EXTRA CREDIT ASSIGNMENT
OPTION #1

Due 11:59 PM Sunday, Dec. 10 2023

Consider Example 6.6 from the lecture notes. This is the motion of a particle confined to the surface of a cone that starts from the origin and extends at a fixed angle α from the z axis. The equations of motion derived in the notes are:

$$\begin{aligned}\ddot{r} &= \frac{L^2 \sin^2 \alpha}{m^2 r^3} - g \sin\alpha \cos\alpha, \\ \frac{d}{dt}\left(m r^2 \dot{\theta}\right) &= 0.\end{aligned}$$

Using $\alpha = 45°$, write a program that prompts you for the following initial conditions at $t = 0$:

- x_0
- $\dot{x}_0$
- $\dot{y}_0$

The program should also prompt the user for the maximum time. Assume $\theta_0 = 0$ which means $y_0 = 0$. Write a program that solves the differential equations and prints out the trajectory θ, r as a list numerous time steps. The output should look something like

t(sec)	θ(deg)	r(m)	Energy
t_0	θ_0	r_0	E_0
t_1	θ_1	r_1	E_1
t_2	θ_2	r_2	E_2
$\vdots$	$\vdots$	$\vdots$	$\vdots$

The total energy E_i at each time step should be constant, so printing out the energy provides a good test of the accuracy of the code.

You need to include a copy of your source code and one example plot. The plot must show an x vs y trajectory. You also need to come to office hours and allow me to run your code so that I can see that it works. I'll compare your output to that from my own code for the same I.C. to determine that it works. Each student earning credit must have their own unique source code. Differential equations must be solved without using Python packages for that specific purpose.

EXAMPLE PLOT: