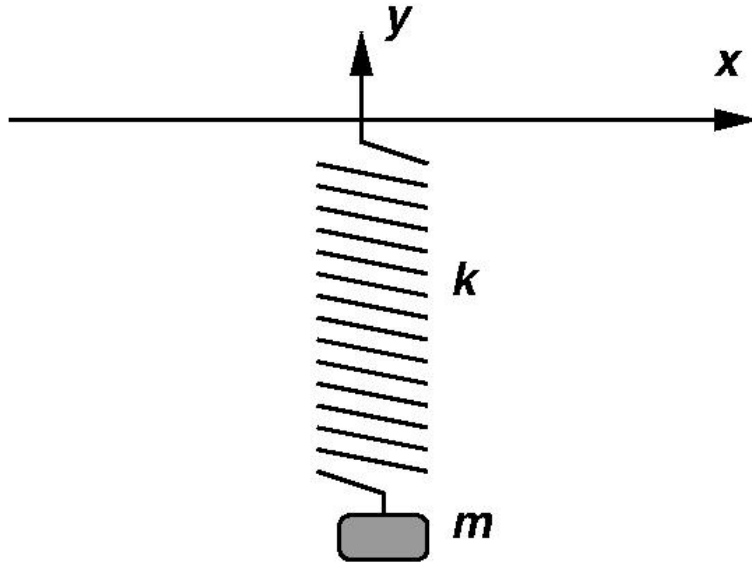


Phys 124 - Freshman Project
Spring 2024
Simulation Homework I

A complicated pendulum is constructed using a spring and a mass suspended from the ceiling as shown in the figure. The spring has a length 10 cm when it is neither compressed or stretched. Its stiffness is $k = 10\text{N/m}$. The mass is $m=100\text{g}$. Take the acceleration of due to gravity to be $\vec{g} = -\hat{y} 10\text{m/s}^2$.



Construct a computer code to simulate the motion of the mass, assuming that it was released from a point of your own choice. Make plots of the x and y coordinates versus time for at least one period of the “swing”, as well as a plot of y versus x .

As an example, my code contains

```
import matplotlib.pyplot as plt
import numpy as np

#####
# Complex pendulum

plt.clf()

n = 5000
dt = 0.001
K=10.0
mass= 0.1

xm=[]
ym=[]
t=[]

# My initial conditions:
xm.append(10.)
ym.append(-10.)
t.append(0.)

vx=0.
vy=0.

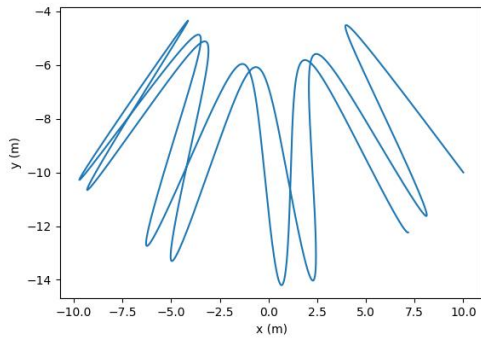
for i in range(1,n):
    xm.append(<new x-value due to vx>)
    ym.append(<new y-value due to vy>)
    t.append(<new t-value>)
# distance from origin:
    d = <calculate distance of mass from origin using x and y>
# force from spring:
    Fs = <force developed by the spring>
    <calculate accelerations in x and y directions due to forces>
    vx = vx + dt* . . . <update x velocity from acceleration>
    vy = vy + dt* . . . <update y velocity from acceleration>

plt.plot(xm,ym)
plt.xlabel("x (m)")
plt.ylabel("y (m)")

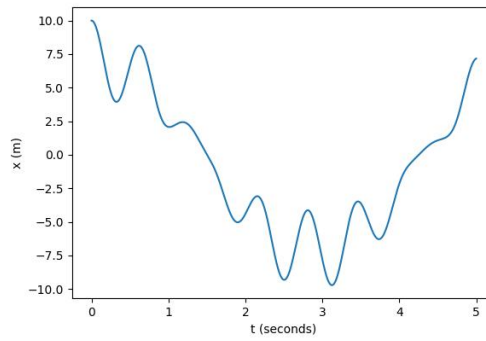
plt.plot(t,ym)
plt.xlabel("t (seconds)")
plt.ylabel("y (m)")

plt.show()
```

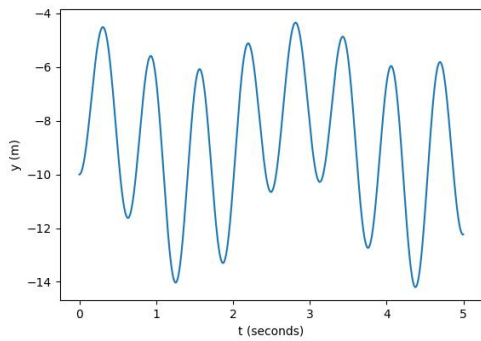
My program gives the plots



y vs x plot.



x vs t plot.



y vs t plot.

You can check that the size of the timestep (Δt) strongly influences the accuracy of the solution.

Please display your results in a PDF manuscript format, using the double-column format of the APS journals and submit it through the Moodle system.

An example LaTeX file is provided through the assignment page to serve as a template which you can modify for your assignment.