

# IMPACT

SATEC

Algebra II



*Lesson created by Thomas Ledvorowski*



### The Ramp and Cars

The ramp used in this activity is constructed from three pieces of board cut three inches wide. A tape measure, both in inches and centimeters is taped, to one side of the ramp. A groove down the middle of the ramp allows for “guidance” as the car rolls down the ramp. The Dual-Range Force Sensor is attached at the lower end of the ramp using the manufacturer’s bracket. The cars are fitted with a screw at the bottom, which allows the car to ride along the groove of the ramp.



### Calibration

Each Dual-Range Force Sensor should be calibrated at 50N.

### Materials

Each group should have:

- Access to a computer and a ramp with the dual force sensor attached.
- A car with screw attached to the bottom for guidance down the ramp.
- A “rubber bumper”
- A graphing calculator or Graphical Analysis
- The Student activity sheet
- A copy of the file **Impact**



**Objective:**

The student will examine a square root function by collecting and representing data in a table, on a graph, and as a function.

**Teachable moments:**

- Students may not remember what correlation is from Algebra 1.
- Students may need help recognizing that the square root is the same as raising to the  $\frac{1}{2}$  power.
- Students may need help clarifying the difference between the general form of an equation vs. the specific equation for the data collected.

**Connections:**

The activity introduces the square root function. This activity will be reused in the future to examine the square root function in more depth. The concepts of domain, range, and independent and dependent variables will be extended.

**Prerequisite knowledge/skills:**

- Use of a graphing calculator or Graphical Analysis
- Understanding of Domain and Range and Independent and Dependent variables

**Performance based questions for assessment of student understanding:**

- How did you determine the independent and dependent variables?
- What is the difference between the domain and range of the data collected and the real world situation?

**Teacher Supplementary Comments:**

- The domain and range can be found for the data collected, the real world situation, and for the mathematical function. In the survey of functions the students will determine the differences between the domain and range of the **data collected and the real world situation only.**
- If Graphical Analysis is not available, use the graphing calculator to determine the Regression equation using the statistical capabilities.
- The rubber bumper must be attached to the force sensor before the force sensor is attached to the ramp.



**(c) Algebra and Geometry**

- (1) The student connects algebraic and geometric representations of functions.

Following are performance descriptions.

- (A) The student identifies and sketches graphs of parent functions, including linear ( $y = x$ ), quadratic ( $y = x^2$ ), square root ( $y = \sqrt{x}$ ), inverse ( $y = 1/x$ ), exponential ( $y = a^x$ ), and logarithmic ( $y = \log_a x$ ) functions.

## **(d) Quadratic and Square Root Functions**

- (4) The student formulates equations and inequalities based on square root functions, uses a variety of methods to solve them, and analyzes the solutions in terms of the situation.

Following are performance descriptions.

- (A) The student uses the parent function to investigate, describe, and predict the effects of parameter changes on the graphs of square root functions and describes limitations on the domains and ranges.
- (B) The student relates representations of square root functions, such as algebraic, tabular, graphical, and verbal descriptions.
- (C) For given contexts, the student determines the reasonable domain and range values of square root functions, as well as interprets and determines the reasonableness of solutions to square root equations and inequalities.
- (E) The student analyzes situations modeled by square root functions, formulates equations or inequalities, selects a method, and solves problems.



## Student Activity

### Overview

Ever since the invention of the automobile, consumers and manufactures have been concerned about car crashes. In this activity you will investigate the force of a car in relation to the distance the car is away from the point of impact. To collect the data you will release a toy car from varying distances on a ramp. The car will collide with a dual-force sensor to measure the impact of the collision.

To begin this investigation, you will need to identify the variables:

Independent Variable: \_\_\_\_\_

Dependent variable: \_\_\_\_\_

1. Describe the correlation you would expect the data to follow. **Explain your reasoning:**

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2. Define the domain and range of these variables based on this situation.

Domain: \_\_\_\_\_

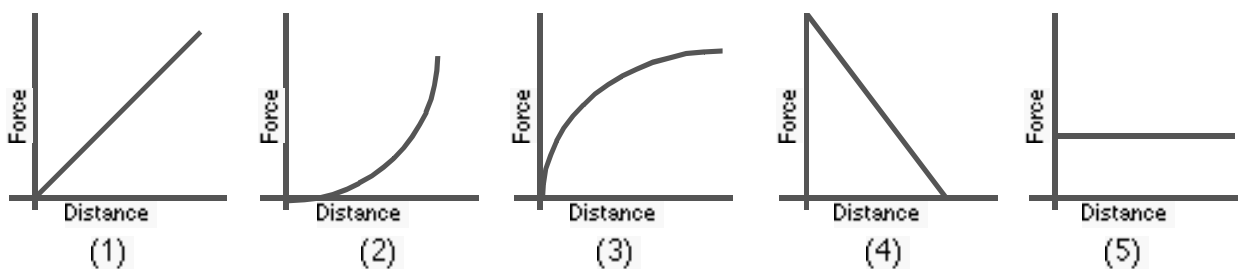
Range: \_\_\_\_\_

**Explain your reasoning.**

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3. Predict how these two variables are related. Choose one of the five graphs below which best matches how you think the two variables are related. **Give a brief description explaining your choice.**



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## Setup

The ramp you will be using should already have the force sensor attached to it. The first time you run through the experiment you will be using the "Rubber Bumper". This is attached to the front of the Dual Range Force sensor. **Do not screw it in too tight!** The proper setup is shown in Figure 1.

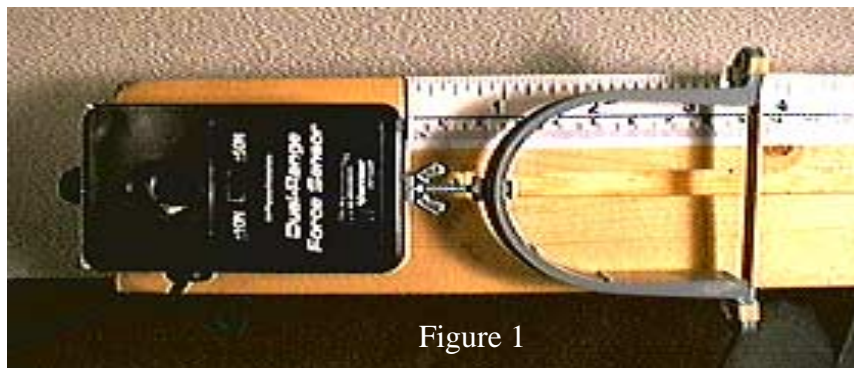



Figure 1

Plug the Dual-Range Force sensor into the slot DI N 2 on the ULI . Open the file **Impact**.

# Collecting the Data

You will be collecting the data by releasing the car from various distances from the sensor and then recording the force of impact. The data will be collected using the “Rubber Bumper” on the force sensor.

Click the  button. When the car first hits the sensor, it will trigger the collection of data. The highest Rubber Bumper recorded on the graph—and the highest value in the table—is the value you want to record for your records. Repeat this 10 times using various distances.

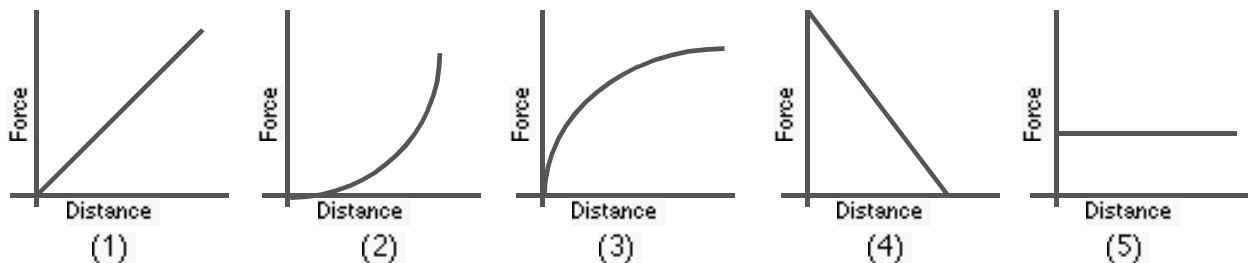
## “Rubber Bumper Data”

Distance										
Force										

## Analyzing the Data

- Launch Graphical Analysis.
- Change the “labels and units” (Click on the X and Y in the table) so that Distance (cm) is the independent variable and Force (N) is the dependent variable.
- Choose from the menu bar **Graph, Connecting Lines** (This should be unchecked)
- Enter the data that you have recorded for the “**Rubber Bumper**” in the table.

4. Circle the graph below that best represents the data you collected.

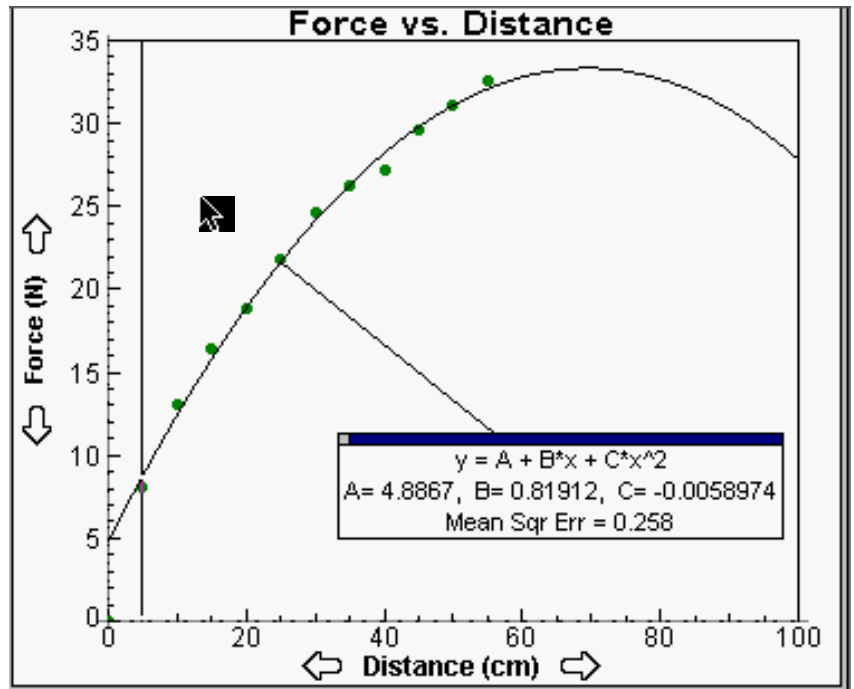


This is the graph of a function whose parent graph is  $f(x)=\sqrt{x}$  (using exponential notation:  $f(x)=x^{1/2}$ ). It is known as the square root function. Since your data resembles this curve, you will use the **automatic curve fit** option of Graphical Analysis to find the equation of your data.

5. Write the specific equation that you obtained from the data collected.

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6. When James and his group were analyzing their data, James experimented with the **Automatic Curve fit** option on Graphical Analysis. He tried using a quadratic equation to model the data. The figure to the right is the results of his fit. James concluded that the data fit a quadratic equation and **not** a square root curve. His partner, Maria disagreed with James saying the data couldn't fit a quadratic equation. Explain why Maria was right.




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