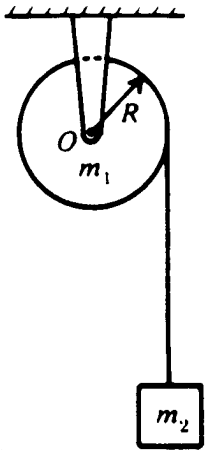
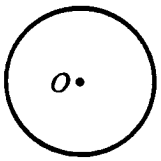
AP Physics Angular Motion Test Question Replacement Name:_____

If you wish, complete **the three** questions below. I will use your score on these to modify your test score accordingly. (+7% for attempting all three, and then some question replacement effects.)



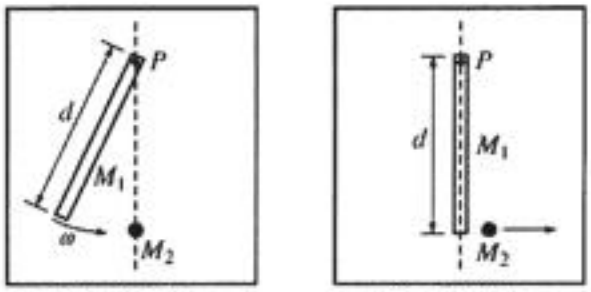
1. A uniform solid cylinder of mass m_1 and radius *R* is mounted on frictionless bearings about a fixed axis through O. The moment of inertia of the cylinder about the axis is $I = \frac{1}{2}m_1R^2$. A block of mass m_2, suspended by a cord wrapped around the cylinder as shown above, is released at time t = 0.
   a. On the diagram below draw and identify all of the forces acting on the cylinder and on the block.



   b. In terms of m_1, m_2, *R*. and g, determine each of the following.
      i. The acceleration of the block

      ii. The tension in the cord

      iii. The angular momentum of the disk as a function of time t.



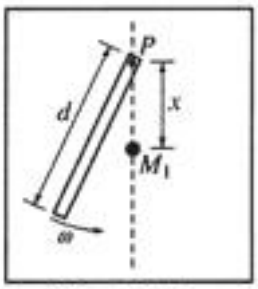
TOP VIEWS

1. A system consists of a ball of mass M_2 and a uniform rod of mass M_1 and length d. The rod is attached to a horizontal frictionless table by a pivot at point P and initially rotates at an angular speed ω, as shown above left. The rotational inertia of the rod about point P is $\frac{1}{3} M_1 d^2$. The rod strikes the ball, which is initially at rest. As a result of this collision, the rod is stopped and the ball moves in the direction shown above right. Express all answers in terms of M_1, M_2, ω, d, and fundamental constants.

a. Derive an expression for the angular momentum of the rod about point P before the collision.

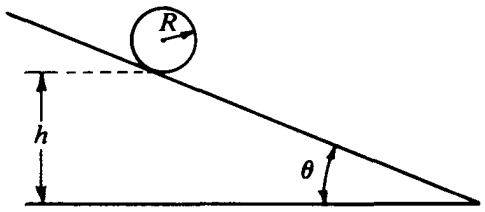
b. Derive an expression for the speed v of the ball after the collision.

c. Assuming that this collision is elastic, calculate the numerical value of the ratio M_1 / M_2



Before Collision

d. A new ball with the same mass M_1 as the rod is now placed a distance x from the pivot, as shown above. Again assuming the collision is elastic, for what value of x will the rod stop moving after hitting the ball?



3. An inclined plane makes an angle of θ with the horizontal, as shown above. A solid sphere of radius R and mass M is initially at rest in the position shown, such that the lowest point of the sphere is a vertical height h above the base of the plane. The sphere is released and rolls down the plane without slipping. The moment of inertia of the sphere about an axis through its center is $2MR^2/5$. Express your answers in terms of M, R. h, g, and θ.

a. Determine the following for the sphere when it is at the bottom of the plane:
   i. Its translational kinetic energy

   ii. Its rotational kinetic energy

b. Determine the following for the sphere when it is on the plane.
   i. Its linear acceleration

   ii. The magnitude of the frictional force acting on it

The solid sphere is replaced by a hollow sphere of identical radius R and mass M. The hollow sphere, which is released from the same location as the solid sphere, rolls down the incline without slipping.

c. What is the total kinetic energy of the hollow sphere at the bottom of the plane?

d. State whether the rotational kinetic energy of the hollow sphere is greater than, less than, or equal to that of the solid sphere at the bottom of the plane. Justify your answer.