

## QUADRATIC MODELS

### ***PROBLEM 2: STOPPING YOUR CAR***

For any particular car, the distance it takes to stop is a function of the speed it is traveling when the brakes are applied. The following chart shows the distance it took a particular car to stop for the given speed.

SPEED (mph)	10	20	30	40	50	60	70
STOPPING DISTANCE (ft)	22	46	76	120	178	255	350

- A. Construct a scatterplot.
- B. Determine an appropriate model. Justify your selection.
- C. Using your scatterplot and model, write a short paragraph discussing your results.

## QUADRATIC MODELS

### ONE SOLUTION TO PROBLEM 2: STOPPING YOUR CAR

#### A. Construct a scatterplot.

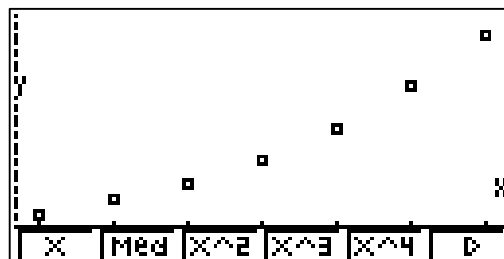
We must first enter the data into the calculator.

- x From the LIST menu, clear two lists for the data. Pressing  $\boxed{\text{F4}}$  followed by  $\boxed{\text{F1}}$  will accomplish this.
- x Type the data into the two lists. The beginning of the lists is shown below.
- x Press  $\boxed{\text{MENU}}$  for the MAIN MENU and choose “Statistics.”
- x Press  $\boxed{\text{F1}}$  for GRAPH and  $\boxed{\text{F6}}$  to set it up. Make sure it is a scatter graph using the correct lists. Also, you may wish to check the SET UP. To do so, press  $\boxed{\text{SHIFT}} \boxed{\text{MENU}}$  from the primary “Statistics” screen. Make sure the window is set on AUTO. When you’re ready, press  $\boxed{\text{F1}}$  twice from the primary “Statistics” screen to display the graph, assuming you set your graph up as Graph 1. Results are shown below right.

	List 1	List 2	List 3	List 4
1	10	22		
2	20	46		
3	30	76		
4	40	120		
5	50	178		

10

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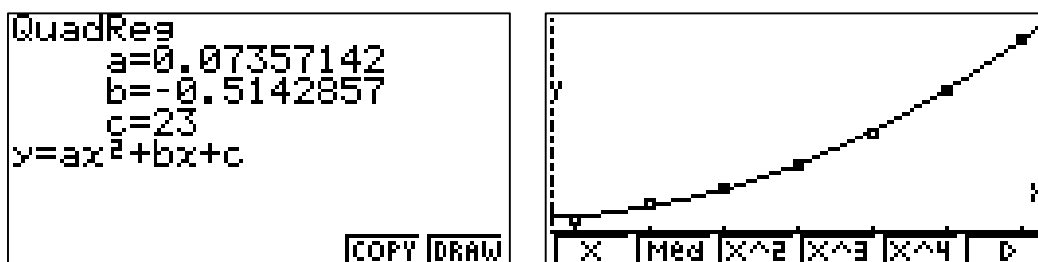
#### B. Determine an appropriate model. Justify your selection.

The model does not appear to be linear, and, in fact, is not. A quadratic is appropriate here. Consider how much distance is needed to slow down 10 miles per hour. Slowing down from 10mph to 0mph may not take too much. According to our data, it takes 22 feet. Slowing down from 20mph to 10mph should take a greater distance because we are traveling faster throughout the time interval. Another words, there cannot be a constant rate of change for the stopping distance. Slowing down from 60 to 50mph should take more than slowing down from 10 to 0mph. The model that is appropriate is quadratic.

## QUADRATIC MODELS

To perform quadratic regression, while looking at the scatterplot:

- x Press **F3** for  $X^2$  (quadratic) regression.
- x Press **F5** and **EXE** to copy the regression equation to Y1. See results below left.
- x Press **F6** to see the scatterplot and the regression function together. See results below right.



The regression equation is  $y = .07357x^2 - .5143x + 23$ .

### C. Using your scatterplot and model, write a short paragraph discussing your results.

The regression curve does seem to fit the data extremely well. As our speed increases, our stopping distance increases, but at a faster rate. The positive value for  $a$  indicates that the parabola opens upward, which is consistent with our common sense understanding of the rate increasing as we move to the right on the graph.

The  $y$ -intercept of 23 feet  $(0, 23)$  is somewhat problematic. In theory, this says that if we are traveling at 0mph, it will take us 23 feet to stop! This, of course, is ludicrous. Ideally we would like the graph to go through  $(0, 0)$ . We cannot just think of this as reaction distance either, because, assuming it always takes us a certain time to reach the brake, the distance we travel will be different when we travel at different speeds. Quite simply, we must recognize our model for what it is: an imperfect mathematical description of a real event. Nevertheless, it is still a very valuable method of making sense of our information.