# Chapter Overview and Pacing

### LESSON OBJECTIVES

1. **Relations and Functions** *(pp. 56–62)*
   - Analyze and graph relations.
   - Find functional values.
   - Pacing: Regular - 1, Optional - 0.5, Block - 0.5

2. **Linear Equations** *(pp. 63–67)*
   - Identify linear equations and functions.
   - Write linear equations in standard form and graph them.
   - Pacing: Regular - 1, Optional - 0.5, Block - 0.5

3. **Slope** *(pp. 68–74)*
   - Find and use the slope of a line.
   - Graph parallel and perpendicular lines.
   - Pacing: Regular - 1, Optional - 0.5, Block - 0.5

4. **Writing Linear Equations** *(pp. 75–80)*
   - Write an equation of a line given the slope and a point on the line.
   - Write an equation of a line parallel or perpendicular to a given line.
   - Pacing: Regular - 1, Optional - 0.5, Block - 0.5

5. **Modeling Real-World Data: Using Scatter Plots** *(pp. 81–88)*
   - Draw scatter plots.
   - Find and use prediction equations.
   - Follow-Up: Lines of Regression
   - Pacing: Regular - 2 (with 2-5 Optional - 1, Block - 1

6. **Special Functions** *(pp. 89–95)*
   - Identify and graph step, constant, and identity functions.
   - Identify and graph absolute value and piecewise functions.
   - Pacing: Regular - 1, Optional - 0.5, Block - 0.5

7. **Graphing Inequalities** *(pp. 96–99)*
   - Graph linear inequalities.
   - Graph absolute value inequalities.
   - Pacing: Regular - 1, Optional - 0.5, Block - 0.5

### PACING (days)

<table>
<thead>
<tr>
<th></th>
<th>Regular</th>
<th>Block</th>
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<tbody>
<tr>
<td><strong>Basic/Average</strong></td>
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</tr>
<tr>
<td><strong>Advanced</strong></td>
<td>Optional</td>
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**TOTAL**: 10 days for Regular, 3 days for Block.

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*Pacing suggestions for the entire year can be found on pages T20–T21.*
### Chapter Resource Manager

#### CHAPTER 2 RESOURCE MASTERS

<table>
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<th>Materials</th>
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<td>75–76 77–78 79 80 113, 115 GCS 30, SC 3</td>
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<tr>
<td>93–94 95–96 97 98 114</td>
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<td>99–112, 116–118</td>
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*Key to Abbreviations:* GCS = Graphing Calculator and Spreadsheet Masters, SC = School-to-Career Masters, SM = Science and Mathematics Lab Manual.
2-1 Relations and Functions

This lesson begins an exploration of two important themes of algebra. One theme is how algebraic equations and the Cartesian coordinate system are related. The other theme is the relationships between equations that represent entire lines and numbers that represent points on or properties of that line.

For this lesson the central idea is ordered pairs. First, ordered pairs are explored as names for points in a coordinate plane. Second, several ordered pairs are used to describe how the set of the first elements (the domain) can be related to the set of the second elements (the range). Third, for equations that represent a line or a curve, ordered pairs are used to determine the graph that represents that equation in the coordinate plane.

In the lesson the relation between functions and relations is explored in two ways. Mappings of domain elements to range elements are used to identify functions that are one to one, functions that are not one to one, and relations that are not functions. In the coordinate plane, the vertical line test is used to distinguish a relation from a function. Relationships between ordered pairs and functions are explored in two ways. First, students are given an equation (for a curve or for a line) and make a table of ordered pairs for the equation. Second, students are given a function and a domain value, and evaluate the function to find the range value.

2-2 Linear Equations

In this lesson students deal with linear functions and intercepts. Linear functions and equations can be written in slope-intercept form, \( f(x) = mx + b \) or \( y = mx + b \), or in standard form, \( Ax + By = C \). The graph of a linear function or equation is always a line.

2-3 Slope

Slope is a fundamental concept in algebra and higher mathematics. In this lesson, students calculate the slope of a line given two points on the line and explore the slopes of families or pairs of lines that are parallel and the slopes of pairs of lines that are perpendicular.

Students graph a line given two points or given one point and the slope. In the coordinate plane, students associate lines with slopes that are positive, negative, zero, or undefined.
2-4 Writing Linear Equations

This lesson focuses on the slope and \( y \)-intercept of a linear equation. In the slope-intercept form of a linear equation, \( y = mx + b \), \( m \) represents the slope of the line and \( b \) is the \( y \)-intercept.

Students use two forms of a linear equation, the slope-intercept form and the point-slope form, to write an equation given two points, given a point and the slope, or given a point and the equation of a parallel or a perpendicular line.

2-5 Special Functions

In this lesson, students explore special functions. The identity and constant functions are special linear functions. The graph of a step function is a series of line segments. An absolute value function has a V-shaped graph made up of portions of two lines. A piecewise function is a function written using two or more algebraic expressions.

2-6 Modeling Real-World Data: Using Scatter Plots

This lesson explores equations that approximate the relation between domain values and range values, extending the idea of using an algebraic equation to represent a set of points in a plane. Starting with a scatter plot of data, students mentally picture a line through the data. After selecting two points on that line, they calculate the slope and \( y \)-intercept of that line. The equation, called a line of fit or a prediction equation, may be used to calculate the value of one variable given a value of the other.

Activities in this lesson require three steps: given a set of ordered pairs, students identify a line that represents a set of ordered pairs; then they select two ordered pairs that lie on the line; and finally they calculate the slope and \( y \)-intercept for that line.

2-7 Graphing Inequalities

In this lesson the graph of an equation is seen as the boundary between two regions of the coordinate plane. An inequality is a description of one of the two regions, and whether the boundary is part of that region depends on the inequality symbol that is used. Students explore how inequalities, including absolute value inequalities, are modeled by points in the coordinate plane, and vice versa.

Additional mathematical information and teaching notes are available in Glencoe’s Algebra 2 Key Concepts: Mathematical Background and Teaching Notes, which is available at www.algebra2.com/key_concepts. The lessons appropriate for this chapter are as follows.

- Linear Relations and Functions (Lesson 5)
- Graphing Linear Equations (Lessons 6 and 12)
- Slope (Lesson 7)
- Writing Linear Equations in Point-Slope and Standard Forms (Lesson 8)
- Writing Linear Equations in Slope-Intercept Form (Lesson 10)
- Integration: Geometry/Parallel and Perpendicular Lines (Lesson 13)
- Statistics: Scatter Plots and Best-Line Fits (Lesson 9)
- Graphing Inequalities in Two Variables (Lesson 17)
### TestCheck and Worksheet Builder

This networkable software has three modules for intervention and assessment flexibility:

- **Worksheet Builder** to make worksheet and tests
- **Student Module** to take tests on screen (optional)
- **Management System** to keep student records (optional)

Special banks are included for SAT, ACT, TIMSS, NAEP, and End-of-Course tests.

### Additional Intervention Resources

- **The Princeton Review’s Cracking the SAT & PSAT**
- **The Princeton Review’s Cracking the ACT**
- ALEKS

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<table>
<thead>
<tr>
<th>Type</th>
<th>Student Edition</th>
<th>Teacher Resources</th>
<th>Technology/Internet</th>
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<tr>
<td>Error Analysis</td>
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<td>Find the Error, TWE pp. 60, 71 Unlocking Misconceptions, TWE p. 58 Tips for New Teachers, TWE pp. 62, 74, 90</td>
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Intervention Technology

Alge2PASS: Tutorial Plus CD-ROM offers a complete, self-paced algebra curriculum.

<table>
<thead>
<tr>
<th>Algebra 2 Lesson</th>
<th>Alge2PASS Lesson</th>
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<td>3  Graphing Linear Equations on the Coordinate Plane</td>
</tr>
<tr>
<td>2-7</td>
<td>4  Graphing Linear Inequalities on the Coordinate Plane</td>
</tr>
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</table>

ALEKS is an online mathematics learning system that adapts assessment and tutoring to the student’s needs. Subscribe at www.k12aleks.com.

Intervention at Home

Log on for student study help.

- For each lesson in the Student Edition, there are Extra Examples and Self-Check Quizzes.
  www.algebra2.com/extra_examples
  www.algebra2.com/self_check_quiz
- For chapter review, there is vocabulary review, test practice, and standardized test practice.
  www.algebra2.com/vocabulary_review
  www.algebra2.com/chapter_test
  www.algebra2.com/standardized_test

For more information on Intervention and Assessment, see pp. T8–T11.

Reading and Writing in Mathematics

Glencoe Algebra 2 provides numerous opportunities to incorporate reading and writing into the mathematics classroom.

Student Edition

- Foldables Study Organizer, p. 55
- Concept Check questions require students to verbalize and write about what they have learned in the lesson. (pp. 60, 65, 71, 78, 83, 92, 98, 100)
- Writing in Math questions in every lesson, pp. 62, 67, 73, 80, 86, 94, 99
- Reading Study Tip, pp. 56, 59, 71, 82
- WebQuest, p. 84

Teacher Wraparound Edition

- Foldables Study Organizer, pp. 55, 100
- Study Notebook suggestions, pp. 60, 65, 71, 78, 83, 93, 97
- Modeling activities, pp. 67, 74, 95
- Speaking activities, pp. 62, 98
- Writing activities, pp. 80, 86
- Differentiated Instruction, (Verbal/Linguistic), p. 92
- ELL Resources, pp. 54, 61, 66, 73, 79, 85, 92, 94, 99, 100

Additional Resources

- Vocabulary Builder worksheets require students to define and give examples for key vocabulary terms as they progress through the chapter. (Chapter 2 Resource Masters, pp. vii-viii)
- Reading to Learn Mathematics master for each lesson (Chapter 2 Resource Masters, pp. 61, 67, 73, 79, 85, 91, 97)
- Vocabulary PuzzleMaker software creates crossword, jumble, and word search puzzles using vocabulary lists that you can customize.
- Teaching Mathematics with Foldables provides suggestions for promoting cognition and language.
- Reading and Writing in the Mathematics Classroom
- WebQuest and Project Resources

For more information on Reading and Writing in Mathematics, see pp. T6–T7.
Have students read over the list of objectives and make a list of any words with which they are not familiar.

Point out to students that this is only one of many reasons why each objective is important. Others are provided in the introduction to each lesson.

Linear equations can be used to model relationships between many real-world quantities. One of the most common uses of a linear model is to make predictions. Most hot springs are the result of groundwater passing through or near recently formed, hot, igneous rocks. Iceland, Yellowstone Park in the United States, and North Island of New Zealand are noted for their hot springs. You will use a linear equation to find the temperature of underground rocks in Lesson 2-2.

The Key Vocabulary list introduces students to some of the main vocabulary terms included in this chapter. For a more thorough vocabulary list with pronunciations of new words, give students the Vocabulary Builder worksheets found on pages vii and viii of the Chapter 2 Resource Masters. Encourage them to complete the definition of each term as they progress through the chapter. You may suggest that they add these sheets to their study notebooks for future reference when studying for the Chapter 2 test.
Prerequisite Skills  To be successful in this chapter, you’ll need to master these skills and be able to apply them in problem-solving situations. Review these skills before beginning Chapter 2.

For Lesson 2-1 Identify Points on a Coordinate Plane
Write the ordered pair for each point.
1. A (−3, 3) 2. B (2, 3) 3. C (−3, −1) 4. D (2, 0) 5. E (0, −4) 6. F (3, −2)

For Lesson 2-1 Evaluate Expressions
Evaluate each expression if \(a = −1\), \(b = 3\), \(c = −2\), and \(d = 0\). (For review, see Lesson 1-1.)
7. \(c + d\) 8. \(4c − b\) 9. \(a^2 − 5a + 3\)
10. \(2b^2 + b + 7\) 11. \(\frac{a−b}{c−d}\) 12. \(\frac{a+c}{b+c}\)

For Lesson 2-4 Simplify Expressions
Simplify each expression. (For review, see Lesson 1-2.)
13. \(x − (−1)\) 14. \(x − (−5)\) 15. \(2[x − (−3)]\)
16. \(4[x − (−2)]\) 17. \(\frac{1}{2}[x − (−4)]\) 18. \(\frac{1}{3}[x − (−6)]\)

For Lessons 2-6 and 2-7 Evaluate Expressions with Absolute Value
Evaluate each expression if \(x = −3\), \(y = 4\), and \(z = −4.5\). (For review, see Lesson 1-4.)
19. \(|x|\) 20. \(|y|\) 21. \(|5x|\)
22. \(−|2z|\) 23. \(5|y + z|\) 24. \(−3|x + y| − |x + z|\)

Making Foldables: Study Organizers
As you read and study the chapter, write notes, examples, and graphs under the tabs.

Organization of Data: Annotating  As students read and work their way through the chapter, have them make annotations under the appropriate tabs of their Foldable. Explain to them that annotations are usually notes taken in the margins of books, which we own, to organize the text for review or studying. Annotations often include questions that arise, reader comments and reactions, short summaries, steps or data numbered by the reader, and key points highlighted or underlined.
5-Minute Check Transparency 2-1  Use as a quiz or review of Chapter 1.

Mathematical Background notes are available for this lesson on p. 54C.

Building on Prior Knowledge
In Chapter 1, students solved equations and inequalities. In this lesson, students relate equations to functions and relations, as well as to their graphs.

How do relations and functions apply to biology?
Ask students:
• What is the difference between average lifetime and maximum lifetime? The average lifetime is a representative number of years for any animal of that type, while the maximum lifetime is the greatest age ever attained by an animal of that type.
• Why can you be sure that the second number in the ordered pairs for this data is always greater than or equal to the first? For each animal, the maximum age will always equal or exceed the average age.

The table shows the average lifetime and maximum lifetime for some animals. The data can also be represented as ordered pairs. The ordered pairs for the data are (12, 28), (15, 30), (8, 20), (12, 20), and (20, 50). The first number in each ordered pair is the average lifetime, and the second number is the maximum lifetime.

<table>
<thead>
<tr>
<th>Animal</th>
<th>Average Lifetime (years)</th>
<th>Maximum Lifetime (years)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cat</td>
<td>12</td>
<td>28</td>
</tr>
<tr>
<td>Cow</td>
<td>15</td>
<td>30</td>
</tr>
<tr>
<td>Deer</td>
<td>8</td>
<td>20</td>
</tr>
<tr>
<td>Dog</td>
<td>12</td>
<td>20</td>
</tr>
<tr>
<td>Horse</td>
<td>20</td>
<td>50</td>
</tr>
</tbody>
</table>

Source: The World Almanac

GRAPH RELATIONS You can graph the ordered pairs above by creating a coordinate system with two axes. Each point represents one of the ordered pairs above. Remember that each point in the coordinate plane can be named by exactly one ordered pair and that every ordered pair names exactly one point in the coordinate plane.

The graph of the animal lifetime data lies in only one part of the Cartesian coordinate plane—the part with all positive numbers. The Cartesian coordinate plane is composed of the x-axis (horizontal) and the y-axis (vertical), which meet at the origin (0, 0) and divide the plane into four quadrants. The points on the two axes do not lie in any quadrant.

In general, any ordered pair in the coordinate plane can be written in the form (x, y).

A relation is a set of ordered pairs, such as the one for the longevity of animals. The domain of a relation is the set of all first coordinates (x-coordinates) from the ordered pairs, and the range is the set of all second coordinates (y-coordinates) from the ordered pairs. The graph of a relation is the set of points in the coordinate plane corresponding to the ordered pairs in the relation.

The vertical axis represents the maximum lifetime. The horizontal axis represents the average lifetime.

Assume that each square on a graph represents 1 unit unless otherwise labeled.
A function is a special type of relation in which each element of the domain is paired with exactly one element of the range. A mapping shows how each member of the domain is paired with each member of the range.

The first two relations shown below are functions. The third relation is not a function because the \(-3\) in the domain is paired with both 0 and 6 in the range. A function like the first one below, where each element of the range is paired with exactly one element of the domain, is called a one-to-one function.

**Example 1**

**Domain and Range**

State the domain and range of the relation shown in the graph. Is the relation a function?

The relation is \{(−4, 3), (−1, −2), (0, −4), (2, 3), (3, −3)\}.

The domain is \{−4, −1, 0, 2, 3\}.

The range is \{−2, 0, 1, 2, 3\}.

Each member of the domain is paired with exactly one member of the range, so this relation is a function.

You can use the vertical line test to determine whether a relation is a function.

**Key Concept**

**Vertical Line Test**

- **Words**  
  If no vertical line intersects a graph in more than one point, the graph represents a function.  
  If some vertical line intersects a graph in two or more points, the graph does not represent a function.

- **Models**  
  ![Graphs showing vertical line test](image)

In Example 1, there is no vertical line that contains more than one of the points. Therefore, the relation is a function.

This CD-ROM is a customizable Microsoft® PowerPoint® presentation that includes:

- Step-by-step, dynamic solutions of each In-Class Example from the Teacher Wraparound Edition
- Additional, Your Turn exercises for each example
- The 5-Minute Check Transparencies
- Hot links to Glencoe Online Study Tools
In-Class Example

2 TRANSPORTATION  The table shows the average fuel efficiency in miles per gallon for light trucks for several years. Graph this information and determine whether it represents a function.

<table>
<thead>
<tr>
<th>Year</th>
<th>Fuel Efficiency (mi/gal)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1995</td>
<td>20.5</td>
</tr>
<tr>
<td>1996</td>
<td>20.8</td>
</tr>
<tr>
<td>1997</td>
<td>20.6</td>
</tr>
<tr>
<td>1998</td>
<td>20.9</td>
</tr>
<tr>
<td>1999</td>
<td>20.5</td>
</tr>
<tr>
<td>2000</td>
<td>20.5</td>
</tr>
<tr>
<td>2001</td>
<td>20.4</td>
</tr>
</tbody>
</table>

Source: U.S. Environmental Protection Agency

Study Tip

**Vertical Line Test**

- You can use a pencil to represent a vertical line. Slowly move the pencil to the right across the graph to see if it intersects the graph at more than one point.

EQUIVATIONS OF FUNCTIONS AND RELATIONS  Relations and functions can also be represented by equations. The solutions of an equation in $x$ and $y$ are the set of ordered pairs $(x, y)$ that make the equation true.

Consider the equation $y = 2x - 6$. Since $x$ can be any real number, the domain has an infinite number of elements. To determine whether an equation represents a function, it is often simplest to look at the graph of the relation.

Example 3  **Graph Is a Line**

- **a.** Graph the relation represented by $y = 2x + 1$.
  
  Make a table of values to find ordered pairs that satisfy the equation. Choose values for $x$ and find the corresponding values for $y$. Then graph the ordered pairs.

<table>
<thead>
<tr>
<th>$x$</th>
<th>$y$</th>
</tr>
</thead>
<tbody>
<tr>
<td>-1</td>
<td>-1</td>
</tr>
<tr>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td>1</td>
<td>3</td>
</tr>
<tr>
<td>2</td>
<td>5</td>
</tr>
</tbody>
</table>

- **b.** Find the domain and range.
  
  Since $x$ can be any real number, there is an infinite number of ordered pairs that can be graphed. All of them lie on the line shown. Notice that every real number is the $x$-coordinate of some point on the line. Also, every real number is the $y$-coordinate of some point on the line. So the domain and range are both all real numbers.

- **c.** Determine whether the relation is a function.
  
  This graph passes the vertical line test. For each $x$ value, there is exactly one $y$ value, so the equation $y = 2x + 1$ represents a function.

Example 2  **Vertical Line Test**

- **GEOGRAPHY** The table shows the population of the state of Indiana over the last several decades. Graph this information and determine whether it represents a function.

<table>
<thead>
<tr>
<th>Year</th>
<th>Population (millions)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1950</td>
<td>3.9</td>
</tr>
<tr>
<td>1960</td>
<td>4.7</td>
</tr>
<tr>
<td>1970</td>
<td>5.2</td>
</tr>
<tr>
<td>1980</td>
<td>5.5</td>
</tr>
<tr>
<td>1990</td>
<td>5.5</td>
</tr>
<tr>
<td>2000</td>
<td>6.1</td>
</tr>
</tbody>
</table>

Source: U.S. Census Bureau

Use the vertical line test. Notice that no vertical line can be drawn that contains more than one of the data points. Therefore, this relation is a function. **Notice also that each year is paired with only one population value.**

Unlocking Misconceptions

- **Relations and Functions** Some students may not realize that all functions are relations. Explain that a function is a special type of relation, analogous to how a square is a special type of rectangle.

- **Vertical Line Test** Make sure students understand that when two points on the graph of a relation are intersected by a vertical line, this means those two points have the same $x$ value but different $y$ values. That is, one domain value is paired with more than one range value.
Example 4 Graph Is a Curve

a. Graph the relation represented by \( x = y^2 - 2 \).

Make a table. In this case, it is easier to choose \( y \) values and then find the corresponding values for \( x \). Then sketch the graph, connecting the points with a smooth curve.

\[
\begin{array}{c|c}
\text{x} & \text{y} \\
-2 & 0 \\
-1 & 1 \\
0 & 2 \\
1 & 2 \\
2 & 0 \\
\end{array}
\]

When an equation represents a function, the variable, usually \( x \), whose values make up the domain is called the independent variable. The other variable, usually \( y \), is called the dependent variable because its values depend on \( x \).

Equations that represent functions are often written in functional notation. The equation \( y = 2x + 1 \) can be written as \( f(x) = 2x + 1 \). The symbol \( f(x) \) replaces the \( y \) and is read “\( f \) of \( x \).” The \( f \) is just the name of the function. It is not a variable that is multiplied by \( x \). Suppose you want to find the value in the range that corresponds to the element 4 in the domain of the function. This is written as \( f(4) \) and is read “\( f \) of 4.” The value \( f(4) \) is found by substituting 4 for each \( x \) in the equation. Therefore, \( f(4) = 2(4) + 1 \) or 9. Letters other than \( f \) can be used to represent a function. For example, \( g(x) = 2x + 1 \).

Example 5 Evaluate a Function

Given \( f(x) = x^2 + 2 \) and \( g(x) = 0.5x^2 - 5x + 3.5 \), find each value.

a. \( f(-3) \)
   \[
   f(-3) = (-3)^2 + 2 \quad \text{Original function} \\
   = 9 + 2 \quad \text{Substitute} \\
   = 11 \quad \text{Simplify}
   \]

b. \( g(2.8) \)
   \[
   g(2.8) = 0.5(2.8)^2 - 5(2.8) + 3.5 \quad \text{Original function} \\
   \approx 3.92 - 14 + 3.5 \quad \text{Estimate} \\
   = -6.58 \quad \text{Multiply} \\
   \]

\[
\text{c. } f(3z)
\]
   \[
   f(3z) = (3z)^2 + 2 \quad \text{Original function} \\
   = 9z^2 + 2 \quad \text{Substitute} \\
   \]

Differentiated Instruction

Auditory/Musical Encourage students to relate to the mathematics in this lesson by asking those who are familiar with reading musical notation to explain to the class how graphing points on a coordinate plane compares to writing musical notes on a staff.
Study Notebook

Have students—
- add the definitions/examples of the vocabulary terms to their
  Vocabulary Builder worksheets for
  Chapter 2.
- draw their own diagrams, similar to those in the Concept Summary
  on p. 51.
- make a sketch illustrating how to
  use the vertical line test, both for
  a function and a non-function.
- include any other item(s) that they
  find helpful in mastering the skills
  in this lesson.

About the Exercises...
Organization by Objective
- Graph Relations: 17–28, 35–45, 55
- Equations of Functions and Relations: 29–34, 46–54, 56

Odd/Even Assignments
Exercises 17–34 are structured so that students practice the same concepts whether they are assigned odd or even problems.

Assignment Guide
Basic: 17–31 odd, 35–37, 47–53 odd, 55–58, 63–73
Average: 17–33 odd, 35–41, 47–53 odd, 55–58, 63–73 (optional: 59–62)
Advanced: 18–34 even, 42–45, 46–54 even, 55–69 (optional: 70–73)

Check for Understanding

Concept Check
1. Sample answer: 
   \((-4, 3), (-2, 3), (1, 5), (-2, 1)\)
2. See pp. 107A–107H.

Guided Practice

Determine whether each relation is a function. Write yes or no.

Graph each relation or equation and find the domain and range. Then determine whether the relation or equation is a function. 7–10. pp. 107A–107H.

Weather For Exercises 13–16, use the table of record high temperatures (°F) for January and July.

13. D = (70, 72, 88), R = (95, 97, 105, 114)
14–16. See margin.

Application

13. D = (70, 72, 88), R = (95, 97, 105, 114)
14–16. See margin.

* indicates increased difficulty

Practice and Apply

Homework Help

Determine whether each relation is a function. Write yes or no.

Record High Temperatures

3. Molly; to find \(g(2a)\), replace \(x\) with \(2a\).
   Teisha found \(2g(a)\), not \(g(2a)\).
4. \((88, 97), (70, 114), (88, 95), (72, 105)\)
5. See graph at right.
6. No; the domain value 88 is paired with two range values.
23. \( \{ (2, 1), (-3, 0), (1, 5) \} \)
24. \( \{ (4, 5), (6, 5), (3, 5) \} \)
25. \( \{ (-2, 5), (3, 7), (-2, 8) \} \)
26. \( \{ (3, 4), (3, 5), (6, 5), (5, 6) \} \)
27. \( \{ (0, -1, 1), (-2, -3, 1, 4, 2), (-3, 6, 8) \} \)
28. \( y = -5x \)
29. \( y = 3x - 4 \)
30. \( y = 7x - 6 \)
31. \( y = x^2 \)
32. \( y = 2x^2 - 3 \)
33. \( R = \{ y \mid y \geq 3 \} \) is all reals; \( D = \{ x \mid x \geq -3 \} \) is all reals; yes

**SPORTS** For Exercises 35–37, use the table that shows the leading home run and runs batted in totals in the American League for 1996–2000.

<table>
<thead>
<tr>
<th>Year</th>
<th>HR</th>
<th>RBI</th>
</tr>
</thead>
<tbody>
<tr>
<td>1996</td>
<td>52</td>
<td>148</td>
</tr>
<tr>
<td>1997</td>
<td>56</td>
<td>147</td>
</tr>
<tr>
<td>1998</td>
<td>56</td>
<td>157</td>
</tr>
<tr>
<td>1999</td>
<td>48</td>
<td>165</td>
</tr>
<tr>
<td>2000</td>
<td>47</td>
<td>145</td>
</tr>
</tbody>
</table>

Source: The World Almanac

35. Make a graph of the data with home runs on the horizontal axis and runs batted in on the vertical axis. See pp. 107A–107H.
36. Identify the domain and range.
37. Does the graph represent a function? Explain your reasoning. See margin.

**FINANCE** For Exercises 38–41, use the table that shows a company's stock price in recent years. 38, 40. See margin.

38. Write a relation to represent the data.
39. Graph the relation. See pp. 107A–107H.
40. Identify the domain and range.
41. Is the relation a function? Explain your reasoning.

Yes; each domain value is paired with only one range value.

**GOVERNMENT** For Exercises 42–45, use the table below that shows the number of members of the U.S. House of Representatives with 30 or more consecutive years of service in Congress from 1987 to 1999.

<table>
<thead>
<tr>
<th>Year</th>
<th>Representatives</th>
</tr>
</thead>
<tbody>
<tr>
<td>1987</td>
<td>12</td>
</tr>
<tr>
<td>1989</td>
<td>13</td>
</tr>
<tr>
<td>1991</td>
<td>11</td>
</tr>
<tr>
<td>1993</td>
<td>12</td>
</tr>
<tr>
<td>1995</td>
<td>6</td>
</tr>
<tr>
<td>1997</td>
<td>3</td>
</tr>
<tr>
<td>1999</td>
<td>3</td>
</tr>
</tbody>
</table>

Source: Congressional Directory

42. Write a relation to represent the data. See margin.
43. Graph the relation. See pp. 107A–107H.
44. Identify the domain and range. See pp. 107A–107H.
45. Is the relation a function? If so, is it a one-to-one function? Explain.

Yes; no; see pp. 107A–107H for explanation.

Find each value if \( f(x) = 3x - 5 \) and \( g(x) = x^2 - x \).
46. \( f(-3) = -14 \)
47. \( g(3) = 6 \)
48. \( g \left( \frac{1}{3} \right) = -\frac{2}{9} \)
49. \( f \left( \frac{2}{3} \right) = -3 \)
50. \( f(a) = 3a - 5 \)
51. \( g(5n) = 25n^2 - 5n \)
52. Find the value of \( f(x) = -3x + 2 \) when \( x = 2 \).
53. What is \( g(4) \) if \( g(x) = x^2 - 5 \)?

www.algebra2.com/self_check_quiz

**Enrichment. p. 62**

**Mappings**

There are three special ways in which one set can be mapped to another. A set can be mapped onto another set, onto another set, or one can have a one-to-one correspondence with another set.

- onto mapping
- onto mapping
- one-to-one correspondence

If there is a one-to-one correspondence between two sets, then each element of the first set is paired with exactly one element of the second set. Each element of the second set is also paired with exactly one element of the first set. If there is no one-to-one correspondence between two sets, then each element of one set is paired with more than one element of the other set, or each element of one set is paired with no element of the other set, or each element of one set is paired with more than one element of the second set. If there is no mapping between two sets, then each element of one set is paired with no element of the other set.

State whether each set is mapped into the second set, onto the second set, or has a one-to-one correspondence with the second set.

**Answers**

37. No; the domain value 56 is paired with two different range values.
39. \( D = \{ (0, 1, 5), (5, 7), (8) \} \)
40. \( D = \{ (0, 1, 5), (5, 7), (8) \} \)
41. \( D = \{ (0, 1, 5), (5, 7), (8) \} \)

**Enrichment. p. 62**

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54. **HOBBIES** Chaz has a collection of 15 CDs. After he gets a part-time job, he decides to buy 3 more CDs every time he goes to the music store. The function $C(t) = 15 + 3t$ counts the number of CDs, $C(t)$, he has after $t$ trips to the music store. How many CDs will he have after he has been to the music store 8 times? 39

55. **CRITICAL THINKING** If $f(3a - 1) = 12a - 7$, find $f(x)$. $f(x) = 4x - 3$

56. **WRITING IN MATH** Answer the question that was posed at the beginning of the lesson. See margin.

How do relations and functions apply to biology?

Include the following in your answer:
• an explanation of how a relation can be used to represent data, and
• a sentence that includes the words average lifetime, maximum lifetime, and function.

57. If $f(x) = 2x - 5$, then $f(0) = \text{B}$
   \[ \text{A} \ 0, \ \text{B} \ -5, \ \text{C} \ -3, \ \text{D} \ \frac{5}{2} \]

58. If $g(x) = x^2$, then $g(x + 1) = \text{C}$
   \[ \text{A} \ 1, \ \text{B} \ x^2 + 1, \ \text{C} \ x^2 + 2x + 1, \ \text{D} \ x^2 - x \]

59. $f(1) = \text{discrete}$
60. $f(1) = \text{continuous}$

61. $((-3, 0), (-1, 1), (1, 3)) \text{ discrete}$
62. $y = -x + 4 \text{ continuous}$

**Getting Ready for the Next Lesson**

**PREREQUISITE SKILL** Solve each equation. Check your solution.

- [Lesson 1-3]

60. $\frac{1}{3^2} - 4 = 1$ 15

62. Chapter 2 Linear Relations and Functions
Identify Linear Functions

State whether each function is a linear function. Explain.

a. \( f(x) = 10 - 5x \)
   
   This is a linear function because it can be written as \( f(x) = -5x + 10. \) \( m = -5, b = 10 \)

b. \( g(x) = x^4 - 5 \)
   
   This is not a linear function because \( x \) has an exponent other than 1.

c. \( h(x, y) = 2xy \)
   
   This is not a linear function because the two variables are multiplied together.

TEACHING TIP
When variables other than \( x \) and \( y \) are used, the letter coming first in the alphabet usually represents the domain variable or horizontal coordinate.
2 Teach

IDENTIFY LINEAR EQUATIONS AND FUNCTIONS

In-Class Examples

### 1
State whether each function is a linear function. Explain.

a. \( g(x) = 2x - 5 \)
   - Yes; \( m = 2; b = -5 \)

b. \( p(x) = x^3 + 2 \)
   - No; \( x \) has an exponent other than 1.

c. \( f(x) = 4 + 7x \)
   - Yes; \( m = 7; b = 4 \)

### 2
METEOROLOGY

The linear function \( f(C) = 1.8C + 32 \) can be used to find the number of degrees Fahrenheit, \( f \), that are equivalent to a given number of degrees Celsius, \( C \).

a. On the Celsius scale, normal body temperature is 37°C. What is normal body temperature in degrees Fahrenheit? 98.6°F

b. There are 100 Celsius degrees between the freezing and boiling points of water and 180 Fahrenheit degrees between these two points. How many Fahrenheit degrees equal 1 Celsius degree? 1.8°F = 1°C

STANDARD FORM

In-Class Example

### 3
Write each equation in standard form. Identify \( A \), \( B \), and \( C \).

a. \( y = 3x - 9 \)
   - \( 3x - y = 9 \); \( A = 3, B = -1, C = 9 \)

b. \( -\frac{2}{3}x = 2y - 1 \)
   - \( 2x + 6y = 3 \);
   - \( A = 2, B = 6, C = 3 \)

c. \( 8x - 6y + 4 = 0 \)
   - \( 4x - 3y = -2 \);
   - \( A = 4, B = -3, C = -2 \)

Example 2 Evaluate a Linear Function

MILITARY

In August 2000, the Russian submarine Kursk sank to a depth of 350 feet in the Barents Sea. The linear function \( P(d) = 62.5d + 2117 \) can be used to find the pressure (lb/ft\textsuperscript{2}) at a depth of \( d \) feet below the surface of the water.

a. Find the pressure at a depth of 350 feet.
   - \( P(d) = 62.5d + 2117 \)
   - Original function
   - \( P(350) = 62.5(350) + 2117 \)
   - Substitute.
   - \( = 23,992 \)
   - Simplify.
   - The pressure at a depth of 350 feet is about 24,000 lb/ft\textsuperscript{2}.

b. The term 2117 in the function represents the atmospheric pressure at the surface of the water. How many times as great is the pressure at a depth of 350 feet as the pressure at the surface?
   - Divide the pressure 350 feet below the surface by the pressure at the surface.
   - \( \frac{23,992}{2117} \approx 11.33 \)
   - Use a calculator.
   - The pressure at that depth is more than 11 times as great as the pressure at the surface.

### Key Concept

**Standard Form of a Linear Equation**

Any linear equation can be written in standard form, \( Ax + By = C \), where \( A \), \( B \), and \( C \) are integers whose greatest common factor is 1.

**Example 3 Standard Form**

Write each equation in standard form. Identify \( A \), \( B \), and \( C \).

a. \( y = -2x + 3 \)
   - \( -2x + y = 3 \)
   - \( A = -2, B = 1, C = 3 \)

b. \( \frac{-3}{5}x = 3y - 2 \)
   - \( \frac{-3}{5}x - 3y = -2 \)
   - \( A = -3, B = 5, C = -2 \)

   - \( \frac{3}{5}x + 15y = 10 \)
   - Multiply each side by \( -5 \) so that the coefficients are integers and \( A \geq 0 \).
   - \( A = 3, B = 15, C = 10 \)

   - \( 3x - 6y = 9 \)
   - \( 3x - 6y = 9 \)
   - \( A = 1, B = -2, C = 3 \)

Reading Tip

Make sure that students understand the difference between the x- and y-intercepts. Some students may use the word intersect instead of the correct term intercept. Help them see that an intercept is the nonzero coordinate of the point where the graph intersects either axis.

Answer (page 65)

1. The function can be written as \( f(x) = \frac{1}{2}x + 1 \), so it is of the form \( f(x) = mx + b \), where \( m = \frac{1}{2} \) and \( b = 1 \).
In Lesson 2-1, you graphed an equation or function by making a table of values, graphing enough ordered pairs to see a pattern, and connecting the points with a line or smooth curve. Since two points determine a line, there are quicker ways to graph a linear equation or function. One way is to find the points at which the graph intersects each axis and connect them with a line. The y-coordinate of the point at which a graph crosses the y-axis is called the y-intercept. Likewise, the x-coordinate of the point at which it crosses the x-axis is the x-intercept.

Example 4 Use Intercepts to Graph a Line

Find the x-intercept and the y-intercept of the graph of \(3x - 4y + 12 = 0\). Then graph the equation.

The x-intercept is the value of \(x\) when \(y = 0\).

\[
3x - 4(0) + 12 = 0 \\
3x = -12 \\
x = -4
\]

The x-intercept is \(-4\). The graph crosses the x-axis at \((-4, 0)\).

Likewise, the y-intercept is the value of \(y\) when \(x = 0\).

\[
3(0) - 4y + 12 = 0 \\
-4y = -12 \\
y = 3
\]

The y-intercept is 3. The graph crosses the y-axis at \((0, 3)\).

Use these ordered pairs to graph the equation.

---

Study Tip

Some students may find it helpful to remember that if there is no \(y\) in the equation, the graph cannot cross the y-axis. Similarly, if there is no \(x\) in the equation, the graph cannot cross the x-axis.
Application
ECONOMICS For Exercises 13 and 14, use the following information.
On January 1, 1999, the euro became legal tender in 11 participating countries
in Europe. Based on the exchange rate on March 22, 2001, the linear function
d(x) = 0.8881x could be used to convert x euros to U.S. dollars.
13. On that date, what was the value in U.S. dollars of 200 euros? $177.62
14. On that date, what was the value in euros of 500 U.S. dollars? $563.00

Online Research Data Update How do the dollar and the euro compare

Practice and Apply
Homework Help
State whether each equation or function is linear. Write yes or no. If no, explain your reasoning.
15. \(x + y = 5\) yes
16. \(\frac{x}{3} + y = -5\) no
17. \(x + \sqrt{y} = 4\) no
18. \(h(x) = 2x^3 - 4x^2 + 5\) no
19. \(g(x) = 10 + \frac{2}{x}\) no
20. \(f(x) = 6x - 19\) yes
21. \(f(x) = 7x^2 + x - 1\) no
22. \(y = \sqrt{2x} - 5\) no
23. Which of the equations \(x + 9y = 7, x^2 + y = 0,\) and \(y = 3x - 1\) is not linear?
24. Which of the functions \(f(x) = 2x + 4, g(x) = 7,\) and \(h(x) = x^3 - x^2 + 3x\) is not linear? \(h(x) = x^3 - x^2 + 3x\)

 Extra Practice
See page 830.
23. \(x^2 + y = 0\)
27. \(3x + y = 4; 3, 1, 4\)
28. \(12x - y = 0; 12, -1, 0\)
29. \(-x - 4y = -5; 1, -4, -5\)
30. \(-x - 7y = 2; 1, -7, 2\)
31. \(-x - y = 5; 2, -1, 5\)
32. \(-x - 2y = -3; 1, -2, -3\)
33. \(-x + y = 12; 1, 1, 12\)
34. \(-x - y = -6; 1, -1, -6\)

Skills Practice, p. 65 and Practice, p. 66 (shown)
State whether each equation or function is linear. Write yes or no. If no, explain your reasoning.
1. \(2x = 5y\) yes \(y\) is the variable that appears in the denominator.
2. \(5y = 3x\) no \(x\) is a denominator.
3. \(y = 2x - 3\) yes \(x\) is a variable and \(y\) is not.

Write each equation in standard form. Identify \(A, B,\) and \(C.
27. \(y = 3x + 4\)
28. \(y = 12x\)
29. \(x = 4y - 5\)
30. \(x = 7y + 2\)
31. \(5y = 10x - 25\)
32. \(4x = 8y - 12\)
33. \(\frac{1}{2}x + \frac{3}{4}y = 6\)
35. \(\frac{1}{3}x - \frac{1}{3}y = -2\)
36. \(\frac{5}{6}x + \frac{10}{13}y = \frac{10}{13}\)
37. \(0.25x = 0.1 + 0.2y\)
38. \(h = 40; 1, 40\)
39. \(25x + 2y = 9; 25, 2, 9\)
5. \(2y - 4x = 25\)
6. \(2y - 5x = 3\)
7. \(3x - 2y = -4\)
8. \(6x - 2y = 4\)

Reading to Learn Mathematics, p. 67
Reading the Lesson
1. Write yes or no to indicate whether each equation is in standard form. If it is not, explain why or why not.
   a. \(-y = 3x - 5\) no. \(A\) is negative.
   b. \(6y = -5x - 3\) yes
   c. \(-y = 3x - 5\) yes
   d. \(-2y = 3x - 5\) no. \(A\) is not an integer.
   e. \(-2y = 3x - 5\) no. \(A\) is not an integer, \(B\) is not an integer, and \(C\) are both 0.
   f. \(-y = 3x - 5\) no. The greatest common factor of \(A, B,\) and \(C\) is 1.

Helping You Remember
1. How to remember something is to explain it to someone else. Suppose that you are studying for a test and you recall an idea from the chapter, which says that if \(a < 0,\) then the graph of \(y = ax + b\) is a horizontal line. To remember the concept, you may find it helpful to make a vertical line.

Answers
16. No; \(x\) appears in a denominator.
17. No; \(y\) is inside a square root.
18. No; \(x\) has exponents other than 2.
19. No; \(x\) appears in a denominator.
20. Yes; this is a linear function because it is written as \(f(x) = 6x - 19, m = 6, b = -19.
21. No; \(x\) has an exponent other than 1.
22. No; \(x\) is inside a square root.
53. Find the temperature at a depth of 2 kilometers. 90°C
54. Find the depth if the temperature is 160°C. 4 km
55. Graph the linear function. See margin.

56. Write an equation that is a model for the different numbers of beverages and candy that can be sold to meet the goal. 1.75b + 1.5c = 525
57. Graph the equation. See margin.
58. Does this equation represent a function? Explain.
59. If they sell 100 beverages and 200 pieces of candy, will the Band Boosters meet their goal? no

60. GEOMETRY Find the area of the shaded region in the graph. (Hint: The area of a trapezoid is given by \( A = \frac{1}{2}(b_1 + b_2) \times h \)) 21 units²

61. WRITING IN MATH Answer the question that was posed at the beginning of the lesson.

How do linear equations relate to time spent studying?
Include the following in your answer: See margin.
• why only the part of the graph in the first quadrant is shown, and
• an interpretation of the graph’s intercepts in terms of the amount of time Lolita spends on each subject.

62. Which function is linear? B
   \( A \) \( f(x) = x^2 \)
   \( B \) \( g(x) = 2.7 \)
   \( C \) \( g(x) = \sqrt{x - 1} \)
   \( D \) \( f(x) = \sqrt{9 - x^2} \)

63. What is the y-intercept of the graph of \( 10 - x = 2y \)? B
   \( A \) 2
   \( B \) 5
   \( C \) 6
   \( D \) 10

64. D = \{−1, 1, 2, 4\}, R = \{-4, 3, 5\}; yes
65. D = \{0, 1, 2\}, R = \{-1, 0, 2, 3\}; no

66. \(-2 < 3x + 1 < 7\) \( \{x \} -1 < x < 2 \)
67. \( |x + 4| > 2\) \( \{x \} x < -6 \) or \( x > -2 \)

68. TAX Including a 6% sales tax, a paperback book costs $8.43. What is the price before tax? (Lesson 1-3) $7.95

69. \((9s - 4) - 3(2s - 6) = 3s + 14\)
70. \([19 - (8 - 1)] + 3 = 4\)

51. 55. 57. 4 Assess

Open-Ended Assessment

Modeling Have students place a piece of spaghetti or a pencil on a large coordinate plane to model the graphs of these equations:
\( x = 4, x = -2, y = 0, y = -3,\)
\( x = y, \) and \( x = -y.\)

Getting Ready for Lesson 2-3

BASIC SKILL Lesson 2-3 presents the fact that perpendicular lines have slopes that are negative reciprocals. Exercises 71–78 should be used to determine your students’ familiarity with finding reciprocals.

Assessment Options

Quiz (Lessons 2-1 and 2-2) is available on p. 113 of the Chapter 2 Resource Masters.

Answers

61. A linear equation can be used to relate the amounts of time that a student spends on each of two subjects if the total amount of time is fixed. Answers should include the following.

• \( x \) and \( y \) must be nonnegative because Lolita cannot spend a negative amount of time studying a subject.

• The intercepts represent Lolita spending all of her time on one subject. The \( x \)-intercept represents her spending all of her time on math, and the \( y \)-intercept represents her spending all of her time on chemistry.
Focus

5-Minute Check Transparency 2-3 Use as a quiz or review of Lesson 2-2.

Mathematical Background notes are available for this lesson on p. 54C.

Building on Prior Knowledge

In Lesson 2-2, students wrote linear equations in standard form and graphed them using intercepts. In this lesson, they apply this skill to finding the slope of a line and to graphing parallel and perpendicular lines.

How does slope apply to the steepness of roads?

Ask students:
- An engineer designed a road with a rise of 4 feet for each horizontal distance of 100 feet. What is the grade of this road? 4%
- If a road has a grade of 3%, what is its rise for each horizontal distance of 50 feet? 1.5 ft

Vocabulary
- slope
- rate of change
- family of graphs
- parent graph
- oblique

How does slope apply to the steepness of roads?

The grade of a road is a percent that measures the steepness of the road. It is found by dividing the amount the road rises by the corresponding horizontal distance.

SLOPE The slope of a line is the ratio of the change in y-coordinates to the corresponding change in x-coordinates. The slope measures how steep a line is.

Suppose a line passes through points \((x_1, y_1)\) and \((x_2, y_2)\). The change in y-coordinates is \(y_2 - y_1\). The change in x-coordinates is \(x_2 - x_1\).

\[
\text{Slope} = \frac{\text{change in } y\text{-coordinates}}{\text{change in } x\text{-coordinates}} = \frac{y_2 - y_1}{x_2 - x_1}
\]

The slope of a line is the same, no matter what two points on the line are used.

Example 1 Find Slope

Find the slope of the line that passes through \((-1, 4)\) and \((1, -2)\). Then graph the line.

\[
m = \frac{y_2 - y_1}{x_2 - x_1} = \frac{-2 - 4}{1 - (-1)} = \frac{-6}{2} = -3
\]

The slope of the line is \(-3\).

Graph the two ordered pairs and draw the line. Use the slope to check your graph by selecting any point on the line. Then go down 3 units and right 1 unit or go up 3 units and left 1 unit. This point should also be on the line.

Resource Manager

Workbook and Reproducible Masters

Chapter 2 Resource Masters
- Study Guide and Intervention, pp. 69–70
- Skills Practice, p. 71
- Practice, p. 72
- Reading to Learn Mathematics, p. 73
- Enrichment, p. 74

Transparencies

5-Minute Check Transparency 2-3
Answer Key Transparencies

Technology

Interactive Chalkboard
Example 2 Use Slope to Graph a Line

Graph the line passing through \((-4, -3)\) with a slope of \(\frac{2}{3}\).

Graph the ordered pair \((-4, -3)\). Then, according to the slope, go up 2 units and right 3 units. Plot the new point at \((-1, -1)\). You can also go right 3 units and then up 2 units to plot the new point.

Draw the line containing the points.

The slope of a line tells the direction in which it rises or falls.

**Concept Summary**

| If the line rises to the right, then the slope is positive. |
| If the line is horizontal, then the slope is zero. |
| If the line falls to the right, then the slope is negative. |
| If the line is vertical, then the slope is undefined. |

\[
m = \frac{y_2 - y_1}{x_2 - x_1}
\]

Slope formula

\[
m = \frac{2 - (-2)}{3 - (-2)} = \frac{4}{5}
\]

\[
m = \frac{2 - 2}{3 - (-3)} = 0
\]

\[
m = \frac{0 - 3}{3 - 0} = -1
\]

\[
x_1 = x_2, \text{ so } m \text{ is undefined.}
\]

Slope is often referred to as rate of change. It measures how much a quantity changes, on average, relative to the change in another quantity, often time.

Example 3 Rate of Change

**TRAVEL** Refer to the graph at the right. Find the rate of change of the number of people taking cruises from 1985 to 2000.

\[
m = \frac{y_2 - y_1}{x_2 - x_1}
\]

Slope formula

\[
m = \frac{6.9 - 2.2}{2000 - 1985} = \frac{4.7}{15} = 0.31
\]

Between 1985 and 2000, the number of people taking cruises increased at an average rate of about 0.31(100,000) or 310,000 people per year.

**USA TODAY Snapshots®**

**Cruises grow in popularity**

The number of North Americans taking cruises, by year:

**COMMUNICATION** Refer to the graph below. Find the rate of change of the number of radio stations on the air in the United States from 1990 to 1998.

**U.S. Radio Stations on the Air**

Source: The New York Times Almanac

Between 1990 and 1998, the number of radio stations on the air in the United States increased at an average rate of 0.225(1000) or 225 stations per year.

"A match it, graph it CBL-motion detector lab is a fun way for students to ‘experience’ slope."
PARALLEL AND PERPENDICULAR LINES

In-Class Example

4. Graph the line through \((1, -2)\) that is parallel to the line with equation \(x - y = -2\).

\[
\begin{array}{c}
\text{Graph of } x - y = -2 \\
(1, -2) \\
(2, -1) \\
\end{array}
\]

Answer

1. \(y = 3x\); The graphs are parallel lines, but they have different \(y\)-intercepts.

Study Tip

**Horizontal Lines**
All horizontal lines are parallel because they all have a slope of 0.

**Example 4** Parallel Lines

Graph the line through \((-1, 3)\) that is parallel to the line with equation \(x + 4y = -4\).

The \(x\)-intercept is \(-4\), and the \(y\)-intercept is \(-1\). Use the intercepts to graph \(x + 4y = -4\).

The line falls 1 unit for every 4 units it moves to the right, so the slope is \(-\frac{1}{4}\).

Now use the slope and the point at \((-1, 3)\) to graph the line parallel to the graph of \(x + 4y = -4\).

The figure at the right shows the graphs of two lines that are perpendicular. You know that parallel lines have the same slope. What is the relationship between the slopes of two perpendicular lines?

\[
\begin{align*}
\text{slope of line } AB & = -\frac{3 - 1}{-4 - 2} = -\frac{2}{-6} = \frac{1}{3} \\
\text{slope of line } CD & = -\frac{4 - 2}{1 - (-3)} = -\frac{2}{4} = -\frac{1}{2}
\end{align*}
\]

The slopes are opposite reciprocals of each other. This relationship is true in general. When you multiply the slopes of two perpendicular lines, the product is always \(-1\).

Graphing Calculator Investigation

**Lines with the Same Slope**
Point out that the simplest of the graphs in a family is often the one that passes through the origin, where the values of \(x\) and \(y\) are both zero. Suggest that students substitute 0 for \(x\) in each equation to find a point that will help them identify which graph goes with each equation.
Example 5 \textbf{Perpendicular Line}

Graph the line through \((-3, 1)\) that is perpendicular to the line with equation \(2x + 5y = 10\).

The \(x\)-intercept is 5, and the \(y\)-intercept is 2. Use the intercepts to graph \(2x + 5y = 10\).

The line falls 2 units for every 5 units it moves to the right, so the slope is \(-\frac{2}{5}\). The slope of the perpendicular line is the \textit{opposite reciprocal} of \(-\frac{2}{5}\), or \(\frac{5}{2}\).

Start at \((-3, 1)\) and go up 5 units and right 2 units. Use this point and \((-3, 1)\) to graph the line.

\[m = \frac{y_2 - y_1}{x_2 - x_1} = \frac{5 - 4}{2 - (-1)} = \frac{1}{3}\]

\[m = \frac{4 - 5}{2 - (-1)} = -\frac{1}{3}\]

Who is correct? Explain your reasoning. \textit{See margin.}

**Check for Understanding**

1. **OPEN ENDED** Write an equation of a line with slope 0. \textit{Sample answer: } \(y = 1\)

2. Decide whether the statement below is \textit{sometimes}, \textit{always}, or \textit{never} true. Explain. The slope of a line is a real number.

3. **FIND THE ERROR** Mark and Luisa are finding the slope of the line through \((2, 4)\) and \((-1, 5)\). Mark \(m = \frac{5 - 4}{2 - (-1)} \text{ or } \frac{1}{3}\). Luisa \(m = \frac{4 - 5}{2 - (-1)} \text{ or } -\frac{1}{3}\).

Who is correct? Explain your reasoning. \textit{See margin.}

**Guided Practice**

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4. \((1, 1), (3, 1)\) 5. \((-1, 0), (3, -2)\) \(-\frac{4}{2}\) 6. \((3, 4), (1, 2)\) \(1\)

Graph the line passing through the given point with the given slope.

7. \((2, -1), -3\) 8. \((-3, -4), \frac{3}{2}\) 7–8. \textit{See pp. 107A–107H.}

Graph the line that satisfies each set of conditions. 9–11. \textit{See pp. 107A–107H.}

9. passes through \((0, 3)\), parallel to graph of \(6y = 10x = 30\) 10. passes through \((4, -2)\), parallel to graph of \(3x - 2y = 6\) 11. passes through \((-1, 5)\), perpendicular to graph of \(5x - 3y = 3 = 0\)

**In-Class Example**

Graph the line through \((2, 1)\) that is perpendicular to the line with equation \(2x - 3y = 3\).

**Practice/Apply**

**Study Notebook**

Have students—

- add the definitions/examples of the vocabulary terms to their Vocabulary Builder worksheets for Chapter 2.
- draw sample graphs to compare and contrast lines with positive slope, negative slope, zero slope, and a slope that is undefined.
- include any other item(s) that they find helpful in mastering the skills in this lesson.

**DAILY INTERVENTION**

**FIND THE ERROR**

Point out that when finding a slope, if you use \(y_1 - y_2\) as the numerator, you must use \(x_1 - x_2\) as the denominator. To find the slope, you can move from point \(A\) to point \(B\), or from point \(B\) to point \(A\), but you must move in a consistent direction for both the rise and the run.

**Answer**

3. Luisa; Mark did not subtract in a consistent manner when using the slope formula. If \(y_2 = 5\) and \(y_1 = 4\), then \(x_2\) must be \(-1\) and \(x_1\) must be \(2\), not vice versa.
Chapter 2  Linear Relations and Functions

31. \( \frac{y}{2} \)  
32. \( \frac{y}{3} \)  
33. \( \frac{y}{4} \)  

31. \( (2, 6), (3, 8) \)  
32. \( (4, 3), (2, 1) \)  
33. \( (1, 2), (3, 4) \)  
34. \( (3, 1), (5, 0) \)  
35. \( (0, 6), (2, 3) \)  
36. \( (6, 0), (3, 2) \)  

27. Determine the value of \( r \) so that the line through \( (6, r) \) and \( (9, 2) \) has slope \( \frac{1}{3} \).  
28. Determine the value of \( r \) so that the line through \( (5, r) \) and \( (2, 3) \) has slope 2. 

ANCIENT CULTURES  Mayan Indians of Mexico and Central America built pyramids that were used as their temples. Ancient Egyptians built pyramids to use as tombs for the pharaohs. Estimate the slope that a face of each pyramid makes with its base.

The Pyramid of the Sun in Teotihuacán, Mexico, measures about 700 feet on each side of its square base and is about 210 feet high.  

The Great Pyramid in Egypt measures 756 feet on each side of its square base and was originally 481 feet high. 

Graph the line passing through the given point with the given slope.

31. \( (2, 6), m = \frac{2}{3} \)  
32. \( (3, 1), m = -\frac{1}{5} \)  
33. \( (3, -2), m = 2 \)  
34. \( (1, 2), m = -3 \)  
35. \( (6, 2), m = 0 \)  
36. \( (2, 3), m = undefined \)
37. about 68 million per year
38. about −32 million per year

ENTERTAINMENT  For Exercises 37–39, refer to the graph that shows the number of CDs and cassette tapes shipped by manufacturers to retailers in recent years.
37. Find the average rate of change of the number of CDs shipped from 1991 to 2000.
38. Find the average rate of change of the number of cassette tapes shipped from 1991 to 2000.
39. Interpret the sign of your answer to Exercise 38. The number of cassette tapes shipped has been decreasing.

TRAVEL  For Exercises 40–42, use the following information.
Mr. and Mrs. Wellman are taking their daughter to college. The table shows their distance from home after various amounts of time.
40. Find the average rate of change of their distance from home between 1 and 3 hours after leaving home. 55 mph
41. Find the average rate of change of their distance from home between 0 and 5 hours after leaving home. 45 mph
42. What is another word for rate of change in this situation? speed or velocity

Graph the line that satisfies each set of conditions. 43–50. See pp. 107A–107H.
43. passes through (−2, 2), parallel to a line whose slope is −1
44. passes through (−4, 1), perpendicular to a line whose slope is −3 2
45. passes through (3, 3), perpendicular to graph of y = 3
46. passes through (2, −5), parallel to graph of x = 4
47. passes through (2, −1), parallel to graph of 2x + 3y = 6
48. passes through origin, parallel to graph of x + y = 10
49. perpendicular to graph of 3x − 2y = 24, intersects that graph at its x-intercept
50. perpendicular to graph of 2x + 5y = 10, intersects that graph at its y-intercept

51. GEOMETRY  Determine whether quadrilateral ABCD with vertices A(−2, −1), B(1, 1), C(3, −2), and D(0, −4) is a rectangle. Explain; yes; slopes show that adjacent sides are perpendicular.

52. CRITICAL THINKING  If the graph of the equation ax + 3y = 9 is perpendicular to the graph of the equation 3x + y = −4, find the value of a. −1

53. WRITING IN MATH  Answer the question that was posed at the beginning of the lesson. See pp. 107A–107H.
How does slope apply to the steepness of roads?
Include the following in your answer:
• a few sentences explaining the relationship between the grade of a road and the slope of a line, and
• a graph of y = 0.08x, which corresponds to a grade of 8%. (A road with a grade of 6% to 8% is considered to be fairly steep. The scales on your x- and y-axes should be the same.)

www.algebra2.com/self_check_quiz

Slope 73

Study Guide and Intervention, p. 69 (shown) and p. 70

DEPRECIATION  For Exercises 10–13, use the following information.
A machine that originally cost $12,000 has a value of $7000 at the end of 3 years. The same machine has a value of $5000 at the end of 5 years.
10. Find the average rate of change in value of the machine between the purchase and the end of 3 years. $500 per year
11. Find the average rate of change in value of the machine between the end of 3 years and the end of 5 years. $3000 per year
12. Interpret the sign of your answers. It is negative because the value is decreasing.

Skills Practice, p. 71 and Practice, p. 72 (shown)

Reading to Learn Mathematics, p. 73

ELL

Enrichment, p. 74

Aerial Surveyors and Area

Most land surveys have irregular shapes. Aerial surveys supply aerial maps with lines of coordinates and elevations for the areas that need to be photographed from the air. These maps are used by planners about the horizontal and vertical features of an area.

Step 1  List the ordered pairs for the vertices in coordinate plane order starting at the point where you began the survey.
Step 2  Find D, the sum of the diagonal products (down-left to right).
D = (x3 × y1) + (x1 × y2) + (x2 × y3)
Step 3  Find Σ, the sum of the opposite diagonal products (down-right to left).
Σ = (x2 × y1) + (x1 × y3) + (x3 × y2)

Helpering You Remember
1. Look up the terms grade, pitch, slant, and slope. How are everyday meanings of these words related to the definitions of slope? Sample answer: All these words can be used when you describe how much a thing slants upward or downward. You can describe this numerically by comparing rise to run.

Lesson 2-3  Slope
54. What is the slope of the line shown in the graph at the right?  
   (A) \(-\frac{3}{2}\)  (B) \(-\frac{2}{3}\)  (C) \(\frac{2}{3}\)  (D) \(\frac{3}{2}\)

55. What is the slope of a line perpendicular to a line with slope \(-\frac{1}{2}\)?  
   (A) \(-2\)  (B) \(-\frac{1}{2}\)  (C) \(\frac{1}{2}\)  (D) 2

### Graphing Calculator

**FAMILY OF GRAPHS** Use a graphing calculator to investigate each family of graphs. Explain how changing the slope affects the graph of the line.

56. \(y = 2x + 3, \ y = 4x + 3, \ y = 8x + 3, \ y = x + 3\)

57. \(y = -3x + 1, \ y = -x + 1, \ y = -5x + 1, \ y = -7x + 1\)

### Maintain Your Skills

#### Mixed Review

**PREREQUISITE SKILL** Solve each equation for \(y\).

(A) \(-\frac{1}{2}\)  (B) \(-\frac{1}{3}\)  (C) \(\frac{1}{2}\)  (D) \(\frac{3}{2}\)

66. \(5 < 2x + 7 < 13\)  \(\frac{x}{2} - 1 < x < 3\)  \(66. \ 2x + 5 \geq 1475\)  \(73. \ \frac{1}{7}(5x + 9b) - \frac{1}{2}(28b - 8ab)\)

69. \(3 + (21 \div 7) \times 8 + 4\)

### Getting Ready for the Next Lesson

**PREREQUISITE SKILL** Solve each equation for \(y\). (To review solving equations, see Lesson 1-2.)

70. \(x + y = 9\)  
71. \(4x + y = 2\)  
72. \(-3x - y = 7\)  
73. \(5x - 2y - 1 = 0\)  
74. \(3x - 5y + 4 = 0\)  
75. \(2x + 3y - 11 = 0\)

### Practice Quiz 1

1. State the domain and range of the relation \{(2, 5), (-3, 2), (2, 1), (-7, 4), (0, -2)\}. (Lesson 2-1) \(D = (-7, -3, 0, 2), \ R = (-2, 1, 2, 4, 5)\)

2. Find the value of \(f(15)\) if \(f(x) = 3x - 4\). (Lesson 2-1) \(f(15) = 43\)

3. Write \(y = 6x + 4\) in standard form. (Lesson 2-2) \(6x + y = 4\)

4. Find the x-intercept and the y-intercept of the graph of \(3x + 5y = 30\). Then graph the equation. (Lesson 2-2) \(10, 6; \) \(\text{See margin for graph}\)

5. Graph the line that goes through \((4, -3)\) and is parallel to the line whose equation is \(2x + 5y = 10\). (Lesson 2-3) \(\text{See margin}\)

### Answers (Practice Quiz 1)

70. \(y = 9 - x\)
71. \(y = -4x + 2\)
72. \(y = -3x + 7\)
73. \(y = \frac{5}{2}x - \frac{1}{2}\)
74. \(y = \frac{3}{5}x + \frac{4}{5}\)
75. \(y = -\frac{2}{3}x + \frac{11}{3}\)
What You’ll Learn
• Write an equation of a line given the slope and a point on the line.
• Write an equation of a line parallel or perpendicular to a given line.

How do linear equations apply to business?
When a company manufactures a product, they must consider two types of cost. There is the fixed cost, which they must pay no matter how many of the product they produce, and there is variable cost, which depends on how many of the product they produce. In some cases, the total cost can be found using a linear equation such as \( y = 5400 + 1.37x \).

FORMS OF EQUATIONS Consider the graph at the right. The line passes through \( A(0, b) \) and \( C(x, y) \). Notice that \( b \) is the y-intercept of \( AC \). You can use these two points to find the slope of \( AC \). Substitute the coordinates of points \( A \) and \( C \) into the slope formula.

\[
m = \frac{y_2 - y_1}{x_2 - x_1} \quad \text{Slope formula}
\]

\[
m = \frac{y - b}{x - 0} \quad (x_1, y_1) = (0, b), \ (x_2, y_2) = (x, y)
\]

\[
m = \frac{y - b}{x} \quad \text{Simplify}
\]

Now solve the equation for \( y \).

\[
mx = y - b \quad \text{Multiply each side by } x.
\]

\[
mx + b = y \quad \text{Add } b \text{ to each side.}
\]

\[
y = mx + b \quad \text{Symmetric Property of Equality}
\]

When an equation is written in this form, it is in **slope-intercept form**.

### Key Concept: Slope-Intercept Form of a Linear Equation

**Words**
The slope-intercept form of the equation of a line is \( y = mx + b \), where \( m \) is the slope and \( b \) is the y-intercept.

**Symbols**
\[
y = mx + b
\]

**Model**

If you are given the slope and y-intercept of a line, you can find an equation of the line by substituting the values of \( m \) and \( b \) into the slope-intercept form. For example, if you know that the slope of a line is \(-3\) and the y-intercept is \(4\), the equation of the line is \( y = -3x + 4 \), or, in standard form, \( 3x + y = 4 \).

You can also use the slope-intercept form to find an equation of a line if you know the slope and the coordinates of any point on the line.

**Workbook and Reproducible Masters**

**Chapter 2 Resource Masters**
- Study Guide and Intervention, pp. 75–76
- Skills Practice, p. 77
- Practice, p. 78
- Reading to Learn Mathematics, p. 79
- Enrichment, p. 80
- Assessment, pp. 113, 115

**Graphing Calculator and Spreadsheet Masters**, p. 30

**School-to-Career Masters**, p. 3

**Technology**
Interactive Chalkboard
In-Class Examples

1. Write an equation in slope-intercept form for the line that has a slope of $-\frac{3}{5}$ and passes through $(5, -2)$. $y = -\frac{3}{5}x + 1$

   **Teaching Tip** Make sure that students understand that the letter $m$ is always used for slope, and $b$ for the $y$-intercept, in $y = mx + b$.

2. What is an equation of the line through $(2, -3)$ and $(-3, 7)$?  
   A $y = -2x - 1$  
   B $y = -\frac{1}{2}x + 1$  
   C $y = \frac{1}{2}x + 1$  
   D $y = -2x + 1$

---

**Example 1** Write an Equation Given Slope and a Point

Write an equation in slope-intercept form for the line that has a slope of $-\frac{3}{2}$ and passes through $(-4, 1)$.

Substitute for $m$, $x$, and $y$ in the slope-intercept form.

$$y = mx + b$$  
Slope-intercept form

1. $1 = \left(-\frac{3}{2}\right)(-4) + b$  
2. $(x, y) = (-4, 1), m = -\frac{3}{2}$

Simplify.

$$1 = 6 + b$$  
$$-5 = b$$  
Subtract 6 from each side.

The $y$-intercept is $-5$. So, the equation in slope-intercept form is $y = -\frac{3}{2}x - 5$.

---

**Example 2** Write an Equation Given Two Points

What is an equation of the line through $(-1, 4)$ and $(-4, 5)$?

A $y = -\frac{1}{3}x + \frac{11}{3}$  
B $y = \frac{1}{3}x + \frac{13}{3}$  
C $y = -\frac{1}{3}x + \frac{13}{3}$  
D $y = -3x + 1$

---

**Key Concept**

**Point-Slope Form of a Linear Equation**

- **Words** The point-slope form of the equation of a line is $y - y_1 = m(x - x_1)$, where $(x_1, y_1)$ are the coordinates of a point on the line and $m$ is the slope of the line.
- **Symbols** Point-slope form

$y - y_1 = m(x - x_1)$

coordinates of point on line

---

**Example 2** Point out that finding the slope eliminated two of the choices. Emphasize that eliminating some of the answer choices helps you to use your time efficiently when taking a timed test.
When changes in real-world situations occur at a linear rate, a linear equation can be used as a model for describing the situation.

**Example 3 Write an Equation for a Real-World Situation**

**SALES** As a salesperson, Eric Fu is paid a daily salary plus commission. When his sales are $1000, he makes $100. When his sales are $1400, he makes $120.

a. Write a linear equation to model this situation.

Let \( x \) be his sales and let \( y \) be the amount of money he makes. Use the points \((1000, 100)\) and \((1400, 120)\) to make a graph to represent the situation.

\[
m = \frac{y_2 - y_1}{x_2 - x_1} \quad \text{Slope formula}
\]

\[
= \frac{120 - 100}{1400 - 1000}
= \frac{20}{400}
= 0.05
\]

Now use the slope and either of the given points with the point-slope form to write the equation.

\[
y - y_1 = m(x - x_1) \quad \text{Point-slope form}
\]

\[
y - 100 = 0.05(x - 1000)
\]

\[
y = 0.05x - 50 \quad \text{Distributive Property}
\]

\[
y = 0.05x + 50 \quad \text{Add 100 to each side.}
\]

The slope-intercept form of the equation is \( y = 0.05x + 50 \).

b. What are Mr. Fu’s daily salary and commission rate?

The \( y \)-intercept of the line is 50. The \( y \)-intercept represents the money Eric would make if he had no sales. In other words, $50 is his daily salary.

The slope of the line is 0.05. Since the slope is the coefficient of \( x \), which is his sales, he makes 5% commission.

c. How much would he make in a day if Mr. Fu’s sales were $2000?

Find the value of \( y \) when \( x = 2000 \).

\[
y = 0.05x + 50 \quad \text{Use the equation you found in part a.}
\]

\[
y = 0.05(2000) + 50 \quad \text{Replace } x \text{ with } 2000.
\]

\[
y = 100 + 50 \quad \text{Simplify.}
\]

Mr. Fu would make $150 if his sales were $2000.

**PARALLEL AND PERPENDICULAR LINES** The slope-intercept and point-slope forms can be used to find equations of lines that are parallel or perpendicular to given lines.

**Example 4 Write an Equation of a Perpendicular Line**

Write an equation for the line that passes through \((-4, 3)\) and is perpendicular to the line whose equation is \( y = -4x - 1 \).

The slope of the given line is \(-4\). Since the slopes of perpendicular lines are opposite reciprocals, the slope of the perpendicular line is \( \frac{1}{4} \).

(continued on the next page)
3 Practice/Apply

**TEACHING TIP**

You could also use slope-intercept form.

Use the point-slope form and the ordered pair \((-4, 3)\) to write the equation.

\[ y - y_1 = m(x - x_1) \quad \text{Point-slope form} \]

\[ y - 3 = \frac{1}{4}[x - (-4)] \quad (x, y) = (-4, 3), \quad m = \frac{1}{4} \]

\[ y = \frac{1}{4}x + 1 \quad \text{Distributive Property} \]

\[ y = \frac{1}{4}x + 4 \quad \text{Add 3 to each side.} \]

An equation of the line is \(y = \frac{1}{4}x + 4\).

---

**Check for Understanding**

**Concept Check**

**1. Sample answer:**

\[ y = 3x + 2 \]

**Guided Practice**

**GUIDED PRACTICE KEY**

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**Standardized Test Practice**

**1. OPEN ENDED**

Write an equation of a line in slope-intercept form.

**2. Identify** the slope and \(y\)-intercept of the line with equation \(y = 6x\).

\(6, 0\)

**3. Explain** how to find the slope of a line parallel to the graph of \(3x - 5y = 2\).

**See margin.**

**State the slope and \(y\)-intercept of the graph of each equation.**

**4.** \(y = 2x - 5\)

\(2, -5\)

**5.** \(3x + 2y - 10 = 0\)

\(-\frac{3}{2}, 5\)

Write an equation in slope-intercept form for the line that satisfies each set of conditions.

**6.** \(y = 0.5x + 1\)

**7.** \(y = -\frac{3}{4}x + 2\)

**8.** \(y = -\frac{3}{4}x + 16\)

**9.** slope 0.5, passes through (6, 4)

\[ y = \frac{3}{5}x + 2 \quad 6 \]

**10.** passes through (6, 1) and (8, -4)

\[ y = \frac{3}{5} - \frac{14}{5} \quad 8 \]

**11.** passes through (0, -2), perpendicular to the graph of \(y = x - 2\)

\[ y = -x - 2 \]

Write an equation in slope-intercept form for the graph at the right.

\[ y = \frac{5}{4}x + 7 \]

**12.** What is an equation of the line through (2, -4) and \((-3, 1)\)?

**B**

\[ y = -\frac{3}{5}x + 26 \]

\[ y = \frac{3}{5}x - 2 \]

**13.** \(y = -\frac{2}{3}x - 4\)

\(-\frac{2}{3}, -4\)

**14.** \(y = \frac{3}{4}x + 0\)

\(3, 0\)

**15.** \(2x - 4y = 10\)

\(1, -\frac{5}{2}\)

**16.** \(3x + 5y - 30 = 0\)

\((-4, 2)\)

**17.** \(x = 7\)

**18.** \(cx + y = d\)

\(-c, d\)

**19.** Write an equation in slope-intercept form for each graph.

\[ y = 0.8x \]

**20.** \(y = -\frac{5}{3}x + \frac{29}{3} \quad 16. \quad -\frac{3}{5}, 6\)

---

**About the Exercises...**

**Organization by Objective**

• Forms of Equations: 13–34

• Parallel and Perpendicular Lines: 35–38

**Odd/Even Assignments**

Exercises 13–40 are structured so that students practice the same concepts whether they are assigned odd or even problems.

**Assignment Guide**

**Basic:** 13, 15, 19–35 odd, 39, 41–43, 45, 49–54, 57–67

**Average:** 13–39 odd, 41–43, 45–54, 57–67 (optional: 55, 56)

**Advanced:** 14–40 even, 44, 46–63 (optional: 64–67)

---

**Answer**

3. Solve the equation for \(y\) to get

\[ y = \frac{3}{5}x - \frac{2}{5} \]

The slope of this line is \(\frac{3}{5}\). The slope of a parallel line is the same.
Write an equation in slope-intercept form for each graph.

21. \(y = -4\)

22. \(y = 2\)

Write an equation in slope-intercept form for the line that satisfies each set of conditions.

23. slope 3, passes through (0, -6)  24. slope 0.25, passes through (0, 4)
25. slope \(-\frac{1}{2}\), passes through (1, 3)  26. slope \frac{3}{2}, passes through (-5, 1)
27. slope -0.5, passes through (2, -3)  28. slope 4, passes through the origin
29. passes through (2, 5) and (3, 1)  30. passes through (7, 1) and (7, 8)
31. passes through (-4, 0) and (3, 0)  32. passes through (-2, -3) and (0, 0)
33. \(x\)-intercept -4, \(y\)-intercept 4  34. \(x\)-intercept 1, \(y\)-intercept -\frac{1}{3}
35. passes through (4, 6), parallel to the graph of \(y = \frac{2}{3}x + 5\)  36. passes through (2, -5), perpendicular to the graph of \(y = \frac{1}{2}x + 7\)
37. passes through (6, -5), perpendicular to the line whose equation is \(3x - \frac{5}{2}y = 3\)  38. passes through (-3, -1), parallel to the line that passes through (3, 3) and (0, 6)
39. Write an equation in slope-intercept form of the line that passes through the points indicated in the table. \(y = 3x - 2\)
40. Write an equation in slope-intercept form of the line that passes through (-2, 10), (2, 2), and (4, -2). \(y = -2x + 6\)

GEOMETRY  For Exercises 41–43, use the equation \(d = 180(c - 2)\) that gives the total number of degrees \(d\) in any convex polygon with \(c\) sides.
41. Write this equation in slope-intercept form. \(d = 180c - 360\)
42. Identify the slope and \(d\)-intercept. 180, -360
43. Find the number of degrees in a pentagon. 540°

ECOLOGY  A park ranger at Blendon Woods estimates there are 6000 deer in the park. She also estimates that the population will increase by 75 deer each year thereafter. Write an equation that represents how many deer will be in the park \(x\) years. \(y = 75x + 6000\)

BUSINESS  Refer to the signs below. At what distance do the two stores charge the same amount for a balloon arrangement? 10 mi

www.algebra2.com/self_check_quiz

Lesson 2-4  Writing Linear Equations 79

Enrichment, p. 80

Two-Intercept Form of a Linear Equation
You are already familiar with the slope-intercept form of a linear equation, \(y = mx + b\). Linear equations can also be written in the form \(y = \frac{x}{A} + B\) with \(A\) the \(x\)-intercept and \(B\) the \(y\)-intercept. This is called two-intercept form.

Example 1  Write the graph of \(x = 2\) in two-intercept form.

The graph crosses the origin at 0 and the \(x\)-axis at 2. Graph \((-2, 0)\) and \((2, 0)\), then draw a straight line through them.

Example 2  Write \(3x + 4y = 12\) in two-intercept form.

Divide by 12 to obtain 1 on the right side.

\[3x + 4y = 12\]
\[\frac{3x}{12} + \frac{4y}{12} = \frac{12}{12}\]
\[x + \frac{4}{3}y = 1\]

Helping You Remember

You can use these guidelines to remember the point-slope form of a linear equation. You can use the definition of slope to remember this form. Sample answer:

Write the equation of a line:

\[y - y_1 = m(x - x_1)\]

Multiply both sides of the equation by \(y_1 - y_2\). Drop the subscripts in \(x_1\) and \(y_1\). This gives the point-slope form of the equation of a line.
P. 115 of the Masters

Lesson 2-5

Getting Ready for

PREREQUISITE SKILL Lesson 2-5 presents modeling real-world data through 2-4.)

Ice forms at a temperature of 0°C, which corresponds to a temperature of 32°F. A temperature of 100°C corresponds to a temperature of 212°F.

Have students write their own summary of how to relate graphs to their equations, including slope, intercepts, and parallel and perpendicular lines.

Familiarity with finding a median is known as the intercept form of the equation of a line because \( a \) is the \( x \)-intercept and \( b \) is the \( y \)-intercept.

Answers

46. Write and graph the linear equation that gives the number \( y \) of degrees Fahrenheit in terms of the number \( x \) of degrees Celsius. \( y = \frac{9}{5}x + 32 \); See margin for graph.

47. What temperature corresponds to 20°C? 68°F

48. What temperature is the same on both scales? −40°C

TELEPHONES For Exercises 49 and 50, use the following information.

Namid is examining the calling card portion of his phone bill. A 4-minute call at the night rate costs $2.65. A 10-minute call at the night rate costs $4.75.

49. Write a linear equation to model this situation. \( y = 0.35x + 1.25 \)

50. How much would it cost to talk for half an hour at the night rate? $11.75

How do linear equations apply to business?

Include the following in your answer: See margin.

- the fixed cost and the variable cost in the equation \( y = 5400 + 1.37x \), where \( y \) is the cost for a company to produce \( x \) units of its product, and
- the cost for the company to produce 1000 units of its product.

53. Find an equation of the line through (0, −3) and (4, 1). \( y = −x + 3 \)

54. Choose the equation of the line through \( \left( \frac{1}{2}, \frac{3}{2} \right) \) and \( \left( −\frac{1}{2}, \frac{1}{2} \right) \). \( y = −2x − 1 \)

55. Write the equation \( 2x − y − 5 = 0 \) in intercept form. \( \frac{x}{5} − \frac{y}{5} = 1 \)

56. Identify the \( x \)- and \( y \)-intercepts of the graph of \( 2x − y − 5 = 0 \). \( \frac{5}{2}, −5 \)

For Exercises 55 and 56, use the following information.

The form \( \frac{x}{a} + \frac{y}{b} = 1 \) is known as the intercept form of the equation of a line because \( a \) is the \( x \)-intercept and \( b \) is the \( y \)-intercept.

52. A linear equation can sometimes be used to relate a company’s cost to the number they produce of a product. Answers should include the following.

- The \( y \)-intercept, 5400, is the cost the company must pay if they produce 0 units, so it is the fixed cost. The slope, 1.37, means that it costs $1.37 to produce each unit. The variable cost is 1.37\( x \).
- $6770

58. (1, −3), (3, 3) \( 59. (−5, 0), (4, 0) \)

60. INTERNET A Webmaster estimates that the time (seconds) required to connect to the server when \( n \) people are connecting is given by \( t(n) = 0.005n + 0.3 \). Estimate the time required to connect when 50 people are connecting. \( 0.85 \) s

Solve each inequality. (Lessons 1-5 and 1-6)

61. \( |x − 2| \leq −99 \) \( \emptyset \)

62. \( −4x + 7 \leq 31 \) \( \{ x | x \geq −6 \} \)

63. \( 2(r − 4) + 5 \geq 9 \) \( \{ r | r \geq 6 \} \)

PREREQUISITE SKILL Find the median of each set of numbers.

(To review finding a median, see pages 822 and 823.)

64. \{3, 2, 1, 3, 4, 8, 4\} \( 3 \)

65. \{9, 3, 7, 5, 6, 3, 7, 9\} \( 6.5 \)

66. \{138, 235, 976, 230, 412, 466\} \( 323.5 \)

67. \{2.5, 7.8, 5.5, 2.3, 6.2, 7.8\} \( 5.85 \)

Maintain Your Skills

Mixed Review

Find the slope of the line that passes through each pair of points. (Lesson 2-3)

57. (7, 2), (5, 6) \( −2 \)

58. (1, −3), (3, 3) \( 3 \)

59. (−5, 0), (4, 0) \( 0 \)

60. INTERNET A Webmaster estimates that the time (seconds) required to connect to the server when \( n \) people are connecting is given by \( t(n) = 0.005n + 0.3 \). Estimate the time required to connect when 50 people are connecting. \( 0.85 \) s

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Modeling Real-World Data: Using Scatter Plots

What You’ll Learn
• Draw scatter plots.
• Find and use prediction equations.

How can a linear equation model the number of Calories you burn exercising?
The table shows the number of Calories burned per hour by a 140-pound person running at various speeds. A linear function can be used to model these data.

<table>
<thead>
<tr>
<th>Speed (mph)</th>
<th>Calories</th>
</tr>
</thead>
<tbody>
<tr>
<td>5</td>
<td>508</td>
</tr>
<tr>
<td>6</td>
<td>636</td>
</tr>
<tr>
<td>7</td>
<td>731</td>
</tr>
<tr>
<td>8</td>
<td>858</td>
</tr>
</tbody>
</table>

Vocabulary
• scatter plot
• line of fit
• prediction equation

SCATTER PLOTS To model data with a function, it is helpful to graph the data. A set of data graphed as ordered pairs in a coordinate plane is called a scatter plot. A scatter plot can show whether there is a relationship between the data.

Example 1 Draw a Scatter Plot
HOUSING The table below shows the median selling price of new, privately-owned, one-family houses for some recent years. Make a scatter plot of the data.

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Price ($1000)</td>
<td>122.9</td>
<td>121.5</td>
<td>130.0</td>
<td>140.0</td>
<td>152.5</td>
<td>169.0</td>
</tr>
</tbody>
</table>

Source: U.S. Census Bureau and U.S. Department of Housing and Urban Development

Graph the data as ordered pairs, with the number of years since 1990 on the horizontal axis and the price on the vertical axis.

PREDICTION EQUATIONS Except for (0, 122.9), the data in Example 1 appear to lie nearly on a straight line. When you find a line that closely approximates a set of data, you are finding a line of fit for the data. An equation of such a line is often called a prediction equation because it can be used to predict one of the variables given the other variable.

How can a linear equation model the number of Calories you burn exercising?
Ask students:
• Will a person that weighs less than 140 pounds burn more or less Calories than shown in the table at the given speeds? less
• What is a reasonable estimate of the number of Calories a 140-pound person burns running at a speed of 4 miles per hour? about 400 Calories

Resource Manager
Workbook and Reproducible Masters

Chapter 2 Resource Masters
• Study Guide and Intervention, pp. 81–82
• Skills Practice, p. 83
• Practice, p. 84
• Reading to Learn Mathematics, p. 85
• Enrichment, p. 86

School-to-Career Masters, p. 4
Science and Mathematics Lab Manual, pp. 97–102
Teaching Algebra With Manipulatives Masters, p. 218

Transparencies
5-Minute Check Transparency 2-5
Answer Key Transparencies

Technology
Interactive Chalkboard
In-Class Example

1 EDUCATION The table below shows the approximate percent of students who sent applications to two colleges in various years since 1985. Make a scatter plot of the data.

<table>
<thead>
<tr>
<th>Years Since 1985</th>
<th>0</th>
<th>3</th>
<th>6</th>
<th>9</th>
<th>12</th>
<th>15</th>
</tr>
</thead>
<tbody>
<tr>
<td>Percentage</td>
<td>20</td>
<td>18</td>
<td>15</td>
<td>15</td>
<td>14</td>
<td>13</td>
</tr>
</tbody>
</table>

Source: U.S. News & World Report

To find a line of fit and a prediction equation for a set of data, select two points that appear to represent the data well. This is a matter of personal judgment, so your line and prediction equation may be different from someone else’s.

Example 2 Find and Use a Prediction Equation

HOUSING Refer to the data in Example 1.

a. Draw a line of fit for the data. How well does the line fit the data?

Ignore the point (0, 122.9) since it would not be close to a line that represents the rest of the data points. The points (4, 130.0) and (8, 152.5) appear to represent the data well. Draw a line through these two points. Except for (0, 122.9), this line fits the data very well.

b. Find a prediction equation. What do the slope and y-intercept indicate?

Find an equation of the line through (4, 130.0) and (8, 152.5). Begin by finding the slope.

\[ m = \frac{y_2 - y_1}{x_2 - x_1} \]

Substitute.

\[ m = \frac{152.5 - 130.0}{8 - 4} \]

Simplify.

\[ m = 5.63 \]

Point-slope form

\[ y - y_1 = m(x - x_1) \]

Substitute.

\[ y - 130.0 = 5.63(x - 4) \]

\[ y = 130.0 + 5.63(8) \]

Add 130.0 to each side.

One prediction equation is \( y = 5.63x + 107.48 \). The slope indicates that the median price is increasing at a rate of about $5630 per year. The y-intercept indicates that, according to the trend of the rest of the data, the median price in 1990 should have been about $107,480.

c. Predict the median price in 2010.

The year 2010 is 20 years after 1990, so use the prediction equation to find the value of \( y \) when \( x = 20 \).

\[ y = 5.63x + 107.48 \]

\[ y = 5.63(20) + 107.48 \]

\[ y = 120.08 \]

The model predicts that the median price in 2010 will be about $220,000.

d. How accurate is the prediction?

Except for the outlier, the line fits the data very well, so the predicted value should be fairly accurate.

Differentiated Instruction

Naturalist Ask students how scatter plots and prediction equations might be used to relate local insect and animal populations to food supplies, temperature, and rainfall. Have interested students devise a plan for conducting the research necessary for developing such a prediction equation.
Study Tip

Outliers
If your scatter plot includes points that are far from the others on the graph, check your data before deciding it is an outlier. You may have made a graphing or recording mistake.

Algebra Activity

Head versus Height

Collect the Data
- Collect data from several of your classmates. Use a tape measure to measure the circumference of each person’s head and his or her height. Record the data as ordered pairs of the form (height, circumference).

Analyze the Data 1–5. See students’ work.
1. Graph the data in a scatter plot.
2. Choose two ordered pairs and write a prediction equation.
3. Explain the meaning of the slope in the prediction equation.

Make a Conjecture
4. Predict the head circumference of a person who is 66 inches tall.
5. Predict the height of an individual whose head circumference is 18 inches.

Check for Understanding

Concept Check
1. Choose the scatter plot with data that could best be modeled by a linear function. d

2. Identify the domain and range of the relation in the graph at the right. Predict the value of y when x = 5.

3. OPEN ENDED Write a different prediction equation for the data in Examples 1 and 2 on pages 81 and 82.
   Sample answer using (4, 130.0) and (6, 140.0): y = 5x + 110

Guided Practice

GUIDED PRACTICE KEY

Exercises Examples
4, 5 1, 2

2. Draw a scatter plot.
3. Use two ordered pairs to write a prediction equation.
4. Use your prediction equation to predict the missing value.

4. SCIENCE Whether you are climbing a mountain or flying in an airplane, the higher you go, the colder the air gets. The table shows the temperature in the atmosphere at various altitudes. 4–5. See pp. 107A–107H.

<table>
<thead>
<tr>
<th>Altitude (ft)</th>
<th>0</th>
<th>1000</th>
<th>2000</th>
<th>3000</th>
<th>4000</th>
<th>5000</th>
</tr>
</thead>
<tbody>
<tr>
<td>Temp (°C)</td>
<td></td>
<td>15.0</td>
<td>13.0</td>
<td>11.0</td>
<td>9.1</td>
<td>7.1</td>
</tr>
</tbody>
</table>

Source: NASA

5. TELEVISION As more channels have been added, cable television has become attractive to more viewers. The table shows the number of U.S. households with cable service in some recent years.

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Households (millions)</td>
<td>55</td>
<td>57</td>
<td>59</td>
<td>65</td>
<td>67</td>
<td>?</td>
</tr>
</tbody>
</table>

Source: Nielsen Media Research

Algebra Activity

Materials: tape measure, grid paper
- You can use string and a ruler as an alternative way to measure the circumference of a person’s head as well as their height.
- Measurements can be made in inches or in centimeters. You may want to have half the class use one system and the other half the alternate system.
Answers

6a. Lives Saved by Minimum Drinking Age

- 2000–2001

<table>
<thead>
<tr>
<th>Year</th>
<th>'94</th>
<th>'95</th>
<th>'96</th>
<th>'97</th>
<th>'98</th>
<th>'99</th>
<th>'00</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lives (thousands)</td>
<td>25</td>
<td>20</td>
<td>15</td>
<td>10</td>
<td>5</td>
<td>0</td>
<td>10</td>
</tr>
</tbody>
</table>

7a. Detroit Red Wings

- Goals
- Assists

8a. Bottled Water Consumption

- Gallons
- Year

8b. Sample answer using (1996, 12.5) and (1997, 13.1):
\[ y = 0.85x + 1680.1 \]
8c. Sample answer: about 13

8d. Sample answer: about 13

8e. Sample answer: about 28,400

8f. Sample answer: about 12,200

8g. Sample answer: about 13

8h. Sample answer: about 28,400

* indicates increased difficulty

Practice and Apply

Complete parts a–c for each set of data in Exercises 6–9.

a. Draw a scatter plot.
b. Use two ordered pairs to write a prediction equation.
c. Use your prediction equation to predict the missing value.

6. SAFETY All states and the District of Columbia have enacted laws setting 21 as the minimum drinking age. The table shows the estimated cumulative number of lives these laws have saved by reducing traffic fatalities.

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Lives (1000s)</td>
<td>15.7</td>
<td>16.5</td>
<td>17.4</td>
<td>18.2</td>
<td>19.1</td>
<td>?</td>
</tr>
</tbody>
</table>

Source: National Highway Traffic Safety Administration

7. HOKEY Each time a hockey player scores a goal, up to two teammates may be credited with assists. The table shows the number of goals and assists for some of the members of the Detroit Red Wings in the 2000–2001 NHL season.

<table>
<thead>
<tr>
<th>Goals</th>
<th>31</th>
<th>15</th>
<th>32</th>
<th>27</th>
<th>16</th>
<th>20</th>
<th>8</th>
<th>4</th>
<th>12</th>
<th>12</th>
<th>?</th>
</tr>
</thead>
<tbody>
<tr>
<td>Assists</td>
<td>45</td>
<td>56</td>
<td>37</td>
<td>30</td>
<td>24</td>
<td>18</td>
<td>17</td>
<td>5</td>
<td>10</td>
<td>7</td>
<td>15</td>
</tr>
</tbody>
</table>

Source: detroitredwings.com

8. HEALTH Bottled water has become very popular. The table shows the number of gallons of bottled water consumed per person in some recent years.

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Gallons</td>
<td>8.2</td>
<td>9.4</td>
<td>10.7</td>
<td>11.6</td>
<td>12.5</td>
<td>13.1</td>
<td>?</td>
</tr>
</tbody>
</table>

Source: U.S. Department of Agriculture

9. THEATER Broadway, in New York City, is the center of American theater. The table shows the total revenue of all Broadway plays for some recent seasons.

<table>
<thead>
<tr>
<th>Season</th>
<th>'95–96</th>
<th>'96–97</th>
<th>'97–98</th>
<th>'98–99</th>
<th>'99–00</th>
<th>'00–01</th>
</tr>
</thead>
<tbody>
<tr>
<td>Revenue ($ millions)</td>
<td>436</td>
<td>499</td>
<td>558</td>
<td>588</td>
<td>603</td>
<td>?</td>
</tr>
</tbody>
</table>

Source: The League of American Theatres and Producers, Inc.

USA TODAY Snapshots®

Cost of seeing the doctor

How much Americans spend a year on doctor visits:

- 1990: $563
- 1995: $739
- 2000: $906
- 2005: $1,172

Source: U.S. Health Care Financing Administration

Online Lesson Plans

USA TODAY Education’s Online site offers resources and interactive features connected to each day’s newspaper. Experience TODAY, USA TODAY’s daily lesson plan, is available on the site and delivered daily to subscribers. This plan provides instruction for integrating USA TODAY graphics and key editorial features into your mathematics classroom. Log on to www.education.usatoday.com.
**Career Choices**

For Exercises 13 and 14, use the following information.

Della has $1000 that she wants to invest in the stock market. She is considering buying stock in either Company 1 or Company 2. The values of the stocks at the ends of the last four months are shown in the tables below.

<table>
<thead>
<tr>
<th>Month</th>
<th>Share Price ($)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Aug.</td>
<td>25.13</td>
</tr>
<tr>
<td>Sept.</td>
<td>22.94</td>
</tr>
<tr>
<td>Oct.</td>
<td>24.19</td>
</tr>
<tr>
<td>Nov.</td>
<td>22.56</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Month</th>
<th>Share Price ($)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Aug.</td>
<td>31.25</td>
</tr>
<tr>
<td>Sept.</td>
<td>32.38</td>
</tr>
<tr>
<td>Oct.</td>
<td>32.06</td>
</tr>
<tr>
<td>Nov.</td>
<td>32.44</td>
</tr>
</tbody>
</table>

**GEOGRAPHY** For Exercises 15–18, use the table below that shows the elevation and average precipitation for selected cities.

<table>
<thead>
<tr>
<th>City</th>
<th>Elevation (feet)</th>
<th>Average Precip. (inches)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rome, Italy</td>
<td>79</td>
<td>33</td>
</tr>
<tr>
<td>Algiers, Algeria</td>
<td>82</td>
<td>27</td>
</tr>
<tr>
<td>Istanbul, Turkey</td>
<td>108</td>
<td>27</td>
</tr>
<tr>
<td>Montreal, Canada</td>
<td>118</td>
<td>37</td>
</tr>
<tr>
<td>Stockholm, Sweden</td>
<td>171</td>
<td>21</td>
</tr>
<tr>
<td>Berlin, Germany</td>
<td>190</td>
<td>23</td>
</tr>
<tr>
<td>Rome, England</td>
<td>203</td>
<td>30</td>
</tr>
<tr>
<td>Paris, France</td>
<td>213</td>
<td>26</td>
</tr>
<tr>
<td>Bucharest, Romania</td>
<td>298</td>
<td>23</td>
</tr>
<tr>
<td>Budapest, Hungary</td>
<td>456</td>
<td>20</td>
</tr>
<tr>
<td>Toronto, Canada</td>
<td>567</td>
<td>31</td>
</tr>
</tbody>
</table>

Source: World Meteorological Association

16. **Sample answer using (213, 26) and (298, 23):**

\[ y = -0.04x + 34.52 \]

19. **Sample answer using (1975, 62.5) and (1995, 81.7):** 96.1%}

18. **Sample answer:** The predicted value differs from the actual value by more than 20%, possibly because no line fits the data very well.

20. **Sample answer:** The predicted percent is almost certainly too high. Since the percent cannot exceed 100%, it cannot continue to increase indefinitely at a linear rate.

**Critical Thinking** For Exercises 19 and 20, use the table that shows the percent of people ages 25 and over with a high school diploma over the last few decades.

19. **Use a prediction equation to predict the percent in 2010.**

20. **Do you think your prediction is accurate? Explain.**
**Open-Ended Assessment**

**Writing** Ask students to write instructions that could be used to teach a friend how to read a graph such as the one shown in Example 2 on p. 82. The importance of reading titles, captions, and text, as well as the scales should be included as part of the instructions.

**Getting Ready for Lesson 2-6**

**PREREQUISITE SKILL** Lesson 2-6 presents the graphing of special functions, including absolute value functions. Exercises 38–42 should be used to determine your students’ familiarity with finding absolute values.

**Answer**

22. Data can be used to write a linear equation that approximates the number of Calories burned per hour in terms of the speed that a person runs. Answers should include the following.

- **Calories Burned While Running**

  ![](Calories_Burned_While_Running.png)

  Sample answer using (5, 508) and (8, 858):
  
  \[ y = 116.67x - 75.35 \]

- **about 975 calories**; Sample answer: The predicted value differs from the actual value by only about 2%.

- **Writing in Math** Answer the question that was posed at the beginning of the lesson.

  **How can a linear equation model the number of Calories you burn exercising?** Include the following in your answer: See margin.

  - a scatter plot and a prediction equation for the data, and
  - a prediction of the number of Calories burned in an hour by a 140-pound person running at 9 miles per hour, with a comparison of your predicted value with the actual value of 953.

23. Which line best fits the data in the graph at the right? **D**

   - **A** \( y = x \)
   - **B** \( y = -0.5x + 4 \)
   - **C** \( y = -0.5x - 4 \)
   - **D** \( y = 0.5 + 0.5x \)

24. A prediction equation for a set of data is \( y = 0.63x + 4.51 \). For which \( x \) value is the predicted \( y \) value 6.4? **A**

   - **A** 3
   - **B** 4.5
   - **C** 6
   - **D** 8.54

25. Which line best fits the data in the graph at the right? **D**

26. Find an equation of the line through \( (x_1, y_1) \) and \( (x_2, y_2) \). \( y = 21.4x - 42,296.2 \)

27. Find \( y \), the \( y \)-coordinate of the point on the line in Exercise 26 with an \( x \)-coordinate of \( x_2 \). 354

28. The median-fit line is parallel to the line in Exercise 26, but is one-third closer to \( (x_2, y_2) \). This means it passes through \( \left[ x_2, \frac{2}{3}y + \frac{1}{3}y_2 \right] \). Find this ordered pair.

29. Write an equation of the median-fit line. \( y = 21.4x - 42,294.03 \)

30. Predict the number of prisoners per 100,000 citizens in 2005 and 2010. about 613, about 720

**Maintain Your Skills**

**Mixed Review**

31. \( y = 4x + 6 \)

32. \( y = -\frac{3}{7}x - \frac{6}{7} \)

33. \( g(3) \)

34. \( g(0) \)

35. \( g(-2) \)

36. \( g(-4) \)

37. Solve \( |x + 4| > 3 \). \( \{x | x < -7 \text{ or } x > -1 \} \)

38. | -3 |

39. | 11 |

40. | 0 |

41. | -2 |

42. | 1.5 |

**Getting Ready for the Next Lesson**

**PREREQUISITE SKILL** Find each absolute value. (To review absolute value, see Lesson 1-4.)

**Teacher to Teacher**

Susan Nelson

Spring H.S., Spring, TX

“I have my students take measurements of their height and arm span and record them. We enter the entire class’ data into a graphing calculator and find the linear regression. Then we use the regression equation to make predictions.”
Lines of Regression

You can use a TI-83 Plus graphing calculator to find a line that best fits a set of data. This line is called a regression line or line of best fit. You can also use the calculator to draw scatter plots and make predictions.

The table shows the median income of U.S. families for the period 1970–1998.

<table>
<thead>
<tr>
<th>Year</th>
<th>Income ($)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1970</td>
<td>9867</td>
</tr>
<tr>
<td>1980</td>
<td>21,023</td>
</tr>
<tr>
<td>1985</td>
<td>27,735</td>
</tr>
<tr>
<td>1990</td>
<td>35,353</td>
</tr>
<tr>
<td>1995</td>
<td>40,611</td>
</tr>
<tr>
<td>1998</td>
<td>46,737</td>
</tr>
</tbody>
</table>

Find and graph a regression equation. Then predict the median income in 2010.

**Step 1** Find a regression equation.
- Enter the years in L1 and the incomes in L2.
  
  **KEYSTROKES:** STAT ENTER 1970 ENTER
- Find the regression equation by selecting LinReg(ax + b) on the STAT CALC menu.
  
  **KEYSTROKES:** STAT → 4 ENTER

The regression equation is about \( y = 1304.19x - 2560335.07 \).

The slope indicates that family incomes were increasing at a rate of about $1300 per year.

The number \( r \) is called the linear correlation coefficient. The closer the value of \( r \) is to 1 or \(-1\), the closer the data points are to the line.

If the values of \( r^2 \) and \( r \) are not displayed, use DiagnosticOn from the CATALOG menu.

**Step 2** Graph the regression equation.
- Use STAT PLOT to graph a scatter plot.
  
  **KEYSTROKES:** 2nd [STAT PLOT] ENTER
- Select the scatter plot, L1 as the Xlist, and L2 as the Ylist.
- Copy the equation to the Y= list and graph.
  
  **KEYSTROKES:** Y= VARS → 5 → 1

```
[1965, 2010] scl: 5 by [0, 50,000] scl: 10,000
GRAPH
```

Notice that the regression line does not pass through any of the data points, but comes close to all of them. The line fits the data very well.

**Step 3** Predict using the regression equation.
- Find \( y \) when \( x = 2010 \). Use value on the CALC menu.
  
  **KEYSTROKES:** 2nd [CALC] 1 2010 ENTER

According to the regression equation, the median family income in 2010 will be about $61,087.
Refer students to the calculator display shown in Step 1 on p. 87, and ask the following questions.

- What is the regression equation for the income data? \( y = 1304.19x - 2,560,335.07 \)
- What does the value of \( r \) tell you about the regression equation? The value of \( r \) is very close to 1, so the data points are very close to the graph of that equation.

Answers

1. Make a scatter plot of the data. See margin.
2. Find a regression equation for the data. \( y = 1.73x + 0.39 \)
3. Predict the number of representatives for Oregon, which has a population of about 2.8 million. 5

**BASEBALL** For Exercises 4–6, use the table at the right that shows the total attendance for minor league baseball in some recent years.

4. Make a scatter plot of the data. See margin.
5. Find a regression equation for the data. \( y = 1.31x - 2581.6 \)
6. Predict the attendance in 2010. 51,500,000

**TRANSPORTATION** For Exercises 7–11, use the table below that shows the retail sales of motor vehicles in the United States for the period 1992–1999.

7. Make a scatter plot of the data. See margin.
8. Find a regression equation for the data. \( y = 470.06x - 922,731.40 \)
9. According to the regression equation, what was the average rate of change of vehicle sales during the period?
10. Predict the sales in 2010. about 22,088,000
11. How accurate do you think your prediction is? Explain. See margin.

**RECREATION** For Exercises 12–15, use the table at the right that shows the amount of money spent on skin diving and scuba equipment in some recent years.

12. Find a regression equation for the data. \( y = 6.93x - 13,494.43 \)
13. Delete the outlier (1997, 332) from the data set. Then find a new regression equation for the data. \( y = 7.36x - 14,354.33 \)
14. Use the new regression equation to predict the sales in 2010.
15. Compare the new correlation coefficient to the old value and state whether the regression line fits the data better. See margin.
**Special Functions**

**What You'll Learn**
- Identify and graph step, constant, and identity functions.
- Identify and graph absolute value and piecewise functions.

**How do step functions apply to postage rates?**

The cost of the postage to mail a letter is a function of the weight of the letter. But the function is not linear. It is a special function called a step function.

**STEP FUNCTIONS, CONSTANT FUNCTIONS, AND THE IDENTITY FUNCTION** The graph of a step function is not linear. It consists of line segments or rays. The greatest integer function, written \( f(x) = \lfloor x \rfloor \), is an example of a step function. The symbol \( \lfloor x \rfloor \) means the greatest integer less than or equal to \( x \). For example, \( \lfloor 7.3 \rfloor = 7 \) and \( \lfloor -1.5 \rfloor = -2 \) because \( -1 > -1.5 \). Study the table and graph below.

<table>
<thead>
<tr>
<th>( x )</th>
<th>( f(x) = \lfloor x \rfloor )</th>
</tr>
</thead>
<tbody>
<tr>
<td>(-3 &lt; x &lt; -2)</td>
<td>(-3)</td>
</tr>
<tr>
<td>(-2 &lt; x &lt; -1)</td>
<td>(-2)</td>
</tr>
<tr>
<td>(-1 &lt; x &lt; 0)</td>
<td>(-1)</td>
</tr>
<tr>
<td>(0 \leq x &lt; 1)</td>
<td>(0)</td>
</tr>
<tr>
<td>(1 \leq x &lt; 2)</td>
<td>(1)</td>
</tr>
<tr>
<td>(2 \leq x &lt; 3)</td>
<td>(2)</td>
</tr>
<tr>
<td>(3 \leq x &lt; 4)</td>
<td>(3)</td>
</tr>
</tbody>
</table>

A dot means that the point is included in the graph.

A circle means that the point is not included in the graph.

**Example 1**: **Step Function**

**BUSINESS** Labor costs at the Fix-It Auto Repair Shop are $60 per hour or any fraction thereof. Draw a graph that represents this situation.

**Explore** The total labor charge must be a multiple of $60, so the graph will be the graph of a step function.

**Plan** If the time spent on labor is greater than 0 hours, but less than or equal to 1 hour, then the labor cost is $60. If the time is greater than 1 hour but less than or equal to 2 hours, then the labor cost is $120, and so on.

**Solve** Use the pattern of times and costs to make a table, where \( x \) is the number of hours of labor and \( C(x) \) is the total labor cost. Then draw the graph.

(continued on the next page)

**Study Tip**

**Greatest Integer Function** Notice that the domain of this step function is all real numbers and the range is all integers.

**Resource Manager**

- **Workbook and Reproducible Masters**
  - Chapter 2 Resource Masters
    - Study Guide and Intervention, pp. 87–88
    - Skills Practice, p. 89
    - Practice, p. 90
    - Reading to Learn Mathematics, p. 91
    - Enrichment, p. 92
    - Assessment, p. 114
  - Graphing Calculator and Spreadsheet Masters, p. 29
  - Teaching Algebra With Manipulatives Masters, p. 219

- **Transparencies**
  - 5-Minute Check Transparency 2-6
  - Answer Key Transparencies

- **Technology**
  - Interactive Chalkboard

**Mathematical Background** notes are available for this lesson on p. 54D.
In-Class Examples

1. **PSYCHOLOGY** One psychologist charges for counseling sessions at the rate of $85 per hour or any fraction thereof. Draw a graph that represents this situation.

2. **Graph** \( g(x) = -3 \).

---

**Teaching Tip** Help clear up confusions about step functions by asking students to choose several sample times, in hours and minutes, and find the associated costs. Lead them to see that two different times (\( x \) values) can have the same cost (\( C \) value).

---

**Examining** Since the shop rounds any fraction of an hour up to the next whole number, each segment on the graph has a circle at the left endpoint and a dot at the right endpoint.

---

**Example 2** Constant Function

Graph \( f(x) = 3 \).

For every value of \( x \), \( f(x) = 3 \). The graph is a horizontal line.

---

Another special case of slope-intercept form is \( m = 1, b = 0 \). This is the function \( f(x) = x \). The graph is the line through the origin with slope 1.

Since the function does not change the input value, \( f(x) = x \) is called the **identity function**.

---

**Absolute Value Function**

Notice that the domain is all real numbers and the range is all nonnegative real numbers.

---

**Absolute Value and Piecewise Functions** Another special function is the **absolute value function**, \( f(x) = |x| \).
The absolute value function can be written as $f(x) = \begin{cases} -x & \text{if } x < 0 \\ x & \text{if } x \geq 0 \end{cases}$. A function that is written using two or more expressions is called a **piecewise function**.

Recall that a family of graphs is a group of graphs that displays one or more similar characteristics. The parent graph of most absolute value functions is $y = |x|$.

### Example 3 Absolute Value Functions

Graph $f(x) = |x| + 1$ and $g(x) = |x| − 2$ on the same coordinate plane. Determine the similarities and differences in the two graphs.

Find several ordered pairs for each function.

| $x$ | $|x| + 1$ | $x$ | $|x| − 2$ |
|-----|----------|-----|----------|
| −2  | 3        | −2  | 0        |
| −1  | 2        | −1  | −1       |
| 0   | 1        | 0   | −2       |
| 1   | 2        | 1   | −1       |
| 2   | 3        | 2   | 0        |

Graph the points and connect them.

- The domain of each function is all real numbers.
- The range of $f(x) = |x| + 1$ is $\{y \mid y \geq 1\}$.
- The range of $g(x) = |x| − 2$ is $\{y \mid y \geq −2\}$.
- The graphs have the same shape, but different $y$-intercepts.
- The graph of $g(x) = |x| − 2$ is the graph of $f(x) = |x| + 1$ translated down 3 units.

You can also use a graphing calculator to investigate families of absolute value graphs.

### In-Class Example

**Graphing Calculator Investigation**

**Families of Absolute Value Graphs**

The calculator screen shows the graphs of $y = |x|$, $y = 2|x|$, $y = 3|x|$, and $y = 5|x|$.

**Think and Discuss**

1. What do these graphs have in common?
2. Describe how the graph of $y = a|x|$ changes as $a$ increases. Assume $a > 0$.
3. Write an absolute value function whose graph is between the graphs of $y = 2|x|$ and $y = 3|x|$. Sample answer: $y = 2.5|x|$.
4. Graph $y = |x|$ and $y = −|x|$ on the same screen. Then graph $y = 2|x|$ and $y = −2|x|$ on the same screen. What is true in each case?
5. In general, what is true about the graph of $y = a|x|$ when $a < 0$?

**Graphing Calculator Investigation**

**Families of Absolute Value Graphs** It is important that students arrive at the conclusion in Exercise 2 that the graph of the function narrows as the coefficient $a$ increases. As an extension, ask students to compare the graph of $y = |x|$ with the graph of $y = |x| + 2$ and with $y = 2|x|$. Make sure they see the difference between adding 2 and having 2 as a coefficient.
In-Class Examples

4 Graph \( f(x) = \begin{cases} x - 1 & \text{if } x \leq 3 \\ -1 & \text{if } x > 3 \end{cases} \)

Identify the domain and range.

The domain is all real numbers.
The range is \( \{y | y \leq 2\} \).

5 Determine whether each graph represents a step function, a constant function, an absolute value function, or a piecewise function.

a. piecewise function

b. absolute value function

Example 4 Piecewise Function

Graph \( f(x) = \begin{cases} x - 4 & \text{if } x < 2 \\ 1 & \text{if } x \geq 2 \end{cases} \)

Identify the domain and range.

Step 1 Graph the linear function \( f(x) = x - 4 \) for \( x < 2 \).
Since 2 does not satisfy this inequality, stop with an open circle at \((2, -2)\).

Step 2 Graph the constant function \( f(x) = 1 \) for \( x \geq 2 \).
Since 2 does satisfy this inequality, begin with a closed circle at \((2, 1)\) and draw a horizontal ray to the right.

The function is defined for all values of \( x \), so the domain is all real numbers. The values that are \( y \)-coordinates of points on the graph are 1 and all real numbers less than \( \frac{1}{2} \), so the range is \( \{y | y < -2 \text{ or } y = 1\} \).

Check for Understanding

1. Find a counterexample to the statement To find the greatest integer function of \( x \) when \( x \) is not an integer, round \( x \) to the nearest integer. Sample answer: \([-1.99] = 1\)

2. Evaluate \( g(4.3) \) if \( g(x) = \lfloor x - 5 \rfloor - 1 \)

3. OPEN ENDED Write a function involving absolute value for which \( f(-2) = 3 \).

Differentiated Instruction

Verbal/Linguistic Have students explain why step functions, constant functions, and piecewise functions are so named.
Identify each function as S for step, C for constant, A for absolute value, or P for piecewise.

4. \( f(x) \)

5. \( f(x) \)

Graph each function. Identify the domain and range.

6. \( f(x) = -\lfloor x \rfloor \)

7. \( g(x) = 2x \)

8. \( h(x) = |x - 4| \)

9. \( f(x) = |3x - 2| \)

10. \( g(x) = \begin{cases} -1 & \text{if } x < 0 \\ -x + 2 & \text{if } x \geq 0 \end{cases} \)  

11. \( h(x) = \begin{cases} x + 3 & \text{if } x \leq -1 \\ 2x & \text{if } x > -1 \end{cases} \)

12. What type of special function models this situation? step function

13. Draw a graph of a function that represents this situation. See margin.

14. Use the graph to find the cost of parking there for \( 4 \frac{1}{2} \) hours. \$6

21. TRANSPORTATION Bluffton High School chartered buses so the student body could attend the girls’ basketball state tournament games. Each bus held a maximum of 60 students. Draw a graph of a step function that shows the relationship between the number of students \( x \) who went to the game and the number of buses \( y \) that were needed. See margin.

Answers

21. Cost ($) vs. Time (hr)
HELPING YOU REMEMBER

Reading the Lesson
1. Find the value of each expression.
   a. \(-2 - (-3)\) = 
   b. \(-12 - 20\) = 
   c. \(|-40|\) = 
   d. \(|-40|\) = 

2. Tell how the nature of each kind of function can help you remember what the graphs look like.
   a. constant function: Sample answer: Something is constant if it does not change. The y-values of a constant function do not change, so the graph is a horizontal line.
   b. absolute value function: Sample answer: The absolute value of a number tells you how far it is from 0 on the number line. It makes no difference whether it is to the left or right of 0, as long as you go the same distance each time.
   c. step function: Sample answer: A step function’s graph looks like steps that go up or down.
   d. identity function: Sample answer: The a- and y-values are always the same for any point on the graph. So the graph is a line through the origin that has slope 1.

Helping You Remember
3. Many students find the greatest integer function confusing. Explain how you can see a number line to find the value of this function for any real number. Answers will vary, but might include:
   a. The greatest integer function gives the largest integer less than or equal to the number. For example, the value of the greatest integer function for any real number that falls on the number line. If it is an integer, the value of the function is the number itself. If not, move to the integer directly to the left of the number you chose. This integer will give the value you need.

48. \(f(x) = \begin{cases} 
0 & \text{if } 0 \leq x < 300 \\
0.8(x - 300) & \text{if } x \geq 300 
\end{cases}\)
51. For which function does \( f\left(-\frac{1}{2}\right) \neq -1? \)  
A) \( f(x) = 2x \)  
B) \( f(x) = |2x| \)  
C) \( f(x) = \frac{1}{x} \)  
D) \( f(x) = 2|x| \)  
52. For which function is the range \( \{y \mid y \leq 0\}? \)  
A) \( f(x) = -x \)  
B) \( f(x) = |x| \)  
C) \( f(x) = |x| \)  
D) \( f(x) = -|x| \)  

### Maintain Your Skills

#### Mixed Review

**HEALTH** For Exercises 53–55, use the table that shows the life expectancy for people born in various years. (Lesson 2-5)

<table>
<thead>
<tr>
<th>Year</th>
<th>Expectancy</th>
</tr>
</thead>
<tbody>
<tr>
<td>1950</td>
<td>68.2</td>
</tr>
<tr>
<td>1960</td>
<td>69.7</td>
</tr>
<tr>
<td>1970</td>
<td>70.8</td>
</tr>
<tr>
<td>1980</td>
<td>73.7</td>
</tr>
<tr>
<td>1990</td>
<td>75.4</td>
</tr>
<tr>
<td>1997</td>
<td>76.5</td>
</tr>
</tbody>
</table>

Source: National Center for Health Statistics

53. Draw a scatter plot in which \( x \) is the number of years since 1950. See margin.  
54. Find a prediction equation.  
55. Predict the life expectancy of a person born in 2010. Sample answer: 78.7 yr  
56. Write an equation in slope-intercept form of the line with slope 4, passes through \( (0, 69) \) and \( (47, 76.5) \): \( y = 0.18x + 67.9 \)

#### PREREQUISITE SKILL

Determine whether \( (0, 0) \) satisfies each condition. Write yes or no. (To review inequalities, see Lesson 1-5.)

57. passes through \( (0, -2) \) and \( (4, 2) \)  
58. \( y = 3x + 10 \)  
59. \( y = x - 2 \)  
60. \( y < 2x + 3 \) yes  
61. \( y \geq -x + 1 \) no  
62. \( 3x - 5 \leq 4 \) yes  
63. \( 2x + 6y + 3 > 0 \) yes  
64. \( y > |x| \) no  
65. \( |x| + y \leq 3 \) yes

### Getting Ready for the Next Lesson

#### Getting Ready for Lesson 2-7

**Practice Quiz 2** The quiz provides students with a brief review of the concepts and skills in Lessons 2-4 through 2-6. Lesson numbers are given to the right of exercises or instruction lines so students can review concepts not yet mastered.

### Assessment Options

**Quiz (Lessons 2-5 and 2-6)** is available on p. 114 of the Chapter 2 Resource Masters.

**Answers** (Practice Quiz 2)

2. **Houston Comets**

<table>
<thead>
<tr>
<th>Weight (lb)</th>
<th>0</th>
<th>50</th>
<th>100</th>
<th>150</th>
<th>200</th>
<th>250</th>
</tr>
</thead>
<tbody>
<tr>
<td>Height (in.)</td>
<td>60</td>
<td>65</td>
<td>70</td>
<td>75</td>
<td>80</td>
<td>---</td>
</tr>
</tbody>
</table>

5. Graph \( f(x) = |x - 1| \). Identify the domain and range. (Lesson 2-6) See margin.
In-Class Example

5-Minute Check Transparency 2-7 Use as a quiz or review of Lesson 2-6.

Mathematical Background notes are available for this lesson on p. 54D.

How do inequalities apply to fantasy football?

Ask students:

• What is the meaning of “receiving yards?” the number of yards that a team advances down the field when the receiver of a pass catches the ball

2 Teach

GRAPH LINEAR INEQUALITIES

In-Class Example

Graph $x - 2y < 4$.

Example 1 Dashed Boundary

Graph $2x + 3y > 6$.

The boundary is the graph of $2x + 3y = 6$. Since the inequality symbol is $>$, the boundary will be dashed. Use the slope-intercept form, $y = \frac{2}{3}x + 2$.

Now test the point $(0, 0)$. The point $(0, 0)$ is usually a good point to test because it results in easy calculations.

$2x + 3y > 6$ Original inequality

$2(0) + 3(0) > 6$ $(x, y) = (0, 0)$

$0 > 6$ false

Shade the region that does not contain $(0, 0)$.

Vocabulary

boundary

How do inequalities apply to fantasy football?

Dana has Vikings receiver Randy Moss as a player on his online fantasy football team. Dana gets 5 points per receiving yard that Moss gets and 100 points per touchdown that Moss scores. He considers 1000 points or more to be a good game. Dana can use a linear inequality to check whether certain combinations of yardage and touchdowns, such as those in the table, result in 1000 points or more.

<table>
<thead>
<tr>
<th>Game</th>
<th>Yards</th>
<th>TDs</th>
</tr>
</thead>
<tbody>
<tr>
<td>Game 1</td>
<td>168</td>
<td>3</td>
</tr>
<tr>
<td>Game 2</td>
<td>144</td>
<td>2</td>
</tr>
<tr>
<td>Game 3</td>
<td>136</td>
<td>1</td>
</tr>
</tbody>
</table>

Graphing Inequalities

A linear inequality resembles a linear equation, but with an inequality symbol instead of an equals symbol. For example, $y \leq 2x + 1$ is a linear inequality and $y = 2x + 1$ is the related linear equation.

The graph of $y = 2x + 1$ separates the coordinate plane into two regions. The line is the boundary of each region. The graph of the inequality $y \leq 2x + 1$ is the shaded region. Every point in the shaded region satisfies the inequality. The graph of $y = 2x + 1$ is drawn as a solid line to show that points on the line satisfy the inequality. If the inequality symbol were $<$ or $>$, then points on the boundary would not satisfy the inequality, so the boundary would be drawn as a dashed line.

You can graph an inequality by following these steps.

Step 1 Determine whether the boundary should be solid or dashed.

Graph the boundary.

Step 2 Choose a point not on the boundary and test it in the inequality.

Step 3 If a true inequality results, shade the region containing your test point.

If a false inequality results, shade the other region.
Inequalities can sometimes be used to model real-world situations.

**Example 2** Solid Boundary

**BUSINESS** A mail-order company is hiring temporary employees to help in their packing and shipping departments during their peak season.

a. Write an inequality to describe the number of employees that can be assigned to each department if the company has 20 temporary employees available.

Let \( p \) be the number of employees assigned to packing and let \( s \) be the number assigned to shipping. Since the company can assign at most 20 employees total to the two departments, use \( p \leq 20 \) and \( s \leq 20 \).

b. Graph the inequality.

Since the inequality symbol is \( \leq \), the graph of the related linear equation \( p + s = 20 \) is solid. This is the boundary of the inequality.

Test \((0, 0)\).

\[
p + s = 20 \\
0 + 0 = 20 \\
0 \leq 20
\]

Shade the region that contains \((0, 0)\). Since the variables cannot be negative, shade only the part in the first quadrant.

c. Can the company assign 8 employees to packing and 10 employees to shipping?

The point \((8, 10)\) is in the shaded region, so it satisfies the inequality. The company can assign 8 employees to packing and 10 to shipping.

**GRAPH ABSOLUTE VALUE INEQUALITIES** Graphing absolute value inequalities is similar to graphing linear inequalities. The inequality symbol determines whether the boundary is solid or dashed, and you can test a point to determine which region to shade.

**Example 3** Absolute Value Inequality

Graph \( y < |x| + 1 \).

Since the inequality symbol is \(<\), the graph of the related equation \( y = |x| + 1 \) is dashed. Graph the equation.

Test \((0, 0)\).

\[
y < |x| + 1 \\
0 < |0| + 1 \\
0 < 0 + 1 \\
0 < 1
\]

Shade the region that includes \((0, 0)\).
Chapter 2  Linear Relations and Functions

Open-Ended Assessment

Speaking  Have students explain how to tell just from looking at an inequality with \( y \) alone on the left whether the shaded area will be below or above the boundary, as well as whether the boundary is solid or dashed.

Assessment Options

Quiz (Lesson 2-7) is available on p. 114 of the Chapter 2 Resource Masters.

Answers

2. Substitute the coordinates of a point not on the boundary into the inequality. If the inequality is satisfied, shade the region containing the point. If the inequality is not satisfied, shade the region that does not contain the point.

44.

45.

46.

47.

Graph each inequality. 13–30. See pp. 107A–107H.

13. \( x + y < -5 \)
14. \( 3 \geq x - 3y \)
15. \( y > 6x - 2 \)
16. \( x - 5 \leq y \)
17. \( y \geq -4x + 3 \)
18. \( y - 2 < 3x \)
19. \( y \geq 1 \)
20. \( y + 1 < 4 \)
21. \( 4x - 5y - 10 \leq 0 \)
22. \( x - 6y + 3 > 0 \)
23. \( y > \frac{1}{3}x + 5 \)
24. \( y \geq \frac{1}{3}x - 5 \)
25. \( y \geq \frac{|x|}{2} \)
26. \( y > \frac{4x}{3} \)
27. \( y + \frac{|x|}{3} < 3 \)
28. \( y \geq \frac{|x - 1| - 2}{3} \)
29. \( |x + y| > 1 \)
30. \( |x| \leq |y| \)

31. Graph all the points on the coordinate plane to the left of the graph of \( x = -2 \). Write an inequality to describe these points. \( x < -2 \)
32. Graph all the points on the coordinate plane below the graph of \( y = 3x - 5 \). Write an inequality to describe these points. \( y < 3x - 5 \)


SCHOOL  For Exercises 33 and 34, use the following information.
Rosa’s professor says that the midterm exam will count for 40% of each student’s grade and the final exam will count for 60%. A score of at least 90 is required for an A.

33. The inequality \( 0.4x + 0.6y \geq 90 \) represents this situation, where \( x \) is the midterm score and \( y \) is the final exam score. Graph this inequality. See pp. 107A–107H.
34. If Rosa scores 85 on the midterm and 95 on the final, will she get an A? yes

DRAMA  For Exercises 35–37, use the following information.
Tickets for the Prestonville High School Drama Club’s spring play cost $4 for adults and $3 for students. In order to cover expenses, at least $2000 worth of tickets must be sold.
35. Write an inequality that describes this situation. \( 4a + 3s \geq 2000 \)
36. Graph the inequality. See pp. 107A–107H.
37. If 180 adult and 465 student tickets are sold, will the club cover its expenses? yes
**Finance**

A dividend is a payment from a company to an investor. It is a way to make money on a stock without selling it.

**Maintain Your Skills**


48. D = all reals, R = all integers
49. D = all reals, R = (y | y ≠ 1)
50. D = all reals, R = all nonnegative reals
52. Sample answer: using (4, 6000) and (6, 8000); y = 1000x + 2000

www.algebra2.com/self_check_quiz

**Lesson 2-7**

51. **Sales vs. Experience**

<table>
<thead>
<tr>
<th>Sales ($)</th>
<th>0</th>
<th>2000</th>
<th>4000</th>
<th>6000</th>
<th>8000</th>
<th>10,000</th>
</tr>
</thead>
<tbody>
<tr>
<td>Years</td>
<td>1</td>
<td>2</td>
<td>4</td>
<td>6</td>
<td>7</td>
<td></td>
</tr>
</tbody>
</table>

**Enrichment, p. 98**

Algebraic Proof

The following paragraph states a result you might be asked to prove in a mathematics course. Both of the paragraphs are numbered.

1. Let z be a positive integer.
2. Also, let a = \( \frac{1}{2} + \frac{1}{3} \) be the sum of the squares of the digits of a.
3. Then, a = \( \frac{1}{2} + \frac{1}{3} \) is the sum of the squares of the digits of a if and only if the sum of the squares of the digits of a.
4. In general, if a = \( \frac{1}{2} + \frac{1}{3} \) is the sum of the squares of the digits of a.
5. Consider the numbers a, a = \( \frac{1}{2} + \frac{1}{3} \), a = \( \frac{1}{2} + \frac{1}{3} \).

For the paragraph above, answer the following questions.

1. What is the value of a?
2. What is the value of a?
3. What is the value of a?
4. What is the value of a?

For the paragraph above, answer the following questions.

1. What is the value of a?
2. What is the value of a?
3. What is the value of a?
4. What is the value of a?
Vocabulary and Concept Check

- This alphabetical list of vocabulary terms in Chapter 2 includes a page reference where each term was introduced.
- Assessment A vocabulary test/review for Chapter 2 is available on p. 112 of the Chapter 2 Resource Masters.

Lesson-by-Lesson Review

For each lesson,
- the main ideas are summarized,
- additional examples review concepts, and
- practice exercises are provided.

Vocabulary PuzzleMaker

ELL The Vocabulary PuzzleMaker software improves students’ mathematics vocabulary using four puzzle formats—crossword, scramble, word search using a word list, and word search using clues. Students can work on a computer screen or from a printed handout.

MindJogger Videoquizzes

ELL MindJogger Videoquizzes provide an alternative review of concepts presented in this chapter. Students work in teams in a game show format to gain points for correct answers. The questions are presented in three rounds.

Round 1 Concepts (5 questions)
Round 2 Skills (4 questions)
Round 3 Problem Solving (4 questions)

Lesson-by-Lesson Review

2-1 Relations and Functions

Concept Summary

- A relation is a set of ordered pairs. The domain is the set of all x-coordinates, and the range is the set of all y-coordinates.
- A function is a relation where each member of the domain is paired with exactly one member of the range.

Example

Graph the relation (−3, 1), (0, 2), (2, 5) and find the domain and range. Then determine whether the relation is a function.

The domain is {−3, 0, 2}, and the range is {1, 2, 5}.

Graph the ordered pairs. Since each x value is paired with exactly one y value, the relation is a function.

Some students may need help in deciding which tabs to use. Ask student volunteers to share the thinking process they used to decide where various material should go. Remind students that their notations should be complete sentences that will make sense when they are reviewed weeks later.

Encourage students to refer to their Foldables while completing the Study Guide and Review and to use them in preparing for the Chapter Test.
Exercises  Graph each relation or equation and find the domain and range. Then determine whether the relation or equation is a function. See Examples 1 and 2 on pages 57 and 58. 9–12. See margin for graphs.

9. \{(-3, 1), (-2, 2), (-1, 3), (0, 4), (1, 5)\} 10. \{(-5, 2), (2, 4), (1, 1), (-5, -2)\}

11. \(y = 0.5x^3\)  \(D = \text{all reals, } R = \text{all reals}; \text{yes}\)

12. \(y = 2x + 1\)  \(D = \text{all reals, } R = \text{all reals}; \text{yes}\)

Find each value if \(f(x) = 5x - 9\). See Example 5 on page 59.

13. \(f(6) = 21\)  14. \(f(-2) = -19\)  15. \(f(y) = 5y - 9\)  16. \(f(-2v) = -10v - 9\)

9. \(D = \{-2, 2, 6\}, R = \{1, 3\}; \text{yes}\)

10. \(D = \{-5, 1, 2\}, R = \{-2, 1, 2, 4\}; \text{no}\)

2-2  Linear Equations

Concept Summary

- A linear equation is an equation whose graph is a line. A linear function can be written in the form \(f(x) = mx + b\).
- The standard form of a linear equation is \(Ax + By = C\).

Example

Write \(2x - 6 = y + 8\) in standard form. Identify \(A, B,\) and \(C\).

\[
2x - 6 = y + 8 \quad \text{Original equation}
\]

\[
2x - y = 14 \quad \text{Subtract } y \text{ from each side.}
\]

\[
2x = 14 + y \quad \text{Add 6 to each side.}
\]

The standard form is \(2x - y = 14\). So, \(A = 2, B = -1, \) and \(C = 14\).

Exercises  State whether each equation or function is linear. Write yes or no. If no, explain your reasoning. See Example 1 on page 63.

17. \(3x^2 - y = 6\)  \(\text{No; } x \text{ has an exponent other than 1.}\)

18. \(2x + y = 11\)  \(\text{yes}\)

19. \(f(x) = \sqrt{2x + 1}\)  \(\text{No; } x \text{ is inside a square root.}\)

Write each equation in standard form. Identify \(A, B,\) and \(C\). See Example 3 on page 64.

20. \(y = 7x + 15\)  21. \(0.5x = -0.2y - 0.4\)  22. \(\frac{2}{3}x - \frac{3}{4}y = 6\)

\(7x - y = -15\);  \(7, -1, -15\)

\(5x + 2y = -4\);  \(5, 2, -4\)

\(8x - 9y = 72\);  \(8, -9, 72\)

Find the \(x\)-intercept and the \(y\)-intercept of the graph of each equation. Then graph the equation. See Example 4 on page 65. 23–25. See margin for graphs.

23. \(-\frac{10}{3}y = x + 4\)  \(-4, -20\)

24. \(6x = -12y + 48\)  \(8, 4\)

25. \(y - x = -9\)  \(9, -9\)

2-3  Slope

Concept Summary

- The slope of a line is the ratio of the change in \(y\)-coordinates to the corresponding change in \(x\)-coordinates.

\[
m = \frac{y_2 - y_1}{x_2 - x_1}
\]

- Lines with the same slope are parallel. Lines with slopes that are opposite reciprocals are perpendicular.
Study Guide and Review

Chapter 2  Study Guide and Review

Answers

29. (y-3)/(x-2) = 1/3

30. (y-1)/(x-4) = -1/3

31. (y-2)/(x-3) = -1/2

32. (y-3)/(x-2) = 1/3

33. (y-2)/(x-1) = -2/3

34. (y-1)/(x-3) = 1/4

35. (y-4)/(x-2) = -3/4

Example

Find the slope of the line that passes through (-5, 3) and (7, 9).

\[ m = \frac{y_2 - y_1}{x_2 - x_1} \]

Slope formula

\[ = \frac{9 - 3}{7 - (-5)} \]

\[ = \frac{6}{12} \text{ or } 1/2 \]

Simplify.

Exercises

Find the slope of the line that passes through each pair of points.

26. (6, -3), (6, 7) \[ \frac{5}{6} \]

27. (5, 5.5), (11, -7) \[ -3 \]

28. (-3, 24), (10, -41) \[ -5 \]

Graph the line passing through the given point with the given slope.

Example 2 on page 69. 29–31. See margin.

29. (0, 1), \[ m = 2 \]

30. (3, -2), \[ m = \frac{5}{2} \]

31. (-5, 2), \[ m = -\frac{1}{4} \]

Graph the line that satisfies each set of conditions.

See Examples 4 and 5 on pages 70 and 71. 32–35. See margin.

32. passes through (2, 0), parallel to a line whose slope is 3

33. passes through (-1, -3), perpendicular to a line whose slope is \( \frac{1}{2} \)

34. passes through (4, 1), perpendicular to graph of \( 2x + 3y = 1 \)

35. passes through (-2, 2), parallel to graph of \( -2x + y = 4 \)

2-4 Writing Linear Equations

Concept Summary

- Slope-Intercept Form: \( y = mx + b \)
- Point-Slope Form: \( y - y_1 = m(x - x_1) \)

Example

Write an equation in slope-intercept form for the line through (4, 5) that is parallel to the line through (-1, -3) and (2, -1).

First, find the slope of the given line.

\[ m = \frac{y_2 - y_1}{x_2 - x_1} \]

Slope formula

\[ = \frac{-1 - (-3)}{2 - (-1)} \]

\[ = \frac{2}{3} \]

Simplify.

The parallel line will also have slope \( \frac{2}{3} \).

The parallel line will also have slope \( \frac{2}{3} \).

\[ y - y_1 = m(x - x_1) \]

Point-slope form

\[ y - 5 = \frac{2}{3}(x - 4) \]

\[ (x_1, y_1) = (4, 5), m = \frac{2}{3} \]

\[ y = \frac{2}{3}x + \frac{7}{3} \]

Slope-intercept form

Exercises

Write an equation in slope-intercept form for the line that satisfies each set of conditions.  See Examples 1, 2, and 4 on pages 76-78.

36. slope \( \frac{3}{4} \), passes through (-6, 9) \( y = \frac{3}{4}x + \frac{13}{2} \)

37. passes through (3, -8) and (-3, 2) \( y = \frac{5}{3}x - 3 \)

38. passes through (-1, 2), parallel to the graph of \( x - 3y = 14 \) \( y = \frac{1}{3}x + \frac{7}{3} \)

39. passes through (3, 2), perpendicular to the graph of \( 4x - 3y = 12 \) \( y = \frac{3}{4}x + \frac{17}{4} \)
Modeling Real-World Data: Using Scatter Plots

Concept Summary
- A scatter plot is a graph of ordered pairs of data.
- A prediction equation can be used to predict one of the variables given the other variable.

Example
The table below shows the median weekly earnings for American workers for the period 1985–1999. Predict the median weekly earnings for 2010.

<table>
<thead>
<tr>
<th>Year</th>
<th>1985</th>
<th>1990</th>
<th>1995</th>
<th>1999</th>
<th>2010</th>
</tr>
</thead>
<tbody>
<tr>
<td>Earnings ($)</td>
<td>343</td>
<td>412</td>
<td>479</td>
<td>549</td>
<td>?</td>
</tr>
</tbody>
</table>

Source: U.S. Bureau of Labor Statistics

A scatter plot suggests that any two points could be used to find a prediction equation. Use (1985, 343) and (1990, 412).

\[
m = \frac{y_2 - y_1}{x_2 - x_1} \quad \text{Slope formula}
\]

\[
= \frac{412 - 343}{1990 - 1985} = \frac{69}{5} = 13.8 \quad \text{Simplify.}
\]

\[
y - y_1 = m(x - x_1) \quad \text{Point-slope form}
\]

\[
y - 343 = 13.8(x - 1985) \quad \text{Substitute.}
\]

\[
y = 13.8x - 27,050 \quad \text{Add 343 to each side.}
\]

To predict the earnings for 2010, substitute 2010 for \(x\).

\[
y = 13.8(2010) - 27,050 = 688 \quad \text{Simplify.}
\]

The model predicts median weekly earnings of $688 in 2010.

Exercises
For Exercises 40–42, use the table that shows the number of people below the poverty level for the period 1980–1998. See Examples 1 and 2 on pages 81 and 82.

40. Draw a scatter plot. See margin.

41. Use two ordered pairs to write a prediction equation.

42. Use your prediction equation to predict the number for 2010. Sample answer: 42.2 million

41. Sample answer using (1980, 29.3) and (1990, 33.6):

\[
y = 0.43x - 822.1
\]

Source: U.S. Census Bureau
### Answers

49. 

50. 

51. 

52. 

53. 

54. 

### 2-6 Special Functions

#### Graph the function $f(x) = 3|x| - 2$.

Identify the domain and range.

The domain is all real numbers. The range is all real numbers greater than or equal to $-2$.

### Exercises

Graph each function. Identify the domain and range.

- **43.** $f(x) = \lfloor x \rfloor - 2$
- **44.** $h(x) = \lfloor 2x - 1 \rfloor$
- **45.** $g(x) = \lfloor x \rfloor + 4$
- **46.** $h(x) = |x - 1| - 7$
- **47.** $f(x) = \begin{cases} 2 & \text{if } x < -1 \\ -x - 1 & \text{if } x \geq -1 \end{cases}$
- **48.** $g(x) = \begin{cases} -2x - 3 & \text{if } x < 1 \\ x - 4 & \text{if } x > 1 \end{cases}$

### 2-7 Graphing Inequalities

#### Concept Summary

You can graph an inequality by following these steps.

1. **Step 1** Determine whether the boundary is solid or dashed. Graph the boundary.
2. **Step 2** Choose a point not on the boundary and test it in the inequality.
3. **Step 3** If a true inequality results, shade the region containing your test point. If a false inequality results, shade the other region.

#### Example

Graph $x + 4y \leq 4$.

Since the inequality symbol is $\leq$, the graph of the boundary should be solid. Graph the equation. Test $(0, 0)$.

- $x + 4y \leq 4$ Original inequality
- $0 + 4(0) \leq 4$ $(x, y) = (0, 0)$
- $0 \leq 4$ Shade the region that contains $(0, 0)$.

### Exercises

Graph each inequality. See Examples 1–3 on pages 96 and 97.

- **49.** $y \leq 3x - 5$
- **50.** $x > y - 1$
- **51.** $0.5x < 4$
- **52.** $2x + y \geq 3$
- **53.** $y \geq |x| + 2$
- **54.** $y > |x - 3|$ 49–54. See margin.
30. Draw a scatter plot, where x represents the number of years since 1995. See margin.
31. Write a prediction equation. Sample answer using (0, 401.6) and (1, 429.6): \( y = 28x + 401.6 \)
32. Predict the amount that will be spent on recreation in 2010. Sample answer: $821.6 billion

**Portfolio Suggestion**

**Introduction** In this chapter, you have graphed many different kinds of functions. The appearances of these graphs were also very different from one another.

**Ask Students** Select one kind of graph that you found difficult to master and explain why you felt this to be the case. Suggest ways that this topic might be presented in a different way to help other students who have the same difficulty.
Part 1  Multiple Choice

Record your answers on the answer sheet provided by your teacher or on a sheet of paper.

1. In the figure, \( \angle B \) and \( \angle BCD \) are right angles. \( BC \) is 9 units, \( AB \) is 12 units, and \( CD \) is 8 units. What is the area, in square units, of \( \triangle ACD? \)
   \[ \begin{align*}
   A & : 36 \\
   B & : 60 \\
   C & : 72 \\
   D & : 135
   \end{align*} \]

2. If \( x + 3 \) is an even integer, then \( x \) could be which of the following?
   \[ \begin{align*}
   A & : -2 \\
   B & : -1 \\
   C & : 0 \\
   D & : 2
   \end{align*} \]

3. What is the slope of the line that contains the points (15, 7) and (6, 4)?
   \[ \begin{align*}
   A & : \frac{1}{4} \\
   B & : \frac{1}{3} \\
   C & : \frac{3}{8} \\
   D & : \frac{2}{3}
   \end{align*} \]

4. In 2000, Matt had a collection of 30 music CDs. Since then he has given away 2 CDs, purchased 6 new CDs, and traded 3 of his CDs to Kashan for 4 of Kashan’s CDs. Since 2000, what has been the percent of increase in the number of CDs in Matt’s collection?
   \[ \begin{align*}
   A & : 3 \% \\
   B & : 10 \% \\
   C & : 14 \frac{2}{7} \% \\
   D & : 16 \frac{2}{3} \%
   \end{align*} \]

5. If the product of \( (2 + 3), (3 + 4), \) and \( (4 + 5) \) is equal to three times the sum of 40 and \( x \), then \( x = \) ______.
   \[ \begin{align*}
   A & : 43 \\
   B & : 65 \\
   C & : 105 \\
   D & : 195
   \end{align*} \]

6. If one side of a triangle is three times as long as a second side and the second side is \( s \) units long, then the length of the third side of the triangle can be \( A \)
   \[ \begin{align*}
   A & : 3s \\
   B & : 4s \\
   C & : 5s \\
   D & : 6s
   \end{align*} \]

7. Which of the following sets of numbers has the property that the product of any two numbers is also a number in the set?
   \[ \begin{align*}
   A & : I only \\
   B & : II only \\
   C & : III only \\
   D & : I and III only
   \end{align*} \]

8. If \( \frac{3 + x}{7 + x} = \frac{3}{7} \), then \( x = \) ______.
   \[ \begin{align*}
   A & : \frac{3}{7} \\
   B & : 3 \\
   C & : 7 \\
   D & : 21
   \end{align*} \]

9. The average (arithmetic mean) of \( r, s, x, \) and \( y \) is 8, and the average of \( x \) and \( y \) is 4. What is the average of \( r \) and \( s? \)
   \[ \begin{align*}
   A & : 4 \\
   B & : 6 \\
   C & : 8 \\
   D & : 12
   \end{align*} \]

---

**Test-Taking Tip**

Questions 1–9  On multiple-choice questions, try to compute the answer first. Then compare your answer to the given answer choices. If you don’t find your answer among the choices, check your calculations.

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**Log On for Test Practice**

The Princeton Review offers additional test-taking tips and practice problems at their web site. Visit www.princetonreview.com or www.review.com

**TestCheck and Worksheet Builder**

Special banks of standardized test questions similar to those on the SAT, ACT, TIMSS 8, NAEP 8, and Algebra 1 End-of-Course tests can be found on this CD-ROM.

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Additional Practice

See pp. 117–118 in the Chapter 2 Resource Masters for additional standardized test practice.
10. If \( n \) is a prime integer such that \( 2n > 19 \), \( \geq \frac{7}{8}n \), what is one possible value of \( n \)?

11. If \( \overline{AC} = 2 \) units, what is the value of \( t \)? \( \frac{1}{4} \) or \( .25 \)

12. If \( 0.85x = 8.5 \), what is the value of \( \frac{1}{x} \)? \( \frac{1}{10} \) or \( .1 \)

13. In \( \triangle ABC \), what is the value of \( \frac{w+x+y+z}{4} \)? \( 240 \)

14. In an election, a total of 4000 votes were cast for three candidates, \( A \), \( B \), and \( C \). Candidate \( C \) received 800 votes. If candidate \( B \) received more votes than candidate \( C \), and candidate \( A \) received more votes than candidate \( B \), what is the least number of votes that candidate \( A \) could have received? \( 1601 \)

15. If the points \( P(-2, 3) \), \( Q(2, 5) \), and \( R(2, 3) \) are vertices of a triangle, what is the area of the triangle? \( 4 \)

16. How many of the first one hundred positive integers contain the digit \( 7 \)? \( 19 \)

17. A triangle has a base of length 17, and the other two sides are equal in length. If the lengths of the sides of the triangle are integers, what is the shortest possible length of a side? \( 9 \)

Part 3 Quantitative Comparison

Compare the quantity in Column A and the quantity in Column B. Then determine whether:

- the quantity in Column A is greater,
- the quantity in Column B is greater,
- the two quantities are equal, or
- the relationship cannot be determined from the information given.

18. \( m \) is an integer greater than 3. \( A \)

<table>
<thead>
<tr>
<th>Column A</th>
<th>Column B</th>
</tr>
</thead>
<tbody>
<tr>
<td>( \frac{1}{4} )</td>
<td>( \frac{1}{m} - \frac{1}{4} )</td>
</tr>
</tbody>
</table>

19. \( \triangle ABC \)

<table>
<thead>
<tr>
<th>the ( x )-coordinate of point ( Q )</th>
<th>the ( y )-coordinate of point ( P )</th>
</tr>
</thead>
<tbody>
<tr>
<td>( o )</td>
<td>( t )</td>
</tr>
</tbody>
</table>

20. The cost of 3 bananas and 2 apples is $1.50. \( D \)

<table>
<thead>
<tr>
<th>cost of one apple</th>
<th>cost of one banana</th>
</tr>
</thead>
<tbody>
<tr>
<td>( c )</td>
<td>( b )</td>
</tr>
</tbody>
</table>

21. The average (arithmetic mean) of three integers, \( x \), \( y \), and \( z \) is 30. \( B \)

<table>
<thead>
<tr>
<th>the average (arithmetic mean) of ( x ), ( y ), and ( z )</th>
<th>30</th>
</tr>
</thead>
</table>

22. \( \triangle ABC \)

<table>
<thead>
<tr>
<th>the slope of line ( m )</th>
<th>1</th>
</tr>
</thead>
</table>
2. Sample answer:

7. $D = \{7\}$,
   $R = \{-1, 2, 5, 8\}$, no

8. $D = \{3, 4, 6\}$,
   $R = \{2.5\}$, yes

9. $D$ = all reals,
   $R$ = all reals, yes

10. $D = \{x | x \geq 0\}$,
     $R = \{x\}$, no

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American League Leaders

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Stock Price

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30+ Years of Service

45. Each domain value is paired with only one range value so the relation is a function, but the range value 12 is paired with two domain values so the function is not one-to-one.

Pages 65–67, Lesson 2-2

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Pages 71–74, Lesson 2-3

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53. The grade or steepness of a road can be interpreted mathematically as a slope. Answers should include the following.

- Think of the diagram at the beginning of the lesson as being in a coordinate plane. Then the rise is a change in $y$-coordinates and the horizontal distance is a change in $x$-coordinates. Thus, the grade is a slope expressed as a percent.

- Sample answer using $(2000, 11.0)$ and $(3000, 9.1)$: $\frac{y}{11002} = 0.0019\frac{x}{14.8}$

- Sample answer: 5.3°C

4a. Atmospheric Temperature

4b. Sample answer using $(2000, 11.0)$ and $(3000, 9.1)$: $y = -0.0019x + 14.8$

4c. Sample answer: 5.3°C

5a. Cable Television

5b. Sample answer using $(1992, 57)$ and $(1998, 67)$: $y = 1.67x - 3269.64$

5c. Sample answer: about 87 million
13. Sample answer: Using the data for August and November, a prediction equation for Company 1 is $y = -0.86x + 25.13$, where $x$ is the number of months since August. The negative slope suggests that the value of Company 1’s stock is going down. Using the data for October and November, a prediction equation for Company 2 is $y = 0.38x + 31.3$, where $x$ is the number of months since August. The positive slope suggests that the value of Company 2’s stock is going up. Since the value of Company 1’s stock appears to be going down, and the value of Company 2’s stock appears to be going up, Della should buy Company 2.

14. No. Past performance is no guarantee of the future performance of a stock. Other factors that should be considered include the companies’ earnings data and how much debt they have.
A step function can be used to model the cost of a letter in terms of its weight. Answers should include the following.

- Since the cost of a letter must be one of the values $0.34, 0.55, 0.76, 0.97, \text{ and so on, a step function is the best model for the cost of mailing a letter. The gas mileage of a car can be any real number in an interval of real numbers, so it cannot be modeled by a step function. In other words, gas mileage is a continuous function of time.}
41. Linear inequalities can be used to track the performance of players in fantasy football leagues. Answers should include the following.

- Let \( x \) be the number of receiving yards and let \( y \) be the number of touchdowns. The number of points Dana gets from receiving yards is \( 5x \) and the number of points he gets from touchdowns is \( 100y \). His total number of points is \( 5x + 100y \). He wants at least 1000 points, so the inequality \( 5x + 100y \geq 1000 \) represents the situation.
47. \( D = \text{all reals,} \)  
    \( R = \{ y | y \leq 0 \text{ or } y = 2 \} \)

48. \( D = \{ x | x \neq 1 \}, \)  
    \( R = \{ y | y > -5 \} \)

Page 105, Chapter 2 Practice Test

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