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

<table>
<thead>
<tr>
<th>MHID</th>
<th>ISBN</th>
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<tbody>
<tr>
<td>Study Guide and Intervention Workbook 0-07-878871-4</td>
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<td>Skills Practice Workbook 0-07-878873-0</td>
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<td>Practice Workbook 0-07-878875-7</td>
<td>978-0-07-878875-8</td>
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<tr>
<td>Word Problem Practice Workbook 0-07-878877-3</td>
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Spanish Versions

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<td>978-0-07-878872-7</td>
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<td>Skills Practice Workbook 0-07-878874-9</td>
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<tr>
<td>Word Problem Practice Workbook 0-07-878878-1</td>
<td>978-0-07-878878-9</td>
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</table>

Answers for Workbooks  The answers for Chapter 11 of these workbooks can be found in the back of this Chapter Resource Masters booklet.

StudentWorks Plus™  This CD-ROM includes the entire Student Edition test along with the English workbooks listed above.

TeacherWorks Plus™  All of the materials found in this booklet are included for viewing, printing, and editing in this CD-ROM.


These masters contain a Spanish version of Chapter 11 Test Form 2A and Form 2C.
Teacher’s Guide to Using the
Chapter 11 Resource Masters

The Chapter 11 Resource Masters includes the core materials needed for Chapter 11. 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 on the TeacherWorks Plus™ CD-ROM.

Chapter Resources

Student-Built Glossary (pages 1–2) These masters are 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. Give this to students before beginning Lesson 11-1. Encourage them to add these pages to their mathematics study notebooks. Remind them to complete the appropriate words as they study each lesson.

Family Letter and Family Activity (pages 3–6) The letter informs your students' families of the mathematics they will be learning in this chapter. The family activity helps them to practice problems that are similar to those on the state test. A full solution for each problem is included. Spanish versions of these pages are also included. Give these to students to take home before beginning the chapter.

Anticipation Guide (pages 7–8) This master, presented in both English and Spanish, is a survey used before beginning the chapter to pinpoint what students may or may not know about the concepts in the chapter. Students will revisit this survey after they complete the chapter to see if their perceptions have changed.

Lesson Resources

Lesson Reading Guide Get Ready for the Lesson reiterates the questions from the beginning of the Student Edition lesson. Read the Lesson asks students to interpret the context of and relationships among terms in the lesson. Finally, Remember What You Learned asks students to summarize what they have learned using various representation techniques. Use as a study tool for note taking or as an informal reading assignment. It is also a helpful tool for ELL (English Language Learners).

Study Guide and Intervention This master provides vocabulary, key concepts, additional worked-out examples and Check Your Progress exercises to use as a reteaching activity. It can also be used in conjunction with the Student Edition as an instructional tool for students who have been absent.

Skills Practice This master focuses more on the computational nature of the lesson. Use as an additional practice option or as homework for second-day teaching of the lesson.

Practice This master closely follows the types of problems found in the Exercises section of the Student Edition and includes word problems. Use as an additional practice option or as homework for second-day teaching of the lesson.
**Word Problem Practice** This master includes additional practice in solving word problems that apply the concepts of the lesson. Use as an additional practice or as homework for second-day teaching of the lesson.

**Enrichment** These activities may extend the concepts of the lesson, offer an historical or multicultural look at the concepts, or widen students’ perspectives on the mathematics they are learning. They are written for use with all levels of students.

**Graphing Calculator, Scientific Calculator, or Spreadsheet Activities** These activities present ways in which technology can be used with the concepts in some lessons of this chapter. Use as an alternative approach to some concepts or as an integral part of your lesson presentation.

**Assessment Options**

The assessment masters in the *Chapter 11 Resource Masters* offer a wide range of assessment tools for formative (monitoring) assessment and summative (final) assessment.

**Student Recording Sheet** This master corresponds with the standardized test practice at the end of the chapter.

**Pre-AP Rubric** This master provides information for teachers and students on how to assess performance on open-ended questions.

**Quizzes** Four free-response quizzes offer assessment at appropriate intervals in the chapter.

**Mid-Chapter Test** This 1-page test provides an option to assess the first half of the chapter. It parallels the timing of the Mid-Chapter Quiz in the Student Edition and includes both multiple-choice and free-response questions.

**Vocabulary Test** This test is suitable for all students. It includes a list of vocabulary words and 10 questions to assess students’ knowledge of those words. This can also be used in conjunction with one of the leveled chapter tests.

**Leveled Chapter Tests**
- **Form 1** contains multiple-choice questions and is intended for use with below grade level students.
- **Forms 2A and 2B** contain multiple-choice questions aimed at on grade level students. These tests are similar in format to offer comparable testing situations.
- **Forms 2C and 2D** contain free-response questions aimed at on grade level students. These tests are similar in format to offer comparable testing situations.
- **Form 3** is a free-response test for use with above grade level students.

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

**Extended-Response Test** Performance assessment tasks are suitable for all students. Sample answers and a scoring rubric are included for evaluation.

**Standardized Test Practice** These three pages are cumulative in nature. It includes three parts: multiple-choice questions with bubble-in answer format, griddable questions with answer grids, and short-answer free-response questions.

**Answers**
- The answers for the Anticipation Guide and Lesson Resources are provided as reduced pages with answers appearing in red.
- Full-size answer keys are provided for the assessment masters.
This is an alphabetical list of new vocabulary terms you will learn in Chapter 11. 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>
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<th>Definition/Description/Example</th>
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<td>complex figure</td>
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<td>Vocabulary Term</td>
<td>Found on Page</td>
<td>Definition/Description/Example</td>
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<td>lateral face</td>
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<td>rectangular prism</td>
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<td>sphere</td>
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<td>three-dimensional figure</td>
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<td>triangular prism</td>
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<td>vertex (vertices)</td>
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<td>volume</td>
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</tbody>
</table>
Dear Parent or Guardian:

People who work in industries such as art, construction, and science study two-and-three-dimensional figures. Knowing how to calculate area, surface area, and volume helps us make decisions about how much material we need to cover and fill things.

In Chapter 11, Measurement: Two-and-Three-Dimensional Figures, your child will learn how to find the area of parallelograms, triangles, trapezoids, circles, and complex figures. Your child will also learn to identify and draw three-dimensional figures, to find the volume of rectangular prisms and cylinders, and to solve problems by solving a simpler problem. 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 you can do with your child that practices how the math we will be learning in Chapter 11 might be tested. You may also wish to log on to ca.gr6math.com for self-check quizzes and other study help. If you have any questions or comments, feel free to contact me at school.

Sincerely,

Signature of Parent or Guardian ____________________________ Date ____________
11

Family Activity

Standards Practice

Fold the page along the dashed line. Work each problem on another piece of paper. Then unfold the page to check your work.

1. A circular table has a diameter of 6 feet.

Which of the following is also true about this table?

A  The radius of this table is 2.5 feet.
B  The circumference of this circle is about 18.84 feet.
C  The area of this circle is about 18.84 square feet.
D  The area of this circle is about 109 square feet.

Solution

1. Hint: The radius of a circle is half of the diameter. The formula for circumference is $C = \pi d$ or $2\pi r$. The formula for the area of a circle is $A = \pi r^2$, and $\pi = 3.14$.

The radius of the table is half of the diameter, or 3, so Choice A is false.

The circumference of the circle is calculated below.

$$C = \pi d$$
$$\approx 3.14 \cdot 6 \text{ ft}$$
$$\approx 18.84 \text{ ft}$$

Option B is true.

The answer is B.

2. Mrs. Andrew's homeroom is collecting change to donate to the local homeless shelter. The container they are using is a cylinder.

What is the volume of the container?

A  140 square centimeters
B  879.2 square centimeters
C  980 cubic centimeters
D  3,077.2 cubic centimeters

Solution

2. The formula for the volume of a cylinder is $V = \pi r^2 h$, where $r$ represents the radius and $h$ represents the height.

The formula for the volume of the container is $V = \pi r^2 h$.

$$V \approx 3.14 \cdot (7\text{ cm})^2 \cdot 20 \text{ cm}$$
$$\approx 3,077.2 \text{ cm}^3$$

Notice that the units are cubed because we multiplied cm by cm$^2$. Units to express volume are always cubic.

The answer is D.
Estimado padre o apoderado:

Los que trabajan en la industria del arte, la construcción y la ciencia, estudian figuras bidimensionales y tridimensionales. Saber calcular el área, el área de superficie y el volumen nos ayuda a tomar decisiones sobre cuánto material necesitamos para cubrir y rellenar cosas.

En el Capítulo 11, Medición: Figuras bidimensionales y tridimensionales, su hijo(a) aprenderá a calcular el área de paralelogramos, triángulos, trapecios, círculos y figuras complejos. Su hijo también aprenderá a identificar y dibujar figuras tridimensionales, a calcular el volumen de prismas y cilindros rectangulares y a resolver problemas resolviendo otros más simples. En el estudio de este capítulo, su hijo(a) completará una variedad de tareas y actividades diarias y es posible que trabaje en un proyecto del capítulo.

Al firmar esta carta y devolverla con su hijo(a), usted se compromete a ayudarlo(a) a participar en su aprendizaje. Junto con esta carta, va incluida una actividad que puede realizar con él(ella) y la cual practica lo que podrían encontrar en las pruebas de los conceptos matemáticos que aprenderán en el Capítulo 11. Además, visiten ca.gr6math.com para ver autocontroles y otras ayudas para el estudio. Si tiene cualquier pregunta o comentario, por favor contácteme en la escuela.

Cordialmente,

Firma del padre o apoderado _____________________________  Fecha ____________
Actividad en familia

Práctica de estándares

Doblen la página a lo largo de las líneas punteadas. Resuelvan cada problema en otra hoja de papel. Luego, desdoblen la página y revisen las respuestas.

1. Una mesa circular tiene un diámetro de 6 pies.

¿Cuál de los siguientes también se cumple con respecto a esta mesa?

A El radio de esta mesa mide 2.5 pies.
B La circunferencia de este círculo es alrededor de 18.84 pies.
C El área de este círculo es de unos 18.84 pies cuadrados.
D El área de este círculo es de unos 109 pies cuadrados.

La opción A es falsa.

La circunferencia del círculo se calcula a continuación.

\[ C = \pi d \approx 3.14 \cdot 6 \text{ pies} \approx 18.84 \text{ pies} \]

La opción B es verdadera.

La respuesta es B.

2. El aula de la Sra. Andrew recoge monedas para donarlas a un refugio local de desamparados. Utilizan un cilindro como recipiente.

¿Cuál es el volumen del recipiente?

A 140 centímetros cuadrados
B 879.2 centímetros cuadrados
C 980 centímetros cúbicos
D 3,077.2 centímetros cúbicos

La respuesta es D.

La fórmula para el volumen de un cilindro es \( V = \pi r^2 h \), donde \( r \) es el radio y \( h \) es la altura.

La fórmula para el volumen del recipiente es \( V = \pi r^2 h \).

\[ V \approx 3.14 \cdot (7\text{cm})^2 \cdot 20\text{ cm} \]

\[ \approx 3,077.2 \text{ cm}^3 \]

Noten que las unidades son cúbicas porque multiplicamos cm por cm\(^2\). Para expresar el volumen siempre se usan unidades cúbicas.

La respuesta es D.
Anticipation Guide

Measurement: Two- and Three-Dimensional Figures

Step 1

Before you begin Chapter 11

- Read each statement.
- Decide whether you Agree (A) or Disagree (D) with the statement.
- Write A or D in the first column OR if you are not sure whether you agree or disagree, write NS (Not Sure).

<table>
<thead>
<tr>
<th>STEP 1 A, D, or NS</th>
<th>Statement</th>
<th>STEP 2 A or D</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>The area of a parallelogram is the product of the length of its base and the length of its side.</td>
<td></td>
</tr>
<tr>
<td>2.</td>
<td>The area of a triangle can be found if the length of the base and the height is known.</td>
<td></td>
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<tr>
<td>3.</td>
<td>The area of any figure is given in square units.</td>
<td></td>
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<tr>
<td>4.</td>
<td>The diameter of a circle is the distance from the center to any point of the circle.</td>
<td></td>
</tr>
<tr>
<td>5.</td>
<td>The circumference of a circle equals the product of ( \pi ) and ( r^2 ), where ( r ) is the radius of the circle.</td>
<td></td>
</tr>
<tr>
<td>6.</td>
<td>( A = \pi(10)^2 ) is the area of a circle with a diameter of 10 units.</td>
<td></td>
</tr>
<tr>
<td>7.</td>
<td>The area of an irregular shape may be found by separating the shape into geometric shapes with known area formulas, then finding the sum of the areas of each smaller shape.</td>
<td></td>
</tr>
<tr>
<td>8.</td>
<td>A rectangular prism has 6 faces and 8 vertices.</td>
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<tr>
<td>9.</td>
<td>All the faces of a pyramid must be triangles.</td>
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<tr>
<td>10.</td>
<td>The top view of a rectangular solid could be a rectangle or a square.</td>
<td></td>
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<tr>
<td>11.</td>
<td>A rectangular prism with a volume of 90 cubic units could have dimensions of 3, 4, and 6 units.</td>
<td></td>
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<tr>
<td>12.</td>
<td>Since the base of a cylinder is a circle, the formula for the area of a circle is part of the formula for the volume of a cylinder.</td>
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</tbody>
</table>

Step 2

After you complete Chapter 11

- Reread each statement and complete the last column by entering an A or a D.
- Did any of your opinions about the statements change from the first column?
- For those statements that you mark with a D, use a piece of paper to write an example of why you disagree.
### Ejercicios preparatorios

**Medición: Figuras bidimensionales y tridimensionales**

#### PASO 1

**Antes de comenzar el Capítulo 11**

- Lee cada enunciado.
- Decide si estás de acuerdo (A) o en desacuerdo (D) con el enunciado.
- Escribe A o D en la primera columna O si no estás seguro(a) de la respuesta, escribe NS (No estoy seguro(a)).

<table>
<thead>
<tr>
<th>PASO 1 A, D o NS</th>
<th>Enunciado</th>
<th>PASO 2 A o D</th>
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<tbody>
<tr>
<td>1.</td>
<td>El área de un paralelogramo es el producto de la longitud de su base por la longitud de su lado.</td>
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<tr>
<td>2.</td>
<td>El área de un triángulo se puede calcular si se conocen la longitud de la base y la altura.</td>
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<tr>
<td>3.</td>
<td>El área de cualquier figura se da en unidades cuadradas.</td>
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<tr>
<td>4.</td>
<td>El diámetro de un círculo es la distancia desde el centro a cualquier punto del círculo.</td>
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<tr>
<td>5.</td>
<td>La circunferencia de un círculo es igual al producto de $\pi$ y $r^2$, donde $r$ es el radio del círculo.</td>
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<tr>
<td>6.</td>
<td>$A = \pi(10)^2$ es el área de un círculo con diámetro de 10 unidades.</td>
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<tr>
<td>7.</td>
<td>Puede calcularse el área de una figura irregular al separar la figura en figuras geométricas cuyas fórmulas de área se conocen y luego sumar las áreas de cada figura más pequeña.</td>
<td></td>
</tr>
<tr>
<td>8.</td>
<td>Un prisma rectangular tiene 6 caras y 8 vértices.</td>
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<tr>
<td>9.</td>
<td>Todas las caras de una pirámide deben ser triángulos.</td>
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<tr>
<td>10.</td>
<td>La vista superior de un sólido rectangular puede ser un rectángulo o un cuadrado.</td>
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<tr>
<td>11.</td>
<td>Un prisma rectangular con volumen de 90 unidades cúbicas puede tener dimensiones de 3, 4 y 6 unidades.</td>
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</tr>
<tr>
<td>12.</td>
<td>Dado que la base de un cilindro es un círculo, la fórmula del área para un círculo es parte de la fórmula del volumen para un cilindro.</td>
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#### PASO 2

**Después de completar el Capítulo 11**

- Vuelve a leer cada enunciado y completa la última columna con una A o una D.
- ¿Cambió cualquiera de tus opiniones sobre los enunciados de la primera columna?
- En una hoja de papel aparte, escribe un ejemplo de por qué estás en desacuerdo con los enunciados que marcaste con una D.
Lesson Reading Guide

Area of Parallelograms

Get Ready for the Lesson

Complete the Mini Lab at the top of page 572 in your textbook. Write your answers below.

1. What is the value of \( x \) and \( y \) for each parallelogram?

2. Count the grid squares to find the area of each parallelogram.

3. On grid paper, draw three different parallelograms in which \( x = 5 \) units and \( y = 4 \) units. Find the area of each.

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4. **MAKE A CONJECTURE** about how to find the area of a parallelogram if you know the values of \( x \) and \( y \).

Read the Lesson

5. Explain how to find the height of a parallelogram.

6. Suppose you are asked to find the area of the parallelogram below. Is the given solution correct? Explain.

```
A = bh
A = 12 \cdot 5
A = 60
```

The area of the parallelogram is 60 square centimeters.

Remember What You Learned

7. Because rectangles, rhombuses, and squares are all parallelograms, the formula for finding the area of a parallelogram is also used to find the areas of each of these figures. Think of a way to remember that the area of a parallelogram is the product of its base and height. For example, draw several parallelograms, rectangles, rhombuses, and squares and label the base and height for each. Write the formula for the area below each model.
The area \( A \) of a parallelogram equals the product of its base \( b \) and its height \( h \).

\[
A = bh
\]

**Example 1** Find the area of a parallelogram if the base is 6 inches and the height is 3.7 inches.

Estimate \( A = 6 \cdot 4 \) or 24 in\(^2\)

\[
A = bh
\]

Area of a parallelogram

\[
A = 6 \cdot 3.7
\]

Replace \( b \) with 6 and \( h \) with 3.7.

\[
A = 22.2
\]

Multiply.

The area of the parallelogram is 22.2 square inches. This is close to the estimate.

**Example 2** Find the area of the parallelogram at the right.

Estimate \( A = 10 \cdot 10 \) or 100 cm\(^2\)

\[
A = bh
\]

Area of a parallelogram

\[
A = 12 \cdot 8
\]

Replace \( b \) with 12 and \( h \) with 8.

\[
A = 96
\]

Multiply.

The area of the parallelogram is 96 square centimeters. This is close to the estimate.

**Exercises**

Find the area of each parallelogram. Round to the nearest tenth if necessary.

1. 
   \[
   \begin{array}{c}
   \text{13.2 ft} \\
   \text{5 ft}
   \end{array}
   \]

2. 
   \[
   \begin{array}{c}
   \text{8 mm} \\
   \text{4.6 mm}
   \end{array}
   \]

3. 
   \[
   \begin{array}{c}
   \text{17 in.} \\
   \text{16 in.}
   \end{array}
   \]
Find the area of each parallelogram. Round to the nearest tenth if necessary.

1. base = 5 ft  
   height = 12 ft

2. base = 9 in.  
   height = 2 in.

3. base = 6 cm  
   height = 5.5 cm

4. base = \(4\frac{2}{5}\) yd  
   height = 2 yd

5. base = 15.3 mm  
   height = 8 mm

6. base = 19.6 m  
   height = 14.5 m

7. base = 7 yd  
   height = 24 ft

8. base = 2\(\frac{3}{4}\) mm  
   height = 11 mm

9. base = 2.3 cm  
   height = 2 cm

10. base = 11 mm  
    height = 15 mm

11. base = 20 in.  
    height = 11\(\frac{4}{5}\) in.

12. base = 12 ft  
    height = 9 ft

13. base = 4.3 mm  
    height = 12 mm

14. base = 24 ft  
    height = 7 yd
Practice

Area of Parallelograms

Find the area of each parallelogram. Round to the nearest tenth if necessary.

1. \[
\text{Base} = 4.5 \text{ mm} \quad \text{Height} = 8.2 \text{ mm}
\]

2. \[
\text{Base} = 12 \text{ m} \quad \text{Height} = 5.2 \text{ yd}
\]

3. \[
\text{Base} = 1 \text{ yd} \quad \text{Height} = 3 \text{ ft}
\]

4. \[
\text{Base} = 8 \text{ in.} \quad \text{Height} = 7 \frac{1}{2} \text{ in.}
\]

5. \[
\text{Base} = 0.9 \text{ cm} \quad \text{Height} = 0.7 \text{ cm}
\]

6. \[
\text{Base} = 14 \text{ ft} \quad \text{Height} = 13 \text{ ft}
\]

7. \[
\text{Base} = 18 \text{ ft} \quad \text{Height} = 3 \text{ yd}
\]

8. \[
\text{Base} = 15 \text{ in.} \quad \text{Height} = 2 \text{ ft}
\]

9. \[
\text{Base} = 24 \text{ in.} \quad \text{Height} = 1.5 \text{ yd}
\]

GEOGRAPHY Estimate the area of each state.

10. Iowa

11. New Jersey

12. ALGEBRA A parallelogram has an area of 240 square meters. Find the height of the parallelogram if the base is 20 meters.

13. ALGEBRA What is the base of a parallelogram if the height is 5 feet and the area is 65 square feet?
1. **SAILS** Joyce wants to construct a sail with the dimensions shown. How much material will be used?

   ![Sails Diagram]

2. **SIGNS** Pedro wants to make the sign in the shape shown and needs to know how much material will be needed. What is the area of the sign?

   ![Signs Diagram]

3. **SHADING** Alma’s engineering firm must determine the area of the largest noontime shadow that a proposed building design will create. What is the area of the shadow?

   ![Shading Diagram]

4. **POOLS** Tamika has designed a pool in the shape shown. What is the area of the bottom of the pool if the surface is perfectly flat?

   ![Pools Diagram]

5. **CITY PLANNING** Two parallel streets are cut across by two other parallel streets as shown in the figure, cutting off a parcel of land in the shape of a parallelogram. Find the area of the parcel of land.

   ![City Planning Diagram]

6. **TARPS** Neka wants to cut a tarp in the shape shown. What is the minimum amount of canvas cloth that he will need?

   ![Tarps Diagram]
Two Area Puzzles

Cut out the five puzzle pieces at the bottom of this page. Then use them to solve these two puzzles.

1. Use all five puzzle pieces to make a square with an area of 9 square inches. Record your solution below.

2. Use the four largest pieces to make a square with an area of 8 square inches. Record your solution below.
11-1

Spreadsheet Activity

Areas of Parallelograms

You can use a spreadsheet to determine the area of a parallelogram.

**Example 1**

Use a spreadsheet to find the area of a parallelogram with base equal to 5 inches and height equal to 4 inches.

**Step 1** Use cell A1 of the spreadsheet for the base of the parallelogram and cell B1 for the height of the parallelogram.

**Step 2** In cell C1, enter an equals sign followed by the formula for the area of a parallelogram. The formula should be =A1*B1. Then press ENTER to return the area.

The area of the parallelogram is 20 square inches.

**Example 2**

Use a spreadsheet to find the area of a parallelogram with base equal to 2.5 centimeters and height equal to 3.5 centimeters.

**Step 3** Enter the base in cell A2 and the height in cell B2.

**Step 4** Click on the bottom right corner of cell C1 and drag it to C2. This returns the area of the parallelogram.

The area of the parallelogram is 8.75 square centimeters.

**Exercises**

Use a spreadsheet to find the areas of the given parallelograms.

1. $b = 3$ in., $h = 6$ in.  
2. $b = 2$ in., $h = 5$ in.  
3. $b = 5$ in., $h = 1$ in.

4. $b = 7$ in., $h = 3$ in.  
5. $b = 3.5$ m, $h = 1.5$ m  
6. $b = 2.2$ m, $h = 1.7$ m

7. $b = 1.5$ m, $h = 0.1$ m  
8. $b = 5.7$ m, $h = 9.1$ m  
9. $b = 0.5$ m, $h = 0.3$ m
Lesson Reading Guide

Area of Triangles and Trapezoids

Get Ready for the Lesson

Complete the Mini Lab at the top of page 578 in your textbook. Write your answers below.

1. What is the area of the parallelogram?

2. Cut along the diagonal. What is true about the triangles formed?

3. What is the area of each triangle?

4. If the area of a parallelogram is \(bh\), then write an expression for the area \(A\) of each of the two congruent triangles that form the parallelogram.

Read the Lesson

5. In a triangle, which side is the base?

6. How do you find the height of a triangle?

7. For what kind of triangle might the height be found outside of the triangle?

8. How is the height of a trapezoid similar to the height of a triangle or parallelogram?

Remember What You Learned

9. The Mini Lab in this lesson gave you a good way to remember the formula for the area of a triangle by showing you that it is half the area of a parallelogram, so \(A = \frac{1}{2}bh\). Think of a way to help you remember the formula for the area of a trapezoid. Do you recognize anything in the formula \(A = \frac{1}{2}h(b_1 + b_2)\)?
The area $A$ of a triangle equals half the product of its base $b$ and its height $h$.

$$A = \frac{1}{2}bh$$

A trapezoid has two bases, $b_1$ and $b_2$. The height of a trapezoid is the distance between the two bases. The area $A$ of a trapezoid equals half the product of the height $h$ and the sum of the bases $b_1$ and $b_2$.

$$A = \frac{1}{2}h(b_1 + b_2)$$

### Example 1

**Find the area of the triangle.**

**Estimate** $\frac{1}{2}(6)(5) = 15$

$$A = \frac{1}{2}bh$$

Area of a triangle

$$A = \frac{1}{2} \cdot 6 \cdot 4.5$$

Replace $b$ with 6 and $h$ with 4.5.

$$A = 13.5$$

Multiply.

The area of the triangle is 13.5 square inches. This is close to the estimate.

### Example 2

**Find the area of the trapezoid.**

$$A = \frac{1}{2}h(b_1 + b_2)$$

Area of a trapezoid

$$A = \frac{1}{2}(4)(3 + 6)$$

Replace $h$ with 4, $b_1$ with 3, and $b_2$ with 6.

$$A = 18$$

Simplify.

The area of the trapezoid is 18 square centimeters.

### Exercises

Find the area of each figure. Round to the nearest tenth if necessary.

1. \[ \text{Triangle with base 12 ft, height 7 ft} \]
2. \[ \text{Triangle with base 9 mm, height 7 mm} \]
3. \[ \text{Trapezoid with bases 14 in. and 7 in., height 7 in.} \]
4. \[ \text{Trapezoid with bases 8 cm and 13.5 cm, height 18 cm} \]
11-2  

Skills Practice  

Area of Triangles and Trapezoids  

Find the area of each figure. Round to the nearest tenth if necessary.

1.  

[Diagram of a triangle with base 10 cm and height 9 cm]

2.  

[Diagram of a triangle with base 2 ft and height 3 ft]

3.  

[Diagram of a trapezoid with bases 12 mm and 10 mm, height 18 mm]

4.  

[Diagram of a trapezoid with bases 3 ft and 4 ft, height 6.5 ft]

5.  

[Diagram of a trapezoid with bases 9.2 cm and 7 cm, height 2 cm]

6.  

[Diagram of a triangle with base 20.7 mm and height 24 mm]

7.  

[Diagram of a trapezoid with bases 12 ft and 25 ft, height 12 ft]

8.  

[Diagram of a triangle with base 6.9 in. and height 5.6 in.]

9.  

[Diagram of a triangle with base 12.2 cm and height 7.5 cm]

10.  

[Diagram of a trapezoid with bases 14 mm and 15.3 mm, height 3.8 mm]

11. triangle: base = 16 cm, height = 9.4 cm

12. triangle: base = 13.5 in., height = 6.4 in.

13. trapezoid: bases 22.8 mm and 19.7 mm, height 36 mm

14. trapezoid: bases 5 ft and $3\frac{1}{2}$ ft, height 7 ft
Find the area of each figure. Round to the nearest tenth if necessary.

1. \[ \text{Area} = \frac{1}{2} \times 11 \times 7 = 38.5 \text{ ft}^2 \]

2. \[ \text{Area} = \frac{1}{2} \times 5 \times 5\frac{3}{4} = 27.125 \text{ in}^2 \]

3. \[ \text{Area} = \frac{1}{2} \times 4 \times 3.6 = 7.2 \text{ m}^2 \]

4. \[ \text{Area} = \frac{1}{2} \times 12 \times 18.4 = 106.8 \text{ cm}^2 \]

5. \[ \text{Area} = \frac{1}{2} \times 3\frac{1}{2} \times 9 = 15.5625 \text{ yd}^2 \]

6. \[ \text{Area} = \frac{1}{2} \times 7 \times 10.1 = 35.45 \text{ mm}^2 \]

7. GEOGRAPHY The shape of Arkansas is roughly trapezoidal with bases of 150 miles and 250 miles and a height of 260 miles. What is the approximate area of Arkansas?

\[ \text{Area} = \frac{1}{2} \times (150 + 250) \times 260 = 27,300 \text{ mi}^2 \]

ALGEBRA Find the height of each figure.

8. Area = 23,000 m$^2$

\[ \text{Area} = \frac{1}{2} \times 125 \times x = 23,000 \]

\[ x = \frac{23,000 \times 2}{125} = 376 \text{ m} \]

9. Area = 6,460 in$^2$

\[ \text{Area} = \frac{1}{2} \times 196 \times 136 = 6,460 \]

\[ x = \frac{2 \times 6,460}{136} = 96 \text{ in} \]

Draw and label each figure. Then find the area.

10. a trapezoid with a height less than 5 feet and an area greater than 50 square feet

11. a right triangle with a base greater than 10 meters and an area greater than 75 square meters
### Word Problem Practice

#### Area of Triangles and Trapezoids

1. **GEOGRAPHY** Arkansas has a shape that is similar to a trapezoid with bases of about 182 miles and 267 miles and a height of about 254 miles. Estimate the area of the state.

2. **PATIOS** Greta is making a patio with the dimensions given in the figure. What is the area of the patio?
   - ![Diagram of a trapezoidal patio]

3. ** FLAGS** Malila wants to make the International Marine Signal flag shown which represents the number six. What is the area of the flag?
   - ![Diagram of a triangular flag]

4. **SIGNS** Estimate the area of the yield sign.
   - ![Diagram of a yield sign]

5. **TILING** A ceramics company wants to produce tiles in the shape shown. What is the area of the surface of each tile?
   - ![Diagram of a triangular tile]

6. **GARDENING** Kinu wants to buy topsoil for a section of her garden that has the dimensions shown in the figure. What is the area of this section of Kinu’s garden?
   - ![Diagram of a triangular garden section]
Heron’s Formula

A formula named after Heron of Alexandria, Egypt, can be used to find the area of a triangle given the lengths of its sides.

**Heron’s formula** states that the area $A$ of a triangle whose sides measure $a$, $b$, and $c$ is given by

$$A = \sqrt{s(s-a)(s-b)(s-c)},$$

where $s$ is the semiperimeter:

$$s = \frac{a + b + c}{2}.$$

Estimate the area of each triangle by finding the mean of the inner and outer measures. Then use Heron’s Formula to compute a more exact area. Give each answer to the nearest tenth of a square unit.

1. Estimated area: __________________________ Computed area: __________________________

2. Estimated area: __________________________ Computed area: __________________________

3. Estimated area: __________________________ Computed area: __________________________

4. Estimated area: __________________________ Computed area: __________________________

5. Estimated area: __________________________ Computed area: __________________________

6. Estimated area: __________________________ Computed area: __________________________
Chapter 11  

22  

Glencoe California Mathematics, Grade 6
A circle is the set of all points in a plane that are the same distance from a given point, called the center. The diameter $d$ is the distance across the circle through its center. The radius $r$ is the distance from the center to any point on the circle. The circumference $C$ is the distance around the circle. The circumference $C$ of a circle is equal to its diameter $d$ times $\pi$, or 2 times its radius $r$ times $\pi$.

**Example 1** Find the circumference of a circle with a diameter of 7.5 centimeters.

\[
C = \pi d
\]

Circumference of a circle.

\[
C \approx 3.14 \times 7.5
\]

Replace $\pi$ with 3.14 and $d$ with 7.5.

\[
C \approx 23.55
\]

The circumference of the circle is about 23.55 centimeters.

**Example 2** If the radius of a circle is 14 inches, what is its circumference?

\[
C = 2\pi r
\]

\[
C \approx 2 \times 3.14 \times 14
\]

Replace $\pi$ with 3.14 and $r$ with 14.

\[
C \approx 87.92
\]

The circumference of the circle is about 87.92 inches.

**Exercises**

Find the circumference of each circle. Use 3.14 for $\pi$. Round to the nearest tenth if necessary.

1. diameter = 6 ft
2. diameter = 20 cm
3. diameter = 5 m
4. diameter = 7.5 in.
5. diameter = 15 km
6. radius = 21 mi
7. radius = 50 m
8. diameter = 600 ft
9. radius = 62 mm
10. diameter = 7 km
11. radius = 95 in.
12. diameter = 6.3 m
13. diameter = $5\frac{1}{4}$ cm


**11-3 Skills Practice**  
**Circles and Circumference**

Find the circumference of each circle. Use 3.14 for \( \pi \). Round to the nearest tenth if necessary.

1. \( \text{radius} = 4 \text{ in.} \)  
2. \( \text{radius} = 15 \text{ cm} \)  
3. \( \text{radius} = 8 \text{ ft} \)  
4. \( \text{radius} = 21 \text{ m} \)  
5. \( \text{radius} = 16 \text{ km} \)  
6. \( \text{radius} = 37 \text{ mm} \)  
7. \( \text{radius} = 3 \text{ km} \)  
8. \( \text{radius} = 46 \text{ cm} \)  
9. \( \text{diameter} = 30 \text{ in.} \)  
10. \( \text{diameter} = 25 \text{ m} \)  
11. \( \text{radius} = 5 \text{ ft} \)  
12. \( \text{diameter} = 9\frac{1}{2} \text{ in.} \)  
13. \( \text{radius} = 3\frac{1}{2} \text{ ft} \)  
14. \( \text{diameter} = 9.7 \text{ mm} \)  
15. \( \text{radius} = 5.2 \text{ km} \)  
16. \( \text{diameter} = 12 \text{ m} \)  
17. \( \text{radius} = 22 \text{ ft} \)  
18. \( \text{diameter} = 9.4 \text{ in.} \)  
19. \( \text{radius} = 100 \text{ m} \)  
20. \( \text{radius} = 65 \text{ mi} \)  
21. \( \text{diameter} = 10\frac{1}{2} \text{ in.} \)  
22. \( \text{diameter} = 8.5 \text{ cm} \)
Find the circumference of each circle. Use 3.14 for \( \pi \). Round to the nearest tenth if necessary.

1. \( 2.4 \text{ cm} \)
2. \( 28 \text{ ft} \)
3. \( 1.5 \text{ yd} \)
4. \( 4.2 \text{ mm} \)
5. \( 12 \text{ m} \)
6. \( 7 \text{ in.} \)

7. radius = \( 2\frac{1}{3} \text{ ft} \)
8. radius = 11.9 m
9. diameter = \( 5\frac{5}{6} \text{ mi} \)
10. radius = \( 6\frac{1}{8} \text{ in.} \)
11. diameter = \( 17\frac{1}{2} \text{ ft} \)
12. radius = 9.2 km

Estimate to find the approximate circumference of each circle. Explain which approximation of \( \pi \) you used.

13.
14.
15.

ALGEBRA Find the diameter or radius of each circle. Use 3.14 for \( \pi \). Round to the nearest tenth if necessary.

16. \( C = 32 \text{ m} \), diameter = ___
17. \( C = 55 \text{ mi} \), radius = ___

18. HELICOPTERS The landing circle for helicopters on the roof of a hospital has a radius of 20 yards. To the nearest yard, find its circumference.

19. SPA A circular spa has a diameter of 12 feet. The spa is decorated with 4-inch porcelain tiles around the rim. How many tiles surround the rim of the spa? Round to the nearest whole tile.
### Word Problem Practice

#### Circles and Circumference

1. **PLATES** A manufacturing company is producing dinner plates with a diameter of 12 inches. They plan to put a gold edge on each plate. Determine how much gold edging they need for each plate by finding the circumference of each plate. Round to the nearest tenth.

2. **MONEY** A dime has a radius of $\frac{8}{2}$ millimeters. Find the circumference of a dime to the nearest tenth.

3. **MERRY-GO-ROUND** Mr. Osterhout is putting trim around the edge of a circular merry-go-round that has a diameter of 15 feet. How much trim does he need to buy to the nearest tenth?

4. **PIZZA** Find the circumference of a pizza with a diameter of 10 inches. Round to the nearest tenth.

5. **RACING** A circular racetrack has a diameter of $\frac{1}{2}$ mile. How far does a car travel in one lap around the track? Round to the nearest tenth.

6. **TIRE** A bicycle tire has a radius of 15 inches. What is the circumference of the tire? Round to the nearest tenth.

7. **EQUATOR** Earth’s diameter at the equator is 7,926 miles. Find the distance around Earth at its equator to the nearest tenth.

8. **SATURN** The ring system around Saturn has a diameter of 170,000 miles. Find the circumference of the ring system.
Finding the Length of an Arc

Recall that the circumference is the measure of the distance around a circle. A portion of the circumference is called an arc. An arc is named by the endpoints of the radii that create it. To find the measure of an arc, you can use a proportion. The ratio of the arc length to the circumference is equal to the ratio of the central angle of the arc to 360°.

To find the measure of \( \overline{AB} \), first set up the ratio. \[
\frac{m\overline{AB}}{2\pi r} = \frac{\angle ACB}{360°}
\]

Next, fill in the known values.

Simplify the fraction.

Then solve for \( m\overline{AB} \).

\[
m\overline{AB} = \frac{4\pi}{9} \approx 1.40 \text{ cm}
\]

Solve the following problems.

1. A circle has a circumference of 48 centimeters. Find the length of an arc that has a central angle of 90°. \[
\frac{m\overline{AB}}{48} = \frac{90°}{360°}
\]

2. A circle has a circumference of 112 meters. The length of \( \overline{DF} \) is 14 meters. Find the measure of the central angle of \( \overline{DF} \). \[
\frac{14}{112} = \frac{x}{360°}
\]

3. A circle has a radius of 5 inches. Find the length of an arc that has a central angle of 72°. \[
\frac{m\overline{AB}}{10\pi} = \frac{72°}{360°}
\]

4. Two arcs in a circle have central angles of 135° and 45°. Find the ratio of the arcs’ lengths. \[
\frac{135°}{45°}
\]

5. \( \overline{AB} \) has a central angle of 50° in a circle whose diameter is 12 feet, while \( \overline{DEF} \) has a central angle of 150° in a circle whose diameter is 3 feet.

Which of these two arcs is longer? Explain.
Spreadsheet Activity

Exploring the Value of $\pi$

You can use a spreadsheet to explore the value of $\pi$. You will need at least 10 different circular items. These could be cups, lids, cans, or even the circular markings on the gym floor or the outline of a basketball hoop. Carefully measure the circumference of each item with a piece of string. Then use a metric ruler to record the measurement in millimeters. Also record the measure of the diameter of each object in millimeters.

Create a spreadsheet with three columns. In column A, enter the circumferences of the items you measured. In column B, enter the diameters. In column C, create a formula for the value of $\pi$ using circumference and diameter. Let the spreadsheet calculate the value for as many decimal places as it can.

Your spreadsheet should look like this.

<table>
<thead>
<tr>
<th>A</th>
<th>B</th>
<th>C</th>
</tr>
</thead>
<tbody>
<tr>
<td>27</td>
<td>8</td>
<td>3.375</td>
</tr>
</tbody>
</table>

Use your spreadsheet to answer the following questions.

1. What is the value of $\pi$ used by your spreadsheet?

2. How close are your calculations to the actual value of $\pi$? To how many decimal places are your calculations correct?

3. What causes your calculations of $\pi$ not to be exact?

4. What could make your calculations more exact?

5. Suppose you created another spreadsheet with the same columns as this one. The new spreadsheet calculates the diameter when given the circumference and the value of $\pi$. What formula would you enter in column B?

6. If you create another spreadsheet that calculates the circumference when given the diameter and the value of $\pi$, what formula would you enter in column A?
11-3 TI-73 Activity
Calculating Circumference

The \( \text{2nd} \) \([\pi]\) key makes it easier to evaluate expressions that use the constant \( \pi \).

**Example**

Find the circumference of a circle with a radius of 8 meters. Express your answer to the nearest tenth.

\[
C = 2\pi r
\]

\[
2 \text{ 2nd} \ [\pi] \ 8 \ \text{ENTER}
\]

The circumference is about 50.3 meters.

**Exercises**

Find the circumference of each circle to the nearest tenth.

1. \[6 \text{ m}\]
2. \[18 \text{ ft}\]
3. \[11 \text{ in.}\]
4. \[7.4 \text{ m}\]
5. \[8.3 \text{ ft}\]
6. \[6.9 \text{ cm}\]
Get Ready for the Lesson

1. What is the measurement of the base and the height?

2. Substitute these values into the formula for the area of a parallelogram.

3. Replace $C$ with the expression for the circumference of a circle, $2\pi r$.
   Simplify the equation and describe what it represents.

Read the Lesson

4. The formula for the area of a circle uses the number $\pi$. How does this affect the value of the area of a circle found using the formula?

5. If you are given the length of the diameter of a circle, how can you find its area?

Remember What You Learned

6. Think about the formulas you have learned that involve circles: $C = 2\pi r$ or $C = \pi d$ and $A = \pi r^2$. To help you remember the difference between the formulas for circumference and the formula for area, think about the differences in the units used for each measurement. What kinds of units are used for each? How can this help you remember the formula for the area of a circle?
The area \( A \) of a circle equals the product of \( \pi \) (\( \pi \)) and the square of its radius \( r \).

\[
A = \pi r^2
\]

**Example 1**  
Find the area of the circle.

\[
A = \pi r^2 \quad \text{Area of circle}
\]

\[
A \approx 3.14 \cdot 5^2 \quad \text{Replace } \pi \text{ with 3.14 and } r \text{ with 5.}
\]

\[
A \approx 78.5
\]

The area of the circle is approximately 78.5 square centimeters.

**Example 2**  
Find the area of a circle that has a diameter of 9.4 millimeters.

\[
A = \pi r^2 \quad \text{Area of a circle}
\]

\[
A = 3.14 \cdot (9.4)^2 \quad \text{Replace } \pi \text{ with 3.14 and } r \text{ with } 9.4 \div 2 \text{ or } 4.7.
\]

\[
A \approx 69.4
\]

The area of the circle is approximately 69.4 square millimeters.

**Exercises**  
Find the area of each circle. Use 3.14 for \( \pi \). Round to the nearest tenth.

1. \[
A = \pi r^2
\]

2. \[
A = \pi r^2
\]

3. \[
A = \pi r^2
\]

4. \( r = 2.6 \text{ cm} \)

5. \( r = 14.3 \text{ in.} \)

6. \( d = \frac{51}{2} \text{ yd} \)

7. \( d = \frac{43}{4} \text{ mi} \)

8. \( d = 7.9 \text{ mm} \)

9. \( r = \frac{21}{5} \text{ ft} \)
Find the area of each circle. Use 3.14 for $\pi$. Round to the nearest tenth.

1. $1$ cm

2. $4$ yd

3. $35$ mm

4. $14$ in.

5. $4.3$ ft

6. $8$ cm

7. $4.7$ yd

8. $22.5$ in.

9. $2.1$ mm

10. $11.9$ ft

11. radius = $5.7$ mm

12. radius = $8.2$ ft

13. diameter = $3\frac{1}{4}$ in.

14. diameter = $15.6$ cm

15. radius = $1.1$ in.

16. diameter = $12\frac{3}{4}$ yd
Find the area of each circle. Use 3.14 for \( \pi \). Round to the nearest tenth if necessary.

1. diameter = 7.1 m
2. diameter = 12 ft
3. diameter = 13 km
4. radius = 4 in.
5. radius = 10 yd
6. radius = 5.6 cm
7. diameter = 9.4 mm
8. diameter = 3\( \frac{1}{2} \) ft
9. radius = 6\( \frac{1}{4} \) in.
10. radius = 4\( \frac{3}{4} \) yd
11. diameter = 15\( \frac{1}{2} \) mi
12. radius = 7.9 km

Estimate to find the approximate area of each circle.

13. diameter = 3.8 yd
14. radius = 6.1 m
15. diameter = 14 cm

16. SPOTLIGHT A spotlight can be adjusted to effectively light a circular area of up to 6 meters in diameter. To the nearest tenth, what is the maximum area that can be effectively lit by the spotlight?

17. ARCHERY The bull’s eye on an archery target has a radius of 3 inches. The entire target has a radius of 9 inches. To the nearest tenth, find the area of the target outside of the bull’s eye.
### Word Problem Practice

#### Area of Circles

1. **POOLS** Susan designed a circular pool with a diameter of 25 meters. What is the area of the bottom of the pool? Round to the nearest tenth.

2. **MONEY** Find the area of the coin to the nearest tenth.

   ![Coin Image]

3. **DRUMS** What is the area of the drumhead on the drum shown below? Round to the nearest tenth.

   ![Drum Image]

4. **PIZZA** Estimate the area of the top of a round pizza that has a diameter of 16 inches. Round to the nearest tenth.

5. **GARDENING** Jane needs to buy mulch for the garden with the dimensions shown in the figure. For how much area does Jane need to buy mulch? Round to the nearest tenth.

   ![Garden Image]

6. **UTILITIES** What is the area of the top surface of a circular manhole cover that has a radius of 30 centimeters? Use 3.14 for \( \pi \).
Seki Kowa

Japanese mathematician Seki Kowa (c. 1642–1708) is called The Arithmetical Sage because of his many contributions to the development of mathematics in Japan. Before Seki, mathematics in Japan was considered a form of art to be enjoyed by intellectuals in their leisure time. Seki demonstrated the practical uses of mathematics and introduced social reforms that made it possible for anyone, not just intellectuals, to study mathematics.

One of Seki’s contributions to mathematics was his calculation of a value of \( \pi \) that was correct to eighteen decimal places.

\[ \pi \approx 3.141592653589793238 \ldots \]

Seki had noticed the phenomenon that you see at the right: as the number of sides of a regular polygon increases, the polygon looks more and more like a circle. So, Seki calculated the following ratio for polygons of increasingly many sides.

\[
\frac{\text{perimeter of regular polygon}}{\text{diameter of circle drawn around the polygon}}
\]

As the number of sides of the polygon gets larger, this ratio must get closer to the ratio of the circumference of the circle to the diameter of the circle. This ratio, of course, is \( \pi \).

You are given information below about a regular polygon and the circle drawn around the polygon. Use a calculator to find Seki’s ratio. (Give as many decimal places as there are in your calculator display.) What do you notice about your answers?

1. length of one side = 5  
   number of sides = 6  
   diameter of circle = 10

2. length of one side \( \approx 4.5922 \)  
   number of sides = 8  
   diameter of circle = 12

3. length of one side \( \approx 3.7544 \)  
   number of sides = 20  
   diameter of circle = 24

4. length of one side \( \approx 37.5443 \)  
   number of sides = 20  
   diameter of circle = 240

5. length of one side \( \approx 1.6754 \)  
   number of sides = 150  
   diameter of circle = 80

6. length of one side \( \approx 2.6389 \)  
   number of sides = 500  
   diameter of circle = 420
When problem solving, sometimes it is easier to solve a simpler problem first to find the correct strategy for solving a more difficult problem.

Example

SPORTS West High School wants to paint field blue, but not the center. The diagram below shows the dimensions of the field and center circle. How much area will they need to paint blue?

Explore
You know that the field is one large rectangle and the center symbol is a large circle.

Plan
You can find the area of the rectangle and the area of the circle and subtract.

Solve
Area of rectangle: \( A = \ell \times w \)
\[ A = 100 \times 75 \text{ or } 7500 \]
Area if circle: \( A = \pi r^2 \)
\[ A = 3.14 \times 15^2 \text{ or } 706.5 \]
Subtract:
\[ 7500 - 706.5 \text{ or } 6793.5 \text{ ft}^2 \]
So, they would need to paint 6,793.5 square feet of field.

Check
Use estimation to check. The area of the entire field is 7,500 ft and the circle is approximately 700 feet so the area should be less than 6,800 feet. Since 6,793.5 is less than 6,800 ft, the answer is reasonable.

Exercises

1. FRAMES Joan wants to paint her favorite picture frame. How much paint would she need to use in order to cover just the frame?

2. WALLPAPER Richard wants to wallpaper one wall of his bathroom. He has two semi-circular windows along the wall. How much wallpaper must he purchase?
11-5
Skills Practice

Problem-Solving Investigation: Solve a Simpler Problem

Solve a simpler problem to solve.

1. **POOL** Find the area of the sidewalk around the pool shown below.

2. **GEOMETRY** Find the area of the shape shown.

3. **POPULATION** The population of Ghostown, USA is decreasing at a rate of 3 people per year. If there are currently 831 people living in the town, when will the town be deserted?

4. **STAINED GLASS** Find the area of the stained glass window shown below. Use 3.14 for \( \pi \). Round to the nearest hundredth if necessary.

5. **STOVETOPS** What is the area of the stovetop shown, not including the burners? Use 3.14 for \( \pi \). Round to the nearest hundredth if necessary.

6. **POOLS** Water is being added at a rate of 50 gallons per minute to a pool. How long will it take until the 10,000 gallon pool is full?
Mixed Problem Solving

Solve Exercises 1 and 2. Use the solve a simpler problem strategy.

1. STADIUM The exits in a stadium are designed to allow 1,200 people to leave the stadium each minute. At this rate, how long would it take for 10,800 people to leave the stadium?

2. PHARMACY A city has three major pharmacy chains which have a total of 895,000 customers. Approximately how many customers do business at each major pharmacy?

<table>
<thead>
<tr>
<th>Pharmacy</th>
<th>Percent</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>54.8%</td>
</tr>
<tr>
<td>B</td>
<td>32.4%</td>
</tr>
<tr>
<td>C</td>
<td>12.8%</td>
</tr>
</tbody>
</table>

Use any strategy to solve Exercises 3 and 4. Some strategies are shown below.

PROBLEM-SOLVING STRATEGIES

- Use the four-step plan.
- Eliminate possibilities.
- Draw a diagram.
- Solve a simpler problem.

3. CARPENTRY Mr. Fernandez uses 7 boards that are 4 feet long and 6 inches wide to make one bookshelf. If he buys lumber in lengths of 8 feet with a width of 12 inches, how many pieces of lumber does he need to purchase to make 5 bookshelves?

4. AREA Stacey is making a stained glass window above her front doorway in the shape as shown in the figure. To the nearest tenth, what is the area of the shaded portion of the window?

5. QUALITY CONTROL For every 250 televisions tested, 3 televisions are found to be defective. How many televisions were tested if 48 televisions were found defective?

6. APPLIANCE REPAIR An appliance repair company charged $35 to make a house call. After arriving, the company charged $10 for every 15 minutes of labor. How much was the repair bill if the new parts cost $23 and the appliance took 45 minutes to repair?
Solve each problem using any strategy you have learned.

1. **AREA** Find the area of the figure below. Use 3.14 for $\pi$.

   ![Figure](image)

2. **MONEY** The table below shows the amount of money Shoshi earned for working various hours. Write a rule to represent the amount of pay, $P$, based on the number of hours worked, $h$.

<table>
<thead>
<tr>
<th>Hours</th>
<th>1</th>
<th>2</th>
<th>3</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pay</td>
<td>5.50</td>
<td>11.00</td>
<td>16.50</td>
</tr>
</tbody>
</table>

3. **SALES** For every nickel increase in price, the subscriptions to the Perrysville Paper decreases by 5 people. If 1,256 people currently subscribe to the Paper, how many people will subscribe to it if the price is increased by $0.25?

4. **SCALE DRAWING** Shannon is creating a scale drawing of her classroom. If she is using the scale 1 foot = 1 \(\frac{1}{2}\) inch and the room model is 10 inches by 15 inches, what are the dimensions of the actual room?

5. **STUDY TIME** The circle graph below shows the results to a survey asking students how long they study each night. In a school of 400 students, how many students study 1.5 – 2.5 hours per night?

   ![Circle Graph](image)

6. **PHOTOGRAPHY** What is the area of the matte pictured below?

   ![Matte](image)

7. **TRAVEL** How far has Kim traveled if she has driven 45 miles per hour for 4 hours?

8. **SISTERS** Angela is 3 years older than Susie. Becca is 2 years younger than Susie. If Becca is 10 years old, how old are Susie and Angela?
Lesson Reading Guide

11-6

Area of Complex Figures

Get Ready for the Lesson

Read the introduction at the top of page 596 in your textbook. Write your answers below.

1. Describe the shape of the kitchen.

2. How could you determine the area of the kitchen?

3. How could you determine the total square footage of a house with rooms shaped like these?

Read the Lesson

4. Look up the term *footage* in a dictionary. Write the meaning that matches the way the term is used in this lesson.

5. What do you think the term *square footage* means?

6. Which word of the compound *square footage* indicates area? Explain.

7. Look up the term *two-dimensional* in a dictionary.

8. Name two dimensions of each of the following figures.
   a. rectangle       b. parallelogram      c. triangle

9. Refer to the figure in Example 1. How do you know that the base of the triangle is 4 inches long?

Remember What You Learned

10. Look in a dictionary for the meanings of the word *complex* when used as an adjective. Write the meaning of the word as it is used in this lesson. Why can the figures in Examples 1 and 2 be considered complex figures?
**Study Guide and Intervention**  

**Area of Complex Figures**

Complex figures are made of triangles, quadrilaterals, semicircles, and other two-dimensional figures. To find the area of a complex figure, separate it into figures whose areas you know how to find, and then add the areas.

**Example 1** Find the area of the figure at the right in square feet.

The figure can be separated into a rectangle and a trapezoid. Find the area of each.

**Area of Rectangle**

\[ A = \ell w \]  
Area of a rectangle

\[ A = 12 \cdot 8 \]  
Replace \( \ell \) with 12 and \( w \) with 8.

\[ A = 96 \]  
Multiply.

**Area of Trapezoid**

\[ A = \frac{1}{2}h(b_1 + b_2) \]  
Area of a trapezoid

\[ A = \frac{1}{2}(4)(4 + 12) \]  
Replace \( h \) with 4, \( b_1 \) with 4, and \( b_2 \) with 12.

\[ A = 32 \]  
Multiply.

The area of the figure is 96 + 32 or 128 square feet.

**Exercises**

Find the area of each figure. Use 3.14 for \( \pi \). Round to the nearest tenth if necessary.

1. \[ \text{Area: } 6 \text{ cm} \times 13 \text{ cm} \times 4 \text{ cm} \times 6 \text{ cm} \]

2. \[ \text{Area: } \frac{1}{2} \times 4 \text{ in.} \times (5 \text{ in.} + \text{radius}) \]

3. \[ \text{Area: } \frac{1}{2} \times 11 \text{ mm} \times (38 \text{ mm} + 18 \text{ mm}) \]
Skills Practice

Area of Complex Figures

Find the area of each figure. Use 3.14 for $\pi$. Round to the nearest tenth if necessary.

1. 2.

3. 4. 5. 6.

7. 8.
Find the area of each figure. Use 3.14 for \( \pi \). Round to the nearest tenth if necessary.

1. \[ \text{area} = \frac{1}{2} \times 	ext{base} \times 	ext{height} \]
2. \[ \text{area} = \frac{1}{2} \times 	ext{base} \times 	ext{height} \]
3. \[ \text{area} = \frac{1}{2} \times 	ext{base} \times 	ext{height} \]
4. \[ \text{area} = \pi \times 	ext{radius}^2 \]
5. \[ \text{area} = \pi \times 	ext{radius}^2 \]
6. \[ \text{area} = \pi \times 	ext{radius}^2 \]

In each diagram below, one square unit represents 5 square meters. Find the area of each figure.

7. \[ \text{area} = \text{number of square units} \times 5 \]
8. \[ \text{area} = \text{number of square units} \times 5 \]

9. **AUDITORIUM** The diagram at the right gives the dimensions of an auditorium. If new carpet is needed for the auditorium, what will be the area of the carpet? Round to the nearest square yard.

10. Each end of the cottage needs new siding. Find the total area that needs new siding.

11. The siding material costs $75 for a bundle of siding that covers an area of 100 square feet. What will be the total cost to put siding on both ends of the cottage? Justify your answer.
11-6 Word Problem Practice

Area of Complex Figures

ARCHITECTURE For Exercises 1–6 use Jaco’s preliminary design of his vacation house at the right. Round to the nearest tenth if necessary.

1. What type of figure is bedroom 1? Find the area of bedroom 1.

2. What is the area of the bedroom 2? What figures did you use to find the area?

3. What is the area of the bathroom? What are the dimensions of the figures you used to find this area?

4. What is the area of the living room? How many figures did you use to find this area?

5. What is the area of the den? What would the area of the den be if the semicircular window were removed and replaced with a flat window?

6. What is the area of the kitchen? If Jaco adds a rectangular cooking island in the middle of the kitchen with dimensions 6 feet by 4 feet, how many square feet of space will be left?
Extending the Pythagorean Theorem

The Pythagorean Theorem says that the sum of the areas of the two smaller squares is equal to the area of the largest square. Show that the Pythagorean Theorem can be extended to include other shapes on the sides of a triangle. To do so, find the areas of the two smaller shapes. Then, check that their sum equals the area of the largest shape. Round each answer to the nearest tenth.

1. area of smallest shape:
   area of middle shape:
   area of largest shape:

2. area of smallest shape:
   area of middle shape:
   area of largest shape:

3. area of smallest shape:
   area of middle shape:
   area of largest shape:

4. area of smallest shape:
   area of middle shape:
   area of largest shape:
Get Ready for the Lesson

Complete the Mini Lab at the top of page 603 in your textbook. Write your answers below.

1. Study the shape of each object. Then compare and contrast the properties of each object.

Read the Lesson

Fill in the blanks.

2. The top and bottom faces of a prism are ______________ and are ______________.

3. The shape of the base tells the name of the ______________.

4. The base of a cone is a ______________.

5. A ______________ has no faces, bases, edges, or vertices.

6. The bases of a cylinder are ______________.

7. All of the points on a ______________ are the same distance from the ______________.

Remember What You Learned

8. Compare and contrast a triangular prism, a triangular pyramid, and a cone.
Exercises

For each figure name the shape of the base(s). Then classify each figure.

1. 

The figure has two parallel rectangular bases and three rectangular faces. The figure is a rectangular prism.

2. 

The figure has two triangular bases and three triangular faces. The figure is a triangular prism.

3. 

The figure has two circular bases and no edges. The figure is a cylinder.

4. 

The figure has one base shaped like a circle and one vertex. The figure is a cone.

5. 

The figure has one base shaped like a triangle and one vertex. The figure is a pyramid.

6. 

The figure has two bases shaped like rectangles and no edges. The figure is a rectangular prism.
For each figure, identify the shape of the base(s). Then classify the figure.

1. 2. 3.
4. 5. 6.
7. 8. 9.
10. 11. 12.
For each figure, identify the shape of the base(s), if any. Then classify the figure.

1. 
2. 
3. 

4. 
5. 
6. 

7. 
8. 
9. 

10. CANDLES What three-dimensional figure describes the candle shown?

11. FENCES The basic shape of a fence post is made of two geometric figures. Classify these figures.
<p>| | | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>1. SPORTS</strong></td>
<td>A regulation basketball weighs 20-22 ounces. Classify the shape of a regulation basketball as a three-dimensional figure.</td>
<td><strong>2. ICE CREAM</strong></td>
</tr>
<tr>
<td><strong>3. SHIPPING</strong></td>
<td>Jessie bought a box to ship her gifts to her grandmother. Classify the shape of a box as a three-dimensional figure.</td>
<td><strong>4. LAUNDRY</strong></td>
</tr>
<tr>
<td><strong>5. SCHOOL PROJECT</strong></td>
<td>Jarnel is creating a diorama for his class project. He plans to use a shoebox to build the diorama. Classify the shape of a shoebox as a three-dimensional figure.</td>
<td><strong>6. SOUP</strong></td>
</tr>
<tr>
<td><strong>7. BABY BLOCKS</strong></td>
<td>Classify the shape of the baby block as a three-dimensional figure.</td>
<td><strong>8. EARTH</strong></td>
</tr>
</tbody>
</table>
Properties of Prisms

Leonard Euler, born in 1707, was one of the world’s greatest mathematicians. One of his accomplishments was discovering a formula for calculating the number of faces, edges, and vertices on a three-dimensional figure. He found that \( V + F = E + 2 \). (Vertices + Faces = Edges + 2)

A triangular prism has 6 vertices, 5 faces, and 9 edges. It has the fewest faces, edges, and vertices of any prism.

1. Complete the table for a hexagonal and an octagonal prism.

<table>
<thead>
<tr>
<th>Prism</th>
<th>Vertices</th>
<th>Faces</th>
<th>Edges</th>
</tr>
</thead>
<tbody>
<tr>
<td>triangular</td>
<td>6</td>
<td>5</td>
<td>9</td>
</tr>
<tr>
<td>rectangular</td>
<td>8</td>
<td>6</td>
<td>12</td>
</tr>
<tr>
<td>pentagonal</td>
<td>10</td>
<td>7</td>
<td>15</td>
</tr>
<tr>
<td>hexagonal</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>octagonal</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

2. If a prism has 14 vertices and 21 edges, how many faces does it have? Use Euler’s formula.
3. A prism has 20 vertices. How many faces does it have? How many edges?

4. An “\( n \)-gonal” prism has two bases, each with \( n \) sides. Use the patterns in the table to write expressions to find the number of faces, edges, and vertices and \( n \)-gonal prism has.
Lesson Reading Guide

Drawing Three-Dimensional Figures

Get Ready for the Lesson

Read the introduction at the top of page 608 in your textbook. Write your answers below.

1. Which view of the Washington monument is shown in the comic?

2. Find a photograph of the Washington Monument and draw a side view.

Read the Lesson

3. A two-dimensional figure has two dimensions. What are they?

4. A three-dimensional figure has three dimensions. What are they?

5. Label the dimensions of each figure.

6. Underline the word that makes the sentence true.
   A (rectangle, cube) is a three-dimensional figure.

Remember What You Learned

7. Make models of a two-dimensional figure and a three-dimensional figure. Use any material you like—for example, paper, cardboard, toothpicks, gumdrops.
A solid is a three-dimensional figure.

**Example 1**  Draw a top, a side, and a front view of the solid at the right.

The top view is a triangle. The side and front views are rectangles.

![Top, side, and front views of a solid]

**Example 2**  Draw the solid using the top, side, and front views shown below.

![Top, side, and front views of a solid]

**Step 1**  Use the top view to draw the base of the figure, a 1-by-3 rectangle.

**Step 2**  Add edges to make the base a solid figure.

**Step 3**  Use the side and front views to complete the figure.

**Exercises**

1. Draw a top, a side, and front view of the solid.

![Diagram of a solid]

2. Draw the solid whose top, side, and front views are shown. Use isometric dot paper.

![Top, side, and front views of a solid on isometric dot paper]
Skills Practice

Drawing Three-Dimensional Figures

Draw a top, a side, and a front view of each solid.

1. 

2. 

3. 

Draw each solid using the top, side, and front views shown. Use isometric dot paper.

4. 

5. 

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Chapter 11

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Glencoe California Mathematics, Grade 6
Draw a top, a side, and a front view of each solid.

1.

2.

3.

4.

Draw each solid whose top, side, and front views are shown. Use isometric dot paper.

1. top side front

2. top side front

7. HAT RACK Draw a top, a side, and a front view of the hat rack shown.

8. MUSIC Sketch views of the top, side, and front of the piano shown.
1. **ARCHITECTURE** The Transamerica Pyramid, built from 1969 to 1972, towers above the San Francisco skyline.

   Draw the top, side, and front views of the Transamerica building.

2. **MONUMENTS** Since its completion in 1965, Eero Saarinen’s 630-foot Gateway Arch has stood above St. Louis.

   Draw the top, side, and front views of the Gateway Arch.

3. **GRAPHICS** Dan is creating a computer-generated image of a coffee cup. To do this, he needs to enter the top, side, and front views of the cup. Draw the views that Dan should enter.

4. **HISTORY** The Mausoleum at Halicarnassus is one of the Seven Wonders of the Ancient World. Draw a top view, a side view, and a front view of the mausoleum without the chariot statue at the top.
## Counting Cubes

The figures on this page have been built by gluing cubes together. Use your visual imagination to count the total number of cubes as well as the number of cubes with glue on 1, 2, 3, 4, or 5, or 6 faces.

Complete this chart for the figures below.

<table>
<thead>
<tr>
<th>Figure</th>
<th>Total Number of Cubes</th>
<th>Number of Faces with Glue on Them</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>1 face</td>
</tr>
<tr>
<td>1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2</td>
<td></td>
<td></td>
</tr>
<tr>
<td>3</td>
<td></td>
<td></td>
</tr>
<tr>
<td>4</td>
<td></td>
<td></td>
</tr>
<tr>
<td>5</td>
<td></td>
<td></td>
</tr>
<tr>
<td>6</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

1. ![Figure 1](image1)
2. ![Figure 2](image2)
3. ![Figure 3](image3)
4. ![Figure 4](image4)
5. ![Figure 5](image5)
6. ![Figure 6](image6)
Lesson Reading Guide

Volume of Prisms

Get Ready for the Lesson

Complete the Mini Lab at the top of page 613 in your textbook. Write your answers below.

1. What is the area of the base, or bottom, of the box? What is the height of the box?

2. How many centimeter cubes fit in the box?

3. What do you notice about the product of the base area and the height of the box?

Read the Lesson

4. Which of the figures at the right is a rectangular prism? Why is the other figure not a rectangular prism?

Remember What You Learned

5. Tell how to find the volume of a rectangular prism in words.
The **volume** of a three-dimensional figure is the measure of space occupied by it. It is measured in cubic units such as cubic centimeters (cm\(^3\)) or cubic inches (in\(^3\)). The volume of the figure at the right can be shown using cubes.

The bottom layer, or base, has \(4 \cdot 3\) or 12 cubes.

It takes \(12 \cdot 2\) or 24 cubes to fill the box. So, the volume of the box is 24 cubic meters.

A **rectangular prism** is a three-dimensional figure that has two parallel and congruent sides, or bases, that are rectangles. To find the volume of a rectangular prism, multiply the area of the base and the height, or find the product of the length \(\ell\), the width \(w\), and the height \(h\).

\[ V = Bh \text{ or } V = \ell \cdot w \cdot h \]

### Example

**Find the volume of the rectangular prism.**

\[ V = \ell \cdot w \cdot h \]

Volume of a rectangular prism

\[ V = 5 \cdot 6 \cdot 8 \]

Replace \(\ell\) with 5, \(w\) with 6, and \(h\) with 8.

\[ V = 240 \]

Multiply.

The volume is 240 cubic inches.

### Exercises

**Find the volume of each rectangular prism. Round to the nearest tenth if necessary.**

1. \(4 \text{ m} \times 3 \text{ m} \times 7 \text{ m}\)
2. \(9 \text{ cm} \times 7 \text{ cm} \times 10 \text{ cm}\)
3. \(2.7 \text{ ft} \times 3 \text{ ft} \times 2 \text{ ft}\)
Skills Practice
Volume of Prisms

Find the volume of each rectangular prism. Round to the nearest tenth if necessary.

1. 3 cm 7 cm
   3 cm

2. 10 in. 6 in.

3. 6 m 4 m

4. 12 mm
   3 mm 5 mm

5. 9.5 in.
   7 in. 2.8 in.

6. 9 cm
   7.2 cm 3 cm

7. 4 3/4 ft
   2 1/2 ft 4 ft

8. 9.6 in.
   4.8 in. 15 in.

9. 4.5 cm
   1.5 cm 1.2 cm
Find the volume of each prism. Round to the nearest tenth if necessary.

1. 2. 3.

4. 5. 6.

7. 8. 9.

ESTIMATION Estimate to find the approximate volume of each prism.

10.

11.

12. ALGEBRA The base of a rectangular prism has an area of 15.3 square inches and a volume of 185.13 cubic inches. Write an equation that can be used to find the height \( h \) of the prism. Then find the height of the prism.

13. MAIL The United States Post Office has two different priority mail flat rate boxes. Which box has the greater volume? Justify your answer. Box 1: \( \frac{61}{2} \) in. \( \times \frac{81}{2} \) in. \( \times 11 \) in. Box 2: \( \frac{32}{8} \) in. \( \times 11 \frac{7}{8} \) in. \( \times 13 \frac{5}{8} \) in.
### 11-9 Word Problem Practice

**Volume of Prisms**

<table>
<thead>
<tr>
<th>1. <strong>PACKAGING</strong></th>
<th>2. <strong>FOOD STORAGE</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td>A cereal box has a length of 8 inches, a width of $1 \frac{3}{4}$ inches, and a height of $12 \frac{1}{8}$ inches. What is the volume of the cereal box?</td>
<td>Nara wants to determine how much ice it will take to fill her cooler. If the cooler has a length of 22 inches, a width of 12 inches, and a height of $10 \frac{1}{2}$ inches, how much ice will her cooler hold?</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>3. <strong>TRANSPORTATION</strong></th>
<th>4. <strong>PLUMBING</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td>The cargo-carrying part of Billy’s truck has a length of 8.3 meters, a width of 3 meters, and a height of 4.2 meters. What is the maximum volume of sand that Billy’s truck can carry?</td>
<td>Alexia’s bathroom has a tub in the shape of a rectangular prism with a length of 1.5 meters, a width of 0.5 meter, and a height of 0.4 meter. How many cubic feet of water can it hold?</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>5. <strong>PACKAGING</strong></th>
<th>6. <strong>GEOMETRY</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td>A box of tissues has a length of 11.2 centimeters, a width of 11.2 centimeters, and a height of 13 centimeters. What is the volume of the tissue box?</td>
<td>A <strong>pentagonal prism</strong> is a prism that has bases that are pentagons. Use $V = Bh$ where $B$ is the area of the base, to find the volume of the pentagonal prism below.</td>
</tr>
</tbody>
</table>

**Diagram:**

- **$B = 26.3 \text{ cm}^2$**
- **4.5 cm**
Volumes of Pyramids

A pyramid and a prism with the same base and height are shown below.

The exercises on this page will help you discover how their volumes are related.

Enlarge and make copies of the two patterns below to make the open pyramid and the open prism shown above. (Each equilateral triangle should measure 8 centimeters on a side.)

1. Describe the bases of the two solids.

2. How do the heights of the solids compare?

3. Fill the open pyramid with sand or sugar. Pour the contents into the open prism. How many times must you do this to fill the open prism?

4. Describe how you would find the volume of the pyramid shown at the right.

5. Generalize: State a formula for the volume of a pyramid.
11-9  TI-73 Activity

Volume of Prisms

To solve problems involving formulas, you can either use basic arithmetic operations or you can use the Equation Solver.

Example

Find the volume of this prism. Use the formula \( V = \ell w h \).

Method A

\[
\begin{align*}
4.6 \times 2.5 \times 7.1 & \quad \text{ENTER}
\end{align*}
\]

The answer is 81.65.

Method B

Step 1  Choose Equation Solver.

\[ \text{MATH} \quad 6 \quad \text{ENTER} \]

Step 2  Enter the formula after the symbol \( eqn \).

\[ \text{2nd} \quad \text{[TEXT]} \quad \text{V = L W H Done ENTER ENTER} \]

Step 3  Enter the values given in the figure: \( L = 4.6 \), \( W = 2.5 \), \( H = 7.1 \)

\[ \downarrow 4.6 \quad \downarrow 2.5 \quad \downarrow 7.1 \]

Step 4  Solve for \( V \), the volume.

\[ \text{ENTER} \]

The volume is 81.65 cubic centimeters.

Exercises

Find the volume of each rectangular prism to the nearest tenth. Use the same formula and enter the values for \( \ell \), \( w \), and \( h \).

1. \[
\begin{align*}
\ell & = 1.6 \text{ cm} \\
w & = 2.7 \text{ cm} \\
h & = 0.8 \text{ cm}
\end{align*}
\]

2. \[
\begin{align*}
\ell & = 21 \text{ yd} \\
w & = 11 \text{ yd} \\
h & = 15 \text{ yd}
\end{align*}
\]

3. \[
\begin{align*}
\ell & = 3.29 \text{ cm} \\
w & = 5.67 \text{ cm} \\
h & = 1.74 \text{ cm}
\end{align*}
\]

4. CHALLENGE  Suppose you need a rectangular prism with length 4 inches and width 3.5 inches and a volume of 140 cubic inches. What height must the prism have?
Lesson Reading Guide

Volume of Cylinders

Get Ready for the Lesson

Complete the Mini Lab at the top of page 619 in your textbook. Write your answers below.

1. Estimate the number of centimeter cubes that would fit at the bottom of the can. Include parts of cubes.

2. How many layers would it take to fill the cylinder?

3. MAKE A CONJECTURE about how you can find the volume of the soup can.

Reading the Lesson

4. Write C if the phrase is true of a cylinder, P if the phrase is true of a prism, or CP if the phrase is true of both.

   _______ has bases that are parallel and congruent

   _______ has sides and bases that are polygons

   _______ has bases that are circular

   _______ is a solid

   _______ has volume

   _______ is three-dimensional

5. What shape is the base of a cylinder?

6. What is the formula for the area of the base of a cylinder?

Remember What You Learned

7. Work with a partner. Bring an object that is a cylinder to school. Take the measurements and determine the volume of your cylindrical object. Exchange objects with your partner, but do not share the calculations. Determine the volume of your partner’s object. Then compare your results with those of your partner.
Study Guide and Intervention

Volume of Cylinders

As with prisms, the area of the base of a cylinder tells the number of cubic units in one layer. The height tells how many layers there are in the cylinder. The volume $V$ of a cylinder with radius $r$ is the area of the base $B$ times the height $h$.

$$V = Bh$$ or $$V = \pi r^2 h$$

**Example**

Find the volume of the cylinder. Use 3.14 for $\pi$.

Round to the nearest tenth.

$$V = \pi r^2 h$$ Volume of a cylinder

$$V = 3.14(2)^2(5)$$ Replace $\pi$ with 3.14, $r$ with 2, and $h$ with 5.

$$V = 62.8$$ Simplify.

The volume is approximately 62.8 cubic inches. Check by using estimation.

**Exercises**

Find the volume of each cylinder. Use 3.14 for $\pi$.

Round to the nearest tenth.

1. 10 mm
   18 mm

2. 4 ft
   12.9 ft

3. 2 in.

4. radius = 9.5 yd
   height = 2.2 yd

5. diameter = 6 cm
   height = 11 cm

6. diameter = $3\frac{2}{5}$ m
   height = $1\frac{1}{4}$ m
Skills Practice

Volume of Cylinders

Find the volume of each cylinder. Use 3.14 for \( \pi \). Round to the nearest tenth.

1. \( \text{radius} = 7 \text{ cm} \)
   \( \text{height} = 20 \text{ cm} \)

2. \( \text{radius} = 8 \text{ ft} \)
   \( \text{height} = 9 \text{ ft} \)

3. \( \text{radius} = 12 \text{ in.} \)
   \( \text{height} = 4 \text{ in.} \)

4. \( \text{radius} = 3 \frac{1}{2} \text{ yd} \)
   \( \text{height} = 6 \text{ yd} \)

5. \( \text{radius} = 5.3 \text{ m} \)
   \( \text{height} = 8.7 \text{ m} \)

6. \( \text{radius} = 1.9 \text{ in.} \)
   \( \text{height} = 6.2 \text{ in.} \)

7. \( \text{radius} = 8.8 \text{ cm} \)
   \( \text{height} = 4.7 \text{ cm} \)

8. \( \text{radius} = 4 \text{ ft} \)
   \( \text{height} = 2 \frac{1}{2} \text{ ft} \)

9. \( \text{diameter} = 10 \text{ mm} \)
   \( \text{height} = 4 \text{ mm} \)

10. \( \text{diameter} = 7.1 \text{ in.} \)
    \( \text{height} = 1 \text{ in.} \)
Find the volume of each cylinder. Use 3.14 for \( \pi \). Round to the nearest tenth.

1. 2. 3.
4. 5. 6.
7. radius = 3.7 cm height = 5.2 cm
8. diameter = 6 in. height = 4\( \frac{1}{2} \) in
9. radius = 5\( \frac{1}{4} \) yd height = 6\( \frac{1}{2} \) yd

10. CONTAINER What is the volume of a barrel that has a diameter of 1\( \frac{1}{2} \) feet and a height of 4 feet?

**ESTIMATION** Match each cylinder with its approximate volume.

11. diameter = 4 cm, height = 3.6 cm a. 108 ft\(^3\)
12. radius = 2.7 cm, height = 5 cm b. 135 ft\(^3\)
13. radius = 3 cm, height = 4.1 cm c. 96 ft\(^3\)
14. diameter = 8.2 cm, height = 2 cm d. 48 ft\(^3\)

15. FUEL Two fuel tanks with the dimensions shown have the same volume. What is the value of \( h \)?
### 11-10 Word Problem Practice

#### Volume of Cylinders

1. **WATER STORAGE** A cylindrical water tank has a diameter of 5.3 meters and a height of 9 meters. What is the maximum volume that the water tank can hold? Round to the nearest tenth.

2. **PACKAGING** A can of corn has a diameter of 6.6 centimeters and a height of 9.9 centimeters. How much corn can the can hold? Round to the nearest tenth.

3. **CONTAINERS** Tionna wants to determine the maximum capacity of a cylindrical bucket that has a radius of 6 inches and a height of 12 inches. What is the capacity of Tionna’s bucket? Round to the nearest tenth.

4. **DESIGN** Rodolfo is designing a new, cylindrical drinking glass. If the glass has a diameter of 8 centimeters and a height of 12.8 centimeters, what is its volume? Round to the nearest tenth.

5. **PAINT** A can of paint is 15 centimeters high and has a diameter of 13.6 cm. What is the volume of the can? Round to the nearest tenth.

6. **SPICES** A spice manufacturer uses a cylindrical dispenser like the one shown. Find the volume of the dispenser to the nearest tenth.

**Diagram:**
- Cylinder with a height of 3 inches and a radius of 1.7 inches.
Volumes of Non-Right Solids

Imagine a stack of ten pennies. By pushing against the stack, you can change its shape as shown at the right. But, the volume of the stack does not change.

The diagrams below show prisms and cylinders that have the same volume but do not have the same shape.

Find the volume of each solid figure. Use 3.14 for π. Round to the nearest tenth.

1. \( \text{Right Prism} \)
   - Base: \( 2 \text{ m} \times 3 \text{ m} \)
   - Height: \( 2.5 \text{ m} \)

2. \( \text{Non-right Prism} \)
   - Base: \( 2 \text{ in.} \times 3 \text{ in.} \)
   - Height: \( 11 \text{ in.} \)

3. \( \text{Right Cylinder} \)
   - Base: \( 5 \text{ in.} \times 5 \text{ in.} \)
   - Height: \( 12 \text{ in.} \)

4. \( \text{Non-right Cylinder} \)
   - Base: \( 4 \text{ cm} \times 15 \text{ cm} \)
   - Height: \( 4 \text{ cm} \)

5. \( \text{10 cm} \times 10 \text{ cm} \times 2 \text{ cm} \)

6. \( \text{10 cm} \times 10 \text{ cm} \times 2 \text{ cm} \)
Read each question. Then fill in the correct answer.

1. ○ ○ ○ ○
2. ○ ○ ○ ○
3. ○ ○ ○ ○
4. ○ ○ ○ ○
5. ○ ○ ○ ○
6. ○ ○ ○ ○
7. ○ ○ ○ ○
8. ○ ○ ○ ○
9. ○ ○ ○ ○
10. ○ ○ ○ ○
11. ○ ○ ○ ○

Record your answers for Question 12 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 12 Rubric

#### Score Specific Criteria

<table>
<thead>
<tr>
<th>Score</th>
<th>Specific Criteria</th>
</tr>
</thead>
<tbody>
<tr>
<td>4</td>
<td>The Pythagorean Theorem is used to determine the height of the parallelogram. An accurate explanation that the area of the side (60 ( \cdot ) 46.5 in(^2)) is greater than the area of the floor (60 ( \cdot ) 30 in(^2)) is given. The area of two triangular regions is correctly determined to be 1,320 in(^2).</td>
</tr>
<tr>
<td>3</td>
<td>The correct values are found. However, the explanation is correct but not complete. <strong>OR</strong> The explanation is correct and complete, but one computational error is made in finding the height of the parallelogram or the area of the two triangular regions.</td>
</tr>
<tr>
<td>2</td>
<td>The Pythagorean Theorem is used to determine the height of the parallelogram, and the explanation is correct and complete. However, the area of only one triangular region is found. <strong>OR</strong> The Pythagorean Theorem is used to determine the height of the parallelogram, the area of the side is stated to be greater than the area of the floor, and the area of the two triangular regions is correctly determined. However, the explanation is incorrect or not given.</td>
</tr>
<tr>
<td>1</td>
<td>The area of the two triangular regions is correct, but the answer to Part a is completely incorrect. <strong>OR</strong> The area of the side is stated to be greater than the area of the floor, but the explanation is incorrect or not given. The area of the two triangular regions is incorrect.</td>
</tr>
<tr>
<td>0</td>
<td>Response is completely incorrect.</td>
</tr>
</tbody>
</table>
Find the area of each parallelogram. Round to the nearest tenth if necessary.

1. 2. 1.

Find the area of each figure.

3. 4. 3.

5. Find the circumference of the circle. Use 3.14 for \( \pi \). Round to the nearest tenth.

5. 

---

Find the area of each figure. Use 3.14 for \( \pi \). Round to the nearest tenth.

1. 2. 1.

3. radius = 4 in. 4. diameter = 12 mm

5. MULTIPLE CHOICE  Mason can make 5 picture frames in 2 hours. How many picture frames can 4 people make in 8 hours working at the same rate?

A. 20  B. 40  C. 80  D. 160  5.
Chapter 11 Quiz 3
(Lessons 11-6 and 11-8)

Find the area of each figure. Round to the nearest tenth if necessary.
1. \( \frac{5 \text{ ft}}{9 \text{ ft}} \)
2. \( \frac{3 \text{ in.}}{4 \text{ in.}} \)
3. Classify the figure at the right.

Draw a top, a side, and a front view of each solid.
4.
5.

Chapter 11 Quiz 4
(Lessons 11-9 and 11-10)

Find the volume of each rectangular prism.
1.
2.

Find the volume of each cylinder. Use 3.14 for \( \pi \). Round to the nearest tenth.
3.
4.
5. Find the volume of a cylinder-shaped oatmeal carton that has a radius of \( 5\frac{1}{2} \) inches and a height of 10 inches. Round to the nearest tenth.
Chapter 11 Mid-Chapter Test
(Lessons 11-1 and 11-3)

PART I

1. Find the circumference of a circle with radius \(6\frac{1}{4}\) meters. Round to the nearest tenth.
   A. 9.8 m  B. 19.6 m  C. 39.3 m  D. 122.7 m  
   1. ____

2. Find the area of the parallelogram.
   F. 72 in\(^2\)  H. 36 in\(^2\)
   G. 70 in\(^2\)  J. 18 in\(^2\)
   2. ____

3. What is the area of a triangle with a base of 24.7 centimeters and a height of 15.2 centimeters?
   A. 39.9 cm\(^2\)  B. 93.85 cm\(^2\)  C. 187.7 cm\(^2\)  D. 375.44 cm\(^2\)
   3. ____

4. Find the area of the circle. Round to the nearest tenth.
   F. 1,661.9 yd\(^2\)  H. 72.3 yd
   G. 415.3 yd\(^2\)  J. 36.1 yd\(^2\)
   4. ____

5. TABLES A circular table has a radius of 16 inches. What is the area of the table?
   A. 100.5 in\(^2\)  B. 201.1 in\(^2\)  C. 803.8 in\(^2\)  D. 3,216.0 in\(^2\)
   5. ____

PART II

Find the area of each figure.

6. [Diagram of a triangle with base 6 cm and height 11 cm]
   6. ____________

7. [Diagram of a trapezoid with bases 5 ft and 3.4 ft, height 3 ft, and height 4 ft]
   7. ____________

Find the circumference of each circle. Use 3.14 for \(\pi\). Round to the nearest tenth if necessary.

8. radius = 8.9 cm
   8. ____________

9. diameter = 4\(\frac{1}{2}\) yd
   9. ____________

10. Find the area of the figure. Round to the nearest tenth if necessary.

   10. ____________
11
Chapter 11 Vocabulary Test

Write the letter of the term that best matches each statement or phrase. Some terms may be used more than once.

_____ 1. any three-dimensional figure

_____ 2. the distance across a circle through the center

_____ 3. the distance around a circle

_____ 4. solid figure that has two parallel and congruent bases that are rectangles

_____ 5. the measures of space occupied by a solid

_____ 6. The expression \(2\pi r\) is used to find this measure.

_____ 7. the distance from the center of a circle to any point on the circle

_____ 8. solid figure that has no vertices and no edges

_____ 9. solid figure that has only one base

_____ 10. solid figure that has two congruent, parallel circles as bases

Define the term in your own words.

11. complex figures

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

1. **POOLS** A rectangular pool is 6 feet long by 4 feet wide and 6 inches deep. What is the volume of the pool?
   - A. 12 ft³
   - B. 144 ft³
   - C. 168 ft³
   - D. 296 ft³

2. What is the area of a parallelogram with a height of 4 yards and a base of 5 yards?
   - F. 80 yd²
   - G. 20 yd²
   - H. 10 yd²
   - J. \( \frac{4}{5} \) yd²

3. **GARDENS** Find the area of a circular garden with a radius of 6 feet. Round to the nearest tenth.
   - A. 18.8 ft²
   - B. 37.7 ft²
   - C. 113.0 ft²
   - D. 452.4 ft²

Find the area of each figure. Round to the nearest tenth if necessary.

4. 
   - F. 5,026.5 m²
   - G. 1,256.0 m²
   - H. 125.7 m²
   - J. 62.8 m²

5. 
   - A. 47 m²
   - B. 60 m²
   - C. 75 m²
   - D. 165 m²

6. 
   - F. 104.5 m²
   - G. 225.5 m²
   - H. 330 m²
   - J. 660 m²

7. 
   - A. 2 in²
   - B. 15 in²
   - C. 50 in²
   - D. 500 in²

8. 
   - F. 56 m²
   - G. 104 m²
   - H. 144 m²
   - J. 2,560 m²

Find the circumference of each circle. Use 3.14 for \( \pi \). Round to the nearest tenth.

9. 
   - A. 15.7 ft
   - B. 31.4 ft
   - C. 62.8 ft
   - D. 314 ft

10. radius = 6.7 mm
    - F. 2.1 mm
    - G. 21.0 mm
    - H. 42.1 mm
    - J. 66.1 mm

11. diameter = 15.4 km
    - A. 48.4 km
    - B. 96.8 km
    - B. 186.3 km
    - D. 745.1 km
12. Identify the shape of the base of the figure.
   F. circle
   H. triangle
   G. square
   J. (no base)

13. CONTAINERS Which container has the top, side, and front views given?
   A.
   C.
   B.
   D.

14. Find the volume of the rectangular prism.
   F. 15 m$^3$
   H. 142 m$^3$
   G. 105 m$^3$
   J. 210 m$^3$

15. Find the volume of a rectangular prism with a length of 2.8 centimeters, a width of 1.5 centimeters, and a height of 1.2 centimeters. Round to the nearest tenth.
   A. 5.0 cm$^3$
   B. 9.4 cm$^3$
   C. 11.0 cm$^3$
   D. 18.7 cm$^3$

16. A cube has 4-inch edges. Find its volume.
   F. 12 in$^3$
   G. 16 in$^3$
   H. 64 in$^3$
   J. 96 in$^3$

17. Find the volume of the cylinder. Round to the nearest tenth.
   A. 110.0 in$^3$
   C. 296.9 in$^3$
   B. 122.5 in$^3$
   D. 384.7 in$^3$

18. CANS A can of juice is 6 inches high, and its base has a radius of 2 inches. Find the volume of the can. Round to the nearest tenth.
   F. 37.7 in$^3$
   G. 75.4 in$^3$
   H. 100.5 in$^3$
   J. 118.4 in$^3$

19. Find the volume of the cylinder. Round to the nearest tenth.
   A. 1,809.6 yd$^3$
   C. 326.7 yd$^3$
   B. 452.2 yd$^3$
   D. 226.2 yd$^3$

20. Classify the figure.
   F. circular pyramid
   H. cylinder
   G. circular prism
   J. rectangular prism

Bonus The base of a rectangular prism has an area of 12.6 square meters. Find the height if the volume is 119.7 cubic meters.
Write the letter for the correct answer in the blank at the right of each question.

1. **PONDS** A rectangular pond is $5\frac{1}{2}$ feet long, $4\frac{3}{4}$ feet wide, and 18 inches deep. What is the volume of the pool?
   - A. 28.25 ft$^3$
   - B. 39.2 ft$^3$
   - C. 360 ft$^3$
   - D. 470.25 ft$^3$
   - 1. ____

2. What is the area of a parallelogram with a base of 6 inches and a height of 8 inches?
   - F. 96 in$^2$
   - G. 48 in$^2$
   - H. 24 in$^2$
   - J. $\frac{3}{4}$ in$^2$
   - 2. ____

3. **GARDENS** Find the area of a circle with a diameter of 24 feet. Round to the nearest tenth.
   - A. 1,808.6 ft$^2$
   - B. 452.2 ft$^2$
   - C. 75.4 ft$^2$
   - D. 37.7 ft$^2$
   - 3. ____

Find the area of each figure. Round to the nearest tenth if necessary.

4. [Diagram of a circle with a radius of 9 mm]
   - F. 1,017.9 mm$^2$
   - G. 254.3 mm$^2$
   - H. 56.5 mm$^2$
   - J. 28.3 mm$^2$
   - 4. ____

5. [Diagram of a triangle with sides 12 m, 15 m, and 30 m]
   - A. 180 m$^2$
   - B. 225 m$^2$
   - C. 360 m$^2$
   - D. 450 m$^2$
   - 5. ____

6. [Diagram of a trapezoid with bases 5 cm and 14 cm, height 9 cm]
   - F. 48 cm$^2$
   - G. 60 cm$^2$
   - H. 96 cm$^2$
   - J. 120 cm$^2$
   - 6. ____

7. [Diagram of a right triangle with base 6 m, height 9 m]
   - A. 36 m$^2$
   - B. 54 m$^2$
   - C. 72 m$^2$
   - D. 108 m$^2$
   - 7. ____

8. [Diagram of a composite figure: a trapezoid with bases 8 in and 4 in, height 6 in]
   - F. 116.5 in$^2$
   - G. 74.1 in$^2$
   - H. 85 in$^2$
   - J. 50.1 in$^2$
   - 8. ____

9. Find the circumference of the circle. Use 3.14 for $\pi$. Round to the nearest tenth.
   - A. 25.0 yd
   - B. 44.1 yd
   - C. 88.2 yd
   - D. 176.5 yd
   - 9. ____
10. Which solid has the top, the side, and the front views given?

F. 

H. 

G. 

J. 

11. Find the volume of the rectangular prism.

A. 28 cm$^3$  
B. 160 cm$^3$  
C. 400 cm$^3$  
D. 600 cm$^3$ 

12. Find the volume of a rectangular prism with a length of 9.3 meters, a width of 6.6 meters, and a height of 3.2 meters. Round to the nearest tenth.

F. 19.1 m$^3$  
G. 112.3 m$^3$  
H. 196.4 m$^3$  
J. 224.5 m$^3$ 


A. 729 in$^3$  
B. 486 in$^3$  
C. 81 in$^3$  
D. 27 in$^3$ 

14. Find the volume of the cylinder to the nearest tenth.

F. 99 cm$^3$  
G. 621.7 cm$^3$ 
H. 2,797.7 cm$^3$  
J. 3,419.5 cm$^3$ 

15. TEA CUPS A cylindrical tea cup has a height of 70 millimeters, and its base has a radius of 30 millimeters. Find the volume of the tea cup to the nearest tenth.

A. 2,100 mm$^3$  
B. 6,594.0 mm$^3$  
C. 197,820 mm$^3$  
D. 461,814.1 mm$^3$ 

16. Classify the figure.

F. rectangular prism  
G. rectangular pyramid  
H. triangular prism  
J. triangular pyramid 

Bonus BATTERIES A 9-volt battery has a volume of 2,657.34 cubic millimeters. The battery is 22.2 millimeters long and 9 millimeters deep. How wide is the battery?
Write the letter for the correct answer in the blank at the right of each question.

1. **PONDS** A rectangular pond is $6\frac{3}{4}$ feet long, 4 feet wide, and 18 inches deep. What is the volume of the pool?
   A. $27 \text{ ft}^3$  
   B. $40.5 \text{ ft}^3$  
   C. $432 \text{ ft}^3$  
   D. $486 \text{ ft}^3$  
   1. ____

2. What is the area of a parallelogram with a base of 4 miles and a height of 8 miles?
   F. $\frac{1}{2} \text{ mi}^2$  
   G. $16 \text{ mi}^2$  
   H. $32 \text{ mi}^2$  
   J. $64 \text{ mi}^2$  
   2. ____

3. **GARDENS** Find the area of a circular garden with a radius of 20 yards. Round to the nearest tenth.
   A. 31.4 yd²  
   B. 62.8 yd²  
   C. 314.2 yd²  
   D. 1,256.0 yd²  
   3. ____

Find the area of each figure. Round to the nearest tenth if necessary.

4. 
   ![Figure 1](image1.png)
   F. $10,201.9 \text{ m}^2$  
   G. $2,550.5 \text{ m}^2$  
   J. $89.5 \text{ m}^2$  
   4. ____

5. 
   ![Figure 2](image2.png)
   A. 578 cm²  
   B. 374 cm²  
   C. 289 cm²  
   D. 187 cm²  
   5. ____

6. 
   ![Figure 3](image3.png)
   F. $735 \text{ mm}^2$  
   G. $588 \text{ mm}^2$  
   H. $367.5 \text{ mm}^2$  
   J. $294 \text{ mm}^2$  
   6. ____

7. 
   ![Figure 4](image4.png)
   A. $56 \text{ m}^2$  
   B. $40 \text{ m}^2$  
   C. $28 \text{ m}^2$  
   D. $20 \text{ m}^2$  
   7. ____

8. 
   ![Figure 5](image5.png)
   F. $164.5 \text{ cm}^2$  
   G. $89.1 \text{ cm}^2$  
   H. $105.1 \text{ cm}^2$  
   J. $81.1 \text{ cm}^2$  
   8. ____

9. Find the circumference of the circle. Use 3.14 for $\pi$. Round to the nearest tenth.
   A. 5.5 m  
   B. 11.0 m  
   C. 22.0 m  
   D. 34.5 m  
   9. ____
10. Which solid has the top, the side, and the front views given?
   - F.
   - H.
   - G.
   - J.

11. Find the volume of the rectangular prism.
   - A. 336 mm$^3$
   - B. 328 mm$^3$
   - C. 168 mm$^3$
   - D. 24 mm$^3$

12. Find the volume of a rectangular prism with a length of 7.8 feet, a width of 4.2 feet, and a height of 5 feet. Round to the nearest tenth.
   - F. 185.5 ft$^3$
   - G. 163.8 ft$^3$
   - H. 92.86 ft$^3$
   - J. 17 ft$^3$

13. A cube has 8-inch edges. Find its volume.
   - A. 64 in$^3$
   - B. 24 in$^3$
   - C. 384 in$^3$
   - D. 512 in$^3$

14. Find the volume of the cylinder to the nearest tenth.
   - F. 34,464.6 cm$^3$
   - G. 17,232.3 cm$^3$
   - H. 1,230.9 cm$^3$
   - J. 392 cm$^3$

15. CANS A cylindrical waste can has a height of 20 inches, and its base has a radius of 10 inches. Find the volume of the waste can to the nearest tenth.
   - A. 12,560 in$^3$
   - B. 6,280.0 in$^3$
   - C. 1,885.0 in$^3$
   - D. 1,570.8 in$^3$

16. Classify the figure.
   - F. rectangular prism
   - G. rectangular pyramid
   - H. triangular prism
   - J. triangular pyramid

Bonus TRUNKS A rectangular trunk has a volume of 26,880 cubic inches. The trunk is 4 feet long by 28 inches wide. How deep is the trunk?
1. Find the circumference of the circle. Use 3.14 for \( \pi \) and round to the nearest tenth.

2. **CIRCUS** A circus elephant walked 19 feet crossing the circus ring through its center. What is the circumference of the circus ring? Use 3.14 for \( \pi \) and round to the nearest tenth.

Find the area of each figure. Round to the nearest tenth if necessary.

3. 

4. 

5. 

6. 

Find the area of each circle. Use 3.14 for \( \pi \). Round to the nearest tenth.

7. radius = 6 cm

8. 

9. **CARTONS** A cylindrical carton is filled with sand. The height of the carton is 9 inches, and the radius of the base is 2 inches. What is the total volume of the carton?

10. Identify the shape of the base(s) of the figure. Then classify the figure.
Draw a top, a side, and a front view of each solid.

11.

12.

Draw each solid using the top, side, and front views shown. Use isometric dot paper.

13.

14.

Find the volume of each solid. Use 3.14 for \( \pi \).
Round to the nearest tenth if necessary.

15.

16.

17.

18.

19.

20.

Bonus STORAGE A storage shed with a flat roof is 4 yards long by 3 yards wide by \( 2\frac{1}{2} \) yards tall. A cubic yard is equal to 27 cubic feet. How many cubic feet of storage space does the shed enclose?
1. Find the circumference of the circle. Use 3.14 for \( \pi \) and round to the nearest tenth.

\[ \text{Circumference} = \pi \times \text{diameter} \]

![Diagonal View of a Circle with Diameter 2.7 mm]

2. The diameter of a blueberry pie is \( 9\frac{1}{2} \) inches. What is the circumference of the pie? Use 3.14 for \( \pi \) and round to the nearest tenth.

Find the area of each figure. Round to the nearest tenth if necessary.

3. \[ \text{Area} = \frac{1}{2} \times \text{base} \times \text{height} \]

![Triangle with Base 4 m and Height 6 m]

4. \[ \text{Area} = \frac{1}{2} \times \text{base} \times \text{height} \]

![Triangle with Base 25 mm and Height 20 mm]

5. \[ \text{Area} = \frac{1}{2} \times \text{base} \times \text{height} \]

![Parallelogram with Base 8 in and Height 4 in]

6. \[ \text{Area} = \frac{1}{2} \times \text{base} \times \text{height} \]

![Parallelogram with Base 22 cm and Height 18 cm]

Find the area of each circle. Use 3.14 for \( \pi \). Round to the nearest tenth.

7. diameter = 7 ft

8. \[ \text{Area} = \pi \times \text{radius}^2 \]

![Circle with Radius 14 in]

9. GLASSES A cylindrical glass is 8 inches tall. The radius of the base is 1.5 inches. If the glass is full, how many cubic inches of liquid does it hold? Round to the nearest tenth.

10. Identify the shape of the base(s) of the figure. Then classify the figure.

![Triangular Prism]
Draw a top, a side, and a front view of each solid.

11. 

12. 

Draw each solid using the top, side, and front views shown. Use isometric dot paper.

13. 

14. 

Find the volume of each solid. Use 3.14 for π. Round to the nearest tenth if necessary.

15. 

16. 

17. 

18. 

19. 

20. 

Bonus SWIMMING POOLS A swimming pool is 30 feet long by 12 feet wide by 4 feet deep. A cubic yard of water is 27 cubic feet. How many cubic yards of water can the pool hold? Round to the nearest tenth.
1. Find the circumference of the circle. Use 3.14 for $\pi$ and round to the nearest tenth.

2. **BICYCLE** A bicycle wheel measures 18 inches across. What is the circumference of the wheel? Use 3.14 for $\pi$ and round to the nearest tenth.

Find the area of each figure. Round to the nearest tenth if necessary.

3. 

4. 

5. 

6. 

Find the area of each circle. Use 3.14 for $\pi$. Round to the nearest tenth.

7. diameter = 100 ft

8. 

9. **TANKS** A cylindrical water tank is 38 meters across and 8 meters high. If the tank is half full, how many cubic meters of water are in the tank? Round to the nearest tenth.

10. Identify the shape of the base(s) of the figure. Then classify the figure.
Draw a top, a side, and a front view of each solid.

11.

12.

Draw each solid using the top, side, and front views shown. Use isometric dot paper.

13. 

14.

Find the volume of each solid. Use 3.14 for \( \pi \). Round to the nearest tenth if necessary.

15.

16.

17.

18.

19.

20.

Bonus RECYCLING The surface area of a large cube-shaped recycling dumpster is 433.5 square feet. What is the volume of the recycling dumpster? Round to the nearest tenth.
1. a. Describe two different ways to represent three-dimensional figures in drawings.

   b. Draw a top, a side, and a front view of a donut.

   c. Draw a three-dimensional figure given the top, side, and front views shown.

   d. Draw a three-dimensional figure of your choice. Then draw the top, side, and front views of the figure.

2. Explain how the formulas for the volume of a rectangular prism and the volume of a cylinder are similar.

3. Will and Steve want to draw a target for playing darts. Will wants to draw a circle, and Steve wants to draw a rectangle. Neither can have a perimeter or circumference larger than 12 centimeters.

   a. Estimate the dimensions of the rectangle and the radius of the circle if the circumference and perimeter both equal 12 centimeters.

   b. The perimeter of the rectangle equals the circumference of the circle. The length of the rectangle is $6\frac{1}{2}$ centimeters and the width is $2\frac{2}{3}$ centimeters. What is the radius of the circle?
11 Standardized Test Practice  
(Chapters 1–11)

Part 1: Multiple Choice

Instructions: Fill in the appropriate oval for the best answer.

1. Find $\sqrt{25}$. (Lesson 10-1)
   A $-25$  B $5$  C $12.5$  D $625$
   1. ○ ○ ○ ○

2. Find $17 - \frac{3}{5}$. Write in simplest form. (Lesson 5-3)
   F $14\frac{3}{5}$  G $13\frac{4}{5}$  H $13\frac{7}{10}$  J $13\frac{2}{5}$
   2. ○ ○ ○ ○

3. Write $4\frac{1}{4}$ as a percent. (Lesson 6-9)
   A $425\%$  B $4.25\%$  C $\frac{17}{4}\%$  D $0.0425\%$
   3. ○ ○ ○ ○

4. Find the sale price to the nearest cent for a CD-ROM that costs $50 and is 15% off. (Lesson 7-7)
   F $7.50$  G $42.50$  H $43.50$  J $57.50$
   4. ○ ○ ○ ○

5. Find the interest earned for a principal of $200, an interest rate of 10%, and a time period of 2 years. (Lesson 8-7)
   A $10$  B $20$  C $30$  D $40$
   5. ○ ○ ○ ○

6. COLORING There are 6 different crayons for Elia to use to create a birthday card. If she uses only 4 of these colors one time each, how many ways can she choose the colors? (Lesson 9-5)
   F $720$  G $360$  H $120$  J $15$
   6. ○ ○ ○ ○

7. Find the missing measure in the triangle. Then classify the triangle as acute, right, or obtuse. (Lesson 10-4)
   A $10$; acute  B $90$; right  C $90$; acute  D $270$; obtuse
   7. ○ ○ ○ ○

8. Use the graph to describe the movement from $\triangle XYZ$ to $\triangle X'Y'Z'$. (Lesson 10-9)
   F 4 right, up 2  H 3 right, up 2
   G 3 right, up 3  J 4 right, up 3
   8. ○ ○ ○ ○
9. What is the area of a parallelogram that has a base of 24 meters and a height of 16.2 meters? (Lesson 11-1)

A 40.2 m²  B 80.4 m²  C 194.4 m²  D 388.8 m²  

10. DINING The tables at Cozy Cafe have a diameter of 4 feet. What is the circumference of a table to the nearest tenth? (Lesson 11-3)

F 6.3 ft  G 12.6 ft  H 16 ft  J 25.1 ft  

11. Choose the top, side, and front views of the figure that are drawn correctly. (Lesson 11-8)

A top side front  B top side front  C top side front  D top side front  

12. Find the volume of a rectangular prism with a length of 1.7 meters, a width of 4 meters, and a height of 2.5 meters. (Lesson 11-9)

F 8.2 m³  G 17 m³  H 42.3 m³  J 551.4 m³  

13. Find the volume of the cylinder. Round to the nearest tenth. (Lesson 11-10)

A 320 cm³  B 628 cm³  C 653.5 cm³  D 1,004.8 cm³  

14. Find the volume of the cylinder. Round to the nearest tenth. (Lesson 11-10)

F 2,671.9 in³  G 10,385.6 in³  H 29,688.1 in³  J 41,542.2 in³  

15. Find the percent of change from 14 to 26, to the nearest whole percent. (Lesson 7-8)

A 33  B 46  C 54  D 86  

16. What is the area of a trapezoid with bases 8 inches and 12.5 inches, and a height of 6 inches? (Lesson 11-2)

F 75 in²  G 61.5 in²  H 48 in²  J 26.5 in²  

Glencoe California Mathematics, Grade 6
17. Write the next three terms of the sequence
6, 12, 18, 24, ... (Lesson 1-9)

18. Write 35% as a decimal. (Lesson 4-7)

19. Complete: \(2\frac{1}{4}\) lb = ? oz (Lesson 6-3)

20. Find the interest earned to the nearest cent for
a principal of \($97.99\), an interest rate of \(6\frac{1}{2}\%\),
and a time period of 3 months. (Lesson 7-8)

21. Draw a top, a side, and a front view of the solid. (Lesson 11-8)

22. Draw the solid using the top, side, and front views shown. Use isometric dot paper. (Lesson 2-8)

Find the volume of the rectangular prism and the cylinder.
Round to the nearest tenth if necessary.

23. 24. 25.

25. GARDENING Roxanne is building a flower box that is
10 inches deep by 12 inches wide by 50 inches long. The
box does not have a top side so that the flowers can be
planted in the box.

a. How many cubic inches of soil will she need if she
fills the box to the top? Show your work. (Lesson 11-9)

b. Suppose she also wants to use a cylindrical flower pot
that uses less than half the amount of soil as the box
that she built. What are possible dimensions of the pot?
Explain. (Lesson 11-10)
Get Ready for the Lesson
Complete the Mini Lab at the top of page 572 in your textbook. Write your answers below.

1. What is the value of \(x\) and \(y\) for each parallelogram?
   \(x = 4\) units, \(y = 2\) units

2. Count the grid squares to find the area of each parallelogram. 8 sq units

3. On grid paper, draw three different parallelograms in which \(x = 5\) units and \(y = 4\) units. Find the area of each.
   The area of each is 20 sq units.

4. MAKE A CONJECTURE about how to find the area of a parallelogram if you know the values of \(x\) and \(y\).
   The area equals \(x \times y\).

Read the Lesson
5. Explain how to find the height of a parallelogram. Sample answer: Draw a segment perpendicular to the base with endpoints on opposite sides of the parallelogram. The height is the length of this segment.

6. Suppose you are asked to find the area of the parallelogram below. Is the given solution correct? Explain.
   
   \[
   A = \frac{1}{2} \times 6 \times 3
   \]
   Sample answer: The area was found using the length of the side of the parallelogram instead of the height. The correct answer is 9 cm².

Remember What You Learned
7. Because rectangles, rhombuses, and squares are all parallelograms, the formula for finding the area of a parallelogram is also used to find the areas of each of these figures. Think of a way to remember that the area of a parallelogram is the product of its base and height. For example, draw several parallelograms, rectangles, rhombuses, and squares and label the base and height for each. Write the formula for the area below each model. See students’ work.
The area $A$ of a parallelogram equals the product of its base $b$ and its height $h$.

\[ A = bh \]

**Example 1** Find the area of a parallelogram if the base is 6 inches and the height is 3.7 inches.

**Estimate** $A = 6 \cdot 4$ or 24 in$^2$

$A = bh$

$A = 6 \cdot 3.7$

Replace $b$ with 6 and $h$ with 3.7.

$A = 22.2$

Multiply.

The area of the parallelogram is 22.2 square inches. This is close to the estimate.

**Example 2** Find the area of the parallelogram at the right.

**Estimate** $A = 10 \cdot 10$ or 100 cm$^2$

$A = bh$

$A = 12 \cdot 8$

Replace $b$ with 12 and $h$ with 8.

$A = 96$

Multiply.

The area of the parallelogram is 96 square centimeters. This is close to the estimate.

**Exercises**

Find the area of each parallelogram. Round to the nearest tenth if necessary.

1. $\text{base} = 5 \text{ ft}$
   $\text{height} = 12 \text{ ft}$
   $60 \text{ ft}^2$

2. $\text{base} = 9 \text{ in.}$
   $\text{height} = 2 \text{ in.}$
   $18 \text{ in}^2$

3. $\text{base} = 6 \text{ cm}$
   $\text{height} = 5.5 \text{ cm}$
   $33 \text{ cm}^2$

4. $\text{base} = 4 \frac{2}{3} \text{ yd}$
   $\text{height} = 2 \text{ yd}$
   $8 \frac{5}{3} \text{ yd}^2$

5. $\text{base} = 15.3 \text{ mm}$
   $\text{height} = 8 \text{ mm}$
   $122.4 \text{ mm}^2$

6. $\text{base} = 19.6 \text{ m}$
   $\text{height} = 14.5 \text{ m}$
   $284.2 \text{ m}^2$

7. $\text{base} = 6 \text{ cm}$
   $\text{height} = 3 \text{ cm}$
   $18 \text{ cm}^2$

8. $\text{base} = 28 \text{ in.}$
   $\text{height} = 4 \text{ in.}$
   $112 \text{ in}^2$

9. $\text{base} = 15 \text{ mm}$
   $\text{height} = 11 \text{ mm}$
   $165 \text{ mm}^2$

10. $\text{base} = 12 \text{ ft}$
    $\text{height} = 9 \text{ ft}$
    $108 \text{ ft}^2$

11. $\text{base} = 4.6 \text{ cm}$
    $\text{height} = 2 \text{ cm}$
    $9.2 \text{ cm}^2$

12. $\text{base} = 20 \text{ in.}$
    $\text{height} = 11 \frac{3}{4} \text{ in.}$
    $236 \text{ in}^2$

13. $\text{base} = 43 \text{ mm}$
    $\text{height} = 12 \text{ mm}$
    $51.6 \text{ mm}^2$

14. $\text{base} = 24 \text{ ft}$
    $\text{height} = 7 \text{ ft}$
    $168 \text{ ft}^2$ or $18.6 \text{ yd}^2$
Practice
Area of Parallelograms

Find the area of each parallelogram. Round to the nearest tenth if necessary.

1. \( 36.9 \text{ mm}^2 \)
2. \( 144 \text{ m}^2 \)
3. \( 5.2 \text{ yd}^2 \)
4. \( 60 \text{ in}^2 \)
5. \( 0.63 \text{ cm}^2 \)
6. \( 182 \text{ ft}^2 \)

7. \( 162 \text{ ft}^2 \) or \( 18 \text{ yd}^2 \)
8. \( 360 \text{ in}^2 \) or \( 2.5 \text{ ft}^2 \)
9. \( 1,296 \text{ in}^2 \) or \( 9 \text{ ft}^2 \) or \( 1 \text{ yd}^2 \)

GEOGRAPHY
Estimate the area of each state.

10. \( 55,900 \text{ mi}^2 \)
11. \( 7,425 \text{ mi}^2 \)

12. ALGEBRA
A parallelogram has an area of 240 square meters. Find the height of the parallelogram if the base is 20 meters.
\( 12 \text{ m} \)

13. ALGEBRA
What is the base of a parallelogram if the height is 5 feet and the area is 65 square feet? \( 13 \text{ ft} \)
**Spreadsheet Activity**

**Areas of Parallelograms**

You can use a spreadsheet to determine the area of a parallelogram.

**Example 1**

Use a spreadsheet to find the area of a parallelogram with base equal to 5 inches and height equal to 4 inches.

**Step 1**

Use cell A1 of the spreadsheet for the base of the parallelogram and cell B1 for the height of the parallelogram.

**Step 2**

In cell C1, enter an equals sign followed by the formula for the area of a parallelogram. The formula should be =A1*B1. Then press **ENTER** to return the area.

The area of the parallelogram is 20 square inches.

**Example 2**

Use a spreadsheet to find the area of a parallelogram with base equal to 2.5 centimeters and height equal to 3.5 centimeters.

**Step 3**

Enter the base in cell A2 and the height in cell B2.

**Step 4**

Click on the bottom right corner of cell C1 and drag it to C2. This returns the area of the parallelogram.

The area of the parallelogram is 8.75 square centimeters.

**Exercises**

Use a spreadsheet to find the areas of the given parallelograms.

1. \( b = 3 \text{ in.}, h = 6 \text{ in.} \)  
   \( \text{area} = 18 \text{ in}^2 \)

2. \( b = 2 \text{ in.}, h = 5 \text{ in.} \)  
   \( \text{area} = 10 \text{ in}^2 \)

3. \( b = 5 \text{ in.}, h = 1 \text{ in.} \)  
   \( \text{area} = 5 \text{ in}^2 \)

4. \( b = 7 \text{ in.}, h = 3 \text{ in.} \)  
   \( \text{area} = 21 \text{ in}^2 \)

5. \( b = 3.5 \text{ m}, h = 1.5 \text{ m} \)  
   \( \text{area} = 5.25 \text{ m}^2 \)

6. \( b = 2.2 \text{ m}, h = 1.7 \text{ m} \)  
   \( \text{area} = 3.74 \text{ m}^2 \)

7. \( b = 1.5 \text{ m}, h = 0.1 \text{ m} \)  
   \( \text{area} = 0.15 \text{ m}^2 \)

8. \( b = 5.7 \text{ m}, h = 9.1 \text{ m} \)  
   \( \text{area} = 51.87 \text{ m}^2 \)

9. \( b = 0.5 \text{ m}, h = 0.3 \text{ m} \)  
   \( \text{area} = 0.15 \text{ m}^2 \)
Chapter 11

11-2

Lesson Reading Guide

Area of Triangles and Trapezoids

Get Ready for the Lesson

Complete the Mini Lab at the top of page 578 in your textbook. Write your answers below:

1. What is the area of the parallelogram? 24 sq units

2. Cut along the diagonal. What is true about the triangles formed? They are congruent.

3. What is the area of each triangle? 12 sq units

4. If the area of a parallelogram is \( bh \), then write an expression for the area \( A \) of each of the two congruent triangles that form the parallelogram.

\[ A = \frac{1}{2}bh \]

Read the Lesson

5. In a triangle, which side is the base? Sample answer: The base can be any side of the triangle.

6. How do you find the height of a triangle? Sample answer: Once you know which side is the base, find the distance from the base to the opposite vertex.

7. For what kind of triangle might the height be found outside of the triangle? obtuse triangle

8. How is the height of a trapezoid similar to the height of a triangle or parallelogram? Sample answer: It is perpendicular to the base.

Remember What You Learned

9. The Mini Lab in this lesson gave you a good way to remember the formula for the area of a triangle by showing you that it is half the area of a parallelogram, so \( A = \frac{1}{2}bh \). Think of a way to help you remember the formula for the area of a trapezoid. Do you recognize anything in the formula \( A = \frac{1}{2}h(b_1 + b_2) \)? Sample answer: Finding \( \frac{1}{2}(b_1 + b_2) \) means to find the average of the lengths of the bases. So, the area of a trapezoid is the product of the average of the lengths of the bases times the height.
Find the area of each figure. Round to the nearest tenth if necessary.

1. 45 cm²
2. 3 ft²
3. 150 mm²
4. 19 ft²
5. 39.2 cm²
6. 248.4 mm²
7. 270.6 ft²
8. 19.3 in²
9. 45.8 cm²
10. 136.2 mm²
11. triangle: base = 16 cm, height = 9.4 cm 75.2 cm²
12. triangle: base = 13.5 in., height = 6.4 in. 43.2 in²
13. trapezoid: bases 22.8 mm and 19.7 mm, height 36 mm 765 mm²
14. trapezoid: bases 5 ft and 3½ ft, height 7 ft 29.8 ft²

7. GEOGRAPHY The shape of Arkansas is roughly trapezoidal with bases of 150 miles and 250 miles and a height of 260 miles. What is the approximate area of Arkansas? 52,000 mi²

ALGEBRA Find the height of each figure.

8. Area = 23,000 m² 115 m
9. Area = 6,460 in² 95 in.

Draw and label each figure. Then find the area.

10. a trapezoid with a height less than 5 feet and an area greater than 50 square feet $A = 56$ ft²

Sample answer: 12 ft

11. a right triangle with a base greater than 10 meters and an area greater than 75 square meters $A = 90$ m²

Sample answer: 16 ft
Lesson 11–2

Heron’s Formula

A formula named after Heron of Alexandria, Egypt, can be used to find the area of a triangle given the lengths of its sides.

Heron’s formula states that the area \( A \) of a triangle whose sides measure \( a \), \( b \), and \( c \) is given by

\[
A = \sqrt{s(s-a)(s-b)(s-c)},
\]

where \( s \) is the semiperimeter:

\[
s = \frac{a + b + c}{2}.
\]

1–6 Estimates will vary.

Estimate the area of each triangle by finding the mean of the inner and outer measures. Then use Heron’s Formula to compute a more exact area. Give each answer to the nearest tenth of a square unit.

1. 2. 3.

Estimated area: 15
Computed area: 15.6

Estimated area: 38
Computed area: 37.4

Estimated area: 25
Computed area: 24

4. 5. 6.

Estimated area: 20.5
Computed area: 21.2

Estimated area: 12.5
Computed area: 11.8

Estimated area: 18
Computed area: 17.4
Circles and Circumference

Get Ready for the Lesson
Read the introduction at the top of page 584 in your textbook. Write your answers below:

1. Which point appears to be the center of the Ferris wheel? G

2. Is the distance from G to F greater than, less than, or equal to the distance from G to J? Equal to

3. What can you say about the distance from G to H and the distance from F to J? It is half of F to J.

4. Find the distance from G to F. 225 ft

Read the Lesson

5. The Greek letter π represents a nonterminating and nonrepeating number. What does this mean? Sample answer: The number that π represents (3.1415926….) is a decimal number whose digits to the right of the decimal point do not end or have any repeating pattern.

6. When is the symbol = used when finding the circumference of a circle? Why is this symbol used? Sample answer: The symbol = is used when a number is substituted for π in the formula for the circumference of a circle. When you use a number in place of π, that number is only an approximation of π, so the value of the circumference will also only be an approximation.

7. What two numbers are used in this lesson as approximations for π? 3.14 and 22/7

Remember What You Learned

8. The word diameter comes from two Greek words that mean “a measure (metron) through (dia).” What is the diameter of a circle? Sample answer: the distance through the center of a circle from one side to the other

9. One of the definitions given for radius is semidiameter. Think of the relationship between radius and diameter. What do you think semidiameter means? Sample answer: half of a diameter

Example 1
Find the circumference of a circle with a diameter of 7.5 centimeters.

\[ C = \pi d \]

C = 3.14 \times 7.5

C = 23.55

The circumference of the circle is about 23.55 centimeters.

Example 2
If the radius of a circle is 14 inches, what is its circumference?

\[ C = 2\pi r \]

C = 2 \times 3.14 \times 14

C = 87.92

The circumference of the circle is about 87.92 inches.

Exercises
Find the circumference of each circle. Use 3.14 for π. Round to the nearest tenth if necessary.

1. Diameter = 6 ft

\[ 2\pi \times 6 = 37.7 \text{ ft} \]

2. Diameter = 20 cm

\[ 2\pi \times 20 = 62.8 \text{ cm} \]

3. Diameter = 5 m

\[ 2\pi \times 5 = 31.4 \text{ m} \]

4. Diameter = 7.5 in.

\[ 2\pi \times 7.5 = 23.6 \text{ in.} \]

5. Diameter = 15 km

\[ 2\pi \times 15 = 47.1 \text{ km} \]

6. Radius = 21 mi

\[ 2\pi \times 21 = 131.9 \text{ mi} \]

7. Radius = 50 m

\[ 2\pi \times 50 = 314 \text{ m} \]

8. Diameter = 600 ft

\[ 2\pi \times 600 = 376.8 \text{ ft} \]

9. Radius = 62 mm

\[ 2\pi \times 62 = 391.4 \text{ mm} \]

10. Diameter = 7 km

\[ 2\pi \times 7 = 43.98 \text{ km} \]

11. Radius = 95 in.

\[ 2\pi \times 95 = 603 \text{ in.} \]

12. Diameter = 6.3 m

\[ 2\pi \times 6.3 = 39.79 \text{ m} \]

13. Diameter = 5 1/4 cm

\[ 2\pi \times 5.25 = 32.7 \text{ cm} \]
Find the circumference of each circle. Use 3.14 for \( \pi \). Round to the nearest tenth if necessary.

1. 15.1 cm
2. 87.9 ft
3. 4.7 yd
4. 26.4 mm
5. 75.4 m
6. 22.0 in.
7. radius = 3 km
8. radius = 46 cm
9. 30 in.
10. diameter = 50.2 ft
11. radius = 5 ft
12. diameter = 25 m
13. radius = \( \frac{3}{2} \) ft
14. diameter = 9.7 mm
15. radius = 5.2 km
16. diameter = 12 m
17. radius = 22 ft
18. diameter = 9.4 in.
19. radius = 100 m
20. radius = 65 m
21. diameter = 10\( \frac{1}{2} \) in.
22. diameter = 8.5 cm

Estimate to find the approximate circumference of each circle. Explain which approximation of \( \pi \) you used.

Sample answer: 5 is about 5 and \( \frac{1}{2} \) is about 3 so, \( 5 \times 3 = 15 \) ft or 24 cm

ALGEBRA Find the diameter or radius of each circle. Use 3.14 for \( \pi \). Round to the nearest tenth if necessary.

16. \( C = 32 \) m, diameter = _10.2_ m
17. \( C = 55 \) mi, radius = _8.8_ mi

18. HELICOPTERS The landing circle for helicopters on the roof of a hospital has a radius of 20 yards. To the nearest yard, find its circumference.

126 yd

19. SPA A circular spa has a diameter of 12 feet. The spa is decorated with 4-inch porcelain tiles around the rim. How many tiles surround the rim of the spa? Round to the nearest whole tile. _113_ tiles
**Word Problem Practice**

**Circles and Circumference**

1. **PLATES** A manufacturing company is producing dinner plates with a diameter of 12 inches. They plan to put a gold edge on each plate. Determine how much gold edging they need for each plate by finding the circumference of each plate. Round to the nearest tenth. **37.7 in.**

2. **MONEY** A dime has a radius of \(8\frac{1}{2}\) millimeters. Find the circumference of a dime to the nearest tenth. **53.4 mm**

3. **MERRY-GO-ROUND** Mr. Osterhout is putting trim around the edge of a circular merry-go-round that has a diameter of 15 feet. How much trim does he need to buy to the nearest tenth? **47.1 ft**

4. **PIZZA** Find the circumference of a pizza with a diameter of 10 inches. Round to the nearest tenth. **31.4 in.**

5. **RACING** A circular racetrack has a diameter of \(\frac{1}{2}\) mile. How far does a car travel in one lap around the track? Round to the nearest tenth. **1.6 mi**

6. **TIRE** A bicycle tire has a radius of 15 inches. What is the circumference of the tire? Round to the nearest tenth. **94.2 in.**

7. **EQUATOR** Earth's diameter at the equator is 7,926 miles. Find the distance around Earth at its equator to the nearest tenth. **24,887.6 mi**

8. **SATURN** The ring system around Saturn has a diameter of 170,000 miles. Find the circumference of the ring system. **533,800 mi**

---

**Enrichment**

**Finding the Length of an Arc**

Recall that the circumference is the measure of the distance around a circle. A portion of the circumference is called an arc. An arc is named by the endpoints of the radii that create it. To find the measure of an arc, you can use a proportion. The ratio of the arc length to the circumference is equal to the ratio of the central angle of the arc to 360°.

\[
\frac{m\overline{AB}}{4\pi} = \frac{m\angle ACB}{360°}
\]

To find the measure of \(\overline{AB}\), first set up the ratio.

Next, fill in the known values.

\[
m\overline{AB} = \frac{4\pi}{9} \approx 1.40 \text{ cm}
\]

Simplify the fraction.

Then solve for \(m\overline{AB}\).

\[
m\overline{AB} = \frac{4\pi}{9} \approx 1.40 \text{ cm}
\]

**Solve the following problems.**

1. A circle has a circumference of 48 centimeters. Find the length of an arc that has a central angle of 90°.

\[
m\overline{AB} = \frac{4\pi}{4} = 90° \approx 12 \text{ cm}
\]

2. A circle has a circumference of 112 meters. The length of \(\overline{DF}\) is 14 meters. Find the measure of the central angle of \(\overline{DF}\).

\[
m\angle DEF = \frac{14}{112} = \frac{\pi}{360°} = 45°
\]

3. A circle has a radius of 5 inches. Find the length of an arc that has a central angle of 72°.

\[
m\overline{AB} = \frac{72°}{10\pi} \approx \frac{72°}{360°} = 0.20 \text{ in.}
\]

4. Two arcs in a circle have central angles of 135° and 45°. Find the ratio of the arcs' lengths.

\[
\frac{135°}{45°} = 3:1
\]

5. \(\overline{AB}\) has a central angle of 50° in a circle whose diameter is 12 feet, while \(\overline{DEFO}\) has a central angle of 150° in a circle whose diameter is 3 feet.

\[
\frac{150°}{360°} = \frac{5.23}{3.93} \approx 3.93 \text{ feet long, and } \overline{DEFO} \text{ is 5.23 feet long.}
\]
### TI-73 Activity
Calculating Circumference

The $\pi$ key makes it easier to evaluate expressions that use the constant $\pi$.  

**Example**
Find the circumference of a circle with a radius of 8 meters. Express your answer to the nearest tenth.  

$$C = 2\pi r$$  

$2 \{2n\} 8 \text{ ENTER}$

The circumference is about 50.3 meters.

**Exercises**

Find the circumference of each circle to the nearest tenth.

1. $37.7$ m
2. $56.5$ ft
3. $34.6$ in.
4. $46.5$ m
5. $52.2$ ft
6. $21.7$ cm

### Spreadsheet Activity
Exploring the Value of $\pi$

You can use a spreadsheet to explore the value of $\pi$. You will need at least 10 different circular items. These could be cups, lids, cans, or even the circular markings on the gym floor or the outline of a basketball hoop. Carefully measure the circumference of each item with a piece of string. Then use a metric ruler to record the measurement in millimeters. Also record the measure of the diameter of each object in millimeters.

Create a spreadsheet with three columns. In column A, enter the circumferences of the items you measured. In column B, enter the diameters. In column C, create a formula for the value of $\pi$ using circumference and diameter. Let the spreadsheet calculate the value for as many decimal places as it can.

Your spreadsheet should look like this.

![Spreadsheet Image]

Use your spreadsheet to answer the following questions.

1. What is the value of $\pi$ used by your spreadsheet?  
   **Sample answer:** $3.141592654$

2. How close are your calculations to the actual value of $\pi$? To how many decimal places are your calculations correct?  
   **Answers will vary.**

3. What causes your calculations of $\pi$ not to be exact?  
   **Sample answer:** Measurements made with a string are inaccurate. It is hard to find the exact diameter unless the center is labeled.

4. What could make your calculations more exact?  
   **Sample answer:** Use scientific instruments to get more exact measurements

5. Suppose you created another spreadsheet with the same columns as this one. The new spreadsheet calculates the diameter when given the circumference and the value of $\pi$. What formula would you enter in column B?  
   **$A/C$**

6. If you create another spreadsheet that calculates the circumference when given the diameter and the value of $\pi$, what formula would you enter in column A?  
   **$C \times B$**
Exercises

Example 2

Find the area of the circle.

A = \pi r^2

1. \[ r = 5 \text{ cm} \]

2. \[ r = 9.4 \text{ mm} \]

3. \[ r = 2.6 \text{ cm} \]

4. \[ r = 14.3 \text{ in.} \]

5. \[ d = 512 \text{ yd} \]

6. \[ d = 3 \frac{3}{4} \text{ mi} \]

7. \[ r = 7.9 \text{ mm} \]

8. \[ r = 2 \frac{1}{5} \text{ ft} \]

9. \[ r = 2 \frac{1}{5} \text{ ft} \]

Find the area of each circle. Use 3.14 for \( \pi \). Round to the nearest tenth.

1. \[ 153.9 \text{ in}^2 \]

2. \[ 490.6 \text{ mm}^2 \]

3. \[ 452.2 \text{ ft}^2 \]

4. \[ 21.2 \text{ cm}^2 \]

5. \[ 642.1 \text{ in}^2 \]

6. \[ 23.7 \text{ yd}^2 \]

7. \[ 17.7 \text{ mi}^2 \]

8. \[ 49.0 \text{ mm}^2 \]

9. \[ 15.2 \text{ ft}^2 \]
Find the area of each circle. Use 3.14 for \( \pi \). Round to the nearest tenth if necessary.

1. \( 3.1 \text{ cm}^2 \)
2. \( 4.6 \text{ yd}^2 \)
3. \( 961.6 \text{ mm}^2 \)
4. \( 615.4 \text{ in}^2 \)
5. \( 14.5 \text{ ft}^2 \)
6. \( 50.2 \text{ cm}^2 \)
7. \( 69.4 \text{ yd}^2 \)
8. \( 1,589.6 \text{ in}^2 \)
9. \( 3.5 \text{ mm}^2 \)
10. \( 444.7 \text{ ft}^2 \)

11. radius = 5.7 mm  
    \( 102.0 \text{ mm}^2 \)
12. radius = 8.2 ft  
    \( 211.1 \text{ ft}^2 \)
13. diameter = \( 3\frac{1}{4} \) in.  
    \( 8.3 \text{ in}^2 \)
14. diameter = 15.6 cm  
    \( 191.0 \text{ cm}^2 \)
15. radius = 1.1 in.  
    \( 3.8 \text{ in}^2 \)
16. diameter = \( 1\frac{3}{4} \) yd  
    \( 127.6 \text{ yd}^2 \)

Estimate to find the approximate area of each circle.

13. \( 4 \times 4^2 = 48 \text{ yd}^2 \)
14. \( 3 \times 6^2 = 108 \text{ m}^2 \)
15. \( 3 \times 7^2 = 147 \text{ cm}^2 \)

16. SPOTLIGHT A spotlight can be adjusted to effectively light a circular area of up to 6 meters in diameter. To the nearest tenth, what is the maximum area that can be effectively lit by the spotlight? \( 28.3 \text{ m}^2 \)

17. ARCHERY The bull's eye on an archery target has a radius of 3 inches. The entire target has a radius of 9 inches. To the nearest tenth, find the area of the target outside of the bull's eye. \( 226.1 \text{ in}^2 \)
Seki Kowa

Japanese mathematician Seki Kowa (c. 1642–1708) is called The Arithmetical Sage because of his many contributions to the development of mathematics in Japan. Before Seki, mathematics in Japan was considered a form of art to be enjoyed by intellectuals in their leisure time. Seki demonstrated the practical uses of mathematics and introduced social reforms that made it possible for anyone, not just intellectuals, to study mathematics.

One of Seki’s contributions to mathematics was his calculation of a value that was correct to eighteen decimal places.

\[\pi = 3.141592653589793238\ldots\]

Seki had noticed the phenomenon that you see at the right: as the number of sides of a regular polygon increases, the polygon looks more and more like a circle. So, Seki calculated the following ratio for polygons of increasingly many sides.

\[
\frac{\text{perimeter of regular polygon}}{\text{diameter of circle drawn around the polygon}}
\]

As the number of sides increases, the ratio gets closer to the value of \(\pi\) given above.

You are given information below about a regular polygon and the circle drawn around the polygon. Use a calculator to find Seki's ratio. (Give as many decimal places as there are in your calculator display.) What do you notice about your answers?

1. length of one side = 5
   number of sides = 6
   diameter of circle = 10
   \[\text{ratio} = 1.000\]

2. length of one side = 4.5922
   number of sides = 8
   diameter of circle = 12
   \[\text{ratio} = 3.061\]

3. length of one side = 3.7544
   number of sides = 20
   diameter of circle = 24
   \[\text{ratio} = 3.12866667\]

4. length of one side = 37.5443
   number of sides = 20
   diameter of circle = 240
   \[\text{ratio} = 3.12891667\]

5. length of one side = 1.6754
   number of sides = 150
   diameter of circle = 80
   \[\text{ratio} = 3.141375\]

6. length of one side = 2.6389
   number of sides = 500
   diameter of circle = 420
   \[\text{ratio} = 3.141547619\]

As the number of sides increases, the ratio gets closer to the value of \(\pi\) given above.
**Study Guide and Intervention**

### 11-5 Problem-Solving Investigation: Solve a Simpler Problem

When problem solving, sometimes it is easier to solve a simpler problem first to find the correct strategy for solving a more difficult problem.

**Example**

**SPORTS** West High School wants to paint the field blue, but not the center. The diagram below shows the dimensions of the field and center circle. How much area will they need to paint blue?

**Explore**

You know that the field is one large rectangle and the center symbol is a large circle.

**Plan**

You can find the area of the rectangle and the area of the circle and subtract.

**Solve**

Area of rectangle: $A = \ell w$

$A = 100 \times 75$ or $7500$

Area if circle: $A = \pi r^2$

$A = 3.14 \times 15^2$ or $706.5$

Subtract: $7500 - 706.5 = 6793.5$ ft$^2$

So, they would need to paint 6,793.5 square feet of field.

**Check**

Use estimation to check. The area of the entire field is 7,500 ft$^2$ and the circle is approximately 700 ft$^2$ so the area should be less than 6,800 ft$^2$. Since 6,793.5 is less than 6,800 ft$^2$, the answer is reasonable.

### Exercises

1. **FRAMES** Joan wants to paint her favorite picture frame. How much paint would she need to use in order to cover just the frame? 41 in$^2$

2. **WALLPAPER** Richard wants to wallpaper one wall of his bathroom. He has two semi-circular windows along the wall. How much wallpaper must he purchase? 83.44 ft$^2$

3. **POPULATION** The population of Ghostown, USA is decreasing at a rate of 3 people per year. If there are currently 831 people living in the town, when will the town be deserted? 277 years

4. **STAINED GLASS** Find the area of the stained glass window shown below. Use 3.14 for $\pi$. Round to the nearest hundredth if necessary. 6.58 in$^2$

5. **STOVETOPS** What is the area of the stovetop shown, not including the burners? Use 3.14 for $\pi$. Round to the nearest hundredth if necessary. 4.23 ft$^2$

6. **POOLS** Water is being added at a rate of 50 gallons per minute to a pool. How long will it take until the 10,000 gallon pool is full? 200 minutes or 3 hours and 20 minutes
1. **AREA**
   Find the area of the figure below. Use 3.14 for \( \pi \).
   \[ 
   \text{Area} = 44.56 \text{ in}^2 
   \]

2. **MONEY**
   The table below shows the amount of money Shoshi earned for working various hours. Write a rule to represent the amount of pay, \( P \), based on the number of hours worked, \( h \).
   
<table>
<thead>
<tr>
<th>Hours</th>
<th>Pay</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>5.50</td>
</tr>
<tr>
<td>2</td>
<td>11.00</td>
</tr>
<tr>
<td>3</td>
<td>16.50</td>
</tr>
</tbody>
</table>
   
   \[ P = 5.5h \]

3. **SALES**
   For every nickel increase in price, the subscriptions to the Perrysville Paper decreases by 5 people. If 1,256 people currently subscribe to the Paper, how many people will subscribe to it if the price is increased by $0.25?
   \[ 1,231 \text{ people} \]

4. **SCALE DRAWING**
   Shannon is creating a scale drawing of her classroom. If she is using the scale 1 foot / 1100 in and the room model is 10 inches by 15 inches, what are the dimensions of the actual room?
   \[ 20 \text{ ft by 30 ft} \]

5. **STUDY TIME**
   The circle graph below shows the results to a survey asking students how long they study each night. In a school of 400 students, how many students study 1.5 – 2.5 hours per night?
   \[ 260 \text{ students} \]

6. **PHOTOGRAPHY**
   What is the area of the matte pictured below?
   \[ 39 \text{ in}^2 \]

7. **TRAVEL**
   How far has Kim traveled if she has driven 45 miles per hour for 4 hours?
   \[ 180 \text{ miles} \]

8. **SISTERS**
   Angela is 3 years older than Susie. Becca is 2 years younger than Susie. If Becca is 10 years old, how old are Susie and Angela?
   \[ 12 \text{ and 15} \]
Lesson Reading Guide

Area of Complex Figures

Get Ready for the Lesson

Read the introduction at the top of page 596 in your textbook. Write your answers below.

1. Describe the shape of the kitchen. rectangle and semicircle

2. How could you determine the area of the kitchen? Sample answer: Find the area of the rectangle and the area of the semicircle, then add.

3. How could you determine the total square footage of a house with rooms shaped like these? Sample answer: Find the area of each room, then add.

Read the Lesson

4. Look up the term footage in a dictionary. Write the meaning that matches the way the term is used in this lesson.

Sample answer: length or quantity expressed in feet

5. What do you think the term square footage means? Sample answer: area in square feet

6. Which word of the compound square footage indicates area? Explain.

Sample answer: square, because area is measured in square units

7. Look up the term two-dimensional in a dictionary. Sample answer: having two dimensions, especially length and width; planar; flat

8. Name two dimensions of each of the following figures.
   a. rectangle length and width
   b. parallelogram base and height
   c. triangle length and width

9. Refer to the figure in Example 1. How do you know that the base of the triangle is 4 inches long? Sample answer: The length of the rectangle is 10 inches, and the side of the rectangle where the triangle meets the rectangle is 6 inches long plus the length of the side of the triangle. So, you can subtract 6 from 10 to find the length of the side of the triangle.

Remember What You Learned

10. Look in a dictionary for the meanings of the word complex when used as an adjective. Write the meaning of the word as it is used in this lesson.

Why can the figures in Examples 1 and 2 be considered complex figures? Sample answer: The word complex means “made up of two or more parts.” The figure in Example 1 can be separated into a rectangle and a semicircle; the figure in Example 2 can be separated into a rectangle and a triangle.

Example 1

Find the area of the figure at the right in square feet.

The figure can be separated into a rectangle and a trapezoid. Find the area of each.

Area of Rectangle

\[ A = lw \]

Replace \( l \) with 12 and \( w \) with 8.

\[ A = 96 \]

Multiply.

Area of Trapezoid

\[ A = \frac{1}{2}(b_1 + b_2)h \]

Replace \( h \) with 4, \( b_1 \) with 4, and \( b_2 \) with 12.

\[ A = 32 \]

Multiply.

The area of the figure is 96 + 32 or 128 square feet.

Exercises

Find the area of each figure. Use 3.14 for \( \pi \). Round to the nearest tenth if necessary.

1. \[ 65 \text{ cm}^2 \]

2. \[ 25.4 \text{ in}^2 \]

3. \[ 806.0 \text{ mm}^2 \]
Find the area of each figure. Use 3.14 for π. Round to the nearest tenth if necessary.

1. 125.9 cm²
2. 90.3 mm²
3. 550 in²
4. 45.6 in²
5. 97.8 m²
6. 234 yd²
7. 16 m²
8. 9.1 ft²

In each diagram below, one square unit represents 5 square meters. Find the area of each figure.

7. 127.5 m²
8. 120 m²
9. AUDITORIUM The diagram at the right gives the dimensions of an auditorium. If new carpet is needed for the auditorium, what will be the area of the carpet? Round to the nearest square yard. 2,466 yd²

SIDING For Exercises 10 and 11, use the diagram that shows one end of a cottage.

10. Each end of the cottage needs new siding. Find the total area that needs new siding. 588 ft²

11. The siding material costs $75 for a bundle of siding that covers an area of 100 square feet. What will be the total cost to put siding on both ends of the cottage? Justify your answer. $450; 588 ÷ 100 = 5.88; Since the siding comes in bundles of 100 ft², 6 bundles are needed. Six bundles at $75 each is $450.
Extending the Pythagorean Theorem

The Pythagorean Theorem says that the sum of the areas of the two smaller squares is equal to the area of the largest square. Show that the Pythagorean Theorem can be extended to include other shapes on the sides of a triangle. To do so, find the areas of the two smaller shapes. Then, check that their sum equals the area of the largest shape. Round each answer to the nearest tenth.

1. area of smallest shape: 3.5 in²
   area of middle shape: 6.3 in²
   area of largest shape: 9.8 in²

2. area of smallest shape: 2.3 in²
   area of middle shape: 4 in²
   area of largest shape: 6.3 in²

3. area of smallest shape: 4.5 in²
   area of middle shape: 8 in²
   area of largest shape: 12.5 in²

4. area of smallest shape: 3.4 in²
   area of middle shape: 6 in²
   area of largest shape: 9.4 in²

11-6 Word Problem Practice

ARCHITECTURE For Exercises 1–6 use Jaco's preliminary design of his vacation house at the right. Round to the nearest tenth if necessary.

1. What type of figure is bedroom 1? Find the area of bedroom 1.
   trapezoid; 216 ft²

2. What is the area of the bedroom 2? What figures did you use to find the area?
   224 ft²; square and rectangle

3. What is the area of the bathroom? What are the dimensions of the figures you used to find this area?
   96 ft²; 8 ft by 4 ft rectangle and 16 ft by 4 ft rectangle

4. What is the area of the living room? How many figures did you use to find this area?
   256 ft²; Sample answer: 3

5. What is the area of the den? What would the area of the den be if the semicircular window were removed and replaced with a flat window?
   198.3 ft²; 192 ft²

6. What is the area of the kitchen? If Jaco adds a rectangular cooking island in the middle of the kitchen with dimensions 6 feet by 4 feet, how many square feet of space will be left?
   352 ft²; 328 ft²
### Exercises

For each figure, name the shape of the base(s). Then classify each figure.

1. **Figure:**
   - **Base(s):** rectangle
   - **Classification:** rectangular prism

2. **Figure:**
   - **Base(s):** triangle
   - **Classification:** triangular prism

3. **Figure:**
   - **Base(s):** circle
   - **Classification:** cylinder

4. **Figure:**
   - **Base(s):** circle
   - **Classification:** cone

5. **Figure:**
   - **Base(s):** triangle
   - **Classification:** triangular pyramid

6. **Figure:**
   - **Base(s):** square
   - **Classification:** cube or square prism

---

**Study Guide and Intervention**

**Three Dimensional Figures**

**Chapter 11**

<table>
<thead>
<tr>
<th>Prisms</th>
<th>Pyramids</th>
<th>Cylinders</th>
<th>Spheres</th>
</tr>
</thead>
<tbody>
<tr>
<td>At least three rectangular faces</td>
<td>At least three triangular faces</td>
<td>Only one base</td>
<td>All points are the same distance from the center</td>
</tr>
<tr>
<td>Top and bottom faces are parallel</td>
<td>One base-shaped like any 3-sided closed figure</td>
<td>Base is a circle</td>
<td>No faces, bases, edges, or vertices</td>
</tr>
<tr>
<td>Example: The figure has two circular bases and no edges. The figure is a cylinder.</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Lesson 11-7**

**Prisms**

At least three rectangular faces.

**Pyramids**

At least three triangular faces.

**Cylinders**

Only one base.

**Spheres**

All points are the same distance from the center.

---

**Example**

7MG3.6

- The figure has two parallel triangular bases and three rectangular faces. The figure is a triangular prism.
- The figure has two circular bases and no edges. The figure is a cylinder.
- The figure has a triangle base and three triangle sides. The figure is a triangular pyramid.
- The figure has a circle base; it has one vertex and no edges. The figure is a cone.
For each figure, identify the shape of the base(s), if any. Then classify the figure.

1. pentagons; circles; cylinder
2. triangles; triangular prism
3. rectangles; square pyramid
4. circle; cone
5. hexagon; hexagonal pyramid
6. trapezoid; trapezoidal pyramid
7. rectangle; square; circle
8. sphere
9. rectangle; triangular prism
10. CANDLES

What three-dimensional figure describes the candle shown?

cylinder

11. FENCES

The basic shape of a fence post is made of two geometric figures. Classify these figures.

rectangular prism and rectangular pyramid
Leonard Euler, born in 1707, was one of the world’s greatest mathematicians. One of his accomplishments was discovering a formula for calculating the number of faces, edges, and vertices on a three-dimensional figure. He found that

\[ V = F - E + 2. \]

(Vertices = Faces - Edges + 2)

A triangular prism has 6 vertices, 5 faces, and 9 edges. It has the fewest faces, edges, and vertices of any prism.

1. Complete the table for a hexagonal and an octagonal prism.

<table>
<thead>
<tr>
<th>Prism</th>
<th>Vertices</th>
<th>Faces</th>
<th>Edges</th>
</tr>
</thead>
<tbody>
<tr>
<td>triangular</td>
<td>6</td>
<td>5</td>
<td>9</td>
</tr>
<tr>
<td>rectangular</td>
<td>8</td>
<td>6</td>
<td>12</td>
</tr>
<tr>
<td>pentagonal</td>
<td>10</td>
<td>7</td>
<td>15</td>
</tr>
<tr>
<td>hexagonal</td>
<td>12</td>
<td>8</td>
<td>18</td>
</tr>
<tr>
<td>octagonal</td>
<td>16</td>
<td>10</td>
<td>24</td>
</tr>
</tbody>
</table>

2. If a prism has 14 vertices and 21 edges, how many faces does it have?
   Use Euler’s formula. 9 faces

3. A prism has 20 vertices. How many faces does it have? How many edges?
   This prism has 12 faces and 30 edges. (It is a “decagonal prism”; the top and base each have 10 sides.)

4. An “n-gonal” prism has two bases, each with n sides. Use the patterns in the table to write expressions to find the number of faces, edges, and vertices and n-gonal prism has. An “n-gonal” prism has n + 2 faces, 3n edges, and 2n vertices.
Example 1

The top view is a triangle. The side and front views are rectangles.

Example 2

Step 1
Use the top view to draw the base of the figure, a 1-by-3 rectangle.

Step 2
Add edges to make the base a solid figure.

Step 3
Use the side and front views to complete the figure.

Exercise 1

1. Draw a top, a side, and a front view of the solid.

Sample answer:

2. Draw the solid whose top, side, and front views are shown. Use isometric dot paper.

Sample answer:
Answers (Lesson 11-8)

Draw a top, a side, and a front view of each solid.

1. 2. 3.

Draw each solid using the top, side, and front views shown. Use isometric dot paper.

4. 5.

HAT RACK

Draw a top, a side, and a front view of the hat rack shown.

7.

MUSIC

Sketch views of the top, side, and front of the piano shown.

8.
Counting Cubes

The figures on this page have been built by gluing cubes together. Use your visual imagination to count the total number of cubes as well as the number of cubes with glue on 1, 2, 3, 4, or 5 faces.

Complete this chart for the figures below.

<table>
<thead>
<tr>
<th>Total Number of Faces with Glue on Them</th>
<th>Figure Number</th>
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</thead>
<tbody>
<tr>
<td></td>
<td>1</td>
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<td></td>
<td>6</td>
</tr>
</tbody>
</table>

1.  
2.  
3.  
4.  
5.  
6.

5MG2.3, 6MR2.4

Word Problem Practice


3. Graphics: Dan is creating a computer-generated image of a coffee cup. To do this, he needs to enter the top, side, and front views of the cup. Draw the views that Dan should enter.

4. History: The Mausoleum at Halicarnassus is one of the Seven Wonders of the Ancient World. Draw a top view, a side view, and a front view of the mausoleum without the chariot statue at the top.

5MG2.3, 6MR2.4

Answers (Lesson 11-8)
11-9 Lesson Reading Guide
Volume of Prisms

Get Ready for the Lesson
Complete the Mini Lab at the top of page 613 in your textbook. Write your answers below:

1. What is the area of the base, or bottom, of the box? What is the height of the box? 64 cm²; 1 cm
2. How many centimeter cubes fit in the box? 64
3. What do you notice about the product of the base area and the height of the box? It equals the number of cubes that fill the box.

Read the Lesson
4. Which of the figures at the right is a rectangular prism? Why is the other figure not a rectangular prism?

Sample answer: A; B is not because the bases are not congruent.

Remember What You Learned
5. Tell how to find the volume of a rectangular prism in words. Sample answer: Multiply the length times the width times the height (or multiply the area of the base times the height).

Example
Find the volume of the rectangular prism.

$V = Bh$ or $V = lwh$

Find the volume of each rectangular prism. Round to the nearest tenth if necessary.

1. 2. 3.

84 m³ 630 cm³ 16.2 ft³
Answers (Lesson 11-9)

**Skills Practice**

**Volume of Prisms**

Find the volume of each rectangular prism. Round to the nearest tenth if necessary.

1. 3 cm x 3 cm x 7 cm = 63 cm³
2. 10 in. x 5 in. x 4 in. = 200 in³
3. 6 m x 4 m x 5 m = 120 m³
4. 3 cm x 5 mm x 12 mm = 180 mm³
5. 9 cm x 2.8 cm x 7 in. = 186.2 in³
6. 9 cm x 7.2 cm x 1 cm = 64.8 cm³
7. 12 mm x 9.5 in. x 3 cm = 108.75 cm³
8. 12 mm x 2.8 in. x 9 cm = 25.2 cm³
9. 12 mm x 9 in. x 3 mm = 32.4 mm³

**Practice**

**Volume of Prisms**

Find the volume of each prism. Round to the nearest tenth if necessary.

1. 6 m x 4 m x 5 m = 120 m³
2. 12 m x 7 m x 10 in. = 1680 in³
3. 4.2 ft x 3.5 ft x 4 ft = 58.8 ft³
4. 1.5 mm x 2.6 mm x 1.1 mm = 4.26 mm³
5. 3 yd x 4 yd x 5 yd = 60 yd³
6. 2.6 m x 4.1 m x 5.1 m = 54.6 m³
7. 2.5 yd x 2.3 yd x 2.5 yd = 17.5 yd³
8. 3 yd x 4 yd x 3 yd = 36 yd³
9. 6 in. x 3 in. x 3 in. = 54 in³
10. 1.1 mm x 1.5 mm x 1.1 mm = 2.025 mm³

**ESTIMATION**

Estimate to find the approximate volume of each prism.

11. Sample answer: \((0.5 \times 5 \times 6) \times 6 = 180\) in³
12. ALGEBRA The base of a rectangular prism has an area of 15.3 square inches and a volume of 185.13 cubic inches. Write an equation that can be used to find the height \(h\) of the prism. Then find the height of the prism. \(185.13 = 15.3h; h = 12.1\) in.

13. MAIL The United States Post Office has two different priority mail flat rate boxes. Which box has the greater volume? Justify your answer. Box 1: \(6\frac{1}{2}\) in. x \(8\frac{1}{2}\) in. x 11 in. Box 2: \(9\frac{3}{8}\) in. x \(11\frac{1}{8}\) in. x \(13\frac{3}{8}\) in. Box 1: 607.8 in³ > 546.1 in³
Enrichment
Chapter 11

Volumes of Pyramids

A pyramid and a prism with the same base and height are shown below.

The exercises on this page will help you discover how their volumes are related.

Enlarge and make copies of the two patterns below to make the open pyramid and the open prism shown above. (Each equilateral triangle should measure 8 centimeters on a side.)

1. Describe the bases of the two solids. equilateral triangles

2. How do the heights of the solids compare? They are the same.

3. Fill the open pyramid with sand or sugar. Pour the contents into the open prism. How many times must you do this to fill the open prism? three times

4. Describe how you would find the volume of the pyramid shown at the right. Divide the volume of a prism with the same base and height by 3.

5. Generalize: State a formula for the volume of a pyramid. The volume is \( \frac{1}{3} \times \text{area of the base} \times \text{height} \).
Lesson 11–10

Lesson Reading Guide

Volume of Cylinders

Get Ready for the Lesson

Complete the Mini Lab at the top of page 619 in your textbook. Write your answers below.

1. Estimate the number of centimeter cubes that would fit at the bottom of the can. Include parts of cubes. See students’ work.
2. How many layers would it take to fill the cylinder? See students’ work.
3. MAKE A CONJECTURE about how you can find the volume of the soup can. Sample answer: Multiply the area of the base and the height.

Reading the Lesson

4. Write C if the phrase is true of a cylinder, P if the phrase is true of a prism, or CP if the phrase is true of both.
   - CP has bases that are parallel and congruent
   - P has sides and bases that are polygons
   - C has bases that are circular
   - CP is a solid
   - CP has volume
   - CP is three-dimensional

5. What shape is the base of a cylinder? circle

6. What is the formula for the area of the base of a cylinder? \( B = \pi r^2 \)

Remember What You Learned

7. Work with a partner. Bring an object that is a cylinder to school. Take the measurements and determine the volume of your cylindrical object. Exchange objects with your partner, but do not share the calculations. Determine the volume of your partner’s object. Then compare your results with those of your partner. See students’ work.
**Skills Practice**

**Volume of Cylinders**

Find the volume of each cylinder. Use 3.14 for \( \pi \).
Round to the nearest tenth.

1. \( V = 20 \times 7 \times 3.14 \) = 439.6 cm\(^3\)
   
2. \( V = 9 \times 20 \times 3.14 \) = 1,808.6 ft\(^3\)
   
3. \( V = 12 \times 4 \times 3.14 \) = 150.7 in\(^3\)
   
4. \( V = 5 \times 3 \times 3.14 \) = 47.1 yd\(^3\)
   
5. \( V = 2 \times 3 \times 3.14 \) = 18.8 m\(^3\)
   
6. \( V = 6 \times 2 \times 3.14 \) = 37.7 m\(^3\)

**Example**

Find the volume of the cylinder. Use 3.14 for \( \pi \).
Round to the nearest tenth.

\[ V = \pi r^2 h \]

1. \( r = 2 \) cm, \( h = 5 \) cm
   
   \[ V = 3.14 \times 2^2 \times 5 = 62.8 \text{ cm}^3 \]

The volume is approximately 62.8 cubic centimeters. Check by using estimation.

**Exercises**

Find the volume of each cylinder. Use 3.14 for \( \pi \).
Round to the nearest tenth.

1. \( r = 10 \) mm, \( h = 13 \) mm
   
   \[ V = 3.14 \times 10^2 \times 13 = 3,562 \text{ mm}^3 \]

2. \( r = 4 \) ft, \( h = 12.3 \) ft
   
   \[ V = 3.14 \times 4^2 \times 12.3 = 209 \text{ ft}^3 \]

3. \( r = 5 \) in., \( h = 2 \) in.
   
   \[ V = 3.14 \times 5^2 \times 2 = 157 \text{ in}^3 \]

4. \( r = 9.5 \) yd, \( h = 2.2 \) yd
   
   \[ V = 3.14 \times 9.5^2 \times 2.2 = 623 \text{ yd}^3 \]

5. \( r = 6 \) cm, \( h = 11 \) cm
   
   \[ V = 3.14 \times 6^2 \times 11 = 310 \text{ cm}^3 \]

6. \( r = 3 \frac{3}{7} \) m, \( h = 1 \frac{1}{4} \) m
   
   \[ V = 3.14 \times \left(3 \frac{3}{7}\right)^2 \times 1 \frac{1}{4} = 31 \text{ m}^3 \]

7. \( r = 8.8 \) cm, \( h = 4.7 \) cm
   
   \[ V = 3.14 \times 8.8^2 \times 4.7 = 1142 \text{ cm}^3 \]

8. \( r = 4 \) ft, \( h = 2 \frac{1}{2} \) ft
   
   \[ V = 3.14 \times 4^2 \times 2 \frac{1}{2} = 126 \text{ ft}^3 \]

9. \( r = 5 \) mm, \( h = 4 \) mm
   
   \[ V = 3.14 \times 5^2 \times 4 = 314 \text{ mm}^3 \]

10. \( r = 7.1 \) in., \( h = 1 \) in.
    
    \[ V = 3.14 \times 7.1^2 \times 1 = 176 \text{ in}^3 \]
Find the volume of each cylinder. Use 3.14 for \( \pi \). Round to the nearest tenth.

1. \( 471.0 \text{ ft}^3 \)
2. \( 1,692.5 \text{ m}^3 \)
3. \( 1,017.4 \text{ yd}^3 \)
4. \( 1,155.5 \text{ in}^3 \)
5. \( 358.9 \text{ mm}^3 \)
6. \( 58.2 \text{ cm}^3 \)

7. \( \text{radius} = 3.7 \text{ cm} \)
   \( \text{height} = 5.2 \text{ cm} \)
   \( 223.5 \text{ cm}^3 \)

8. \( \text{diameter} = 6 \text{ in.} \)
   \( \text{height} = 4\frac{1}{2} \text{ in.} \)
   \( 127.2 \text{ in}^3 \)

9. \( \text{radius} = 5\frac{1}{2} \text{ yd} \)
   \( \text{height} = 6\frac{1}{2} \text{ yd} \)
   \( 562.6 \text{ yd}^3 \)

10. \( \text{CONTAINER} \) What is the volume of a barrel that has a diameter of \( 1\frac{1}{2} \text{ feet} \) and a height of 4 feet? \( 7.1 \text{ ft}^3 \)

ESTIMATION Match each cylinder with its approximate volume.

11. \( \text{diameter} = 4 \text{ cm}, \text{height} = 3.6 \text{ cm} \)
   \( \text{d.} \)
   \( \text{a.} \)
   \( 108 \text{ ft}^3 \)

12. \( \text{radius} = 2.7 \text{ cm}, \text{height} = 8 \text{ cm} \)
   \( \text{b.} \)
   \( \text{b.} \)
   \( 135 \text{ ft}^3 \)

13. \( \text{radius} = 3 \text{ cm}, \text{height} = 4.1 \text{ cm} \)
   \( \text{a.} \)
   \( \text{c.} \)
   \( 96 \text{ ft}^3 \)

14. \( \text{diameter} = 8.2 \text{ cm}, \text{height} = 2 \text{ cm} \)
   \( \text{c.} \)
   \( \text{d.} \)
   \( 48 \text{ ft}^3 \)

15. \( \text{FUEL} \) Two fuel tanks with the dimensions shown have the same volume. What is the value of \( h \)? \( 2 \text{ ft} \)

1. \( \text{WATER STORAGE} \) A cylindrical water tank has a diameter of 5.3 meters and a height of 9 meters. What is the maximum volume that the water tank can hold? Round to the nearest tenth. \( 198.5 \text{ m}^3 \)

2. \( \text{PACKAGING} \) A can of corn has a diameter of 6.6 centimeters and a height of 9.9 centimeters. How much corn can the can hold? Round to the nearest tenth. \( 338.5 \text{ cm}^3 \)

3. \( \text{CONTAINERS} \) Tionna wants to determine the maximum capacity of a cylindrical bucket that has a radius of 6 inches and a height of 12 inches. What is the capacity of Tionna’s bucket? Round to the nearest tenth. \( 1,356.5 \text{ in}^3 \)

4. \( \text{DESIGN} \) Rodolfo is designing a new, cylindrical drinking glass. If the glass has a diameter of 8 centimeters and a height of 12.8 centimeters, what is its volume? Round to the nearest tenth. \( 643.1 \text{ cm}^3 \)

5. \( \text{PAINT} \) A can of paint is 15 centimeters high and has a diameter of 13.6 cm. What is the volume of the can? Round to the nearest tenth. \( 2,177.9 \text{ cm}^3 \)

6. \( \text{SPICES} \) A spice manufacturer uses a cylindrical dispenser like the one shown. Find the volume of the dispenser to the nearest tenth. \( 27.2 \text{ in}^3 \)
Imagine a stack of ten pennies. By pushing against the stack, you can change its shape as shown at the right. But, the volume of the stack does not change.

The diagrams below show prisms and cylinders that have the same volume but do not have the same shape.

Find the volume of each solid figure. Use 3.14 for \pi. Round to the nearest tenth.

1. 7.9 m³ 2. 60 in³ 3. 785.0 in³
4. 180 yd³ 5. 240 cm³ 6. 125.6 cm³

Find the volume of each solid figure. Use 3.14 for \pi. Round to the nearest tenth.

1. 750 in³ 2. 785.0 in³ 3. 60 in³ 4. 180 yd³ 5. 125.6 cm³ 6. 240 cm³
Chapter 11 Assessment Answer Key

Quiz 1 (Lessons 11-1 and 11-3)

1. 38.3 m²
2. 663 ft²
3. 3,840 m²
4. 792 ft²
5. 31.4 mm

Quiz 2 (Lessons 11-4 and 11-5)

1. 20.3 ft²
2. 10.2 cm²
3. 50.2 in²
4. 113.0 mm²
5. C

Quiz 3 (Lessons 11-6 and 11-8)

1. 76.8 ft²
2. 25 in²
3. Triangular prism
4. C
5. G

Quiz 4 (Lessons 11-9 and 11-10)

1. 518.4 ft³
2. 2,200 mm³
3. 854.1 yd³
4. 16,328.0 cm³
5. 949.9 in³
6. 33 cm²
7. 20.25 ft²
8. 55.9 cm²
9. 14.1 yd
10. 89.2 cm

Mid-Chapter Test

1. C
2. F
3. C
4. G
5. C
6. 33 cm²
7. 20.25 ft²
8. 55.9 cm²
9. 14.1 yd
10. 89.2 cm
## Chapter 11 Assessment Answer Key

### Vocabulary Test

**Page 76**

<p>| | | |</p>
<table>
<thead>
<tr>
<th></th>
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<tbody>
<tr>
<td>1.</td>
<td>____</td>
<td>f</td>
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<tr>
<td>2.</td>
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**Sample answer:** a figure that is made up of various two-dimensional figures.

**Sample answer:** the sides of a three-dimensional figure.

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<tbody>
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### Form 1

**Page 77**

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**Page 78**

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<table>
<thead>
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<tbody>
<tr>
<td>1.</td>
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**B:** 9.5 m
## Chapter 11 Assessment Answer Key

<table>
<thead>
<tr>
<th>Form 2A</th>
<th>Form 2B</th>
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<tbody>
<tr>
<td>Page 79</td>
<td>Page 81</td>
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<tr>
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<td>2. H</td>
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<td>11. D</td>
<td>11. A</td>
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<td>3. D</td>
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<td>7. C</td>
<td>8. G</td>
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<tr>
<td>8. G</td>
<td>B: 20 in.</td>
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<tr>
<td>B: 13.3 mm</td>
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</tbody>
</table>
1. 80.4 cm

2. 59.7 ft

3. 32 ft²

4. 108 mm²

5. 476.6 m²

6. 288 mi²

7. 113.0 cm²

8. 907.5 in²

9. 113.0 in³

10. pentagon; pentagonal pyramid

11. B: 810 ft³
Chapter 11 Assessment Answer Key

Form 2D
Page 85

1. _______ 17.0 mm _______

2. _______ 29.8 in. _______

3. _______ 36 m² _______

4. _______ 500 mm² _______

5. _______ 57.1 in² _______

6. _______ 576 cm² _______

7. _______ 38.5 ft² _______

8. _______ 615.4 in² _______

9. _______ 56.5 in³ _______

10. triangle; triangular prism

11. □ △ △

12. □ □ □

13. □ □ □

14. □ □ □

15. _______ 672 cm³ _______

16. _______ 6,384 in³ _______

17. _______ 6,335.6 mm³ _______

18. _______ 4,421.1 ft³ _______

19. _______ 67,794.6 mm³ _______

20. _______ 1,077.0 cm³ _______

B: _______ 53.3 yd³ _______
Chapter 11 Assessment Answer Key

Form 3
Page 87

1. 23.9 yd

2. 56.5 in.

3. 160 cm²

4. 360 m²

5. 138.4 ft²

6. 900 cm²

7. 7,850.0 ft²

8. 1,169.6 m²

9. 4,534.2 m³

10. hexagon; hexagonal prism

11. 4,534.2 m³

12. 1,169.6 m²

13. 7,850.0 ft²

14. 900 cm²

15. 1,008.2 m³

16. 2,060.0 ft³

17. 6,217.2 in³

18. 15,878.4 in³

19. 5,342.2 cm³

20. 15,878.4 in³

B: 614.1 ft³
## Chapter 11 Assessment Answer Key

### Page 89, Extended-Response Test

### Scoring Rubric

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<th>Level</th>
<th>Specific Criteria</th>
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<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>
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<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>
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<tr>
<td>0</td>
<td>The student has provided a <strong>completely incorrect</strong> solution or uninterpretable response, or no response at all.</td>
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</table>
Chapter 11 Assessment Answer Key

Page 89, Extended-Response Test
Sample Answers

In addition to the scoring rubric found on page A39, the following sample answers may be used as guidance in evaluating extended-response assessment items.

1. **a.** Use isometric drawings to draw three-dimensional figures.
   
   OR
   
   Draw the top, side, and front views of three-dimensional figures.

2. The volumes of both a prism and a cylinder are given by the area of the base times the height.

3a. \(12 = 2\ell + 2w\)
   
   If the length is 4, \(12 = 2(4) + 2w\)
   
   \(2 = w\)
   
   The dimensions of the rectangle could be 4 cm \(\times\) 2 cm.
   
   \(12 = 2\pi r\)
   
   \(6 \approx 3.14r\)
   
   \(1.9 \approx r\)
   
   The radius of the circle is about 1.9 cm.

3b. \(\ell = 6\frac{1}{2}\) cm \(P = C\)
   
   \(w = 2\frac{2}{3}\) cm
   
   \(P = 2\left(\frac{13}{2}\right) + 2\left(\frac{8}{3}\right)\)
   
   \(P = \frac{55}{3} = 18\frac{1}{3} = C\)
   
   \(\frac{55}{3} \approx 2(3.14)r\)
   
   \(r \approx 2.9\) cm
## Chapter 11 Assessment Answer Key

### Standardized Test Practice

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Chapter 11 Assessment Answer Key

Standardized Test Practice
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17. 30, 36, 42

18. 0.35

19. 36

20. $1.59

21.

22.

23. 10.3 ft³

24. 2,059.8 yd³

25a. \( V = 10 \cdot 12 \cdot 50 = 6,000 \text{ in}^3 \)
Sample answer; diameter 15 inches, height 12 inches
\( V = \pi r^2 h = \pi (7.5)^2 \)

25b. \( 12 = 2,120 \text{ in}^3 \)