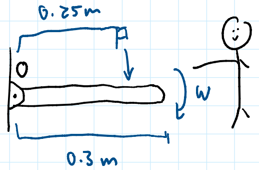
20-R-KIN DK20-22

June 1, 2020 10:07 AM

CH17-DK-20 Beginner Rotation (RBK) Homework

CHECK: Answer seems off (ang. accel)

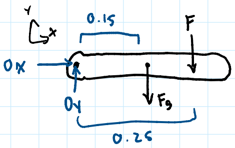
Inspiration: Hibbeler pg. 445



Kronk is asked to pull the lever. He applies a force of 40 N, causing the 10 kg lever to have an angular velocity of 3 rad/s. Determine the angular acceleration of the lever and the reaction forces at O. Assume the lever is a slender rod

$\alpha = ?$ $O_x = ?$ $O_y = ?$

The lever was originally propped up to be level horizontally and the prop was removed at the instant Kronk applied the force.



$\Sigma F_x = O_x = m a_{Gx}$ $\Sigma F_y = O_y - F_g - F = m a_{Gy}$

$\Sigma M_G = -O_y(0.15) - F(0.1) = I_G \alpha = \frac{1}{12}(10)(0.3)^2 \alpha$

$a_G = \vec{a}_O + \vec{\alpha} \times \vec{r}_{G/O} - \omega^2 \vec{r}_{G/O}$
$= 0 + \alpha \hat{k} \times (0.15\hat{i}) - 9(0.15\hat{i})$
$= 0.15\alpha\hat{j} - 1.35\hat{i}$

$a_{Gx} = -1.35$
$a_{Gy} = 0.15\alpha$

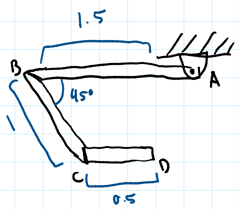
$O_x = 10(-1.35) = \boxed{-13.5\ N}$

$O_y - 10(9.81) - 40 = 10(0.15)\alpha$
$O_y = 1.5\alpha + 138.1$
$O_y = -30 O_y - 80 + 138.1$
$40 O_y = 58.1$ $\boxed{O_y = 14.525}$

$-0.15 O_y - 4 = 0.075\alpha$
$-2 O_y - \frac{160}{3} = \alpha$
$\boxed{\alpha = -82.3833\ rad/s^2}$

CH17-DK-21 Intermediate Rotation (RBK) Video

Inspiration: Hibbeler 17-60

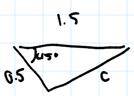


3 slender rods with equal mass are welded together. If the assembly is released from rest, what are the reaction forces at A and the angular acceleration of the rods? The rods have a mass of 2 kg each.

Two ways to solve → Find CoG of assembly then use I_G

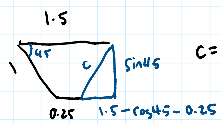
Chose to find I_A because I thought it was simpler

$\Sigma M_P = I_P \alpha$ $\Sigma M_A = I_A \alpha$



$c^2 = 0.5^2 + 1.5^2 - 2(0.5)(1.5)\cos 45$

$c = 1.19472487$



$c = 0.891478012$

$I_A = \underbrace{\frac{1}{12}(2)(1.5^2) + (2)(0.75)^2}_{AB} + \underbrace{\frac{1}{12}(2)(1^2) + (2)(1.19472)^2}_{BC} + \underbrace{\frac{1}{12}(2)(0.5)^2 + (2)(0.891478012)^2}_{CD}$

$= 11.27540632$

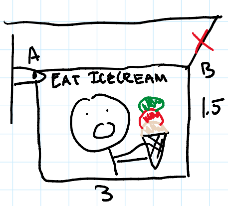
$\Sigma M_A = F_{GAB}(0.75) + F_{GBC}(1.5 - 0.5\cos 45) + F_{GCD}(1.5 - 0.5\cos 45 - 0.25)$

$= 2(9.81)(0.75) + 2(9.81)(1.5 - 0.5\cos 45) + 2(9.81)(1.5 - 0.5\cos 45 - 0.25) = 11.27540632\,\alpha$

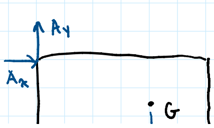
$\boxed{\alpha = 4.859656227\ rad/s^2}$

CH17-DK-22 Intermediate Rotation (RBK) Video

Inspiration: 7.4.1 Example, 17-58



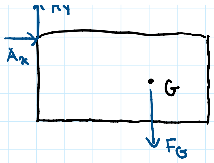
An advertisement can be modelled as a thin plate with density distribution $\rho = 50x$. If the supporting wire at B suddenly snaps, what is the angular acceleration of the advertisement and the reaction forces at A at that instant



Find Center of gravity: $\rho = 50x$ By symmetry $\bar{y} = \frac{1.5}{2} = 0.75$

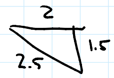
$\bar{x} = \frac{\int x\, dm}{\int dm}$ $dm = \rho dA = \rho y\, dx = 50xy\, dx$ $\bar{x} = \frac{\int x \cancel{50} x \cancel{y} dx}{\int \cancel{50} x \cancel{y} dx}$

$\bar{x} = \int_0^3 x^2\, dx = \frac{x^3}{3}\Big|_0^3 = \frac{2}{?}x\Big|^3 = 2$



$\int dm$ $\quad$ $\int \cancel{50} x \cancel{y}\, dx$

$$\bar{x} = \frac{\int_0^3 x^2\, dx}{\int_0^3 x\, dx} = \frac{\frac{x^3}{3}\Big|_0^3}{\frac{x^2}{2}\Big|_0^3} = \frac{2}{3}x\Big|_0^3 = 2$$



$m = \rho y x = (50x)yx = 50(3^2)(1.5) = 675$ kg

$\sum M_A = F_G(2) = I_A \alpha$ $\quad$ $675(9.81)(2) = \left[\frac{1}{12}(675)(3^2+1.5^2) + 675(2.5^2)\right]\alpha$

$13243.5 = 4851.5625\alpha$ $\quad$ $\boxed{\alpha = 2.72973913}$

$\sum F_x = 675 a_{Gx} = A_x$ $\quad$ $\sum F_y = A_y - (675)(9.81) = 675 a_{Gy}$

$a_G = a_A + \vec{\alpha} \times \vec{r_{G/A}} - w^2 \vec{r_{G/A}}$ $\quad$ $w^2 = 0 \Rightarrow$ started from rest $\quad$ $a_A = 0$ pinned

$a_G = \alpha \hat{k} \times (2\hat{i} - 1.5\hat{j}) = 2\alpha j + 1.5\alpha \hat{i}$

$a_{Gx} = 1.5\alpha = 4.094608696$

$a_{Gy} = 2\alpha = 5.459478261$

$\boxed{A_x = 2763.86087}$

$\boxed{A_y = 10306.89783}$