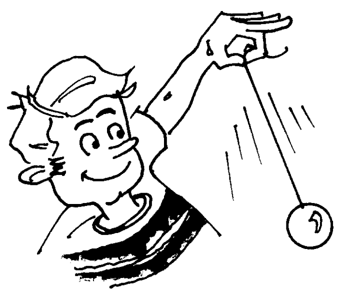
Name ____________________________

Date ____________________________

EXPLORATIONS

ACTIVITY 10

Swing Thing



When you swing back and forth on a playground swing, you're modeling the motion of a simple pendulum. What affects the way a pendulum swings? Its length? How far it is pulled back before you release it? The weight of the object hanging from it? When the important characteristics of a pendulum are identified, you can use math to make predictions about its motion.

Objectives

In this activity you will:

- ♦ Construct a *pendulum*.
- ♦ Create a motion plot for a swinging pendulum.
- ♦ Identify characteristics that effect a pendulum's motion.

You'll Need

- ♦ CBR unit
- ♦ TI-82 or TI-83 and calculator-to-CBR cable
- ♦ Meter stick
- ♦ String
- ♦ Scissors
- ♦ Empty aluminum can with pull-tab
- ♦ Funnel
- ♦ Sand

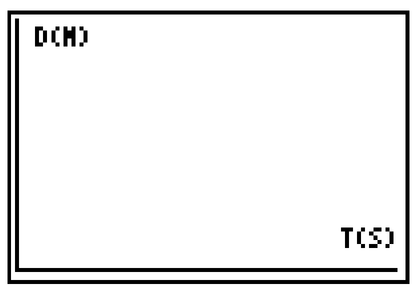
CBR Setup

1. Connect the CBR to the calculator using the link cable.
2. Turn on your calculator. If you have not already loaded the **RANGER** program into your calculator, follow these steps:
   a. Press [2nd] [LINK] [▶] [ENTER]. The calculator displays **Waiting** …
   b. Press the (82/83) transfer button on the CBR.
3. Run the **RANGER** program on your calculator:
   a. Press [PRGM].
   b. Choose **RANGER**.
   c. Press [ENTER].
4. From the **MAIN MENU**, select **2: SET DEFAULTS**.
5. With the selector arrow (▶) at **START NOW**, press [ENTER].

Collecting the Data

1. Tie one end of the string to an empty aluminum can. Measure 50 centimeters of the string and cut the string at this point.
2. Place the CBR on a table or desk. Position the pendulum about 1 meter from it. Be sure you are holding the string by its end.
3. Aim the sensor at the can. Pull the can back about 10 centimeters and release it so that it swings toward and away from the sensor. When you are ready to begin collecting data, press [ENTER].

   Your plot should show a smooth, wave-like plot.



4. If you are satisfied with your plot, sketch it at the right, and go on to the next section. If not, press [ENTER], select **3: REPEAT SAMPLE** from the **PLOT MENU**, and try again.

Looking at the Results

1. A pendulum completes a cycle as it moves from one extreme position to the other and back again. How many complete cycles are displayed on calculator screen?

   ____

2. The time required for the pendulum to complete a cycle is called the *period*. To find your pendulum's period, use [▶] and [◀] to trace to the first peak and record the time (x-value) below.

   First Peak: ______________________ seconds

Trace to the second peak and record the x-value below.

Second Peak: ____________________ seconds

When you have finished tracing the data, press [ENTER]. From the **PLOT MENU**, select **5: QUIT**. Press [CLEAR].

3. The period is the difference between the two time peaks. Find the period and record it below.

Period: _________________________ seconds

4. How do you think the period would be affected if a heavier can were used? Record your prediction below.

____

Insert the funnel into the can's opening. Add some sand to the can so that it is about half-filled. Repeat the experiment, exactly as described above with the heavier can. Record your results below.

First Peak: ______________________ seconds

Second Peak: ____________________ seconds

Period: _________________________ seconds

Are the periods significantly different for the light can and the heavy can? Does this result agree with your hypothesis?

____

5. How do you think the period would be affected if a shorter piece of string were used? Record your prediction below.

____

Measure 25 centimeters along the string that is already attached to the can and cut the string at this point. Repeat the experiment, exactly as described above with the shorter string. Record your results below:

First Peak: ______________________ seconds

Second Peak: ____________________ seconds

Period: _________________________ seconds

Are the periods significantly different for the longer string and the shorter string? Does the result agree with your hypothesis?

____

6. Complete the following statement based on your observations during this activity. (Use the words "increase," "decrease," or "remain the same.")

Changing the weight of the pendulum's hanging object causes its period to

_____________________________, and decreasing its length causes its

period to ____.

Going Further

Answer these questions on a separate piece of paper. Show all work.

1. In the second part of this activity, the pendulum's length was divided in half, and this caused its period to change. Was the period divided in half also? What does this tell you about the relationship between pendulum length and period?

2. The *frequency* of a swinging pendulum tells how many cycles it completes per second. Frequency and period are related by this simple formula:

Frequency = 1 ÷ Period

Based on the data you collected, find the frequencies for the long-string pendulum and the short-string pendulum.

3. How would frequency be affected (increase, decrease, or remain the same) if the pendulum length increased? How would frequency change if a pendulum's period is tripled? Be specific.