

## Homework Set # 8, due November 5,2007

1. A spool is made of two uniform disks, each of mass  $M$  and radius  $R$  joined by a uniform hollow cylinder of radius  $r < R$ . The disks and cylinder share a common axis which is also their symmetry axis. A thread (massless and thin) is wound around the cylinder and a force  $T$  acts at its free end at a fixed angle  $\theta$  above the horizontal. The spool can move on a horizontal table.
  - a) Find the condition on  $T$  for the spool not to move vertically.
  - b) Find the moment of inertia of the spool about its axis.
  - c) If no slipping occurs find the conditions on  $\theta$  that the spool either winds or unwinds.
  - d) Find the condition of the coefficient of friction between the spool and the table so that no slippings occurs.
2. You can roll a coin on a table such that it rolls in a circle of radius  $R$  and leans inward at an angle  $\phi$ . Express  $\phi$  in terms of the radius  $R$  of the circle, the radius  $b$  of the coin and the velocity  $v$  of the coin. No slipping occurs.
3. Find the principal moments of inertia about the center of mass of a flat rigid body in the shape of a 45 degrees right triangle with uniform mass density. What are the principle axis?
4. An automobile is started from rest with one of its doors open at a right angle. Find the time it takes that the door closes if the acceleration of the car is  $f$ , the radius of gyration of the door is  $r_0$  and its center of mass is at a distance  $a$  from its hinges. Hint: Start with the Lagrangian of the system.