**Consumable Workbooks**

Many of the worksheets contained in the Chapter Resource Masters booklets are available as consumable workbooks in both English and Spanish.

- **Study Guide and Intervention Workbook** 0-07-860162-2
- **Study Guide and Intervention Workbook (Spanish)** 0-07-860168-1
- **Practice: Skills Workbook** 0-07-860163-0
- **Practice: Skills Workbook (Spanish)** 0-07-860169-X
- **Practice: Word Problems Workbook** 0-07-860164-9
- **Practice: Word Problems Workbook (Spanish)** 0-07-860170-3
- **Reading to Learn Mathematics Workbook** 0-07-861062-1

**Answers for Workbooks** The answers for Chapter 4 of these workbooks can be found in the back of this Chapter Resource Masters booklet.

**Spanish Assessment Masters** Spanish versions of forms 2A and 2C of the Chapter 4 Test are available in the *Glencoe Mathematics: Applications and Concepts Spanish Assessment Masters, Course 3* (0-07-860172-X).
Teacher’s Guide to Using the
Chapter 4 Resource Masters

The Fast File Chapter Resource system allows you to conveniently file the resources you use most often. The Chapter 4 Resource Masters includes the core materials needed for Chapter 4. These materials include worksheets, extensions, and assessment options. The answers for these pages appear at the back of this booklet.

All of the materials found in this booklet are included for viewing and printing in the Glencoe Mathematics: Applications and Concepts, Course 3, TeacherWorks CD-ROM.

Vocabulary Builder Pages vii-viii include a student study tool that presents up to twenty of the key vocabulary terms from the chapter. Students are to record definitions and/or examples for each term. You may suggest that students highlight or star the terms with which they are not familiar.

When to Use Give these pages to students before beginning Lesson 4-1. Encourage them to add these pages to their mathematics study notebook. Remind them to add definitions and examples as they complete each lesson.

Family Letter and Family Activity Page ix is a letter to inform your students’ families of the requirements of the chapter. The family activity on page x helps them understand how the mathematics students are learning is applicable to real life.

When to Use Give these pages to students to take home before beginning the chapter.

Study Guide and Intervention There is one Study Guide and Intervention master for each lesson in Chapter 4.

When to Use Use these masters as reteaching activities for students who need additional reinforcement. These pages can also be used in conjunction with the Student Edition as an instructional tool for students who have been absent.

Practice: Skills There is one master for each lesson. These provide practice that more closely follows the structure of the Practice and Applications section of the Student Edition exercises.

When to Use These provide additional practice options or may be used as homework for second day teaching of the lesson.

Practice: Word Problems There is one master for each lesson. These provide practice in solving word problems that apply the concepts of the lesson.

When to Use These provide additional practice options or may be used as homework for second day teaching of the lesson.

Reading to Learn Mathematics One master is included for each lesson. The first section of each master asks questions about the opening paragraph of the lesson in the Student Edition. Additional questions ask students to interpret the context of and relationships among terms in the lesson. Finally, students are asked to summarize what they have learned using various representation techniques.

When to Use This master can be used as a study tool when presenting the lesson or as an informal reading assessment after presenting the lesson. It is also a helpful tool for ELL (English Language Learner) students.
Enrichment  There is one extension master for each lesson. These activities may extend the concepts in the lesson, offer an historical or multicultural look at the concepts, or widen students’ perspectives on the mathematics they are learning. These are not written exclusively for honors students, but are accessible for use with all levels of students.

When to Use  These may be used as extra credit, short-term projects, or as activities for days when class periods are shortened.

Assessment Options
The assessment masters in the Chapter 4 Resources Masters offer a wide range of assessment tools for intermediate and final assessment. The following lists describe each assessment master and its intended use.

Chapter Assessment

Chapter Tests

• Form 1 contains multiple-choice questions and is intended for use with basic level students.

• Forms 2A and 2B contain multiple-choice questions aimed at the average level student. These tests are similar in format to offer comparable testing situations.

• Forms 2C and 2D are composed of free-response questions aimed at the average level student. These tests are similar in format to offer comparable testing situations. Grids with axes are provided for questions assessing graphing skills.

• Form 3 is an advanced level test with free-response questions. Grids without axes are provided for questions assessing graphing skills.

All of the above tests include a free-response Bonus question.

• The Extended-Response Assessment includes performance assessment tasks that are suitable for all students. A scoring rubric is included for evaluation guidelines. Sample answers are provided for assessment.

• A Vocabulary Test, suitable for all students, includes a list of the vocabulary words in the chapter and ten questions assessing students’ knowledge of those terms. This can also be used in conjunction with one of the chapter tests or as a review worksheet.

Intermediate Assessment

• Four free-response quizzes are included to offer assessment at appropriate intervals in the chapter.

• A Mid-Chapter Test provides an option to assess the first half of the chapter. It is composed of both multiple-choice and free-response questions.

Continuing Assessment

• The Cumulative Review provides students an opportunity to reinforce and retain skills as they proceed through their study of Glencoe Mathematics: Applications and Concepts, Course 3. It can also be used as a test. This master includes free-response questions.

• The Standardized Test Practice offers continuing review of pre-algebra concepts in various formats, which may appear on the standardized tests that they may encounter. This practice includes multiple-choice, short response, grid-in, and extended response questions. Bubble-in and grid-in answer sections are provided on the master.

Answers

• Page A1 is an answer sheet for the Standardized Test Practice questions that appear in the Student Edition on pages 202–203. This improves students’ familiarity with the answer formats they may encounter in test taking.

• Detailed rubrics for assessing the extended response questions on page 203 are provided on page A2.

• The answers for the lesson-by-lesson masters are provided as reduced pages with answers appearing in red.

• Full-size answer keys are provided for the assessment masters in this booklet.
This is an alphabetical list of new vocabulary terms you will learn in Chapter 4. As you study the chapter, complete each term’s definition or description. Remember to add the page number where you found the term. Add this page to your math study notebook to review vocabulary at the end of the chapter.

<table>
<thead>
<tr>
<th>Vocabulary Term</th>
<th>Found on Page</th>
<th>Definition/Description/Example</th>
</tr>
</thead>
<tbody>
<tr>
<td>congruent</td>
<td></td>
<td></td>
</tr>
<tr>
<td>corresponding parts</td>
<td></td>
<td></td>
</tr>
<tr>
<td>cross products</td>
<td></td>
<td></td>
</tr>
<tr>
<td>dilation</td>
<td>[deye-LAY-shuhn]</td>
<td></td>
</tr>
<tr>
<td>indirect measurement</td>
<td></td>
<td></td>
</tr>
<tr>
<td>polygon</td>
<td></td>
<td></td>
</tr>
<tr>
<td>proportion</td>
<td></td>
<td></td>
</tr>
<tr>
<td>rate</td>
<td></td>
<td></td>
</tr>
<tr>
<td>rate of change</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Vocabulary Term</td>
<td>Found on Page</td>
<td>Definition/Description/Example</td>
</tr>
<tr>
<td>-----------------</td>
<td>--------------</td>
<td>--------------------------------</td>
</tr>
<tr>
<td>ratio</td>
<td></td>
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<tr>
<td>rise</td>
<td></td>
<td></td>
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<tr>
<td>run</td>
<td></td>
<td></td>
</tr>
<tr>
<td>scale</td>
<td></td>
<td></td>
</tr>
<tr>
<td>scale drawing</td>
<td></td>
<td></td>
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<tr>
<td>scale factor</td>
<td></td>
<td></td>
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<tr>
<td>scale model</td>
<td></td>
<td></td>
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<tr>
<td>similar</td>
<td></td>
<td></td>
</tr>
<tr>
<td>slope</td>
<td></td>
<td></td>
</tr>
<tr>
<td>unit rate</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Dear Parent or Guardian:

“When am I ever going to use this stuff?” Students in math classes often ask this question. Too often, math seems to be a series of procedures that one learns and then uses to solve a particular type of problem—without having any application to the real world. In our math class, however, we try to take mathematics beyond the classroom to a point where students will realize and appreciate its importance in their daily lives.

In Chapter 4, Proportions, Algebra, and Geometry, your child will learn about ratios, rates, and proportions. Your child will also learn about slope as a rate of change and will find the slope of a line. In addition, your child will learn to make scale models and use indirect measurement. In the study of this chapter, your child will complete a variety of daily classroom assignments and activities and possibly produce a chapter project.

By signing this letter and returning it with your child, you agree to encourage your child by getting involved. Enclosed is an activity that you can do with your child that also relates the math we will be learning in Chapter 4 to the real world. You may also wish to log on to the Online Study Tools for self-check quizzes, Parent and Student Study Guide pages, and other study help at www.msmath3.net. If you have any questions or comments, feel free to contact me at school.

Sincerely,

Signature of Parent or Guardian ______________________________________ Date ________
Scale Drawings and Models

Work with a family member. Below is a scale drawing of a house plan. The scale for the drawing is \( \frac{1}{2} \) inch = 3 feet. Use the drawing to answer the following questions. You will need a ruler to complete this activity.

1. What are the dimensions of the kitchen in the drawing?
2. What are the dimensions of the kitchen in real life?
3. What is the area of Bedroom 2 in the drawing?
4. What is the area of Bedroom 2 in real life?
5. How many square feet of carpet will be needed to carpet the living room and the hallway?
A ratio is a comparison of two numbers by division. Since a ratio can be written as a fraction, it can be simplified.

**EXAMPLE 1** Express 35 wins to 42 losses in simplest form.

\[
\frac{35}{42} = \frac{5}{6}
\]

Divide the numerator and denominator by the greatest common factor, 7.

The ratio in simplest form is \(\frac{5}{6}\) or 5:6.

**EXAMPLE 2** Express 1 foot to 3 inches in simplest form.

To simplify a ratio involving measurements, both quantities must have the same unit of measure.

\[
\frac{1 \text{ foot}}{3 \text{ inches}} = \frac{12 \text{ inches}}{3 \text{ inches}}
\]

Convert 1 foot to 12 inches.

\[
= \frac{4 \text{ inches}}{1 \text{ inch}}
\]

Divide the numerator and denominator by 3.

The ratio in simplest form is \(\frac{4}{1}\) or 4:1.

A rate is a ratio that compares two quantities with different types of units. A unit rate is a rate with a denominator of 1.

**EXAMPLE 3** Express 309 miles in 6 hours as a unit rate.

\[
\frac{309 \text{ miles}}{6 \text{ hours}} = \frac{51.5 \text{ miles}}{1 \text{ hour}}
\]

Divide the numerator and denominator by 6 to get a denominator of 1.

The unit rate is 51.5 miles per hour.

**EXERCISES**

Express each ratio in simplest form.

1. 3 out of 9 students
2. 8 passengers:2 cars
3. 5 out of 10 dentists
4. 35 boys:60 girls
5. 18 red apples to 42 green apples
6. 50 millimeters to 1 meter

Express each rate as a unit rate.

7. 12 waves in 2 hours
8. 200 miles in 4 hours
9. 21 gallons in 2.4 minutes
10. $12 for 4.8 pounds
11. $49,500 in 12 months
12. 112 feet in 5 seconds
Express each ratio in simplest form.

1. 15 cats:50 dogs
2. 18 adults to 27 teens
3. 27 nurses to 9 doctors
4. 12 losses in 32 games
5. 50 centimeters:1 meter
6. 1 foot:1 yard
7. 22 players:2 teams
8. $28:8 pounds
9. 8 completions:12 passes
10. 21 hired out of 105 applicants
11. 18 hours out of 1 day
12. 64 boys to 66 girls
13. 66 miles on 4 gallons
14. 48 wins:18 losses
15. 112 peanuts:28 cashews
16. 273 miles in 6 hours

Express each rate as a unit rate.

17. 96 students in 3 buses
18. $9,650 for 100 shares of stock
19. $21.45 for 13 gallons of gasoline
20. 125 meters in 10 seconds
21. 30.4 pounds of tofu in 8 weeks
22. 6.5 inches of rainfall in 13 days
23. 103.68 miles in 7.2 hours
24. $94.99 for 7 pizzas
## Practice: Word Problems

### Ratios and Rates

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>1. COOKING</strong></td>
<td>In a bread dough recipe, there are 3 eggs for every 9 cups of flour. Express this ratio in simplest form.</td>
</tr>
<tr>
<td><strong>2. WILDLIFE</strong></td>
<td>Dena counted 14 robins out of 150 birds. Express this ratio in simplest form.</td>
</tr>
<tr>
<td><strong>3. INVESTMENTS</strong></td>
<td>Josh earned dividends of $2.16 on 54 shares of stock. Find the dividends per share.</td>
</tr>
<tr>
<td><strong>4. TRANSPORTATION</strong></td>
<td>When Denise bought gasoline, she paid $18.48 for 11.2 gallons. Find the price of gasoline per gallon.</td>
</tr>
<tr>
<td><strong>5. WATER FLOW</strong></td>
<td>Jacob filled his 60-gallon bathtub in 5 minutes. How fast was the water flowing?</td>
</tr>
<tr>
<td><strong>6. TRAVEL</strong></td>
<td>On her vacation, Charmaine’s flight lasted 4.5 hours. She traveled 954 miles. Find the average speed of the plane.</td>
</tr>
<tr>
<td><strong>7. HOUSING</strong></td>
<td>Mr. And Mrs. Romero bought a 1,200 square-foot house for $111,600. How much did they pay per square foot?</td>
</tr>
<tr>
<td><strong>8. SHOPPING</strong></td>
<td>A breakfast cereal comes in two different sized packages. The 8-ounce box costs $2.88, while the 12-ounce box costs $3.60. Which box is the better buy? Explain your reasoning.</td>
</tr>
</tbody>
</table>
Pre-Activity  Read the introduction at the top of page 156 in your textbook. Write your answers below.

1. Which combination of ingredients would you use to make a smaller amount of the same recipe? Explain.

2. In order to make the same recipe of trail mix, how many scoops of peanuts should you use for every scoop of raisins?

Reading the Lesson

3. What does it mean if the ratio of red marbles to blue marbles is 3 to 5?

4. What is another way to write the ratio 3 to 5?

5. What must you do before you can simplify the ratio 30 minutes to 8 hours? What is the simplified ratio?

Helping You Remember

6. When you go to a bank to exchange money of one currency for another, the bank uses a conversion rate to calculate the amount of money in the new currency. Find out what the current conversion rate is to exchange U.S. dollars to Canadian dollars at a local bank. Then write the rate as a ratio of one currency compared to the other.
Bargain Hunting

Rates are useful and meaningful when expressed as a unit rate. For example, which is the better buy—one orange for $0.29 or 12 oranges for $3.00?

To find the unit rate for 12 oranges, divide $3.00 by 12. The result is $0.25 per orange. If a shopper needs to buy at least 12 oranges, then 12 oranges for $3.00 is the better buy.

For each exercise below, rates are given in Column A and Column B. In the blank next to each exercise number, write the letter of the column that contains the better buy.

<table>
<thead>
<tr>
<th>Column A</th>
<th>Column B</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. _____ 1 apple for $0.19</td>
<td>3 apples for $0.59</td>
</tr>
<tr>
<td>2. _____ 20 pounds of pet food for $14.99</td>
<td>50 pounds of pet food for $37.99</td>
</tr>
<tr>
<td>3. _____ A car that travels 308 miles on 11 gallons of gasoline</td>
<td>A car that travels 406 miles on 14 gallons of gasoline</td>
</tr>
<tr>
<td>4. _____ 10 floppy discs for $8.99</td>
<td>25 floppy discs for $19.75</td>
</tr>
<tr>
<td>5. _____ 1-gallon can of paint for $13.99</td>
<td>5-gallon bucket of paint for $67.45</td>
</tr>
<tr>
<td>6. _____ 84 ounces of liquid detergent for $10.64</td>
<td>48 ounces of liquid detergent for $6.19</td>
</tr>
<tr>
<td>7. _____ 5,000 square feet of lawn food for $11.99</td>
<td>12,500 square feet of lawn food for $29.99</td>
</tr>
<tr>
<td>8. _____ 2 compact discs for $26.50</td>
<td>3 compact discs for $40.00</td>
</tr>
<tr>
<td>9. _____ 8 pencils for $0.99</td>
<td>12 pencils for $1.49</td>
</tr>
<tr>
<td>10. _____ 1,000 sheets of computer paper for $8.95</td>
<td>5,000 sheets of computer paper for $41.99</td>
</tr>
</tbody>
</table>
EXAMPLE 1 INCOME The graph shows Mr. Jackson’s annual income between 1994 and 2002. Find the rate of change in Mr. Jackson’s income between 1994 and 1997.

Use the formula for the rate of change.
Let \((x_1, y_1) = (1994, 48,500)\) and \((x_2, y_2) = (1997, 53,000)\).

\[
\frac{y_2 - y_1}{x_2 - x_1} = \frac{53,000 - 48,500}{1997 - 1994}
\]

Write the formula for rate of change.
\[
= \frac{4,500}{3}
\]

\[
= 1,500
\]

Express this rate as a unit rate.

Between 1994 and 1997, Mr. Jackson’s income increased an average of $1,500 per year.

EXERCISES SURF For Exercises 1–3, use the graph that shows the average daily wave height as measured by an ocean buoy over a nine-day period.

1. Find the rate of change in the average daily wave height between day 1 and day 3.

2. Find the rate of change in the average daily wave height between day 3 and day 7.

3. Find the rate of change in the average daily wave height between day 7 and day 9.
Practice: Skills

Rate of Change

TEMPERATURE  Use the table below that shows the high temperature of a city for the first part of August.

<table>
<thead>
<tr>
<th>Date</th>
<th>1</th>
<th>5</th>
<th>14</th>
<th>15</th>
</tr>
</thead>
<tbody>
<tr>
<td>High Temperature (°F)</td>
<td>85</td>
<td>93</td>
<td>102</td>
<td>102</td>
</tr>
</tbody>
</table>

1. Find the rate of change in the high temperature between August 1 and August 5.

2. Find the rate of change in the high temperature between August 5 and August 14.

3. During which of these two time periods did the high temperature rise faster?

4. Find the rate of change in the high temperature between August 14 and August 15. Then interpret its meaning.

COMPANY GROWTH  Use the graph that shows the number of employees at a company between 1994 and 2002.

5. Find the rate of change in the number of employees between 1994 and 1996.

6. Find the rate of change in the number of employees between 1996 and 1999.

7. During which of these two time periods did the number of employees grow faster?

8. Find the rate of change in the number of employees between 1999 and 2002. Then interpret its meaning.
ELECTIONS  For Exercises 1–3, use the table that shows the total number of people who had voted in District 5 at various times on election day.

<table>
<thead>
<tr>
<th>Time</th>
<th>8:00 A.M.</th>
<th>10:00 A.M.</th>
<th>1:00 P.M.</th>
<th>4:30 P.M.</th>
<th>7:00 P.M.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of Voters</td>
<td>141</td>
<td>351</td>
<td>798</td>
<td>1,008</td>
<td>1,753</td>
</tr>
</tbody>
</table>

1. Find the rate of change in the number of voters between 8:00 A.M. and 10:00 A.M. Then interpret its meaning.

2. Find the rate of change in the number of voters between 10:00 A.M. and 1:00 P.M. Then interpret its meaning.

3. During which of these two time periods did the number of people who had voted so far increase faster? Explain your reasoning.

4. MUSIC  At the end of 1999, Candace had 47 CDs in her music collection. At the end of 2002, she had 134 CDs. Find the rate of change in the number of CDs in Candace’s collection between 1999 and 2002.

5. FITNESS  In 1992, the price of an annual membership at Mr. Jensen’s health club was $225. In 2002, the price of the same membership was $319.50. Find the rate of change in the price of the annual membership between 1992 and 2002.

6. HIKING  Last Saturday Fumio and Kishi went hiking in the mountains. When they started back at 2:00 P.M., their elevation was 3,560 feet above sea level. At 6:00 P.M., their elevation was 2,390 feet. Find the rate of change of their elevation between 2:00 P.M. and 6:00 P.M. Then interpret its meaning.
Lesson 4–2
Reading to Learn Mathematics
Rate of Change

Pre-Activity Read the introduction at the top of page 160 in your textbook. Write your answers below.

1. By how many bears did Alicia’s collection increase between 1997 and 1999? Between 1999 and 2002?

2. Between which years did Alicia’s collection increase the fastest?

Reading the Lesson

3. What does a rate of change measure on a graph?

4. On a graph, what does it mean when a rate of change is negative?

5. Complete the sentence: When a quantity does not change over a period of time, it is said to have a ________ rate of change.

Helping You Remember

6. Write out in words the formula for finding a rate of change between two data points \((x_1, y_1)\) and \((x_2, y_2)\).
Analyzing Graphs

A graph can be used to represent many real-life situations. Graphs such as these often have time as the dimension on the horizontal axis. By analyzing the rate of change of different parts of a graph, you can draw conclusions about what was happening in the real-life situation at that time.

TRAVEL. The graph at the right represents the speed of a car as it travels along the road. Describe what is happening in the graph.

- At the origin, the car is stopped.
- Where the line shows a fast, positive rate of change, the car is speeding up.
- Then the car is going at a constant speed, shown by the horizontal part of the graph.
- The car is slowing down where the graph shows a negative rate of change.
- The car stops and stays still for a short time. Then it speeds up again. The starting and stopping process repeats continually.

Analyze each graph.

1. Ashley is riding her bicycle along a scenic trail. Describe what is happening in the graph.

2. The graph shows the depth of water in a pond as you travel out from the shore. Describe what is happening in the graph.
Lesson 4

Study Guide and Intervention

Slope

The slope of a line is the ratio of the rise, or vertical change, to the run, or horizontal change.

**EXAMPLE 1** Find the slope of the line in the graph.

Choose two points on the line. The vertical change from point A to point B is 4 units while the horizontal change is 2 units.

\[
\text{slope} = \frac{\text{rise}}{\text{run}} \quad \text{Definition of slope}
\]

\[
= \frac{4}{2} \quad \text{The rise is 4, and the run is 2.}
\]

\[
= 2 \quad \text{Simplify.}
\]

The slope of the line is 2.

**EXAMPLE 2** The points in the table lie on a line. Find the slope of the line.

<table>
<thead>
<tr>
<th>x</th>
<th>-2</th>
<th>1</th>
<th>4</th>
<th>7</th>
</tr>
</thead>
<tbody>
<tr>
<td>y</td>
<td>5</td>
<td>1</td>
<td>-3</td>
<td>-7</td>
</tr>
</tbody>
</table>

\[
\text{slope} = \frac{\text{rise}}{\text{run}} \quad \text{Definition of slope}
\]

\[
= \frac{-4}{3} \quad \text{or} \quad \frac{4}{3}
\]

The slope of the line is \(-\frac{4}{3}\).

**EXERCISES**

Find the slope of each line.

1.  
2.  
3.  

The points given in each table lie on a line. Find the slope of the line.

4.  

<table>
<thead>
<tr>
<th>x</th>
<th>3</th>
<th>5</th>
<th>7</th>
<th>9</th>
</tr>
</thead>
<tbody>
<tr>
<td>y</td>
<td>-1</td>
<td>2</td>
<td>5</td>
<td>8</td>
</tr>
</tbody>
</table>

5.  

<table>
<thead>
<tr>
<th>x</th>
<th>-5</th>
<th>0</th>
<th>5</th>
<th>10</th>
</tr>
</thead>
<tbody>
<tr>
<td>y</td>
<td>4</td>
<td>3</td>
<td>2</td>
<td>1</td>
</tr>
</tbody>
</table>
Find the slope of each line.

1. 

2. 

3. 

4. 

5. 

6. 

The points given in each table lie on a line. Find the slope of the line.

Then graph the line.

7. 

8. 

9. 

10. 

11. 

12. 

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Practice: Word Problems

**Slope**

FLOWERS  For Exercises 1 and 2, use the graph that shows the depth of the water in a vase of flowers over 8 days.

**Long Distance**  For Exercises 3–6, use the graph that compares the costs of long distance phone calls with three different companies.

---

1. Find the slope of the line.

2. Interpret the meaning this slope as a rate of change.

3. Find the slope of the line for Company A. Then interpret this slope as a rate of change.

4. Find the slope of the line for Company B. Then interpret this slope as a rate of change.

5. Find the slope of the line for Company C. Then interpret this slope as a rate of change.

6. Which company charges the least for each additional minute? Explain your reasoning.
Pre-Activity  
Read the introduction at the top of page 166 in your textbook.  
Write your answers below.

1. Pick several pairs of points from those plotted and find the rate of change between them. Write each rate in simplest form.

2. What is true of these rates?

Reading the Lesson

3. Slope can be positive, negative, or zero. For each one of these possibilities draw an example of a line with that kind of slope.

Helping You Remember

4. The slope of a line is defined by the rise compared to the run between any two points on the line. Think about the words rise and run. How can you remember which word represents vertical change and which word represents horizontal change?
Chien-Shiung Wu

American physicist Chien-Shiung Wu (1912–1997) was born in Shanghai, China. In 1936, she came to the United States to further her studies in science. She received her doctorate in physics in 1940 from the University of California, and became known as one of the world’s leading physicists. In 1975, she was awarded the National Medal of Science.

Wu is most famous for an experiment that she conducted in 1957. The outcome of the experiment was considered the most significant discovery in physics in more than seventy years. The exercise below will help you learn some facts about it.

The points given in each table lie on a line. Find the slope of the line. The word or phrase following the solution will complete the statement correctly.

1. | x  | 0 | 1 | 2 | 3 |
<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>y</td>
<td>1</td>
<td>4</td>
<td>7</td>
</tr>
</tbody>
</table>

At the time of the experiment, Wu was a professor at _______?_______.
slope = 3: Columbia University
slope = 1: Stanford University

2. | x  | −2 | −1 | 0 | 1 |
<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>y</td>
<td>3</td>
<td>3</td>
<td>3</td>
</tr>
</tbody>
</table>

The site of the experiment was the _______?______ in Washington, D.C.
slope = 0: National Bureau of Standards
slope = 3: Smithsonian Institution

3. | x  | 0 | 2 | 4 | 6 |
<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>y</td>
<td>2</td>
<td>4</td>
<td>6</td>
</tr>
</tbody>
</table>

The experiment involved a substance called _______?_______.
slope = 2: carbon 14
slope = 1: cobalt 60

4. | x  | −2 | 1 | 4 | 7 |
<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>y</td>
<td>−3</td>
<td>1</td>
<td>5</td>
</tr>
</tbody>
</table>

In the experiment, the substance was cooled to _______?_______.
slope = $\frac{4}{3}$: $-273^\circ C$
slope = $\frac{3}{4}$: $-100^\circ C$
A proportion is an equation that states that two ratios are equivalent. To determine whether a pair of ratios forms a proportion, use cross products. You can also use cross products to solve proportions.

**EXAMPLE 1** Determine whether the pair of ratios \(\frac{20}{24}\) and \(\frac{12}{18}\) forms a proportion.

Find the cross products.

\[
\frac{20}{24} \rightarrow 20 \cdot 12 = 240 \\
\frac{12}{18} \rightarrow 20 \cdot 18 = 360
\]

Since the cross products are not equal, the ratios do not form a proportion.

**EXAMPLE 2** Solve \(\frac{12}{30} = \frac{k}{70}\).

\[
\begin{align*}
12 &= k \\
30 &= 70 & \text{Write the equation.} \\
12 \cdot 70 &= 30 \cdot k & \text{Find the cross products.} \\
840 &= 30k & \text{Multiply.} \\
840 &= 30k \\
30 &= 30 & \text{Divide each side by 30.} \\
28 &= k & \text{Simplify. The solution is 28.}
\end{align*}
\]

**EXERCISES**

Determine whether each pair of ratios forms a proportion.

1. \(\frac{17}{10}, \frac{12}{5}\)  
2. \(\frac{6}{9}, \frac{12}{18}\)  
3. \(\frac{8}{12}, \frac{10}{15}\)

4. \(\frac{7}{15}, \frac{13}{32}\)  
5. \(\frac{7}{9}, \frac{49}{63}\)  
6. \(\frac{8}{24}, \frac{12}{28}\)

7. \(\frac{4}{7}, \frac{12}{71}\)  
8. \(\frac{20}{35}, \frac{30}{45}\)  
9. \(\frac{18}{24}, \frac{3}{4}\)

Solve each proportion.

10. \(\frac{x}{5} = \frac{15}{25}\)  
11. \(\frac{3}{4} = \frac{12}{c}\)  
12. \(\frac{6}{9} = \frac{10}{r}\)

13. \(\frac{16}{24} = \frac{z}{15}\)  
14. \(\frac{5}{8} = \frac{s}{12}\)  
15. \(\frac{14}{t} = \frac{10}{11}\)

16. \(\frac{w}{6} = \frac{2.8}{7}\)  
17. \(\frac{5}{y} = \frac{7}{16.8}\)  
18. \(\frac{x}{18} = \frac{7}{36}\)
Determine whether each pair of ratios forms a proportion.

1. \( \frac{5}{8} : \frac{2}{3} \)
2. \( \frac{7}{3} : \frac{14}{6} \)
3. \( \frac{6}{8} : \frac{9}{12} \)

4. \( \frac{16}{9} : \frac{11}{6} \)
5. \( \frac{55}{10} : \frac{12}{2} \)
6. \( \frac{6}{8} : \frac{15}{20} \)

7. \( \frac{5}{9} : \frac{15}{27} \)
8. \( \frac{3}{18} : \frac{11}{66} \)
9. \( \frac{7}{11} : \frac{15}{23} \)

10. \( \frac{9}{13} : \frac{13}{17} \)
11. \( \frac{3}{42} : \frac{5}{70} \)
12. \( \frac{6}{7} : \frac{36}{49} \)

Solve each proportion.

13. \( \frac{4}{12} = \frac{y}{9} \)
14. \( \frac{6}{18} = \frac{4}{c} \)
15. \( \frac{7}{z} = \frac{84}{12} \)

16. \( \frac{5}{10} = \frac{8}{w} \)
17. \( \frac{x}{9} = \frac{4}{15} \)
18. \( \frac{6}{20} = \frac{y}{5} \)

19. \( \frac{5}{9} = \frac{6}{r} \)
20. \( \frac{8}{n} = \frac{10}{7} \)
21. \( \frac{d}{5} = \frac{12}{80} \)

22. \( \frac{y}{5} = \frac{13}{10} \)
23. \( \frac{2}{28} = \frac{p}{35} \)
24. \( \frac{11}{t} = \frac{100}{11} \)

25. \( \frac{1.2}{m} = \frac{3}{5} \)
26. \( \frac{0.9}{1.5} = \frac{a}{10} \)
27. \( \frac{3}{7} = \frac{k}{4.2} \)

28. \( \frac{6.3}{x} = \frac{18}{5} \)
29. \( \frac{3.6}{9} = \frac{b}{0.5} \)
30. \( \frac{14}{1.5} = \frac{4.2}{y} \)
### Practice: Word Problems

#### Solving Proportions

<table>
<thead>
<tr>
<th><strong>1. USAGE</strong></th>
<th><strong>2. COMPUTERS</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td>A 12-ounce bottle of shampoo lasts Enrique 16 weeks. How long would you expect an 18-ounce bottle of the same brand to last him?</td>
<td>About 13 out of 20 homes have a personal computer. On a street with 60 homes, how many would you expect to have a personal computer?</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th><strong>3. SNACKS</strong></th>
<th><strong>4. TYPING</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td>A 6-ounce package of fruit snacks contains 45 pieces. How many pieces would you expect in a 10-ounce package?</td>
<td>Ingrid types 3 pages in the same amount of time that Tanya types 4.5 pages. If Ingrid and Tanya start typing at the same time, how many pages will Tanya have typed when Ingrid has typed 11 pages?</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th><strong>5. SCHOOL</strong></th>
<th><strong>6. AMUSEMENT PARKS</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td>A grading machine can grade 48 multiple-choice tests in 1 minute. How long will it take the machine to grade 300 tests?</td>
<td>The waiting time to ride a roller coaster is 20 minutes when 150 people are in line. How long is the waiting time when 240 people are in line?</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th><strong>7. PRODUCTION</strong></th>
<th><strong>8. FISH</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td>A shop produces 39 wetsuits every 2 weeks. How long will it take the shop to produce 429 wetsuits?</td>
<td>Of the 50 fish that Jim caught from the lake, 14 were trout. The estimated population of the lake is 7,500 fish. About how many trout would you expect to be in the lake?</td>
</tr>
</tbody>
</table>
Reading to Learn Mathematics

Solving Proportions

Pre-Activity

Read the introduction at the top of page 170 in your textbook. Write your answers below.

1. Write a ratio that compares the number of Calories from fat to the total number of Calories. Write the ratio as a fraction in simplest form.

2. Suppose you plan to eat two such granola bars. Write a ratio comparing the number of Calories from fat to the total number of Calories.

3. Is the ratio of Calories the same for two granola bars as it is for one granola bar? Why or why not?

Reading the Lesson

4. Complete the sentence: If two ratios form a proportion, then the ratios are said to be __________.

5. Do the ratios $\frac{a}{b}$ and $\frac{c}{d}$ always form a proportion? Why or why not?

6. Explain how you can use cross products to solve proportions in which one of the terms is not known.

Helping You Remember

7. For the proportion $\frac{a}{b}$ and $\frac{c}{d}$, why do you think the products $ad$ and $bc$ are called cross products?
People of the United States

A national census is taken every ten years. The 1990 census revealed that there were about 250,000,000 people in the United States, and that about 8 out of 100 of these people were 5–13 years old. To find the number of people in the United States that were 5–13 years old, use the ratio of people 5–13 years old and create a proportion.

\[
\frac{8}{100} = \frac{n}{250,000,000}
\]

To solve the proportion, find cross products.

\[8 \times 250,000,000 = 2,000,000,000 \quad \text{and} \quad n \times 100 = 100n\]

Then divide: \(2,000,000,000 \div 100 = 20,000,000\).

In 1990, about 20,000,000 people in the United States were 5–13 years old.

Use the approximate ratios in each exercise to create a proportion, given that there were about 250,000,000 people in the United States. Then solve and choose the correct answer from the choices at the right.

1. The United States is a diverse collection of different races and ethnic origins. Asians or Pacific Islanders accounted for about \(\frac{3}{100}\) of the population of the United States. About how many people of Asian or Pacific-Island origin lived in the United States? A. 200,000,000
3. People of Hispanic origin accounted for about \(\frac{9}{100}\) of the population of the United States. About how many people of Hispanic origin lived in the United States? C. 7,500,000
4. Caucasian people accounted for about \(\frac{4}{5}\) of the population of the United States. About how many people of white or Caucasian origin lived in the United States? D. 2,000,000
5. People of American-Indian, Eskimo, or Aluet origin accounted for about \(\frac{8}{1,000}\) of the population of the United States. About how many people of American-Indian, Eskimo, or Aluet origin lived in the United States? E. 30,000,000
Lesson 4-5
Study Guide and Intervention
Similar Polygons

Two polygons are **similar** if their corresponding angles are congruent and their corresponding sides are proportional.

**Example 1** Determine whether \( \triangle ABC \) is similar to \( \triangle DEF \). Explain your reasoning.

\[
\angle A \cong \angle D, \quad \angle B \cong \angle E, \quad \angle C \cong \angle F,
\]

\[
\frac{AB}{DE} = \frac{6}{12} \text{ or } \frac{2}{3}, \quad \frac{BC}{EF} = \frac{8}{16} \text{ or } \frac{2}{3}, \quad \frac{AC}{DF} = \frac{8}{16} \text{ or } \frac{2}{3},
\]

The corresponding angles are congruent, and the corresponding sides are proportional.

Thus, \( \triangle ABC \) is similar to \( \triangle DEF \).

**Example 2** Given that polygon \( KLMN \sim \) polygon \( PQRS \), write a proportion to find the measure of \( PQ \). Then solve.

The ratio of corresponding sides from polygon \( KLMN \) to polygon \( PQRS \) is \( \frac{4}{3} \). Write a proportion with this scale factor. Let \( x \) represent the measure of \( PQ \).

\[
\frac{KL}{PQ} = \frac{4}{3} \quad \text{\( KL \) corresponds to \( PQ \). The scale factor is \( \frac{4}{3} \).}
\]

\[
\frac{5}{x} = \frac{4}{3} \quad \text{\( KL = 5 \) and \( PQ = x \)}
\]

\[
5 \cdot 3 = x \cdot 4 \quad \text{Find the cross products.}
\]

\[
\frac{15}{4} = \frac{4x}{4} \quad \text{Multiply. Then divide each side by 4.}
\]

\[
3.75 = x \quad \text{Simplify.}
\]

**Exercises**

1. Determine whether the polygons below are similar. Explain your reasoning.

2. The triangles below are similar. Write a proportion to find each missing measure. Then solve.

---

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Determine whether each pair of polygons is similar. Explain your reasoning.

1. 

2. 

3. 

4. 

5. 

6. 

7. 

8. 

NAME __________________________ DATE ______________ PERIOD _____

Practice: Skills
Similar Polygons
Practice: Word Problems
Similar Polygons

1. **JOURNALISM** The editor of the school newspaper must reduce the size of a graph to fit in one column. The original graph is 2 inches by 2 inches, and the scale factor from the original to the reduced graph is 8:3. Find the dimensions of the graph as it will appear in one column of the newspaper.

2. **PHOTOCOPIES** Lydia plans to use a photocopy machine to increase the size of a small chart that she has made as part of her science project. The original chart is 4 inches by 5 inches. If she uses a scale factor of 5:11, will the chart fit on a sheet of paper $8\frac{1}{2}$ inches by 11 inches? Explain.

3. **MICROCHIPS** The image of a microchip in a projection microscope measures 8 inches by 10 inches. The width of the actual chip is 4 millimeters. How long is the chip?

4. **PROJECTIONS** A drawing on a transparency is 11.25 centimeters wide by 23.5 centimeters tall. The width of the image of drawing projected onto a screen is 2.7 meters. How tall is the drawing on the screen?

5. **GEOMETRY** Polygon $ABCD$ is similar to polygon $FGHI$. Each side of polygon $ABCD$ is $3\frac{3}{4}$ times longer than the corresponding side of polygon $FGHI$. Find the perimeter of polygon $FGHI$.

6. **KITES** A toy company produces two kites whose shapes are geometrically similar. Find the length of the missing side of the smaller kite.

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Pre-Activity  Complete the Mini Lab at the top of page 178 in your textbook. Write your answers below.

1. Compare the angles of the triangles by matching them up. Identify the angle pairs that have equal measure.

2. Express the ratios $\frac{DF}{LK}$, $\frac{EF}{JK}$, and $\frac{DE}{LJ}$ to the nearest tenth.

3. What do you notice about the ratios of the matching sides of matching triangles?

Reading the Lesson

4. Complete the sentence: If two polygons are similar, then their corresponding angles are __________, and their corresponding sides are __________.

5. If two polygons have corresponding angles that are congruent, does that mean that the polygons are similar? Why or why not?

6. If the sides of one square are 3 centimeters and the sides of another square are 9 centimeters, what is the ratio of corresponding sides from the first square to the second square?

Helping You Remember

7. Look up the everyday definition of the word similar in a dictionary. How does the definition relate to what you learned in this lesson?
Similar and Congruent Figures

If a 4-inch by 5-inch photograph is enlarged to an 8-inch by 10-inch photograph, the photographs are said to be **similar**. They have the same shape, but they do not have the same size. If a 4-inch by 5-inch photograph is duplicated and a new 4-inch by 5-inch photograph is made, the photographs are said to be **congruent**. They have the same size and shape.

In each exercise, identify which of the triangles are congruent to each other and identify which of the shapes are similar to each other. Use the symbol for \( \cong \) congruence and the symbol \( \sim \) for similarity.

1. 
   - [Diagram of triangle with labeled vertices]
2. 
   - [Diagram of triangle with labeled vertices]
3. 
   - [Diagram of quadrilateral with labeled vertices]
4. 
   - [Diagram of quadrilateral with labeled vertices]
5. 
   - [Diagram of quadrilateral with labeled vertices]
Study Guide and Intervention

Scale Drawings and Models

Distances on a scale drawing or model are proportional to real-life distances. The scale is determined by the ratio of a given length on a drawing or model to its corresponding actual length.

**EXAMPLE 1**

INTERIOR DESIGN  A designer has made a scale drawing of a living room for one of her clients. The scale of the drawing is 1 inch = $1\frac{1}{3}$ feet. On the drawing, the sofa is 6 inches long. Find the actual length of the sofa.

Let $x$ represent the actual length of the sofa. Write and solve a proportion.

```
Drawing Scale   → Actual Length
1 in. 1 \frac{1}{3} ft
6 in.  \cdot x ft
```

Find the cross products.

```
6 \cdot x = 1 \frac{1}{3} \cdot 8
```

Simplify.

```
x = 8
```

The actual length of the sofa is 8 feet.

To find the scale factor for scale drawings and models, write the ratio given by the scale in simplest form.

**EXAMPLE 2**

Find the scale factor for the drawing in Example 1.

Write the ratio of 1 inch to $1\frac{1}{3}$ feet in simplest form.

```
\frac{1 \text{ in.}}{1 \frac{1}{3} \text{ ft}} = \frac{1 \text{ in.}}{1 \frac{1}{3} \text{ ft}} \cdot \frac{16 \text{ in.}}{16 \text{ in.}}
```

Convert $1\frac{1}{3}$ feet to inches.

The scale factor is $\frac{1}{16}$ or 1:16. This means that each distance on the drawing is $\frac{1}{16}$ the actual distance.

**EXERCISES**

LANDSCAPING  Yutaka has made a scale drawing of his yard. The scale of the drawing is 1 centimeter = 0.5 meter.

1. The length of the patio is 4.5 centimeters in the drawing. Find the actual length.
2. The actual distance between the water faucet and the pear tree is 11.2 meters. Find the corresponding distance on the drawing.
3. Find the scale factor for the drawing.
Practice: Skills

Scale Drawings and Models

ARCHITECTURE The scale on a set of architectural drawings for a house is 1.5 inches = 2 feet. Find the length of each part of the house.

<table>
<thead>
<tr>
<th>Room</th>
<th>Drawing Length</th>
<th>Actual Length</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Living Room</td>
<td>15 inches</td>
<td></td>
</tr>
<tr>
<td>2. Dining Room</td>
<td>10.5 inches</td>
<td></td>
</tr>
<tr>
<td>3. Kitchen</td>
<td>12 3/4 inches</td>
<td></td>
</tr>
<tr>
<td>4. Laundry Room</td>
<td>8 1/4 inches</td>
<td></td>
</tr>
<tr>
<td>5. Hall</td>
<td>13 7/8 inches</td>
<td></td>
</tr>
<tr>
<td>6. Garage</td>
<td>16.5 inches</td>
<td></td>
</tr>
</tbody>
</table>

7. What is the scale factor of these drawings?

TOWN PLANNING For Exercises 8–11, use the following information.

As part of a downtown renewal project, businesses have constructed a scale model of the town square to present to the city commission for its approval. The scale of the model is 1 inch = 7 feet.

8. The courthouse is the tallest building in the town square. If it is 5 1/2 inches tall in the model, how tall is the actual building?

9. The business owners would like to install new lampposts that are each 12 feet tall. How tall are the lampposts in the model?

10. In the model, the lampposts are 3 3/7 inches apart. How far apart will they be when they are installed?

11. What is the scale factor?

12. MAPS On a map, two cities are 6 1/2 inches apart. The actual distance between the cities is 104 miles. What is the scale of the map?
## Practice: Word Problems

### Scale Drawings and Models

**CAMPUS PLANNING** For Exercises 1–3, use the following information.

The local school district has made a scale model of the campus of Engels Middle School including a proposed new building. The scale of the model is 1 inch = 3 feet.

<table>
<thead>
<tr>
<th>Exercise</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>An existing gymnasium is 8 inches tall in the model. How tall is the actual gymnasium?</td>
</tr>
<tr>
<td>2.</td>
<td>The new building is 22.5 inches from the gymnasium in the model. What will be the actual distance from the gymnasium to the new building if it is built?</td>
</tr>
<tr>
<td>3.</td>
<td>What is the scale factor of the model?</td>
</tr>
<tr>
<td>4.</td>
<td>MAPS On a map, two cities are (\frac{53}{4}) inches apart. The scale of the map is (\frac{1}{2}) inch = 3 miles. What is the actual distance between the towns?</td>
</tr>
<tr>
<td>5.</td>
<td>TRUCKS The bed of Jerry’s pickup truck is 6 feet long. On a scale model of the truck, the bed is 8 inches long. What is the scale of the model?</td>
</tr>
<tr>
<td>6.</td>
<td>HOUSING Marta is making a scale drawing of her apartment for a school project. The apartment is 28 feet wide. On her drawing, the apartment is 7 inches wide. What is the scale of Marta’s drawing?</td>
</tr>
</tbody>
</table>
Pre-Activity  
Read the introduction at the top of page 184 in your textbook.  
Write your answers below.

1. How many units wide is the room?

2. The actual width of the room is 18 feet. Write a ratio comparing the drawing width to the actual width.

3. Simplify the ratio you found and compare it to the scale shown at the bottom of the drawing.

Reading the Lesson

4. Give another example of a scale drawing or scale model that is different from the examples of scale drawings and scale models given on pages 184–185 in your textbook.

5. Complete the sentence: distances on a scale model are _________ to distances in real life.

6. What is the scale factor for a model if part of the model that is 4 inches corresponds to a real-life object that is 16 inches?

Helping You Remember

7. Make a scale drawing of a room, such as your classroom or your bedroom. Select an appropriate scale so that your drawing is a reasonable size. Be sure to indicate your scale on your drawing. Use another piece of paper if necessary.
Scale Drawings

The figure at the right has an area of 6 square units. If the figure represented a map, and was drawn to a scale of 1 unit = 3 feet, the lengths of the sides would be 6 ft and 9 ft. So, the figure would represent an area of 54 square feet.

The ratio of the actual area of the figure to the scale area of the figure can be expressed as a ratio.

\[
\frac{\text{actual area}}{\text{scale area}} = \frac{6}{54} = \frac{1}{9} \text{ or } 1 \text{ to } 9
\]

Find the actual area and the scale area of these figures. Then determine the ratio of actual area to scale area.

1. Scale: 1 unit = 4 ft

   actual area _______
   scale area _______
   ratio ____________

2. Scale: 1 unit = 50 cm

   actual area _______
   scale area _______
   ratio ____________

3. Scale: 1 unit = 8 mi

   actual area _______
   scale area _______
   ratio ____________

4. Scale: 1 unit = 12 m

   actual area _______
   scale area _______
   ratio ____________

5. Scale: 1 unit = 18 in.

   actual area _______
   scale area _______
   ratio ____________

6. Scale: 1 unit = 6 km

   actual area _______
   scale area _______
   ratio ____________
**4-7 Study Guide and Intervention**

**Indirect Measurement**

Distances or lengths that are difficult to measure directly can sometimes be found using the properties of similar polygons and proportions. This kind of measurement is called **indirect measurement**.

**EXAMPLE 1**

**LIGHTING** George is standing next to a lightpole in the middle of the day. George’s shadow is 1.5 feet long, and the lightpole’s shadow is 4.5 feet long. If George is 6 feet tall, how tall is the lightpole?

Write a proportion and solve.

George’s shadow \[ \frac{1.5}{h} = \frac{6}{4.5} \] George’s height

lightpole’s shadow \[ \frac{4.5}{h} = \frac{4.5}{6} \] lightpole’s height

Find the cross products.

\[ 1.5h = 27 \] Multiply.

\[ \frac{1.5h}{1.5} = \frac{27}{1.5} \] Divide each side by 1.5.

\[ h = 18 \] Simplify.

The lightpole is 18 feet tall.

**EXERCISES**

1. **MONUMENTS** A statue casts a shadow 30 feet long. At the same time, a person who is 5 feet tall casts a shadow that is 6 feet long. How tall is the statue?

2. **BUILDINGS** A building casts a shadow 72 meters long. At the same time, a parking meter that is 1.2 meters tall casts a shadow that is 0.8 meter long. How tall is the building?

3. **SURVEYING** The two triangles shown in the figure are similar. Find the distance \( d \) across Red River.
Write a proportion and solve the problem.

1. **HEIGHT** How tall is Becky?

2. **FLAGS** How tall is the flagpole?

3. **BEACH** How deep is the water 50 feet from shore?

4. **ACCESSIBILITY** How high is the ramp when it is 2 feet from the building? (Hint: \( \triangle ABE \sim \triangle ACD \))

5. **AMUSEMENT PARKS** The triangles in the figure are similar. How far is the water ride from the roller coaster? Round to the nearest tenth.

6. **CLASS CHANGES** The triangles in the figure are similar. How far is the entrance to the gymnasium from the band room?
1. **HEIGHT** Paco is 6 feet tall and casts a 12-foot shadow. At the same time, Diane casts an 11-foot shadow. How tall is Diane?

2. **LIGHTING** If a 25-foot-tall house casts a 75-foot shadow at the same time that a streetlight casts a 60-foot shadow, how tall is the streetlight?

3. **FLAGPOLE** Lena is $5\frac{1}{2}$ feet tall and casts an 8-foot shadow. At the same time, a flagpole casts a 48-foot shadow. How tall is the flagpole?

4. **LANDMARKS** A woman who is 5 feet 5 inches tall is standing near the Space Needle in Seattle, Washington; she casts a 13-inch shadow at the same time that the Space Needle casts a 121-foot shadow. How tall is the Space Needle?

5. **NATIONAL MONUMENTS** A 42-foot flagpole near the Washington Monument casts a shadow that is 14 feet long. At the same time, the Washington Monument casts a shadow that is 185 feet long. How tall is the Washington Monument?

6. **ACCESSIBILITY** A ramp slopes upward from the sidewalk to the entrance of a building at a constant incline. If the ramp is 2 feet high when it is 5 feet from the sidewalk, how high is the ramp when it is 7 feet from the sidewalk?
Reading to Learn Mathematics

Indirect Measurement

Pre-Activity  Read the introduction at the top of page 188 in your textbook. Write your answers below.

1. How is the caveman measuring the distance to the Sun?

Reading the Lesson

2. Complete the following sentence.
   When you solve a problem using shadow reckoning, the objects being compared and their shadows form two sides of _______________.

3. Suppose that you are standing near a building and you see the shadows cast by you and the building. If you know the length of each of these shadows and you know how tall you are, write a proportion in words that you can use to find the height of the building.

4. STATUE  If a statue casts a 6-foot shadow and a 5-foot mailbox casts a 4-foot shadow, how tall is the statue?

Helping You Remember

5. Work with a partner. Have your partner draw two triangles that are similar with the lengths of two corresponding sides labeled and the length of one additional side labeled. Tell your partner how to write a proportion to solve for the length of the side corresponding to the additional side labeled.
Indirect Measurement

A proportion can be used to determine the height of tall structures if three variables of the proportion are known. The three known variables are usually the height $a$ of the observer, the length $b$ of the observer’s shadow, and the length $d$ of the structure’s shadow. However, a proportion can be solved given any three of the four variables.

This chart contains information about various observers and tall buildings. Use proportions and your calculator to complete the chart of tall buildings of the world.

<table>
<thead>
<tr>
<th>Height of Observer</th>
<th>Length of Shadow</th>
<th>Building Location</th>
<th>Height of Building</th>
<th>Length of Shadow</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. 5 ft</td>
<td>8 in.</td>
<td>Natwest, London</td>
<td>80 ft</td>
<td></td>
</tr>
<tr>
<td>2. 4 ft 9 in.</td>
<td></td>
<td>Columbia Seafirst Center, Seattle</td>
<td>954 ft</td>
<td>318 ft</td>
</tr>
<tr>
<td>3. 5 ft 10 in.</td>
<td>14 in.</td>
<td>Wachovia Building, Winston-Salem</td>
<td>410 ft</td>
<td></td>
</tr>
<tr>
<td>4.</td>
<td>15 in.</td>
<td>Waterfront Towers, Honolulu</td>
<td>400 ft</td>
<td>83 ft 4 in.</td>
</tr>
<tr>
<td>5. 6 ft</td>
<td></td>
<td>CN Tower, Toronto</td>
<td>1,821 ft</td>
<td>303 ft 6 in.</td>
</tr>
<tr>
<td>6. 5 ft 9 in.</td>
<td>1 ft 11 in.</td>
<td>Gateway Arch, St. Louis</td>
<td>630 ft</td>
<td></td>
</tr>
<tr>
<td>7. 5 ft 3 in.</td>
<td>1 ft 9 in.</td>
<td>Eiffel Tower, Paris</td>
<td>328 ft</td>
<td></td>
</tr>
<tr>
<td>8.</td>
<td>8 in.</td>
<td>Texas Commerce Tower, Houston</td>
<td>1,002 ft</td>
<td>167 ft</td>
</tr>
<tr>
<td>9. 5 ft 6 in.</td>
<td>11 in.</td>
<td>John Hancock Tower, Boston</td>
<td>131 ft 8 in.</td>
<td></td>
</tr>
<tr>
<td>10. 5 ft 4 in.</td>
<td>8 in.</td>
<td>Sears Tower, Chicago</td>
<td>181 ft 9 in.</td>
<td></td>
</tr>
<tr>
<td>11. 5 ft 6 in.</td>
<td></td>
<td>Barnett Tower, Jacksonville</td>
<td>631 ft</td>
<td>105 ft 2 in.</td>
</tr>
</tbody>
</table>
The image produced by enlarging or reducing a figure is called a **dilation**.

**EXAMPLE 1**  
Graph \( \triangle ABC \) with vertices \( A(-2, -1) \), \( B(2, 3) \), and \( C(2, -1) \). Then graph its image \( \triangle A'B'C' \) after a dilation with a scale factor of \( \frac{3}{2} \).

\[
egin{align*}
A(-2, -1) & \rightarrow \left( -2 \cdot \frac{3}{2}, -1 \cdot \frac{3}{2} \right) \rightarrow A'(-3, -\frac{3}{2}) \\
B(2, 3) & \rightarrow \left( 2 \cdot \frac{3}{2}, 3 \cdot \frac{3}{2} \right) \rightarrow B'(3, \frac{3}{2}) \\
C(2, -1) & \rightarrow \left( 2 \cdot \frac{3}{2}, -1 \cdot \frac{3}{2} \right) \rightarrow C'(3, -\frac{3}{2})
\end{align*}
\]

**EXAMPLE 2**  
Segment \( M'N' \) is a dilation of segment \( MN \). Find the scale factor of the dilation and classify it as an **enlargement** or a **reduction**.

Write the ratio of the \( x \)- or \( y \)-coordinate of one vertex of the dilated figure to the \( x \)- or \( y \)-coordinate of the corresponding vertex of the original figure. Use the \( x \)-coordinates of \( N(1, -2) \) and \( N'(2, -4) \).

\[
\frac{x\text{-coordinate of point } N'}{x\text{-coordinate of point } N} = \frac{2}{1} \text{ or } 2
\]

The scale factor is 2. Since the image is larger than the original figure, the dilation is an enlargement.

**EXERCISES**

1. Polygon \( ABCD \) has vertices \( A(2, 4), B(-1, 5), C(-3, -5) \), and \( D(3, -4) \). Find the coordinates of its image after a dilation with a scale factor of \( \frac{1}{2} \). Then graph polygon \( ABCD \) and its dilation.

2. Segment \( P'Q' \) is a dilation of segment \( PQ \). Find the scale factor of the dilation and classify it as an enlargement or a reduction.
4-8 Practice: Skills

Dilations

Find the coordinates of the vertices of triangle $A'B'C'$ after triangle $ABC$ is dilated using the given scale factor. Then graph triangle $ABC$ and its dilation.

1. $A(1, 1), B(1, 3), C(3, 1)$; scale factor 3

2. $A(-2, -2), B(-1, 2), C(2, 1)$; scale factor 2

3. $A(-4, 6), B(2, 6), C(0, 8)$; scale factor $\frac{1}{2}$

4. $A(-3, -2), B(1, 2), C(2, -3)$; scale factor 1.5

Segment $P'Q'$ is a dilation of segment $PQ$. Find the scale factor of the dilation and classify it as an enlargement or a reduction.

5. $P', Q'$

6. $P', Q'$

7. $P', Q'$

8. $P', Q'$
### Practice: Word Problems

**Dilations**

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>1. EYES</strong></td>
<td>Dave’s optometrist used medicine to dilate his eyes. Before dilation, his pupils had a diameter of 4.1 millimeters. After dilation, his pupils had a diameter of 8.2 millimeters. What was the scale factor of the dilation?</td>
</tr>
<tr>
<td><strong>2. BIOLOGY</strong></td>
<td>A microscope increases the size of objects by a factor of 8. How large will a 0.006 millimeter paramecium appear?</td>
</tr>
<tr>
<td><strong>3. PHOTOGRAPHY</strong></td>
<td>A photograph was enlarged to a width of 15 inches. If the scale factor was ( \frac{3}{2} ), what was the width of the original photograph?</td>
</tr>
<tr>
<td><strong>4. MOVIES</strong></td>
<td>Film with a width of 35 millimeters is projected onto a screen where the width is 5 meters. What is the scale factor of this enlargement?</td>
</tr>
<tr>
<td><strong>5. PHOTOCOPYING</strong></td>
<td>A 10-inch long copy of a 2.5-inch long figure needs to be made with a copying machine. What is the appropriate scale factor?</td>
</tr>
<tr>
<td><strong>6. MODELS</strong></td>
<td>A scale model of a boat is going to be made using a scale of ( \frac{1}{50} ). If the original length of the boat is 20 meters, what is the length of the model?</td>
</tr>
<tr>
<td><strong>7. MODELS</strong></td>
<td>An architectural model is 30 inches tall. If the scale used to build the model is ( \frac{1}{120} ), what is the height of the actual building?</td>
</tr>
<tr>
<td><strong>8. ADVERTISING</strong></td>
<td>An advertiser needs a 4-inch picture of a 14-foot automobile. What is the scale factor of the reduction?</td>
</tr>
</tbody>
</table>
Pre-Activity  Complete the Mini Lab at the top of page 194 in your textbook. Write your answers below.

1. Multiply each coordinate by 2 to find the coordinates of points \(A', B',\) and \(C'.\)

2. On the same coordinate plane, graph points \(A', B',\) and \(C'.\) Then draw \(\triangle A'B'C'.\)

3. Determine whether \(\triangle ABC \sim \triangle A'B'C'.\) Explain your reasoning.

Reading the Lesson

4. If you are given the coordinates of a figure and the scale factor of a dilation of that figure, how can you find the coordinates of the new figure?

5. When you graph a figure and its image after a dilation, how can you check your work?

Helping You Remember

6. Complete the table below to help you remember the effects of different scale factors.

<table>
<thead>
<tr>
<th>If the scale factor is</th>
<th>Then the dilation is</th>
</tr>
</thead>
<tbody>
<tr>
<td>between 0 and 1</td>
<td></td>
</tr>
<tr>
<td>greater than 1</td>
<td></td>
</tr>
<tr>
<td>equal to 1</td>
<td></td>
</tr>
</tbody>
</table>
Dilation and Area

A dilation of a shape creates a new shape that is similar to the original. The ratio of the new image to the original is called the **scale factor**.

Plot and draw each shape. Then perform the dilation of each shape using a scale factor of two. After the new image has been drawn, determine the area of both the original shape and its dilation.

1. \(A(2, 1), B(7, 1), C(4, 4)\)
   
   Area of original ________

   Area of dilation ________

2. circle with radius (1, 2) to (4, 2)
   
   Area of original ________

   Area of dilation ________

3. \(R(-3, 2), E(-3, -2), C(4, -2), I(4, 2)\)

   Area of original ________

   Area of dilation ________

4. \(S(-3, 3), Q(-3, -3), A(3, -3), R(3, 3)\)

   Area of original ________

   Area of dilation ________

5. What general statement can be made about the area of a figure when compared to its area after being dilated by scale factor 2?
Write the letter for the correct answer in the blank at the right of each question.

1. Express 4 inches:32 inches in simplest form.
   A. 8:1  B. 1:8  C. 2:16  D. 16:1  1.____

2. Express 18 blue-eyed students to 20 brown-eyed students in simplest form.
   F. 3 to 4  G. 9 to 10  H. 4 to 5  I. 90 to 100  2.____

3. Express 150 tickets for 30 students as a unit rate.
   A. 5 tickets per student  B. \( \frac{1}{5} \) ticket per student
   C. 150 tickets per student  D. \( \frac{1}{30} \) ticket per student  3.____

4. Express 12 miles in 5 hours as a unit rate.
   F. \( \frac{5}{12} \) mi/h  G. 12 mi/h  H. 2.4 mi/h  I. 2 mi/h  4.____

DANCE For Questions 5 and 6, use the table at the right that shows the number of boys at the school dance at different times.

<table>
<thead>
<tr>
<th>Time</th>
<th>Number of Boys</th>
</tr>
</thead>
<tbody>
<tr>
<td>6:00</td>
<td>50</td>
</tr>
<tr>
<td>6:15</td>
<td>65</td>
</tr>
<tr>
<td>6:18</td>
<td>71</td>
</tr>
<tr>
<td>6:30</td>
<td>90</td>
</tr>
<tr>
<td>6:50</td>
<td>87</td>
</tr>
</tbody>
</table>

5. Find the rate of change in the number of boys between 6:00 and 6:15.
   A. 50 boys/min  B. 65 boys/min  C. 15 boys/min  D. 1 boy/min  5.____

6. Find the rate of change in the number of boys between 6:15 and 6:18.
   F. 1 boy/min  G. 2 boys/min  H. 3 boys/min  I. 6 boys/min  6.____

7. Find the slope of the line of the graph at the right.
   A. 2  B. \( \frac{1}{2} \)  C. \( -\frac{1}{2} \)  D. \( \frac{1}{2} \)  7.____

For Questions 8 and 9, the points given in each table lie on a line. Find the slope of the line.

8. | \( x \) | -3 | 1 | 5 | 9 |
   | \( y \) | -2 | -1 | 0 | 1 |
   F. 1  G. 4  H. \( \frac{1}{4} \)  I. \( -\frac{1}{4} \)  8.____

9. | \( x \) | 0 | 3 | 6 | 9 |
   | \( y \) | 5 | 3 | 1 | -1 |
   A. \( \frac{2}{3} \)  B. \( -\frac{2}{3} \)  C. -2  D. 3  9.____

10. Which pair of ratios form a proportion?
    F. \( \frac{21}{15} : \frac{7}{5} \)  G. \( \frac{9}{10} : \frac{10}{11} \)  H. \( \frac{5}{6} : \frac{2}{3} \)  I. \( \frac{4}{17} : \frac{17}{20} \)  10.____

11. Solve \( \frac{2}{9} = \frac{b}{36} \).
    A. 8  B. 4  C. 2  D. 7  11.____

12. Solve \( \frac{5}{6} = \frac{11}{d} \).
    F. \( 8\frac{1}{3} \)  G. 12  H. 13.2  I. \( \frac{5}{66} \)  12.____
13. Which pair of polygons is similar?

A.  

B.  

C.  

D.  

13. ____

14. The triangles shown are similar. Find the missing measure.

F. 18.75  
G. 7.5  
H. 48  
I. 12  

14. ____

15. MAPS The scale on a map is 1 centimeter = 50 kilometers. Find the actual distance for a map distance of 3 centimeters.

A. 150 km  
B. 3 km  
C. 150 cm  
D. 3 cm  

15. ____

16. MOVIES In a science fiction movie, the model of one of the aliens was 12 inches tall. In the movie, the alien was seen as 6 feet tall. What was the scale used?

F. 2 in. = 1 ft  
G. 1 in. = 2 ft  
H. 1 in. = 6 ft  
I. 6 in. = 1 ft  

16. ____

17. FLAGS A flagpole casts a 12-foot shadow. A bush next to it is 4 feet tall and casts a 2-foot shadow. How tall is the flagpole?

A. 24 ft  
B. 6 ft  
C. 12 ft  
D. 36 ft  

17. ____

18. FORESTRY How tall is the tree?

F. 15 ft  
G. 2.4 ft  
H. 60 ft  
I. 4.2 ft  

18. ____

19. Triangle ABC has vertices A(−1, 0), B(−3, 4), and C(2, 3). Find the coordinates of vertex A after the triangle is dilated using a scale factor of 2.

A. (−1, 2)  
B. (−2, 0)  
C. (0, −1)  
D. (1, 0)  

19. ____

20. PROJECTIONS An image that is 10 inches wide on a transparency is 30 inches wide when projected onto a screen. What is the scale factor?

F. 30  
G. \(\frac{1}{10}\)  
H. \(\frac{1}{3}\)  
I. 3  

20. ____

Bonus Write a proportion to find the missing measure. Then solve.
Write the letter for the correct answer in the blank at the right of each question.

1. Express 9 inches:3 yards in simplest form.
   A. 3:1  B. 1:4  C. 12:1  D. 1:12  1. ____

2. Express 112 passengers to 8 minivans in simplest form.
   F. 14 to 1  G. 896 to 1  H. 28 to 1  I. 1 to 14  2. ____

3. Express $10.78 for 11 dozen eggs as a unit rate.
   A. $0.22/dozen  B. $0.89/dozen  C. $1.20/dozen  D. $0.98/dozen  3. ____

4. Express 1,211 gallons of water in 28 hours as a unit rate.
   F. 85 gal/h  G. $\frac{4}{173}$ gal/h  H. $43\frac{1}{4}$ gal/h  I. 173 gal/h  4. ____

**FOOTBALL** For Questions 5 and 6, use the information and graph given. The graph shows the attendance at school football games for each of the past six weeks.

5. Find the rate of change in attendance between week 3 and week 4.
   A. $-25$ fans/week  B. 25 fans/week  C. 50 fans/week  D. 100 fans/week  5. ____

6. Find the rate of change in attendance between week 1 and week 6.
   F. $-25$ fans/week  G. 20 fans/week  H. 50 fans/week  I. 10 fans/week  6. ____

7. Find the slope of the line.
   A. $\frac{2}{3}$  B. $-\frac{2}{3}$  C. $\frac{3}{2}$  D. $-\frac{3}{2}$  7. ____

For Questions 8 and 9, the points given in each table lie on a line. Find the slope of the line.

8. \[
\begin{array}{c|c|c|c|c|c}
  x & -5 & 0 & 5 & 10 \\
  y & 4 & 4 & 4 & 4 \\
\end{array}
\]
   F. 5  G. $-5$  H. 0  I. 4  8. ____

9. \[
\begin{array}{c|c|c|c|c|c}
  x & 1 & 5 & 9 & 13 \\
  y & -6 & -3 & 0 & 3 \\
\end{array}
\]
   A. $-\frac{4}{3}$  B. $-\frac{3}{4}$  C. $\frac{3}{4}$  D. $\frac{4}{3}$  9. ____

10. Solve $\frac{a}{36} = \frac{3}{8}$.
   F. $\frac{2}{3}$  G. 12  H. 13.5  I. 96  10. ____
11. **FUEL ECONOMY** A car uses 40 gallons of gasoline to travel 980 miles. How many miles will the car travel on 5 gallons of gasoline?
   A. 4.9 mi  
   B. 250 mi  
   C. 175.5 mi  
   D. 122.5 mi

12. The pair of polygons is similar. Use a proportion to find the missing measure.

![Diagram of two similar triangles]

   F. 12.5  
   G. 15  
   H. 20  
   I. 14.5

13. **MAPS** The distance between two cities on a map is 4/11 inches. Find the actual distance if the scale on the map is 2 inches = 40 miles.
   A. 165 mi  
   B. 82 1/2 mi  
   C. 41 1/4 mi  
   D. 100 mi

14. **PROJECTIONS** An image that is 28 mm wide on a transparency is 154 mm wide when projected onto a screen. What is the scale factor?
   F. 1/5  
   G. 5  
   H. 6  
   I. 15/2

15. **LIGHTING** How tall is the streetlight at the right?
   A. 18 ft  
   B. 5 ft  
   C. 25 ft  
   D. 13 ft

16. **ARCHITECTURE** A fence post 8.4 feet tall casts a shadow 12.6 feet long. A nearby building casts a shadow 96 feet long. How tall is the building?
   F. 81 ft  
   G. 72 ft  
   H. 144 ft  
   I. 64 ft

17. Triangle ABC has vertices A(−4, 4), B(1, 0), and C(−1, −2). Find the coordinates vertex A after the triangle is dilated using a scale factor of 3.5.
   A. (−14, 14)  
   B. (14, −14)  
   C. (14, 14)  
   D. (−14, −14)

18. Segment D′E′ with endpoints D(−4, 8) and E′(2, −2) is a dilation of segment DE with endpoints D(−9, 12) and E(3, −3). Find the scale factor of the dilation.
   F. 3/2  
   G. 2/3  
   H. 3/1  
   I. 1/3

**Bonus** The ratio of red marbles in a bag to green marbles is 2:3. If two red marbles are taken away, the ratio becomes 1:2. How many red marbles are in the bag?
Chapter 4 Test, Form 2B

Write the letter for the correct answer in the blank at the right of each question.

1. Express 10 inches : 5 feet in simplest form.
   A. 1:6       B. 2:1       C. 1:2       D. 1:5
   1. ______

2. Express 35 wins to 25 losses in simplest form.
   F. 5 to 7   G. 13 to 10   H. 6 to 5   I. 7 to 5
   2. ______

Express each rate as a unit rate.

3. $11.70 for 13 pounds of grapes
   A. $0.90/lb   B. $9.90/lb   C. $0.09/lb   D. $9.00/lb
   3. ______

4. 1,350 miles in 24 hours
   F. 65 mi/h   G. 225 mi/h
   H. $\frac{561}{4}$ mi/h   I. $\frac{4}{225}$ mi/h
   4. ______

ENROLLMENT For Questions 5 and 6, use the information and graph given. The graph shows the number of girls enrolled at Hill Elementary for each of the past six years.

5. Find the rate of change in enrollment between year 2 and year 3.
   A. -10 girls/year   B. 30 girls/year
   C. 10 girls/year   D. 60 girls/year
   5. ______

6. Find the rate of change in enrollment between year 1 and year 6.
   F. -10 girls/year   G. 12 girls/year
   H. 10 girls/year   I. 60 girls/year
   6. ______

7. Find the slope of the line.
   A. $\frac{1}{2}$   B. $-\frac{1}{2}$
   C. 2   D. -2
   7. ______

For Questions 8 and 9, the points given in each table lie on a line. Find the slope of the line.

8. | x  | -3  | -1  | 1   | 3   |
<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>y</td>
<td>7</td>
<td>4</td>
<td>1</td>
<td>-2</td>
</tr>
</tbody>
</table>
   F. $\frac{3}{2}$   G. $\frac{2}{3}$
   H. $-\frac{2}{3}$   I. $-\frac{3}{2}$
   8. ______

9. | x  | 5   | 7   | 9   | 11  |
<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>y</td>
<td>-3</td>
<td>-3</td>
<td>-3</td>
<td>-3</td>
</tr>
</tbody>
</table>
   A. 2   B. -2
   C. -3   D. 0
   9. ______

10. Solve $\frac{5}{8} = \frac{c}{36}$.
    F. $\frac{2}{45}$   G. 22.5
    H. 57.6   I. $1\frac{1}{9}$
    10. ______
11. **FUEL ECONOMY** A car uses 35 gallons of gasoline to travel 840 miles. How many gallons are used to go 156 miles?
   A. 19.5 gal   B. 7.2 gal   C. 188 gal   D. 6.5 gal

12. The pair of polygons is similar. Use a proportion to find the missing measure.

```
9          x
---       ---
12        11.25
```

A. 6   B. 12   C. 6.75   D. 8.4

13. **MAPS** The distance between two cities on a map is 2.75 centimeters. Find the actual distance if the scale on the map is 1 centimeter = 60 kilometers.
   A. 165 km   B. 21 km   C. 180 km   D. 150 km

14. **PROJECTIONS** An image that is 12\(\frac{1}{2}\) inches wide on the transparency is 35 inches wide on a screen. What is the scale factor?
   A. \(\frac{35}{12}\)   B. \(\frac{14}{5}\)   C. 3   D. \(\frac{35}{13}\)

15. **FLAGS** How tall is the flagpole?
   A. 18 ft   B. 63 ft   C. 21 ft   D. 36 ft

16. **ARCHITECTURE** A 16-foot tree casts a 18-foot shadow at the same time that a building casts a 72-foot shadow. How tall is the building?
   A. 81 ft   B. 72 ft   C. 64 ft   D. 96 ft

17. Triangle \(ABC\) has vertices \(A(-2, -4), B(-3, 1),\) and \(C(2, 2)\). Find the coordinates of vertex \(A\) after the triangle is dilated using a scale factor of 0.5.
   A. \(A'(−4, −8)\)   B. \(A'(−1.5, −3.5)\)   C. \(A'(−1, −2)\)   D. \(A'(−4, −2)\)

18. Segment \(R'S'\) with endpoints \(R'(13.5, 0)\) and \(S'(0, 4.5)\) is a dilation of segment \(RS\) with endpoints \(R(-9, 0)\) and \(S(0, 3)\). Find the scale factor of the dilation.
   A. \(\frac{3}{2}\)   B. \(\frac{2}{3}\)   C. \(\frac{9}{1}\)   D. \(\frac{1}{6}\)

**Bonus** The ratio of red beans in a bag to green beans is 1:2. If two red beans are eaten, the ratio becomes 1:3. How many green beans are in the bag?
1. Find the slope of the line.

For Questions 2 and 3, express each ratio in simplest form.
2. 95 girls to 105 boys
3. 84 out of 144 students
4. Express the rate 296 miles in 5 hours as a unit rate.
5. Which is the better buy, 12 reams of paper for $24.50 or 5 reams of paper for $15.25? Explain your reasoning.

RAINFALL For Questions 6 and 7, use the information in the table. The table shows the amount of rain in Shawn’s rain gauge at selected times during a recent storm.

<table>
<thead>
<tr>
<th>Time</th>
<th>2:10</th>
<th>2:15</th>
<th>2:30</th>
<th>3:00</th>
</tr>
</thead>
<tbody>
<tr>
<td>Inches of Rain</td>
<td>0.5</td>
<td>1</td>
<td>1.5</td>
<td>2.1</td>
</tr>
</tbody>
</table>

6. Find the rate of change in rainfall between 2:10 and 2:15.
7. Find the rate of change in rainfall between 2:30 and 3:00.
8. The points in the table lie on a line. Find the slope of the line. Then graph the line.

<table>
<thead>
<tr>
<th>x</th>
<th>-2</th>
<th>0</th>
<th>2</th>
<th>4</th>
</tr>
</thead>
<tbody>
<tr>
<td>y</td>
<td>4</td>
<td>3</td>
<td>2</td>
<td>1</td>
</tr>
</tbody>
</table>

9. Find the slope of the line and interpret its meaning as a rate of change.

For Questions 10 and 11, solve each proportion.
10. \( \frac{b}{48} = \frac{9}{16} \)
11. \( \frac{12}{f} = \frac{40}{55} \)
12. **SWIMMING** Aretha swims 3 laps every 50 seconds. How many laps will she swim in 120 seconds?

13. Determine whether the pair of polygons is similar. Explain your reasoning.

14. The pair of polygons is similar. Write a proportion to find the missing measure. Then solve.

For Questions 15 and 16, the scale on a map is 1 inch = 575 miles. Find the actual distance for each map distance.

15. 3\(\frac{1}{4}\) inches  
16. 7\(\frac{1}{2}\) inches

17. **PLAYGROUND** The triangles formed by the slide and the person are similar. How tall is the slide?

18. **ROAD SIGNS** A road sign casts a shadow that is 4 feet long. At the same time, a 6-foot man standing next to the sign casts a shadow that is 2.4 feet long. How tall is the sign?

19. Polygon \(ABCD\) has vertices \(A(−4\frac{1}{2}, 3), B(2, 5), C(\frac{1}{2}, −1)\) and \(D(−3, −8)\). Find the coordinates of its image after a dilation using a scale factor of \(\frac{1}{2}\).

20. In the figure below \(\triangle X'Y'Z'\) is a dilation of \(\triangle XYZ\). Find the scale factor of the dilation, and classify it as an enlargement or a reduction.

**Bonus** A recipe calls for 2 pounds, 8 ounces of apples for 8 servings. How many apples, in pounds and ounces, are needed for 12 servings?
1. Find the slope of the line.

For Questions 2 and 3, express each ratio in simplest form.

2. 77 out of 121 dentists
3. 85 men to 110 women

4. Express the rate 315 miles in 6 hours as a unit rate.

5. Which is the better buy, $14.60 for 36 juice boxes or $9.50 for 24 juice boxes? Explain.

FOOTBALL For Questions 6 and 7, use the information below and in the table. The table shows the total number of tickets sold at the gate by each time shown.

<table>
<thead>
<tr>
<th>Time</th>
<th>5:15</th>
<th>5:20</th>
<th>5:35</th>
<th>6:00</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tickets</td>
<td>27</td>
<td>47</td>
<td>197</td>
<td>1,072</td>
</tr>
</tbody>
</table>

6. Find the rate of change in ticket sales between 5:15 and 5:20.

7. Find the rate of change in ticket sales between 5:35 and 6:00.

8. The points in the table lie on a line. Find the slope of the line. Then graph the line.

9. Find the slope of the line and interpret its meaning as a rate of change.

For Questions 10 and 11, solve each proportion.

10. \( \frac{5}{8} = \frac{d}{36} \)
11. \( \frac{15}{36} = \frac{5}{r} \)

12. HEART RATE If a person’s heart beats 96 times in 60 seconds, how many times does it beat in 45 seconds?
13. Determine whether the pair of polygons is similar. Explain your reasoning.

14. The pair of polygons is similar. Write a proportion to find the missing measure. Then solve.

For Questions 15 and 16, the scale on a map is 1 inch = 240 miles. Find the actual distance for each map distance.

15. \( \frac{1}{8} \) inch

16. \( 2 \frac{3}{4} \) inches

17. FORESTRY How tall is the tree?

18. MONUMENTS A statue casts a shadow 25 feet long. A boy standing next to the statue is 4.5 feet tall and casts a shadow that is 3.6 feet long. How tall is the statue?

19. Polygon MNOP has vertices M(–2, –2), N(–3, 3), O(1, 3), and P(3, –1). Find the coordinates of its image after a dilation using a scale factor of \( \frac{1}{3} \).

20. The figure \( \triangle DEF \) is a dilation of \( \triangle DEF \). Find the scale factor of the dilation and classify it as an enlargement or reduction.

Bonus \( \triangle GHI \) has vertices at G(–4, 1), H(3, 2) and I(5, –6). \( \triangle GHI \) is dilated using a scale factor of \( \frac{2}{1} \), and the new triangle is then dilated using a scale factor of \( \frac{2}{3} \). Find the coordinate of the vertices of the new triangle after the second dilation.
1. Express 45 inches:3 feet in simplest form.

2. Which is the better buy, 120 peak-time minutes for $24.95 or 180 peak-time minutes for $35.95? Explain your reasoning.

For Questions 3 and 4, use the graph and information below. The graph shows a dolphin’s depth below the ocean’s surface as it swims.

3. Find the rate of change in the dolphin’s depth between 1 and 2 minutes.

4. During which time period was the rate of change in depth 0 feet per minute? How can you tell this from the graph?

5. Five days ago there were 6 cells growing in a sample. Today there are 192 cells. Find the rate of change in the number of cells.

Find the slope of each line.

6. 7.

8. The points given in the table lie on a line. Find the slope of the line. Then graph the line.

<table>
<thead>
<tr>
<th>x</th>
<th>-3</th>
<th>-2</th>
<th>-1</th>
<th>0</th>
</tr>
</thead>
<tbody>
<tr>
<td>y</td>
<td>5</td>
<td>1</td>
<td>-3</td>
<td>-7</td>
</tr>
</tbody>
</table>

For Questions 9 and 10, the scale on a map is 1 inch = 330 miles. Find the actual distance.

9. 1 1/2 inches

10. 4.75 inches

11. Solve \( \frac{p}{4} = \frac{0.6}{1.6} \).
12. **TICKET SALES** Eight student tickets cost $160.50. How much will 20 student tickets cost?

For Questions 13 and 14, each pair of polygons is similar. Write a proportion to find each missing measure. Then solve.

13.  

14.  

15. **\( \triangle EFG \sim \triangle HIJ \)**. Each side of \( \triangle HIJ \) is \( 2\frac{1}{4} \) times longer than the corresponding sides of \( \triangle EFG \). Find the perimeter of \( \triangle EFG \).

16. **MONUMENTS** The St. Louis arch is 630 feet tall. A model of the arch is 9 feet. What is the scale of the model?

17. **GEOGRAPHY** How wide is Citrus Lake?

18. **ARCHITECTURE** The Sears Tower in Chicago, Illinois, is 443 meters tall. A smaller building nearby casts a shadow 6.8 meters long. At the same time the Sears Tower casts a shadow 8.6 meters long. How tall is the smaller building to the nearest meter?

19. Polygon \( \triangle ABCD \) has vertices \( A(-4, \frac{1}{3}), B(\frac{2}{2}, 8), C(2, \frac{3}{4}) \), and \( D(0, -1) \). Find the vertices for a dilation using a scale factor of 2.

20. In the figure \( \triangle L'M'N' \) is a dilation of \( \triangle LMN \). Find the scale factor, and classify the dilation as an enlargement or as a reduction.

**Bonus** After burning for 5 minutes, a 600-gram candle weighs 540 grams. Assuming the candle burns at the same rate, how many grams will burn away in 32 minutes?
Demonstrate your knowledge by giving a clear, concise solution to each problem. Be sure to include all relevant drawings and justify your answers. You may show your solution in more than one way or investigate beyond the requirements of the problem. If necessary, record your answer on another piece of paper.

1. Ratios are used to make concrete. A recommended concrete mix is 1 part cement, 2 parts sand, 4 parts gravel, and water to moisten.

   a. Explain what is meant by ratio.

   b. Write three ratios that describe the concrete mix. Write each ratio in a different form.

   c. Explain what is meant by a proportion.

   d. Suppose 400 pounds of sand were loaded into a mixer. Tell how much cement and gravel should be added. Show your work.

2. a. Polygons ABCD and EFGH are similar. Explain what this means.

   b. In the above polygons, identify the corresponding sides. How can you use this information to find the lengths of the sides BC, EF, and GH?

   c. You can also use indirect measurement to find a missing measurement. Draw a diagram illustrating the following situation. Then solve the problem. Show your work.

      An 8-foot barber pole casts a shadow 2 feet long. The barber standing next to the pole is \( 5 \frac{3}{5} \) feet tall. How long is his shadow?

   d. Explain how using a scale drawing to find a measurement is related to using similar polygons and indirect measurement.

   e. If a dilated image is smaller than the original, is the scale factor larger or smaller than 1? Explain.
Write whether each sentence is true or false. If false, replace the underlined word to make a true sentence.

1. If the slope of a line is \( \frac{2}{3} \), the ratio corresponding to a rise of 2 is 3.

2. In a proportion, the two cross products are opposites.

3. A simple closed figure in a plane formed by at least three line segments is called a polygon.

4. A proportion is a special kind of ratio in which two quantities with different types of units are compared.

5. The average amount of snow that fell each hour over a period of several hours is an example of a rate of change.

6. If two polygons are scale factors, their corresponding angles are congruent and their corresponding sides are proportional.

7. Distances on a scale drawing are proportional to distances in real life.

8. A comparison of two numbers by division is called a ratio.

9. In a scale drawing, the indirect measurement is determined by the ratio of a given length on the drawing to its corresponding actual length.

10. Slope is the dilation of the vertical change between two points to the horizontal change between the points.

In your own words, define each term.

11. unit rate

12. corresponding parts
Express each ratio in simplest form.

1. 12 goals in 15 attempts
2. 27 winners chosen out of 90 contestants
3. 44 out of 100 dentists
4. 6 cups for each quart

Express each rate as a unit rate.

5. 253 students for 11 teachers
6. $555 for 6 chairs
7. 165 students for 60 computers

SCIENCE Use the information below and in the table.

Sara decided to study the growth of a plant for her science project. She recorded the height of her plant in the table.

<table>
<thead>
<tr>
<th>Week</th>
<th>Height</th>
</tr>
</thead>
<tbody>
<tr>
<td>6</td>
<td>2</td>
</tr>
<tr>
<td>3</td>
<td>2 cm</td>
</tr>
<tr>
<td>6</td>
<td>2 1/2 cm</td>
</tr>
<tr>
<td>9</td>
<td>4 cm</td>
</tr>
<tr>
<td>15</td>
<td>8 cm</td>
</tr>
</tbody>
</table>

8. Find the rate of change in the height of the plant from week 1 to week 3.
9. Find the rate of change in the height of the plant from week 9 to week 15.
10. During which of these two time periods did the plant grow faster?

Find the slope of each line.

1. \[
\begin{array}{c|cccc}
  x & -2 & 0 & 2 & 4 \\
  y & 1 & 4 & 7 & 10 \\
\end{array}
\]

2. [Graph of a line]

Solve each proportion.

3. \[
\frac{8}{5} = \frac{a}{15}
\]
4. \[
\frac{30}{100} = \frac{6}{c}
\]
5. \[
\frac{t}{7} = \frac{13}{28}
\]
Chapter 4 Quiz
(Lessons 4-5 and 4-6)

Each pair of polygons is similar. Write a proportion to find each missing measure. Then solve.

1. 2. 1. ______________ 2. ______________

For Questions 3 and 4, the scale on a map is 1 inch = 40 miles. Find the actual distance for each map distance.

3. \(\frac{7}{8}\) inch 4. \(5\frac{1}{2}\) inches

5. MULTIPLE-CHOICE TEST ITEM Polygon \(ABCD\) is similar to polygon \(PQRS\). Each side of polygon \(ABCD\) is \(1\frac{1}{2}\) times longer than the corresponding side of polygon \(PQRS\). If the perimeter of polygon \(ABCD\) is 15 inches, what is the perimeter of polygon \(PQRS\)?
   A. \(22\frac{1}{2}\) inches  B. 10 inches  C. 37 inches  D. \(16\frac{1}{2}\) inches

Chapter 4 Quiz
(Lessons 4-7 and 4-8)

1. FLAGS A flagpole casts a shadow 9 feet long at the same time that a 6-foot man casts a shadow of 2.5 feet. How tall is the flagpole?

2. FORESTRY A tree casts a shadow 75 feet long at the same time that an 8-foot sign casts a shadow 10 feet long. How tall is the tree?

For Questions 3 and 4, find the coordinates of the vertices of \(\triangle XYZ'\) after \(\triangle XYZ\) is dilated using the given scale factor.

3. \((x, 9), (12, 16)\); scale factor 3

4. \((x, 20), (12)\); scale factor \(\frac{1}{2}\)

5. Segment \(A'B'\) with endpoints \(A\left(\frac{1}{2}\right), 2\) and \(B\left(\frac{1}{2}\right), 3\) is a dilation of segment \(AB\). If segment \(AB\) has endpoints \(A(2, 8)\) and \(B(6, 12)\), find the scale factor of the dilation. Then classify the dilation as an enlargement or as a reduction.
Chapter 4 Mid-Chapter Test
(Lessons 4-1 through 4-4)

PART I

Write the letter for the correct answer in the blank at the right of each question.

1. Express $42 for 4 days in simplest form.
   A. 1:4    B. 42:1    C. 2:21    D. 21:2

2. Express 154 miles on 7 gallons as a unit rate.
   F. 22 mi/gal    G. 0.05 mi/gal
   H. 147 mi/gal   I. 7 mi/gal

3. Express $2.76 for 12 sandwich rolls as a unit rate.
   A. $4.35/roll   B. $2.76/roll   C. $0.23/roll   D. $12/roll

4. The points given in the table lie on a line. Find the slope of the line.

<table>
<thead>
<tr>
<th>x</th>
<th>0</th>
<th>3</th>
<th>6</th>
<th>9</th>
</tr>
</thead>
<tbody>
<tr>
<td>y</td>
<td>-4</td>
<td>-5</td>
<td>-6</td>
<td>-7</td>
</tr>
</tbody>
</table>

F. -1    G. 3    H. \(-\frac{1}{3}\)    I. -3

5. Solve \(\frac{c}{15} = \frac{10}{20}\).
   A. 30    B. 15    C. 13    D. 7.5

PART II

SCHOOL For Exercises 6 and 7, use the following table.

<table>
<thead>
<tr>
<th>Month</th>
<th>1</th>
<th>3</th>
<th>6</th>
<th>9</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of Copies Made</td>
<td>420</td>
<td>619</td>
<td>800</td>
<td>1,215</td>
</tr>
</tbody>
</table>

6. Find the rate of change in the number of copies between month 1 and month 3.

7. Find the rate of change in the number of copies between month 6 and month 9 to the nearest whole number.

8. GARDENING If it takes Sheila 1.5 hours to plant 28 tomato plants, how long will it take her to plant 98 plants?

9. RACECAR A car on a racetrack drove 96 miles in 60 minutes. How many miles did it drive in 10 minutes?

10. Find the slope of the line and interpret its meaning as a rate of change.

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1. Evaluate $\frac{-32}{x-y}$ if $x = 5$ and $y = -3$. (Lesson 1-6)

2. Solve $-17 = q - 9$. (Lesson 1-8)

3. Find $\frac{19}{36} \cdot \frac{4}{5}$. Write in simplest form. (Lesson 2-3)

4. Find $3\frac{2}{3} + 5\frac{1}{6}$. Write in simplest form. (Lesson 2-6)

5. Evaluate $4^3 \cdot 2^2$. (Lesson 2-8)

6. Find $\sqrt{729}$. (Lesson 3-1)

7. Estimate the solution of $x^2 = 80$ to the nearest integer. (Lesson 3-2)

8. Name all sets of numbers to which $\sqrt{49}$ belongs. (Lesson 3-3)

9. Find the distance between the points $(4, 9)$ and $(-3, -5)$. Round to the nearest tenth. (Lesson 3-6)

10. Express 220 miles on 11 gallons in simplest form. (Lesson 4-1)

11. Express $15.50$ for 5 pounds of cashews as a unit rate. (Lesson 4-1)

12. Find the slope of the line. (Lesson 4-3)

13. Solve $\frac{4}{5} = \frac{10}{y}$. (Lesson 4-4)

14. The scale on a map is 1 inch $= 40$ miles. Find the actual distance if two towns are $2\frac{1}{4}$ inches apart on the map. (Lesson 4-6)

15. A flagpole casts a shadow 10 feet long at the same time that an 6-foot man casts a shadow that is 4 feet long. How tall is the flagpole? (Lesson 4-7)

16. Segment $B'C'$ is a dilation of segment $BC$. The endpoints are $B(-6, 4)$, $C(2, -8)$, $B'(-9, 6)$ and $C'(3, -12)$. Find the scale factor of the dilation and classify it as an enlargement or as a reduction. (Lesson 4-8)
1. Jill purchased a pair of shoes that cost $59.00. After tax, the total cost was $63.43. Which equation could be used to find the amount of the tax? (Lesson 1-8)
   A. \( x + 63.43 = 59 \)
   B. \( 59 + x = 63.43 \)
   C. \( x - 59 = 63.43 \)
   D. \( x - 63.43 = 59 \)
   1. A B C D

2. A board that is \(49\frac{1}{2}\) inches long is cut into pieces that are \(4\frac{1}{8}\) inches long. How many pieces are there? (Lesson 2-4)
   F. 9  G. 10  H. 11  I. 12
   2. F G H I

3. The distance between Lakeland and Iceville is 129 kilometers. If there are 1,000 meters in a kilometer, use scientific notation to write the distance from Lakeland to Iceville in meters. (Lesson 2-9)
   A. \(1.29 \times 10^5\)
   B. \(1.29 \times 10^2\)
   C. \(1.29 \times 10^3\)
   D. \(1.29 \times 10^{-3}\)
   3. A B C D

4. The area of a square is 144 square meters. What is the perimeter? (Lesson 3-1)
   F. 12 meters  G. 24 meters  H. 48 meters  I. 288 meters
   4. F G H I

5. Randall walked 80 yards east and then walked 50 yards north. How far is Randall from his starting point to the nearest tenth? (Lesson 3-4)
   A. 62.5 yd  B. 94.3 yd  C. 130.0 yd  D. 8,900.0 yd
   5. A B C D

6. Find the distance between \((-3, 4)\) and \((7, -7)\). Round to the nearest tenth. (Lesson 3-6)
   F. 4.6 units  G. 10 units  H. 14.9 units  I. 11 units
   6. F G H I

7. Which of the following cannot be written as a ratio? (Lesson 4-1)
   A. $6 out of $10 earned  B. $20 for every $100 donated
   C. $15 less than the average price  D. $48 for three baseball caps
   7. A B C D

8. A recipe calls for \(12\frac{1}{2}\) pounds of carrots for 60 servings. How many pounds of carrots are needed for 1,000 servings? (Lesson 4-4)
   F. \(2,083\frac{1}{3}\)  G. \(208\frac{1}{3}\)  H. \(500\frac{1}{3}\)  I. 4,800
   8. F G H I

9. Polygons \(ABC\) and \(XYZ\) are similar. Find the length of \(YZ\). (Lesson 4-5)
   A. 3 cm  B. 1 cm  C. 8 cm  D. 2 cm
   9. A B C D

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10. Evaluate the expression \( m(n + p) \) if \( m = \frac{13}{5}, n = \frac{2}{9}, \) and \( p = \frac{1}{3} \). (Lesson 2-6)

11. Estimate \( \sqrt{77} \) to the nearest tenth. (Lesson 3-3)

12. Find the slope of the line. (Lesson 4-3)

13. A 6-foot man casts a shadow that is 7.5 feet long. A flagpole near the man casts a shadow that is 45 feet long. How tall is the flagpole? (Lesson 4-7)

14. **ELECTIONS** The table shows the number of people who had voted by each time in Precinct 109.

<table>
<thead>
<tr>
<th>Time</th>
<th>8 A.M.</th>
<th>10 A.M.</th>
<th>12 P.M.</th>
<th>2 P.M.</th>
<th>3 P.M.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of Voters</td>
<td>25</td>
<td>67</td>
<td>149</td>
<td>275</td>
<td>275</td>
</tr>
</tbody>
</table>

a. Find the rate of change in the number of voters between 10 A.M. and 12 P.M. Interpret its meaning.

b. During which time period was the rate of change 0? Explain.

c. During which time period was the rate of change the greatest?
Part 1: Multiple Choice
Select the best answer from the choices given and fill in the corresponding oval.

1. A B C D
2. F G H I
3. A B C D
4. F G H I
5. A B C D

Part 2: Short Response/Grid in
Solve the problem and write your answer in the blank.
For grid in questions, also enter your answer by writing each number or symbol in a box. Then fill in the corresponding circle for that number of symbol.

7. __________
8. __________ (grid in)
9. __________ (grid in)
10. __________ (grid in)
11. __________ (grid in)
12. __________ (grid in)
13. __________ (grid in)
14. __________
15. __________

Part 3: Extended Response
Record your answers for Questions 16 and 17 on the back of this paper.
General Scoring Guidelines

• If a student gives only a correct numerical answer to a problem but does not show how he or she arrived at the answer, the student will be awarded only 1 credit. All extended response questions require the student to show work.

• A fully correct answer for a multiple-part question requires correct responses for all parts of the question. For example, if a question has three parts, the correct response to one or two parts of the question that required work to be shown is not considered a fully correct response.

• Students who use trial and error to solve a problem must show their method. Merely showing that the answer checks or is correct is not considered a complete response for full credit.

Exercise 16 Rubric

<table>
<thead>
<tr>
<th>Score</th>
<th>Specific Criteria</th>
</tr>
</thead>
<tbody>
<tr>
<td>4</td>
<td>The 4 points are correctly graphed and a line is drawn through the points. The slope of the line is correctly determined to be $\frac{9}{2}$. The value of the slope is translated to mean that Susan's rate of pay is $4.50 per hour. The amount of money Susan will make for 10 hours of work is correctly determined to be $45.</td>
</tr>
<tr>
<td>3</td>
<td>The 4 points are correctly graphed and the line is correctly drawn, but a computational error in finding one of the values is made.</td>
</tr>
<tr>
<td>2</td>
<td>The 4 points are correctly graphed and the line is correctly drawn, but two of the other values are incorrect. <strong>OR</strong> The 4 points are not correctly graphed and a different line is drawn, but the numerical answers are all correct for the graph drawn.</td>
</tr>
<tr>
<td>1</td>
<td>The 4 points are correctly graphed and the line is correctly drawn, but none of the values are correct. <strong>OR</strong> The 4 points are not correctly graphed and a different line is drawn, but one or two of the numerical answers are correct for the graph drawn.</td>
</tr>
<tr>
<td>0</td>
<td>Response is completely incorrect.</td>
</tr>
</tbody>
</table>

Exercise 17 Rubric

<table>
<thead>
<tr>
<th>Score</th>
<th>Specific Criteria</th>
</tr>
</thead>
<tbody>
<tr>
<td>4</td>
<td>The coordinates of the vertices of the triangle after the dilation using a scale factor of $\frac{2}{3}$ are found to be $A'(-4, 2)$, $B'(2, 4)$, and $C'(4, -6)$. The graphs of $\triangle ABC$ and this dilation are correct. A scale factor greater than 1 is given for an enlargement the $\triangle ABC$. This scale factor is correctly used to find the coordinates of the vertices of the dilation.</td>
</tr>
<tr>
<td>3</td>
<td>The work is mostly correct, but a computational error is made in finding the coordinates of one of the vertices of a dilated figure. <strong>OR</strong> The work is mostly correct, but one of the vertices is incorrectly graphed.</td>
</tr>
<tr>
<td>2</td>
<td>The graphs of $\triangle ABC$ and its dilation using a scale factor of $\frac{2}{3}$ are correct, but scale factor for an enlargement is incorrect or not given. <strong>OR</strong> The coordinates of the dilations are correctly given, but the graphs are incorrect or not shown.</td>
</tr>
<tr>
<td>1</td>
<td>The coordinates of one of the dilations are correctly given, but the coordinates of the other dilation are incorrect or not given. The graph is incorrect or not shown. <strong>OR</strong> The coordinates of the dilation are incorrect or not given and the graph is incorrect or not shown, but a correct scale factor of an enlargement is given.</td>
</tr>
<tr>
<td>0</td>
<td>Response is completely incorrect.</td>
</tr>
</tbody>
</table>
Express each ratio in simplest form.

1. 15 cats:50 dogs  \[\frac{3}{10}\]

2. 18 adults to 27 teens  \[\frac{2}{3}\]

3. 27 nurses to 9 doctors  \[\frac{3}{1}\]

4. 12 losses in 32 games  \[\frac{3}{8}\]

5. 50 centimeters:1 meter  \[\frac{1}{2}\]

6. 1 foot:1 yard  \[\frac{1}{3}\]

7. 22 players:2 teams  \[\frac{11}{1}\]

8. $28:8 pounds  \[\frac{7}{2}\]

9. 8 completions:12 passes  \[\frac{2}{3}\]

10. 21 hired out of 105 applicants  \[\frac{1}{5}\]

11. 18 hours out of 1 day  \[\frac{3}{4}\]

12. 64 boys to 66 girls  \[\frac{32}{33}\]

13. 66 miles on 4 gallons  \[\frac{33}{2}\]

14. 48 wins:18 losses  \[\frac{8}{3}\]

15. 112 peanuts:28 cashews  \[\frac{28}{7}\]

16. 273 miles in 6 hours  \[\frac{91}{2}\]

Express each rate as a unit rate.

17. 96 students in 3 buses  \[32 \text{ students per bus}\]

18. $9,650 for 100 shares of stock  \[$96.50 \text{ per share}\]

19. $21.45 for 13 gallons of gasoline  \[$1.65/gal\]

20. 125 meters in 10 seconds  \[12.5 \text{ m/s}\]

21. 30.4 pounds of tofu in 8 weeks  \[3.8 \text{ lbs/week}\]

22. 6.5 inches of rainfall in 13 days  \[0.5 \text{ in/day}\]

23. 103.68 miles in 7.2 hours  \[14.4 \text{ mi/h}\]

24. $94.99 for 7 pizzas  \[$13.57/pizza\]
### 4-1 Practice: Word Problems

#### Ratios and Rates

1. **COOKING** In a bread dough recipe, there are 3 eggs for every 9 cups of flour. Express this ratio in simplest form. 1:3

2. **WILDLIFE** Dena counted 14 robins out of 150 birds. Express this ratio in simplest form. 7:75

3. **INVESTMENTS** Josh earned dividends of $2.16 on 54 shares of stock. Find the dividends per share. $0.04/share

4. **TRANSPORTATION** When Denise bought gasoline, she paid $18.48 for 11.2 gallons. Find the price of gasoline per gallon. $1.65/gal

5. **WATER FLOW** Jacob filled his 60-gallon bathtub in 5 minutes. How fast was the water flowing? 12 gal/min

6. **TRAVEL** On her vacation, Charmaine's flight lasted 4.5 hours. She traveled 954 miles. Find the average speed of the plane. 212 mi/h

7. **HOUSING** Mr. And Mrs. Romero bought a 1,200 square-foot house for $111,600. How much did they pay per square foot? $93/ft²

8. **SHOPPING** A breakfast cereal comes in two different sized packages. The 8-ounce box costs $2.88, while the 12-ounce box costs $3.60. Which box is the better buy? Explain your reasoning. The 12-oz box at $0.30/oz; the 8-oz box costs $0.36 per oz, but the 12-oz box costs $0.30 per oz.

### 4-1 Reading to Learn Mathematics

#### Ratios and Rates

**Pre-Activity** Read the introduction at the top of page 156 in your textbook. Write your answers below.

1. Which combination of ingredients would you use to make a smaller amount of the same recipe? Explain. combination #2; Sample answer: In the original batch, there are twice as many scoops of peanuts as raisins.

2. In order to make the same recipe of trail mix, how many scoops of peanuts should you use for every scoop of raisins? 2

**Reading the Lesson**

3. What does it mean if the ratio of red marbles to blue marbles is 3 to 5? For every 3 red marbles, there are 5 blue marbles.

4. What is another way to write the ratio 3 to 5? Sample answer: 3:5 or \(\frac{3}{5}\)

5. What must you do before you can simplify the ratio 30 minutes to 8 hours? Convert minutes to hours or hours to minutes; 1:16

**Helping You Remember**

6. When you go to a bank to exchange money of one currency for another, the bank uses a conversion rate to calculate the amount of money in the new currency. Find out what the current conversion rate is to exchange U.S. dollars to Canadian dollars at a local bank. Then write the rate as a ratio of one currency compared to the other. Sample answer: 1 U.S. dollar to 1.56 Canadian dollars.
INCOME: The graph shows Mr. Jackson's annual income between 1994 and 2002. Find the rate of change in Mr. Jackson's income between 1994 and 1997.

Use the formula for the rate of change.

Let \((x_1, y_1) = (1994, 48,500)\) and \((x_2, y_2) = (1997, 53,000)\).

\[
\frac{y_2 - y_1}{x_2 - x_1} = \frac{53,000 - 48,500}{1997 - 1994}
\]

\[
= \frac{4,500}{3}
\]

\[
= 1,500
\]

Express this rate as a unit rate.

Between 1994 and 1997, Mr. Jackson's income increased an average of $1,500 per year.

SURF: For Exercises 1–3, use the graph that shows the average daily wave height as measured by an ocean buoy over a nine-day period.

1. Find the rate of change in the average daily wave height between day 1 and day 3. 
   \[2 \text{ ft/day}\]

2. Find the rate of change in the average daily wave height between day 3 and day 7.
   \[0.5 \text{ ft/day}\]

3. Find the rate of change in the average daily wave height between day 7 and day 9.
   \[-1.5 \text{ ft/day}\]
ELECTIONS
For Exercises 1–3, use the table that shows the total number of people who had voted in District 5 at various times on election day.

<table>
<thead>
<tr>
<th>Time</th>
<th>Number of Voters</th>
</tr>
</thead>
<tbody>
<tr>
<td>8:00 A.M.</td>
<td>141</td>
</tr>
<tr>
<td>10:00 A.M.</td>
<td>351</td>
</tr>
<tr>
<td>1:00 P.M.</td>
<td>788</td>
</tr>
<tr>
<td>4:30 P.M.</td>
<td>1,008</td>
</tr>
<tr>
<td>7:00 P.M.</td>
<td>1,753</td>
</tr>
</tbody>
</table>

1. Find the rate of change in the number of voters between 8:00 A.M. and 10:00 A.M. Then interpret its meaning.
   - Rate of change: 105 voters/hr; Between 8:00 A.M. and 10:00 A.M., an average of 105 people voted each hour.

2. Find the rate of change in the number of voters between 10:00 A.M. and 1:00 P.M. Then interpret its meaning.
   - Rate of change: 149 voters/hr; Between 10:00 A.M. and 1:00 P.M., an average of 149 people voted each hour.

3. During which of these two time periods did the number of people who had voted so far increase faster? Explain your reasoning.
   - Between 10:00 A.M. and 1:00 P.M.; the rate of change is greater for this time period.

4. MUSIC At the end of 1999, Candace had 47 CDs in her music collection. At the end of 2002, she had 134 CDs. Find the rate of change in the number of CDs in Candace’s collection between 1999 and 2002.
   - Rate of change: 29 CDs/yr

5. FITNESS In 1992, the price of an annual membership at Mr. Jensen’s health club was $225. In 2002, the price of the same membership was $319.50. Find the rate of change in the price of the annual membership between 1992 and 2002.
   - Rate of change: $9.45/yr

6. HIKING Last Saturday Fumio and Kishi went hiking in the mountains. When they started back at 2:00 P.M., their elevation was 3,560 feet above sea level. At 6:00 P.M., their elevation was 2,390 feet. Find the rate of change of their elevation between 2:00 P.M. and 6:00 P.M. Then interpret its meaning.
   - Rate of change: −292.5 ft/h; They descended at an average rate of 292.5 ft/h.

COMPANY GROWTH
Use the graph that shows the number of employees at a company between 1994 and 2002.

5. Find the rate of change in the number of employees between 1994 and 1996.
   - Rate of change: 7 employees/yr

6. Find the rate of change in the number of employees between 1996 and 1999.
   - Rate of change: 3 employees/yr

7. During which of these two time periods did the number of employees grow faster? Explain your reasoning.
   - Between 1994 and 1996, the rate of change is greater for this time period.

8. Find the rate of change in the number of employees between 1999 and 2002. Then interpret its meaning.
   - Rate of change: −1 employee/yr; Between 1999 and 2002, the number of employees decreased an average of 1 employee/yr.
Analyzing Graphs

A graph can be used to represent many real-life situations. Graphs such as these often have time as the dimension on the horizontal axis. By analyzing the rate of change of different parts of a graph, you can draw conclusions about what was happening in the real-life situation at that time.

TRAVEL

The graph at the right represents the speed of a car as it travels along the road. Describe what is happening in the graph.

• At the origin, the car is stopped.
• Where the line shows a fast, positive rate of change, the car is speeding up.
• Then the car is going at a constant speed, shown by the horizontal part of the graph.
• The car is slowing down where the graph shows a negative rate of change.
• The car stops and stays still for a short time. Then it speeds up again. The starting and stopping process repeats continually.

Analyze each graph.

1. Ashley is riding her bicycle along a scenic trail. Describe what is happening in the graph.

Sample answer: At the beginning, Ashley is sitting still. She speeds up quickly, then slows down a little. Then she travels at the same speed for a long time. Finally, she slows down slowly and stops.

2. The graph shows the depth of water in a pond as you travel out from the shore. Describe what is happening in the graph.

Sample answer: At the beginning, the water is shallow. Then there is a fast increase in depth. The depth is the same for a short distance, then increases slowly for a long distance. Then the depth decreases for a short distance before beginning to increase again.
4-3 Study Guide and Intervention
Slope

The slope of a line is the ratio of the rise, or vertical change, to the run, or horizontal change.

**Example 1** Find the slope of the line in the graph.

Choose two points on the line: $A$ and $B$. The vertical change from point $A$ to point $B$ is 4 units while the horizontal change is 2 units.

$$\text{slope} = \frac{\text{rise}}{\text{run}}$$

= $\frac{4}{2}$  The rise is 4, and the run is 2.

= 2  Simplify

The slope of the line is 2.

**Example 2** The points in the table lie on a line. Find the slope of the line.

<table>
<thead>
<tr>
<th>x</th>
<th>-2</th>
<th>1</th>
<th>4</th>
<th>7</th>
</tr>
</thead>
<tbody>
<tr>
<td>y</td>
<td>5</td>
<td>1</td>
<td>-3</td>
<td>-7</td>
</tr>
</tbody>
</table>

rise: 4  run: 2

$$\text{slope} = \frac{\text{rise}}{\text{run}} = \frac{4}{2}$$

= 2 or $\frac{4}{2}$

The slope of the line is $-\frac{4}{3}$.

**Exercises**

Find the slope of each line.

4. \[\text{The points given in each table lie on a line. Find the slope of the line.}

4. $x$ 3 5 7 9  |  $y$ -1 2 5 8

5. $x$ -5 0 5 10 |  $y$ 4 3 2 1

The points given in each table lie on a line. Find the slope of the line.

4. $x$ 3 5 7 9  |  $y$ -1 2 5 8

5. $x$ -5 0 5 10 |  $y$ 4 3 2 1
Pre-Activity
Read the introduction at the top of page 166 in your textbook. Write your answers below.

1. Pick several pairs of points from those plotted and find the rate of change between them. Write each rate in simplest form.
   All rates of change equal 8 ft/s.

2. What is true of these rates? They are all the same.

Reading the Lesson

3. Slope can be positive, negative, or zero. For each one of these possibilities draw an example of a line with that kind of slope.
   Sample answer: positive slope
   Sample answer: negative slope
   Sample answer: zero slope

Helping You Remember

4. The slope of a line is defined by the rise compared to the run between any two points on the line. Think about the words rise and run. How can you remember which word represents vertical change and which word represents horizontal change? Sample answer: Rise is a vertical action, as in rising from your seat at the table; run is a horizontal action, as in running around a track.
Enrichment

Chien-Shiung Wu

American physicist Chien-Shiung Wu (1912–1997) was born in Shanghai, China. In 1936, she came to the United States to further her studies in science. She received her doctorate in physics in 1940 from the University of California, and became known as one of the world's leading physicists. In 1975, she was awarded the National Medal of Science.

Wu is most famous for an experiment that she conducted in 1957. The outcome of the experiment was considered the most significant discovery in physics in more than seventy years. The exercise below will help you learn some facts about it.

The points given in each table lie on a line. Find the slope of the line.

1. \[
\begin{array}{c|c|c|c|c}
 x & 0 & 1 & 2 & 3 \\
 y & 1 & 4 & 7 & 10 \\
\end{array}
\]
   At the time of the experiment, Wu was a professor at ___ .
   slope = 3 Columbia University
   slope = 1 Stanford University Columbia University

2. \[
\begin{array}{c|c|c|c|c}
 x & -2 & -1 & 0 & 1 \\
 y & 3 & 3 & 3 & 3 \\
\end{array}
\]
   The site of the experiment was the ___ .
   slope = 0 National Bureau of Standards
   slope = 3 Smithsonian Institution National Bureau of Standards

3. \[
\begin{array}{c|c|c|c|c}
 x & 0 & 2 & 4 & 6 \\
 y & 2 & 4 & 6 & 8 \\
\end{array}
\]
   The experiment involved a substance called ___ .
   slope = 2 carbon 14
   slope = 1 cobalt 60 cobalt 60

4. \[
\begin{array}{c|c|c|c|c}
 x & -2 & 1 & 4 & 7 \\
 y & -3 & 1 & 5 & 9 \\
\end{array}
\]
   In the experiment, the substance was cooled to ___ .
   slope = \(-\frac{4}{3}\) -273°C
   slope = \(-\frac{4}{3}\) -100°C

Lesson 4-3

Study Guide and Intervention

Solving Proportions

A proportion is an equation that states that two ratios are equivalent. To determine whether a pair of ratios forms a proportion, use cross products. You can also use cross products to solve proportions.

**Example 1**
Determine whether the pair of ratios \(\frac{20}{24}\) and \(\frac{12}{18}\) forms a proportion.

Find the cross products.
\[
20 \cdot 18 = 360 \\
24 \cdot 12 = 288
\]
Since the cross products are not equal, the ratios do not form a proportion.

**Example 2**
Solve \(\frac{12}{30} = \frac{k}{70}\).

Write the equation.
\(12 \cdot 70 = 30 \cdot k\)
Find the cross products.
\(840 = 30k\)
Divide each side by 30.
\(28 = k\)
Simplify.
The solution is 28.

**Exercises**

Determine whether each pair of ratios forms a proportion.

1. \(\frac{17}{10}, \frac{12}{5}\) no
2. \(\frac{9}{7}, \frac{12}{18}\) yes
3. \(\frac{8}{12}, \frac{10}{15}\) yes

4. \(\frac{7}{15}, \frac{13}{32}\) no
5. \(\frac{7}{9}, \frac{49}{81}\) yes
6. \(\frac{9}{18}, \frac{12}{28}\) no

7. \(\frac{4}{7}, \frac{12}{35}\) no
8. \(\frac{20}{30}, \frac{30}{45}\) no
9. \(\frac{18}{34}, \frac{8}{4}\) yes

Solve each proportion.

10. \(\frac{x}{5} = \frac{15}{25}\)
11. \(\frac{3}{4}, \frac{12}{c}\)
12. \(\frac{6}{9}, \frac{10}{15}\)

13. \(\frac{16}{24}, \frac{x}{15}\)
14. \(\frac{5}{8}, \frac{x}{12}\)
15. \(\frac{14}{7}, \frac{10}{11}\)

16. \(\frac{w}{6}, \frac{28}{7}\)
17. \(\frac{5}{y}, \frac{7}{16.8}\)
18. \(\frac{E}{y}, \frac{7}{18}\)

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Mathematics: Applications and Concepts, Course 3
Practice: Skills

Solving Proportions

Determine whether each pair of ratios forms a proportion.

1. \( \frac{5}{8} \) \( \frac{2}{3} \) no
2. \( \frac{7}{3} \) \( \frac{14}{6} \) yes
3. \( \frac{6}{9} \) \( \frac{8}{12} \) yes

4. \( \frac{16}{9} \) \( \frac{11}{6} \) no
5. \( \frac{5}{10} \) \( \frac{12}{2} \) no
6. \( \frac{6}{5} \) \( \frac{15}{20} \) yes

7. \( \frac{5}{9} \) \( \frac{15}{27} \) yes
8. \( \frac{3}{18} \) \( \frac{11}{66} \) yes
9. \( \frac{7}{11} \) \( \frac{15}{23} \) no

10. \( \frac{9}{13} \) \( \frac{13}{17} \) no
11. \( \frac{3}{42} \) \( \frac{5}{70} \) yes
12. \( \frac{6}{7} \) \( \frac{36}{49} \) no

Solve each proportion.

13. \( \frac{4}{12} = \frac{x}{9} \) 3
14. \( \frac{6}{15} = \frac{4}{c} \) 12
15. \( \frac{7}{9} = \frac{84}{12} \) 1

16. \( \frac{5}{10} = \frac{8}{w} \) 16
17. \( \frac{x}{9} = \frac{4}{15} \) 2.4
18. \( \frac{6}{20} = \frac{x}{5} \) 1.5

19. \( \frac{5}{9} = \frac{6}{r} \) 10.8
20. \( \frac{8}{n} = \frac{10}{7} \) 5.6
21. \( \frac{4}{5} = \frac{12}{80} \) 0.75

22. \( \frac{x}{5} = \frac{13}{15} \) 6.5
23. \( \frac{2}{5} = \frac{d}{85} \) 2.5
24. \( \frac{11}{r} = \frac{100}{11} \) 1.21

25. \( \frac{1.2}{m} = \frac{3}{2} \) 2
26. \( \frac{0.9}{15} = \frac{a}{10} \) 6
27. \( \frac{3}{7} = \frac{k}{42} \) 1.8

28. \( \frac{6.3}{x} = \frac{18}{5} \) 1.75
29. \( \frac{3.6}{9} = \frac{b}{0.5} \) 0.2
30. \( \frac{14}{1.5} = \frac{4.2}{y} \) 0.45

Practice: Word Problems

Solving Proportions

1. USAGE A 12-ounce bottle of shampoo lasts Enrique 16 weeks. How long would you expect an 18-ounce bottle of the same brand to last him? 24 wk
2. COMPUTERS About 13 out of 20 homes have a personal computer. On a street with 60 homes, how many would you expect to have a personal computer? 39 homes

3. SNACKS A 6-ounce package of fruit snacks contains 45 pieces. How many pieces would you expect in a 10-ounce package? 75 pieces

4. TYPING Ingrid types 3 pages in the same amount of time that Tanya types 4.5 pages. If Ingrid and Tanya start typing at the same time, how many pages will Tanya have typed when Ingrid has typed 11 pages? 16.5 pages

5. SCHOOL A grading machine can grade 48 multiple-choice tests in 1 minute. How long will it take the machine to grade 300 tests? 6.25 min

6. AMUSEMENT PARKS The waiting time to ride a roller coaster is 20 minutes when 150 people are in line. How long is the waiting time when 340 people are in line? 32 min

7. PRODUCTION A shop produces 39 wetsuits every 2 weeks. How long will it take the shop to produce 429 wetsuits? 22 wk

8. FISH Of the 50 fish that Jim caught from the lake, 14 were trout. The estimated population of the lake is 7,500 fish. About how many trout would you expect to be in the lake? 2,100 trout
People of the United States

A national census is taken every ten years. The 1990 census revealed that there were about 250,000,000 people in the United States, and that about 8 out of 100 of these people were 5–13 years old. To find the number of people in the United States that were 5–13 years old, use the ratio of people 5–13 years old and create a proportion.

\[
\frac{8}{100} = \frac{n}{250,000,000}
\]

To solve the proportion, find cross products.

\[8 \times 250,000,000 = 2,000,000,000 \text{ and } n \times 100 = 100n\]

Then divide: \[2,000,000,000 = 100n = 20,000,000\.

In 1990, about 20,000,000 people in the United States were 5–13 years old.

Use the approximate ratios in each exercise to create a proportion, given that there were about 250,000,000 people in the United States. Then solve and choose the correct answer from the choices at the right.

1. The United States is a diverse collection of different ________
   A. 200,000,000
   B. 22,500,000
   C. 7,500,000
   D. 2,000,000
   E. 30,000,000

2. African-Americans accounted for about \(\frac{3}{25}\) of the population of the United States. About how many African-American people lived in the United States?
   A. 30,000,000
   B. 22,500,000
   C. 7,500,000
   D. 2,000,000
   E. 30,000,000

3. People of Hispanic origin accounted for about \(\frac{9}{100}\) of the population of the United States. About how many people of Hispanic origin lived in the United States?
   A. 30,000,000
   B. 22,500,000
   C. 7,500,000
   D. 2,000,000
   E. 30,000,000

4. Caucasian people accounted for about \(\frac{4}{5}\) of the population of the United States. About how many people of white or Caucasian origin lived in the United States?
   A. 30,000,000
   B. 22,500,000
   C. 7,500,000
   D. 2,000,000
   E. 30,000,000

5. People of American-Indian, Eskimo, or Aluet origin accounted for about \(\frac{8}{1000}\) of the population of the United States. About how many people of American-Indian, Eskimo, or Aluet origin lived in the United States?
   A. 30,000,000
   B. 22,500,000
   C. 7,500,000
   D. 2,000,000
   E. 30,000,000

Reading the Lesson

4. Complete the sentence: If two ratios form a proportion, then the ratios are said to be ________
   proportional

5. Do the ratios \(\frac{a}{b}\) and \(\frac{c}{d}\) always form a proportion? Why or why not?
   No; Sample answer: The ratios only form a proportion if the cross products \(ad\) and \(bc\) are equal.

6. Explain how you can use cross products to solve proportions in which one of the terms is not known. Sample answer: Find the cross products, then divide both sides of the equation by the constant that is multiplied by the unknown variable.

Helping You Remember

7. For the proportion \(\frac{a}{b}\) and \(\frac{c}{d}\), why do you think the products \(ad\) and \(bc\) are called cross products? Sample answer: If you draw lines from \(a\) to \(d\) and from \(b\) to \(c\) in the proportion, the lines form a cross.
Two polygons are **similar** if their corresponding angles are congruent and their corresponding sides are proportional.

**Example 1**
Determine whether \( \triangle ABC \) is similar to \( \triangle DEF \). Explain your reasoning.

\[
\begin{align*}
\angle A &= \angle D, \quad \angle B = \angle E, \quad \angle C = \angle F, \\
\frac{AB}{DE} &= \frac{4}{2}, \quad \frac{BC}{EF} = \frac{8}{3}, \quad \frac{AC}{DF} = \frac{8}{3} \quad \text{or} \quad 4 \neq \frac{2}{3}
\end{align*}
\]

The corresponding angles are congruent, and the corresponding sides are proportional.

Thus, \( \triangle ABC \) is similar to \( \triangle DEF \).

**Example 2**
Given that polygon \( \text{KLMN} \) — polygon \( \text{PQRS} \), write a proportion to find the measure of \( PQ \). Then solve.

The ratio of corresponding sides from polygon \( \text{KLMN} \) to polygon \( \text{PQRS} \) is \( \frac{2}{3} \). Write a proportion with this scale factor. Let \( x \) represent the measure of \( PQ \).

\[
\frac{KL}{PQ} = \frac{4}{3}, \quad \text{KL corresponds to PQ. The scale factor is } \frac{4}{3}
\]

\[
\begin{align*}
x &= \frac{2}{3} \\
5 \cdot 3 &= x \cdot 4 \\
15 &= 4x \\
x &= \frac{15}{4}
\end{align*}
\]

Find the cross products. Multiply. Then divide each side by 4.

\[
x = \frac{15}{4} = 3.75
\]

**Exercises**

1. Determine whether the polygons below are similar. Explain your reasoning:

   \[
   \frac{12}{11} \neq \frac{5}{4}
   \]

   No; corresponding angles are congruent, but \( 12 \neq 5 \).

   \[
   \frac{15}{4} \neq 6 \quad x = 10
   \]

   **Exercises**

   2. The triangles below are similar. Write a proportion to find each missing measure. Then solve.

   \[
   \begin{align*}
x &= \frac{8}{4} = 2 \quad \text{or} \quad 2.6
   \end{align*}
   \]

   \[
   \begin{align*}
x &= \frac{30}{20} = 1.5 \quad \text{or} \quad 3.6
   \end{align*}
   \]

   \[
   \begin{align*}
x &= \frac{6}{2} = 3 \quad \text{or} \quad 1.8
   \end{align*}
   \]

   \[
   \begin{align*}
x &= \frac{6.5}{2.6} = 2.5 \quad \text{or} \quad 6.5
   \end{align*}
   \]

   \[
   \begin{align*}
x &= \frac{9.6}{9} = 1.1 \quad \text{or} \quad 10
   \end{align*}
   \]

   \[
   \begin{align*}
x &= \frac{10}{6} = 1.6 \quad \text{or} \quad 6
   \end{align*}
   \]

   \[
   \begin{align*}
x &= \frac{22.4}{14} = 1.6 \quad \text{or} \quad 14
   \end{align*}
   \]
Pre-Activity

Complete the Mini Lab at the top of page 178 in your textbook. Write your answers below.

1. **Compare the angles of the triangles by matching them up. Identify the angle pairs that have equal measure.**
   - $m\angle D = m\angle L$
   - $m\angle E = m\angle J$
   - $m\angle F = m\angle K$

2. **Express the ratios $\frac{DF}{EF}$, $\frac{DE}{FK}$, and $\frac{DF}{LK}$ to the nearest tenth.**
   - $0.7; 0.7; 0.7$

3. **What do you notice about the ratios of the matching sides of matching triangles?**
   - They are approximately equal.

Reading the Lesson

4. **Complete the sentence:** If two polygons are similar, then their corresponding angles are ________, and their corresponding sides are ________.
   - congruent; proportional

5. **If two polygons have corresponding angles that are congruent, does that mean that the polygons are similar? Why or why not?**
   - **Sample answer:** No; the polygons are similar only if their corresponding sides are proportional.

6. **If the sides of one square are 3 centimeters and the sides of another square are 9 centimeters, what is the ratio of corresponding sides from the first square to the second square?**
   - $\frac{1}{3}$

Helping You Remember

7. **Look up the everyday definition of the word similar in a dictionary. How does the definition relate to what you learned in this lesson?**
   - **Sample answer:** The word similar means having characteristics in common; similar polygons have congruent angles in common and proportional sides in common.
Enrichment Study Guide and Intervention
Scale Drawings and Models

Similar and Congruent Figures
If a 4-inch by 5-inch photograph is enlarged to an 8-inch by 10-inch photograph, the photographs are said to be similar. They have the same shape, but they do not have the same size. If a 4-inch by 5-inch photograph is duplicated and a new 4-inch by 5-inch photograph is made, the photographs are said to be congruent. They have the same size and shape.

In each exercise, identify which of the triangles are congruent to each other and identify which of the shapes are similar to each other. Use the symbol for congruence and the symbol for similarity.

1. \( a \sim b; c \sim d \)
2. \( a \sim b; b \sim c, a \sim c \)
3. \( ABD \sim CBD; HKJ \sim NML; HKJ \sim ABD; HKJ \sim CBD; LMN \sim DBC; LMN \sim DBA \)
4. \( ABH \sim LKC; CDP \sim MNP; QRT \sim MNP; QRT \sim CDP; BCG \sim JKM; AQH \sim LHQ; BTD \sim BCG; JKM \sim JNP; BTD \sim JNP; BCG \sim JNP, BTD \sim JKM \)
5. \( ADC \sim HKJ, ADC \sim ABD, ADC \sim CBD, ADC \sim DBC, ADC \sim DBA \)

Distances on a scale drawing or model are proportional to real-life distances. The scale is determined by the ratio of a given length on a drawing or model to its corresponding actual length.

Example 1: Interior Design
A designer has made a scale drawing of a living room for one of her clients. The scale of the drawing is 1 inch = 1 \( \frac{1}{3} \) feet. On the drawing, the sofa is 6 inches long. Find the actual length of the sofa.

Let \( x \) represent the actual length of the sofa. Write and solve a proportion.

\[
\frac{1 \text{ in.}}{1 \frac{1}{3} \text{ ft}} = \frac{6 \text{ in.}}{x \text{ ft}}
\]

Find the cross products.

\[
1 \cdot x = 1 \frac{1}{3} \cdot 6 \quad \text{Simplify}
\]

\[
x = 8
\]

The actual length of the sofa is 8 feet.

Example 2: Find the scale factor for the drawing in Example 1.
Write the ratio of 1 inch to 1 \( \frac{1}{3} \) feet in simplest form.

\[
\frac{1 \text{ in.}}{1 \frac{1}{3} \text{ ft}} = \frac{1}{1 \frac{1}{3}} \text{ or } \frac{1}{\frac{4}{3}} \quad \text{Convert } 1 \frac{1}{3} \text{ feet to inches.}
\]

The scale factor is \( \frac{1}{16} \) or 1:16. This means that each distance on the drawing is \( \frac{1}{16} \) the actual distance.

Exercises:

1. The length of the patio is 4.5 centimeters in the drawing. Find the actual length. 2.25 m
2. The actual distance between the water faucet and the pear tree is 11.2 meters. Find the corresponding distance on the drawing. 22.4 cm
3. Find the scale factor for the drawing. \( \frac{1}{50} \)
**Practice: Skills**

**Scale Drawings and Models**

**ARCHITECTURE** The scale on a set of architectural drawings for a house is 1.5 inches = 2 feet. Find the length of each part of the house.

<table>
<thead>
<tr>
<th>Room</th>
<th>Drawing Length</th>
<th>Actual Length</th>
</tr>
</thead>
<tbody>
<tr>
<td>Living Room</td>
<td>15 inches</td>
<td>20 ft</td>
</tr>
<tr>
<td>Dining Room</td>
<td>10.5 inches</td>
<td>14 ft</td>
</tr>
<tr>
<td>Kitchen</td>
<td>12 3/4 inches</td>
<td>17 ft</td>
</tr>
<tr>
<td>Laundry Room</td>
<td>8 1/4 inches</td>
<td>11 ft</td>
</tr>
<tr>
<td>Hall</td>
<td>13 7/8 inches</td>
<td>18.5 ft</td>
</tr>
<tr>
<td>Garage</td>
<td>16.5 inches</td>
<td>22 ft</td>
</tr>
</tbody>
</table>

7. What is the scale factor of these drawings? \( \frac{1}{16} \)

**TOWN PLANNING** For Exercises 8–11, use the following information.

As part of a downtown renewal project, businesses have constructed a scale model of the town square to present to the city commission for its approval. The scale of the model is 1 inch = 7 feet.

8. The courthouse is the tallest building in the town square. If it is 5 \( \frac{1}{2} \) inches tall in the model, how tall is the actual building? 38 \( \frac{1}{2} \) ft

9. The business owners would like to install new lampposts that are each 12 feet tall. How tall are the lampposts in the model? 1 \( \frac{5}{7} \) in.

10. In the model, the lampposts are 3 \( \frac{3}{4} \) inches apart. How far apart will they be when they are installed? 24 ft

11. What is the scale factor? 1 \( \frac{1}{84} \)

12. MAPS On a map, two cities are 62 \( \frac{1}{2} \) inches apart. The actual distance between the cities is 104 miles. What is the scale of the map? 1 in. = 16 mi

**Practice: Word Problems**

**Scale Drawings and Models**

**CAMPUS PLANNING** For Exercises 1–3, use the following information.

The local school district has made a scale model of the campus of Engels Middle School including a proposed new building. The scale of the model is 1 inch = 3 feet.

1. An existing gymnasium is 8 inches tall in the model. How tall is the actual gymnasium? 24 ft

2. The new building is 22.5 inches from the gymnasium in the model. What will be the actual distance from the gymnasium to the new building if it is built? 67.5 ft

3. What is the scale factor of the model? \( \frac{1}{100} \)

**MAPS** On a map, two cities are 5 \( \frac{3}{4} \) inches apart. The scale of the map is 1 inch = 3 miles. What is the actual distance between the towns? 34 \( \frac{1}{2} \) mi

**TRUCKS** The bed of Jerry’s pickup truck is 6 feet long. On a scale model of the truck, the bed is 8 inches long. What is the scale of the model? 1 in. = \( \frac{3}{4} \) ft

**HOUSING** Marta is making a scale drawing of her apartment for a school project. The apartment is 28 feet wide. On her drawing, the apartment is 7 inches wide. What is the scale of Marta’s drawing? 1 in. = 4 ft

**TOWN PLANNING** For Exercises 8–11, use the following information.

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8. The courthouse is the tallest building in the town square. If it is 5 \( \frac{1}{2} \) inches tall in the model, how tall is the actual building? 38 \( \frac{1}{2} \) ft

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12. MAPS On a map, two cities are 62 \( \frac{1}{2} \) inches apart. The actual distance between the cities is 104 miles. What is the scale of the map? 1 in. = 16 mi
Scale Drawings

The figure at the right has an area of 6 square units. If the figure represented a map, and was drawn to a scale of 1 unit to 2,100 feet, the lengths of the sides would be 6 ft and 9 ft. So, the figure would represent an area of 54 square feet.

The ratio of the actual area of the figure to the scale area of the figure can be expressed as a ratio.

\[ \frac{\text{actual area}}{\text{scale area}} = \frac{6}{54} = \frac{1}{9} \text{ or } 1 \text{ to } 9 \]

Find the actual area and the scale area of these figures. Then determine the ratio of actual area to scale area.

1. Scale: 1 unit to 4 ft
   - actual area: 15
   - scale area: 240
   - ratio: 1 to 16

2. Scale: 1 unit = 50 cm
   - actual area: 16
   - scale area: 4,000
   - ratio: 1 to 250

3. Scale: 1 unit = 8 mi
   - actual area: 12
   - scale area: 768
   - ratio: 1 to 64

4. Scale: 1 unit = 12 m
   - actual area: 30
   - scale area: 4,320
   - ratio: 1 to 144

5. Scale: 1 unit = 18 in.
   - actual area: 10
   - scale area: 3,240
   - ratio: 1 to 324

6. Scale: 1 unit = 6 km
   - actual area: 24
   - scale area: 864
   - ratio: 1 to 36

NAME ________________________________________ DATE ______________ PERIOD _____

Pre-Activity Read the introduction at the top of page 184 in your textbook. Write your answers below.

1. How many units wide is the room? 9
2. The actual width of the room is 18 feet. Write a ratio comparing the drawing width to the actual width. 9 units : 18 feet
3. Simplify the ratio you found and compare it to the scale shown at the bottom of the drawing. 2, 3. Both the ratio and the scale indicate that 1 unit on the drawing is equal to 2 feet in reality.

Reading the Lesson

4. Give another example of a scale drawing or scale model that is different from the examples of scale drawings and scale models given on pages 184–185 in your textbook. Sample answer: scale models of buildings
5. Complete the sentence: distances on a scale model are _______ to distances in real life. proportional

6. What is the scale factor for a model if part of the model that is 4 inches corresponds to a real-life object that is 16 inches? 1 : 4

Helping You Remember

7. Make a scale drawing of a room, such as your classroom or your bedroom. Select an appropriate scale so that your drawing is a reasonable size. Be sure to indicate your scale on your drawing. Use another piece of paper if necessary. See students’ work.
EXAMPLE 1

George is standing next to a lightpole in the middle of the day. George’s shadow is 1.5 feet long, and the lightpole’s shadow is 4.5 feet long. If George is 6 feet tall, how tall is the lightpole?

Write a proportion and solve.

\[
\frac{\text{George’s shadow}}{\text{George’s height}} = \frac{\text{lightpole’s shadow}}{\text{lightpole’s height}}
\]

\[
\frac{1.5}{6} = \frac{4.5}{h}
\]

Find the cross products.

\[
1.5h = 27
\]

Multiply.

\[
\frac{1.5h}{1.5} = \frac{27}{1.5}
\]

Divide each side by 1.5.

\[
h = 18
\]

Simplify.

The lightpole is 18 feet tall.

EXERCISES

1. MONUMENTS A statue casts a shadow 30 feet long. At the same time, a person who is 5 feet tall casts a shadow that is 6 feet long. How tall is the statue? **25 ft**

2. BUILDINGS A building casts a shadow 72 meters long. At the same time, a perking meter that is 1.2 meters tall casts a shadow that is 0.8 meter long. How tall is the building? **108 m**

3. SURVEYING The two triangles shown in the figure are similar. Find the distance \(d\) across Red River. **2 m**

4. ACCESSIBILITY How high is the ramp when it is 2 feet from the building? **22.3 ft**

5. AMUSEMENT PARKS The triangles in the figure are similar. How far is the water ride from the roller coaster? **21.4 m**

6. CLASS CHANGES The triangles in the figure are similar. How far is the entrance to the gymnasium from the band room? **38.4 m**
NAME ______________________ DATE ___________ PERIOD _____

Pre-Activity
Read the introduction at the top of page 188 in your textbook.
Write your answers below.

1. How is the caveman measuring the distance to the Sun? He is measuring the distance as if it were a flat surface directly in front of him.

Reading the Lesson

2. Complete the following sentence.
When you solve a problem using shadow reckoning, the objects being compared and their shadows form two sides of similar triangles.

3. Suppose that you are standing near a building and you see the shadows cast by you and the building. If you know the length of each of these shadows and you know how tall you are, write a proportion in words that you can use to find the height of the building. Sample answer:

   \[
   \frac{\text{shadow of the building}}{\text{my shadow}} = \frac{\text{height of the building}}{\text{my height}}
   \]

4. STATUE If a statue casts a 6-foot shadow and a 5-foot mailbox casts a 4-foot shadow, how tall is the statue? 7.5 ft

Helping You Remember

5. Work with a partner. Have your partner draw two triangles that are similar with the lengths of two corresponding sides labeled and the length of one additional side labeled. Tell your partner how to write a proportion to solve for the length of the side corresponding to the additional side labeled. See students' work.

Answers

1. HEIGHT Paco is 6 feet tall and casts a 12-foot shadow. At the same time, Diane casts an 11-foot shadow. How tall is Diane?
   \[5\frac{1}{2}\text{ ft}\]

2. LIGHTING If a 25-foot-tall house casts a 75-foot shadow at the same time that a streetlight casts a 60-foot shadow, how tall is the streetlight?
   \[20\text{ ft}\]

3. FLAGPOLE Lena is 5\frac{1}{2} feet tall and casts an 8-foot shadow. At the same time, a flagpole casts a 48-foot shadow. How tall is the flagpole?
   \[33\text{ ft}\]

4. LANDMARKS A woman who is 5 feet 5 inches tall is standing near the Space Needle in Seattle, Washington; she casts a 13-inch shadow at the same time that the Space Needle casts a 121-foot shadow. How tall is the Space Needle?
   \[614\text{ ft}\]

5. NATIONAL MONUMENTS A 42-foot flagpole near the Washington Monument casts a shadow that is 14 feet long. At the same time, the Washington Monument casts a shadow that is 185 feet long. How tall is the Washington Monument?
   \[555\text{ ft}\]

6. ACCESSIBILITY A ramp slopes upward from the sidewalk to the entrance of a building at a constant incline. If the ramp is 2 feet high when it is 5 feet from the sidewalk, how high is the ramp when it is 7 feet from the sidewalk?
   \[2.8\text{ ft}\]
### Indirect Measurement

A proportion can be used to determine the height of tall structures if three variables of the proportion are known. The three known variables are usually the height of the observer, the length of the observer’s shadow, and the length of the structure’s shadow. However, a proportion can be solved given any three of the four variables.

This chart contains information about various observers and tall buildings. Use proportions and your calculator to complete the chart of tall buildings of the world.

<table>
<thead>
<tr>
<th>Height of Observer</th>
<th>Length of Shadow</th>
<th>Building Location</th>
<th>Height of Building</th>
<th>Length of Shadow</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. 5 ft 8 in.</td>
<td>Natwest, London</td>
<td>600 ft</td>
<td>80 ft</td>
<td></td>
</tr>
<tr>
<td>2. 4 ft 9 in.</td>
<td>Columbia Seafirst Center, Seattle</td>
<td>954 ft</td>
<td>318 ft</td>
<td></td>
</tr>
<tr>
<td>3. 5 ft 10 in.</td>
<td>Wachovia Building, Winston-Salem</td>
<td>410 ft</td>
<td>82 ft</td>
<td></td>
</tr>
<tr>
<td>4. 6 ft 15 in.</td>
<td>Waterfront Towers, Honolulu</td>
<td>400 ft</td>
<td>83 ft 4 in.</td>
<td></td>
</tr>
<tr>
<td>5. 6 ft 1 ft</td>
<td>CN Tower, Toronto</td>
<td>1,821 ft</td>
<td>303 ft 6 in.</td>
<td></td>
</tr>
<tr>
<td>6. 5 ft 9 in.</td>
<td>Gateway Arch, St. Louis</td>
<td>630 ft</td>
<td>210 ft</td>
<td></td>
</tr>
<tr>
<td>7. 5 ft 3 in.</td>
<td>Eiffel Tower, Paris</td>
<td>984 ft</td>
<td>328 ft</td>
<td></td>
</tr>
<tr>
<td>8. 4 ft 8 in.</td>
<td>Texas Commerce Tower, Houston</td>
<td>1,002 ft</td>
<td>167 ft</td>
<td></td>
</tr>
<tr>
<td>9. 5 ft 6 in.</td>
<td>John Hancock Tower, Boston</td>
<td>790 ft</td>
<td>131 ft 8 in.</td>
<td></td>
</tr>
<tr>
<td>10. 5 ft 4 in.</td>
<td>Sears Tower, Chicago</td>
<td>1,454 ft</td>
<td>181 ft 9 in.</td>
<td></td>
</tr>
<tr>
<td>11. 5 ft 6 in.</td>
<td>Barnett Tower, Jacksonville</td>
<td>631 ft</td>
<td>105 ft 2 in.</td>
<td></td>
</tr>
</tbody>
</table>

### Example 1

Graph $\triangle ABC$ with vertices $A(-2, -1)$, $B(2, 3)$, and $C(2, -1)$. Then graph its image $\triangle A'B'C'$ after a dilation with a scale factor of $\frac{3}{2}$.

- $A(-2, -1) \rightarrow \left(-\frac{3}{2} \cdot 2, -\frac{3}{2} \cdot 1\right) \rightarrow A'\left(-3, -\frac{3}{2}\right)$
- $B(2, 3) \rightarrow \left(\frac{3}{2} \cdot 2, \frac{3}{2} \cdot 3\right) \rightarrow B'(3, 4\frac{1}{2})$
- $C(2, -1) \rightarrow \left(2 \cdot \frac{3}{2} \cdot 2, -1 \cdot \frac{3}{2}\right) \rightarrow C'(3, -\frac{3}{2})$

### Example 2

Segment $M'N'$ is a dilation of segment $MN$. Find the scale factor of the dilation and classify it as an enlargement or a reduction.

Write the ratio of the $x$- or $y$-coordinate of one vertex of the dilated figure to the $x$- or $y$-coordinate of the corresponding vertex of the original figure. Use the $x$-coordinates of $N(1, -2)$ and $N'(2, -4)$.

$x$-coordinate of point $N' = 2$ or $x$-coordinate of point $N' = \frac{2}{1}$

The scale factor is 2. Since the image is larger than the original figure, the dilation is an enlargement.
Practice: Word Problems

Dilations

1. **EYES**
   Dave’s optometrist used medicine to dilate his eyes. Before dilation, his pupils had a diameter of 4.1 millimeters. After dilation, his pupils had a diameter of 8.2 millimeters. What was the scale factor of the dilation?

2. **BIOLOGY**
   A microscope increases the size of objects by a factor of 8. How large will a 0.006 millimeter paramecium appear?

3. **PHOTOGRAPHY**
   A photograph was enlarged to a width of 15 inches. If the scale factor was \( \frac{1}{500} \), what was the width of the original photograph?

4. **MOVIES**
   Film with a width of 35 millimeters is projected onto a screen where the width is 5 meters. What is the scale factor of this enlargement?

5. **PHOTOCOPYING**
   A 10-inch long copy of a 2.5-inch long figure needs to be made with a copying machine. What is the appropriate scale factor?

6. **MODELS**
   A scale model of a boat is going to be made using a scale of \( \frac{5}{100} \). If the original length of the boat is 20 meters, what is the length of the model?

7. **MODELS**
   An architectural model is 30 inches tall. If the scale used to build the model is \( \frac{1}{200} \), what is the height of the actual building?

8. **ADVERTISING**
   An advertiser needs a 4-inch picture of a 14-foot automobile. What is the scale factor of the reduction?
Dilation and Area

A dilation of a shape creates a new shape that is similar to the original. The ratio of the new image to the original is called the scale factor.

Plot and draw each shape. Then perform the dilation of each shape using a scale factor of two. After the new image has been drawn, determine the area of both the original shape and its dilation. See students' work.

1. \(A(2, 1), B(7, 1), C(4, 4)\)
   - Area of original ________ 7.5 sq. units
   - Area of dilation ________ 30 sq. units

2. circle with radius (1, 2) to (4, 2)
   - Area of original ________ 28.26 sq. units
   - Area of dilation ________ 113.04 sq. units

3. \(R(3, 3), E(-3, -2), C(4, -2), U(4, 2)\)
   - Area of original ________ 28 sq. units
   - Area of dilation ________ 112 sq. units

4. \(S(-3, -3), Q(-3, -3), A(3, -3), R(3, 3)\)
   - Area of original ________ 36 sq. units
   - Area of dilation ________ 144 sq. units

5. What general statement can be made about the area of a figure when compared to its area after being dilated by scale factor 2? Accept logical responses; the area of a figure is 4 times greater when dilated by scale factor 2.
Chapter 4 Assessment Answer Key

Form 1
Page 225

1. __B__
2. __G__
3. __A__
4. __H__
5. __D__
6. __G__
7. __A__
8. __H__
9. __B__
10. __F__
11. __A__
12. __H__
13. __D__
14. __I__
15. __A__
16. __F__
17. __A__
18. __F__
19. __B__
20. __I__

B: _______ 7 m _______

(continued on the next page)

Form 2A
Page 227

1. __D__
2. __F__
3. __D__
4. __H__
5. __C__
6. __I__
7. __A__
8. __H__
9. __C__
10. __H__

(continued on the next page)
<table>
<thead>
<tr>
<th>Question</th>
<th>Form 2A (continued)</th>
<th>Form 2B</th>
<th>Form 2B</th>
</tr>
</thead>
<tbody>
<tr>
<td>11.</td>
<td>D</td>
<td>11.</td>
<td>D</td>
</tr>
<tr>
<td>12.</td>
<td>G</td>
<td>3.</td>
<td>A</td>
</tr>
<tr>
<td>14.</td>
<td>F</td>
<td>5.</td>
<td>B</td>
</tr>
<tr>
<td>15.</td>
<td>C</td>
<td>6.</td>
<td>H</td>
</tr>
<tr>
<td>16.</td>
<td>I</td>
<td>7.</td>
<td>B</td>
</tr>
<tr>
<td>17.</td>
<td>A</td>
<td>8.</td>
<td>I</td>
</tr>
<tr>
<td>18.</td>
<td>G</td>
<td>9.</td>
<td>D</td>
</tr>
<tr>
<td>B:</td>
<td>8 red marbles</td>
<td>10.</td>
<td>G</td>
</tr>
<tr>
<td></td>
<td></td>
<td>B:</td>
<td>12 green beans</td>
</tr>
</tbody>
</table>
Chapter 4 Assessment Answer Key

Form 2C
Page 231

1. _____ 0 _____
2. _____ 19:21 _____
3. _____ 7/12 _____
4. _____ 59.2 mi/h _____
   12 reams for $24.50;
   12 reams for $24.50 is
   about $2.04/ream and
   5 reams for $15.25 is
   $3.05/ream.
5. _____ 5 reams for $15.25 is
   about $3.05/ream.
6. _____ 0.1 in./min _____
7. _____ 0.02 in./min _____
8. _____ x; y _____
9. _____ 8; $8 for each hour _____
10. _____ 27 _____
11. _____ 16.5 _____

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12. _____ 7.2 laps _____
    Yes; corresponding
    angles are
    congruent and
    \[
    \frac{6}{3} = \frac{8}{4} = \frac{11}{5.5}.
    \]
13. _____ Sample answer: _____
    \[
    \frac{5}{2} = \frac{6}{x}; 2.4
    \]
14. _____ 1,868.75 mi _____
15. _____ 4,312.5 mi _____
16. _____ 72.8 in. _____
17. _____ 10 ft _____
18. _____ \( A'(-2\frac{1}{4}, 1\frac{1}{2}) \) _____
19. _____ \( B(1, 2\frac{1}{2}) C(1\frac{1}{4}, -\frac{1}{2}) \) _____
    \[
    D(-1\frac{1}{2}, -4)
    \]
20. _____ 2; enlargement _____

B: _____ 3 lb, 12 oz _____
Chapter 4 Assessment Answer Key

Form 2D
Page 233

1. −3

2. \(\frac{7}{11}\)

3. 17:22

4. 52.5 mi/h

5. $9.50 for 24 juice boxes; $14.60 for 36 boxes is about $0.41/box, and $9.50 for 24 boxes is about $0.40/box.

6. 4 tickets/min

7. 35 tickets/min

8. \(\frac{2}{3}\)

9. \(\frac{1}{10} : \frac{1}{10}\) gal/mi

10. 22.5

11. 12

12. 72 times

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13. Yes; corresponding angles are congruent and \(\frac{2}{4} = \frac{1}{2}\).

Sample answer:

\[\frac{12}{9} = \frac{5}{x}; 3.75\]

14. \(\frac{5}{9}\)

15. 30 mi

16. 660 mi

17. 22.4 ft

18. 31.25 ft

19. \(M\left(-\frac{2}{3}, -\frac{2}{3}\right)\)

\(N(-1, 1), O\left(\frac{1}{3}, 1\right)\)

\(P\left(1, \frac{1}{3}\right)\)

20. \(\frac{1}{2}\); reduction

\(G\left(-5\frac{1}{3}, 1\frac{1}{3}\right)\)

\(H\left(4, 2\frac{2}{3}\right)\)

B: \(I\left(6\frac{2}{3}, -8\right)\)
Chapter 4 Assessment Answer Key

Form 3
Page 235

1. 5:4

180 min for $35.95; 2. 120 min for $24.95 is about $0.21/min and 180 min for $35.95 is about $0.20/min.

3. 10 ft/min

Between 5 and 6 min; the line segment between these two times is horizontal.

4. 37.2 cells/day

5. -1

6. 1/2

7. -4;

8. 495 mi

9. 1,567.5 mi

10. 1.5

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11. 384 g

12. $401.25

Sample answer: \( \frac{16}{5} = \frac{20}{x}; 6.25 \)

Sample answer: \( \frac{90}{60} = \frac{75}{x}; 50 \text{ yd} \)

13. \( \frac{20^4}{9} \text{ m} \)

14. \( \frac{1}{70} \)

15. 120 m

16. 350 m

17. \( A(-8, \frac{2}{3}), B(-5, 16), \)

18. \( C(4, 6\frac{1}{2}), D(0, -2) \)

19. \( \frac{1}{2}; \text{ reduction} \)

B: 384 g
## Chapter 4 Assessment Answer Key

### Page 237, Extended Response Assessment Scoring Rubric

<table>
<thead>
<tr>
<th>Level</th>
<th>Specific Criteria</th>
</tr>
</thead>
<tbody>
<tr>
<td>4</td>
<td>The student demonstrates a <strong>thorough understanding</strong> of the mathematics concepts and/or procedures embodied in the task. The student has responded correctly to the task, used mathematically sound procedures, and provided clear and complete explanations and interpretations. The response may contain minor flaws that do not detract from the demonstration of a thorough understanding.</td>
</tr>
<tr>
<td>3</td>
<td>The student demonstrates an <strong>understanding</strong> of the mathematics concepts and/or procedures embodied in the task. The student's response to the task is essentially correct with the mathematical procedures used and the explanations and interpretations provided demonstrating an essential but less than thorough understanding. The response may contain minor errors that reflect inattentive execution of the mathematical procedures or indications of some misunderstanding of the underlying mathematics concepts and/or procedures.</td>
</tr>
<tr>
<td>2</td>
<td>The student has demonstrated only a <strong>partial understanding</strong> of the mathematics concepts and/or procedures embodied in the task. Although the student may have used the correct approach to obtaining a solution or may have provided a correct solution, the student's work lacks an essential understanding of the underlying mathematical concepts. The response contains errors related to misunderstanding important aspects of the task, misuse of mathematical procedures, or faulty interpretations of results.</td>
</tr>
<tr>
<td>1</td>
<td>The student has demonstrated a <strong>very limited understanding</strong> of the mathematics concepts and/or procedures embodied in the task. The student's response to the task is incomplete and exhibits many flaws. Although the student has addressed some of the conditions of the task, the student reached an inadequate conclusion and/or provided reasoning that was faulty or incomplete. The response exhibits many errors or may be incomplete.</td>
</tr>
<tr>
<td>0</td>
<td>The student has provided a <strong>completely incorrect</strong> solution or uninterpretable response, or no response at all.</td>
</tr>
</tbody>
</table>
1. a. A ratio is a comparison of two numbers by division.

\[ \text{b. 1 to 2; 1:4; } \frac{2}{4} \]

\[ \text{c. A proportion is an equation that shows that two ratios are equivalent.} \]

\[ \frac{1}{2} = \frac{x}{400} \]

\[ \frac{4}{2} = \frac{x}{400} \]

\[ 2x = 400 \quad 2x = 1600 \]

\[ x = 200 \text{ lbs cement} \quad x = 800 \text{ lbs gravel} \]

\[ \frac{5}{3} \text{ is the same as 5.6.} \]

\[ \frac{5.6}{8} = \frac{x}{2} \]

\[ 2(5.6) = 8x \]

\[ 11.2 = 8x \]

\[ x = 1.4 \]

The man’s shadow is 1.4 feet long.

\[ \text{d. All three involve using proportions and ratios to find a missing measurement.} \]

\[ \text{e. The scale factor would be smaller than 1 because it is the ratio of the dilated image to the original.} \]

2. a. Two polygons are similar if their corresponding angles are congruent and their corresponding sides are in proportion.

\[ \text{b. } AB \text{ and } EF; \ BC \text{ and } FG; \ CD \text{ and } GH; \]

\[ \text{and } DA \text{ and } HE; \text{ You can find the ratio of the lengths of one pair of corresponding sides where both lengths are known. Because the ratios of the lengths of all the corresponding sides are equal, you can use the ratio you found to form proportions to find the lengths of the sides whose lengths are not given— } BC, EF, \text{ and } GH. \]

\[ \text{c.} \]

\[ \text{8 ft} \quad \frac{3}{5} \text{ ft} \]

\[ \text{2 ft} \quad x \]
### Vocabulary Test/Review Page 238
1. false; run
2. false; equal
3. true
4. false; rate
5. true
6. false; similar
7. true
8. true
9. false; scale
10. false; ratio
11. a rate that is simplified so it has a denominator of 1
12. the parts of similar figures that “match”

### Quiz (Lessons 4-1 and 4-2) Page 239
1. \( \frac{4}{5} \)
2. \( \frac{3}{10} \)
3. \( \frac{11}{25} \)
4. \( \frac{3}{2} \)
5. 23 students/teacher
6. $92.50/chair
7. 2.75 students/computer
8. \( \frac{1}{2} \) cm/week
9. \( \frac{2}{3} \) cm/week
10. week 9 to week 15

### Quiz (Lessons 4-5 and 4-6) Page 240
1. \( \frac{x}{16} = \frac{9}{12}; x = 12 \)
2. \( \frac{8}{x} = \frac{20}{12}; x = 4.8 \)
3. 35 mi
4. 220 mi
5. B

### Quiz (Lessons 4-7 and 4-8) Page 240
1. 21.6 ft
2. 60 ft

### Quiz (Lessons 4-3 and 4-4) Page 239
1. \( \frac{3}{2} \)
2. \( -\frac{1}{2} \)
3. 24
4. 20
5. 3.25

Sample answer: \( x'(-3, -6), Y(6, 3), Z(12, -3) \)

Sample answer: \( x'(1\frac{1}{2}, -1), Y(0, 0), Z(2, 2) \)
Chapter 4 Assessment Answer Key

Mid-Chapter Test
Page 241

1. D

2. F

3. C

4. H

5. D

6. 99.5 copies/mo

7. \( \approx 138 \) copies/mo

8. 5.25 h

9. 16/mi

10. \( \frac{1}{2}, \frac{1}{2} \) gal of juice/student

Cumulative Review
Page 242

1. \(-4\)

2. \(-8\)

3. \(\frac{19}{45}\)

4. \(\frac{85}{6}\)

5. 256

6. 27

7. 9 or \(-9\)

8. whole, integer, rational

9. 15.7 units

10. 20

11. \$3.10/lb

12. \(-\frac{1}{2}\)

13. 12.5

14. 90 mi

15. 15 ft

16. \(\frac{3}{2}\); enlargement
1. A B C D

2. F G H I

3. A B C D

4. F G H I

5. A B C D

6. F G H I

7. A B C D

10. \[ \frac{8}{9} \]

11. \[ \frac{8}{8} \]

12. \[ \frac{3}{2} \]

13. \[ 36 \text{ ft} \]

14. a. 41 voters/h; Between 10 A.M. and 12 P.M. an average of 41 people voted each hour.

b. Between 2 P.M. and 3 P.M.; there was no change in the number of voters during this time period.

c. between 12 P.M. and 2 P.M.