

## TEACHER INFORMATION

Crawling Around:  
Parametric Plots

1. There are currently four Motion Detectors that can be used for this lab activity. Listed below is the best method for connecting your type of Motion Detector. Optional methods are also included:

**Vernier Motion Detector:** Connect the Vernier Motion Detector to a CBL 2 or LabPro using the Motion Detector Cable included with this sensor. The CBL 2 or LabPro connects to the calculator using the black unit-to-unit link cable that was included with the CBL 2 or LabPro.

MDC  
cable

**CBR:** Connect the CBR directly to the graphing calculator's I/O port using the extended length I/O cable that comes with the CBR.

Optionally, the CBR can connect to a CBL 2 or LabPro using a Motion Detector Cable. This cable is not included with the CBR, but can be purchased from Vernier Software & Technology (order code: MDC-BTD).

I/O  
cable

**CBR2:** The CBR 2 includes two cables: an extended length I/O cable and a Calculator USB cable. The I/O cable connects the CBR 2 to the I/O port on any TI graphing calculator. The Calculator USB cable is used to connect the CBR 2 to the USB port located at the top right corner of any TI-84 Plus calculator.

Optionally, the CBR 2 can connect to a CBL 2 or LabPro using the Motion Detector Cable. This cable is not included with the CBR 2, but can be purchased from Vernier Software & Technology (order code: MDC-BTD).

I/O  
cableUSB  
cable

**Go! Motion:** This sensor does not include any cables to connect to a graphing calculator. The cable that is included with it is intended for connecting to a computer's USB port. To connect a Go! Motion to a TI graphing calculator, select one of the options listed below:

Option I—the Go! Motion connects to a CBL 2 or LabPro using the Motion Detector Cable (order code: MDC-BTD) sold separately by Vernier Software & Technology.

Option II—the Go! Motion connects to the graphing calculator's I/O port using an extended length I/O cable (order code: GM-CALC) sold separately by Vernier Software & Technology.

Option III—the Go! Motion connects to the TI-84 Plus graphing calculator's USB port using a Calculator USB cable (order code: GM-MINI) sold separately by Vernier Software & Technology.

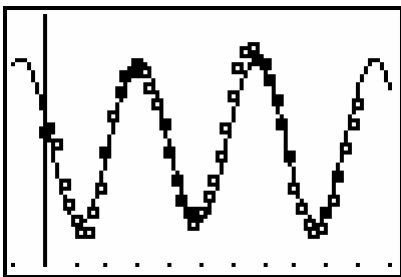
2. This activity requires two Motion Detectors. If a Vernier LabPro interface is used, both detectors can be connected to a single interface. If the TI CBL 2 is used, or you are connecting your Motion Detectors directly to a calculator, you must use two interfaces/detectors and two calculators, and then transfer data to a single calculator for analysis.

## Activity 23

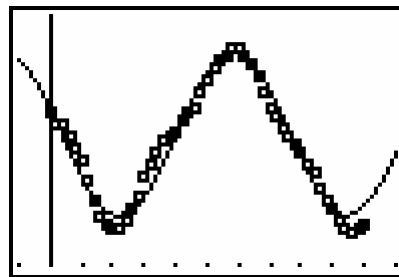
LabPros must have ROM version number 1.13 (code from TI) or 6.13 (code from Vernier), or newer. ROM versions x.12 and older do not fully support two Motion Detectors. To determine ROM version, notice the numbers shown on the title screen as EasyData is launched. For updates to ROM (also called firmware), see [www.vernier.com](http://www.vernier.com).

- When connecting a CBR 2 or Go!Motion to a TI-84 calculator using USB, the EasyData application automatically launches when the calculator is turned on and at the home screen.
- A wooden dowel or a section of PVC plastic pipe works well. A very small diameter (less than 0.5 cm) may result in noisy distance data.
- Arrange the Motion Detectors so that their faces are parallel to the edges of the pattern sheet.
- Note that the sine regression expressions are recorded in the Data Table as functions of  $x$ , as that is the way they are first created. When entering the sine models parametrically, you must replace  $x$  with  $t$ .

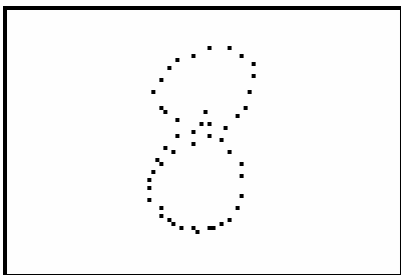
## SAMPLE RESULTS



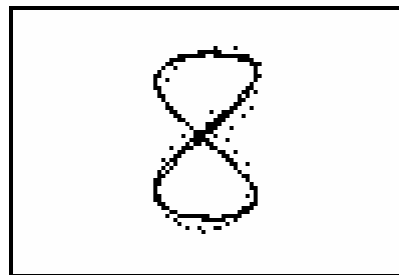
$x$  data with sine regression



$y$  data with sine regression



$y$  vs.  $x$  distance data



$y$  vs.  $x$  distance data with parametric model

## DATA TABLE

<b>x model equation</b>	$y = 0.0238 \cdot \sin(x \cdot 2.650 + 2.53) + 0.530$
<b>y model equation</b>	$y = 0.0538 \cdot \sin(x \cdot 1.342 + 2.815) + 0.578$

## ANSWERS TO QUESTIONS

- The parametric model fits the actual data well. This makes sense because the sine curves were fit to the original data; all we've done is to plot the sine curves parametrically.
- Each point in a parametric plot corresponds to a particular value of time.