

# Investigating a Sequence Using the TI-83 Plus Calculator and the TI Calculator-Based Ranger (CBR)

2.2

In this activity, you will explore the changing height of a bouncing ball and develop a sequence that will predict the maximum height of the ball after each bounce. You will also find the total vertical distance that the ball travels after a number of bounces.

## Equipment

- TI CBR (Calculator-Based Ranger)
- TI-83 Plus graphing calculator
- ball (a racquetball or a large rubber ball)



## Procedure

1. Connect the CBR to the calculator. Turn on both the calculator and the CBR.
2. Press **[APPS]** on the calculator.
3. Select **2:CBL/CBR** and press any key. Then select **3:RANGER** and press **[ENTER]**.
4. From the main menu of the RANGER program, select **3:APPLICATIONS**.
5. For the units, select **1:METERS**. Under the applications menu, select **3:BALL BOUNCE**.
6. Follow the directions on your calculator's screen. Choose one person to release the ball and another to operate the CBR. Release the ball, making sure that the CBR is at least 0.5 m above the ball. Press the **TRIGGER** key on the CBR just before the ball hits the ground.
7. Your graph should have at least five bounces. If this is not the case or you are not satisfied with the results of your experiment, press **[ENTER]**. Then select **5:REPEAT SAMPLE**, and try the experiment again.
8. When you are satisfied with your data, sketch the graph of height versus time.

## Analyzing the Data

1. Use **[▢]** and **[TRACE]** to find the approximate maximum height of the ball,  $y$ , after the first bounce. After each bounce,  $n$ , record the maximum height of the ball,  $y$ , in your notebook, using a table. Use these values to calculate the total vertical distances, as described in the table, travelled by the ball.

| Bounce,<br>$n$ | Maximum<br>Height of the<br>Ball After<br>Bounce $n$ , $y$ (m) | $\frac{\text{Maximum Height After this Bounce}}{\text{Maximum Height After Previous Bounce}} \times 100 (\%)$ | Total Vertical<br>Distance<br>Travelled by<br>the Ball Between<br>this Bounce and the<br>Next Bounce (m) | Total Vertical<br>Distance<br>Travelled<br>Since $t = 0$ (m) |
|----------------|----------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------|--------------------------------------------------------------|
| 1              |                                                                |                                                                                                               |                                                                                                          |                                                              |
| 2              |                                                                |                                                                                                               |                                                                                                          |                                                              |
| 3              |                                                                |                                                                                                               |                                                                                                          |                                                              |
| 4              |                                                                |                                                                                                               |                                                                                                          |                                                              |
| 5              |                                                                |                                                                                                               |                                                                                                          |                                                              |

- Press **[ENTER]** to return to the **PLOT MENU** and select 7:QUIT to exit the RANGER program.
- Plot the data points representing the maximum height of the ball on a scatter plot. Press **[STAT]**, select 1:Edit to enter the bounce number,  $n$ , in L1 and the maximum height of the ball after each bounce,  $y$ , in L2. Press **[2nd]** **[Y=]**. Press **[ENTER]** to select Plot1. Press **[ENTER]** again. For **Type**, select the second graph; for **Xlist**, select L1; for **Ylist**, select L2; and select the square for **Mark**. To see a plot of this data, press **[ZOOM]** **[9]**.
- Write the sequence that represents the maximum height of the ball after each bounce. Describe this type of sequence. Use the third column in your table to help you determine the general term,  $t_n$ , that models this sequence.
- Rewrite your model for  $t_n$  by substituting  $x$  for  $n$ . Press **[Y=]** and enter the equation of your model. Press **[ENTER]** and then **[GRAPH]**. Describe how well the model fits the data.
- Use **[TRACE]** and the graph of your model to predict the maximum height after each bounce from  $n = 1$  to  $n = 8$ . Record your predictions in your notebook.
- Use your model to calculate the total vertical distance travelled by the ball after the first
  - five bounces
  - eight bounces
  - Compare the answer you found in (a) to the total vertical distance that you calculated for the table.
- Suppose you dropped a large super ball from a great height. Explain the difficulty of using this method to calculate the total vertical distance travelled by the ball after the first 20 bounces.
- Repeat this exploration to determine how the maximum height and the total vertical distance travelled by the ball is affected by different surfaces, for example, a concrete floor, different balls, or different initial heights.