SATEC

# IMPACT

## revisited

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*Lesson created by Thomas Ledvorowski*

## A. Student Performance Objectives

### (c) Algebra and Geometry

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

- (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.
- (B) The student extends parent functions with parameters such as m in $y = mx$ and describes parameter changes on the graph of parent functions.
- (C) The student recognizes inverse relationships between various 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.

- (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.
- (D) The student solves square root equations and inequalities using graphs, tables, and algebraic methods.
- (E) The student analyzes situations modeled by square root functions, formulates equations or inequalities, selects a method, and solves problems.
- (F) The student expresses inverses of quadratic functions using square root functions.

## B. Critical Mathematics Explored in this Activity

This activity will explore the square root function, investigating the domain, range, and parameter changes of the function. Students will write equations from graphs which model the given situation and then use tables, graphs, and equations to interpolate and make predictions regarding specific events.

## C. How Students will Encounter the Concepts

The student will examine and reexamine the square root function by collecting and representing data in a table, on a graph and as a function. From the data, the graph, and the function, the student will then describe the characteristics of the square root function.

## D. Setting -Up

**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 grove down the middle of the ramp allows for "guidance" as the car rolls down the ramp. The Duel-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 grove of the ramp.

## Calibration

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

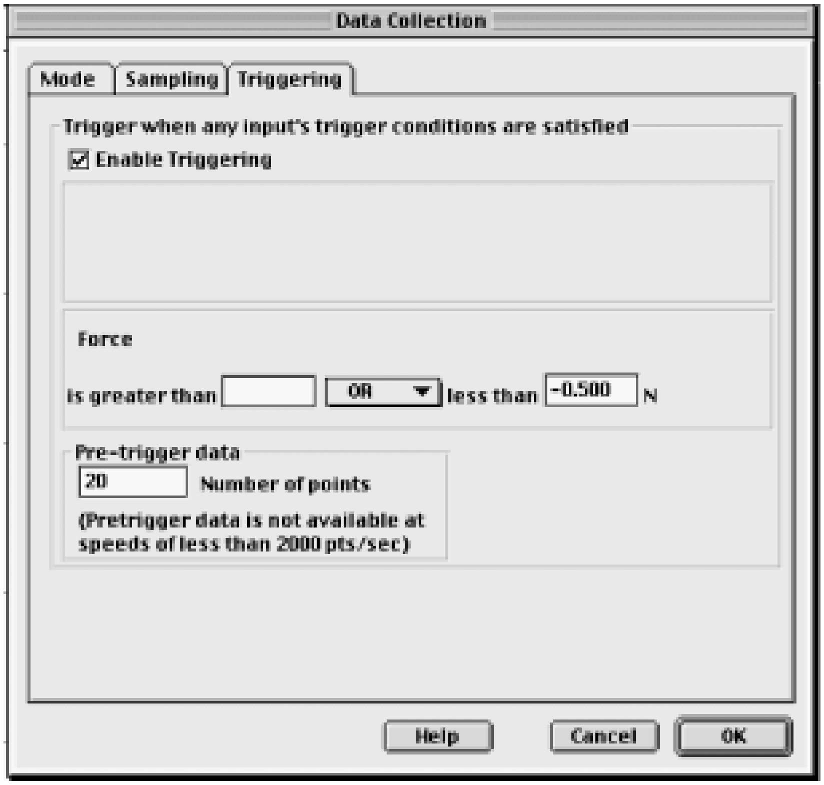
The Logger Pro file "Impact" is specially constructed to collect the data and present it in a user friendly manner. Since the Dual-Range Force Sensor records "negative" force when objects push into it, the file changes that data to a "positive" force. That is why there is an "extra" column (although hidden) for the force.

The Activity is designed to have Logger Pro **Trigger** the collection data. When the students click the collect button, the program will not begin to collect the data until the car strikes the force sensor.

Sometimes, the force sensor will automatically start collecting data--it has been triggered. To trouble shoot this try the following:

--Make sure that when there is nothing pushing into the sensor that the experiment has been "zero-ed" out. Choose Experiment, Zero… from the menu.

--From the Experiment, choose Triggering. Make sure that the triggering settings are as follows:




**Materials**

Each group should have:

Access to a computer and a ramp, with the dual force sensor attached.
A car
A "spike" and a "rubber bumper"
A graphing calculator
The Student activity sheet.
The Logger Pro file "Impact" should be loaded on the computer for the students to access.

**<u>Students will need the data they quired from doing this lesson during the Survey.</u>**

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

**F. Answers and Notes**

**G. Homework**

**H. Extension**

# IMPACT revisited

Last time we did this activity, we discovered the **SQUARE ROOT FUNCTION.** The parent function for this is given as $f(x) = \sqrt{x}$, Sometimes it is not possible to use the $\sqrt{\ }$ symbol so another way this function can be express is $f(x) = x^{1/2}$. This is read as "x raised to the one-half power." They mean the same thing.

Previously, we ran this activity using the rubber bumpers. This time, we are going to use the spike. (You will need to look at your previous results from the Survey to answer the following)

1. What do you think will be different about this activity if we use the spike?

   ______________________________________________________________

2. How might this change the way the graph will look?

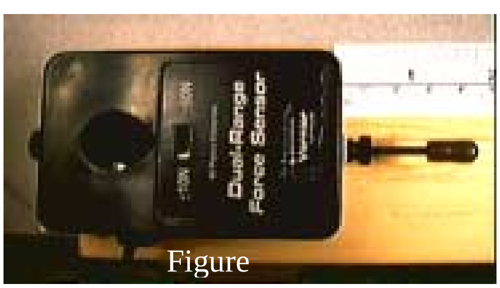
   ______________________________________________________________

3. What might change in the equation of this model if we use the spike?

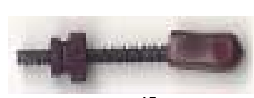
   ______________________________________________________________

**Setup**

The ramp you will be using should already have the force sensor attached to it. Attach the spike 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



**Spike**

Plug the Dual-Range Force sensor into the slot DIN 2 on the ULI and launch Logger Pro. From the file menu select FILE and OPEN. 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 first set of data will be collected from using the "spike" on the force sensor; the second set of data will be from 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 spike 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.

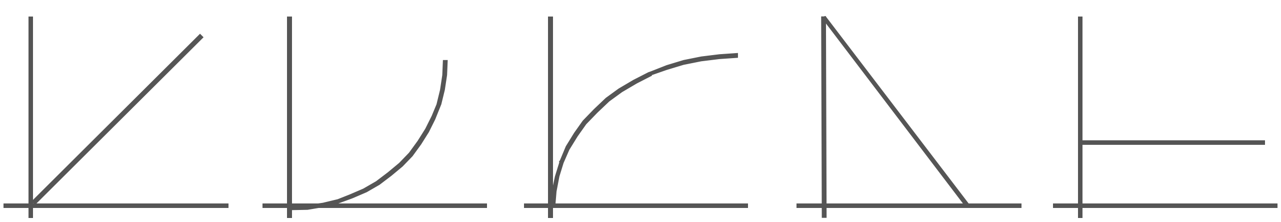
"Spiked Data"

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Distance | | | | | | | | | | |
| Force | | | | | | | | | | |

## Analyzing the Data

Launch Graphical Analysis.
Change the "labels and units"(do this by clicking 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 **"SPIKE"** in the table.

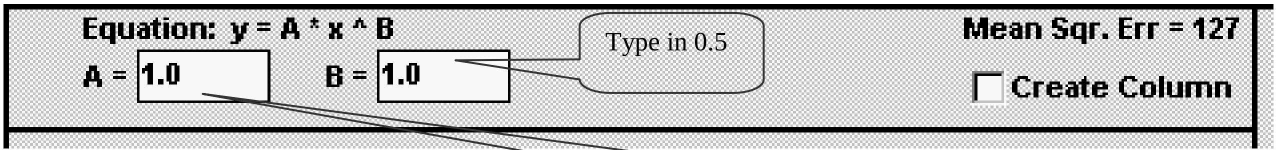
4. Compare once again the general shape of the data to the graphs below. Circle the appropriate graph.



**Your data should resemble the square root function.** You will use the **manual curve fit** option of Graphical Analysis to find the equation of your data. Since

Graphical Analysis does not use the square root symbol, you will need to choose the exponential function and type in 0.5 as the exponent.

- A window appears below the graph with the following information




- Click on the box for B= and type in 0.5.
- Increase or decrease the value of A (to three decimal places) to that which will give you the smallest **mean square error.**
- Now, write the equation in the appropriate blank below.

5. Equation for **Spiked Data**: ____________________________________

Once you have found the equation that will give you the smallest **Mean Sqr. Err**, print your screen. Choose **File, Print, Print Whole Screen**.
Open the Impact file for the **rubber bumper** data.
Repeat the above steps to perform a **Manual Curve Fit**.

6. Equation for **Rubber Bumper Data**: _________________________________

7. Describe the differences in the two equations that were found for the Manual curve fit for the **Spiked Data** and the **Rubber Bumper Data**. **EXPLAIN YOUR REASONING.**

_______________________________________________________________

_______________________________________________________________

_______________________________________________________________

Using Graphical Analysis' **Interpolation** tool, found under the **Analyze** menu, find the following values:

8. The strike force given a distance of 17.3 cm:
Hitting the spike__________ Hitting the Rubber bumper:____________

9. The distance required to have a strike force of 50 N:
Hitting the spike__________ Hitting the Rubber bumper:____________

**10-11 Use the equations found in numbers 2 and 3, find the following values. <u>Show your work</u>**:

10. The strike force given a distance of 90 cm:
Hitting the spike:___________ Hitting the Rubber bumper:__________

11. The distance required to have a strike force of 20 N:
Hitting the spike__________ Hitting the Rubber bumper:____________

12. A study team, examining two different types of plastic for guard rails, finds the following two equations for their data: $f_1 = 8.97\sqrt{x}$ and $f_2 = 9.67\sqrt{x}$. Based on this activity, which equation models a "softer" impact. State the reason for your choice.

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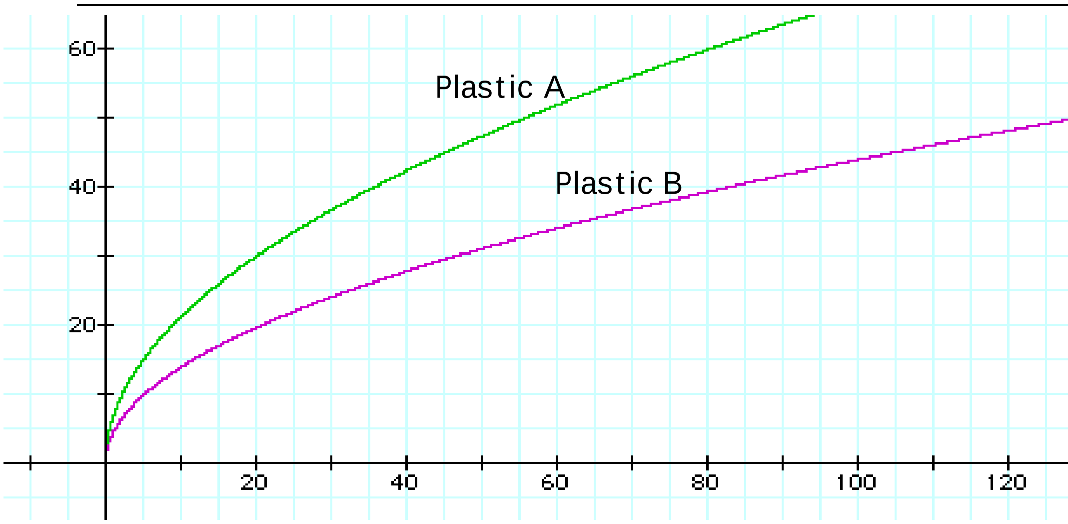
_______________________________________________________________

13. The same study team is evaluating the following graphs. Based on this activity, which equation models a "softer" impact. State the reason for your choice.

_______________________________________________________________

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