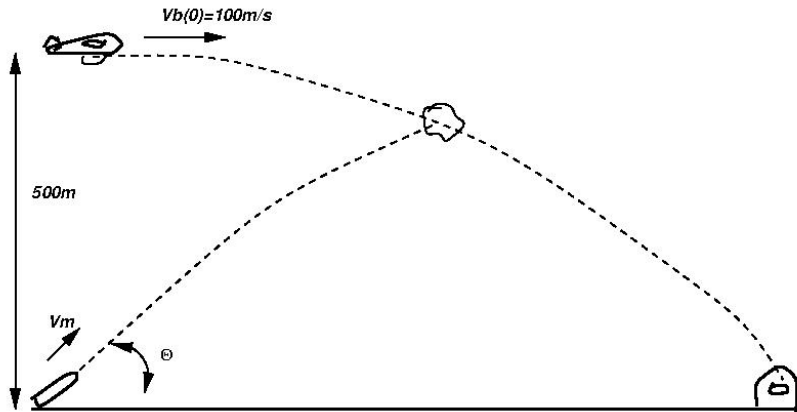


Phys 124 - Freshman Project

Spring 2024

Simulation Homework II

A bomber airplane flying at a height of 500m horizontally with a speed of 100m/s releases a bomb. At the same instant, a missile operator exactly below the airplane fires a missile to destroy the bomb. The operator can make two adjustments to the missile: its initial speed ($5\text{m/s} < V_m < 20\text{m/s}$) and the angle θ with which it is fired. The missile then moves under the effect of its engine (which provides a constant acceleration of $10g$ in the direction of its motion) and the acceleration due to gravity. The missile will be able to destroy the bomb if it can come within a 1m distance of it.



Construct a computer code to simulate the motion of the bomb and the missile. Your code should stop if the distance between the objects is less than 1m, or whenever the height of the missile becomes larger than that of the bomb. Adjust V_m and θ so that the bomb is destroyed. Your code should print out the distance between the objects at the time it stops. You should also obtain an $x - y$ plot of the motion of the objects.

As an example, my code contains

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

plt.clf()

n = 5000
dt = 0.002

xb=[]
yb=[]
xm=[]
ym=[]

# Initial conditions for missile (m) and bomb (b):
xm.append(0.)
ym.append(0.)
xb.append(0.)
yb.append(500.)

vxb=100.
vyb=0.

# Adjustable parameters theta and missile initial velocity:
theta=65. *np.pi/180.
vm=7.

vxm=vm*np.cos(theta)
vym=vm*np.sin(theta)

for i in range(1,n):
    xm.append(...)
    ym.append(...)
    xb.append(...)
    yb.append(...)
    ...
    vyb = ...
    vxm = ...
    vym = ...
# distance between objects:
    d = np.sqrt((xm[i]-xb[i])**2 + (ym[i]-yb[i])**2)
    if d < 1. or ym[i] > yb[i] : break

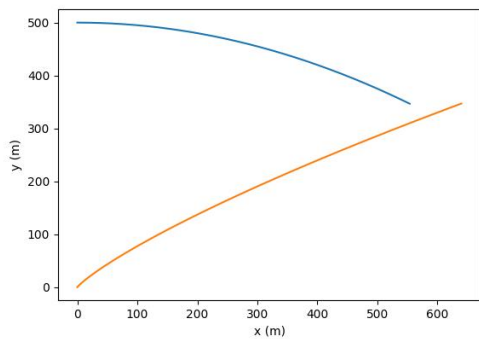
print("Distance between objects: ",d)

plt.plot(xb,yb)
plt.plot(xm,ym)
```

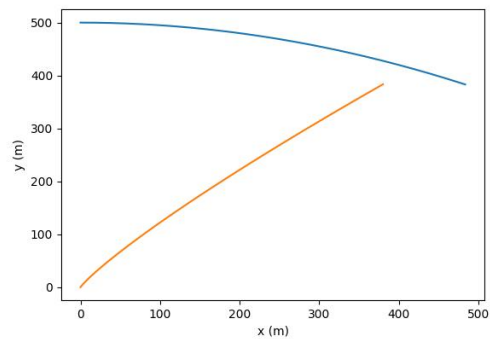
```
plt.xlabel("x (m)")
plt.ylabel("y (m)")

plt.show()
```

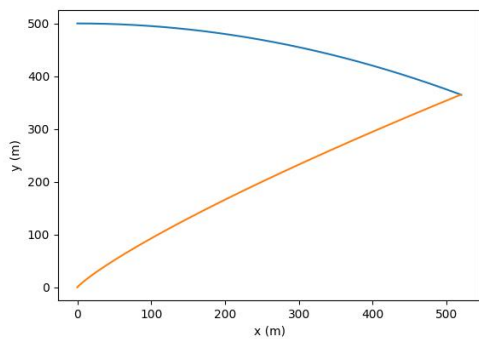
My program gives the plots



Angle a little small or velocity somewhat high



Angle a little high or velocity low



Success!

You can check that the size of the timestep (Δt) 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.