Challenge Problem Set 1
PY 211

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- 1.1)

A string of total mass, M, and length, ℓ, is situated on a table such that, initially, a small amount, δ, hangs over the edge as shown in Figure 1. At what time, t, does the string slide all the way off of the table? Assume that the table is high enough off the ground such that the string does not come into contact with the ground before sliding off the table. Further assume that the mass of the string is uniformly distributed (i.e. we may write $\lambda = \frac{M}{\ell}$). (Hint: Use Newton's Second Law and note that the mass of the left-hand side of the equation does *not* equal the mass on the right-hand side of the equation.)

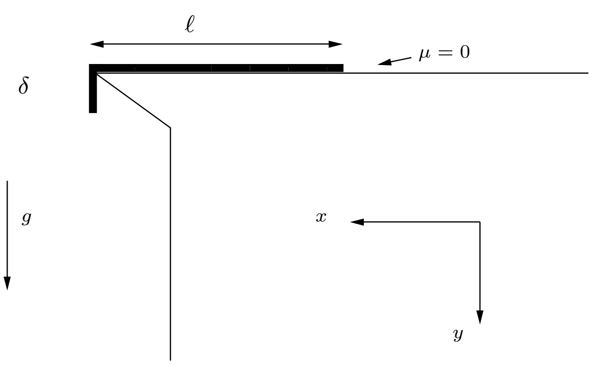

Figure 1:

- 1.2)

A particle slides along a one dimensional surface given by the equation $y(x) = x^2$. Assume the surface is frictionless.

(i) Show that the force, F, on a particle of mass m can be expressed as $F = mv\frac{dv}{dx}$. (Hint: This is a one-liner)

(ii) Find the force on the particle as a function of x (Hint: All forces in this problem are conservative).

(iii) If $x(t = 0) = -d$, determine the time, t, at which the particle arrives at the origin ($x = 0$).

(iv) If $y(x) \rightarrow x^{2n}$ where n is an integer greater than one, qualitatively, how do you expect t to change? Why?

- 1.3)

A box of mass m is situated on top of a sphere of radius R as shown in Figure 2. At what angle, θ, does the box lose contact with the sphere? Assume the box is given a small nudge to get it moving, but that this nudge provides negligible kinetic energy. Further assume that there is not friction between the box and the sphere and that the sphere is held in place during the whole process. Qualitatively, how would the angle change if there were friction in the system?

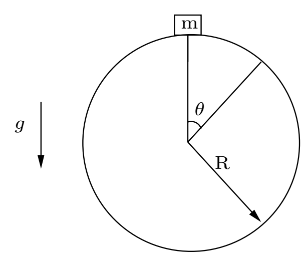

Figure 2: