FACULTAD
DE INGENIERÍA

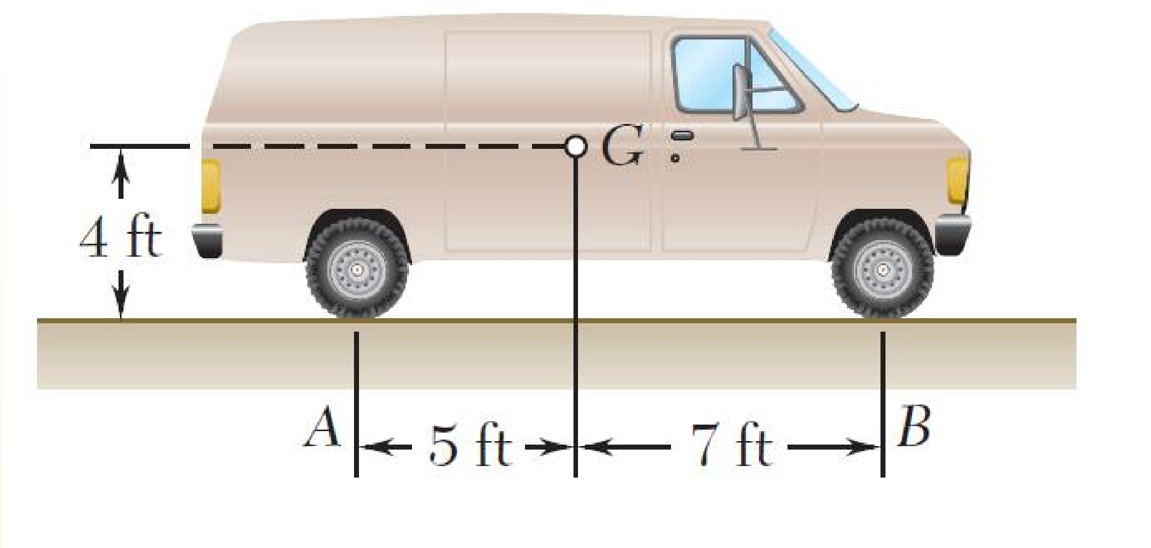
MECÁNICA APLICADA

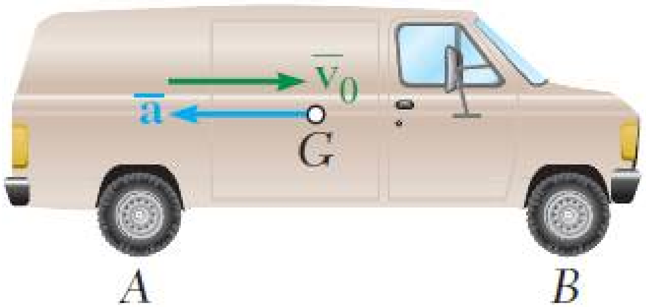
MECÁNICA Y MECANISMOS

CUERPO RÍGIDO

Ing. Carlos Barrera-2021

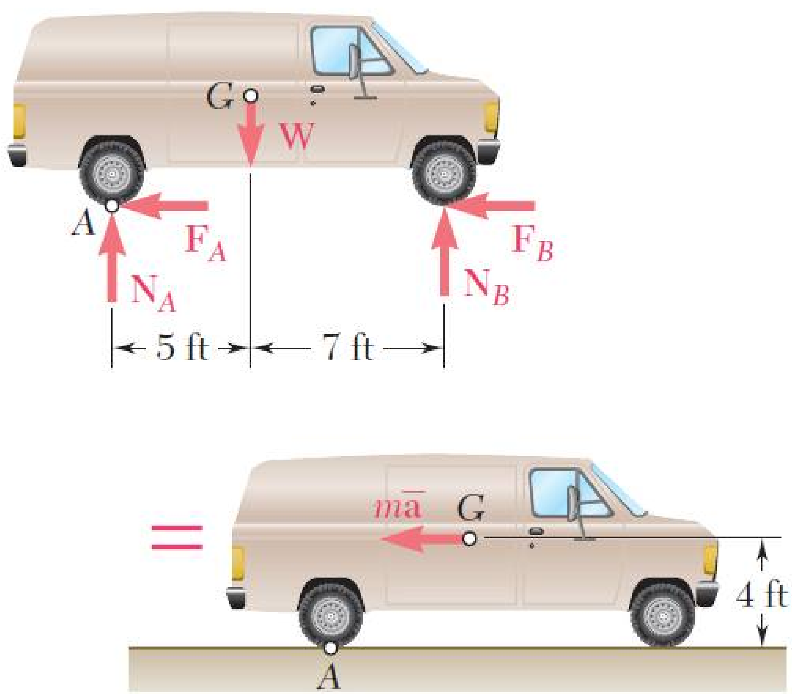
Ejerc. Nº 1) La camioneta se mueve a 30 pie/s y se aplican repentinamente los frenos, lo que provoca que las ruedas dejen de girar. La camioneta patina 20 pies antes de detenerse. Calcular la magnitud de la reacción normal y la fuerza de rozamiento en cada rueda cuando la camioneta patinó.





$$\bar{v}_0 = +30 \text{ ft/s} \qquad \bar{v}^2 = \bar{v}_0^2 + 2\bar{a}\bar{x} \qquad 0 = (30)^2 + 2\bar{a}(20)$$

$$\bar{a} = -22.5 \text{ ft/s}^2 \qquad \bar{\mathbf{a}} = 22.5 \text{ ft/s}^2 \leftarrow$$



$$+\uparrow \Sigma F_y = \Sigma (F_y)_{\text{ef}}: \qquad N_A + N_B - W = 0$$

$$F_A + F_B = \mu_k(N_A + N_B) = \mu_k W$$

$$\xrightarrow{+} \Sigma F_x = \Sigma(F_x)_{\text{ef}}: \qquad -(F_A + F_B) = -m\bar{a}$$

$$-\mu_k W = -\frac{W}{32.2 \text{ ft/s}^2}(22.5 \text{ ft/s}^2)$$

$$\mu_k = 0.699$$

$$+\circlearrowleft \Sigma M_A = \Sigma(M_A)_{\text{ef}}: \qquad -W(5 \text{ ft}) + N_B(12 \text{ ft}) = m\bar{a}(4 \text{ ft})$$

$$-W(5 \text{ ft}) + N_B(12 \text{ ft}) = \frac{W}{32.2 \text{ ft/s}^2}(22.5 \text{ ft/s}^2)(4 \text{ ft})$$

$$N_B = 0.650W$$

$$F_B = \mu_k N_B = (0.699)(0.650W) \qquad F_B = 0.454W$$

$$+\uparrow \Sigma F_y = \Sigma(F_y)_{\text{ef}}: \qquad N_A + N_B - W = 0$$

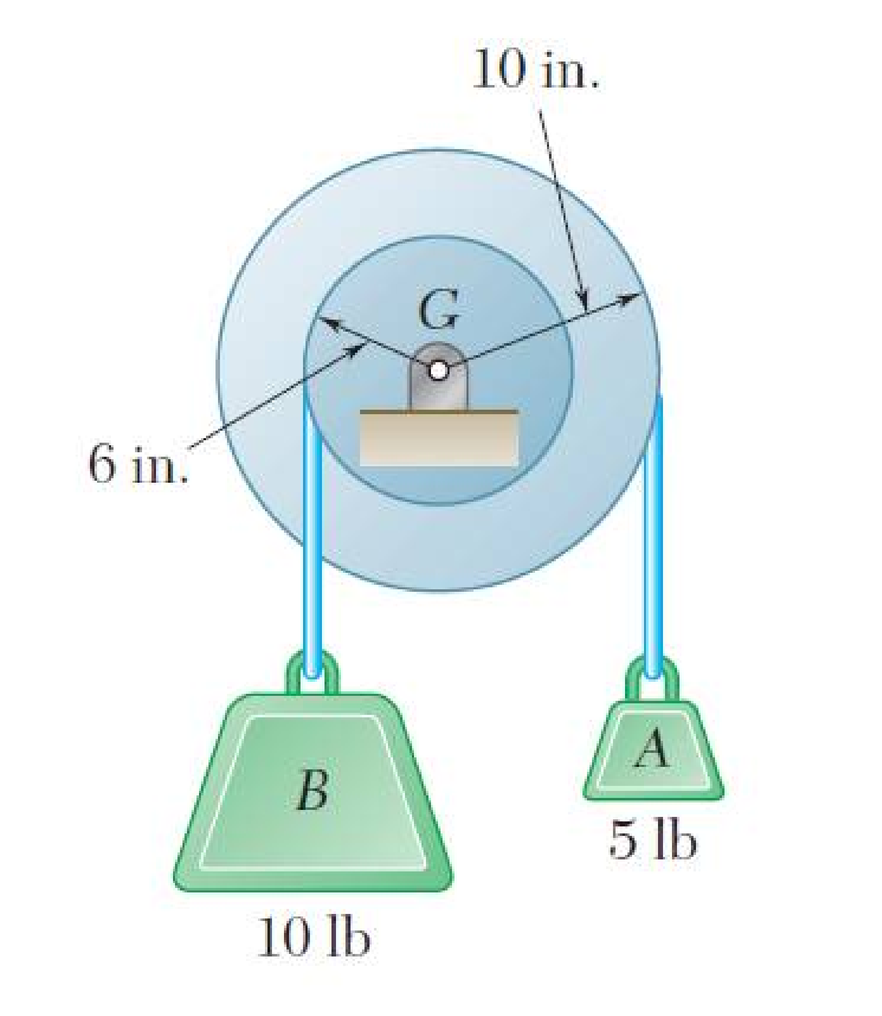
$$N_A + 0.650W - W = 0$$

$$N_A = 0.350W$$

$$F_A = \mu_k N_A = (0.699)(0.350W) \qquad F_A = 0.245W$$

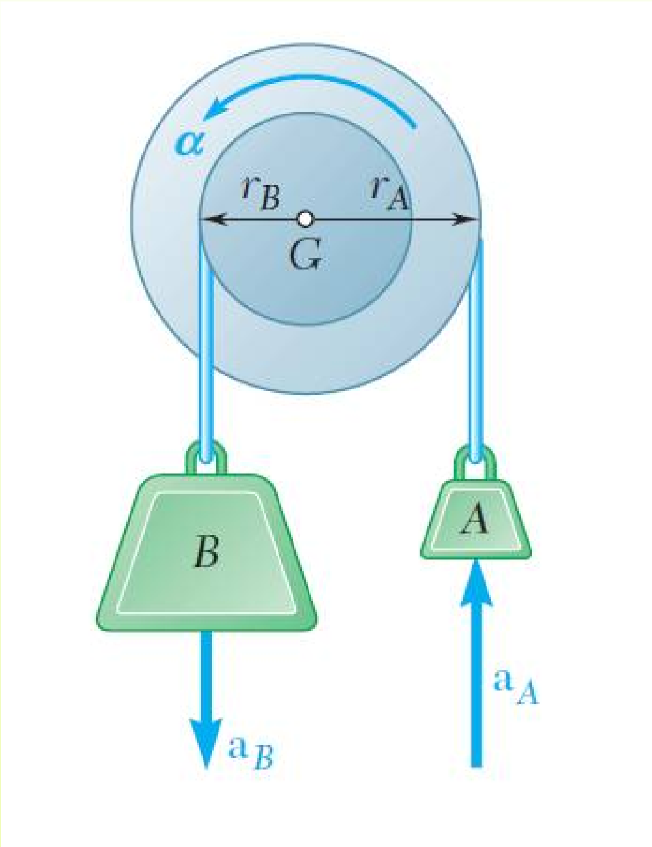
$$N_{\text{frontal}} = \tfrac{1}{2}N_B = 0.325W \qquad N_{\text{trasera}} = \tfrac{1}{2}N_A = 0.175W$$

$$F_{\text{frontal}} = \tfrac{1}{2}F_B = 0.227W \qquad F_{\text{trasera}} = \tfrac{1}{2}F_A = 0.122W$$

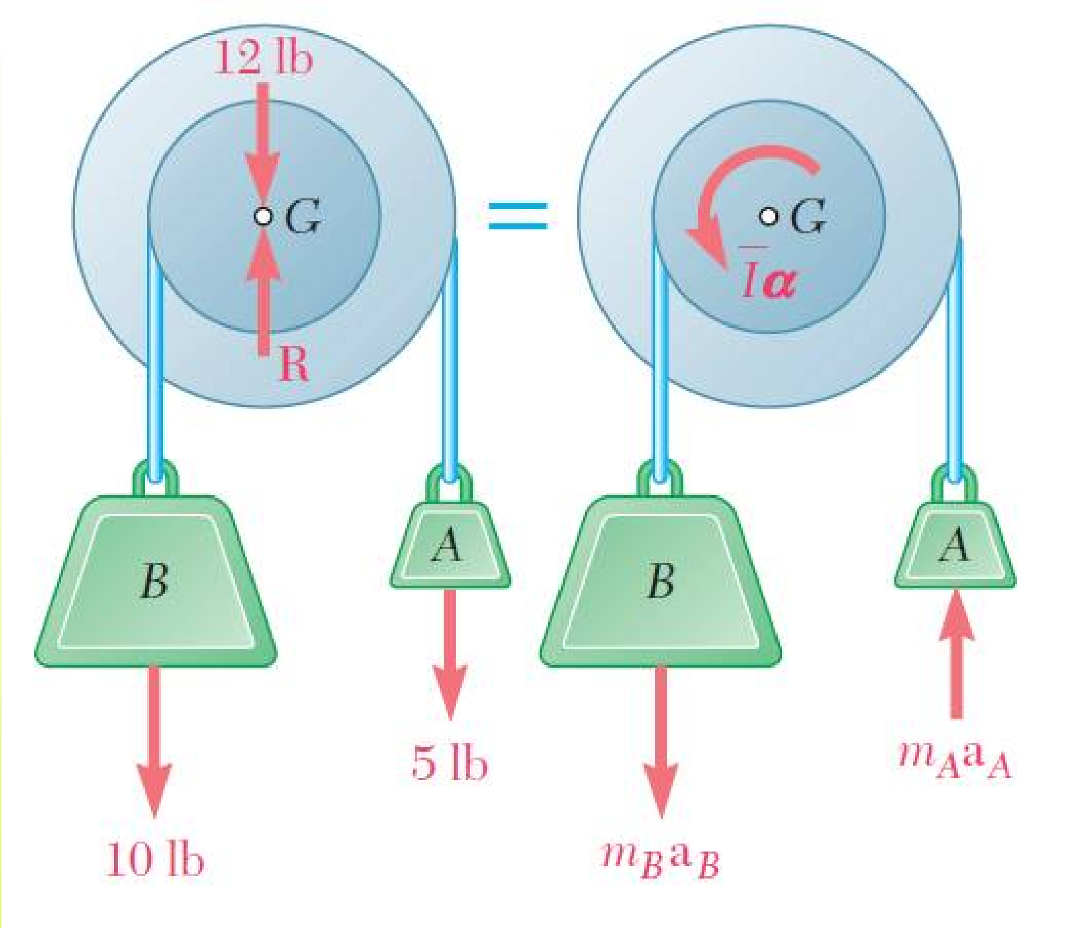


Ejerc. Nº 2) Una polea de 12 lb y de 8 pulg de radio de giro se conecta a dos bloques. Suponiendo que no hay fricción en el eje, calcular la aceleración angular de la polea y la aceleración de cada bloque.

$$+\circlearrowleft \Sigma M_G = 0: \qquad W_B(6 \text{ in.}) - (5 \text{ lb})(10 \text{ in.}) = 0 \qquad W_B = 8.33 \text{ lb}$$



$$\mathbf{a}_A = (\tfrac{10}{12} \text{ ft})\alpha \uparrow \qquad \mathbf{a}_B = (\tfrac{6}{12} \text{ ft})\alpha \downarrow$$



$$\bar{I} = m\bar{k}^2 = \frac{W}{g}\bar{k}^2 = \frac{12 \text{ lb}}{32.2 \text{ ft/s}^2}\left(\tfrac{8}{12} \text{ ft}\right)^2 = 0.1656 \text{ lb} \cdot \text{ft} \cdot \text{s}^2$$

$$+\circlearrowleft \Sigma M_G = \Sigma (M_G)_{\text{ef}}:$$

$$(10 \text{ lb})(\tfrac{6}{12} \text{ ft}) - (5 \text{ lb})(\tfrac{10}{12} \text{ ft}) = +\bar{I}\alpha + m_B a_B(\tfrac{6}{12} \text{ ft}) + m_A a_A(\tfrac{10}{12} \text{ ft})$$

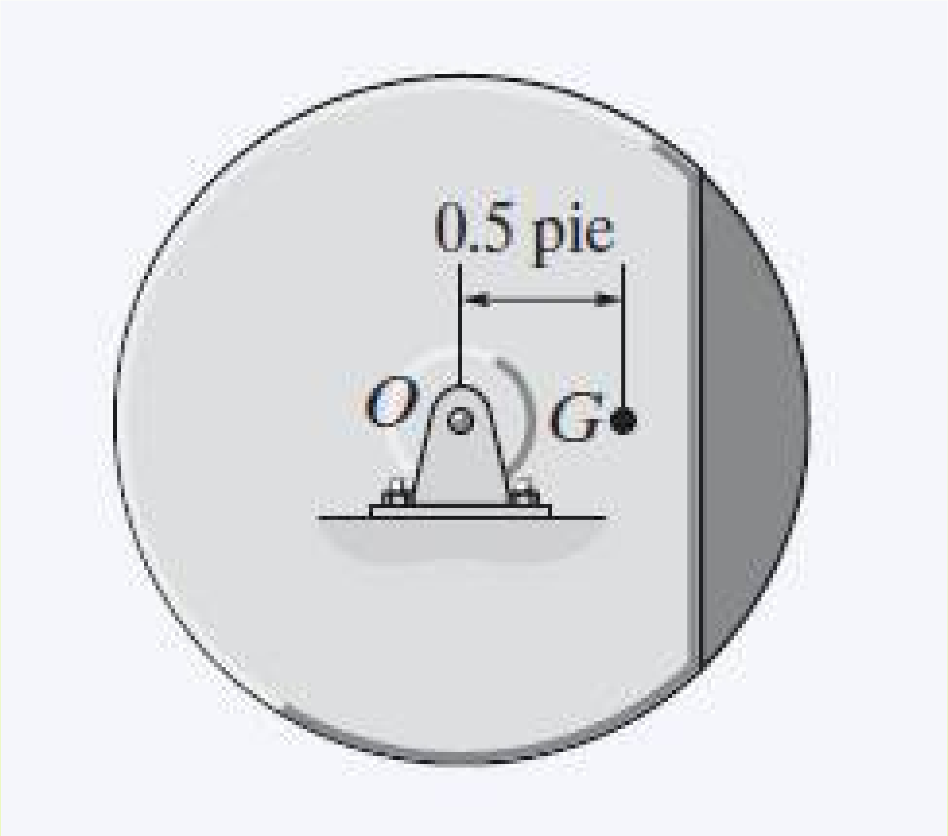
$$(10)(\tfrac{6}{12}) - (5)(\tfrac{10}{12}) = 0.1656\alpha + \tfrac{10}{32.2}(\tfrac{6}{12}\alpha)(\tfrac{6}{12}) + \tfrac{5}{32.2}(\tfrac{10}{12}\alpha)(\tfrac{10}{12})$$

$$\alpha = +2.374 \text{ rad/s}^2 \qquad \boldsymbol{\alpha} = 2.37 \text{ rad/s}^2 \circlearrowleft$$

$$a_A = r_A\alpha = (\tfrac{10}{12} \text{ ft})(2.374 \text{ rad/s}^2) \qquad \mathbf{a}_A = 1.978 \text{ ft/s}^2 \uparrow$$

$$a_B = r_B\alpha = (\tfrac{6}{12} \text{ ft})(2.374 \text{ rad/s}^2) \qquad \mathbf{a}_B = 1.187 \text{ ft/s}^2 \downarrow$$

Ejerc. Nº 3) La rueda desbalanceada de 50 lb tiene un radio de giro de 0,6 pie con respecto a un eje que pasa por su centro de masa G. Si se pone en movimiento desde el reposo, calcular las componentes horizontal y vertical de la reacción en el pasador O.

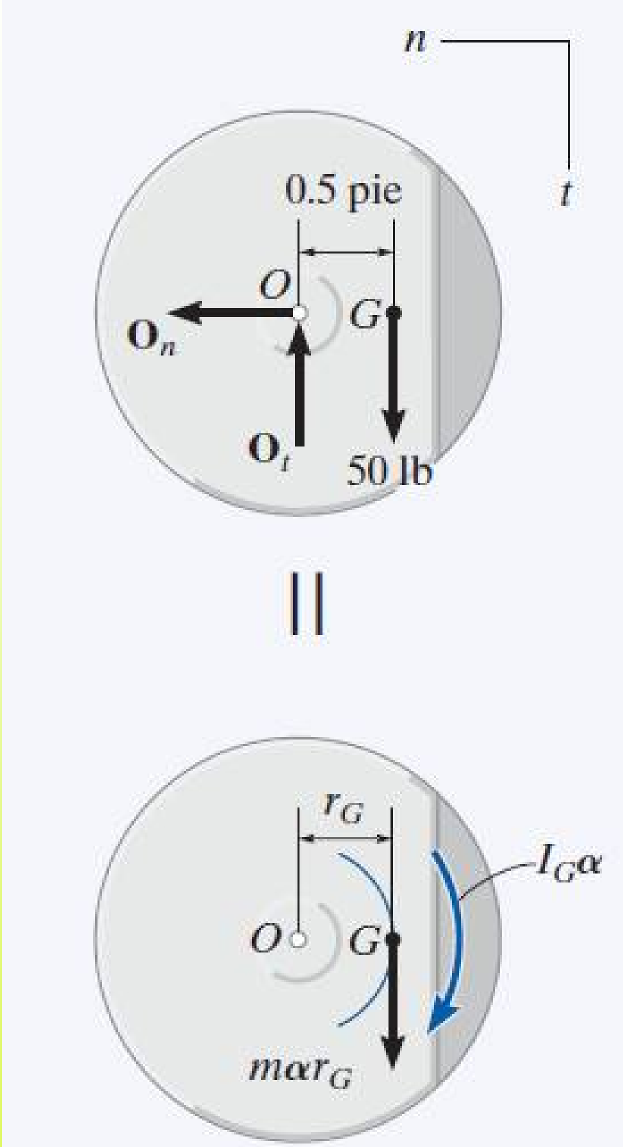


$$I_G = mk_G^2 = (50 \text{ lb}/32.2 \text{ pies/s}^2)(0.6 \text{ pie})^2 = 0.559 \text{ slug} \cdot \text{pie}^2$$

$$\overset{+}{\leftarrow} \Sigma F_n = m\omega^2 r_G; \qquad O_n = 0$$

$$+\downarrow \Sigma F_t = m\alpha r_G; \quad -O_t + 50\text{ lb} = \left(\frac{50\text{ lb}}{32.2\text{ pies/s}^2}\right)(\alpha)(0.5\text{ pie})$$

$$\circlearrowright + \Sigma M_G = I_G\alpha; \quad O_t(0.5\text{ pie}) = (0.5590\text{ slug}\cdot\text{pie}^2)\alpha$$



$$\alpha = 26.4\text{ rad/s}^2 \qquad O_t = 29.5\text{ lb}$$

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Los momentos también pueden sumarse con respecto al punto O para eliminar On y Ot y obtener una solución para α

$$\circlearrowright + \Sigma M_O = \Sigma(\mathcal{M}_k)_O;$$

$$(50\ \text{lb})(0.5\ \text{pie}) = (0.5590\ \text{slug}\cdot\text{pie}^2)\alpha + \left[\left(\frac{50\ \text{lb}}{32.2\ \text{pies/s}^2}\right)\alpha(0.5\ \text{pie})\right](0.5\ \text{pie})$$

$$50\ \text{lb}(0.5\ \text{pie}) = 0.9472\alpha$$

$$I_O = I_G + mr_G^2 = 0.559 + \left(\frac{50}{32.2}\right)(0.5)^2 = 0.9472\ \text{slug}\cdot\text{pie}^2$$

$$\circlearrowright + \Sigma M_O = I_O\alpha;\quad (50\ \text{lb})(0.5\ \text{pie}) = (0.9472\ \text{slug}\cdot\text{pie}^2)\alpha$$

Al resolver α y sustituir en la ecuación, se obtiene la respuesta.

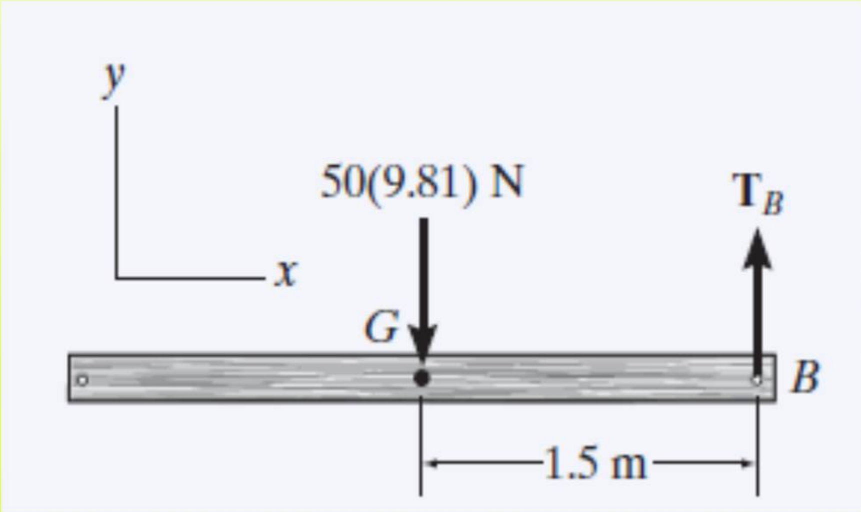
Ejerc. Nº 4) Las cuerdas AC y BD mantienen en equilibrio la barra de 50 kg. Calcular la tensión en BD y la aceleración angular de la barra inmediatamente después de que se corta AC.

$$\xrightarrow{+} \Sigma F_x = m(a_G)_x; \qquad 0 = (50\text{ kg } a_G)_x$$

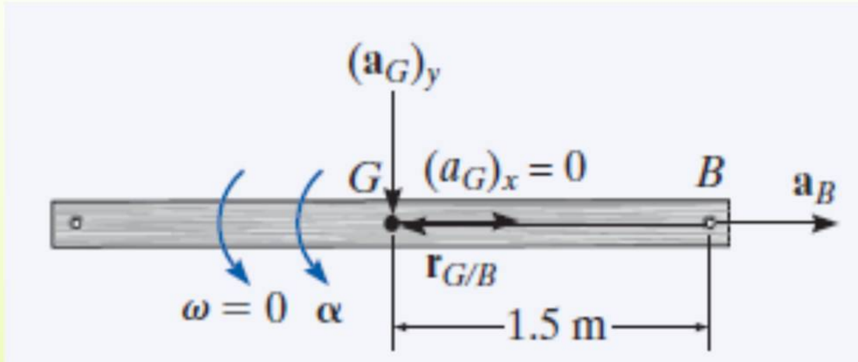
$$(a_G)_x = 0$$

$$+\uparrow \Sigma F_y = m(a_G)_y; \quad T_B - 50(9.81)\text{N} = -(50\text{ kg } a_G)_y$$

$$\circlearrowleft + \Sigma M_G = I_G\alpha; \qquad T_B(1.5\text{ m}) = \left[\frac{1}{12}(50\text{ kg})(3\text{ m})^2\right]\alpha$$



$$(a_B)_n = v_B^2/\rho_{BD} = 0$$



$$\mathbf{a}_G = \mathbf{a}_B + \boldsymbol{\alpha} \times \mathbf{r}_{G/B} - \omega^2\mathbf{r}_{G/B}$$

$$-(a_G)_y\mathbf{j} = a_B\mathbf{i} + (\alpha\mathbf{k}) \times (-1.5\mathbf{i}) - \mathbf{0}$$

$$-(a_G)_y\mathbf{j} = a_B\mathbf{i} - 1.5\alpha\mathbf{j}$$

$$0 = a_B$$

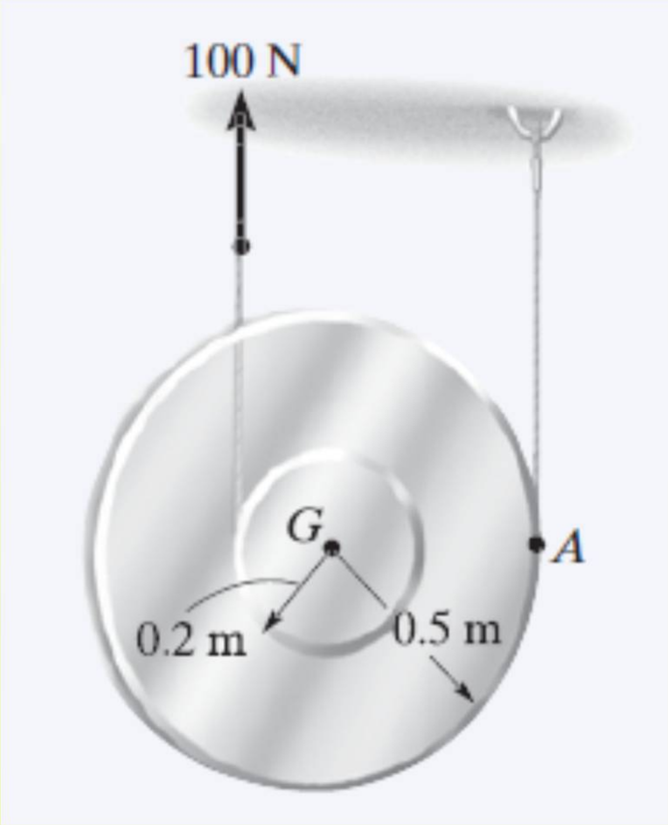
$$(a_G)_y = 1.5\alpha$$

$$\alpha = 4.905 \text{ rad/s}^2$$

$$T_B = 123 \text{ N}$$

$$(a_G)_y = 7.36 \text{ m/s}^2$$

Ejerc. Nº 5) Calcular la aceleración angular del sistema que se ilustra. La masa es de 8 kg y el radio de giro es 0,35 m.



$$I_G = mk_G^2 = 8\,\text{kg}(0.35\,\text{m})^2 = 0.980\,\text{kg}\cdot\text{m}^2$$

$$+\uparrow \Sigma F_y = m(a_G)_y; \qquad T + 100\text{ N} - 78.48\text{ N} = (8\text{ kg})a_G$$

$$\circlearrowright + \Sigma M_G = I_G\alpha; \quad 100\text{ N}(0.2\text{ m}) - T(0.5\text{ m}) = (0.980\text{ kg}\cdot\text{m}^2)\alpha$$

$$(\circlearrowright +)\; a_G = \alpha r. \qquad a_G = \alpha\,(0.5\text{ m})$$

$$\alpha = 10.3\text{ rad/s}^2$$
$$a_G = 5.16\text{ m/s}^2$$
$$T = 19.8\text{ N}$$

Otra forma de calcular

$$\circlearrowright + \Sigma M_A = \Sigma(\mathcal{M}_k)_A; \qquad 100\ \text{N}(0.7\ \text{m}) - 78.48\ \text{N}(0.5\ \text{m})$$
$$= (0.980\ \text{kg}\cdot\text{m}^2)\alpha + [(8\ \text{kg})a_G](0.5\ \text{m})$$

$$\alpha = 10.3\ \text{rad/s}^2$$

3° Solución

$$\circlearrowright + \Sigma M_A = I_A\alpha; \ (100\ \text{N})(0.7\ \text{m}) - (78.48\ \text{N})(0.5\ \text{m})$$
$$= [0.980\ \text{kg}\cdot\text{m}^2 + (8\ \text{kg})(0.5\ \text{m})^2]\alpha$$
$$\alpha = 10.3\ \text{rad/s}^2$$