4

Modeling Behavior

Using Quadratic Functions to Model Data

Warm Up

Determine a linear regression equation that best models the data.

x	*y*
1	32
2	35
3	34
4	35
5	39
6	38
7	40
8	42
9	41

Learning Goals

- Use a quadratic function to model data.
- Interpret characteristics of a quadratic function in terms of a problem situation.
- Use graphs of quadratic functions to make predictions.
- Interpret the inverse of a function in terms of a problem situation.

You know how to model data with regression equations and how to write inverses of linear and quadratic functions. How can you determine whether a quadratic regression equation may best model the data?

That Might Be a Bad Idea. . .

A 12-ounce can of soda was put into a freezer. The table shows the volume of the soda in the can, measured at different temperatures.

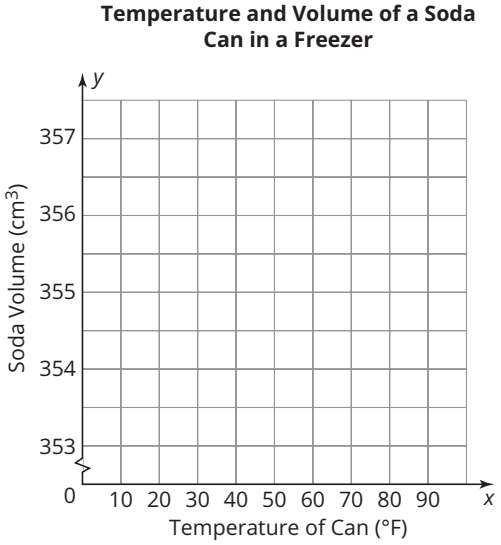
The first step of the modeling process is to notice and wonder. What do you notice about the data? Is there a question it brings to mind that you wonder about?

Temperature of Can (°F)	Soda Volume cm^3
68.0	355.51
50.0	354.98
42.8	354.89
39.2	354.88
35.6	354.89
32.0	354.93
23.0	355.13
14.0	355.54

1. Describe the data distribution.

2. Create a scatter plot of the data. Sketch the plot of points on the coordinate plane shown.

The second step of the modeling process is to organize and mathematize. The scatter plot is a way to organize the data.



ACTIVITY
4.1

Using Quadratic Functions to Model Data

Let's continue to analyze the data and make some predictions about the volume of soda at different temperatures.

1. **Use technology to calculate the regression equation that best models the data in the previous activity. Sketch the graph of the regression equation on the coordinate plane on which you created your scatter plot. Explain why the regression equation best models the data.**

You can mathematize the data by modeling it with an appropriate regression equation.

2. **State the domain and range of your function. How do they compare to the domain and range of this problem situation?**

3. **Use the regression equation to answer each question.**

   a. **Determine the *y*-intercept and interpret its meaning in terms of this problem situation.**

   b. **Determine the *x*-intercepts, and interpret the meaning of each in terms of this problem situation.**

The third step of the modeling process is to predict and analyze, and the fourth step is to test and interpret. These questions focus on these two steps of the process.

4. **Predict the volume of the soda can when the temperature is:**

   a. 20°F.

   b. 60°F.

5. **Write a summary of the problem situation, your model as the solution, and any limitations of your model.**

ACTIVITY
4.2

Analyzing a Quadratic Model and Its Inverse

Arlen City Police Department is offering special classes for interested high school students this summer. Elsa decides to enroll in an introductory forensic science class. On the first day, Dr. Suarez tells Elsa's class that crime scenes often involve speeding vehicles which leave skid marks on the road as evidence. Taking into account the road surface, weather conditions, the percent grade of the road, and vehicle type, they use this function:

$$f(s) = 0.034s^2 + 0.96s - 26.6$$

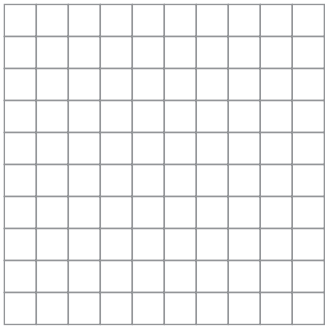
to determine the length in feet of skid marks left by a vehicle based on its speed, s, in miles per hour.

25	
30	
45	
55	
60	
75	
90	
100	
110	

1. Complete the table based on $f(s)$. Label the column titles with the independent and dependent quantities and their units.

2. According to the table, what are the domain and range for the problem situation?

3. Graph the table values and sketch the graph of $f(s)$ on the grid shown. Label the axes.



During another class period, Dr. Suarez takes Elsa's class to a mock crime scene to collect evidence.

4. **One piece of evidence is a skid mark that is 300 feet long.**

   a. **Use the graph to estimate the speed of the vehicle that created this skid mark. Explain your process.**

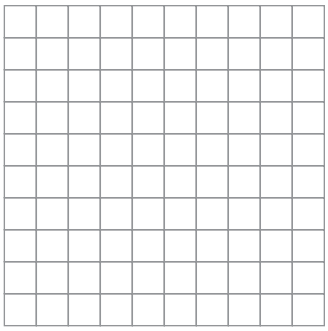
Ask yourself:

How do these data differ from the data in the table?

   b. **Determine the exact speed of the vehicle that created this skid mark. Show your work.**

5. **Describe a new function that Elsa can use to determine the speed of a vehicle given the length of a skid mark it created. In your description, include information about the independent and dependent variables, and the domain and range of this problem situation.**

6. **Predict what you think the graph of the new function will look like and sketch the graph on the grid shown.**



7. **Use your graph to estimate the car's speed before stopping for each given skid mark length.**

   a. **50 feet**

   b. **175 feet**

   c. **350 feet**

8. **Write a report about the length of skid marks left by vehicles and vehicle speeds. Discuss possible factors that would affect the length of the skid marks left by a vehicle, and what effect these factors would have on the graph of $f(s)$ and the graph of its inverse.**

NOTES

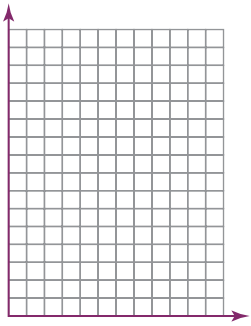
TALK the TALK

Living to 100

Using data from the US Census Bureau, the table lists the number of Americans, in thousands, who lived to be over 100 years old for the specified years.

Year	Number of Americans (thousands)
1994	50
1996	56
1998	65
2000	75
2002	94
2004	110

1. **Graph the table values on the grid shown. Let *x* be the number of years since 1994. Label the axes.**



2. **Use technology to calculate the linear, exponential and quadratic regression equations. Which model best fits the data? Explain your reasoning. Sketch the graph of the best fit regression equation on the coordinate plane on which you created your scatter plot.**

3. **State the domain and range of your function. How do they compare to the domain and range of this problem situation?**

4. **Use your regression equation to predict the number of Americans that will live to be over 100 years old in the year 2025.**