Physics 18 Spring 2011
Homework 8
Wednesday March 9, 2011

Make sure your name is on your homework, and please box your final answer. Because we will be giving partial credit, be sure to attempt all the problems, even if you don’t finish them. The homework is due at the beginning of class on Wednesday, March 16th. Because the solutions will be posted immediately after class, no late homeworks can be accepted! You are welcome to ask questions during the discussion session or during office hours.

1. Two points are on a disk that is turning about a fixed axis perpendicular to the disk and through its center at increasing angular velocity. One point is on the rim and the other point is halfway between the rim and the center.

(a) Which point moves the greater distance in a given time?
(b) Which point turns through the greater angle?
(c) Which point has the greater speed?
(d) Which point has the greater angular speed?
(e) Which point has the greater tangential acceleration?
(f) Which point has the greater angular acceleration?
(g) Which point has the greater centripetal acceleration?
2. The methane molecule (CH$_4$) has four hydrogen atoms located at the vertices of a regular tetrahedron of edge length 0.18 nm, with the carbon atom at the center of the tetrahedron. Find the moment of inertia of this molecule for rotation about an axis that passes through the centers of the carbon atom and one of the hydrogen atoms.
3. A pendulum consisting of a string of length $L$ attached to a bob of mass $m$ swings in a vertical plane. When the string is at an angle $\theta$ to the vertical,

(a) calculate the tangential acceleration of the bob using $\sum F_t = ma_t$.

(b) What is the torque exerted about the pivot point?

(c) Show that $\sum \tau = I\alpha$ with $a_t = L\alpha$ gives the same tangential acceleration as found in Part (a).
4. A uniform solid sphere of mass $M$ and radius $R$ is free rotate about a horizontal axis through its center. A string is wrapped around the sphere and is attached to an object of mass $m$. Assume that the string does not slip on the sphere. Find

(a) the acceleration of the object and

(b) the tension in the string.
5. A basketball rolls without slipping down an incline of angle $\theta$. The coefficient of static friction is $\mu_s$. Model the ball as a thin spherical shell. Find

(a) the acceleration of the center of mass of the ball,
(b) the frictional force acting on the ball, and
(c) the maximum angle of the incline for which the ball will roll without slipping.