

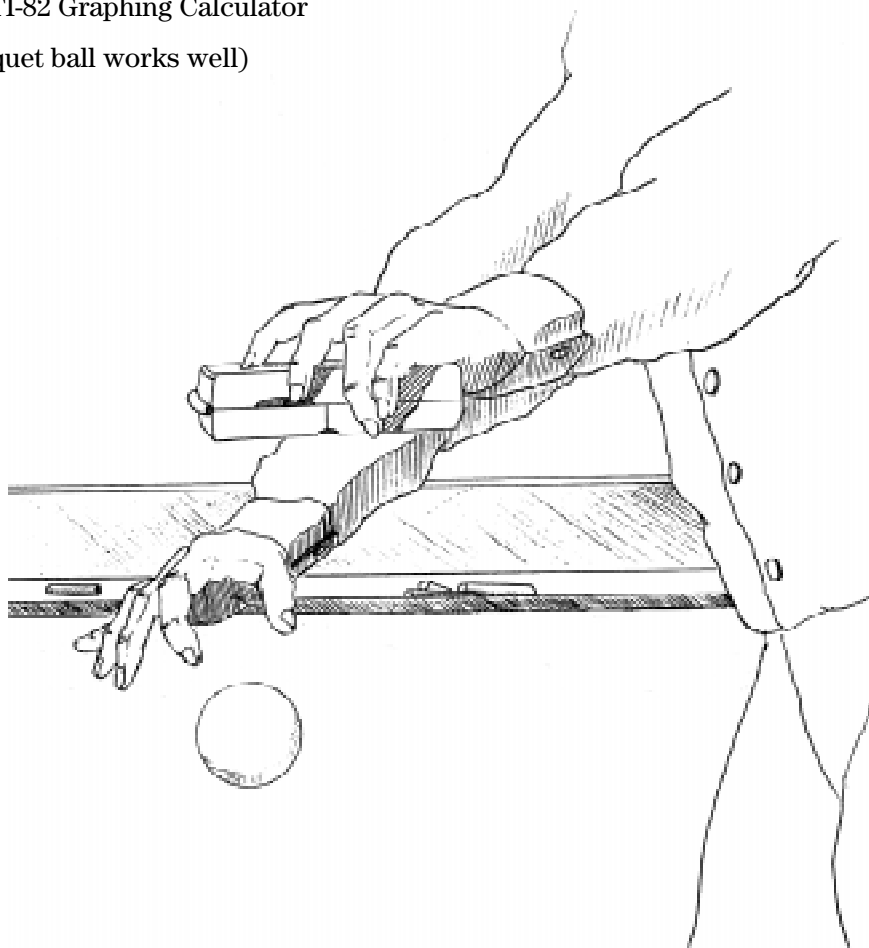
ACTIVITY 8**The Bouncing Ball**

If a ball is dropped from a given height, what does a Height-Time graph look like? How does the velocity change as the ball rises and falls? What affects the shape of the graphs of both the height and the velocity?

In this activity, you will graph the height of a ball versus time after it is dropped from some height. You will then examine one ball bounce and investigate the parameters that affect the shape of the graph. You will also explore the relationship between the height of the ball and the velocity.

You'll Need

- ◆ 1 CBR unit
- ◆ 1 TI-83 or TI-82 Graphing Calculator
- ◆ Ball (a racquet ball works well)



Instructions

1. Run the **RANGER** program on your calculator.
2. From the **MAIN MENU** of the **RANGER** program, select **3:APPLICATIONS**.
3. Select **1:METERS**, then select **3:BALL BOUNCE**.
4. Follow the directions on the screen of your calculator. Release the ball. Press the **TRIGGER** key on the CBR as the ball strikes the ground.
5. Your graph should have a minimum of five bounces. If you are not satisfied with the results of your experiment, press **ENTER**, select **5:REPEAT SAMPLE**, and try again.
6. When you are satisfied with your data, sketch a Distance-Time plot.



Data Collection

1. The goal here is to “capture” one parabola. Use **▶** (the right arrow) to trace to a point near the lower left side of this parabola. Record this point in the **Xmin** category of the table below. Continue tracing until you reach the approximate vertex of the first bounce. Record the coordinates of this point in the table below. Continue tracing until you reach a point near the lower right side of this parabola. Record this point in the **Xmax** category.

	<i>T</i>	<i>y</i>
Xmin		
Vertex		
Xmax		

2. Press **ENTER** to return to the **PLOT MENU**. Select **7:QUIT** to exit the **RANGER** program.
3. Press **WINDOW**. Enter the *T* values for **Xmin** and **Xmax** from the table above. Press **GRAPH**. Record the graph of this parabola in the window at the right.



Questions - Part One

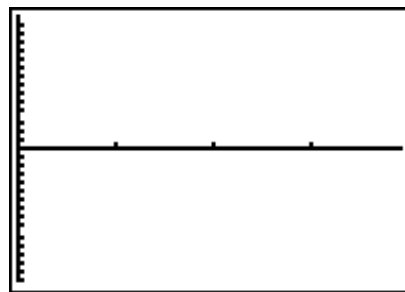
- The vertex form of a parabola is $y = a(x - h)^2 + k$ where h is the x -coordinate and k is the y -coordinate of the vertex of the parabola. Press $\boxed{2\text{nd}} \boxed{[\text{QUIT}]}$ to go to the home screen. To store the x -coordinate of the vertex as H, enter the x -coordinate of the vertex, then press $\boxed{\text{STO}} \boxed{[\text{ALPHA}]} \boxed{[\text{H}]} \boxed{[\text{ENTER}]}$. To store the y -coordinate of the vertex as K, enter the y -coordinate of the vertex, then press $\boxed{\text{STO}} \boxed{[\text{ALPHA}]} \boxed{[\text{K}]} \boxed{[\text{ENTER}]}$. To store -1 for A, press $\boxed{(-)} \boxed{1} \boxed{\text{STO}} \boxed{[\text{ALPHA}]} \boxed{[\text{A}]} \boxed{[\text{ENTER}]}$.
- Press $\boxed{Y=}$. Enter $A(X - H)^2 + K$ for **Y1**. Press $\boxed{[\text{GRAPH}]}$. A value of -1 for A does not fit this parabola. Press $\boxed{2\text{nd}} \boxed{[\text{QUIT}]}$. Store a better guess for A. Press $\boxed{[\text{GRAPH}]}$. Continue the process of storing a better guess for A until you have fit the parabola.

Record your value for A. _____

- What is the equation of the parabola that fits this curve?

$y =$ _____

- Press $\boxed{[\text{PRGM}]}$. Execute the **RANGER** program. From the **MAIN MENU**, select **4:PLOT MENU**. Select **2:VEL-TIME**.
- Press $\boxed{[\text{ENTER}]}$ to return to the **PLOT MENU**. Select **7:QUIT** to exit the **RANGER** program. Press $\boxed{[\text{WINDOW}]}$. Enter the T -values for **Xmin** and **Xmax** from the table on page 40. Press $\boxed{[\text{GRAPH}]}$. Record the graph of the velocity for this time interval in the window at the right.



- Press $\boxed{[\text{TRACE}]}$. Record the coordinates of two points that lie on the velocity graph.

Point 1: _____ Point 2: _____

Find the slope and the y -intercept of this line.

$m =$ _____ $b =$ _____

Record the equation of this line.

$y =$ _____

- Press $\boxed{Y=}$. Enter the equation of this line in **Y2**. Press $\boxed{[\text{GRAPH}]}$. How well does this line fit the velocity data?

Questions - Part Two

1. Press $\boxed{\text{PRGM}}$. Execute the **RANGER** program. From the **MAIN MENU**, select **4:PLOT MENU**. Select **1:DIST-TIME**.
2. Capture the second parabola.

	T	y
Xmin		
Vertex		
Xmax		

3. Press $\boxed{\text{ENTER}}$ to return to the **PLOT MENU**. Select **7:QUIT** to exit the **RANGER** program. Press $\boxed{\text{WINDOW}}$. Enter the T values for **Xmin** and **Xmax** from the table above. Press $\boxed{\text{GRAPH}}$. Record the graph of this parabola in the window at the right.



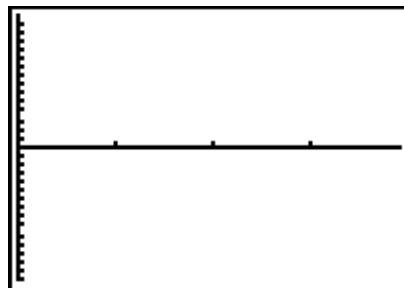
4. Press $\boxed{2\text{nd}}$ **[QUIT]**. Store the x -coordinate of the vertex as H; store the y -coordinate of the vertex as K. Store -1 for A. Press $\boxed{Y=}$, highlight **Y1s** equal sign and press $\boxed{\text{ENTER}}$ to activate the function. Press $\boxed{\text{GRAPH}}$. Press $\boxed{2\text{nd}}$ **[QUIT]**. Store a better guess for A. Press $\boxed{\text{GRAPH}}$. Continue storing a guess for A until you have fit the parabola.

Record your value for A. _____

5. What is the equation of the parabola that fits this curve?

$y =$ _____

6. Press $\boxed{\text{PRGM}}$. Execute the **RANGER** program. From the **MAIN MENU**, select **4:PLOT MENU**. Select **2:VEL-TIME**.
7. Press $\boxed{\text{ENTER}}$ to return to the **PLOT MENU**. Select **7:QUIT** to exit the **RANGER** program. Press $\boxed{\text{WINDOW}}$. Enter the T values for **Xmin** and **Xmax** from the table above. Press $\boxed{\text{GRAPH}}$. Record the graph of the velocity for this time interval in the given window.



8. Record the coordinates of two points that lie on the velocity graph.

Point 1: _____

Point 2: _____

9. Find the slope and the y -intercept of this line.

$$m = \underline{\hspace{4cm}}$$

$$b = \underline{\hspace{4cm}}$$

Record the equation of this line.

$$y = \underline{\hspace{4cm}}$$

10. Press $\boxed{Y=}$. Enter the equation of this line in **Y2**. Press $\boxed{\text{GRAPH}}$. How well does this line fit the velocity data?

Make a Mathematical Statement

1. The equations found in this lab are

Bounce	Distance-Time	Velocity-Time
1		
2		

2. What influences the change in the ball's velocity?

3. What is the relationship between the slope of the velocity graph and the leading coefficient, A , of the distance graph?

4. What force is associated with this quantity?
