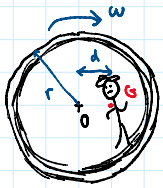
20-R-KIN DK29-34

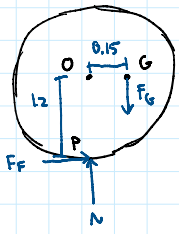
June 5, 2020 9:24 AM

CH17-DK-29 Intermediate General Plane Motion Video

Inspiration: 17-112 Hibbeler



Montana James is at it again. He jumps into a pipe to escape from monkeys, rolling the pipe at an angular velocity of $\omega = 1$ rad/s. At this instant, the center of gravity of Montana and the pipe is at G, and their radius of gyration is $k_G = 1.05$ m. Determine the angular acceleration of the pipe if the combined mass of Montana James and the pipe is 220 kg. Assume Montana does not move within the pipe and that the pipe rolls without slipping. The radius of the pipe is 1.2 m and G is a horizontal distance of 0.15 m away from O.



$$I_G = m k_G^2 = (220)(1.05)^2 = 242.55$$

$$\sum M_P = m\vec{r}_{G/P} \times \vec{a}_G + I_G \vec{\alpha} = 220(0.15\hat{i} + 1.2\hat{j}) \times (a_{Gx}\hat{i} + a_{Gy}\hat{j}) + 242.55\alpha = -F_G(0.15)$$

$$= -220(1.2)a_{Gx}\hat{k} + 220(0.15)(a_{Gy})\hat{k} + 242.55\alpha = -220(9.81)(0.15)$$

$$-264 a_{Gx} + 33 a_{Gy} + 242.55\alpha = -323.73$$

Rolling without slipping: $a_0 = \vec{\alpha} \times \vec{r}_{O/P} = \alpha\hat{k} \times (1.2\hat{j}) = -1.2\alpha\hat{i}$

$$\vec{a}_G = \vec{a}_0 + \vec{\alpha} \times \vec{r}_{G/O} - \omega^2 \vec{r}_{G/O} = -1.2\alpha\hat{i} + \alpha\hat{k} \times (0.15\hat{i}) - (1^2)(0.15\hat{i})$$

$$\vec{a}_G = -1.2\alpha\hat{i} - 0.15\hat{i} + 0.15\alpha\hat{j} \qquad a_{Gx} = -1.2\alpha - 0.15 \qquad a_{Gy} = 0.15\alpha$$

$$-264(-1.2\alpha - 0.15) + 33(0.15\alpha) = -323.73$$

$$316.8\alpha + 39.6 + 4.95\alpha = -323.73$$

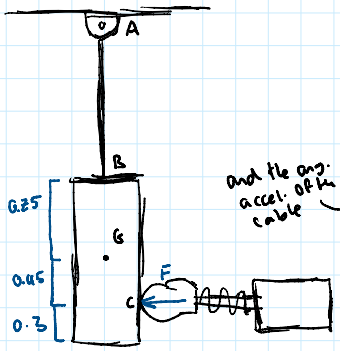
$$321.75\alpha = -363.33$$

$$\boxed{\alpha = -1.12923 \text{ rad/s}^2}$$

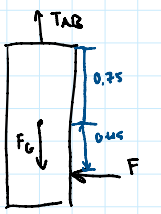
CH17-DK-30 Intermediate General Plane Motion Video or Homework or Lecture

Inspiration: 17-91 Hibbeler

maybe beginner



An engineering student is testing out the maximum settings on her punching machine. If the punching bag has a mass of 45 kg and an initial angular acceleration of 4 rad/s² when the machine makes contact, determine the force applied by the machine, the tension in the supporting cable AB. The length of cable AB is 1 m. Assume the punching bag can be modelled as a cylinder of uniform density with a radius of r = 21 cm.



$$\sum F_x = -F = m a_{Gx} \rightarrow -F = 45 a_{Gx}$$

$$\sum F_y = T_{AB} - F_G = m a_{Gy} \rightarrow T_{AB} - 45(9.81) = 45 a_{Gy}$$

$$\sum M_G = -F(0.45) = I_G \alpha \qquad I_G = \frac{1}{12} m (3r^2 + h^2) = \frac{1}{12}(45)(3(0.21)^2 + 1.5^2)$$

$$-0.45F = 8.433625(-4) \qquad = 8.433625$$

$$\boxed{F = 79.41}$$

$$-79.41 = 45 a_{Gx} \qquad a_{Gx} = -1.76466$$

$$a_B = \vec{a}_G + \vec{\alpha} \times \vec{r}_{B/G} - \omega^2 \vec{r}_{B/G} = -1.76466\hat{i} + a_{Gy}\hat{j} + (-4\hat{k}) \times (0.75\hat{j}) - 0$$

$\hat{k}$ $\hat{j}$

$$a_B = \vec{a}_G + \vec{\alpha} \times \vec{r}_{B/G} - \omega^2 \vec{r}_{B/G} = -1.746\hat{i} + a_{Gy}\hat{j} + (-4\hat{k}) \times (0.75\hat{j}) - 0$$
$$= 1.23\overline{3}\hat{i} + a_{Gy}\hat{j}$$

$$a_B = \vec{a}_A + \vec{\alpha}_{AB} \times \vec{r}_{B/A} - \omega^2 \vec{r}_{B/A} = 0 + \alpha_{AB}\hat{k} \times (-1\hat{j}) - 0$$
$$= \alpha_{AB}\hat{i}$$

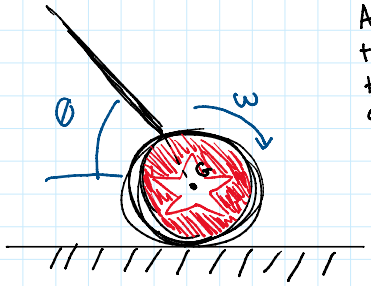
$\alpha_{AB}\hat{i} = 1.23\overline{3}\hat{i} + a_{Gy}\hat{j} \Rightarrow a_{Gy} = 0$ $\quad \boxed{\alpha_{AB} = 1.233\ \hat{k}\ \text{rad/s}^2}$

$T_{AB} = (45)(9.81) = \boxed{441.45\ \text{N}}$

CH17-DK-31 Intermediate General Plane Motion CHECK Complete later

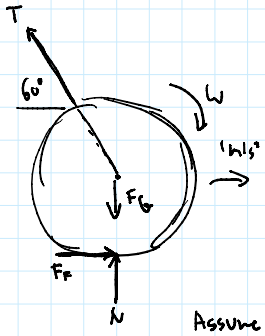
Inspiration: None

Figure out what variables need to be given



A mechanical engineering student has been practicing his yoyo tricks because he has too much free time. For one trick he spins the yoyo such that it contacts the ground and moves forward, emulating someone walking their dog. If the yoyo has a radius of gyration $k_G = 0.02\,m$ and a mass of $0.2\,kg$, determine the angular acceleration of the yoyo and the tension in the string.

The coefficient of static and kinetic friction is found to be $\mu_S = 0.3$ and $\mu_K = 0.2$ respectively. The angle is $\theta = 60°$ and the radius of the yoyo is $0.03\,m$. Take the initial angular velocity of the yoyo to be $\omega = 6\ \text{rad/s}$



$\sum F_x = F_F - T\cos 60 = m a_{Gx}$

$\sum F_y = T\sin 60 + N - F_G = m a_{Gy} = 0$

Have I worded the problem such that this is evident?

$\sum M_G = F_F(0.03) = I_G \alpha \qquad I_G = m k_G^2 = 0.2(0.02)^2 = 0.00008$

Assume rolling without slipping: $F_F \le \mu_S N$ $\qquad a_{Gx} = \alpha \times r = \alpha\hat{k} \times (0.03\hat{j}) = -0.03\alpha\hat{i}$

$0.5 = -0.03\alpha \qquad \alpha = -\frac{50}{3}$

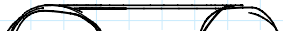
$F_F - T\cos 60 = (0.2)(0.5) = 0.1 \qquad T\sin 60 + N = (0.2)(9.81) = 1.962$

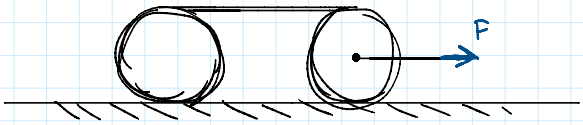
$F_F(0.03) = 0.00008\left(-\frac{50}{3}\right)$

CH17-DK-32 Advanced General Plane Motion

IDEA Must be fleshed out

Determine rolling with or without slipping

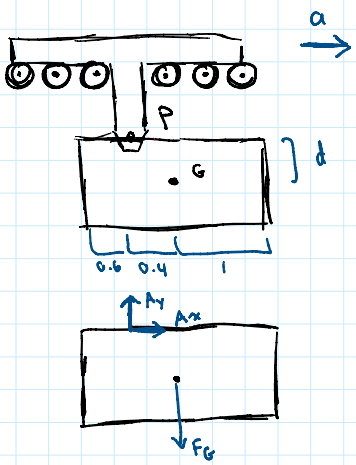




Determine rolling with or without slipping
Determine tension in cord

CHP-Dk-33 Intermediate General Plane Motion

Inspiration: 17-103 Hibbeler



An engineering student is testing a component of her vehicle for a design competition. The 5 kg rectangular plate is pinned to a track at P. If the track is given an acceleration of 2 m/s², determine the reaction forces at P and the angular acceleration of the plate. The height of the plate is h=2d and G is located a vertical distance d=0.8 away from P.

$I_G = \frac{1}{12}(5)(2^2 + 1.6^2) = \frac{41}{15}$

$\Sigma F_x = m a_{Gx} = A_x \qquad 5 a_{Gx} = A_x$

$\Sigma F_y = A_y - F_g = m a_{Gy} \Rightarrow A_y - (5)(9.81) = 5 a_{Gy}$

$\Sigma M_G = -A_x(0.8) - A_y(0.4) = I_G \alpha = \frac{41}{15}\alpha$

$a_G = a_P + \alpha \times \vec{r}_{G/P} - \omega^2 \vec{r}_{G/P}$

$= 5\hat{\imath} + \alpha \hat{k} \times (0.4\hat{\imath} - 0.8\hat{\jmath})$

$= 5\hat{\imath} + 0.4\alpha\hat{\jmath} + 0.8\alpha\hat{\imath}$

$a_{Gx} = 5 + 0.8\alpha$

$a_{Gy} = 0.4\alpha$

$25 + 4\alpha = A_x \qquad A_y = 49.05 + 2\alpha$

$-20 - 3.2\alpha - 19.62 - 0.8\alpha = \frac{41}{15}\alpha$

$-39.62 = \frac{101}{15}\alpha$

$\alpha = -5.884$

$A_x = 1.46336$ $\quad A_y = 37.2816$

CHP-Dk-34 Intermediate General Plane Motion

Inspiration: 17-10a Hibbeler

Montana James is at it again! He has found himself stuck on a conveyor belt with a rolling pipe. If the 200 kg pipe has a radius of r = 0.5 m and the