Scatter Plots and Trend Lines

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Overview

Data that is collected by measurement or observation naturally varies. A scatter plot helps students decide whether there is a relationship (an association) between two numerical variables.

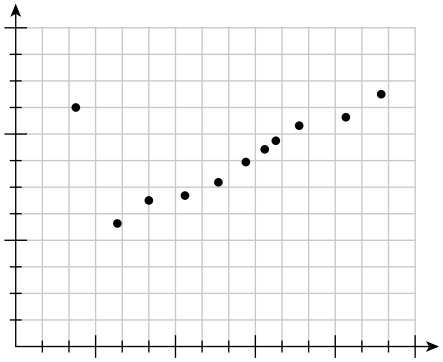
If a linear relationship exists, the trend can be shown graphically with a line on the scatter plot. In this course, students use a ruler to estimate a trend line. The equation of the best-fit line can be determined from the slope and the *y*-intercept.

An association is often described by its form, direction, strength, and outliers. See the Methods & Meanings boxes in Lessons 7.1.2, 7.1.3, and 7.3.2 of the *Core Connections Course 3* text.

For additional examples and practice, see the *Core Connections Course 3* Checkpoint 9 materials.

Examples

1. Sam collected data by measuring the pencils of her classmates. She recorded the length of the painted part of each pencil and the pencil's weight. Her data is shown in the following graph.

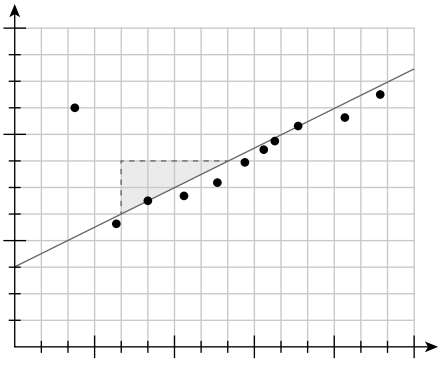


a. Describe the association between the weight of a pencil and the length of its painted part.

There is a strong positive linear association with one apparent outlier at ≈ 2.3 cm.

b. Draw a trend line and use that to determine the equation for the relationship of the length of the pencil to its weight.

The equation of the line is approximately $y = \frac{1}{4}x + 1.5$.



c. Sam's teacher has a pencil with a painted part that is 11.5 cm long. Predict the weight of the teacher's pencil using the equation found in part (b).

$x = 11.5$

$\downarrow$

$y = \frac{1}{4}x + 1.5$

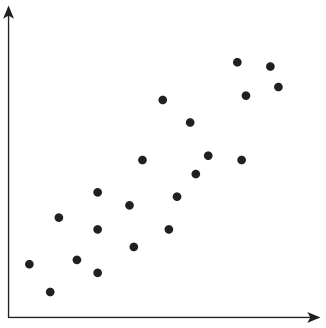
$y = \frac{1}{4}(11.5) + 1.5$

$y = 4.4$ g

Practice

In problems 1 through 4, describe the form, direction, strength, and outliers of the scatter plot, if they exist.

1.



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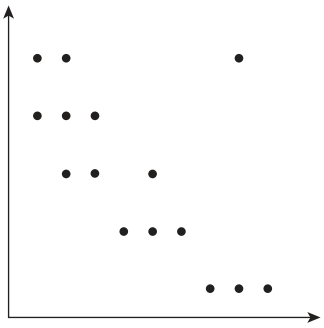

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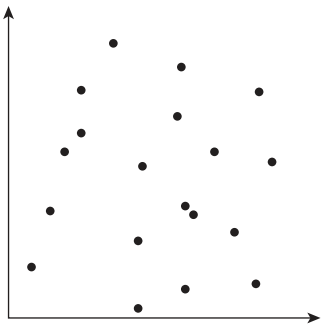

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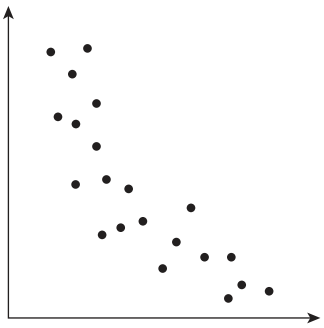


5. Dry ice (frozen carbon dioxide) has the unusual property of sublimating, or changing directly from a solid to a gas. Giulia's father uses dry ice to keep the glasses in the family's restaurant cold. Since dry ice sublimates in the restaurant cooler, Giulia was curious how long a piece of dry ice would last. She collected the data in the table shown.

Draw a scatter plot and a trend line. What is the approximate equation of the trend line?

Time After Noon (hours)	Weight of Dry Ice (oz)
0	15.3
1	14.7
2	14.3
3	13.6
4	13.1
5	12.5
6	11.9
7	11.5
8	11.0
9	10.6
10	10.2

6. Ranger Scott is responsible for monitoring the population of the elusive robins in McNeil State Park. He would like to determine a relationship between the elm trees (their preferred nesting site) and the number of robins in the park. He randomly selects seven different areas in the park and painstakingly counts the elms and robins in each area.

Number of Elms	8	13	4	5	10	9	4
Number of Robins	5	9	3	5	7	7	5

a. Make a scatter plot on graph paper and describe the association.

b. Sketch the trend line on your scatter plot. Determine the equation of the trend line.

c. Based on the equation, how many robins should Ranger Scott expect to see in an area with 6 elm trees?

7. A study was done on a vitamin supplement that claims to shorten the length of the common cold. The data the scientists collected from ten patients in an early study is shown in the table.

Time Taking Supplement (months)	0.5	2.5	1	2	0.5	1	2	1	1.5	2.5
Length of Cold (days)	4.5	1.6	3	1.8	5	4.2	2.4	3.6	3.3	1.4

a. Create a scatter plot and describe the association.

b. Model the data with a trend line. Use x to represent the time taking the supplement (in months) and y to represent the length of the cold (in days).

c. According to your model, how many days do you expect a cold to last for a patient who has been taking the supplement for 1.5 months?

Answers

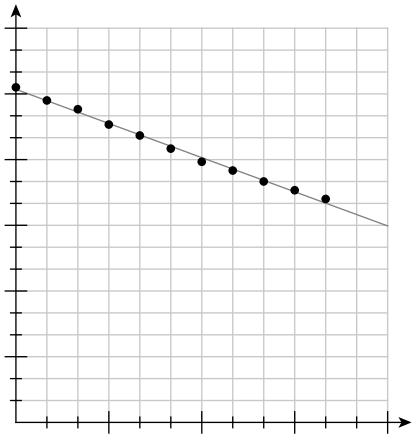
1. Moderate, positive, linear association with no outliers.

2. Strong, negative, linear association with an outlier.

3. No association.

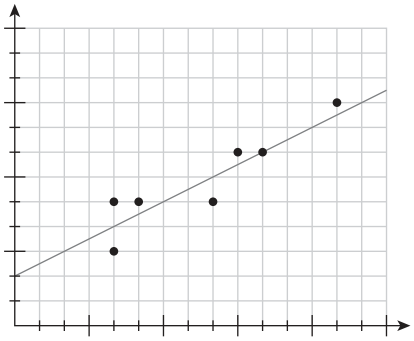
4. Strong, positive, curved association.

5.



$y = -\frac{1}{2}x + 15.3$

6.

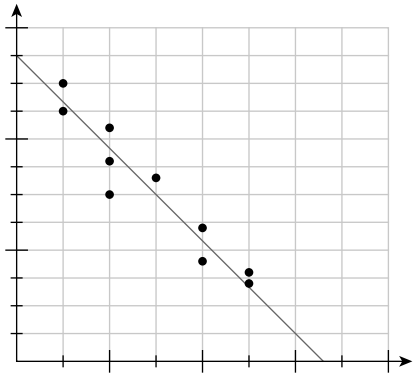


a. Strong, positive, linear association with no outliers.

b. $y = \frac{1}{2}x + 2$

c. 5 robins

7. a.



The form is linear, the direction is negative, the strength is moderate, and there are no apparent outliers.

b. $y = -\frac{5}{3}x + 5.5$

c. $-\frac{5}{3}\left(\frac{3}{2}\right) + 5 = 2\frac{1}{2}$ days

Slope

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Overview

The slope of a line is the ratio of the change in y to the change in x between any two points on the line. The slope indicates the steepness (or flatness) of a line, as well as its direction (up or down) going from left to right.

The slope is determined by the ratio $\frac{\text{vertical change}}{\text{horizontal change}}$ between any two points on a line.

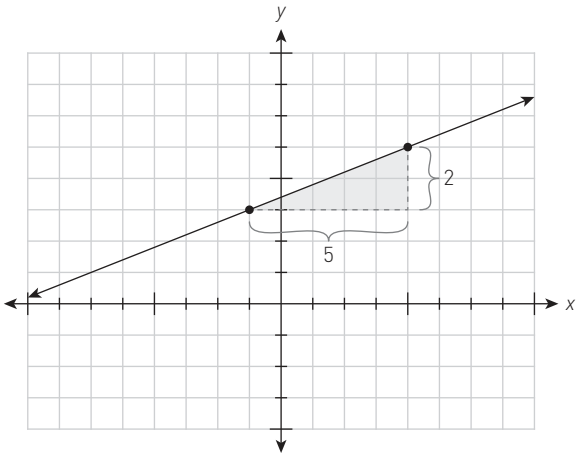
For lines that go up (from left to right), the sign of the slope is positive (the change in y is positive). For lines that go down (left to right), the sign of the slope is negative (the change in y is negative). A horizontal line has zero slope, while the slope of a vertical line is undefined.

For additional information, see the Methods & Meanings box in Lesson 7.2.4 of the *Core Connections Course 3* text.

Examples

1. Write the slope of the line containing the points (–1, 3) and (4, 5).

First, graph the two points and draw a line through them. Look for and draw a slope triangle using the two given points.

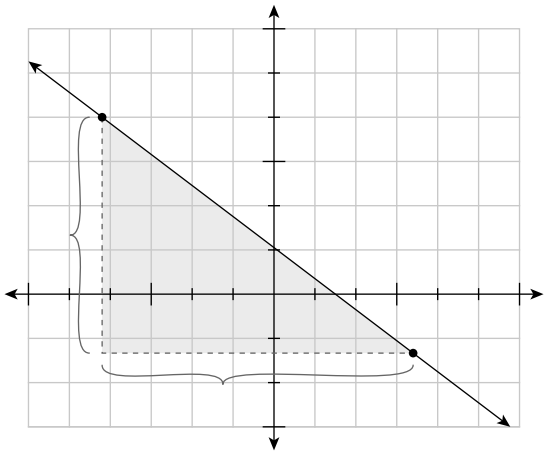


Write the ratio $\frac{\text{vertical change}}{\text{horizontal change}}$ using the legs of the right triangle: $\frac{2}{5}$.

Assign a positive or negative value to the slope depending on whether the line goes up (+) or down (–) from left to right. In this case, the line goes up, so the slope is positive.

2. Determine the slope of the line that contains the points (–21, 12) and (17, –4).

Since the points are inconvenient to graph, use a generic slope triangle, visualizing where the points lie with respect to each other. Sketch a graph to approximate the position of the two points, draw a slope triangle, and calculate the length of the leg of each triangle. Write the ratio $\frac{\text{change in } y}{\text{change in } x} = \frac{-16}{38}$, then rewrite.



The slope is $-\frac{8}{19}$ since the change in y is negative (decreasing).

Practice

Write the slope of the line containing each pair of points.

1. (3, 4) and (5, 7)

2. (5, 2) and (9, 4)

3. (1, –3) and (–4, 7)

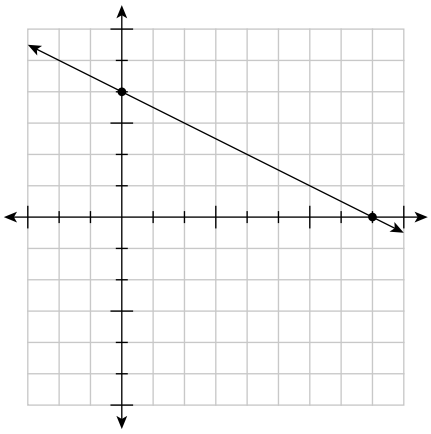
4. (–2, 1) and (2, –2)

5. (–2, 3) and (4, 3)

6. (32, 12) and (12, 20)

Determine the slope of each line using the highlighted points.

7.



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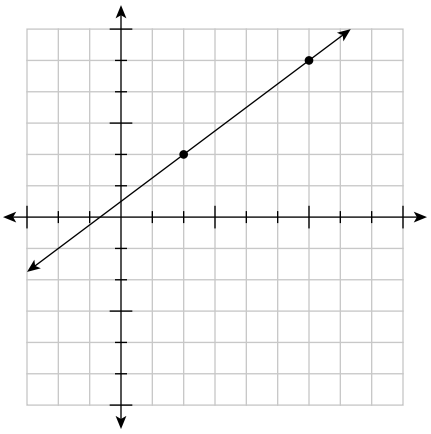
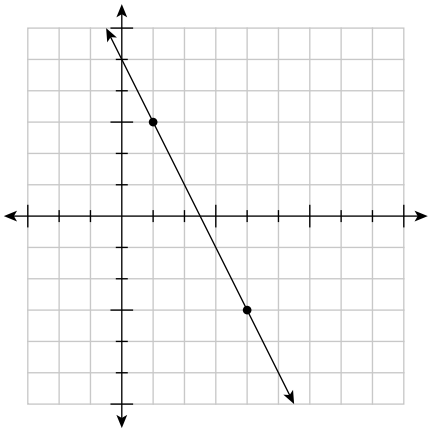


9.



Answers

1. $\frac{3}{2}$ **2.** $\frac{1}{2}$ **3.** -2

4. $-\frac{3}{4}$ **5.** 0 **6.** $-\frac{2}{5}$

7. $-\frac{1}{2}$ **8.** $\frac{3}{4}$ **9.** -2