Examining Bouncing Balls with Fathom[1]

Introduction:

Imagine what happens when you drop a ball onto a hard surface, such as a floor. The ball will descend, hit the surface, and then ascend back up. How does the height of the bouncing ball change over time? How does each height of each bounce compare to the previous bounce height? These are the questions we will investigate in this experiment.

To investigate these questions, we will collect data using the motion detector.

Data Collection:

(1) Plug the Motion Detector into the USB port of the computer that is running Fathom.
(2) Select Motion Detector from the Meter and drag it to the Fathom window. If the motion detector is on, you should notice that distance measures are appearing in the Meter.
(3) Drag a Collection from the shelf and place it in the Fathom window. Drag the plug from the Meter to the Collection to make an Experiment. Collect by Time, and choose 30 cases per second for 5 seconds.
(4) Click on the Collection and drag a Case Table to the Window.
(5) Drag a Graph to the window and drag the attribute Distance to the dependent axis and the attribute Time to the independent axis.
(6) Make sure the Motion Detector setting is switched to the Ball. One person should hold the motion detector above the ball.
(7) Click Turn Experiment On and when the Motion Detector begins to click, drop the ball.
(8) Examine the data and graph. You may repeat steps 6 and 7 until you collect a “good” set of data.

Questions:

Q1. Describe the relationship between the graph of the bounce and the distance of the ball from the motion detector.

Q2. Use the graph to determine: the height of the motion detector from the floor, and the highest bounce of the ball.

Q3. Describe how you could transform the data so that the graph looks like the physical bounce of the ball. The greatest height of a single ball bounce is the maximum value of the graph.

Q4. Using your descriptions, transform the data to represent the ball bouncing on the floor. Using complete sentences, explain why the plot appears to look like the ball bounced across the floor.

Q5. Bring down a new Case Table. Input the time and greatest height for each bounce.

Q6. Determine the ratio between the heights for the each successive bounce.

Q7. Write a function to represent the data you have created.

Q8. Is your data finite or infinite? Explain your reasoning using complete sentences.

Q9. Can the data that you have collected be summed? If so, write your function using summation notation and calculate the sum.

Q10. Create a graph of the distance versus the time for the bounce heights.

Q11. Use sliders to create a function to model the rebound heights of the ball versus time. Explain the parameters in the function, how they are related to the context of the bouncing ball, and mathematically describe the function.

Q12. Create a graph demonstrating the inverse of the distance versus the time for the bounce heights.

Q13. Use sliders to create a function to model the inverse graph. Explain the parameters in the function, how they are related to the context of the bouncing ball, and mathematically describe the function.

Q14. Describe all the relationships that you have noticed throughout the experiment.

[1] Adapted from http://www.vernier.com/experiments/rwcalc/11/thats_the_way_the_ball_bounces_-_height_and_time_for_a_bouncing_ball/