QP32

A uniform disk of mass m and radius r begins to slide down an inclined plane with an initial velocity v_0 at its center of mass at time $t = 0$. The inclined plane has a surface frictional coefficient μ and forms an angle θ relative to the ground, as shown below. At time $t = t_1$, the disk begins to roll down the plane without slipping. The local gravitational acceleration is g, pointing vertically down.

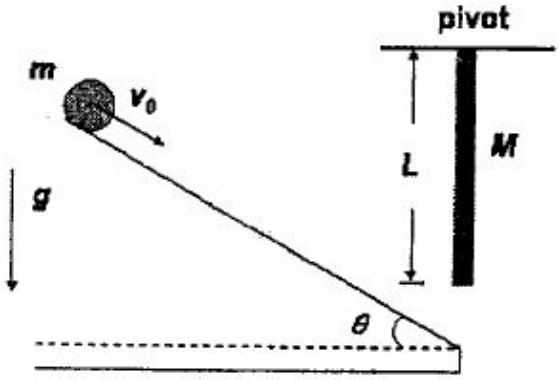

Figure 1A

a) (2 points) Express t_1 in terms of v_0, g, μ and θ.

b) (1 point) Find the minimal frictional coefficient μ (in terms of g and θ) required for the disk to achieve pure rolling motion?

At $t > t_1$ the disk reaches the end of the inclined plane with a final speed v_f at its center of mass, and it becomes stuck instataneously upon impact to the end of a uniform thin rod of length L and mass M hanging vertically from the ceiling. The rod-disk assembly swings to the right, as shown below.

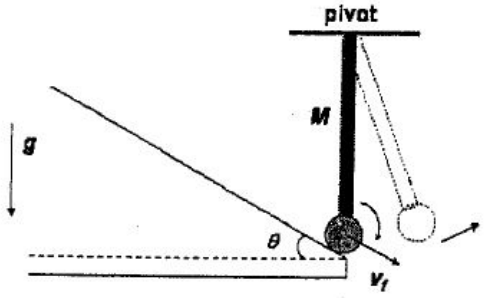

Figure 1B

c) (1 point) Find the moment of interia I of the rod-disk assembly about the axis through the pivot.

d) (2 points) Find the angular momentum (both the magnitude and direction) of the rod-disk assembly about the axis through the pivot after the impact. Express your answer in terms of v_f, m, M, r and L. Discuss the condition required for the rod-disk assembly to swing to the right.