CHAPTER 18

Teaching Suggestions

Science and Mathematics Lab

(Course 3, Lesson 12-2)

The Way the Ball Bounces

OVERVIEW

This activity will involve students in graphing quadratic equations. They will be asked to make predictions and to use information from the graphs to learn about constants.

RECOMMENDED TIME

1 class period

MATERIALS

- TI graphing calculator
- Calculator-Based Ranger (CBR)
- grid paper
- ball (racquetball or basketball)

PREPARATION

Before starting this exercise, it is recommended that you clear all previous programs from the graphing calculator memory to ensure proper functioning of the CBR program. To do this, turn the calculator on. Then press 2nd [MEM] 5 1 2.

Download the Ranger program into the calculator by connecting the CBR to the calculator. Press 2nd [LINK] ▶ ENTER on the calculator. Press the 82/83 button on the CBR. Start the Ranger program by pressing PRGM on the calculator. Select RANGER from the menu and press ENTER. Select 3: APPLICATIONS from the main menu. From the UNITS? menu, select 1: METERS ENTER. From the APPLICATIONS menu, select 3: BALL BOUNCE ENTER ENTER.

TEACHING THE LAB

1. Have students work in groups of three. One student should release the ball, one should hold the CBR unit, and one should record the data from the calculator.

Teaching Suggestions

Science and Mathematics Lab

(Course 3, Lesson 12-2)

The Way the Ball Bounces (continued)

2. It will be necessary to show the students how to use the CBR. The student holding the unit will need to press TRIGGER to initiate data collection. Emphasize the importance of holding the unit steady while it is collecting data.

3. For best results, do not use a soft or felt-covered ball. The student who releases the ball should be reminded to remove his or her hands quickly.

Answers and Conclusions

1. Students should graph the following points and draw a parabola to connect them.

$y = -1(x - 3)^2 + 5$

x	*y*
1	1
2	4
3	5
4	4
5	1

2. Students should graph the following points and draw a parabola to connect them.

$y = 1(x - 3)^2 + 5$

x	*y*
1	9
2	6
3	5
4	6
5	9

Changing the sign of A inverts the parabola.

3. Answers should be either positive or negative.

4. Answers may vary; no change, increase, or decrease.

5. Answers may vary, but should be approximately –4.9.

6. gravity

CHAPTER 18

Name _____ Date _____

Science and Mathematics Lab

(Course 3, Lesson 12-2)

The Way the Ball Bounces

INTRODUCTION

The motion of a bouncing ball can be described by a quadratic equation. The curve that results from a graph of the height of the ball over time is called a *parabola.* How quickly the ball accelerates and the maximum height that the ball bounces will affect the shape of the parabola. These variables are factors in the quadratic equation.

OBJECTIVES

In this lab, you will:

- graph the distance of a ball from the floor over time as it bounces.
- compare the equations for different bounces to see how they change.

MATERIALS

- TI graphing calculator
- Calculator-Based Ranger (CBR)
- grid paper
- ball (racquetball or basketball)

PROCEDURE

1. Before collecting any data, answer Questions 1–4.
2. Have one person hold the CBR at waist-height. Another person should hold the ball 0.5 meter below the CBR. The person with the calculator should press ENTER.
3. When the person with the CBR presses TRIGGER, the CBR will click as it collects data. The person with the ball should release it and quickly remove his or her hands.
4. If necessary, resample by repeating Steps 2–3. When you have finished collecting data, press ENTER. The calculator should show a height-time graph of the bouncing ball.
5. Using the arrow keys, find the x- and y-coordinates near the lower left and lower right of the first complete parabola and the coordinates for the vertex, or highest point, of the parabola. Be sure that the cursor is on the parabola for the lower data points. Record the data in Table 1.

Name _____ Date _____

Science and Mathematics Lab

(Course 3, Lesson 12-2)

The Way the Ball Bounces (continued)

6. Press ENTER and select 5: REPEAT SAMPLE from the PLOT menu. Press ENTER again. Repeat Steps 2–5, holding the CBR at shoulder-height. Record the data in Table 2.

DATA AND OBSERVATIONS

Table 1

Location	*x*	*y*
lower left		
vertex (*H*, *K*)		
lower right		

Table 2

Location	*x*	*y*
lower left		
vertex (*H*, *K*)		
lower right		

Questions and Conclusions

1. The quadratic equation for the height of a bouncing ball over time is $y = A(x - H)^2 + K$ (x is time and y is height). Calculate the following y values from the given x values if $A = -1$, $H = 3$, and $K = 5$. First rewrite the equation, substituting in the A, H, and K values. Graph the points and connect them with a smooth curve on a separate piece of grid paper.

x	*y*
1	
2	
3	
4	
5	

2. What effect does changing the sign of A have? Repeat Question 1 using $A = 1$. Compare the two graphs and describe the difference.

x	*y*
1	
2	
3	
4	
5	

3. What do you predict the sign of A will be for the bouncing ball?

4. A is related to the *acceleration* of the ball, in other words, how quickly it speeds up. If you drop the ball from different heights, will A change? If yes, how will it change?

5. Using the calculator and the formula $A = (y - K)/(x - H)^2$, calculate A from the data in Table 1 and calculate A from the data in Table 2. Use the vertex (H, K) and the lower left point (x, y).

A for Table 1 = A for Table 2 =

6. What physical force is responsible for the rate at which the height of the ball decreases?