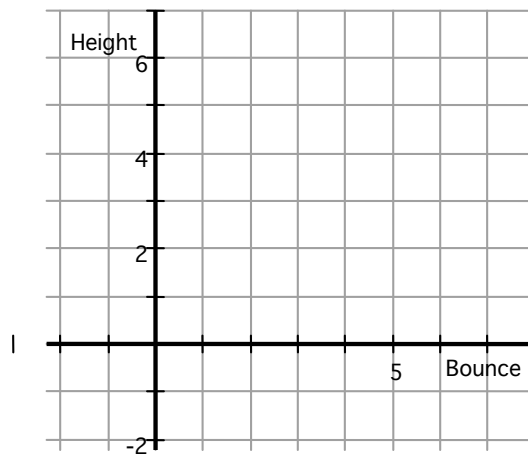# Using Recursion in Models and Decision Making: Recursion in Exponential Growth and Decay

IV.B Student Activity Sheet 3: Recursion and Exponential Functions

Different balls bounce at various heights depending on things like the type of ball, the pressure of air in the ball, and the surface on which it is bounced. The rebound percentage of a ball is found by determining the quotient of the rebound height (that is the height of each bounce) to the height of the ball before that bounce, converted to a percentage.

1. Collect data on a bouncing ball that show the maximum height of at least five bounces of the ball. Then make a scatterplot of the maximum height as a function of the bounce number. (Let Bounce 0 be the initial drop height of the ball.)

Bounce No.	Height
0	
1	
2	
3	
4	
5	

2. Find the average rebound percentage for your ball. Show your work.

Bounce No.	Height	Process	Rebound Percentage
0			
1			
2			
3			
4			
5			

Using Recursion in Models and Decision Making: Recursion in Exponential Growth and Decay

IV.B Student Activity Sheet 3: Recursion and Exponential Functions

3. Tennis balls are sealed in a pressurized container to maintain the rebound percentage of the balls. A tennis ball has a rebound percentage of 55% when it is taken out of the pressurized can. Suppose a tennis ball is dropped from a height of 2 meters onto a tennis court. Use the rebound rate given to predict the height of the ball's first seven bounces.

Bounce No.	Process	Height (m)
0	(initial drop height given)	2
1		
2		
3		
4		
5		
6		
7		

4. Write a recursive rule for the height of the ball for each successive bounce.

5. Describe, in words, how the height of each bounce is calculated from the height of the previous bounce.

Using Recursion in Models and Decision Making: Recursion in Exponential Growth and Decay

IV.B Student Activity Sheet 3: Recursion and Exponential Functions

---

6. Enter the bounce height data into a graphing calculator. Make a scatterplot and then sketch the graph below.
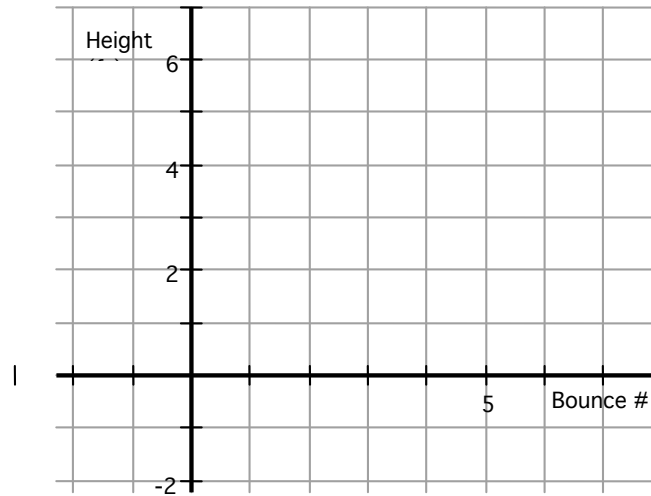
7. What kind of function might model the tennis ball bounce situation? Explain your reasoning with a table of values or other representation.

8. Look back at the table you generated in Question 3. Write a function rule for bounce height in terms of bounce number. Graph the function rule with the scatterplot on your graphing calculator to see if the function rule models the data.

9. What is the height of the fifth bounce of a new tennis ball if the initial drop height is 10 meters above the ground? Use a function rule to find your answer.

10. Suppose a new tennis ball is dropped from a height of 20 feet. How many times does it bounce before it has a bounce height of less than 4 inches (the diameter of the ball)? Explain your solution.

11. What is the total vertical distance that the ball from Question 10 has traveled after six bounces? Explain your answer.

12. REFLECTION: How can you decide if a data set can be modeled by an exponential function? How are recursive rules different from function rules for modeling exponential data? How are they the same?

Using Recursion in Models and Decision Making: Recursion in Exponential Growth and Decay
IV.B Student Activity Sheet 3: Recursion and Exponential Functions

13. **EXTENSION:** As our population uses more antibiotics for minor infections, bacteria adapt and become resistant to the medications that are available. Methicillin-resistant *Staphylococcus aureus* (MRSA) is strain of *Staphylococcus* bacteria that is resistant to antibiotics. MRSA causes skin and respiratory infections and can be fatal. The Center for Disease Control (CDC) reported that in the United States 94,360 MRSA infections occurred in 2005, with 18,650 of these cases resulting in deaths. To put this number in perspective, CDC reported 16,316 deaths in 2005 related to AIDS.

A research lab is observing the growth of a new strain of MRSA in an agar dish. The initial area occupied by the bacteria is 2 square millimeters. In previous experiments with MRSA, scientists observed the bacteria to increase by 20% each week.

- Fill in the table, showing the increase in area of the bacteria over eight weeks.
- Write a recursive rule for the area (*a*) of the bacteria after *n* weeks.
- Then make a scatterplot of the data.

Week	Process	Area (mm^2)
0		2
1		
2		
3		
4		
5		
6		
7		
8		
n		

Using Recursion in Models and Decision Making: Recursion in Exponential Growth and Decay

IV.B Student Activity Sheet 3: Recursion and Exponential Functions

    a. How are the data in this situation the same and different from the data in the rebound rate situation? Consider the data, recursive rule, and graph in your response.

    b. Write a function rule that models the area of MRSA bacteria in terms of the number of weeks they grow. Describe where the values in the function rule appear in the data. Graph the function rule with a scatterplot to check the rule.

    c. Use the function rule to predict the area of the MRSA bacteria after 20 weeks.

14. EXTENSION

- Research a set of population data. Use data from a country's census report or other state/national population data or animal population data.
- Cite the source of the data.
- Decide if the data, or a portion of the data, can be modeled by an exponential function.
- Support your decision with a mathematical argument.
- Find an appropriate model for the data.
- Based on your model, make a prediction about the population.

Charles A. Dana Center at The University of Texas at Austin   Advanced Mathematical Decision Making (2010)
Activity Sheet 3, 5 pages

14