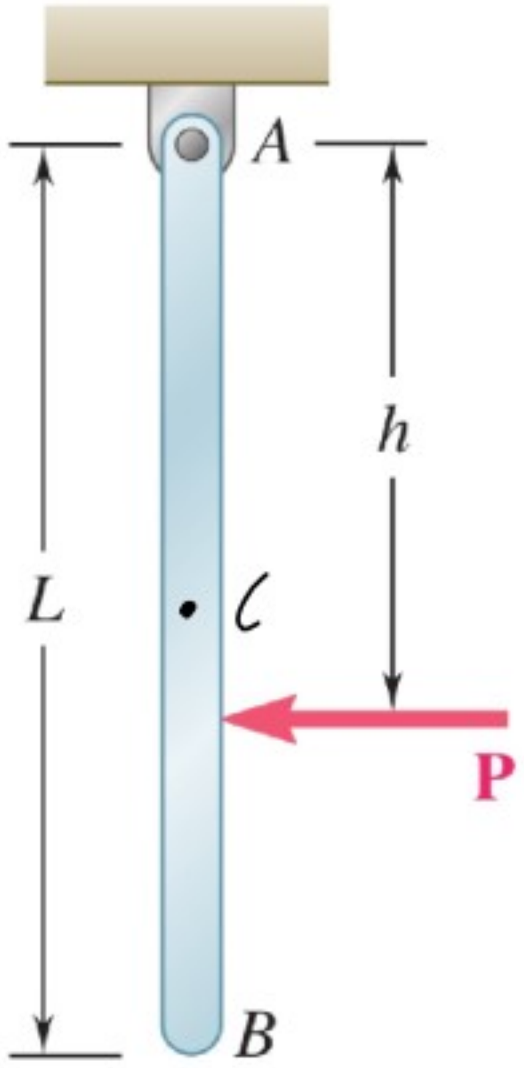
$$-\frac{L}{2} R_A = I_c \left(\frac{-3}{2} \frac{g}{L} \right)$$

$$-\frac{\cancel{L}}{2} R_A = \frac{1}{12} m \cancel{L^2} \left(\frac{-3}{2} \frac{g}{\cancel{L}} \right)$$

$$-R_A/2 = \frac{1}{12} m \left(-\frac{3}{2} g \right)$$

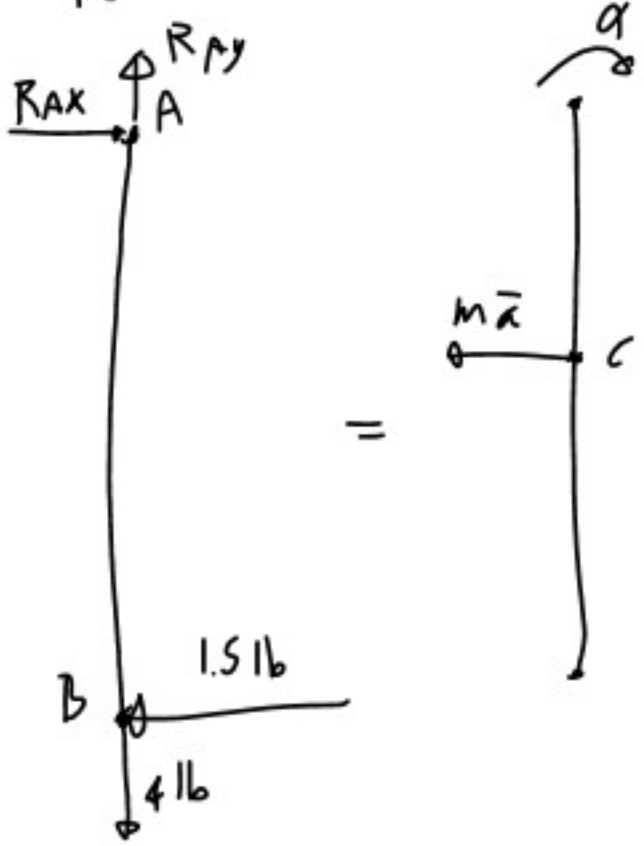
$$R_A = \frac{1}{12} m 3 g = \boxed{\frac{W}{4}}$$

A uniform slender rod of length $L = 36$ in. and weight $W = 4$ lb hangs freely from a hinge at A. If a force $\mathbf{P}$ of magnitude 1.5 lb is applied at B horizontally to the left ($h = L$), determine (a) the angular acceleration of the rod, (b) the components of the reaction at A.



$I_C = \frac{1}{12} mL^2$

$I_A = I_C + md^2 = I_C + m\left(\frac{L}{2}\right)^2 = \frac{1}{3} mL^2 = \frac{1}{3} \frac{4 \text{ lb}}{32.2 \text{ ft}/\text{s}^2} (36 \text{ in})^2 = 53.7 \frac{\text{lb in}^2 \text{s}^2}{\text{ft}}$



$53.7 \frac{\text{lb in}^2 \text{s}^2}{\cancel{\text{ft}}} \frac{1 \cancel{\text{ft}}}{12 \cancel{\text{in}}} = 4.47 \text{ lb in s}^2$

$\Sigma M_A = I_A \alpha$

$-36 \cdot 1.5 = 4.47\alpha$

$\frac{-36 \cdot 1.5}{4.47} = \alpha = \boxed{12.1 \text{ rad}/\text{s}^2}$

$\bar{a} = \alpha \frac{-L}{2} = 12.1 \frac{-36}{2} = 217 \text{ in}/\text{s}^2$

$\Sigma F_y = ma_y \Rightarrow \boxed{R_{Ay} = 4 \text{ lb}}$

$\Sigma F_x = ma_x$

$R_{Ax} - 1.5 = -m a_x$

$R_{Ax} = 1.5 \text{ lb} - m\, 217 \text{ in}/\text{s}^2$

$= 1.5 \text{ lb} - 0.01 \frac{\text{lb s}^2}{\text{in}} 217 \text{ in}/\text{s}^2$

$\boxed{= 3.75 \text{ lb}}$

$W = 4\ lb$

$$m = \frac{W}{g} = \frac{4\ lb}{32.2\ ft/s^2} = 0.124\ \frac{lb\ s^2}{\cancel{ft}}\ \frac{1\ \cancel{ft}}{12\ in} = 0.01\ \frac{lb\ s^2}{in}$$