

TEACHER INFORMATION

Tic, Toc: Pendulum Motion

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.

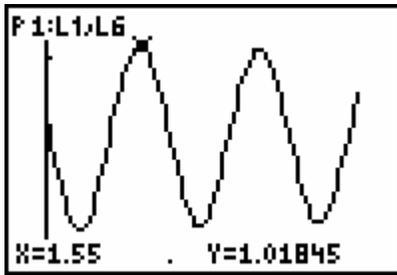
2. When connecting a CBR 2 or Go! Motion to a TI-84 calculator using USB, the EasyData application automatically launches when the calculator is turned on and at the home screen.
3. This activity has the student measure the amplitude, period, and offset distance for a pendulum using a meter stick and a stopwatch. Although these values could be obtained from

Activity 25

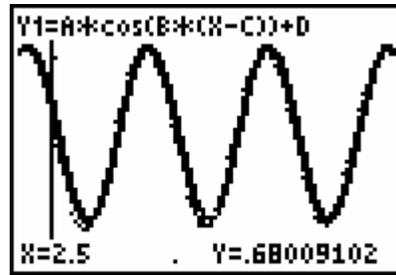
the Motion Detector graph, independent measurements show the student that the Motion Detector is using the same distance and time standards as conventional instruments.

- Avoid using a soft or felt-covered ball for the pendulum bob, as the ultrasonic waves from the motion detector tend to be absorbed by these surfaces. A ball with a hole drilled through its center works well as a pendulum bob. Other objects such as a large fishing bobber or an empty soft drink can also work well.

SAMPLE RESULTS



Raw data graphed outside of EasyData



Model superimposed on data

DATA TABLE

A (m)	0.17
B	3.27
C (s)	1.53
D (m)	0.85
Time for ten cycles (s)	19.2
Period (s)	1.92

ANSWERS TO QUESTIONS

- The model fits the experimental data well. $y = 0.17 * \sin(3.27 * (x - 1.53)) + 0.85$.
- The values of A , B , and D would not change. The value of C would change because the horizontal shifts needed to fit a sine and cosine curve are different. Students may use a trial and error method to find the new value of C . Some students may reason that the sine curve is the cosine curve shifted right by one-fourth of the period. They may calculate one-fourth of the period and subtract it from the current value of C to find the new value of C . In this case, $1.53 - (1.53/4) = 1.91$. This would be a good method to share in a post-activity discussion for those students who do not discover it.
- The new sine model fits as well as the cosine model, as long as the appropriate adjustment is made in the C parameter.
- A is the distance that the pendulum swings to either side of the stationary point. B is the number of cycles in the natural period of the function. C is the amount of time that passed between the start of the program and the time the pendulum was a maximum distance from the detector. D is the stationary point of the pendulum or the position of the pendulum when it is at rest.