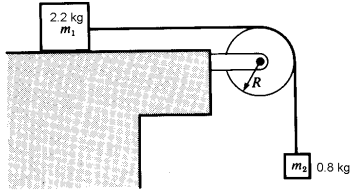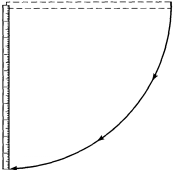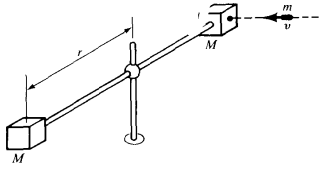# ROTATIONAL MOTION
REVIEW PROBLEMS

1. A seesaw consists of a piece of wood of mass 40 kg and length 6 m. It is placed on a fulcrum below its center of mass. On the left side, a 20 kg mass is positioned 2.0 m from the fulcrum, and on the right side a 50 kg mass is 3.0 m away.
   a. Where can a final mass of 40-kg be placed to balance the seesaw?
   b. The masses are now removed and the seesaw is placed on a fulcrum 1.5 m from its left end. The seesaw is balanced when an unknown mass is placed 1.0 m from its left end. What is the value of the unknown mass?
   c. The board of wood (without any masses) is then taken to the top of a building and placed near the edge so that 5.0 m is on the roof and 1.0 m overhangs. How far can a 90-kg person walk past the edge of the building on the wood before it begins to tip?

2. A hoop starts from rest at a height h and rolls down an incline without slipping.
   a. Derive an expression (in terms of g and h) for the linear speed of the hoop when it reaches the bottom of the incline.
   b. If a cylinder were rolling without slipping along flat ground with the same speed found in part (a), would it roll up a hill to a height greater than h, smaller than h, or equal to h?
   c. Confirm your answer to b.

3. A disk of radius R = 0.12 m and mass M = 3 kg is supported by frictionless bearings. A lightweight cord passes over the rim of the disk and is attached to two blocks of m_1 = 2.2 kg and m_2 = 0.8 kg. The friction between the cord and disk prevents the cord from slipping. What is the acceleration of the system if m_1 slides on a frictionless surface?

4. A meter stick, pivoted at one end, is released from rest in a horizontal position. Calculate its angular momentum at the instant it passes the vertical position as shown in the diagram. The meter stick has a mass of 350 g.

5. Two blocks of wood, each of mass M = 800 g are mounted of opposite ends of a massless rod so that their centers are 0.12 m from the midpoint of a rod. The rod is pivoted about a vertical axis on frictionless bearings. A bullet of mass 'm' = 20 g, moving at 'v' = 240 m/s, embeds itself in one of the blocks. Determine the angular velocity of the device if it was initially at rest.

6. A pendulum consists of a 3.0-m long rod of negligible mass with a uniform sphere of mass 10 kg and radius 2.0 m attached to its end. The pendulum oscillates about an axis through its other end.
   a. What is the rotational inertia of the pendulum?
   b. Assuming the angular displacement is small, determine the period of oscillation for this pendulum.

Answers
(1) 2.75 m to the left of fulcrum, 120 kg, 0.89 m   (2) $(gh)^{1/2}$, smaller than h, reaches 3h/4
(3) 1.74 m/s^2 (4) 0.63 kgm^2/s   (5) 24.7 rad/s   (6) 266 kgm^2, 4.63