CHAPTER 15

Teaching Suggestions

Science and Mathematics Lab

(Course 3, Lesson 11-6)

The Force of a Bean

OVERVIEW

In this activity, students will explore the relationship between force and distance. Students will create five graphs displaying the distance of displacement of a bowl under the weight of different numbers of kidney beans. They will determine coordinate pairs from each graph and use them to create a composite graph. Finally, students will use the composite graph to predict the distance of displacement under the weight of certain numbers of beans.

RECOMMENDED TIME

1 class period

MATERIALS

- Calculator-Based Ranger (CBR)
- TI graphing calculator
- spring
- ring stand and hook
- 16-oz bag of dried kidney beans
- heavy paper bowl
- straightedge

PREPARATION

Before beginning 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].

Attach the center of the paper bowl to one end of the spring. Hang the spring from the crossbar of the ring stand with the hook.

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The Force of a Bean (continued)

TEACHING THE LAB

1. Have students work in small groups.
2. Review the steps required to create distance-time graphs with the CBR. Press ENTER and select SET UP/SAMPLE from the Main Menu. Position the cursor to the right of REALTIME. Press ENTER until NO appears. Move the cursor down to TIME by pressing the arrow buttons on the calculator. Enter 5 to change TIME to 5 seconds. Position the cursor at DISPLAY and select DIST for distance. Continue in this manner to set the defaults as follows: BEGIN ON: ENTER, SMOOTHING: LIGHT, UNITS: METERS. Position the cursor at START NOW and press ENTER.

Answers and Conclusions

1. Graphs will vary.
2. Answers will vary. The line will probably not be straight because beans vary in weight and size.
3. Answers will vary.
4. Answers will vary. The actual distance is not likely to match the prediction exactly because the straight line is not an exact trace through the points. Beans also vary in size and weight.

EXTENSION

Cooked beans weigh more because they have absorbed water. The slope of the graph would be greater.

Name ______________________________ Date ______________

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The Force of a Bean

INTRODUCTION

Can a bean have force? What is *force?* The energy required to accomplish a task is one definition of force. Gravity is a type of energy that exerts force. The direct measurement of gravity is not always an easy task. However, force can be determined indirectly by using measurements of weight and distance. In general, the weight of an object and the force of gravity determine the distance the object can move. Force is proportional to this distance. So, a bean can have force. How much? That is what you will find out in this lab.

OBJECTIVES

In this lab, you will:

- create graphs of the movement of a bowl under the weight of dried kidney beans.
- determine the distance the bowl moves when different numbers of beans are added.
- use coordinates from each graph to create a composite graph.
- predict the distance the bowl would move under the weight of certain numbers of beans.

MATERIALS

- Calculator-Based Ranger (CBR)
- TI graphing calculator
- spring
- ring stand and hook
- 16-oz bag of dried kidney beans
- heavy paper bowl
- straightedge

PROCEDURE

1. Place the CBR on the floor beneath the bowl with the detector plate pointed upward.
2. Press ENTER on the calculator.
3. Quickly place 5 beans in the bowl all at once.

Name ______________________ Date ____________

CHAPTER 15

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The Force of a Bean (continued)

4. Determine a pair of coordinates from the graph by moving the cursor along the line to any position. Enter the coordinate values from the graph in the Data Table.
5. Return to the Main Menu by pressing [ENTER] and select REPEAT SAMPLE. Add 10 beans to the bowl all at once. Repeat this procedure with 25, 40, and 50 beans. Enter coordinate pairs from these graphs in the Data Table.
6. Press [ENTER] and select QUIT. Disconnect the CBR from the calculator.
7. Enter the data from your table into lists in the calculator. First, clear all of the data that are in the lists by pressing [2nd] [MEM] 4 [ENTER]. Press [STAT] [ENTER] to get to the lists window. Enter the number of beans under L1. Enter the distance (*Y*) in the L2 column. Create a composite graph of these points with the calculator. Press [2nd] [STAT PLOT] [ENTER] [ENTER] [▼] [▶] [ENTER]. Press [ZOOM] 9.

DATA AND OBSERVATIONS

Number of Beans	*X* (Time)	*Y* (Distance)
5		
10		
25		
40		
50		

Questions and Conclusions

1. Sketch your composite graph on a separate sheet of paper.
2. Connect the points in the graph. Is your line straight? Why or why not?
3. Use a straightedge and draw a line that passes through the center of the group of data points. What is the slope of this line?
4. Use your graph and the slope of your line to predict how far 100 beans would displace the bowl. If you were to measure this with the spring and the bowl, would the distance match your prediction exactly? Why or why not?

EXTENSION

How would your composite graph differ if you used cooked beans?