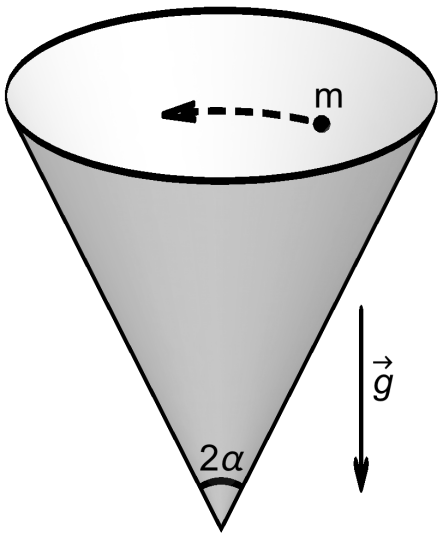
3. **Orbits in a cone**



A cone sits apex down with its axis vertical. The inside opening angle of the cone is 2α, with $\pi > 2\alpha > 0$, so the inside surface of the cone in cylindrical coordinates is $r = z \tan\alpha > 0$. A point mass slides without friction and nonrelativistically on the inside surface of the cone.

(a) Solve for the circular orbit with radius r_0. What is the period $T_0(r_0)$ of this orbit?

(b) If this circular orbit is slightly perturbed away from circular, what is the period $T_1(r_0)$ of the resulting oscillations in the radial position r? Show your work.