Physics 262: Problem Set #9

These problems are due at the end of the day on Friday March 7.

1. Kleppner and Kolenkow, problem 6.9, pg. 279.

2. Find the moment of inertia of a hollow sphere of mass m and radius R. Do this in two ways: (a) by explicit integration, considering e.g. the sphere to be a stack of hoops of different radii, and (b) using your knowledge that for uniform sphere, $I_0 = \frac{2}{5}mR^2$ (and observing that a uniform sphere can be broken up in to a set of hollow spheres of different radii).

3. (BONUS) A basketball (a hollow sphere of mass m and radius R) rolls (without slipping) on horizontal circle (of radius r). The point of contact traces out a great circle on the ball, and the radius to the point of contact makes an angle θ with respect to horizontal. Gravity (g) points down as usual. Find the angular rate Ω at which the ball rolls around in a circle.

4. Kleppner and Kolenkow, problem 9.9, pg. 407.

5. Kleppner and Kolenkow, problem 9.10, pg. 407. If the result seems surprising, observe that work is being done on the satellite both by the friction force and by gravity.

6. Kleppner and Kolenkow, problem 9.11, pg. 407.

7. Kleppner and Kolenkow, problem 9.12, pg. 408.

8. Practice in dimensional analysis. Consider a satellite of mass m in a circular orbit of radius r about the earth. For each of the following quantities, use dimensional analysis to find the dependence on the radius r of the orbit. That is, noting that the input parameters are r, m, and GM, find the powers α, β and γ so that $r^\alpha m^\beta (GM)^\gamma$ has the appropriate units. Report α in particular. It is not required to actually find these quantities (including the dimensionless factors), but you are of course welcome to cross-check.

   (a) period

   (b) kinetic energy

   (c) angular momentum

   (d) speed