

QUADRATIC APPLICATIONS

Summary

In this lesson students explore various situations that can be modeled with quadratic functions including the bounce of a ball and projectiles. Students use the CBR (Calculator Based Lab) and a graphing calculator to collect data from a bouncing ball, graph the data, and model the curve with an equation.

Utah State Core Standards

- Find the vertex, maximum or minimum values, intercepts, and axis of symmetry of a quadratic or absolute value function, algebraically, graphically, and numerically.
- Solve problems involving absolute value and quadratic functions algebraically and graphically.
- Determine the quadratic regression equation for a given set of bivariate data using technology.
- Analyze the meaning of the maximum or minimum and intercepts of the regression equation as they relate to a given set of bivariate data.

Desired Results

Benchmark/Enduring Understanding

Students understand that quadratic equations are used to model many situations that involve gravity causing the object's speed to change as it rises or falls.

Essential Questions

- What is the difference in functions that increase or decrease at a constant rate compared to functions that increase or decrease at changing rates?
- What type of real-life situations can be modeled by quadratic equations?

Skills

- Graphing a quadratic function.
- Interpreting the intercepts and vertex of a quadratic function.
- Writing the equation of a quadratic, given the function graph.

Assessment Evidence

The final part of this lesson is a quiz on falling bodies, assessing students' ability to interpret the distance/time graph of an object. Formative assessment questions are imbedded throughout the lesson.

Instructional Activities

Launch: Begin this lesson by demonstrating how the CBR works and asking

students to complete the first page of the worksheet.

Explore: Follow the lesson plan for the ball drop lesson. If there are not enough CBRs available for students to work in groups, this lesson can be conducted by generating the data using the CBR as a demonstration in front of the class, and then having students interpret the data.

Summarize: Discuss the results of the ball drop activity and ask students to summarize and extend their understanding with "The Arrow, The Ball, and the Rock" activity.

Materials Needed

Classroom set of CBRs (approximately 1 CBR for each group of 4)

Graphing calculators for each CBR

Bouncing ball for each group - basketballs work well if they are bouncy

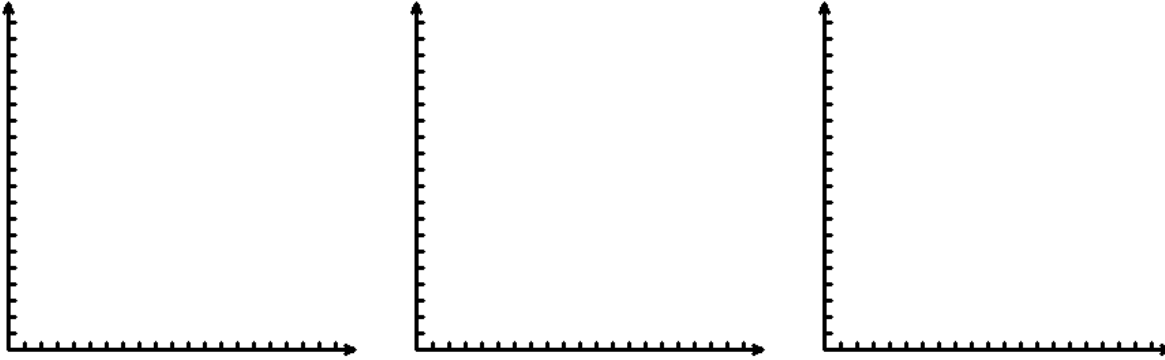
Copies of worksheets for each student

QUADRATIC APPLICATIONS

I. Activating prior knowledge

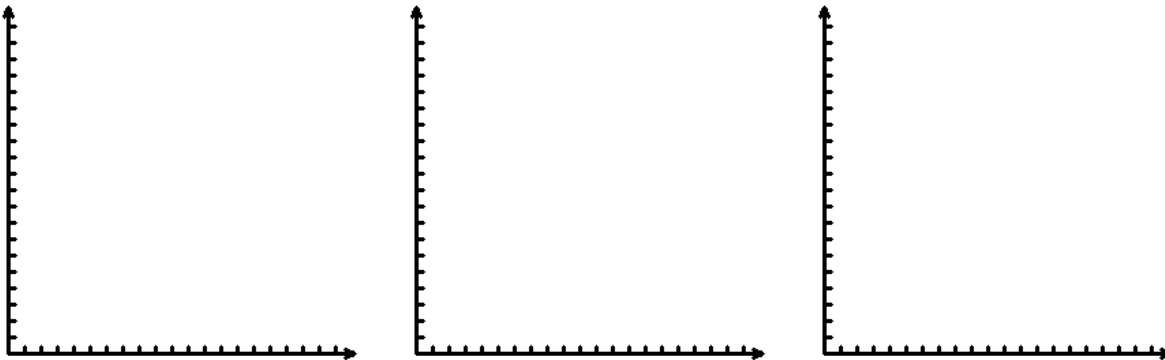
Using the CBR, try to create the graph of each of the following shapes. Each person on your team must try to walk the given graph. As each person tries, label the axes, sketch the line they created and write a suggestion for what should be done to make their graph more closely match the required graph.

1) A “V”



Suggestions:

2) A “U”



Suggestions:

What did you do differently to create these two graphs?

Does the graph show the path you walked? If not, what does it show? To explain this, interpret the point at the bottom of the “V”.

II. A 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?

Overview

In this lesson, 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

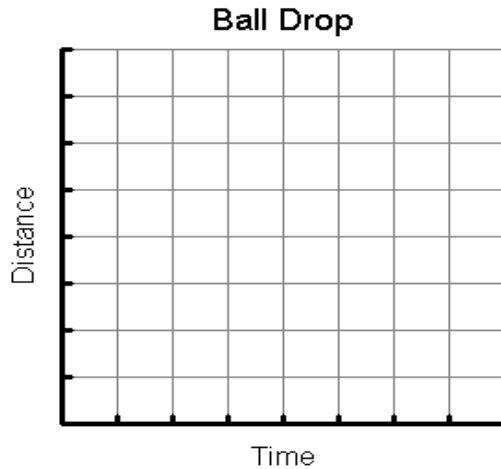
1. Run the **RANGER** program on your calculator. It can be accessed using the APPS menu, and selecting CBL/CBR.
2. From the **MAIN MENU** of the **RANGER** program, select **3:APPLICATIONS**.
3. Select **1:METERS**, then select **3:BALL BOUNCE**.
4. Follow the directions on the screen of your calculator. Release the ball. Press the **TRIGGER** key on the CBR as the ball strikes the ground.
5. Your graph should have at least two 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.*



Note: The CBR is measuring the distance from the ball to the ground.

Data Collection

1. The goal here is to “capture” one complete curve. Choose the best curve that your bouncing ball created. Press **ENTER** and go to **4: PLOT TOOLS**. Choose **1: SELECT DOMAIN**. Use the *right arrow* to trace to a point near the lower left side of the parabola that you chose and press **ENTER**. Continue tracing until you reach a point near the lower right side of this parabola and press **ENTER**.
2. Now you are going to clean-up and perfect your graph. Trace on the graph to find the maximum and use it and a few other points that you get from tracing to draw an accurate graph below.



3. In what interval(s) is the ball traveling the fastest? Explain.

In what interval(s) is the ball traveling the slowest? Explain.

Why is the graph curved? What is the ball doing that makes the graph curve? Write a paragraph describing what the graph tells us about the motion of the ball. Be sure to interpret all the important features of this type of graph.

Using mathematical language, describe the type of graph and function that seems to fit this motion.

Function type: _____ Graph type: _____

Based on your knowledge of transformations, estimate an equation of the curve. Write your equation here:

Graph your equation along with the data from the ball drop. How well do they match?

You can use your calculator to find an equation of the parabola. This is called a quadratic regression. Go to **STAT**, select **CALC**, then **QuadReg** and press enter. Write the quadratic regression equation from your calculator.

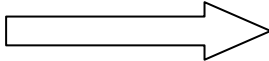
Use your finest algebra to compare the two equations algebraically. Show your work here:

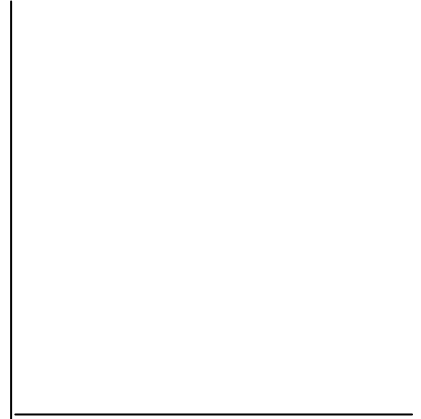
NAME _____

Period _____

Falling Body Quiz

Florinda Zacchini, the human cannon ball, was shot by a cannon straight up in the air from the Golden Gate Bridge. The cannon shot her at a velocity of 50 feet per second. The bridge is 300 feet above the water.

- A. Write the equation: _____
- B. Graph the situation and label each axis. 
- C. How high did she go? _____
- D. When did she begin to descend? _____
- E. When did she reach the water? _____
- F. Where was she at 2.1 seconds? _____
- G. When was she 150 ft above the water? _____

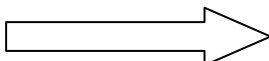


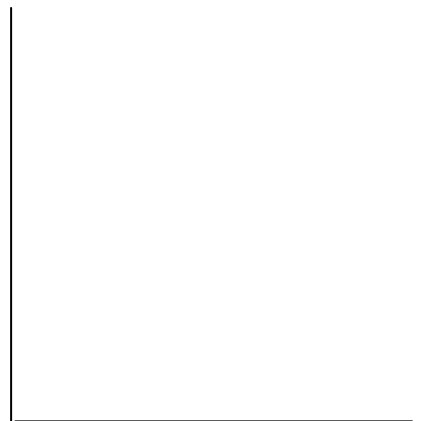
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Falling Body Quiz

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Complete the Venn diagram, showing the similarities and differences between

$$y = |x| \quad \text{and} \quad y = x^2$$

Characteristics
of $y = x^2$ only

Characteristics
of both

Characteristics
of $y = |x|$ only

