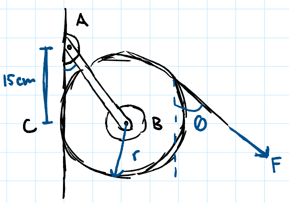
20-R-KIN DK23-26

June 2, 2020 9:25 AM

CH17-DK-23 Intermediate Rotation Homework CHECK INCOMPLETE

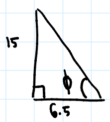
Inspiration: 17-69 Hibbeler ← maybe Advanced

To Be Edited

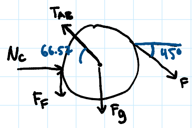


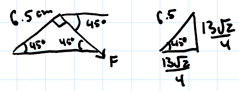
You were able to obtain a roll of toilet paper during quarantine and put it to good use. If the roll rests against a wall where its coefficient of friction is $\mu_k = 0.18$ and you apply a force of 20 N at an angle of 45° tangent to the roll, determine the angular acceleration of the precious toilet paper. Assume the roll can be treated as a cylinder with a mass of 0.25 kg, a width of 11.5 cm, and a radius of 6.5 cm.

30 – 45°
10 – 30 N
0.2 kg – 0.25 kg



$\phi = \tan^{-1}\frac{15}{6.5} = 66.5713°$





$\sum F_x = m a_{Gx} = 0.25 a_{Gx} = N_C - T_{AB}\cos 66.5713 + F\cos 45$

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

$\sum M_A = \sum M_G = I_A \alpha = \mu_k N_C (0.065) - F\sin 45 \left(\frac{13\sqrt{2}}{4} \div 100\right) - F\cos 45 \left(\frac{13\sqrt{2}}{4} \div 100\right) = \frac{1}{2}(0.25)(0.065)^2 \alpha$

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

$N_C = T_{AB}\cos 66.5713 - 20\cos 45 + 0.25 a_{Gx}$ $\quad 0.18 N_C (0.065) - 20\sin 45\left(\frac{13\sqrt{2}}{400}\right) - 20\cos 45\left(\frac{13\sqrt{2}}{400}\right) = \frac{1}{2}(0.25)(0.065)^2 \alpha$

$a_B = \vec{a}_A + \vec{\alpha} \times \vec{r}_{BA} - \omega^2 \vec{r}_{B/A}$ $\quad a_B = 0 + \alpha\hat{k} \times (0.065\hat{i} - 0.15\hat{j}) = 0.065\alpha\hat{j} + 0.15\alpha\hat{i}$

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

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

$0.18(0.065) T_{AB}\cos 66.5713 - 0.18(0.065) 20\cos 45 + 0.25(0.18)(0.065)(0.15)\alpha - 40\sin 45\left(\frac{13\sqrt{2}}{400}\right) = \frac{1}{2}(0.25)(0.065)^2\alpha$

$0.004652008 T_{AB} - 0.165462986 + 0.00043875\alpha - 1.3 = 0.000528125\alpha$

$0.004652008 T_{AB} - 1.465462986 = 0.000089375\alpha$

$52.05043916 T_{AB} - 16396.78865 = \alpha$

$0.845986215 T_{AB} = 14.04405121 + 0.351340464 T_{AB} - 110.6783234 + 0.84581$

$-0.351173085 T_{AB} = -363.0770878$ $\quad T_{AB} = 1033.895467$ Seems way too big, most likely error somewhere

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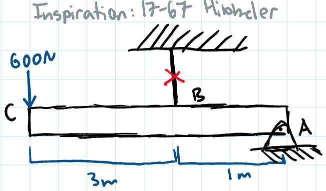
N_C	T_{AB}	a_{Gx}	a_{Gy}	α	constant
-1	$\cos 66.5713$	0.25	0	0	$20\cos 45$
0.18	$\sin 66.5713$	0	0.25	0	$-0.25(9.81) - 20\sin 45$
$0.18(0.065)$	0	0	0	$-\frac{1}{2}(0.25)(0.065)^2$	$40\sin 45\left(\frac{13\sqrt{2}}{400}\right)$
0	0	-1	0	0.15	0
0	0	0	-1	0.065	0

$N_C = -238.83961$
$T_{AB} = 166.07033$
$a_{Gx} = -1162.91319$
$a_{Gy} = -503.62905$
$\alpha = -7752.75463$

Also wrong
Definitely made error

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.

$I_A = \frac{1}{12} m l^2 + m d^2 = \frac{1}{12}(200)4^2 + (200)(2^2) = \frac{3200}{3}$

$\sum F_x = m a_{Gx} = A_x \quad a_{Gx} = 0 \Rightarrow \boxed{A_x = 0}$ ✓

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

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

$\boxed{\alpha = 5.92875}$

$a_G = \vec{a}_A + \vec{\alpha} \times \vec{r}_{G/A} - \omega^2 \vec{r}_{G/A}$

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

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

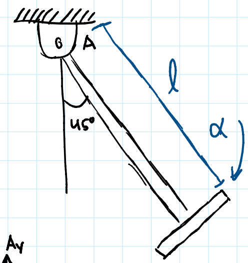
$= 0 + \alpha\hat{k} \times (-2\hat{i}) - 0$

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

$200(-11.8575) = A_y - 600 - 200(9.81) \qquad \boxed{A_y = 190.5}$

CH17-DK-25 Beginner Rotation (RBK) Homework

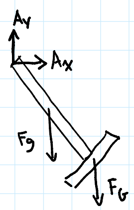
Inspiration: None



Kid engineers are developing the newest, state-of-the-art playground rides. If the maximum angular acceleration of the rode should not exceed 5 rad/s², 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

$I_A = \frac{1}{3}ml^2 + \frac{1}{4}mr^2 + md^2$

$= \frac{1}{3}(0.6)l^2 + \frac{1}{4}(1)(0.3)^2 + (1)\,l^2$



-5 don't forget

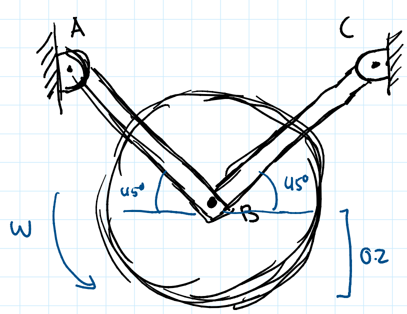
$\Sigma M_A = I_A\alpha = [\frac{1}{3}(0.6)l^2 + \frac{1}{4}(1)(0.3)^2 + l^2]\alpha = -\frac{l}{2}\sin 45\,(0.6)(9.81) - l\sin 45(1)(9.81)$

$-6l^2 - 0.1125 + 9.0177327\,l = 0 \qquad l = 0.0125907 \text{ or } 1.49037$

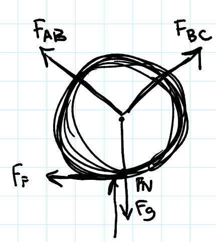
CH17-DK-26 Intermediate Rotation (RBK) PDF

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/s², and has a radius of gyration of $k_B = 0.2$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.



$\Sigma F_x = ma_{Gx} = 0 = -F_{AB}\cos 45 + F_{BC}\cos 45 - 0.4F_N$

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

$\Sigma M_B = I_B\alpha = 0.4F_N(0.2) \qquad 0.6\alpha = 0.08F_N$

$I_B = mk_B^2 = 15(0.2)^2 = 0.6 \qquad 0.6(15) = 0.08F_N \qquad F_N = 112.5$

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

$F_{BC} = 215.42 \qquad F_{AB} = 151.7804706$
