20-R-KIN-DK-15

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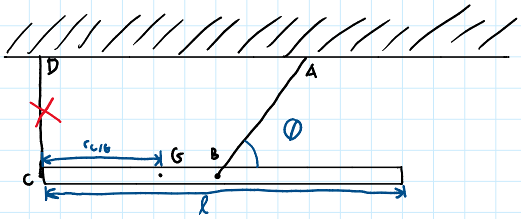
20-R-KIN-DK-15 Intermediate

Inspiration: 8.5.3 Example 3 (Mech Notes)



In his new movie, Montana James makes a daring escape by cutting wire CD on a platform. The wire is actually a prop cable that instantly snaps when triggered, and the footage is to be edited such that it looks as if Montana James cuts the wire in one swift motion. Before they film the scene, they do a test run without Montana James to ensure everything works properly. If the platform has a mass of ***m = 12 kg*** and has a center of gravity at G, what would be the angular acceleration of the platform and the tension in the cable AB immediately after the wire is snapped? Assume the platform can be considered a slender rod.

The platform has a length of ***l = 16 m*** and wire AB is connected at exactly half of its length.

The center of gravity G is found a horizontal distance ***r_G/C = 6 m*** from C.

The angle is given as ***theta = 50 degrees***.

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

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

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

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

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

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

$$\vec{a}_G = \vec{a}_B + \alpha \times \vec{r}_{G/B} - \cancel{\omega^2 r_{G/B}}^{\,0} \qquad \alpha\hat{k} \times (-2\hat{i})$$

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

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

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

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

$$\boxed{F_{AB} = 81.239958\ N}$$

$$F_{AB}\sin 50 - (12)(9.81) = 12(-a_B\cos 50 - 2\alpha)$$

$$\frac{12\,a_B\sin 50}{\cos 50}\sin 50 - (12)(9.81) = -12a_B\cos 50 - 48\left(\frac{12\,a_B\sin 50}{16^2\cos 50}\right)\sin 50$$

$$20.7227\,a_B = 117.72$$

$$a_B = 5.6807$$

$$2F_{AB}\sin 50 = \frac{1}{12}(12)\,16^2\alpha$$

$$2\left(\frac{12\,a_B\sin 50}{16^2\cos 50}\right)\sin 50 = \alpha$$

$$\boxed{\alpha = 0.48619\ rad/s^2}$$