Physics 135-1 Sample Midterm II
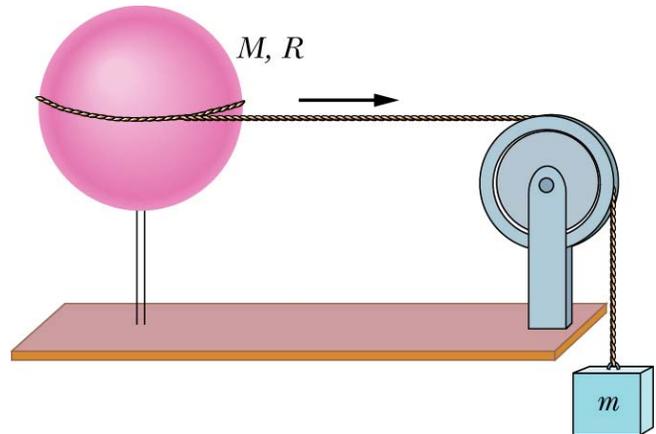
1) A sphere of mass M = 5 kg and radius R = 40 cm has a cord tied around its equator, which is also attached to a small mass of m = 1.5 kg. The system is originally at rest. Then the small mass is released and allowed to fall. After it has fallen 50 cm, how fast (in radians per second) will the sphere be rotating? There is no friction in the system, and the pulley has no mass.


M, R

m

2) Suppose a ball of mass M = 0.5 kg and R = 3 cm is setting at the top of a ramp which has a height of 50 cm. Then, I release the ball and let it roll without sliping down the ramp. How fast will its center of mass be moving (horizontally) when the ball reaches the bottom of the ramp?

3) Assume the Earth is a uniform sphere of radius 6370 km and mass 5.97 x 10^{24} kg. Assume it rotates exactly once every 24 hours. Then, suppose an asteroid (treat it as a point) with a mass of 1.83 x 10^{18} kg strikes the Earth along its equator, in the same direction as the Earth is turning, but angled at 60° to the radius of the Earth. The asteroid has a speed of 60 km/s relative to the Earth. By what amount will the period of the Earth speed up? (Hint – taking a ratio at the proper place could save you a lot of number-punching.)

4) Suppose you have a flat 45° triangle whose short sides are of length L. The tip of the 45° angle point is just touching a vertical rotation axis. The triangle has a total mass of M.

a) (8 points) Set up an integral to calculate the moment of inertia of the triangle around the rotation axis. It might be wise to explain your thinking, for partial credit.

b) (2 points) Evaluate the integral.

rotation axis

45°

L

L
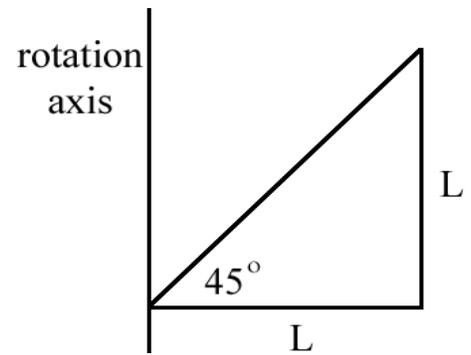
5) A small monkey with a mass of M = 10 kg is hanging by his tail from a horizontal thin rod of mass m = 2 kg. The rod is 3 m long and the monkey is 0.5 m from the right-hand end, as shown at right. The rod in turn is suspended from a left rope that makes an 150° with the horizontal, and a right rope that is tilted at an unknown angle. What are the tensions in the left- and right-hand ropes, and what is the angle of the right-hand rope?

150°

0.50 m

2.50 m