20-R-KIN DK12-16

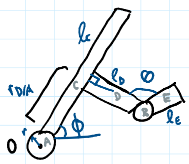
May 28, 2020 9:48 AM

NEW NAMING SCHEME

20-R-KIN-DK-12 Intermediate Radius of Gyration Homework Check Pls

Inspiration: None

Reworded



An 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 ***I = 15.2 kgm^2*** about point O, calculate the radius of gyration. Each component is a plate with thickness ***t = 5mm***. Assume the plates are rigidly attached to one another.
Plate A is identical to plate B, and has a radius ***r = 2w***.
Plates C, D, and E have the same width ***w = 15 cm***.
Plate C has a length ***l_C = 1.1 m***, and is angled at phi = 30 degrees with the horizontal.
Plate D is attached perpendicular to plate C at a distance ***r_D/A = 0.55 m*** from plate A, and has a length ***l_D = 0.3 m***
Plate E has a length ***l_E = 0.21 m***, and is angled theta = 105 degrees away from plate D.

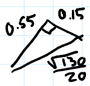
Disk A: $I_{zz} = \frac{1}{2} m r^2 = \frac{1}{2}\rho\pi(0.3)^4(0.005)$ $\quad m = \rho V = \rho\pi r^2 h = \rho\pi(0.3)^2(0.005)$

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

$I_{OB} = \frac{1}{2}\rho\pi(0.3)^4(0.005) + \rho\pi(0.3)^2(0.005)(53/80)$

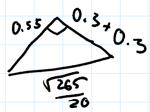
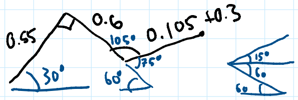


Plate E:



x: $0.55\cos 30 + 0.6\cos 60 + 0.405\cos 15$

y: $0.55\sin 30 + 0.6\sin 60 + 0.405\sin 60$

$d^2 = 2.674428073$

$m = \rho V = \rho(0.21 \times 0.15 \times 0.005) = 0.0001575\rho$

$I_{OE} = \frac{1}{12}(0.0001575\rho)(0.21^2+0.15^2) + 0.0001575\rho(2.674428073)$

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

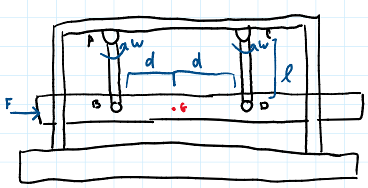
$15.2 = 0.001895528\rho$ $\quad \rho = 8018.872379$

$m = 32.3556159\ kg$ $\quad k = \sqrt{\frac{I}{m}} = \boxed{0.6854}$

20-R-KIN-DK-13 Beginner Translation (RBK) Video

Inspiration: F17-5 Hibbeler

Reworded



A group of engineering peasants have constructed a stationary battering ram in attempts to siege the castle of Santa Ono. Determine the tension developed in the linkages AB and CD as well as 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 ***omega = 6 rad/s***. Assume the mass of the linkages are negligible.
Links AB and CD have a length ***l = 1.2 m*** and are an equal distance ***d = 1.5 m*** away from the center of gravity of the log.

der acceleration

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

$F_{AB} = F_{CD}$

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

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

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

Rigid body thus entire log undergoes this acceleration

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

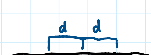
$300 = 400(1.2)\alpha$ $\quad \boxed{\alpha = \frac{5}{8}\ rad/s^2}$

$2F_{AB} - (400)(9.81) = 400(43.2)$ $\quad \boxed{F_{CD} = 10602\ N \quad F_{AB} = 10602\ N}$

20-R-KIN-DK-14 Beginner Translation (RBK) Video

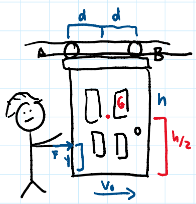
Inspiration: 17-24 Hibbeler

Reworded



An engineering student gets a co-op job at a door factory. They transport a door by pushing one on its side with a horizontal force of ***F = 200 N***. If the door has a mass of ***m = 16 kg*** and initial velocity ***v_o = 0.05 m/s***, how far would it travel in ***t = 5 seconds***? What are the reaction forces

Inspiration: 17-24 Hibbeler



Reworded

An engineering student gets a co-op job at a door factory. They transport a door by pushing one on its side with a horizontal force of ***F = 200 N***. If the door has a mass of ***m = 16 kg*** and initial velocity ***v_o = 0.05 m/s***, how far would it travel in ***t = 5 seconds***? What are the reaction forces at A and B?
The center of gravity is an equal distance ***d = 0.4 m*** away from rollers A and B.
The door has a height ***h = 2.3 m*** and the center of gravity is found at h/2.
The student applies the force at a height ***y = 0.8 m*** from the bottom of the door.

$$\sum F_x = m a_{Gx} = 200$$
$$= 16 a_{Gx} = 200 \qquad a_{Gx} = 12.5$$

$$\sum F_y = 16 a_{Gy} = F_A + F_B - (16)(9.81) = 0$$
$$\sum M_A = F_B(0.8) + F(1.5) - (16)(9.81)(0.4) = 0$$
$$F_B(0.8) = 32.784 \qquad \boxed{F_B = 40.98}$$
$$\boxed{F_A = 115.98}$$

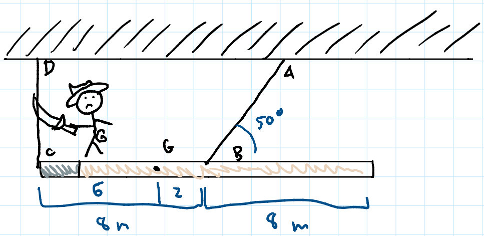
$$s = s_0 + v_0 t + \tfrac{1}{2} a_G t^2 \qquad s = (0.05)(5) + \tfrac{1}{2}(12.5)(5)^2$$
$$= \boxed{156.5 \text{ m}}$$

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

Redone in separate PDF, solution updated



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.

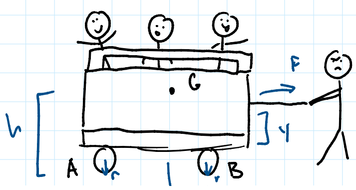
Comment: The steel and wood were highlighted so students wouldn't be confused why the center of gravity of the platform was to the left, not in the middle

$$\sum F_x = F_{AB}\cos 50 = m a_{Gx}$$
$$\sum F_y = F_{AB}\sin 50 - mg = m a_{Gy}$$
$$\sum M_G = \vec{r}_{B/G} \times \vec{F}_{AB} = (2\hat{i}) \times (F_{AB}\cos 50\,\hat{i} + F_{AB}\sin 50\,\hat{j}) = I_G \alpha$$
$$= 2F_{AB}\sin 50\,\hat{k} = I_G \alpha \hat{k}$$
$$\vec{a}_B = \cancel{\vec{a}_A}^{\,0} + \vec{\alpha}_{AB} \times \vec{r}_{B/A} - \cancel{\omega_{AB}^2 r_{B/A}}^{\,0} = \alpha_{AB}\hat{k} \times (-r_{B/A}\cos 50\,\hat{i} - r_{B/A}\sin 50\,\hat{j})$$
$$= \underbrace{-\alpha_{AB} r_{B/A}\cos 50}_{a_B}\,\hat{j} + \underbrace{\alpha_{AB} r_{B/A}\sin 50}_{a_B}\,\hat{i}$$
$$\vec{a}_G = \vec{a}_B + \alpha \times \vec{r}_{G/B} - \cancel{\omega^2 r_{G/B}}^{\,0} \qquad \alpha\hat{k} \times (-2\hat{i})$$
$$= -a_B\cos 50\,\hat{j} + a_B \sin 50\,\hat{i} - 2\alpha\,\hat{j}$$
$$a_{Gx} = a_B \sin 50 \qquad a_{Gy} = -a_B\cos 50 - 2\alpha$$

$$F_{AB}\cos 50 = 12 a_B \sin 50 \qquad F_{AB}\sin 50 - (12)(9.81) = 12(-a_B\cos 50 - 2\alpha) \qquad 2F_{AB}\sin 50 = \tfrac{1}{12}(12)16^2\alpha$$
$$F_{AB} = \frac{12 a_B \sin 50}{\cos 50} \qquad \frac{12 a_B \sin 50}{\cos 50}\sin 50 - (12)(9.81) = -12a_B\cos 50 - 4\left(\frac{12 a_B \sin 50}{16^2 \cos 50}\right)\sin 50 \qquad 2\left(\frac{12 a_B \sin 50}{16^2 \cos 50}\right)\sin 50 = \alpha$$
$$\boxed{F_{AB} = 89.35940417} \qquad 18.63986146\, a_B = 117.72 \qquad \boxed{\alpha = 0.534791211}$$
$$a_B = 6.248$$
$$a_{Gx} = 4.78659 \qquad a_{Gy} = 5.086\,01097$$

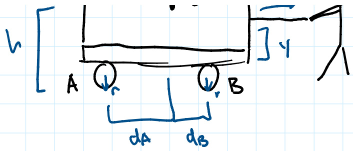
20-R-KIN-DK-16 Beginner Translation (RBK) Homework

Inspiration: 17-34 Hibbeler



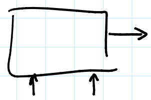
Reworded

You are forced to pull a group of kindergarteners in a cart. If you apply a horizontal force of ***F = 600 N***, determine the normal force on its wheels. The cart has a total mass of ***m = 160 kg*** and has a center of mass at G. Assume the wheels have negligible mass.
Wheel A is located ***0.25 m*** from one end of the cart and is a horizontal distance of ***d_A = 0.89 m*** from G.
Wheel B is located ***0.25 m*** from one end of the cart is a horizontal distance of ***d_B = 0.39 m***.
You apply the horizontal force at a height ***y = 0.5 m*** from the bottom of the cart.
The center of gravity G is located at a height ***h = 1.1 m*** from the ground.



Wheel B is located ***0.25 m*** from one end of the cart is a horizontal distance of ***d_B = 0.39 m***.
You apply the horizontal force at a height ***y = 0.5 m*** from the bottom of the cart.
The center of gravity G is located at a height ***h = 1.1 m*** from the ground.

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



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

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

$N_B = 1064.12$

$N_A = 505.44$