CHAPTER 16

Teaching Suggestions

Science and Mathematics Lab

(Course 3, Lesson 12-1)

The Period of a Pendulum

OVERVIEW

This activity illustrates the graphing of functions from ordered pairs. It also relates time and distance to the period of a pendulum. Students will collect data on the movement of a pendulum and create a graph of this motion with a graphing calculator. Students will determine the periodic function that represents the motion and identify the factors that affect this motion.

RECOMMENDED TIME

1 class period

MATERIALS

- stopwatch or watch with a second hand
- Calculator-Based Ranger (CBR)
- TI graphing calculator
- yo-yo
- ring stand
- meterstick
- masking tape

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. Press 2nd [MEM] 5 1 2.

On the calculator, press MODE and change the mode to RADIAN. Press CLEAR. 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.

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The Period of a Pendulum (continued)

TEACHING THE LAB

1. Have students work in small groups.
2. Set up the ring stand.
3. Review the steps required to create distance-time graphs. On the calculator, 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

Sample Data for Time and Distance of Pendulum

Curve	Time ($x = L_1$)	Distance ($y = L_2$)
1	1.099	1.084
2	2.598	1.083
3	4.298	1.084
4	5.697	1.083
5	7.296	1.083
6	8.695	1.069

1. Sample answer: 1.099 seconds
2. The *y*-value remains relatively constant because the period does not change much in such a short time. The *x*-value increases because time is passing.
3. The curves correspond to movement towards and away from the CBR.
4. Answers will vary. The time required to complete one period will decrease as the distance of displacement decreases.

CHAPTER 16

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The Period of a Pendulum

INTRODUCTION

Pendulums have been used in clocks for centuries because they swing back and forth at a very regular rate. The time it takes for a pendulum to make one complete back-and-forth swing is called the *period* of the pendulum. A pendulum's period depends on several factors: gravity, time, distance, and mass. A period can be identified on a graph of several curves as the distance from one peak to the next or one trough (low point) to the next.

OBJECTIVES

In this lab, you will:

- measure the distance of displacement of a pendulum.
- collect data on the motion of a pendulum.
- graph the function of the movement of a pendulum.
- determine the period of a pendulum.

MATERIALS

- stopwatch or watch with a second hand
- Calculator-Based Ranger (CBR)
- TI graphing calculator
- yo-yo
- ring stand
- meterstick
- masking tape

PROCEDURE

1. Unroll the yo-yo to the end of its string.
2. Attach the end of the string to the crossbar of the ring stand.
3. Hold the yo-yo straight down to keep it from swinging. Mark the position of the yo-yo at rest on the table with masking tape.
4. Place the CBR 0.5 meter in front of the yo-yo so that the yo-yo will swing directly away from and back towards the CBR sensor.
5. Pull the yo-yo 0.25 meter back from its resting position, away from the CBR, and mark this position on the table.

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The Period of a Pendulum (continued)

6. Press ENTER on the calculator to start the CBR. Release the yo-yo. A graph of the results will be displayed on the calculator.
7. Move the cursor to the right until it reaches the end of the first curve. Write the time for curve 1 in the Data Table. The number of seconds will be marked by small ticks on the *x*-axis. Position the cursor at the end of the second curve and record the time in the Data Table. Repeat until the time of each curve is recorded.
8. Press STAT ENTER . Enter your time data in the column marked L_1. Enter your distance data in the column marked L_2.
9. Press WINDOW . Enter settings that are appropriate for your data. For example, if your distance data range from 0.418 to 1.126, set the Ymin at 0, the Ymax at 1.5, and the Yscl at 0.5.
10. Finally, press 2nd [STAT PLOT] ENTER ENTER ▼ ▶ ENTER GRAPH . The calculator will display the graph of the function created by your ordered pairs.

DATA AND OBSERVATIONS

Curve	Time ($x = L_1$)	Distance ($y = L_2$)
1		
2		
3		
4		
5		
6		

Questions and Conclusions

1. How long does it take for the yo-yo to complete the first period?
2. Which value of your ordered pairs remains fairly constant? Why?
3. Why does the movement of the pendulum result in a line that is curved?
4. Do the periods of the pendulum increase or decrease as time passes?