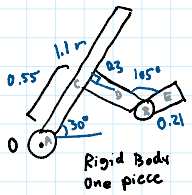
20-R-KIN DK12-16

May 28, 2020 9:48 AM

NEW NAMING SCHEME

## Ch17 - DK - 12 Intermediate Radius of Gyration Homework Check PIs

Inspiration: None




Given inertia, find density → mass → radius of gyration

A procrastinating engineer puts together a form study prototype of a robotic arm to show a group of stakeholders. Specifically, they want to know about its radius of gyration. Unfortunately, he forgot what material he used. If the mass moment of inertia of the arm is 15.2 about point O, calculate the radius of gyration. The width of the rectangular plate is w = 15 cm and the radius of the circular plate is r = 2w. Each plate has a thickness of 5 mm

Disk A: $I_{zz} = \frac{1}{2}mr^2$ $m = \rho V = \rho\pi r^2 h = \rho\pi(0.3)^2(0.005)$

$= \frac{1}{2}\rho\pi(0.3)^4(0.005)$

Plate C: $m = \rho V = \rho(1.1 \times 0.15 \times 0.005) = 0.000825\rho$

$I_{zz} = \frac{1}{12}m(a^2+b^2)$

$I_{OC} = \frac{1}{12}(0.000825\rho)(1.1^2+0.15^2) + 0.000825\rho(0.55)^2$

Plate D: 


$m = \rho V = \rho(0.3 \times 0.15 \times 0.005) = 0.000225\rho$

$I_{OD} = \frac{1}{12}(0.000225\rho)(0.3^2+0.15^2) + 0.000225\rho\left(\frac{13}{40}\right)$

Disc B: $m = \rho V = \rho\pi(0.3)^2(0.005)$

$I_{OB} = \frac{1}{2}\rho\pi(0.3)^4(0.005)$

$+\rho\pi(0.3)^2(0.005)(53/80)$

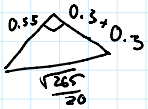
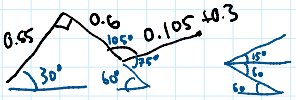



Plate E:




x: $0.55\cos30 + 0.6\cos60 + 0.405\cos15$

y: $0.55\sin30 + 0.6\sin60 + 0.405\sin60$

$d^2 = 2.67404728073$

$m = \rho V = \rho(0.21 \times 0.15 \times 0.005)$

$= 0.0001575\rho$

$I_{OE} = \frac{1}{12}(0.0001575\rho)(0.21^2+0.15^2) + 0.0001575\rho(2.67404728073)$

$I = I_{OA} + I_{OB} + I_{OC} + I_{OD} + I_{OE}$

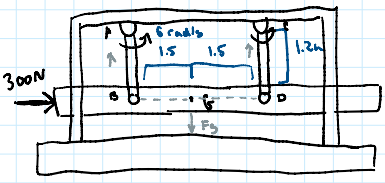
$15.2 = 0.0016845528\rho$ $\rho = 8018.872379$

$m = 32.3556154$ kg $k = \sqrt{\frac{I}{m}} = \boxed{0.6854}$

---

## CH17 - DK - 13 Beginner Translation (RBK) Video

Inspiration: F17-5 Hibbeler




A group of engineering peasants, with the help of Sir Bedevere the Wise, have constructed a stationary battering ram in attempts to siege the castle of Santa Ana. Determine the tension developed in the linkages AB and CD and the angular acceleration if the 400 kg log is subject to a horizontal force of 300 N and both linkages have an angular velocity of $\vec{\omega} = 6$ rad/s. Assume the mass of the linkages are negligible.

$\sum F_x = 300 = m_{log}a_x$ $\sum F_y = F_{AB} + F_{CD} - F_g = m_{log}a_y$ $\sum M_G = 0 = F_{CD}(1.5) - F_{AB}(1.5)$

$F_{AB} = F_{CD}$

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

$= 0 + \alpha\hat{k}\times -1.2\hat{j} - 36(-1.2\hat{j})$

$= 1.2\alpha\hat{i} + 43.2\hat{j}$

Rigid body the entire log undergoes this acceleration

$a_x = 1.2\alpha$ $a_y = 43.2$

$300 = 400(1.2)\alpha$ $\boxed{\alpha = \frac{5}{2}\ rad/s^2}$ $2F_{AB} - (400)(9.81) = 400(43.2)$ $\boxed{F_{CD} = 10602\ N,\ F_{AB} = 10602\ N}$

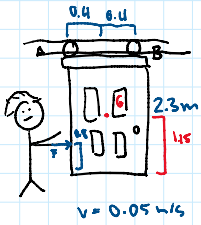
---

## CH17 - DK - 14 Beginner Translation (RBK) Video

Inspiration: 17-24 Hibbeler


An engineering student gets a co-op at a door factory

Inspiration: 17-24 Hibbeler




An engineering student gets a co-op at a door factory one by pushing on its side with a horizontal force of 200 N. If the door has a mass of 16 kg, how far would it travel in 5 seconds? What are the reaction forces at A and B?

$\sum F_x = m a_{Gx} = 200$

$= 16\, a_{Gx} = 200 \quad a_{Gx} = 12.5$

$\sum F_y = 16\, a_{Gy} = F_A + F_B - (16)(9.81) = 0$

$\sum M_A = F_B(0.8) + F(1.5) - (16)(9.81)(0.4) = 0$

$F_B(0.8) = 32.784$ $\quad$ $F_B = 40.98$

$F_A = 115.98$

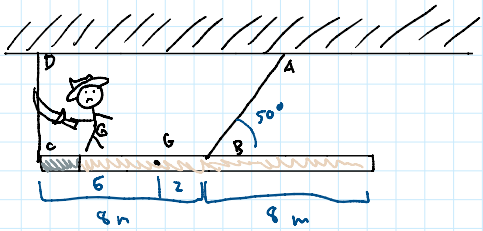
$s = s_0 + v_0 t + \frac{1}{2} a_G t^2 \qquad s = (0.05)(5) + \frac{1}{2}(12.5)(5)^2$

$= 156.5$ m

---

CH17-DK-15 Intermediate Translation (RBK) Video maybe relabel, might not be considered in the correct MM section

Inspiration: 8.5.3 Example 3 (Mech Notes) Maybe advanced Check




In his new movie, Montana James makes a daring escape by cutting wire CD on a platform. What would be the angular acceleration of the bar and the tension in the cable AB immediately after Montana James snaps the wire. The platform has a mass of 12 kg has a center of gravity at G, and can be considered a slender rod.

Comment: The steel and wood were highlighted so students wouldn't be confused why the center of gravity of the platform was to the left, not in the middle

$\sum F_x = F_{AB}\cos 50 = m a_{Gx}$

$\sum F_y = F_{AB}\sin 50 - mg = m a_{Gy}$

$\sum M_G = \vec{r}_{B/G} \times \vec{F}_{AB} = (2\hat{i}) \times (F_{AB}\cos 50\, \hat{i} + F_{AB}\sin 50\, \hat{j}) = I_G \alpha$

$= 2 F_{AB}\sin 50\, \hat{k} = I_G \alpha \hat{k}$

$\vec{a}_B = \vec{a}_A + \vec{\alpha}_{AB} \times \vec{r}_{B/A} - \omega_{AB}^2 r_{B/A}$ ($\vec{a}_A$ and $\omega_{AB}^2 r_{B/A}$ are 0) $= \alpha_{AB}\hat{k} \times (-r_{B/A}\cos 50\, \hat{i} - r_{B/A}\sin 50\, \hat{j})$

$= -\alpha_{AB} r_{B/A}\cos 50\, \hat{j} + \alpha_{AB} r_{B/A}\sin 50\, \hat{i}$

$\alpha_{AB} r_{B/A} = a_B$ $\qquad \alpha\hat{k} \times (-2\hat{i})$

$\vec{a}_G = \vec{a}_B + \vec{\alpha} \times \vec{r}_{G/B} - \omega^2 r_{G/B}$ ($\omega^2 r_{G/B}$ is 0)

$= -a_B\cos 50\, \hat{j} + a_B \sin 50\, \hat{i} - 2\alpha\, \hat{j}$

$a_{Gx} = a_B \sin 50 \qquad a_{Gy} = -a_B\cos 50 - 2\alpha$

$F_{AB}\cos 50 = 12\, a_B \sin 50 \qquad F_{AB}\sin 50 - (12)(9.81) = 12(-a_B\cos 50 - 2\alpha) \qquad 2F_{AB}\sin 50 = \frac{1}{12}(12)16^2\alpha$

$F_{AB} = \frac{12\, a_B \sin 50}{\cos 50}$

$F_{AB} = 89.36940417$

$\frac{12 a_B \sin 50}{\cos 50}\sin 50 - (12)(9.81) = -12 a_B\cos 50 - 4\left(\frac{12 a_B \sin 50}{16^2\cos 50}\right)\sin 50 \qquad 2\left(\frac{12 a_B \sin 50}{16^2\cos 50}\right)\sin 50 = \alpha$

$19.63946146\, a_B = 117.72$

$a_B = 6.248$

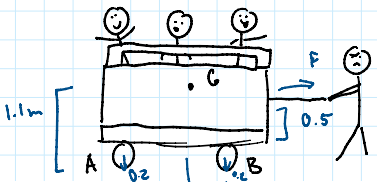
$\alpha = 0.5\,3047911211$

$a_{Gx} = 4.786\,59 \qquad a_{Gy} = 5.066\,01097$

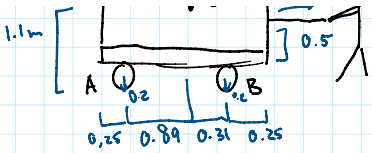
---

Ch17-DK-16 Beginner Translation (RBK) Homework

Inspiration: 17-34 Hibbeler



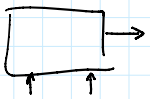

You are forced to pull a group of kindergarteners in a cart If you apply a horizontal force of 600N, determine the normal force on its wheels. The cart weighs a total of 160 kg and has a center of mass at G. Assume the wheels have negligible mass.




If you apply a horizontal force of 600N, determine the normal force on its wheels. The cart weighs a total of 160 kg and has a center of mass at G. Assume the wheels have negligible mass.

$\sum F_x = 160\, a_{Gx} = 600 \qquad a_{Gx} = 3.75$

$\sum F_y = N_A + N_B - (160)(9.81) = 0$



$\sum M_A = -160(9.81)(0.89) + N_B(1.2) - 600(0.9) = -(160)(3.75)(1.1)$

$N_B = 1064.12$

$N_A = 505.44$