TEACHER INFORMATION

That's the Way the Ball Bounces: Height and Time for a Bouncing Ball

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

    CBR 2: 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   USB
    cable   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. A basketball works well for this activity. Avoid using a soft or felt-covered ball such as a tennis ball as the surface prevents good detection by the Motion Detector.

4. The Motion Detector cord must not get between the ball and the detector during data collection.

5. The activity is best done by a group of three students: one to hold the detector, another to release the ball, and a third to operate the calculator.

6. Hold the ball from the sides, and release it by quickly moving hands outward and out of the detection cone of the Motion Detector.
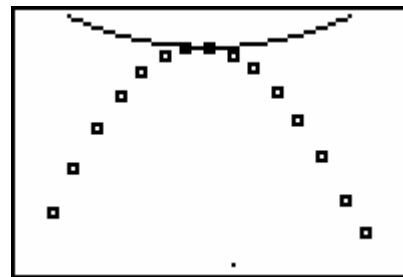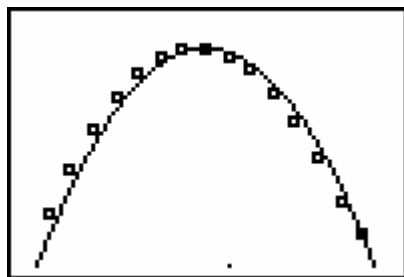
SAMPLE RESULTS
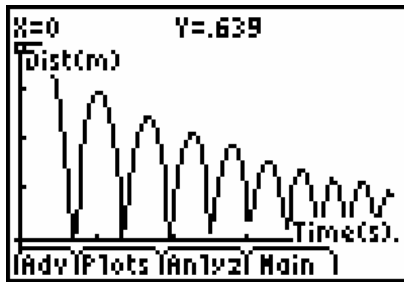
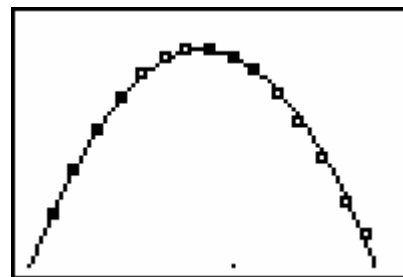

Data collected in EasyData
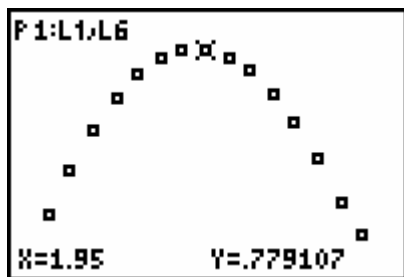
Data regraphed after selecting region

First attempt to fit vertex form of quadratic; $A = 1$

$A = -4.85$

Fit of calculator regression

DATA TABLE

Vertex	
x-coordinate	*y*-coordinate
1.95	0.78

Parameters	Values calculated from vertex form	Values from regression
a	− 4.8	− 4.6
b	18.9	17.8
c	− 19.2	− 16.4

ANSWERS TO QUESTIONS

1. The graph we are using is vertical distance *vs.* time, not vertical distance *vs.* horizontal distance. That is, the horizontal axis is not horizontal distance, so the appearance of the graph has nothing to do with a side-ways moving ball.

2. Vertex model equation: $y = -4.85 (x - 1.95)^2 + 0.78$.

3. The parameters of the standard form quadratic as determined by calculator regression and by the vertex fit are similar.

4. The magnitude of *a* determines how sharply curved the parabola is, while the sign of *a* determines whether the parabola is open upward (positive *a*) or downward (negative *a*).

5. Since the vertex of the new parabola would be to the right of the one originally used, the time value *h* would be larger. The *y* coordinate of the vertex would be smaller than before, as the ball doesn't bounce as high each time.