**That’s the Way the Ball Bounces**

**OBJECTIVES**

* Record height versus time data for a bouncing ball.
* Model a single bounce using both the vertex and standard forms of a parabola.

**PROCEDURE**

1. Connect the Motion Detector to the TI-Nspire calculator.
2. Position the Motion detector about 1.5 m above the floor, so that the disc is pointing straight downward.
3. Set up the Motion Detector so that distance above the floor will read as positive position. Press **menu >Experiment >Set Up Sensors >CBR 2/Go!Motion**. Check the box next to **Reverse Readings**. Then click **Zero**.
4. Practice dropping the ball so that it is bounces straight up and down beneath the Motion Detector.
5. Start data collection by pressing the **green arrow** on the calculator screen. The calculator will automatically stop the data collection after 5 seconds.
6. Press **>menu >Graph >Show Graph >Graph 1**. Only the Position vs. Time Graph will be displayed. Examine the graph; it should contain a series of parabolic regions. If necessary to repeat data collection, repeat step 5.
7. Disconnect the Motion Detector from the TI-Nspire calculator.

**ANALYSIS**

1. Select the data corresponding to the ball’s position between two bounces.
	1. Select just one parabolic portion of the data. Position your cursor on the left side of the parabola and press **click**. Then press **crtl click**. Then position your cursor on the right side of the parabola and press **click**. The region you have marked should be shaded.
	2. Remove the outside region. Press **menu >Data > Strike Data >Outside Selected Region**. A new graph showing only the parabolic portion of the data will be displayed.
2. Now fit the vertex form of a quadratic model $y=a\left(x-h\right)^{2}+k$ to your data.
	1. Press **menu >Send To >Data & Statistics**.
	2. Press **menu >Analyze >Graph Trace**. Click the ►and ◄ (left and right arrows) to trace across the graph to determine the $x-$ and $y-$ coordinates of the vertex of the parabola (in this case, the maximum point of the curve). **Record the values for** $h$ **and** $k$ **in Data Table on your record sheet. Round to 3 decimal places**.Then press **esc**. If there does not appear to be one maximum point, use the average of the $x$ – values for $h$.
	3. To plot the function, press **menu > Analyze > Plot Function**. Enter your function $f1\left(x\right)≔a\left(x-h\right)^{2}+k$ using the $h$ and $k$ values you determined earlier. Enter 1 as the initial value for parameter $a$.
	4. Change the value of $a $until the curve fits your data. To change the value, place your cursor on the equation and double-click. **When you have found the best value for the parameter** $a$**, place your equation in Data Table on your record sheet.**
3. Now expand your vertex form equation into the standard form of $y=ax^{2}+bx+c$. **Show your work in the space provided for Analysis question #2 on your record sheet, and record the values for** $a$**,** $b$**, &** $c$ **in Data Table on your record sheet.**
4. Another way to determine the $a$, $b$, and $c$ parameters is to do a quadratic regression. Plot a regression line on your scatter plot. Press **menu > Analyze >Regression >Show Quadratic**. **Record the regression values for** $a$**,** $b$**, &** $c$ **in Data Table on your record sheet. Round to 3 decimal places.**