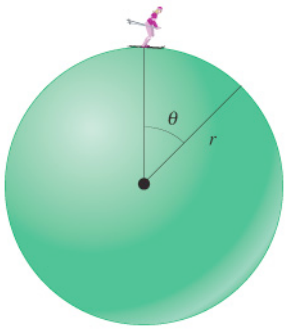
Physics 7A, Spring 2010 **Lecture 1, Professor Yildiz** **MT 2, 4/05/10**

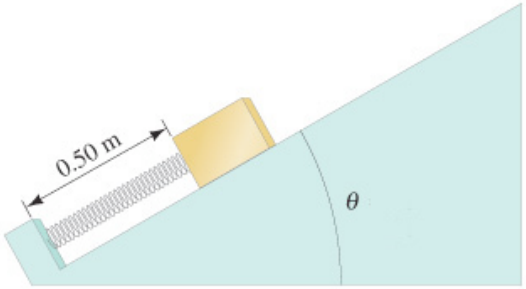
1. (20 points) A skier of mass m starts from rest at the top of a solid sphere of radius r and slides down its frictionless surface.

   a) At what angle, θ, will the skier leave the sphere?
   b) Now, instead of a skier, consider a ring of radius R and mass m. Assuming the ring rolls without slipping, at what angle, θ, will the ring leave the sphere?



2. (20 points) A spring with spring constant $k = 80$ N/m has an equilibrium length of 1.00 m. The spring is compressed to a length of 0.5 m and a mass of $m = 1.8$ kg is placed at its free end on a frictionless slope which makes an angle of $\theta = 37°$ with respect to the horizontal. The spring is then released. [Note: you may use the approximations sin 37° = 0.6 and cos 37° = 0.8 for simplicity]

   a) If the mass is *not* attached to the spring, how far up the slope will the mass move before coming to rest?
   b) If the mass *is* attached to the spring, how far up the slope will the mass move before coming to rest?
   c) Now the incline has a coefficient of kinetic friction μ_k. If the block, attached to the spring, is observed to stop just as it reaches the spring's equilibrium position, what is the coefficient of friction?

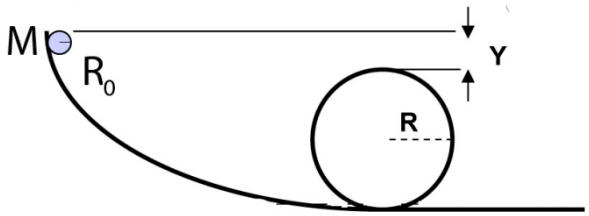


3.

a) (10 points) *Calculate* the moment of inertia of a uniform solid sphere of radius R_0 and mass M for an axis through its center.

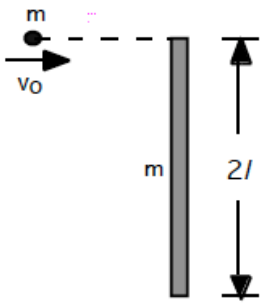
b) (15 points) What should be the minimum height, Y, above the loop shown below, that the disk must be released so that it can roll without slipping and still make it around the loop of radius R? If you were unable to solve part (a), $I_{sphere} = 2/5\ MR_0^2$

(Hint: The sphere is not a point object - do not neglect its radius!)



4. (15 points) A rocket traveling at a speed 1850 m/s away from the Earth at an altitude of 6400 km fires its rockets, which eject gas at a speed of 1300 m/s relative to the rocket. If the mass of the rocket at this moment is 25000 kg and an acceleration of 1.5 m/s^2 is desired, at what rate must the gases be ejected?

5. (20 points) A plank of length $2l$ and mass m lies on a frictionless plane. A ball, also of mass m, strikes the end of the plank with speed v_0, as shown. After the collision, the ball continues along the original line of motion with decreased speed. Mechanical energy is conserved in the collision.



a) Find the final velocity of the ball, v_f.

b) The experiment is repeated, but this time the plank is pivoted (pegged to the ground) at its lower end. What is the new final velocity of the ball?