Bounce Back

OBJECTIVES

- Record the successive maximum heights for a bouncing ball.

- Model the bounce height data with an exponential function.

PROCEDURE

1. Connect the Motion Detector to the TI-Nspire calculator.

2. Position the Motion detector about 1.5 m above the floor, so that the disc is pointing straight downward.

3. Set up the Motion Detector so that distance above the floor will read as positive position. Press **menu >Experiment >Set Up Sensors >CBR 2/Go!Motion**. Check the box next to **Reverse Readings**. Then click **Zero**.

4. Practice dropping the ball so that it is bounces straight up and down beneath the Motion Detector.

5. Start data collection by pressing the **green arrow** on the calculator screen. The calculator will automatically stop the data collection after 5 seconds.

6. Press **>menu >Graph >Show Graph >Graph 1**. Only the Position vs. Time Graph will be displayed. Examine the graph; it should contain a series of parabolic regions. If necessary to repeat data collection, repeat step 5.

7. Disconnect the Motion Detector from the TI-Nspire calculator.

ANALYSIS

1. Click any data point and use the ► and ◄ (left and right arrows) to trace across the graph and read the maximum height of each bounce from your distance versus time data. Start with the initial release height, and call that bounce number zero. Record the consecutive maximum rebound heights for the next five bounces.

2. Enter the information from your data table into list in List & Spreadsheets and create a graph of rebound height versus bounce number.

   a. Insert a new page in the document. Press **doc>Insert >Lists & Spreadsheet**.

   b. Label column A **bounce** and column B **height**. Enter the data from your table. When you are done, you will have six entries in each column.

   c. Add a Data & Statistics page. Press **doc >Insert >Data & Statistics**.

   d. On the horizontal axis, click to add variable. Choose **bounce**.

   e. On the vertical axis, click to add variable. Choose **height**.

Adapted from *Real-World Math with Vernier*

3. Fit an exponential model $y = a(B)^x$ to your data.

   a. Answer Analysis Question 1. Record your values for a and B in the Data Table. Round to 3 decimals.

   b. Press **menu >Analyze >Plot Function**. Enter your function from Analysis Question 1. Press **enter**.

4. Find the exponential regression.

   a. Another way to determine the a and B parameters is to do an exponential regression. Plot a regression line on your scatter plot. Press **menu > Analyze >Regression >Show Exponential**.

   b. Record your values for a and B in the Data Table. Round to 3 decimals.

5. Answer Analysis Questions 2 – 6.

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Mathematician _____

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DATA TABLES

Bounce Number	Maximum Height (m)
0	
1	
2	
3	
4	
5	

	Values Calculated from Analysis Question 1	Values Calculated from Exponential Regression
a		
B		

ANALYSIS QUESTIONS

1. Use the points from bounce 1 and bounce 4 to write an exponential function in the form $y = a(B)^x$.

2. What does a represent in the model?

3. What does B represent in the model?

Adapted from *Real-World Math with Vernier*

4. How do the values of a and B in the exponential regression equation compare with the values you determined in Analysis Question 1?

5. Suppose that you repeat this activity using a ball that is not as resilient (does not rebound as well) as the ball you used. For example, if you used a basketball, imagine that some air is let out of it, and then the exercises is repeated. Would the constants a and B in the equation $y = a(B)^x$ be affected by this? How?

6. Use either one of the models developed in this activity to estimate the smallest number of bounces required by the ball for the rebound height to be less than 10% of its starting height. Remember that the number of bounces must be an integer. Show work to support your answer.