

# Phys 124 - Freshman Project

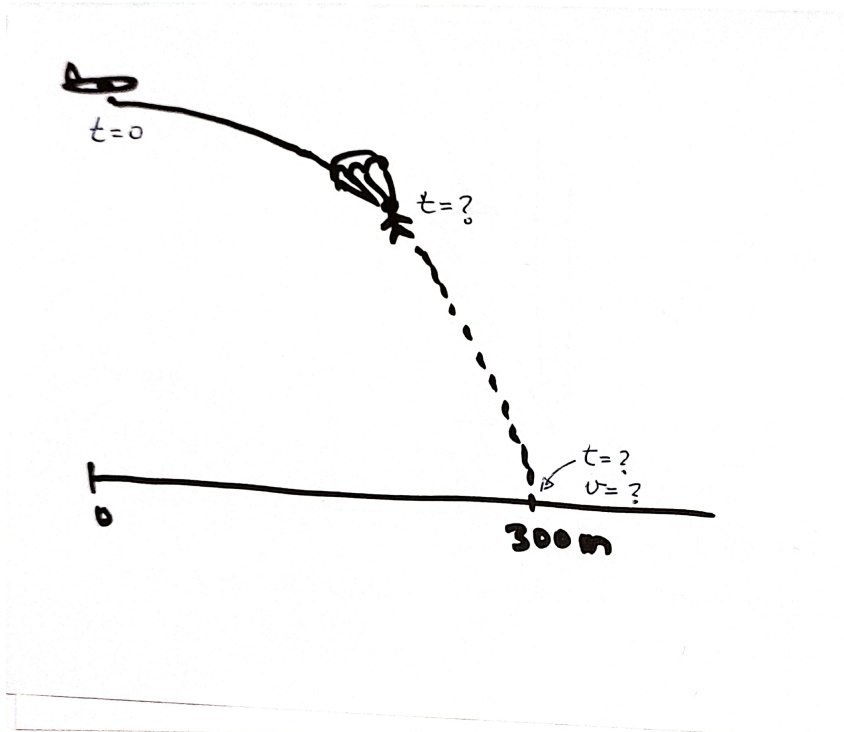
## Spring 2022

### Simulation Homework I

An parachutist jumps off an airplane that is flying with speed 200Km/Hr at an altitude of 500m. She undergoes free flight for some initial time (which you will have to determine), and then opens her parachute. After that, there is an additional force on her due to air friction, so that her overall acceleration is

$$\frac{d}{dt}\vec{v} = \vec{g} - \alpha\vec{v}$$

where  $\vec{g}$  is the acceleration due to gravity,  $10m/s^2$  directed downwards, and  $\alpha$  is a constant with a value equal to 1.0 in SI units. (Notice that the direction of the friction force is opposite the velocity.)



The aim is to open the parachute at the correct time so that the landing is exactly 300 meters after the jump. Write a python code to simulate this event. Your program should print out the distance, time and speed at the landing. It should also produce plots of height vs horizontal distance and height as a function of time.

As an example, my code contains

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

#####
# Fall with a parachute after a free fall

plt.clf()

. . .

x=[]
y=[]
t=[]

x.append(0.)
y.append(500.)
t.append(0.)

for i in range(1,n):

. . .

    if y[i]<0 :
        print("x=",x[i],"vx=",vx,"vy=",vy,"v=",np.sqrt(vx*vx+vy*vy))
        break

plt.plot(x, y)
plt.xlabel("Horizontal distance (m)")
plt.ylabel("Height (m)")

plt.show()

plt.plot(t,y)
plt.xlabel("time (s)")
plt.ylabel("Height (m)")

plt.show()
```

A trial run with the program prints out

```
x= 399.99 vx= 0.0 vy= -10.0000 v= 10.000
```

and produces the following plots

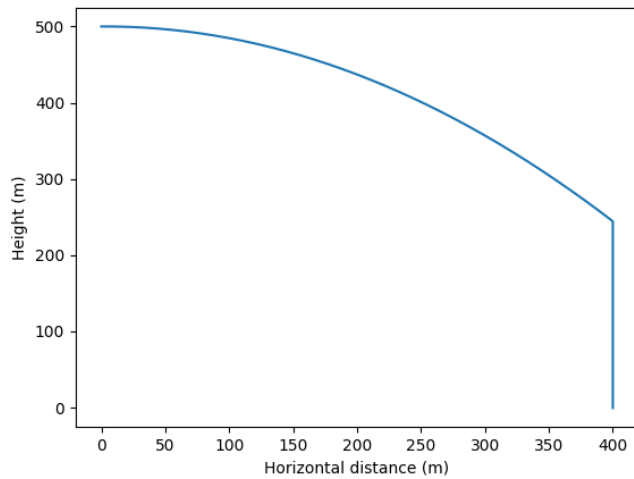


Figure 1: So, the landing is 400m from the jump. I will need to adjust the adjust the parachute opening time to bring that to 350m.

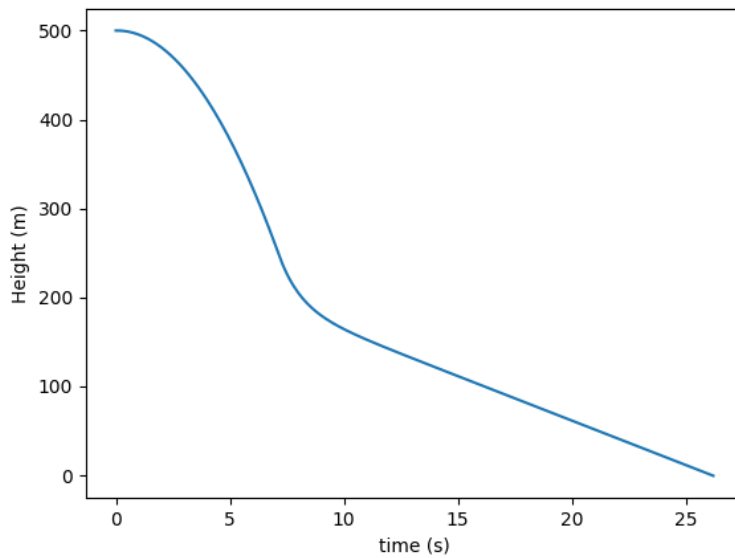


Figure 2: You can see that there is parabolic free fall for the first 7 seconds, then the frictional force becomes effective and the approach to ground is with a constant velocity.

**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.**