1) Two wheels of radius R are at the end of an axle of length L. There is no slipping. Show that there are two nonholonomic constraints:

\[ \cos \theta \, dx + \sin \theta \, dy = 0 \]
\[ \sin \theta \, dx - \cos \theta \, dy = \frac{L}{2} (d\phi + d\theta) \]

(x,y) is the center of mass.
Show that there is also a holonomic constraint.

2) A uniform hoop with mass m and radius r rolls from rest from the top of a cylinder. Use the method of Lagrange constraints to find at which point the hoop leaves the cylinder. Gravity is the only external force.

3) Find the Lagrange equations of a mass m suspended by a weightless rod. (The mass can move on the surface of a sphere)

4) If the kinetic and potential energy are given by

\[ T = \sum F_u(\mathbf{q}_u) \cdot \dot{\mathbf{q}}_u \]
\[ V = \sum V_u(\mathbf{q}_u) \]

show that the Lagrange equations separate.