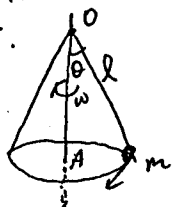1. A disk of mass M and radius R rolls without slipping down an
30% inclined plane of angle θ with the horizontal plane.

(a). Find the velocity of the disk when it reaches the bottom.
(It starts from the top with zero velocity)

(b) Find the frictional force by Newton's law. (considering force directly)

(c) Find the frictional force by using Lagrange multiplier.

2. Assume that the earth is ~~to be~~ a rigid sphere of mass M and radius
15% R. If a particle is allowed to go through a tunnel along a
diameter. Prove that its motion is simple harmonic.

3. Discuss the motion of a particle subject to a restoring force kx.
15% a velocity dependent force $\beta \dot{x}$. Then discuss the motion of it if
we apply an additional force $F_0 \cos \omega t$.

20% 4. If a particle of mass m is attached to a massless
rod of length l. The particle undergoes a conical
rotation about OA axis. Find the angular momentum
of m about point O. ~~Then~~ The torque Γ the forces ~~acted~~
exerted on it. Discuss the relation $\frac{dL}{dt} = \Gamma$

20% 5. A string is loaded with two mass points m_1, m_2 at
distance d from each other as shown in the figure.
Find the equations of motion of the particles for the transverse displacements.
Find the normal modes of the oscillations. How many
normal modes do you expect ~~to have~~ . Why?
(The tension in the string is assumed to be constant T)