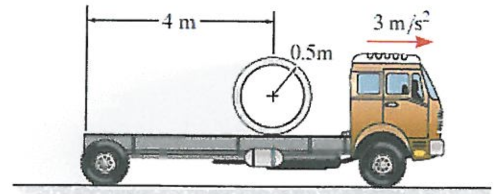
17–109.



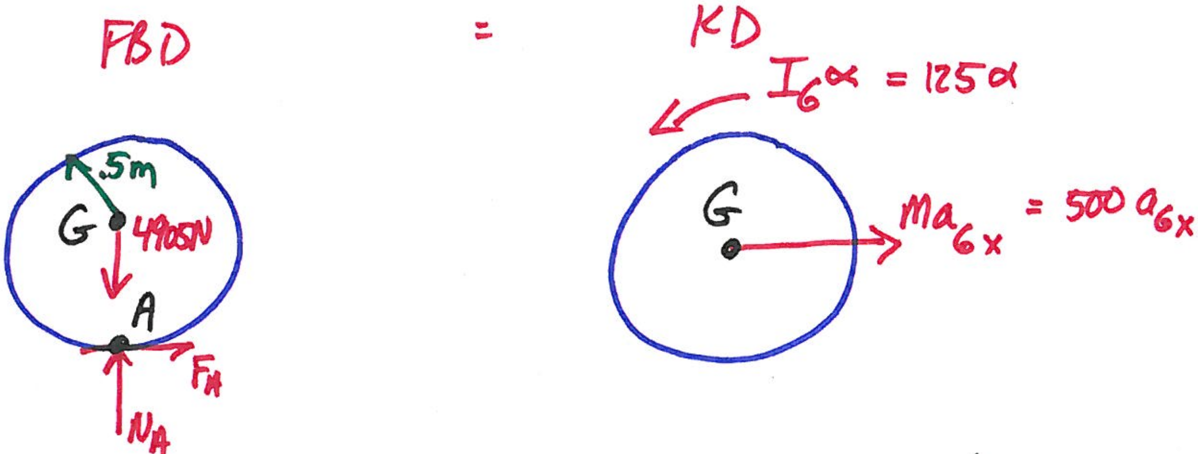
The 500-kg concrete culvert has a mean radius of 0.5 m. If the truck has an acceleration of 3 m/s², determine the culvert's angular acceleration. Assume that the culvert does not slip on the truck bed, and neglect its thickness.

$M = 500\ \text{Kg} \quad W = 500(9.81) = 4905\ \text{N}$

$I_G = mr^2 = 500(.5)^2 = 125\ \text{Kg-m}^2$

CLASSIFY MOTION

GPM



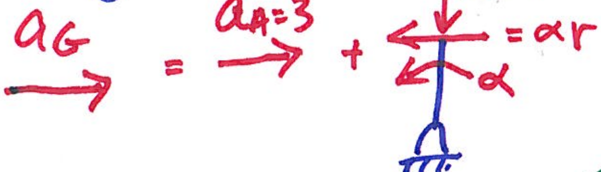
$\rightarrow \Sigma F_x = F = ma_{Gx} = 500\,a_{Gx} = 500(3-\alpha(0.5))$

$\uparrow \Sigma F_y = -4905 + N_A = 0$

$\circlearrowleft \Sigma M_G = -0.5F = -I_G\alpha = -125\alpha$

RELATIVE ACCELERATION (BECAUSE TRUCK IS MOVING)

$a_G = a_A + \underbrace{a_{G/A}}_{=\omega^2 r}$



$X \rightarrow \quad a_G = 3 - \alpha(0.5)$

SOLVE

$F + 250\alpha = 1500$

$-0.5F + 125\alpha = 0$

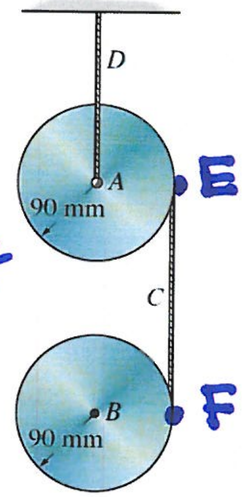
$$\begin{bmatrix} 1 & 250 \\ -0.5 & 125 \end{bmatrix} \begin{Bmatrix} F \\ \alpha \end{Bmatrix} = \begin{Bmatrix} 1500 \\ 0 \end{Bmatrix}$$

$F = 750\ \text{N}$

$\alpha = 3\ \text{rad/s}^2 \circlearrowleft$

17-115

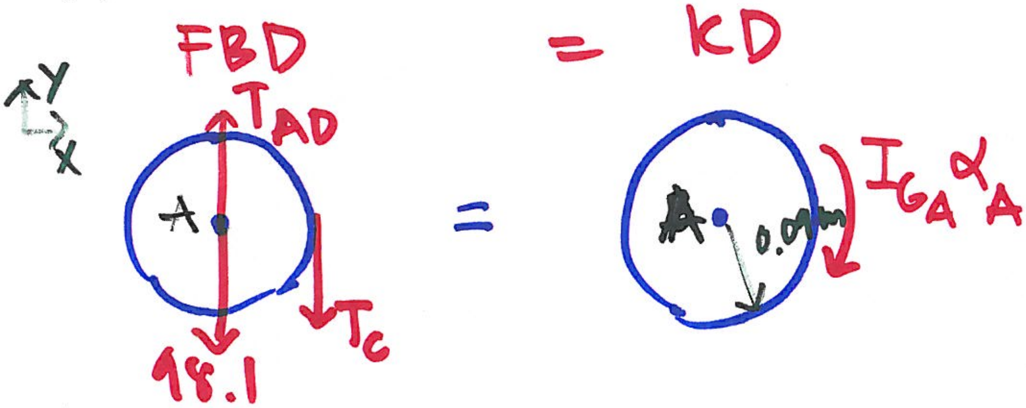
A cord is wrapped around each of the two 10-kg disks. If they are released from rest, determine the angular acceleration of each disk and the tension in the cord C. Neglect the mass of the cord.



$m_A = m_B = 10\text{ kg}$ $\quad W_A = W_B = 10\times 9.81 = 98.1\text{ N}$

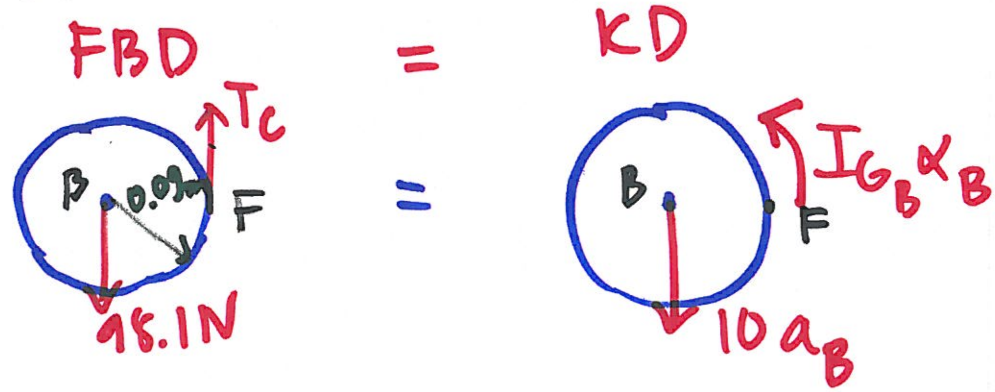
$I_{G_A} = I_{G_B} = \frac{1}{2}mr^2 = \frac{1}{2}10(.09)^2 = .0405\text{ kg}\cdot\text{m}^2$

Disk A : RAFA



$\circlearrowleft \Sigma M_A = I_{G_A}\alpha_A$: $\quad 0.09T_C = .0405\alpha_A$ (1)

Disk B : GPM

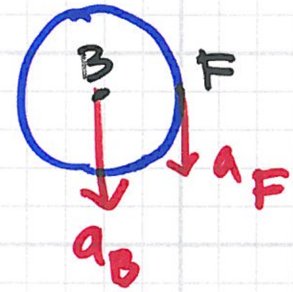


$\circlearrowright \Sigma M_F$: $\quad 98.1(.09) = .0405\alpha_B + 10a_B(0.09)$ (2)

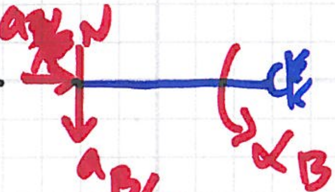
$\uparrow \Sigma F_y$: $\quad -98.1 + T_C = -10a_B$ (3)

17-115 (Con't)

Kinematics: $\vec{a}_B = \vec{a}_F + \vec{a}_{B/F}$



$\downarrow a_B = \downarrow a_F +$



$a_{B/F_T} = \alpha_B r = \alpha_B(0.09)$

$\downarrow \Sigma Y \downarrow$: $a_B = a_F + 0.09\alpha_B$

No slip wheels @ E & F:

$a_F = a_E = \alpha_A r = 0.09\alpha_A$

$a_B = 0.09\alpha_A + 0.09\alpha_B$ (4)

Solve (1), (2), (3) & (4):

$$\begin{bmatrix} 0.09 & -.0405 & 0 & 0 \\ 0 & 0 & .0405 & .9 \\ 1 & 0 & 0 & 10 \\ 0 & 0.09 & 0.09 & -1 \end{bmatrix} \begin{bmatrix} T_c \\ \alpha_A \\ \alpha_B \\ a_B \end{bmatrix} = \begin{bmatrix} 0 \\ 8.829 \\ 98.1 \\ 0 \end{bmatrix}$$

$T_c = \underline{19.62 \text{ N}}$ Ans.

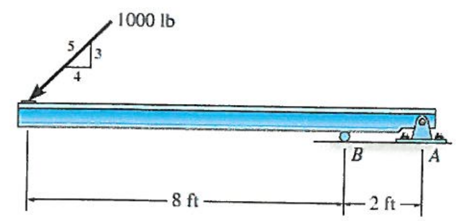
$\alpha_A = \underline{43.6 \text{ rad/s}^2}$ Ans.

$\alpha_B = \underline{43.6 \text{ rad/s}^2}$ Ans.

$a_B = 7.85 \text{ m/s}^2 \downarrow$

17–118.

The 500-lb beam is supported at A and B when it is subjected to a force of 1000 lb as shown. If the pin support at A suddenly fails, determine the beam's initial angular acceleration and the force of the roller support on the beam. For the calculation, assume that the beam is a slender rod so that its thickness can be neglected.

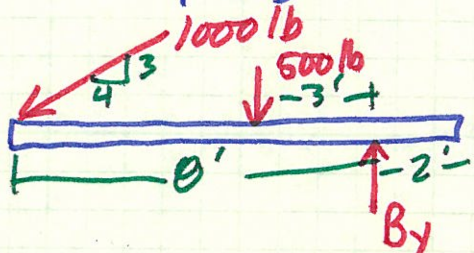


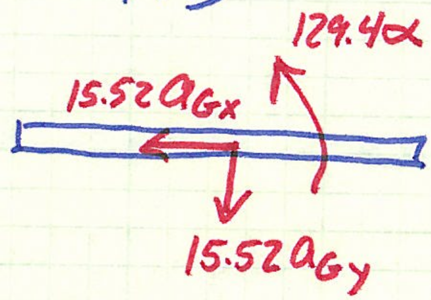
SOLUTION

$W = 1000 \text{ lb} \qquad m = \dfrac{500}{32.2} = 15.52 \text{ slug}$

$I_G = \dfrac{1}{12} m l^2 = \dfrac{1}{12}(15.52)(10^2) = 129.4 \text{ slug-ft}^2$

FBD = KD





$\rightarrow \Sigma F_x \qquad -\tfrac{4}{5}(1000) = -15.52\, a_{Gx}$

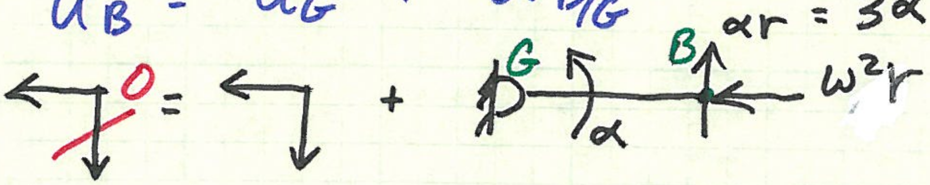
$a_{Gx} = 51.5 \text{ ft/s}^2 \leftarrow$

$\uparrow \Sigma F_y \qquad B_y - \tfrac{3}{5}(1000) - 500 = -15.52\, a_{Gy} \qquad (1)$

$\circlearrowleft \Sigma M_B \qquad \tfrac{3}{5}(1000)(8) + 500(3) = 15.52\, a_{Gy}(3) + 129.4\alpha \qquad (2)$

KINEMATICS

$\vec{a}_B = \vec{a}_G + \vec{a}_{B/G}$



$\uparrow \Sigma F_y \qquad 0 = -a_{Gy} + 3\alpha \qquad a_{Gy} = 3\alpha \qquad a_{Gy} = 70.24$

SOLVING (2)

$6300 = 15.52(3\alpha)(3) + 129.4\alpha$

$\underline{\alpha = 23.4 \text{ rad/s}^2} \circlearrowleft$

SOLVING (1)

$B_y - 600 - 500 = -15.52(70.24)$

$\underline{B_y = 9.89 \text{ lb} \uparrow}$