Homework 12

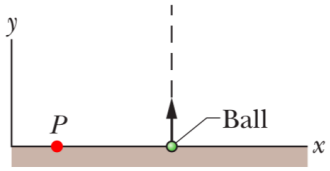
Due Wednesday, November 27th at 7pm

Finish reading Ch. 15. **Nota Bene**: Because this homework set is due the evening before Thanksgiving break there will be no corrections due for this set. Please turn it in on the evening of Nov. 27th and then you are done. This means you should give it your best shot on the first go. Of course, I will post solutions as always and you are expected to look through them, but you do not need to submit corrections and I will only look over the set once. Happy Thanksgiving!

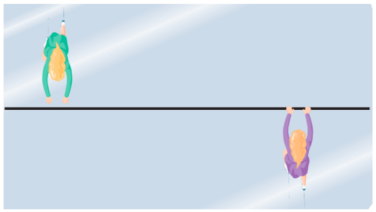
Exercises:

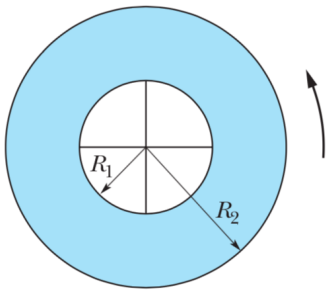
1. A particle is acted on by two torques about the origin: $\vec{\tau}_1$ has a magnitude of 2 Nm and is directed in the positive direction of the x axis, and $\vec{\tau}_2$ has a magnitude of 4 Nm and is directed in the negative direction of the y axis. In unit-vector notation, find $d\vec{\ell}/dt$ where $\vec{\ell}$ is the angular momentum of the particle about the origin.

2. In the figure at right, a 0.400 kg ball is shot directly upward at initial speed 40.0 m/s. What is its angular momentum about P, 2.00 m horizontally from the launch point, when the ball is (a) at maximum height and (b) halfway back to the ground? What is the torque on the ball about P due to the gravitational force when the ball is (c) at maximum height and (d) halfway back to the ground?



3. In the figure at right, two skaters, each of mass 50 kg, approach each other along parallel paths separated by 3.0 m. They have opposite velocities of 1.4 m/s each. One skater carries one end of a long pole of negligible mass, and the other skater grabs the other end as she passes. The skaters then rotate around the center of the pole. Assume that the friction between skates and ice is negligible. What are (a) the radius of the circle, (b) the angular speed of the skaters, and (c) the kinetic energy of the two-skater system? Next, the skaters pull along the pole until they are separated by 1.0 m. What then are (d) their angular speed and (e) the kinetic energy of the system? (f) What provided the energy for the increased kinetic energy?





4. Pictured at left is an overhead view of a ring that can rotate about its center like a merry-go-round. Its outer radius R_2 is 0.800 m, its inner radius R_1 is $R_2/2$, its mass M is 8 kg, and the mass of the crossbars at its center is negligible. It initially rotates at an angular speed of 8.00 rad/s with a cat of mass $m = M/4$ on its outer edge, at radius R_2. By how much does the cat increase the kinetic energy of the cat ring system if the cat crawls to the inner edge, at radius R_1?

5. An object undergoing simple harmonic motion takes 0.25 s to travel from one point of zero velocity to the next such point. The distance between those points is 36 cm. Calculate the (a) period, (b) frequency, and (c) amplitude of the motion.

6. An oscillating block-spring system takes 0.75 s to begin repeating its motion. Find (a) the period, (b) the frequency in hertz, and (c) the angular frequency in radians per second.

7. In the figure at right, a block weighing 14.0 N, which can slide without friction on an incline at angle $\theta = 40°$, is connected to the top of the incline by a massless spring of unstretched length 0.45 m and spring constant 120 N/m. (a) How far from the top of the incline is the block's equilibrium point? (b) If the block is pulled slightly down the incline and released, what is the period of the resulting oscillations?

Physical problem:

8. In the figure at right, a small 50 g block slides down a frictionless surface through height $h = 20$ cm and then sticks to a uniform rod of mass 100 g and length 40 cm. The rod pivots about point O through angle θ before momentarily stopping. Find θ.