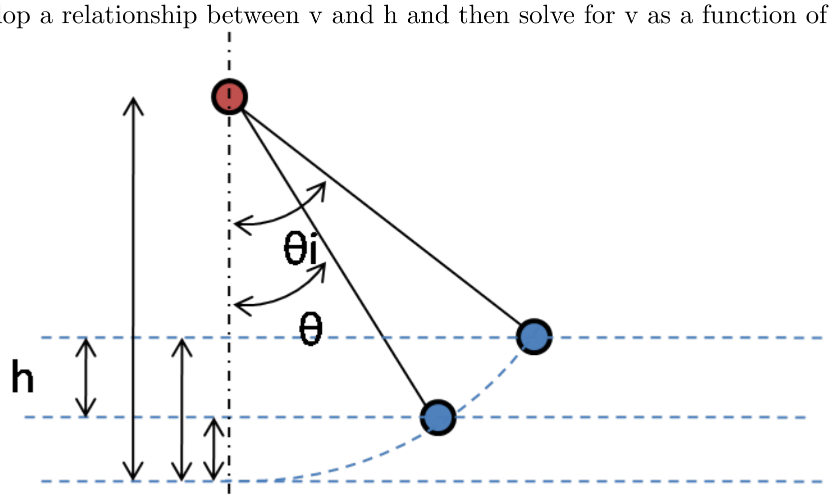
Project 4. Pendulum

The goal of this project is to determine the period of 0.5 m long pendulum as a function of its amplitude, for amplitudes of 10,20,30 and 40 degrees.

1. First, predict the period one one oscillation using the small angle approximation.

For this project, we will not make the approximation that theta is small. You will analyze this problem computationally and then compare your results to an experiment. Use an energy approach. Suppose the pendulum is released from angle θ_i. As it falls, PE is transformed to KE. Develop a relationship between v and h and then solve for v as a function of θ and θ_i.



Next, assume that the pendulum is rigid. If so, there will be no radial component of the velocity and we can replace v with $L\frac{d\theta}{dt}$. Finally, separate variables and prepare your integrals. The time integral you can do easily. The other you can do numerically. CHECK THIS WITH ME BEFORE MOVING ON.

3. Numerically evaluate this integral for $\theta_i = 0.01$ radian. This should be very close to what one would get if they were to use the small angle approximation.

At this point you are probably having an "oh-no" moment. Soemthing is wrong. The problem is that the integrand goes to infinity when $\theta = 0$. There are several ways to handle this.

4. Before moving on, let's try to solve this integral, $\int_0^1 x^{-0.5}dx$. Solve it with pencil and paper and then use a numerical method. Keep refining your numerical method until you reduce your error to ¡0.01. I will suggest alternate algorithms upon request.

5. Return to the pendulum problem and predict the period for initial angles of 10,20,30 and 40 degrees.

6. Use DataStudio to measure the period for these angles. Make a graph of period verses initial angle. Include your predictions and actual measurements on the same graph.

Place cpp and Excel file in the project 4 dropbox. place answers to questions in a comment at the top of your cpp file. Due Wednesday 2-20.