

1. Sign-out a laptop. Create a visual window that fills the left half of the computer screen. Turn off the autoscale and make the scene range 800 in the x, 1000 in the y, and 800 in the z. Set the center of the scene to be (0, 0, 0). [Use Python 1, steps 1-4 for guidance]
2. Create a wooden floor near the bottom of the visual window. [Use Python 2, step 2]
3. Create a marble tower that sits on the left edge of the floor and is about as tall as the floor is wide. The tower can be a box just like the floor is, but with a much smaller length and width and a much greater height. [Use Python 2, step 3]
4. Create a colored sphere that sits on the top of the tower. [Use Python 1, step 5]
5. Give the sphere an initial velocity of 50 in the x-dimension and an acceleration of -10 in the y-dimension. [Use Python 2, step 4 and Python 3, step 6]

In standard units, this gives the sphere an initial velocity of 50m/s to the right and an acceleration of -10m/s^2 downward, similar to the surface of the Earth.

6. Define the starting time as zero and give the upcoming while loop a time step of 0.02. [Use Python 2, step 4]
7. To make the sphere move, create a while loop. [Use Python 2, step 4]. Translate into code the following ideas:

while the sphere is above the floor and to the left of the floor's right edge:
position = previous position plus velocity times time step
velocity = previous velocity plus acceleration times time step
run through this loop eighty times per second

Once you have a sphere that leaves the tower and stops when either it reaches the floor or the right boundary of the floor, save it as Your_Name_Python4a.py and email the file to akeller@longmeadow.k12.ma.us.

8. Now lessen the initial velocity of the sphere so that it only travels about one-quarter of the way across the floor before it hits the floor.
9. Also, change the while loop to having only one condition:

while the sphere is left of the floor's right edge

10. Now add an *if* condition near the start of the while loop that makes the ball bounce when it reaches the floor. [Python 3, step 9]

When the sphere bounces across the floor and stops at the right edge of the floor, save and email it as Your_Name_Python4b.py.

11. Now we'll add a few more options. One is to draw a vector which represents the instantaneous velocity of the projectile. Do this with the following line before the while loop:

```
velocity_vector=arrow(pos= sphere1.pos, axis= sphere1.velocity, shaftwidth=2)
```

And inside the while loop:

```
velocity_vector.pos= sphere1.pos  
velocity_vector.axis= sphere1.velocity
```

The first of the three lines creates the arrow, the second places the base of the arrow at the center of the ball, and the third orients the arrow along the velocity of the ball. You'll need to use whatever you called your sphere instead of "sphere1".

12. We'll add a trail that shows the path of the projectile in flight. All it takes is adding the following to the properties of the ball (the line with the color and materials):

```
make_trail=True
```

13. Now we'll add a display that shows the speed of the ball as it is in flight. Use this line before the while loop:

```
speed_label=label(pos=(0,0,0), height=10, color=color.yellow, border=4)
```

This just creates a box in which the information will appear.

14. And these lines in the while loop:

```
sphere1_speed=round(mag(sphere1.velocity),1)  
speed_label.text = "Speed is: " + str(sphere1_speed) + " m/s"
```

What the first of these two lines is doing is defining the speed of the sphere to be the velocity vector magnitude and then rounding it to one decimal place. The second line is defining the text to be inserted into the label created before the while loop.

When your program runs correctly, save it as Your_Name_Python4c and email it.

Bonus (due by the end of class):

Add six graphs on the right side of the computer screen. [Use Python 3b]

x-position vs. time	y-position vs. time
x-velocity vs. time	y-velocity vs. time
x-acceleration vs. time	y-acceleration vs. time

When your program runs correctly, save it as Your_Name_Python4Bonus and email it.