The Laws of Rotational Motion

Pre-Lecture Questions

Problem Set #26 (due next time)

Lecture Outline

1. The First Law of Rotation
2. The Second Law of Rotation

Pre-Class Summary:

Newton's First Law *for Rotation*
"Every object will move with a constant angular velocity unless a torque acts on it."

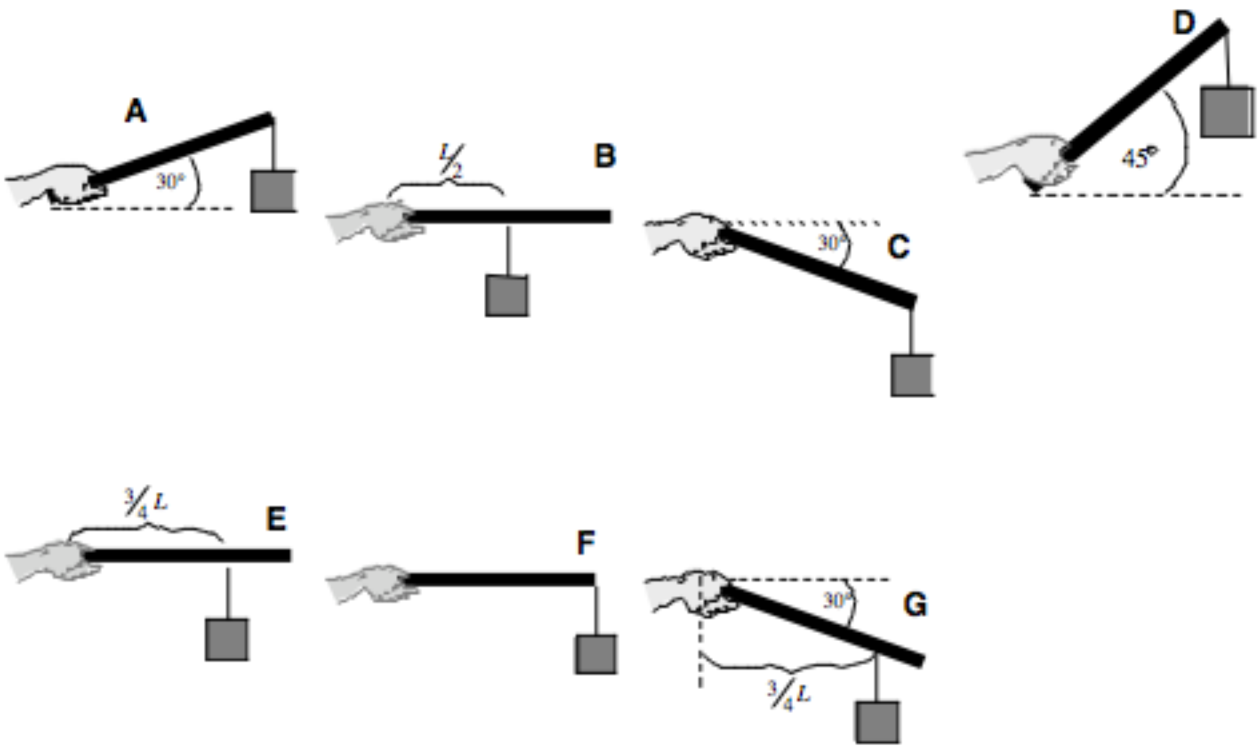
Newton's Second Law *for Rotation*
"Angular acceleration of an object is directly proportional to the net torque acting on it and inversely proportional to its rotational inertia."

The Definition of Torque $\vec{\tau} \equiv \vec{r} \times \vec{F}$.

The Second Law was rewritten mathematically as, $\Sigma\tau = I\alpha$.

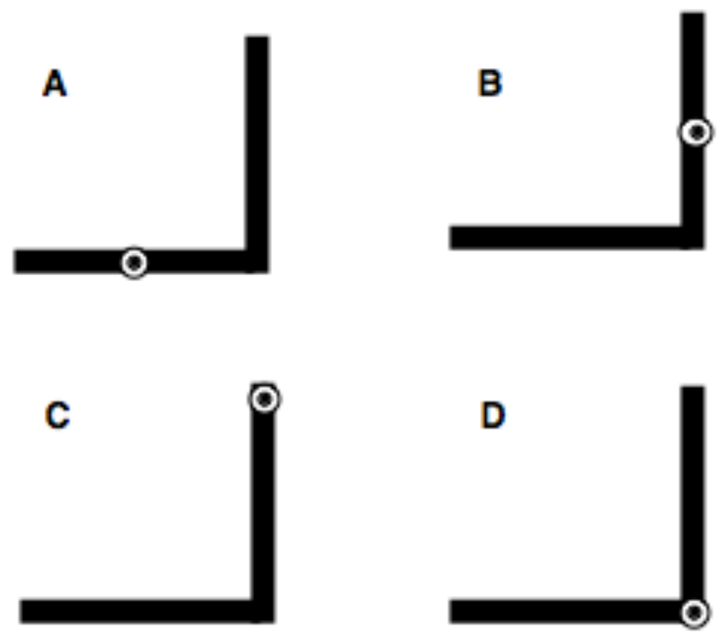
The Definition of Rotational Inertia $I \equiv \int r^2\, dm$.

A student holds a light stick at one end. In each situation, identical masses are attached at different locations and the stick is held at different angles. Rank the situations based upon the torque exerted by the masses about the student's hand.



Example 1: The wind blowing NNE exerts a force of 50.0N on the center-of-mass of a 0.80cm square sign mounted on it west side. The sign is in the east-west plane. Find the torque on the sign.

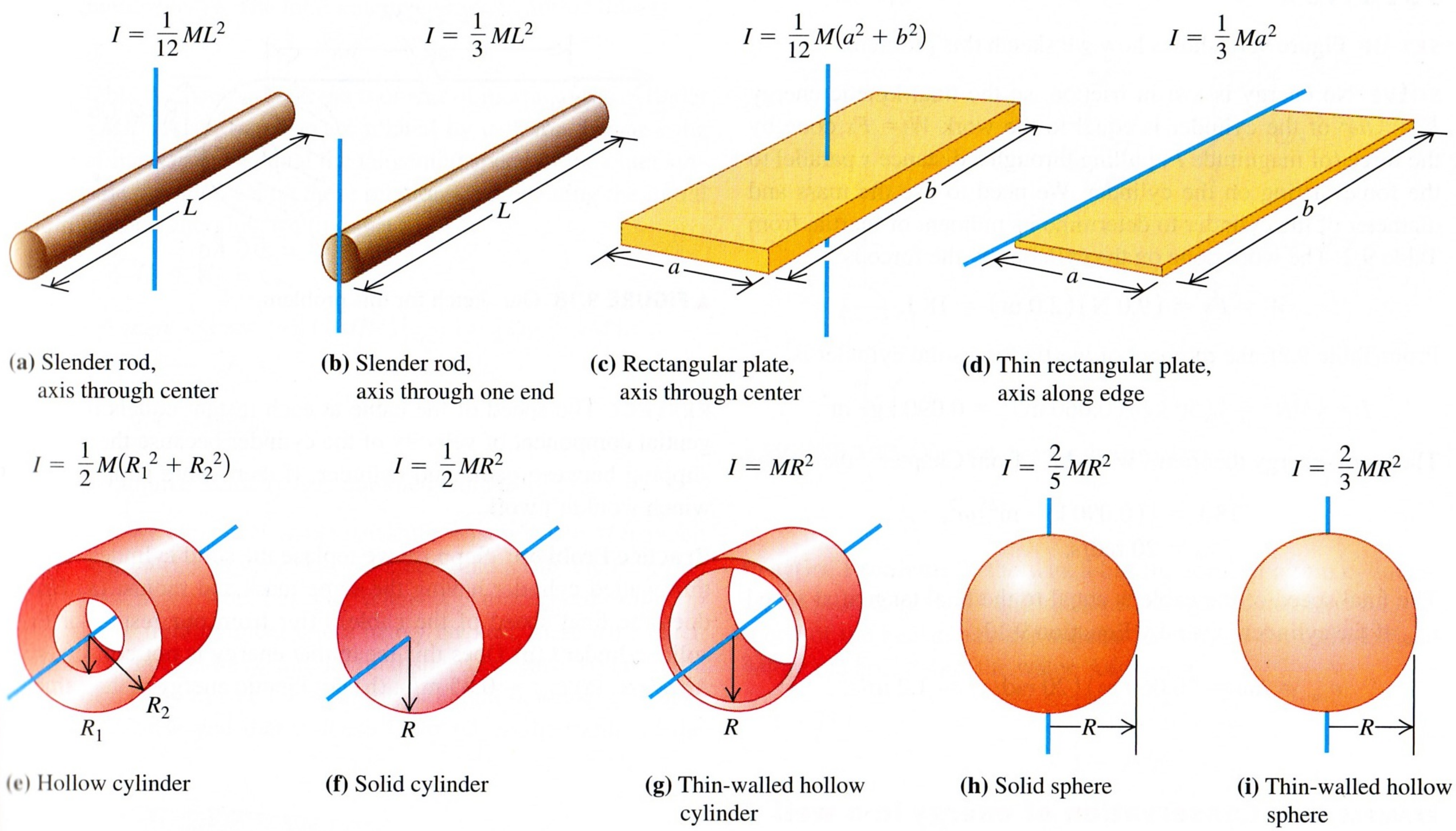
Below are four identical figure **L**'s, which are constructed from two rods of equal lengths and masses. For each figure, a different axis of rotation is indicated by the small circle with the dot inside, which indicates an axis that is perpendicular to the plane of the **L**'s. The axis of rotation is located either at the center or one end of a rod for each figure.



Rank these **L** figures according to their moments of inertia about the indicated axes, from largest to smallest. Ignore the width of each rod but not the length.

Example 2: Find the rotational inertia of a stick of length L and mass M about one end.

TABLE 9.2 Moments of inertia for various bodies



Example 3: A 90.0cm long bat has a center-of-mass 60.0cm from the end. It is held horizontally and then allow to rotate downward about the end. Its initial angular acceleration is 30.0rad/s^2 its mass is 1.00kg. Find (a)the torque exerted on the bat and (b)the rotational inertia of the bat.

Lecture 26 - Summary

Newton's First Law *for Rotation*
"Every object will move with a constant angular velocity unless a torque acts on it."

Newton's Second Law *for Rotation*
"Angular acceleration of an object is directly proportional to the net torque acting on it and inversely proportional to its rotational inertia."

The Definition of Torque $\vec{\tau} \equiv \vec{r} \times \vec{F}$.

The Second Law was rewritten mathematically as, $\Sigma\tau = I\alpha$.

The Definition of Rotational Inertia $I \equiv \int r^2 \, dm$.