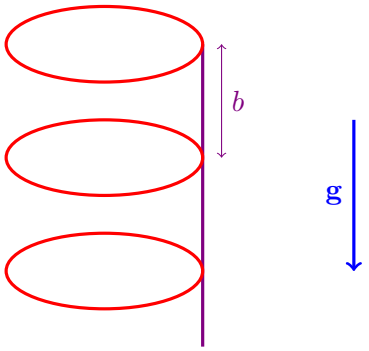
Falling Slinky

Consider a simple model of a slinky as follows: N rings of equal mass μ are held by one end in a gravitational field g. Under the influence of gravity, the slinky extends until the separation between each ring is b. In this problem, we will approximate that the force in the slinky connecting neighboring rings is a tension force, whose strength is independent of the separation of the rings. This should make the problem much simpler to think about by hand.



(a) Find the tension force in between rings n and $n+1$, where ring 1 is the ring held fixed at the top, and ring N is the free-hanging ring at the bottom.

Now, at time $t = 0$, we let go of the ring, so that it may fall under the influence of gravity. Assume that if two rings collide, the collision is *inelastic*. Also, assume the motion is along the vertical direction only, for simplicity.

(b) Calculate the velocity of each ring at time t, and find the total momentum as a function of time t.

(c) Sketch the velocity $v_1(t)$ of the first ring as a function of time t. Note carefully any key features and scales present.

(d) How much energy is dissipated, if any, as the slinky falls? If energy is dissipated, where do you think it goes?

(e) Let $x = h_0$ be the initial vertical position of ring N. Let t_{slinky} be the time it takes for the center of mass of the slinky to reach $x = h_0$; let t_{point} be the time it would take a point mass to fall from the initial center of mass of the slinky to the same point. Is t_{slinky} larger, smaller, or the same as t_{point} – explain your answer.