Homework set 5 – Rotations and angular momentum
Due: 5 January, 2016 - 08:45hr, before the Analysis lecture

1. A solid cylinder of mass m, radius r, and moment of inertia $I = \frac{1}{2}mr^2$, rolls without slipping down a plane inclined at an angle θ.
   (a) Find an expression for the linear speed v of the center of the cylinder, as a function of the distance d it has traveled along the plane.
   (b) Determine the acceleration of the center of the cylinder.

2. Calculate the moment of inertia of a rectangle with sides a and b, thickness d, and total mass M about
   (a) an axis through the center, parallel to the side with length a;
   (b) an axis through the side with length a;
   (c) an axis through the center, perpendicular to the plane of the rectangle.
   (Naturally, you may use the theorems we proved in class; however, if you do so, you have to explicitly indicate how you apply them).

3. A cockroach of mass m lies on the rim of a uniform disk of mass 10.0 m that can rotate freely about its center like a merry-go-round. Initially the cockroach and disk rotate together with an angular velocity of 0.250 rad/s. Then the cockroach walks halfway to the center of the disk. (a) What then is the angular velocity of the cockroach-disk system? (b) What is the ratio K/K_0 of the new kinetic energy of the system to its initial kinetic energy? (c) What accounts for the change in kinetic energy?

4. An Atwood's machine consists of two masses m_1 and m_2, connected by a string that passes over a pulley. If the pulley is a disk of radius R and mass M, find the acceleration of the masses.