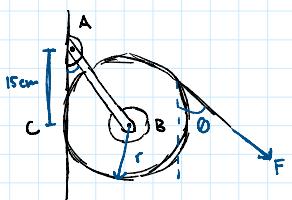


CH17-DK-23 Intermediate Rotation Homework
Inspiration: 17-69 Hibbeler
CHECK**INCOMPLETE**

To Be Edited

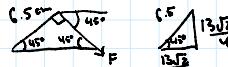
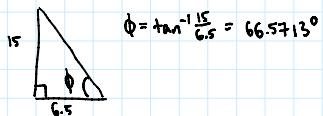


You were able to obtain a roll of toilet paper during quarantine and put it to good use. If the roll rests against a wall where its coefficient of friction is $\mu_k = 0.18$ and you apply a force of 20 N at an angle of 45° tangent to the roll, determine the angular acceleration of the precious toilet paper. Assume the roll can be treated as a cylinder with a mass of 0.25 kg , a width of 15 cm , and a radius of 6.5 cm .

$$30 - 45^\circ$$

$$10 - 30\text{ N}$$

$$0.2\text{ kg} - 0.25\text{ kg}$$



$$\sum F_x = ma_{Gx} = 0.25a_{Gx} = N_c \cos 66.5713 + F \cos 45$$

$$\sum F_y = ma_{Gy} = 0.25a_{Gy} = T_{AB} \sin 66.5713 - mg - F \sin 45 - \mu_k N_c$$

$$\sum M_A = \sum M_B = I_A \alpha = \mu_k N_c (0.065) - F \sin 45 (\frac{13.75}{4}) - F \cos 45 (\frac{13.75}{4}) = \frac{1}{2}(0.25)(0.065)^2 \alpha$$

$$T_{AB} \sin 66.5713 = 0.25(9.81) + 20 \sin 45 + 0.18 N_c + 0.25 a_{Gy}$$

$$N_c = T_{AB} \cos 66.5713 - 20 \cos 45 + 0.25 a_{Gx} - 0.18 N_c (0.065) - 20 \sin 45 (\frac{13.75}{400}) - 20 \cos 45 (\frac{13.75}{400}) = \frac{1}{2}(0.25)(0.065)^2 \alpha$$

$$a_{Gx} = \vec{a}_A + \vec{\alpha} \times \vec{r}_{BA} - \omega^2 \vec{r}_{BA} \quad a_{Gx} = 0 + \vec{\alpha} \times (0.065 \hat{i} - 0.15 \hat{j}) = 0.065 \alpha \hat{j} + 0.15 \alpha \hat{i}$$

$$a_{Gx} = 0.15 \alpha \quad a_{Gy} = 0.065 \alpha$$

$$T_{AB} \sin 66.5713 = 0.25(9.81) + 20 \sin 45 + 0.18 T_{AB} \cos 66.5713 - 0.18 (20 \cos 45) + 0.18 (0.25(0.15 \alpha)) + 0.25 (0.065 \alpha)$$

$$0.18 (0.065) T_{AB} \cos 66.5713 - 0.18 (0.065) 20 \cos 45 + 0.25(0.18)(0.065)(0.15) \alpha - 40 \sin 45 (\frac{13.75}{400}) = \frac{1}{2}(0.25)(0.065)^2 \alpha$$

$$0.004652008 T_{AB} - 0.165462486 + 0.00043875 \alpha - 1.3 = 0.000528125 \alpha$$

$$0.004652008 T_{AB} - 1.465462486 = 0.000089375 \alpha$$

$$52.05043916 T_{AB} - 163.9678465 = \alpha$$

$$0.845986215 T_{AB} = 14.04905171 + 0.351340164 T_{AB} - 11.6783234 + 0.645461$$

$$-0.351173688 T_{AB} = -363.0770478 \quad T_{AB} = 1033.695467 \quad \text{Seems way too big, most likely error somewhere}$$

N_c	T_{AB}	a_{Gx}	a_{Gy}	α	constant
-1	$\cos 66.5713$	0.25	0	0	$20 \cos 45$
0.16	$\sin 66.5713$	0	0.25	0	$-0.25(9.81) - 20 \sin 45$
0.18(0.065)	0	0	0	$-\frac{1}{2}(0.25)(0.065)^2$	$40 \sin 45 (\frac{13.75}{400})$
0	0	-1	0	0.15	0
0	0	0	-1	0.065	0

$$N_c = -238.83961$$

$$T_{AB} = 166.07023$$

Also wrong
Definitely made error

$$a_{Gx} = -1162.9131 \alpha$$

$$a_{Gy} = -503.62905 \alpha$$

$$\alpha = -7752.75463 \alpha$$

CH17-DK-24 Beginner
Rotation (RBK) PDF

Inspiration: 17-67 Hibbeler



If the wire at B suddenly snaps, determine the reaction forces at A and the angular acceleration of the 200 kg beam if a force of 600N is applied at point C. Assume the beam is a slender rod.

$$I_A = \frac{1}{3}ml^2 + md^2 = \frac{1}{3}(200)^4 + (200)(2)^2 = \frac{3200}{3}$$

$$\sum F_x = ma_{Gx} = A_x \quad a_{Gx} = 0 \Rightarrow A_x = 0$$

$$\sum F_y = ma_{Gy} = A_y - F - mg$$

$$A_y = \vec{a}_A + \vec{\alpha} \times \vec{r}_{GA} - \omega^2 \vec{r}_{GA}$$

$$= 0 + \vec{\alpha} \times (-2 \hat{i}) - 0$$

$$= -2 \alpha \hat{j} \quad a_{Gy} = 0 \quad a_{Gy} = -11.8575$$

$$\sum M_A = I_A \alpha = 600(4) + 200(9.81)(2) = \frac{3200}{3} \alpha$$

$$\alpha = 5.92475$$

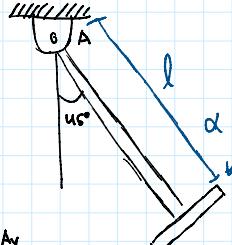
$$= 0 + \alpha \hat{k} \times (-2\hat{i}) - 0 \\ = -2\alpha \hat{j} \quad \alpha_{ox} = 0 \quad \alpha_{oy} = -11.9575$$

$$200(-11.9575) = A_y - 600 - 200(9.81)$$

$$A_y = 190.5$$

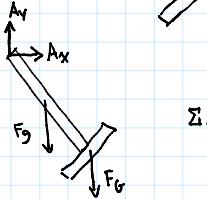
CH17-DK-25 Beginner Rotation (RBK) Homework

Inspiration: None



Kid engineers are developing the newest, state-of-the-art playground rides. If the maximum angular acceleration of the ride should not exceed 5 rad/s^2 , at what length on the rod should a 1 kg seat be attached if the seat can be modelled as a thin disk with radius 0.3 m ? The rod has a mass of 0.6 kg . Which seat location would kids enjoy more?

$$I_A = \frac{1}{3}ml^2 + \frac{1}{4}mr^2 + md^2 \\ = \frac{1}{3}(0.6)l^2 + \frac{1}{4}(1)(0.3)^2 + (1)l^2$$



$$\sum M_A = I_A \alpha = [\frac{1}{3}(0.6)l^2 + \frac{1}{4}(1)(0.3)^2 + l^2] \alpha = -\frac{l}{2} \sin 45 (0.6)(9.81) - l \sin 45 (1)(9.81)$$

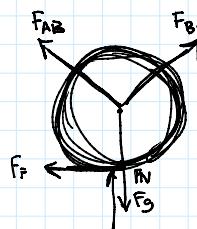
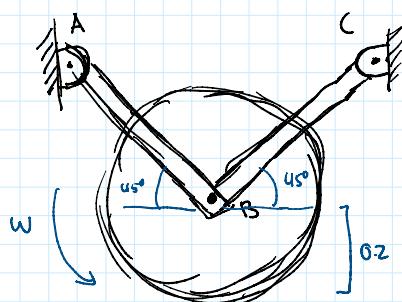
$$-6l^2 - 0.1125 + 0.01773274l = 0 \quad l = 0.0125907 \text{ or } 1.44037$$

CH17-DK-26 Intermediate Rotation (RBE) PDF

Inspiration: 17-75 Hibbeler

maybe change to Beginner

Students in the ROVER competition test out their chassis frame. Originally, the wheel spins at 15 rad/s , and has a radius of gyration of $k_g = 0.2 \text{ m}$ and a mass of 15 kg . If the wheel contacts the ground with a kinetic coefficient of friction of $\mu_k = 0.4$, determine the reaction forces exerted on links AB and BC. Neglect the mass of the links.



$$\sum F_x = m a_{ox} = 0 = -F_{AB} \cos 45 + F_{BC} \cos 45 - 0.4 F_N$$

$$\sum F_y = F_{AB} \sin 45 + F_{BC} \sin 45 - F_g - F_N = 0$$

$$\sum M_B = J_B \alpha = 0.4 F_N (0.2) \quad 0.6 \alpha = 0.08 F_N$$

$$I_B = m k_g^2 = 15(0.2)^2 = 0.6$$

$$0.6(15) = 0.08 F_N \quad F_N = 112.5$$

$$45 + F_{AB} \cos 45 = F_{BC} \cos 45$$

$$F_{BC} = 215.42$$

$$F_{AB} \sin 45 + 112.5 + F_{AB} \cos 45 - 15(9.81) - 112.5 = 0$$

$$F_{AB} = 151.7904706$$