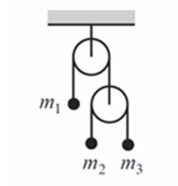
I. Obtain the Lagrangian in terms of suitable generalized coordinates:

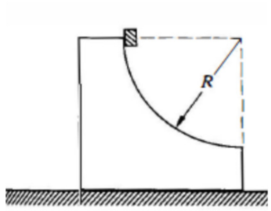
a) An Atwood's machine: two masses, $m1$ and $m2$ connected through a light string of length l, which passes over a pulley of mass M and radius R. The pulley is perfectly rough such that string doesn't slip over it. The motion is on the vertical plane under gravity.

b) Another pulley mass system: Three masses as shown in the figure on right. Let the lengths of the strings be l_1, and l_1. The pulleys are of radius R, but of negligible mass.



II. For the following systems (a) obtain the Euler-Lagrange (E-L) equations of motion. Ignore frictional forces, unless otherwise mentioned! Always, make a sketch of the system, marking the origin as O, (w.r.to which the potential energy is defined), the Cartesian axes and the generalized coordinates chosen.

a) A small block of mass m slides down a circular path of radius R cut in to a large block of mass M as shown. The block M is free to move on a horizontal table. Initially (that is, at time t= 0) the whole system is at rest, when the mass m starts sliding down. Calculate the net displacement of the block M when the small mass m leaves the system.



b) A rod of mass m and length, $2l$, is kept vertical with one end resting on a perfectly smooth surface. When slightly disturbed from the vertical axis the rod falls, as the contact point slides on the surface. Based on E-L equations show that the center of mass of the rod follows a vertical trajectory.

c) A ring of mass m and radius R rolls down from the top of a wedge mass M, height h, and angle 45° (as shown on the right). The contact between the ring and the surface of the wedge is perfectly rough that the ring *rolls down without slipping*. The wedge is resting on a smooth horizontal surface, that it can slide freely.