

Assignment 9
Rigid Body Motion

1. Calculate the moments of inertia I_1 , I_2 and I_3 for a homogeneous sphere of radius R and mass M . Choose the origin at the center of the sphere.
2. Two spheres are of the same diameter and same mass but one is solid and the other is a hollow shell. Describe in detail a nondestructive experiment to determine which is solid and which is hollow.
3. A three particle system consists of masses m_i and coordinates (x_1, x_2, x_3) as follows:

$$\begin{array}{ll} m_1 = 3m & (b,0,b) \\ m_2 = 4m & (b,b,-b) \\ m_3 = 2m & (-b,b,0) \end{array}$$

Find the inertia tensor, principal axes and principal moments of inertia.

4. A uniform rod of length b stands vertically upright on a rough floor and then tips over. What is the rod's angular velocity when it hits the floor?
5. Investigate the motion of the symmetric top discussed in Chapter 11 for the case in which the axis of rotation is vertical (i.e. the x_c' and x_c axes coincide). Show that the motion is either stable or unstable depending on whether the quantity $4I_1 M h g / I_3^2 \omega_3^2$ is less than or greater than unity. If the top is set spinning in the stable configuration, what is the effect as friction gradually reduces the value of ω_3 ?