

The "Simple" pendulum

Now that we have looked at the simple harmonic oscillator, it's time to look at another system that is actually not so simple: the simple pendulum. In this case, we will consider a point mass at the end of a massless string. Now, you might think that we're making a lot of approximations here, but actually, even if it wasn't a point mass and even if we allowed for a string with mass, those details can easily be accounted for exactly. What I want to focus on in this computational assignment is that it is only for small angles that the period of the pendulum is approximately independent of amplitude.

Goals of this assignment

1. Write down the Newton's law for the simple pendulum without any finite angle approximation. Include a free body diagram.
2. Write down the Euler-Cromer equations for numerically solving this system. Be able to correctly pronounce "Euler". :-)
3. Successfully writing code to simulate this system. Create a normalized phase space plot for the motion.
4. Use your simulation to compute and plot the period of the pendulum as a function of angle (when released from rest) for angles in the range 0 to $\pi/2$ radians.
5. For $\theta \in [0, \pi/10]$ radians, determine the coefficient, β , of the quadratic term in $T = T_0(1 + \beta\theta^2)$. Include a plot of your simulation for this range of angles and the best quadratic fit to this data. Express the coefficient β as a fraction of the form $1/n$; what is n ?
6. Write all of this up in a Jupyter Notebook with markdown cells explaining your thinking. This assignment is worth 50 points, and should represent your best work to date. Think of it as a take home exam.
7. Your writeup is due by 10 am on Wednesday 5 November in this dropbox folder:
<https://www.dropbox.com/request/0HvDv7xKkXCmcwfvDujl>