

# MECH230 - Fall 2024

## Recommended Problems - Set 17

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[RB Kinetics](#) Recall that for a rigid body the BoLM is

$$\mathbf{F} = m\mathbf{a}_C, \quad (1)$$

and the BoAM can be written in three equivalent forms

$$\mathbf{M}^O = \dot{\mathbf{H}}^O \quad \text{about a fixed point } O, \quad (2)$$

$$\mathbf{M}^C = \dot{\mathbf{H}}^C \quad \text{about the center of mass } C, \quad (3)$$

$$\mathbf{M}^P = \dot{\mathbf{H}}^P + (\mathbf{v}_P - \mathbf{v}_C) \times \mathbf{G} = \dot{\mathbf{H}}^C + (\mathbf{r}_C - \mathbf{r}_P) \times m\mathbf{a}_C \quad \text{about any material point } P \text{ on the body.} \quad (4)$$

To calculate the right-hand side of the BoAM for the case  $\boldsymbol{\omega} = \dot{\theta}\mathbf{E}_z$ , we have

$$\dot{\mathbf{H}}^O = (I_{xz}^O\dot{\omega} - I_{yz}^O\omega^2)\mathbf{e}_x + (I_{yz}^O\dot{\omega} + I_{xz}^O\omega^2)\mathbf{e}_y + I_{zz}^O\dot{\omega}\mathbf{E}_z, \quad (5)$$

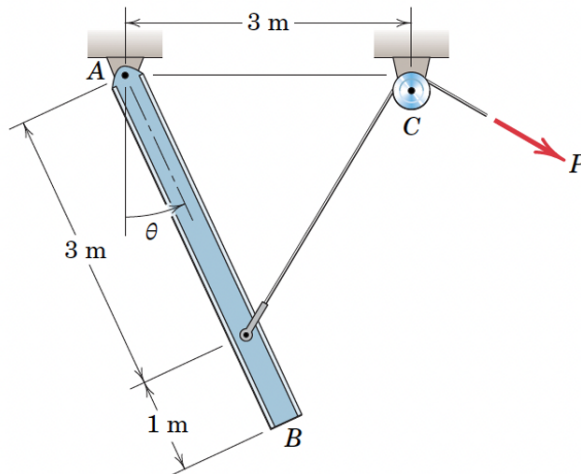
$$\dot{\mathbf{H}}^C = (I_{xz}^C\dot{\omega} - I_{yz}^C\omega^2)\mathbf{e}_x + (I_{yz}^C\dot{\omega} + I_{xz}^C\omega^2)\mathbf{e}_y + I_{zz}^C\dot{\omega}\mathbf{E}_z, \quad (6)$$

$$\dot{\mathbf{H}}^P = (I_{xz}^P\dot{\omega} - I_{yz}^P\omega^2)\mathbf{e}_x + (I_{yz}^P\dot{\omega} + I_{xz}^P\omega^2)\mathbf{e}_y + I_{zz}^P\dot{\omega}\mathbf{E}_z. \quad (7)$$

These problems are taken from J. L. Meriam, L. G. Kraige, and J. N. Bolton (MKB), Engineering Mechanics: Dynamics, Ninth Edition, Wiley, New York, 2018.

1. [MKB 06-029]

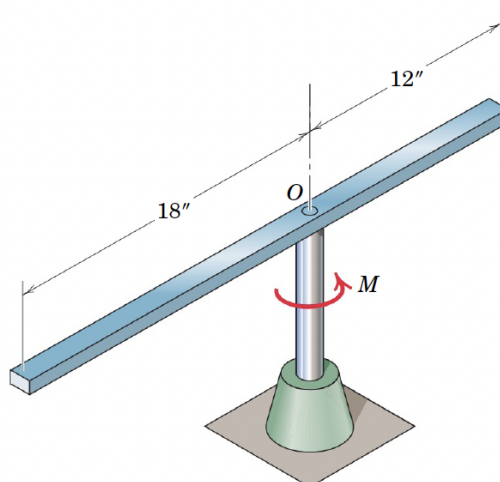
**6/29** The uniform 100-kg beam is freely hinged about its upper end  $A$  and is initially at rest in the vertical position with  $\theta = 0$ . Determine the initial angular acceleration  $\alpha$  of the beam and the magnitude  $F_A$  of the force supported by the pin at  $A$  due to the application of the force  $P = 300$  N on the attached cable.



**PROBLEM 6/29**

2. [MKB 06-035]

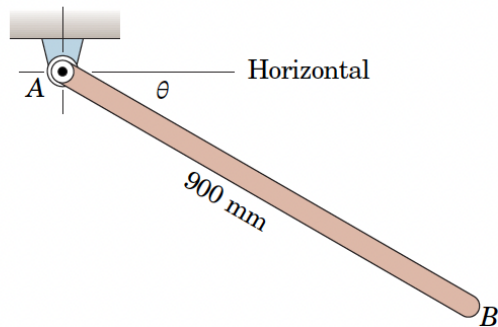
**6/35** The 30-in. slender bar weighs 20 lb and is mounted on a vertical shaft at  $O$ . If a torque  $M = 100$  lb-in. is applied to the bar through its shaft, calculate the horizontal force  $R$  on the bearing as the bar starts to rotate.



**PROBLEM 6/35**

3. [06-037]

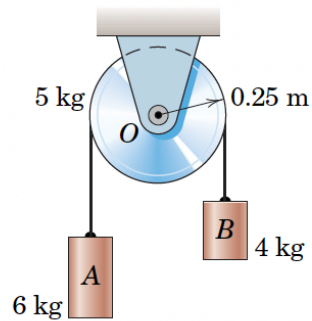
**6/37** The uniform slender bar  $AB$  has a mass of 8 kg and swings in a vertical plane about the pivot at  $A$ . If  $\dot{\theta} = 2 \text{ rad/s}$  when  $\theta = 30^\circ$ , compute the force supported by the pin at  $A$  at that instant.



**PROBLEM 6/37**

4. [06-039]

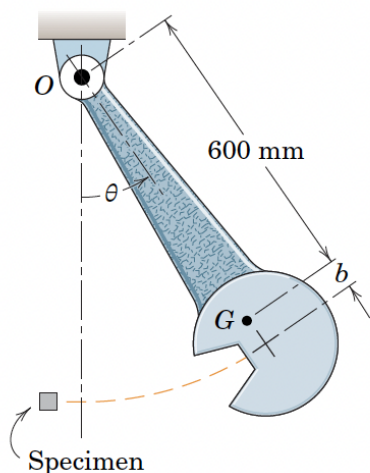
**6/39** Determine the angular acceleration of the uniform disk if (a) the rotational inertia of the disk is ignored and (b) the inertia of the disk is considered. The system is released from rest, the cord does not slip on the disk, and bearing friction at  $O$  may be neglected.



**PROBLEM 6/39**

5. [06-051]

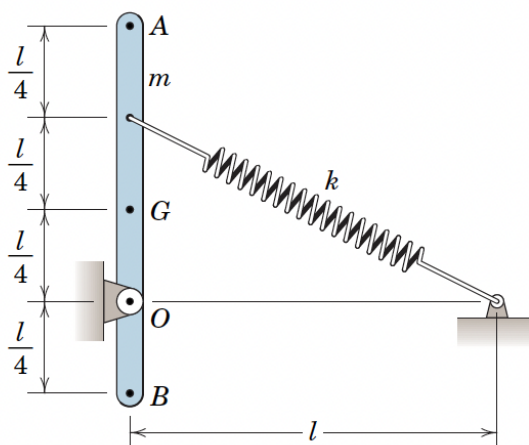
**6/51** A device for impact testing consists of a 34-kg pendulum with mass center at  $G$  and with radius of gyration about  $O$  of 620 mm. The distance  $b$  for the pendulum is selected so that the force on the bearing at  $O$  has the least possible value during impact with the specimen at the bottom of the swing. Determine  $b$  and calculate the magnitude of the total force  $R$  on the bearing  $O$  an instant after release from rest at  $\theta = 60^\circ$ .



**PROBLEM 6/51**

6. [06-054]

**6/54** The spring is uncompressed when the uniform slender bar is in the vertical position shown. Determine the initial angular acceleration  $\alpha$  of the bar when it is released from rest in a position where the bar has been rotated  $30^\circ$  clockwise from the position shown. Neglect any sag of the spring, whose mass is negligible.



**PROBLEM 6/54**