Simulated Kinematics Lab I

In this lab we will use ‘Beyond Labz’ to conduct a simulated experiment. In this experiment we will explore how to present data in different ways to highlight different aspects of the phenomenon being studied. Line graphs are used to describe the motion of an object such as a rolling ball, a moving automobile, or an airplane in flight. However, there are different types of motion graphs that each express different properties of motion. Displacement graphs, x vs. y graphs, and velocity graphs may all be used to graph the exact same motion, but they each use different data and are used to communicate varying information.

Please look over the entire worksheet before you begin the experiment.

Procedure

1. Start Virtual Physics and select Graphing Constant Velocity Motion from the list of assignments. The lab will open in the Mechanics laboratory.

2. The laboratory will be set up with a 10 kg ball on a table. Attached to the ball is a plunger that will be used to hit the ball. You will hit the ball and observe it as it rolls across the table. You will record the position and velocity of the ball over a period of time in your Lab Book and then use your data to make several graphs of the motion.

3. Click on the red Recording button to start recording data. Start the ball rolling by clicking on the Force button. Click the Pause button to stop the experiment before the ball hits the wall. A link will appear in the Lab Book. This contains the position and velocity versus time data for the ball as it rolls across the table.

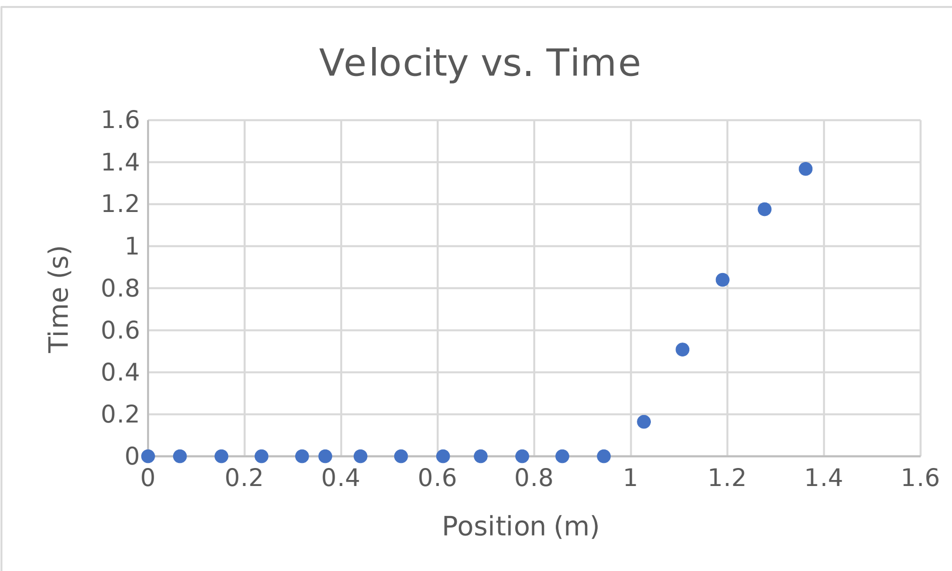
4. Click the Reset button. Repeat the experiment by changing the force to 1600 Newtons using the Parameters Palette and under the Forces tab. Click in the Lab Book next to each link to label each with the corresponding mass and direction.

5. Reset the experiment again and under the Forces tab, change the angle to 30 degrees and the force to 800 N. This will move the plunger to hit the ball at an angle. Repeat the experiment, stopping after 2 bounces off the wall. Label the link in the Lab Book 2D Bounce.

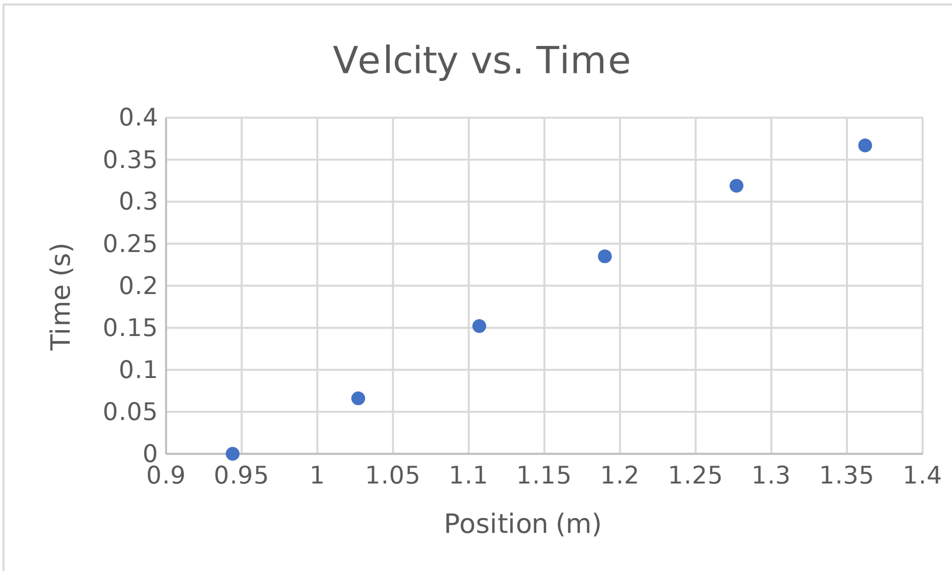
6. Copy all of the data you have collected and paste it in a new Excel workbook. Make sure to label all of your data appropriately with the corresponding units.

Data Manipulation

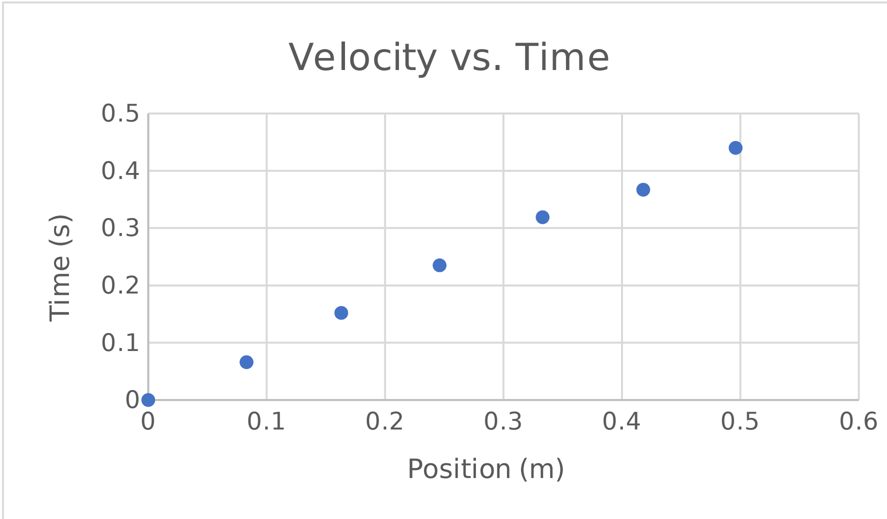
Many times, when we conduct an experiment, we begin collecting data before the experiment starts. For example, imagine we were measuring the position of an object over a period of time at a constant velocity. We must start recording data before the object begins its motion otherwise, we may miss some important data. Therefore, the velocity corresponding to the first second or two will be zero. If we plot this, we get the following.



In order to get an accurate fit during regression analysis we must delete the useless data and shift the data corresponding to the motion back to the origin. We see the last data point before there is a non-zero velocity occurs at 0.944 s. We can see this by hovering over the corresponding data point. In excel, you can delete the time and velocity all the way up to that data point. If this is done correctly, you get the following graph.



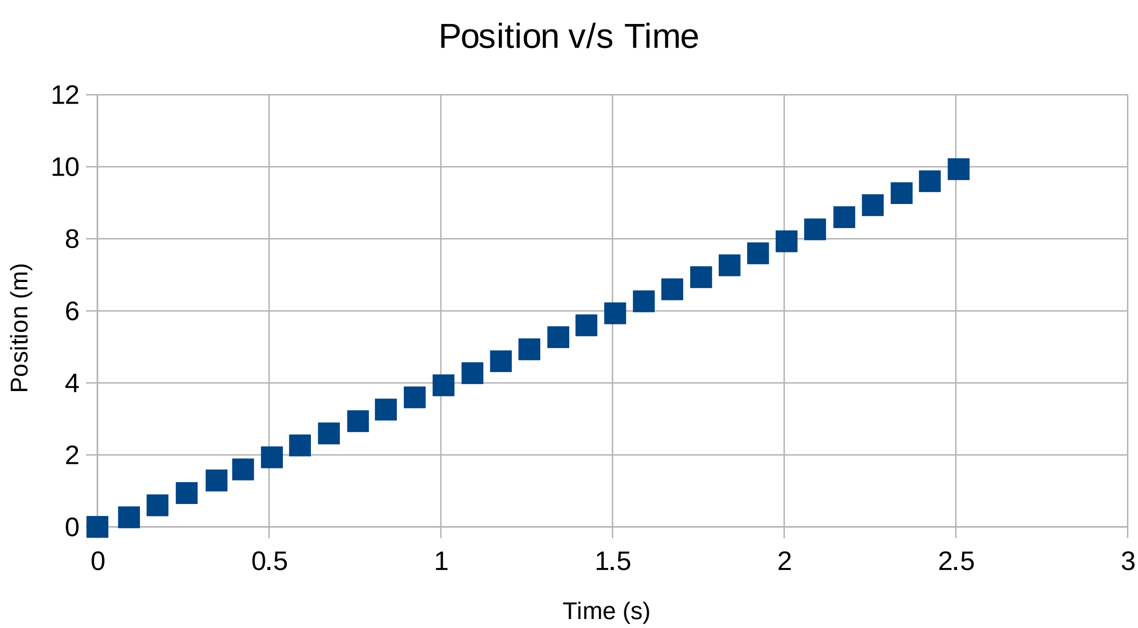
Now we must shift the data back to the origin. We can do this by subtracting 0.944s from the entire time column. First, click on the second cell of an empty column. Now in the function input type the equal sign (=) and then click on the first time of the old time column. The cell label should appear in the function input. Now type -0.944. The function input should look similar to the following: (=A1-0.944). Now click back on the cell in the new time column and click and drag the bottom right hand corner of the cell straight down. You will see the time column will auto populate with the new times according to the equation you entered into the function input. Make sure you populate enough cells for the amount of data you have collected. Now copy and paste the position data to the right of the new time column and plot. You should get the following:



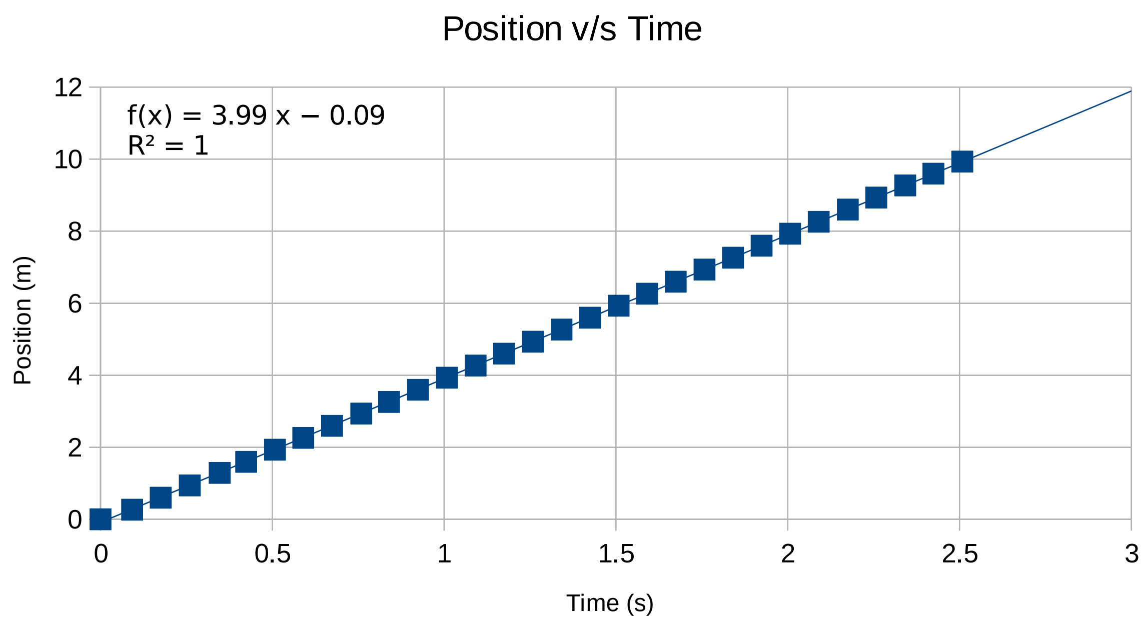
Now the data is ready for regression analysis. It is important that you can manipulate the data to present it properly.

Data Analysis

1. Plot the position versus time graph from step 3 with all the appropriate axes and graph titles and paste it in the space below



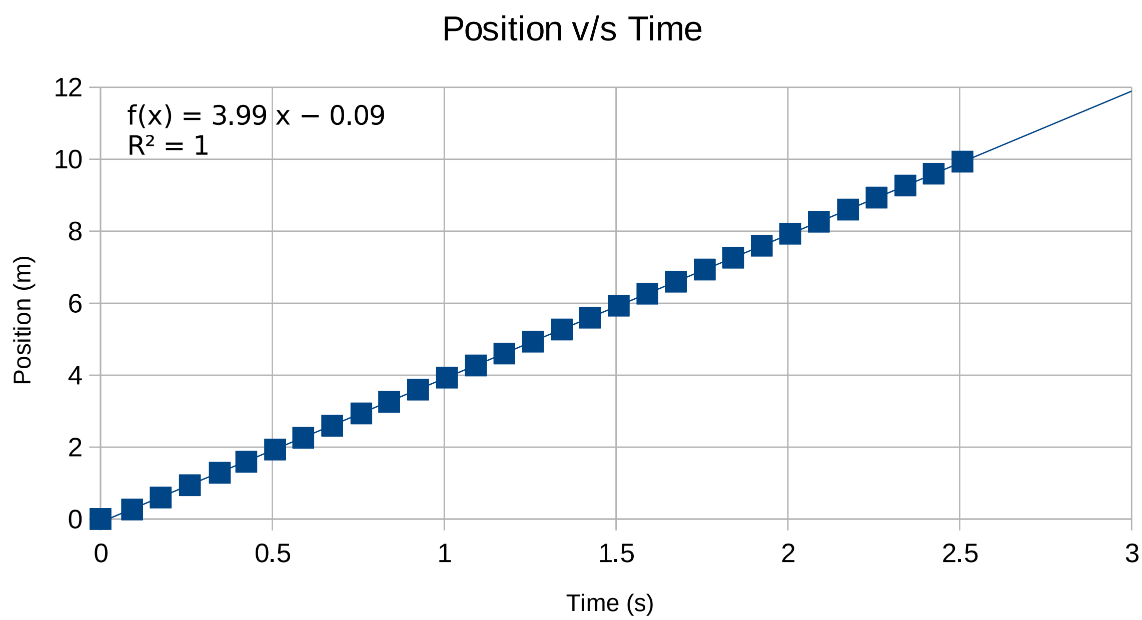
2. Fit the data to a linear equation. Since the acceleration is zero, this equation corresponds to the kinematic equation $x(t)=vt+x_o$. Make sure the graph shows the trendline, equation of best fit, and the R-squared value. Paste the new graph below.



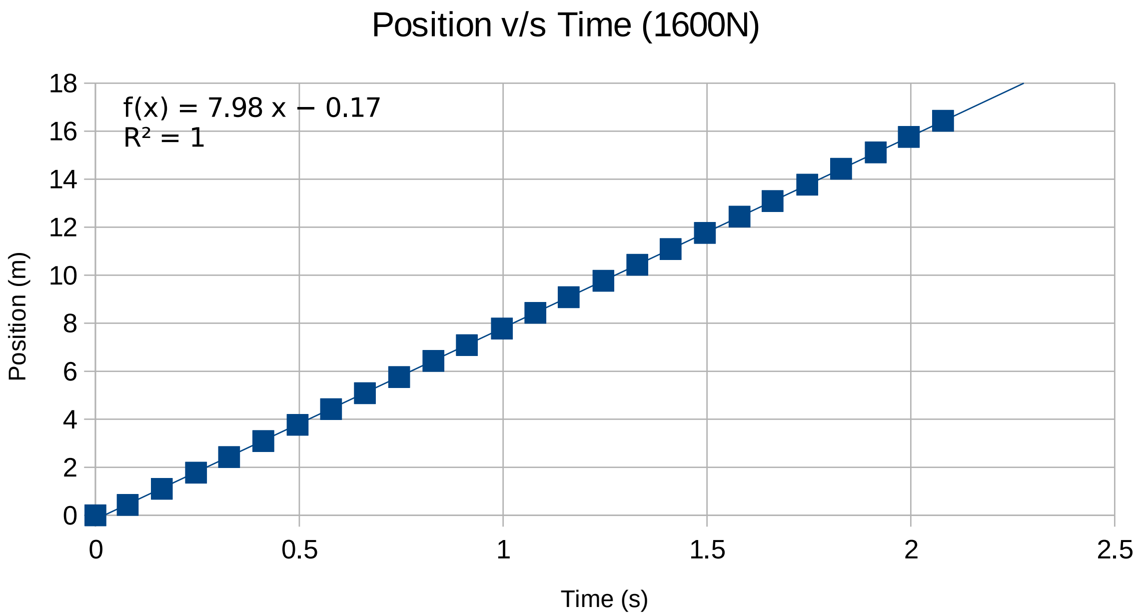
3. What is the velocity of the ball obtained from the fit?

v = 3.99m/s

4. Plot the position versus time graph form step 4 with all the appropriate axes and graph titles and paste it in the space below



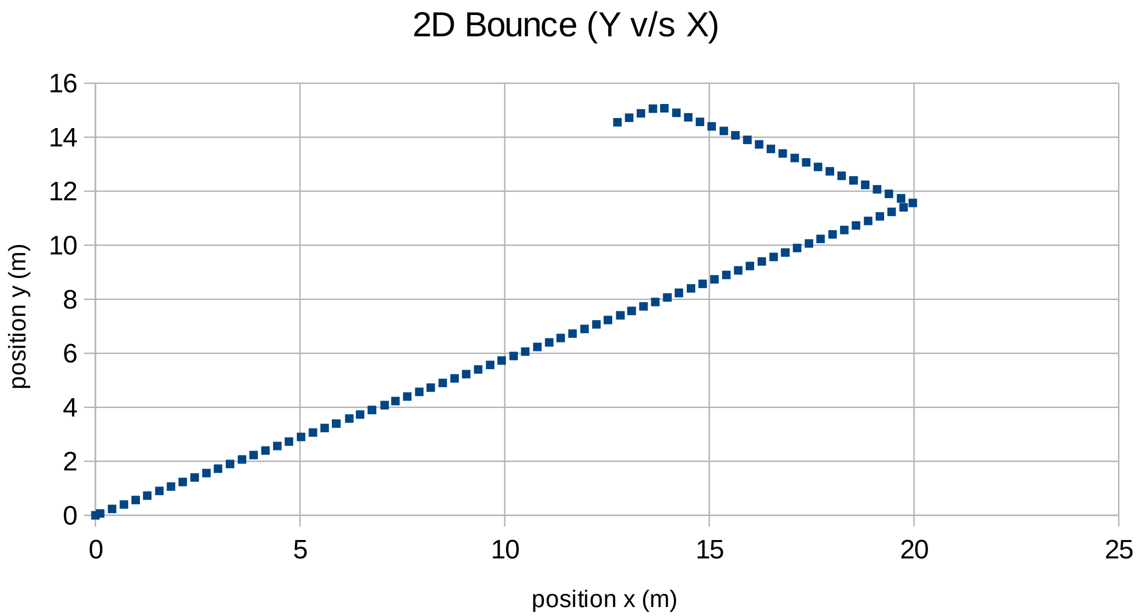
5. Fit the graph with a linear equation and paste the new graph below. Make sure the trendline, equation of best fit, and R-squared value are visible



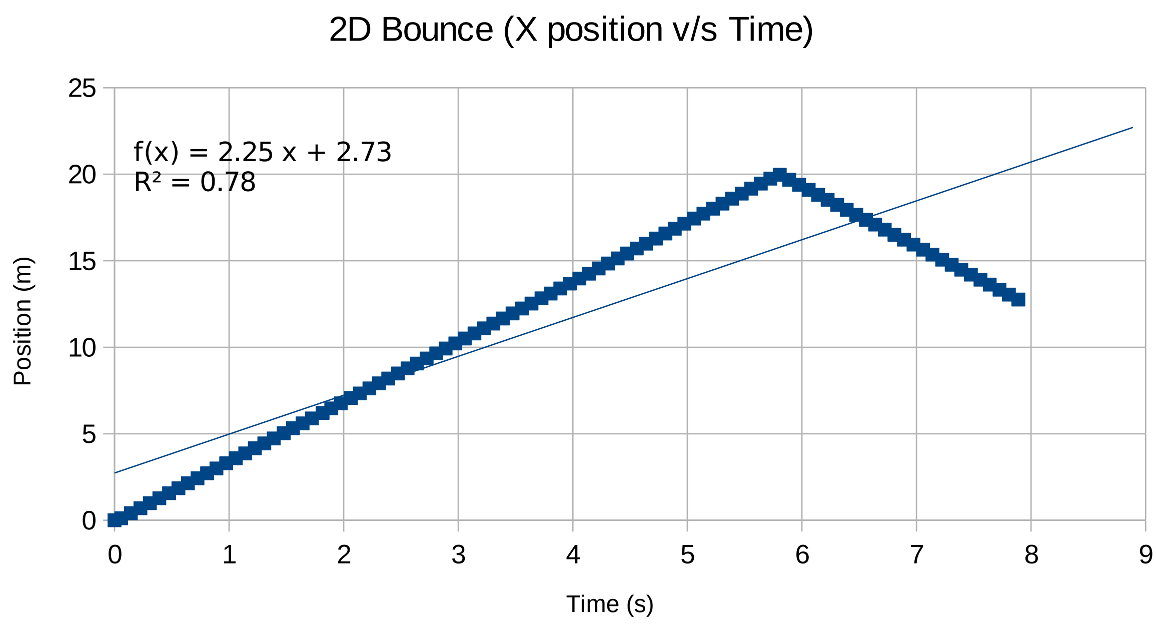
6. Did the velocity increase or decrease from changing the force? Explain why this happened.

The velocity increased by increasing the force. This is because a larger impulse acted on the ball when it was hit by the plunger.

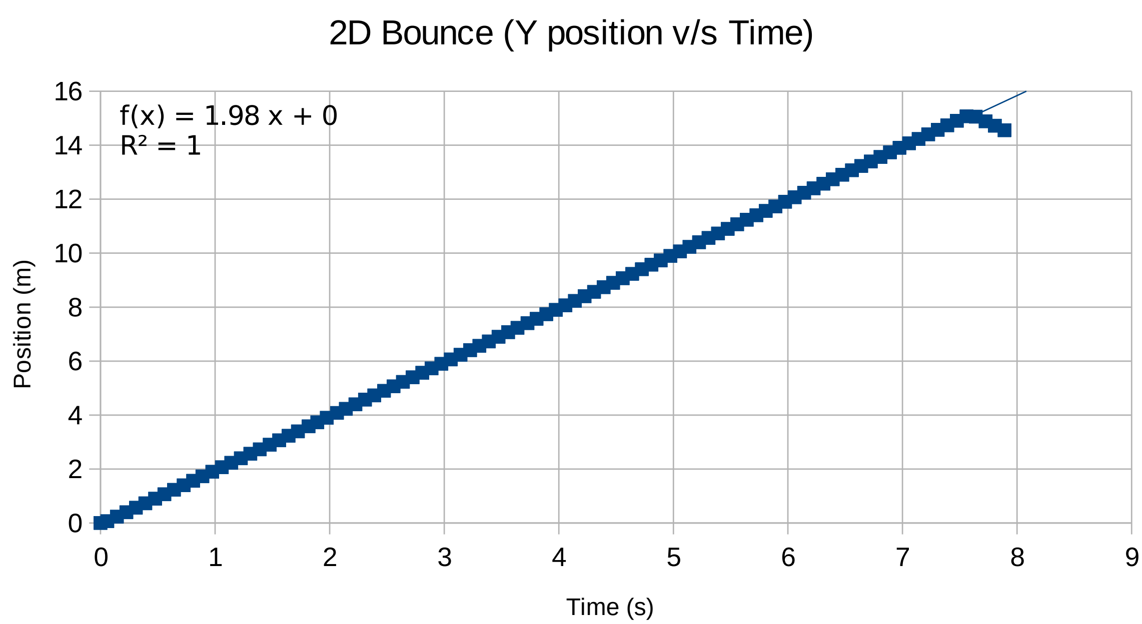
7. Graph the x-position versus the y-position from the data collected in step 5. Make sure the graph as the appropriate titles and units. Paste the graph in the space below.



8. Plot the x-position versus time and fit the data to a linear equation. Make sure the graph has the appropriate units titles, trendline, equation of best fit, and R-squared value. Paste the graph in the space below.



9. Plot the y-position versus time and fit the data to a linear equation. Make sure the graph has the appropriate units titles, trendline, equation of best fit, and R-squared value. Paste the graph in the space below.



10. Why are the velocities in question 8 and 9 different from one another? Calculate the magnitude of the velocity. How does this compare to velocity found in question 5?

The velocities in question 8 and 9 are different because these velocities in different directions and are independent.

$|v_{2D\ Bounce}| = (2.247^2 + 1.979^2)^{0.5} = (5.049 + 3.916)^{0.5}$

$|v_{2D\ Bounce}| = 2.994$ m/s

$v_5 = 7.980$ m/s