Student Name: Points:20 Period:

Date:

Due:

Activity 4.4

Mathematical Modeling

INTRODUCTION

In this activity you will collect and analyze data to make predictions based on that data. You will use both manual and computer methods to record, manipulate, and analyze the data to determine mathematical relationships between quantities. These mathematical relationships can be represented graphically and by equations, also known as **mathematical models**. You will then use the mathematical models to make predictions related to the quantities.

RESOURCES

Part 1

Given the following data, determine a mathematical model for the amount of rain water that runs off of the ground into surrounding waterways with respect to the amount of rain that falls on the ground.

Gauging Station	Estimated mean annual rainfall over area (in.)	Average annual runoff from area (in.)
Middle Fork Cottonwood Creek near Ono	40	14.1
Red Bank Creek near Red Bluff	24	6.4
Elder Creek at Gerber	30	9.6
Thomes Creek at Paskenta	45	21.2
Grindstone Creek near Elk Creek	47	16.8
Stone Corral Creek near Sites	21	2.2
Bear Creek near Rumsey	27	6

1. Use Excel to create a scatter plot of your data and find a trend line.

   a. Input the data in tabular form. Be sure to include column headings. You do not need to include the piece color column.

   b. Create a scatterplot of the data. Format the axes, label the axes, and title the chart as shown below.

   c. Add a linear trend line and include the equation on the graph. Format the trend line to forecast backward 5 units.

   d. Print your graphical model showing the trendline and equation (mathematical model).

   e. Would you describe the relationship between Average Annual Runoff and Estimated Annual Rainfall as a strong correlation, a weak correlation, or neither? Provide evidence.

2. Use the mathematical model (trendline) to respond to items a–f.

   a. Rewrite the equation of the trend line using function notation where R(w) represents the annual Runoff and w represents the annual Rainfall.

   b. What is the domain of the function? That is, what values of *w* make sense?

   c. What is the range of the function?

   d. What is the slope of your trend line? Explain the interpretation of the slope in words.

   e. Estimate the annual runoff amount if the annual rainfall amount is 54 inches. Show your work.

      - Mark this point on your graph and label the point, Point E.

   f. If the annual runoff amount from an area was measured to be 11.5 inches, estimate the annual rainfall amount that fell on that area. Show your work.

      - Mark this point on your graph and label the point, Point F.

Part 2

Find a mathematical model to represent the minimum jump height of a BMX bike as a function of the bike weight. Then use the mathematical model to make predictions.

The following data was collected for minimum jump heights achieved by an experienced rider for bikes of different weights.

Bike Weight (lb)	Minimum Jump Height (in.)
19	83.5
19.5	82.0
20	79.2
20.5	77.1
21	74.9
22	73.3
22.5	71.0
23	68.1
23.5	65.8
24	64.2

Use this data to complete each of the following items.

3. Create a scatter plot and find a trend line for the data using Excel. Print a copy of your worksheet that includes the following:
   - Table of data
   - Scatterplot with properly formatted axes, axes labels and units, and an appropriate chart title
   - Trend line and its equation displayed on the scatterplot

4. Use the equation of the trend line to respond to items a–g.

   a. Write the equation relating Bike Weight to Minimum Jump Height in function notation. Be sure to define your variable.

   b. What is the domain of the function? Explain.

   c. What is the range of the function?

   d. What is the slope of the line (include units). Is the slope positive or negative? Explain the interpretation of the slope in words.

   e. If the engineer designed a bike that weighs 18 pounds, predict the minimum jump height. Give your answer in inches (to the nearest hundredth of an inch) and in feet and inches (to the nearest inch). Show your work.

   f. If the engineer designed a bike that weighs 1 pound, predict the minimum jump height. Give your answer in inches (to the nearest hundredth of an inch) and in feet and inches (to the nearest inch). Show your work.

      - Does the predicted height for a one-pound bike make sense? Is this function a good predictor for minimum jump heights at all bike weights? Explain.

   g. If a minimum jump height of 89.7 inches is recorded, predict the estimated weight of the bike. Show your work.

   h. Based on the correlation coefficient, how confident are you that your predictions are accurate?

CONLUSION