

A hoop of mass M and radius R rolls without slipping along a track which has the shape of a circle with radius $4R$. It is subject to gravity. It is confined to a plane, so when the no-slip constraint is imposed there is just one degree of freedom. Use the angle θ as your coordinate. (This angle gives the location of the center of the hoop, as measured from the center of the track circle.) Find T , U , L , and the Lagrange equation. For small oscillations find the angular frequency of oscillation ω . (Hint: Think carefully about what the no-slip condition says about the rate of rotation of the hoop compared to the rate of movement of its center, given by $\dot{\theta}$. Remember you will have two terms in the kinetic energy – which you can assume are due to the translation of its center of mass, and the rotation about its center of mass.)

