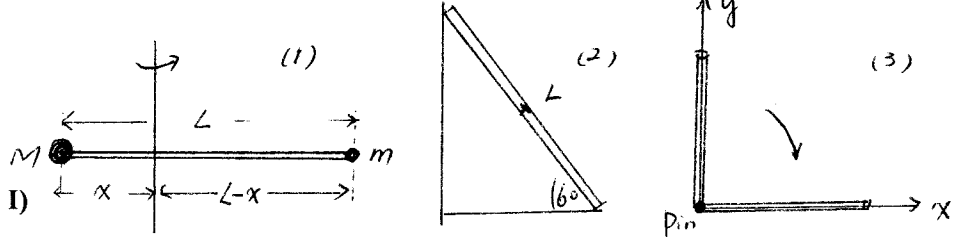
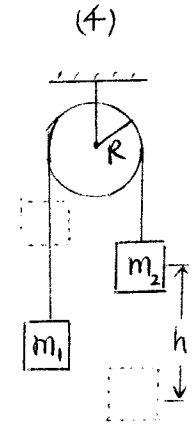


HW Chapter 10 (Rotation I)

1. Two balls with masses M and m are connected by a rigid rod of length L and negligible mass. For an axis perpendicular to the rod, (a) show that the system has the minimum moment of inertia when the axis passes through the center of mass, (b) show that this moment of inertia is I = $mML^2/(m+M)$

2. A 3.0-m-long ladder leans against a frictionless wall at an angle of 60°. What is the minimum value of μs, the coefficient of static friction with the ground that prevents the ladder from slipping?

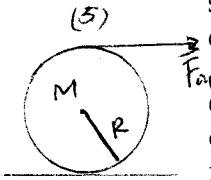
$\mu_s \geq \frac{1}{2\tan 60} = 0.29$



3. A long uniform rod of length L and mass M is pivoted about a frictionless, horizontal pin through one end. The rod is nudged from rest in vertical position. At the instant the rod is horizontal, find (a) its angular speed, (b) the magnitude of its angular acceleration, (c) the x and y components of the acceleration of its center of mass, and (d) the components of the reaction force at the pivot.

$\omega = \sqrt{\frac{3g}{L}} \quad \alpha = \frac{3g}{2L} \quad \vec{a} = -\frac{3}{2}g\hat{i} - \frac{3}{4}g\hat{j} \quad \vec{F} = m\vec{a}$

4. Two blocks having different masses m_1 and m_2 are connected by a string passing over a pulley. The pulley has a radius R and moment of inertia I about its axis of rotation. The string does not slip on the pulley, and the system is released from rest. Find the translational speeds of the blocks after block 2 descends through a distance h and find the angular speed of the pulley at this time.



5. A constant horizontal force Fapp is applied to a uniform solid cylinder of mass M and radius R by a string wrapped around the cylinder. The cylinder is rolling without slipping on the horizontal surface. Find (a) the acceleration of the center of mass of the cylinder, and (b) the magnitude and direction of the friction force on the cylinder. ($I = \frac{1}{2} MR^2$)

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6. A basketball of mass M and radius R rolls without slipping down an incline of angle θ. The coefficient of static friction is μs. Find (a) the acceleration of the center of mass of the ball, (b) the frictional force acting on the ball, and (c) the maximum angle of the incline for which the ball will roll without slipping. ($I = 2/3\ MR^2$)

7. A uniform spherical shell of mass M and radius r can rotate about a vertical axis on frictionless bearings. A massless cord passes around the equator of the shell, over a pulley of rotational inertia I and radius r, and is attached to a small object of mass m. There is no friction on the pulley's axle; the cord does not slip on the pulley. What is the speed of the object when it has fallen h after being released from rest?

8. A spool of thread consists of a cylinder of radius R_1 with end caps of radius R_2. The mass of the spool, including the thread, is M, and its moment of inertia about an axis through its center is I. The spool is placed on the rough, horizontal surface so that it rolls without slipping when a tension force F acting to the right is applied to the free end of the thread (a) What is the friction exerted by the surface on the spool. (b) Determine the direction of the friction.

$f = \frac{MR_1R_2 + I}{MR_2^2 + I}$

9. A uniform cylinder of mass M and radius R is at rest on a block of mass m, which in turn rests on a horizontal, frictionless table. If a horizontal force F is applied to the block, it accelerates and the cylinder rolls without slipping. Find the acceleration of the block.

$a_B = \frac{3F}{M+3m}$