

**LessonTitle: Ball Bounce****Alg 7.3****Utah State Core Standard and Indicators** Algebra Content Standard 2.1 Process Standards 1-5**Summary**

In this lesson, students collect data which models a quadratic growth function.

**Enduring Understanding**

Relationships found in physics, geometry and other real-world situations often can be expressed as rules in the form of equations. By studying the patterns of change in data, we can identify the patterns which produce linear, exponential and quadratic equations

**Essential Questions**

What are the patterns of change found in real world data?  
How do we represent these patterns using mathematics?

**Skill Focus**

- Patterns and functions
- Problem solving

**Vocabulary Focus****Assessment****Materials****Launch****Explore****Summarize****Apply**

# Bouncing Ball



## Questions to Think About

If a ball bounces from a given height, what type of a graph does it create? What does the graph represent? How does the graph change as the ball continues to bounce?

## Overview

In this activity, you will graph the height of the ball versus time after it is dropped from some height. You will then examine the ball bounce and investigate its vertex and x-intercepts.

## Materials

- 1 CBR unit
- 1 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 at least 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. On the grid below. Label the axes.



## Data Collection

1. The goal here is to “capture” one parabola. Choose the best parabola that your bouncing ball created. Use the *right arrow* to trace to a point near the lower left side of this parabola. Record this point in the **Xmin** category 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>d</i>
Xmin		
Xmax		

- Press **ENTER** to return to the PLOT MENU. Select **7:QUIT** to exit the **RANGER** program.
- 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 below.



### Analyzing the data

- What is the maximum height reached during the ball bounce? What does this represent on the graph?
- How long did it take the ball to reach its maximum height on this bounce?
- How long did it take for the ball to return to the ground? What does this represent on the graph?
- How is this graph different from the graph of a linear function?
- Using the vertex of your graph (*h*, *k*), find an equation to fit your data.

$$y = a(x - h)^2 + k \quad a = \underline{\hspace{2cm}} \quad y = \underline{\hspace{2cm}}$$

$$h = \underline{\hspace{2cm}}$$

$$k = \underline{\hspace{2cm}}$$

- What do you think *a* represent in the equation?

**Overview**

Using the sketch of your original ball bounces, answer the following questions.

1. If a ball bounces from a given height, what type of a graph does it create?
2. What does the graph represent?
3. How does the graph change as the ball continues to bounce?

# Bouncing Ball



create?  
ball

## Questions to Think About

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11. Your graph should have at least five bounces. If you are not satisfied with the results of your experiment, press **ENTER**, select **5:REPEAT SAMPLE**, and try again.
12. When you are satisfied with your data, sketch a Distance-Time plot. On the grid below. Label the axes.



## Data Collection

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	<i>T</i>	<i>d</i>
Xmin		
Xmax		

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- 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 below.



### Analyzing the data

- What is the maximum height reached during the ball bounce? What does this represent on the graph?
- How long did it take the ball to reach its maximum height on this bounce?
- How long did it take for the ball to return to the ground? What does this represent on the graph?
- Trace on your graph from the initial point to the final point and record each of the points in the table below in under time and height. Record the time and height data in L1 and L2. Compute the first differences of the height values in L3 and the second differences of the height values L4. (Use  $\Delta$ List found **STAT** under **OPS** to find the differences.

<i>Time (t)</i>	<i>Height (h)</i>	<i>First Difference</i>	<i>Second Difference</i>



5. What does the graph represent?

6. How does the graph change as the ball continues to bounce?