

PHY 504

Problem Set #8

due 30 October 2009

1. A child riding on a platform rotating at ω rad/s drops a ball from a height h , while standing a distance r from the center of the platform. How far from her feet does the ball hit the platform?
2. A bullet is fired at 100 m/s in a horizontal direction at a target 1 km away, at a latitude of 38° N. Compute the horizontal component of its net linear deflection as a sum of Coriolis and centrifugal effects, if its initial velocity is to the south. Repeat for initial velocity to the east.
3. Calculate the inertia tensor of a thin plate of mass M , in the shape of an equilateral triangle of side a , with uniform mass density.
4. A rigid body consists of eight equal point masses m situated at the corners of a cube and connected by massless rods of length a .
 - (a) Calculate the inertia tensor about a corner of the cube. Show that the long diagonal of the cube is a principal axis.
 - (b) If the cube is hanging by a string attached to a corner, and a torque N_z is applied about the vertical axis, what will be its angular acceleration?
 - (c) Suppose the body hangs by one of its corners in a uniform gravitational field and swings in a vertical plane. Write down a Lagrangian in terms of the swinging angle and the moment of inertia. What is the frequency of the pendulum?
5. The cube in problem 3 is set on top of a table and balanced on an edge, in unstable equilibrium. The cube is given a small nudge and allowed to fall.
 - (a) Obtain an equation of motion for the angular orientation of the cube, assuming that the edge of the cube in contact with the table is held in place by friction. With what angular speed does the cube hit the table?
 - (b) Repeat, now assuming that the cube can slide without friction.