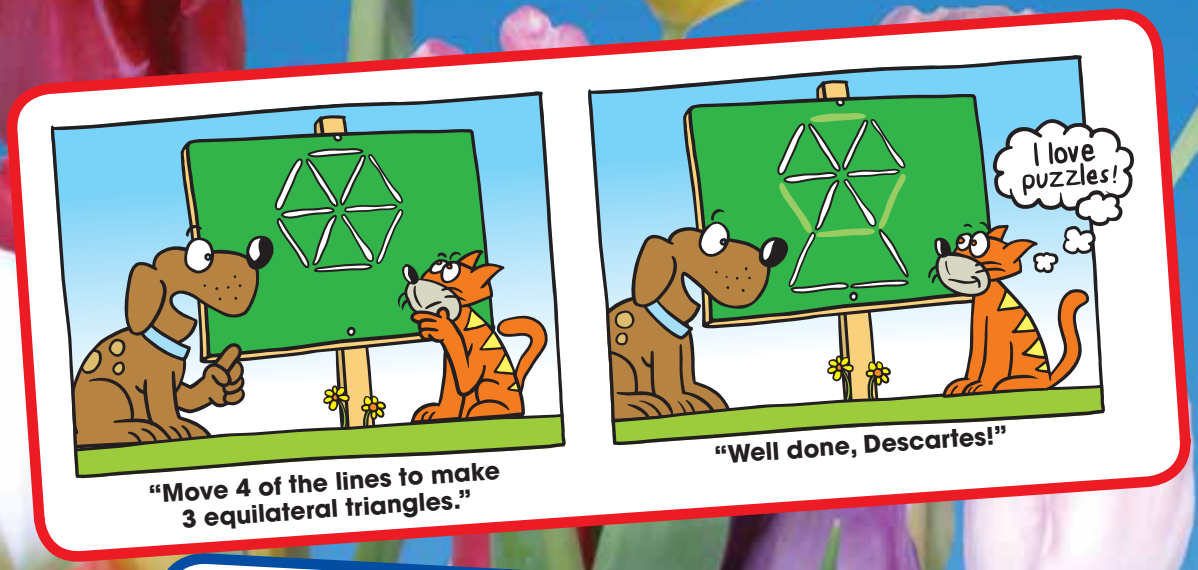
12 Constructions and Scale Drawings

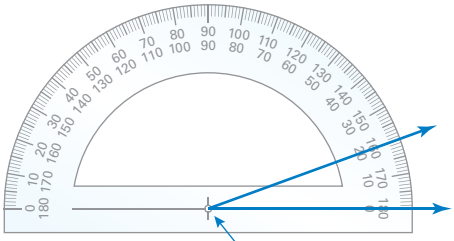


What You Learned Before

Measuring Angles (4.MD.6)

Example 1 **Use a protractor to find the measure of each angle. Then classify the angle as *acute*, *obtuse*, *right*, or *straight*.**

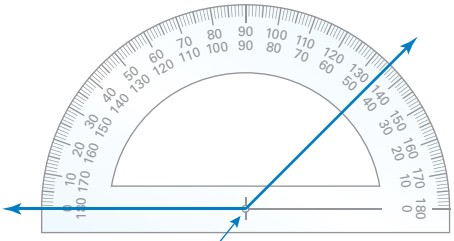
a.



Align the center of the protractor with the angle's vertex.

∴ The angle measure is 20°.
So, the angle is acute.

b.

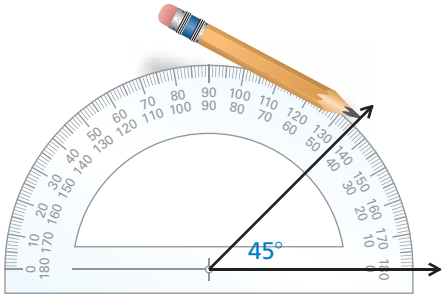


∴ The angle measure is 135°.
So, the angle is obtuse.

Drawing Angles (4.G.1)

Example 2 **Use a protractor to draw a 45° angle.**

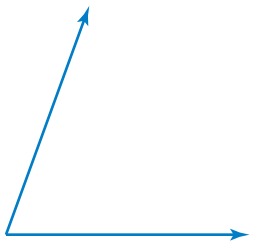
Draw a ray. Place the center of the protractor on the endpoint of the ray and align the protractor so the ray passes through the 0° mark. Make a mark at 45°. Then draw a ray from the endpoint at the center of the protractor through the mark at 45°.



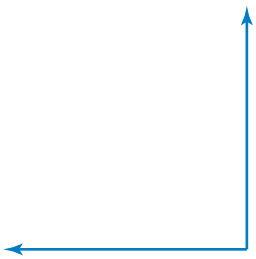
Try It Yourself

Use a protractor to find the measure of the angle. Then classify the angle as *acute*, *obtuse*, *right*, or *straight*.

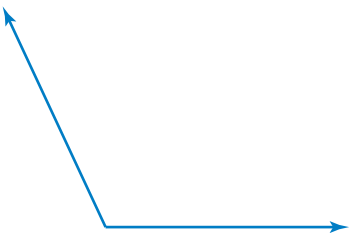
1.



2.



3.



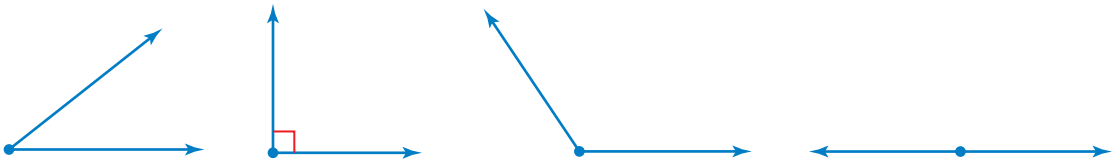
Use a protractor to draw an angle with the given measure.

4. 55° **5.** 160° **6.** 85° **7.** 180°

12.1 Adjacent and Vertical Angles

Essential Question What can you conclude about the angles formed by two intersecting lines?

Classification of Angles



Acute:
Less than 90°

Right:
Equal to 90°

Obtuse:
Greater than 90° and less than 180°

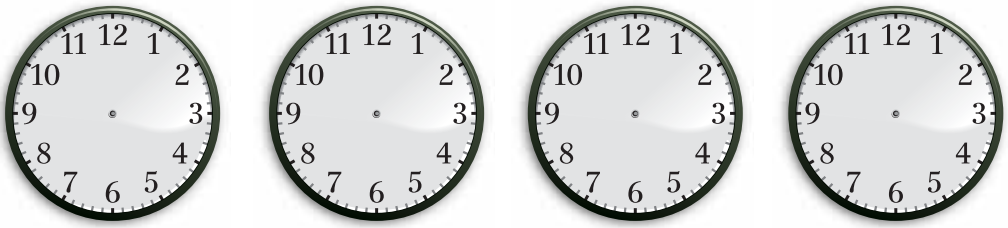
Straight:
Equal to 180°

1 ACTIVITY: Drawing Angles

Work with a partner.

a. Draw the hands of the clock to represent the given type of angle.

Acute Straight Right Obtuse



b. What is the measure of the angle formed by the hands of the clock at the given time?

9:00 6:00 12:00

Common Core

Geometry

In this lesson, you will

- identify adjacent and vertical angles.
- find angle measures using adjacent and vertical angles.

Learning Standard 7.G.5

The Meaning of a Word • Adjacent

When two states are **adjacent**, they are next to each other and they share a common border.

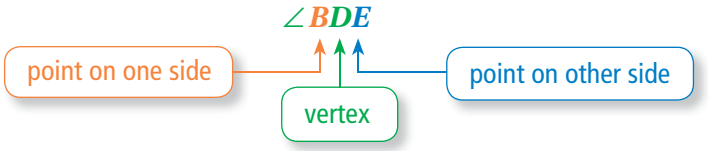
2 ACTIVITY: Naming Angles

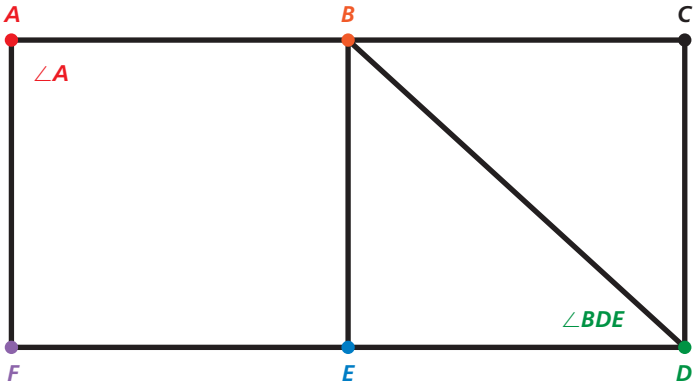
Work with a partner. Some angles, such as $\angle A$, can be named by a single letter. When this does not clearly identify an angle, you should use three letters, as shown.

Math Practice 3

Justify Conclusions

When you name an angle, does the order in which you write the letters matter? Explain.





ABEF and *BCDE* are squares.

a. Name all the right angles, acute angles, and obtuse angles.

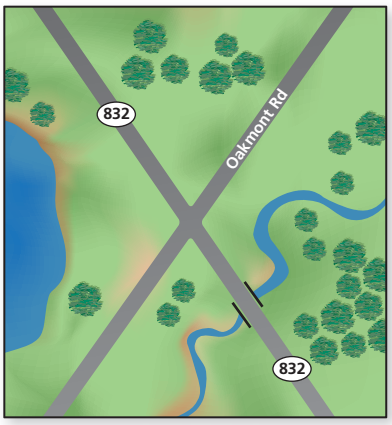
b. Which pairs of angles do you think are *adjacent?* Explain.

3 ACTIVITY: Measuring Angles

Work with a partner.

a. How many angles are formed by the intersecting roads? Number the angles.

b. **CHOOSE TOOLS** Measure each angle formed by the intersecting roads. What do you notice?



What Is Your Answer?

4. **IN YOUR OWN WORDS** What can you conclude about the angles formed by two intersecting lines?

5. Draw two acute angles that are adjacent.

Practice Use what you learned about angles and intersecting lines to complete Exercises 3 and 4 on page 506.

12.1 Lesson

Check It Out
Lesson Tutorials
BigIdeasMath.com

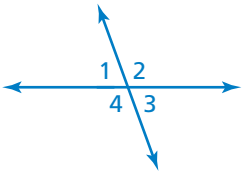
Key Vocabulary
adjacent angles, *p. 504*
vertical angles, *p. 504*
congruent angles, *p. 504*

Key Ideas

Adjacent Angles

Words Two angles are **adjacent angles** when they share a common side and have the same vertex.

Examples

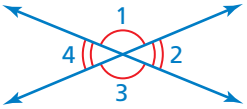


$\angle 1$ and $\angle 2$ are adjacent.
$\angle 2$ and $\angle 4$ are not adjacent.

Vertical Angles

Words Two angles are **vertical angles** when they are opposite angles formed by the intersection of two lines. Vertical angles are **congruent angles**, meaning they have the same measure.

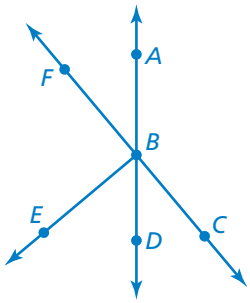
Examples



$\angle 1$ and $\angle 3$ are vertical angles.
$\angle 2$ and $\angle 4$ are vertical angles.

EXAMPLE 1 Naming Angles

Use the figure shown.



a. Name a pair of adjacent angles.

$\angle ABC$ and $\angle ABF$ share a common side and have the same vertex B.

∴ So, $\angle ABC$ and $\angle ABF$ are adjacent angles.

b. Name a pair of vertical angles.

$\angle ABF$ and $\angle CBD$ are opposite angles formed by the intersection of two lines.

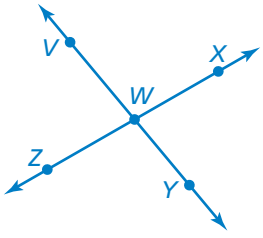
∴ So, $\angle ABF$ and $\angle CBD$ are vertical angles.

On Your Own

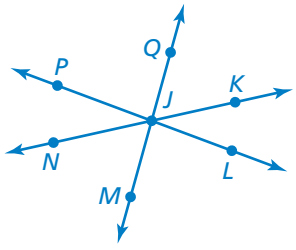
Now You're Ready
Exercises 5 and 6

Name two pairs of adjacent angles and two pairs of vertical angles in the figure.

1.



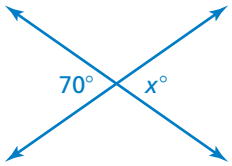
2.



EXAMPLE 2 Using Adjacent and Vertical Angles

Tell whether the angles are *adjacent* or *vertical*. Then find the value of x.

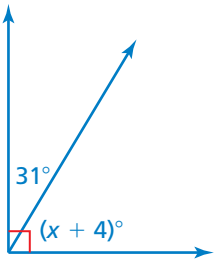
a.



The angles are vertical angles. Because vertical angles are congruent, the angles have the same measure.

∴ So, the value of x is 70.

b.



The angles are adjacent angles. Because the angles make up a right angle, the sum of their measures is 90°.

$(x + 4) + 31 = 90$ Write equation.

$x + 35 = 90$ Combine like terms.

$x = 55$ Subtract 35 from each side.

∴ So, the value of x is 55.

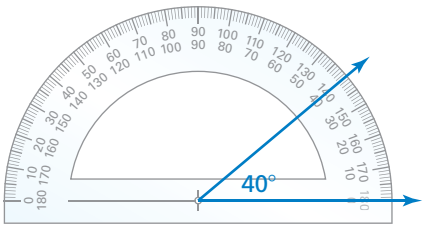
Remember

You can add angle measures. When two or more adjacent angles form a larger angle, the sum of the measures of the smaller angles is equal to the measure of the larger angle.

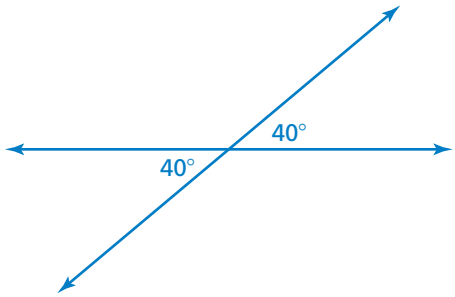
EXAMPLE 3 Constructing Angles

Draw a pair of vertical angles with a measure of 40°.

Step 1: Use a protractor to draw a 40° angle.



Step 2: Use a straightedge to extend the sides to form two intersecting lines.

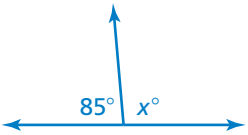


On Your Own

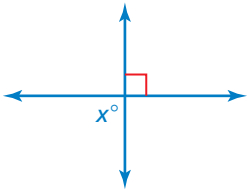
Now You're Ready
Exercises 8–17

Tell whether the angles are *adjacent* or *vertical*. Then find the value of x.

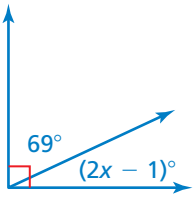
3.



4.



5.



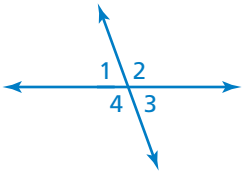
6. Draw a pair of vertical angles with a measure of 75°.

12.1 Exercises

Check It Out
Help with Homework
BigIdeasMath.com

Vocabulary and Concept Check

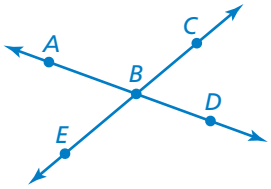
1. **VOCABULARY** When two lines intersect, how many pairs of vertical angles are formed? How many pairs of adjacent angles are formed?
2. **REASONING** Identify the congruent angles in the figure. Explain your reasoning.



Practice and Problem Solving

Use the figure at the right.

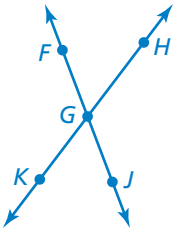
3. Measure each angle formed by the intersecting lines.
4. Name two angles that are adjacent to $\angle ABC$.



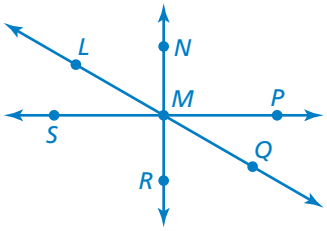
Name two pairs of adjacent angles and two pairs of vertical angles in the figure.

1

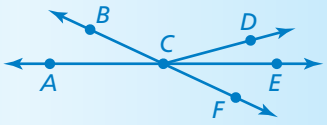
5.



6.



7. **ERROR ANALYSIS** Describe and correct the error in naming a pair of vertical angles.

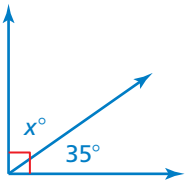


$\angle ACB$ and $\angle BCD$ are vertical angles.

Tell whether the angles are *adjacent* or *vertical*. Then find the value of x.

2

8.



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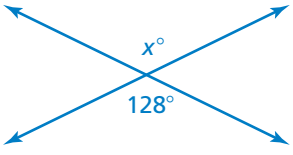

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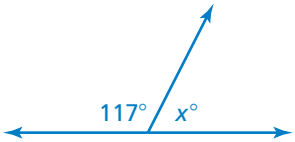
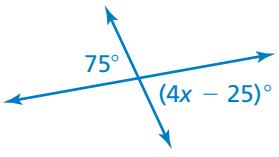


11.



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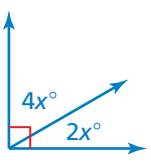
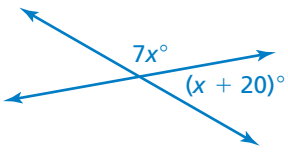


13.



Draw a pair of vertical angles with the given measure.

14. 25° **15.** 85° **16.** 110° **17.** 135°

18. IRON CROSS The iron cross is a skiing trick in which the tips of the skis are crossed while the skier is airborne. Find the value of x in the iron cross shown.

19. OPEN-ENDED Draw a pair of adjacent angles with the given description.

a. Both angles are acute.

b. One angle is acute, and one is obtuse.

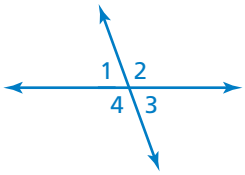
c. The sum of the angle measures is 135°.

20. PRECISION Explain two procedures that you can use to draw adjacent angles with given measures.

Determine whether the statement is *always*, *sometimes*, or *never* true.

21. When the measure of $\angle 1$ is 70°, the measure of $\angle 3$ is 110°.

22. When the measure of $\angle 4$ is 120°, the measure of $\angle 1$ is 60°.

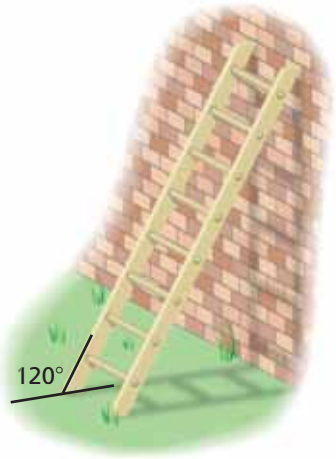


23. $\angle 2$ and $\angle 3$ are congruent.

24. The measure of $\angle 1$ plus the measure of $\angle 2$ equals the measure of $\angle 3$ plus the measure of $\angle 4$.

25. REASONING Draw a figure in which $\angle 1$ and $\angle 2$ are acute vertical angles, $\angle 3$ is a right angle adjacent to $\angle 2$, and the sum of the measure of $\angle 1$ and the measure of $\angle 4$ is 180°.

26. Structure For safety reasons, a ladder should make a 15° angle with a wall. Is the ladder shown leaning at a safe angle? Explain.



Fair Game Review What you learned in previous grades & lessons

Solve the inequality. Graph the solution. *(Section 11.3)*

27. $-6n > 54$ **28.** $-\frac{1}{2}x \leq 17$ **29.** $-1.6 < \frac{m}{-2.5}$

30. MULTIPLE CHOICE What is the slope of the line that passes through the points (2, 3) and (6, 8)? *(Skills Review Handbook)*

A $\frac{4}{5}$ **B** $\frac{5}{4}$ **C** $\frac{4}{3}$ **D** $\frac{3}{2}$

12.2 Complementary and Supplementary Angles

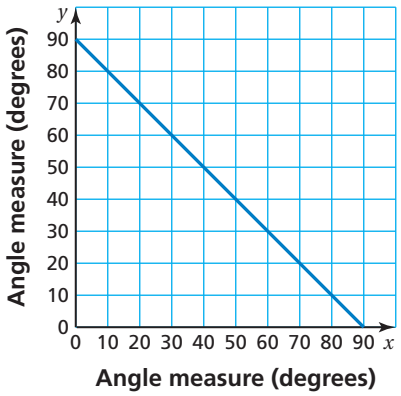
Essential Question How can you classify two angles as complementary or supplementary?

1 ACTIVITY: Complementary and Supplementary Angles

Work with a partner.

a. The graph represents the measures of *complementary angles*. Use the graph to complete the table.

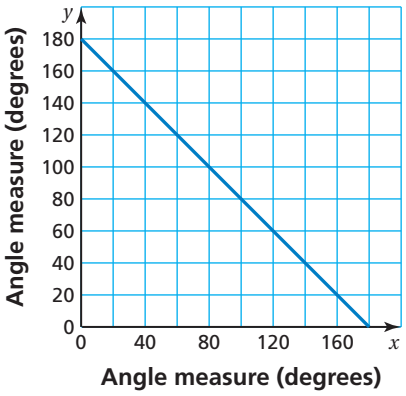
x		20°		30°	45°		75°
y	80°		65°	60°		40°	



b. How do you know when two angles are complementary? Explain.

c. The graph represents the measures of *supplementary angles*. Use the graph to complete the table.

x	20°		60°	90°		140°	
y		150°		90°	50°		30°



d. How do you know when two angles are supplementary? Explain.

2 ACTIVITY: Exploring Rules About Angles

Work with a partner. Copy and complete each sentence with *always*, *sometimes*, or *never*.

a. If x and y are complementary angles, then both x and y are _____ acute.

b. If x and y are supplementary angles, then x is _____ acute.

c. If x is a right angle, then x is _____ acute.

d. If x and y are complementary angles, then x and y are _____ adjacent.

e. If x and y are supplementary angles, then x and y are _____ vertical.

Common Core

Geometry

In this lesson, you will

- classify pairs of angles as complementary, supplementary, or neither.
- find angle measures using complementary and supplementary angles.

Learning Standard 7.G.5

3 ACTIVITY: Classifying Pairs of Angles

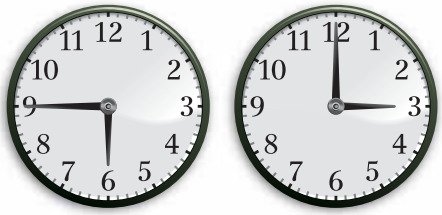
Work with a partner. Tell whether the two angles shown on the clocks are *complementary*, *supplementary*, or *neither*. Explain your reasoning.

a.

b.

c.

d.



4 ACTIVITY: Identifying Angles

Work with a partner. Use a protractor and the figure shown.

a. Name four pairs of complementary angles and four pairs of supplementary angles.

b. Name two pairs of vertical angles.

Math Practice 3

Use Definitions

How can you use the definitions of *complementary*, *supplementary*, and *vertical angles* to answer the questions?

What Is Your Answer?

5. IN YOUR OWN WORDS How can you classify two angles as complementary or supplementary? Give examples of each type.

Practice Use what you learned about complementary and supplementary angles to complete Exercises 3–5 on page 512.

12.2 Lesson

Check It Out
Lesson Tutorials
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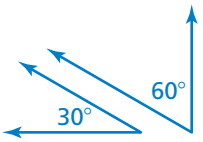
Key Vocabulary
complementary angles, *p. 510*
supplementary angles, *p. 510*

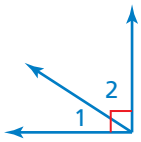
Key Ideas

Complementary Angles

Words Two angles are **complementary angles** when the sum of their measures is 90°.

Examples



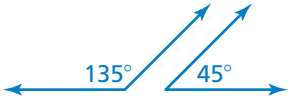


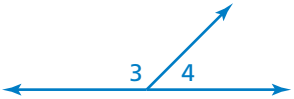
∠1 and ∠2 are complementary angles.

Supplementary Angles

Words Two angles are **supplementary angles** when the sum of their measures is 180°.

Examples

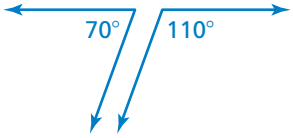




∠3 and ∠4 are supplementary angles.

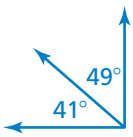
EXAMPLE 1 Classifying Pairs of Angles

Tell whether the angles are *complementary*, *supplementary*, or *neither*.

a. 

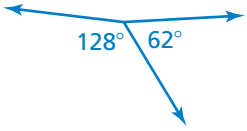
$70° + 110° = 180°$

∴ So, the angles are supplementary.

b. 

$41° + 49° = 90°$

∴ So, the angles are complementary.

c. 

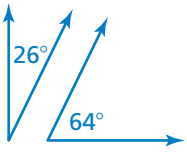
$128° + 62° = 190°$

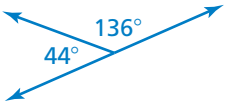
∴ So, the angles are *neither* complementary nor supplementary.

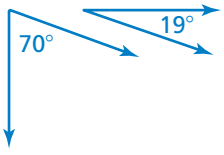
On Your Own

Now You're Ready
Exercises 6–11

Tell whether the angles are *complementary*, *supplementary*, or *neither*.

1. 

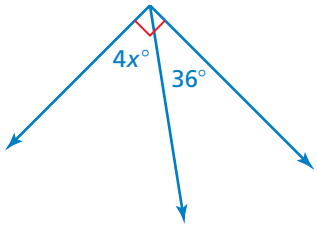
2. 

3. 

EXAMPLE 2 Using Complementary and Supplementary Angles

Tell whether the angles are *complementary* or *supplementary*. Then find the value of x.

a.



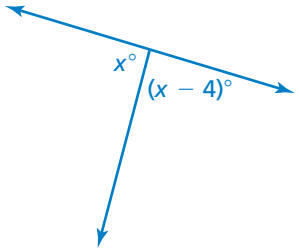
The two angles make up a right angle. So, the angles are complementary angles, and the sum of their measures is 90°.

$4x + 36 = 90$ Write equation.

$4x = 54$ Subtract 36 from each side.

$x = 13.5$ Divide each side by 4.

b.



The two angles make up a straight angle. So, the angles are supplementary angles, and the sum of their measures is 180°.

$x + (x - 4) = 180$ Write equation.

$2x - 4 = 180$ Combine like terms.

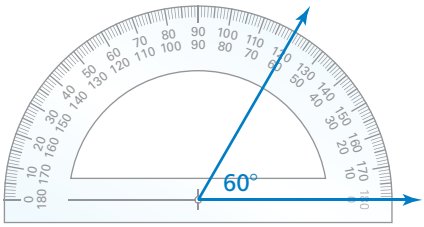
$2x = 184$ Add 4 to each side.

$x = 92$ Divide each side by 2.

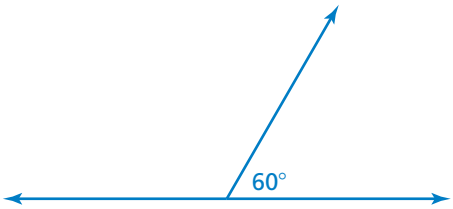
EXAMPLE 3 Constructing Angles

Draw a pair of adjacent supplementary angles so that one angle has a measure of 60°.

Step 1: Use a protractor to draw a 60° angle.



Step 2: Extend one of the sides to form a line.

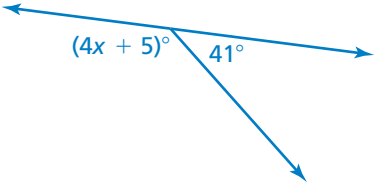


On Your Own

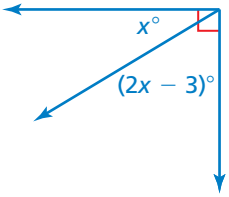
Now You're Ready
Exercises 12–14 and 17–20

Tell whether the angles are *complementary* or *supplementary*. Then find the value of x.

4.



5.



6. Draw a pair of adjacent supplementary angles so that one angle has a measure of 15°.

12.2 Exercises

Check It Out
Help with Homework
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Vocabulary and Concept Check

1. **VOCABULARY** Explain how complementary angles and supplementary angles are different.
2. **REASONING** Can adjacent angles be supplementary? complementary? neither? Explain.

Practice and Problem Solving

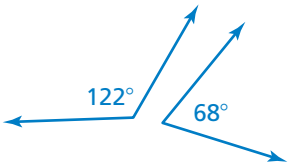
Tell whether the statement is *always*, *sometimes*, or *never* true. Explain.

3. If x and y are supplementary angles, then x is obtuse.
4. If x and y are right angles, then x and y are supplementary angles.
5. If x and y are complementary angles, then y is a right angle.

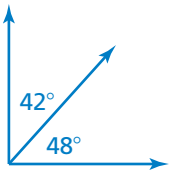
Tell whether the angles are *complementary*, *supplementary*, or *neither*.

1

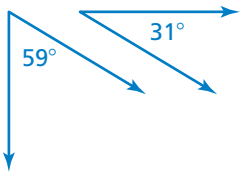
6.



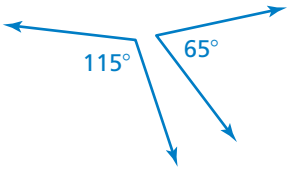
7.



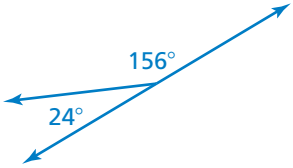
8.



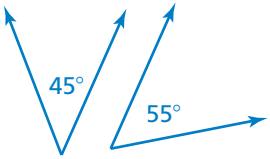
9.



10.



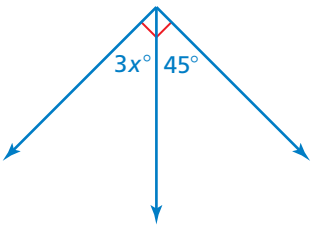
11.



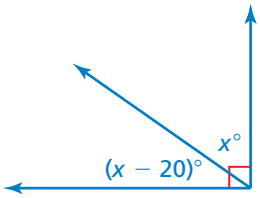
Tell whether the angles are *complementary* or *supplementary*. Then find the value of x.

2

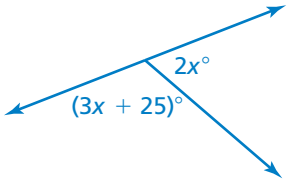
12.



13.

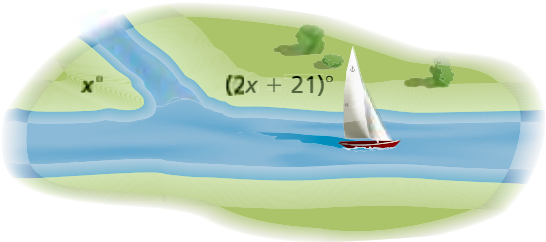


14.



15. **INTERSECTION** What are the measures of the other three angles formed by the intersection?

16. **TRIBUTARY** A tributary joins a river at an angle. Find the value of x.



Draw a pair of adjacent supplementary angles so that one angle has the given measure.

3 **17.** 20° **18.** 35° **19.** 80° **20.** 130°

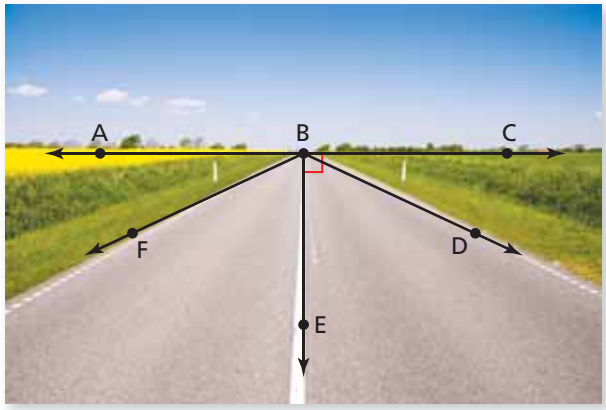
21. **PRECISION** Explain two procedures that you can use to draw two adjacent complementary angles. Then draw a pair of adjacent complementary angles so that one angle has a measure of 30°.

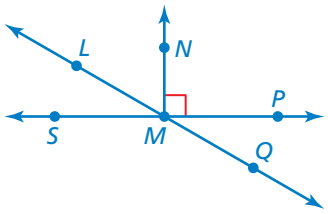
22. **OPEN-ENDED** Give an example of an angle that can be a supplementary angle but cannot be a complementary angle. Explain.

23. **VANISHING POINT** The vanishing point of the picture is represented by point *B*.

a. The measure of $\angle ABD$ is 6.2 times greater than the measure of $\angle CBD$. Find the measure of $\angle CBD$.

b. $\angle FBE$ and $\angle EBD$ are congruent. Find the measure of $\angle FBE$.



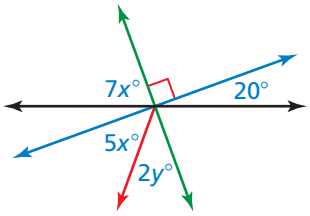


24. **LOGIC** Your friend says that $\angle LMN$ and $\angle PMQ$ are complementary angles. Is she correct? Explain.

25. **RATIO** The measures of two complementary angles have a ratio of 3 : 2. What is the measure of the larger angle?

26. **REASONING** Two angles are vertical angles. What are their measures if they are also complementary angles? supplementary angles?

27. Problem Solving Find the values of *x* and *y*.



Fair Game Review What you learned in previous grades & lessons

Solve the equation. Check your solution. *(Section 1.1)*

28. $x + 7 = -8$ **29.** $\frac{1}{3} = n + \frac{3}{4}$ **30.** $-12.7 = y - 3.4$

31. **MULTIPLE CHOICE** Which decimal is equal to 3.7%? *(Skills Review Handbook)*

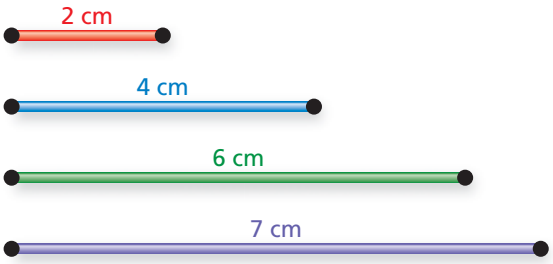
(A) 0.0037 (B) 0.037 (C) 0.37 (D) 3.7

12.3 Triangles

Essential Question How can you construct triangles?

1 ACTIVITY: Constructing Triangles Using Side Lengths

Work with a partner. Cut different-colored straws to the lengths shown. Then construct a triangle with the specified straws if possible. Compare your results with those of others in your class.

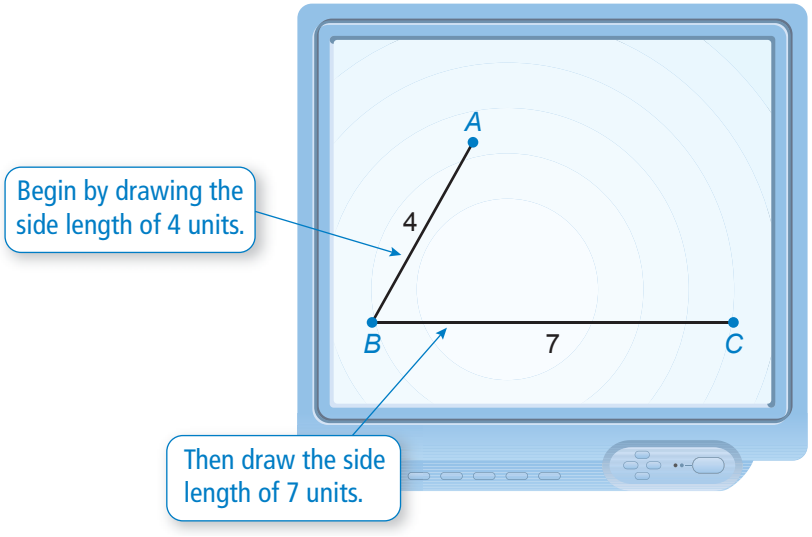


a. blue, green, purple
b. red, green, purple
c. red, blue, purple
d. red, blue, green

2 ACTIVITY: Using Technology to Draw Triangles (Side Lengths)

Work with a partner. Use geometry software to draw a triangle with the two given side lengths. What is the length of the third side of your triangle? Compare your results with those of others in your class.

a. 4 units, 7 units



b. 3 units, 5 units
c. 2 units, 8 units
d. 1 unit, 1 unit

Common Core

Geometry

In this lesson, you will

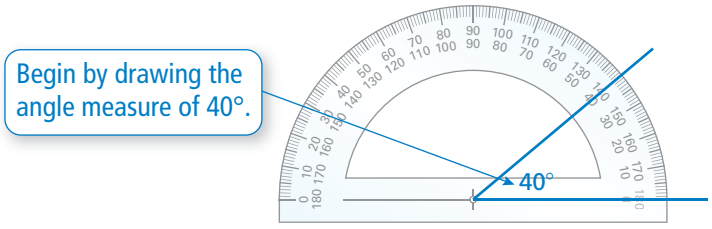
- construct triangles with given angle measures.
- construct triangles with given side lengths.

Learning Standard 7.G.2

3 ACTIVITY: Constructing Triangles Using Angle Measures

Work with a partner. Two angle measures of a triangle are given. Draw the triangle. What is the measure of the third angle? Compare your results with those of others in your class.

a. 40°, 70°



b. 60°, 75°

c. 90°, 30°

d. 100°, 40°

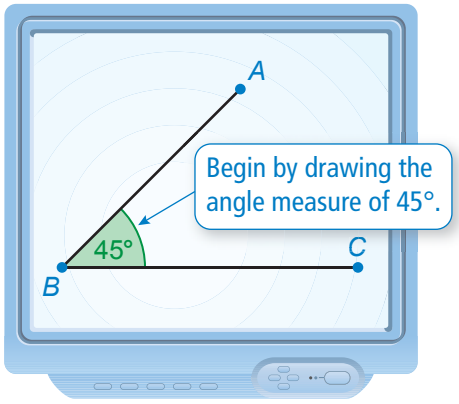
4 ACTIVITY: Using Technology to Draw Triangles (Angle Measures)

Work with a partner. Use geometry software to draw a triangle with the two given angle measures. What is the measure of the third angle? Compare your results with those of others in your class.

a. 45°, 55°

b. 50°, 40°

c. 110°, 35°



Math Practice 5

Recognize Usefulness of Tools

What are some advantages and disadvantages of using geometry software to draw a triangle?

What Is Your Answer?

5. **IN YOUR OWN WORDS** How can you construct triangles?

6. **REASONING** Complete the table below for each set of side lengths in Activity 2. Write a rule that compares the sum of any two side lengths to the third side length.

Side Length			
Sum of Other Two Side Lengths			

7. **REASONING** Use a table to organize the angle measures of each triangle you formed in Activity 3. Include the sum of the angle measures. Then describe the pattern in the table and write a conclusion based on the pattern.

Practice Use what you learned about constructing triangles to complete Exercises 3–5 on page 518.

12.3 Lesson

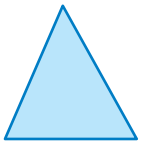
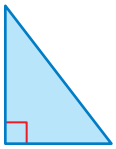
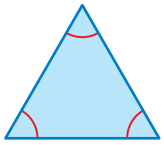
Check It Out
Lesson Tutorials
BigIdeasMath.com

Key Vocabulary
congruent sides, *p. 516*

You can use side lengths and angle measures to classify triangles.

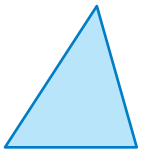
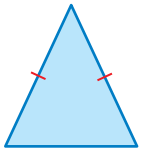
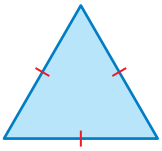
Key Ideas

Classifying Triangles Using Angles

acute triangle	*obtuse* triangle	*right* triangle	*equiangular* triangle
			
all acute angles	1 obtuse angle	1 right angle	3 congruent angles

Classifying Triangles Using Sides

Congruent sides have the same length.

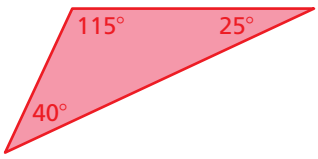
scalene triangle	*isosceles* triangle	*equilateral* triangle
		
no congruent sides	at least 2 congruent sides	3 congruent sides

Reading
Red arcs indicate congruent angles.
Red tick marks indicate congruent sides.

EXAMPLE 1 Classifying Triangles

Classify each triangle.

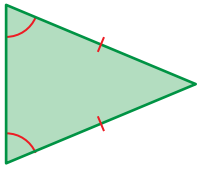
a.



The triangle has one obtuse angle and no congruent sides.

∴ So, the triangle is an obtuse scalene triangle.

b.



The triangle has all acute angles and two congruent sides.

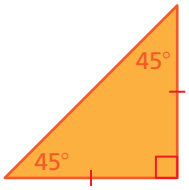
∴ So, the triangle is an acute isosceles triangle.

On Your Own

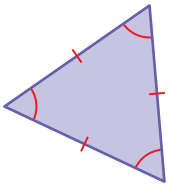
Now You're Ready
Exercises 6–11

Classify the triangle.

1.



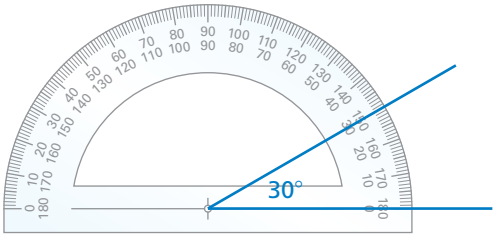
2.



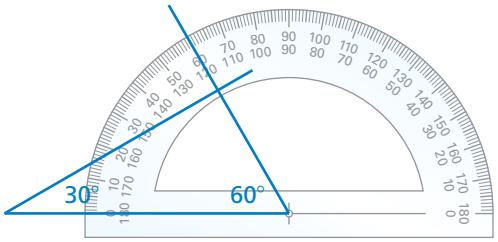
EXAMPLE 2 Constructing a Triangle Using Angle Measures

Draw a triangle with angle measures of 30°, 60°, and 90°. Then classify the triangle.

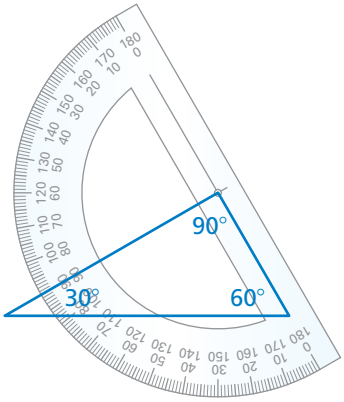
Step 1: Use a protractor to draw the 30° angle.



Step 2: Use a protractor to draw the 60° angle.



Step 3: The protractor shows that the measure of the remaining angle is 90°.



Study Tip

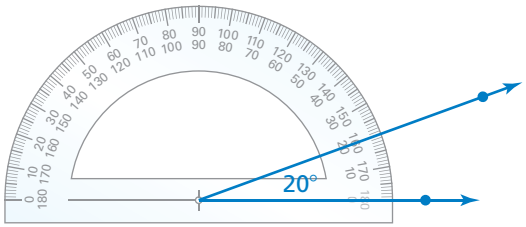
After drawing the first two angles, make sure you check the remaining angle.

∴ The triangle is a right scalene triangle.

EXAMPLE 3 Constructing a Triangle Using Side Lengths

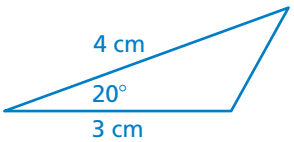
Draw a triangle with a 3-centimeter side and a 4-centimeter side that meet at a 20° angle. Then classify the triangle.

Step 1: Use a protractor to draw a 20° angle.



Step 2: Use a ruler to mark 3 centimeters on one ray and 4 centimeters on the other ray.

Step 3: Draw the third side to form the triangle.



∴ The triangle is an obtuse scalene triangle.

On Your Own

Now You're Ready
Exercises 14–19

3. Draw a triangle with angle measures of 45°, 45°, and 90°. Then classify the triangle.

4. Draw a triangle with a 1-inch side and a 2-inch side that meet at a 60° angle. Then classify the triangle.

12.3 Exercises

Check It Out
Help with Homework
BigIdeasMath.com

Vocabulary and Concept Check

1. **WRITING** How can you classify triangles using angles? using sides?
2. **DIFFERENT WORDS, SAME QUESTION** Which is different? Find "both" answers.

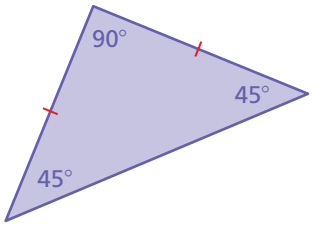
Construct an equilateral triangle.	Construct a triangle with 3 congruent sides.
Construct an equiangular triangle.	Construct a triangle with no congruent sides.

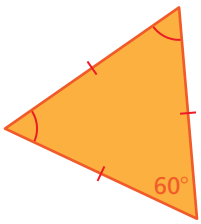
Practice and Problem Solving

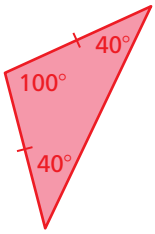
Construct a triangle with the given description.

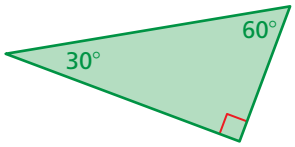
3. side lengths: 4 cm, 6 cm
4. side lengths: 5 cm, 12 cm
5. angles: 65°, 55°

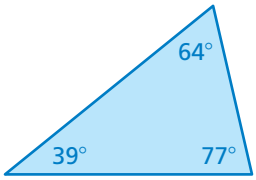
Classify the triangle.

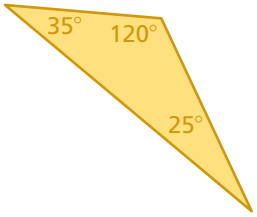
6.


7.


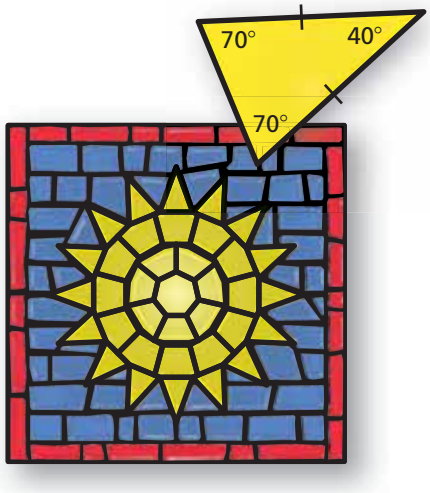
8.


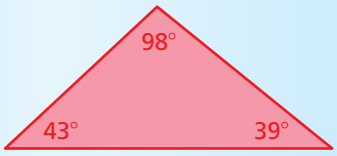
9.


10.


11.


12. **ERROR ANALYSIS** Describe and correct the error in classifying the triangle.





The triangle is acute and scalene because it has two acute angles and no congruent sides.

13. **MOSAIC TILE** A mosaic is a pattern or picture made of small pieces of colored material. Classify the yellow triangle used in the mosaic.

Draw a triangle with the given angle measures. Then classify the triangle.

2 **14.** 15°, 75°, 90° **15.** 20°, 60°, 100° **16.** 30°, 30°, 120°

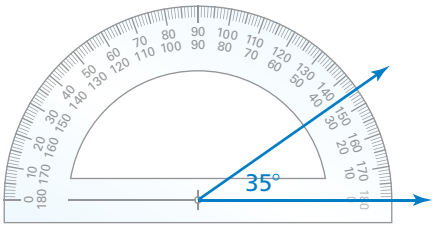
Draw a triangle with the given description.

3 **17.** a triangle with a 2-inch side and a 3-inch side that meet at a 40° angle

18. a triangle with a 45° angle connected to a 60° angle by an 8-centimeter side

19. an acute scalene triangle

20. **LOGIC** You are constructing a triangle. You draw the first angle, as shown. Your friend says that you must be constructing an acute triangle. Is your friend correct? Explain your reasoning.



Determine whether you can construct *many, one,* or *no* triangle(s) with the given description. Explain your reasoning.

21. a triangle with angle measures of 50°, 70°, and 100°

22. a triangle with one angle measure of 60° and one 4-centimeter side

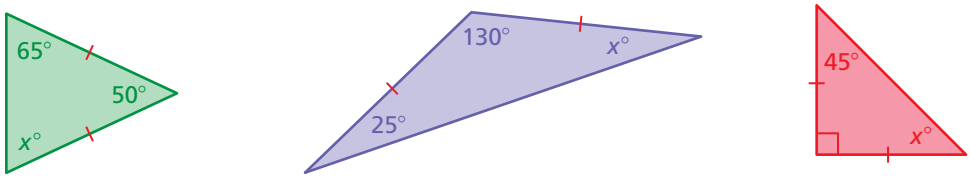
23. a scalene triangle with a 3-centimeter side and a 7-centimeter side

24. an isosceles triangle with two 4-inch sides that meet at an 80° angle

25. an isosceles triangle with two 2-inch sides and one 5-inch side

26. a right triangle with three congruent sides

27. Critical Thinking Consider the three isosceles triangles.



a. Find the value of x for each triangle.

b. What do you notice about the angle measures of each triangle?

c. Write a rule about the angle measures of an isosceles triangle.

Fair Game Review What you learned in previous grades & lessons

Tell whether x and y show direct variation. Explain your reasoning. If so, find the constant of proportionality. *(Skills Review Handbook)*

28. $x = 2y$ **29.** $y - x = 6$ **30.** $xy = 5$

31. **MULTIPLE CHOICE** A savings account earns 6% simple interest per year. The principal is \$800. What is the balance after 18 months? *(Skills Review Handbook)*

(A) \$864 (B) \$872 (C) \$1664 (D) \$7200

Extension 12.3 Angle Measures of Triangles

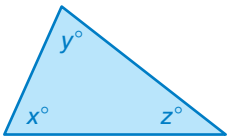
Check It Out
Lesson Tutorials
BigIdeasMath.com

Key Idea

Sum of the Angle Measures of a Triangle

Words The sum of the angle measures of a triangle is 180°.

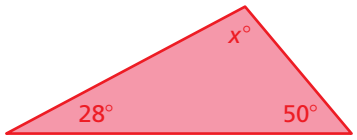
Algebra $x + y + z = 180$



EXAMPLE 1 Finding Angle Measures

Find each value of x. Then classify each triangle.

a.



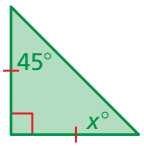
$x + 28 + 50 = 180$

$x + 78 = 180$

$x = 102$

The value of x is 102. The triangle has one obtuse angle and no congruent sides. So, it is an obtuse scalene triangle.

b.



$x + 45 + 90 = 180$

$x + 135 = 180$

$x = 45$

The value of x is 45. The triangle has a right angle and two congruent sides. So, it is a right isosceles triangle.

COMMON CORE

Geometry

In this extension, you will

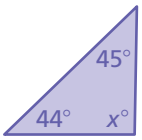
- understand that the sum of the angle measures of any triangle is 180°.
- find missing angle measures in triangles.

Learning Standard
7.G.5

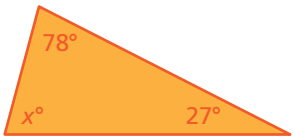
Practice

Find the value of x. Then classify the triangle.

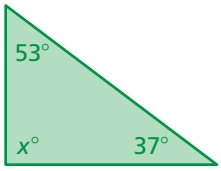
1.



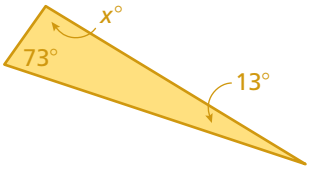
2.



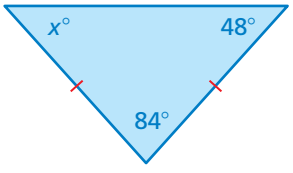
3.



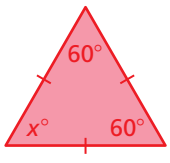
4.



5.



6.



Tell whether a triangle can have the given angle measures. If not, change the first angle measure so that the angle measures form a triangle.

7. 76.2°, 81.7°, 22.1°

8. 115.1°, 47.5°, 93°

9. $5\frac{2}{3}°$, $64\frac{1}{3}°$, 87°

10. $31\frac{3}{4}°$, $53\frac{1}{2}°$, $94\frac{3}{4}°$

EXAMPLE 2 Finding Angle Measures

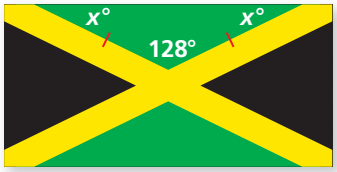
Math Practice 1

Analyze Givens

What information is given in the problem? How can you use this information to answer the question?

Find each value of x. Then classify each triangle.

a. Flag of Jamaica



$$x + x + 128 = 180$$
$$2x + 128 = 180$$
$$2x = 52$$
$$x = 26$$

∴ The value of x is 26. The triangle has one obtuse angle and two congruent sides. So, it is an obtuse isosceles triangle.

b. Flag of Cuba

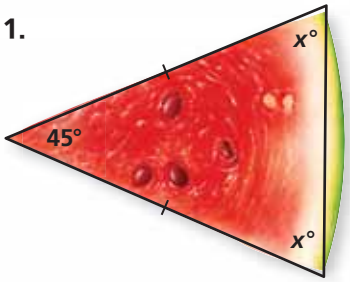
$$x + x + 60 = 180$$
$$2x + 60 = 180$$
$$2x = 120$$
$$x = 60$$

∴ The value of x is 60. All three angles are congruent. So, it is an equilateral and equiangular triangle.

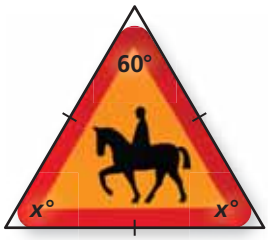
Practice

Find the value of x. Then classify the triangle.

11.

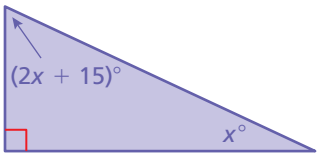


12.

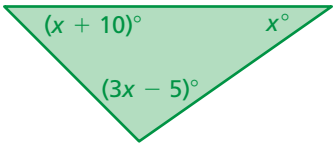


13.

14.

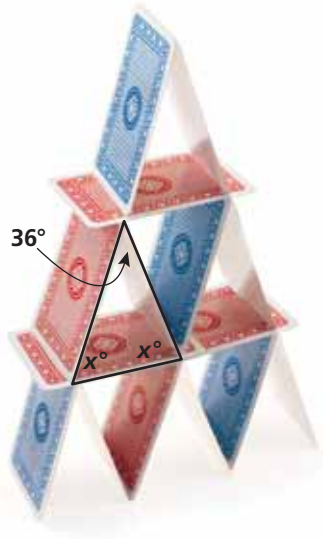


15.



16. **REASONING** Explain why all triangles have at least two acute angles.

17. **CARDS** One method of stacking cards is shown.



a. Find the value of x.

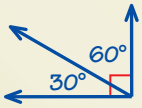
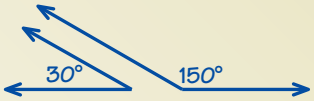
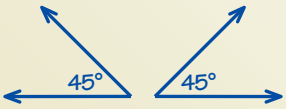
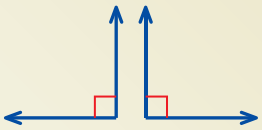
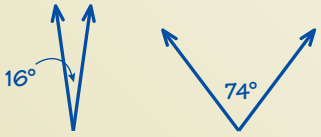
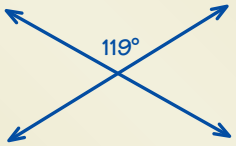
b. Describe how to stack the cards with different angles. Is the value of x limited? If so, what are the limitations? Explain your reasoning.

12 Study Help

Check It Out
Graphic Organizer
BigIdeasMath.com

You can use an **example and non-example chart** to list examples and non-examples of a vocabulary word or item. Here is an example and non-example chart for complementary angles.

Complementary Angles

Examples	Non-Examples
	
	
	
89°, 1°	63°, 26°

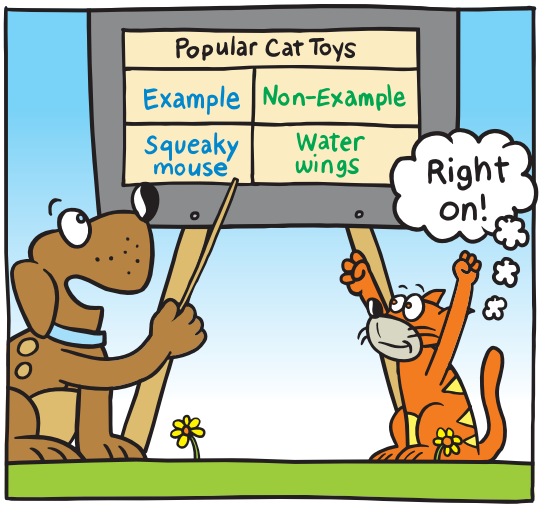
On Your Own

Make example and non-example charts to help you study these topics.

1. adjacent angles
2. vertical angles
3. supplementary angles

After you complete this chapter, make example and non-example charts for the following topics.

4. quadrilaterals
5. scale factor



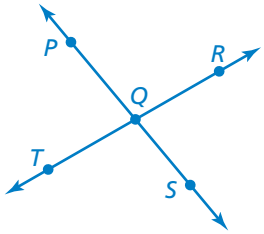
"What do you think of my example & non-example chart for popular cat toys?"

12.1–12.3 Quiz

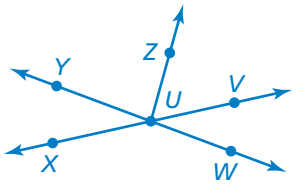
Check It Out
Progress Check
BigIdeasMath.com

Name two pairs of adjacent angles and two pairs of vertical angles in the figure. *(Section 12.1)*

1.

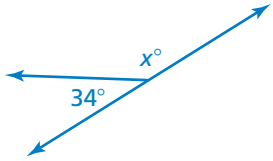


2.

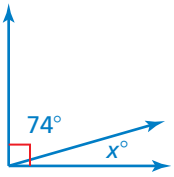


Tell whether the angles are *adjacent* or *vertical*. Then find the value of *x*. *(Section 12.1)*

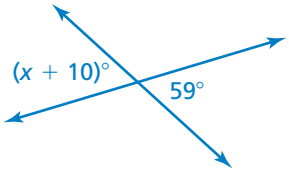
3.



4.

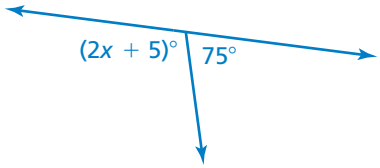


5.

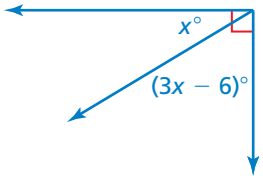


Tell whether the angles are *complementary* or *supplementary*. Then find the value of *x*. *(Section 12.2)*

6.



7.



Draw a triangle with the given description. *(Section 12.3)*

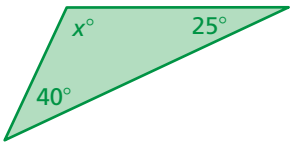
8. a triangle with angle measures of 35°, 65°, and 80°

9. a triangle with a 5-centimeter side and a 7-centimeter side that meet at a 70° angle

10. an obtuse scalene triangle

Find the value of *x*. Then classify the triangle. *(Section 12.3)*

11.



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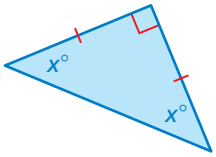

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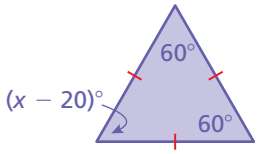
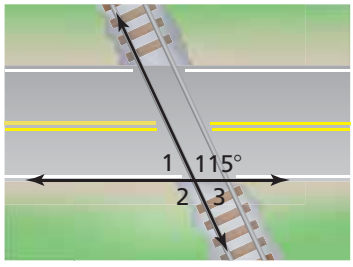


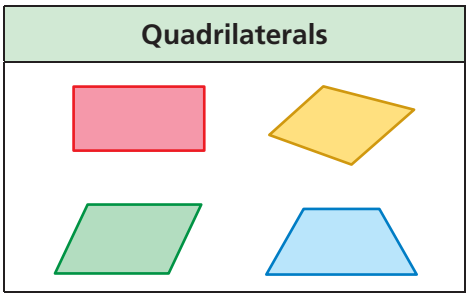
14. RAILROAD CROSSING Describe two ways to find the measure of ∠2. *(Section 12.1 and Section 12.2)*



12.4 Quadrilaterals

Essential Question How can you classify quadrilaterals?

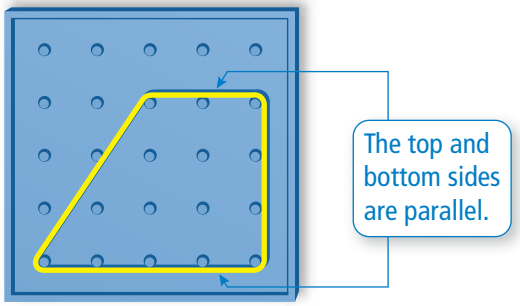
Quad means *four* and *lateral* means *side*. So, *quadrilateral* means a polygon with *four sides*.



1 ACTIVITY: Using Descriptions to Form Quadrilaterals

Work with a partner. Use a geoboard to form a quadrilateral that fits the given description. Record your results on geoboard dot paper.

a. Form a quadrilateral with exactly one pair of parallel sides.



b. Form a quadrilateral with four congruent sides and four right angles.

c. Form a quadrilateral with four right angles that is *not* a square.

d. Form a quadrilateral with four congruent sides that is *not* a square.

e. Form a quadrilateral with two pairs of congruent adjacent sides and whose opposite sides are *not* congruent.

f. Form a quadrilateral with congruent and parallel opposite sides that is *not* a rectangle.

Common Core

Geometry

In this lesson, you will

- understand that the sum of the angle measures of any quadrilateral is 360°.
- find missing angle measures in quadrilaterals.
- construct quadrilaterals.

Learning Standard 7.G.2

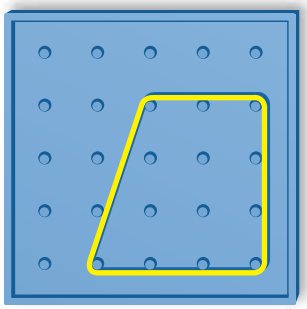
2 ACTIVITY: Naming Quadrilaterals

Work with a partner. Match the names *square, rectangle, rhombus, parallelogram, trapezoid,* and *kite* with your 6 drawings in Activity 1.

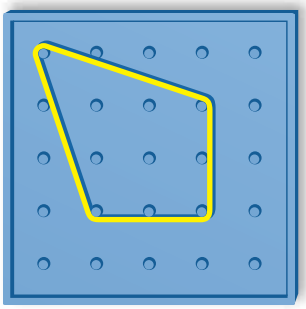
3 ACTIVITY: Forming Quadrilaterals

Work with a partner. Form each quadrilateral on your geoboard. Then move *only one* vertex to create the new type of quadrilateral. Record your results on geoboard dot paper.

a. Trapezoid ⇨ Kite



b. Kite ⇨ Rhombus (*not* a square)



4 ACTIVITY: Using Technology to Draw Quadrilaterals

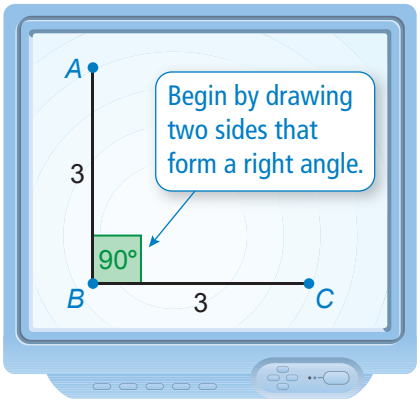
Work with a partner. Use geometry software to draw a quadrilateral that fits the given description.

a. a square with a side length of 3 units

b. a rectangle with a width of 2 units and a length of 5 units

c. a parallelogram with side lengths of 6 units and 1 unit

d. a rhombus with a side length of 4 units



Math Practice 5

Use Technology to Explore

How does geometry software help you learn about the characteristics of a quadrilateral?

What Is Your Answer?

5. **REASONING** Measure the angles of each quadrilateral you formed in Activity 1. Record your results in a table. Include the sum of the angle measures. Then describe the pattern in the table and write a conclusion based on the pattern.

6. **IN YOUR OWN WORDS** How can you classify quadrilaterals? Explain using properties of sides and angles.

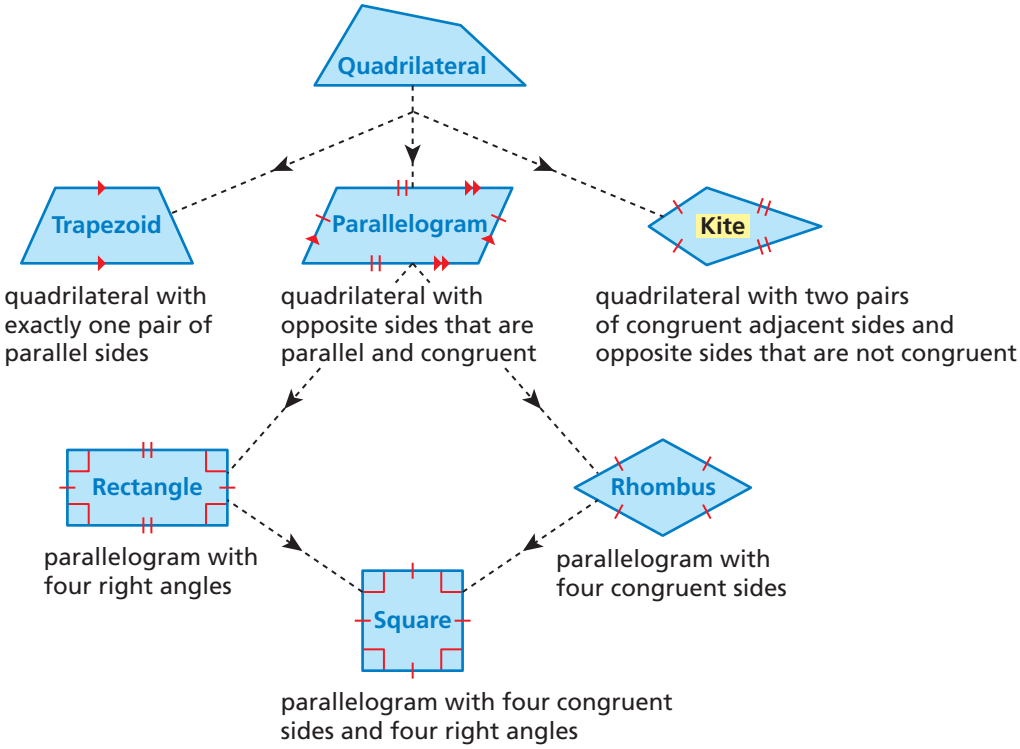
Practice Use what you learned about quadrilaterals to complete Exercises 4–6 on page 528.

12.4 Lesson

Check It Out
Lesson Tutorials
BigIdeasMath.com

Key Vocabulary
kite, *p. 526*

A quadrilateral is a polygon with four sides. The diagram shows properties of different types of quadrilaterals and how they are related. When identifying a quadrilateral, use the name that is most specific.



Reading
Red arrows indicate parallel sides.

EXAMPLE 1 Classifying Quadrilaterals

Study Tip
In Example 1(a), the square is also a parallelogram, a rectangle, and a rhombus. Square is the most specific name.

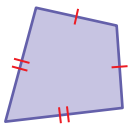
Classify the quadrilateral.

a.

The quadrilateral has four congruent sides and four right angles.

∴ So, the quadrilateral is a square.

b.



The quadrilateral has two pairs of congruent adjacent sides and opposite sides that are not congruent.

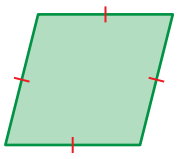
∴ So, the quadrilateral is a kite.

On Your Own

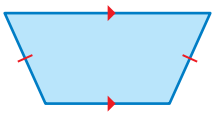
Now You're Ready
Exercises 4–9

Classify the quadrilateral.

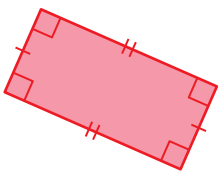
1.



2.



3.

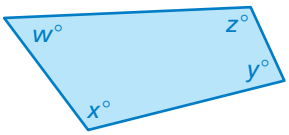


Key Idea

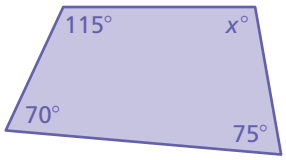
Sum of the Angle Measures of a Quadrilateral

Words The sum of the angle measures of a quadrilateral is 360°.

Algebra $w + x + y + z = 360$



EXAMPLE 2 Finding an Angle Measure of a Quadrilateral



Find the value of x.

$$\begin{aligned} 70 + 75 + 115 + x &= 360 && \text{Write an equation.} \\ 260 + x &= 360 && \text{Combine like terms.} \\ -260 \quad & \quad -260 && \text{Subtraction Property of Equality} \\ x &= 100 && \text{Simplify.} \end{aligned}$$

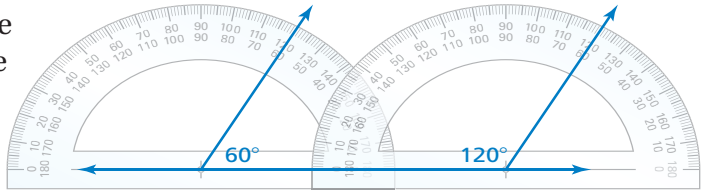
∴ The value of x is 100.

EXAMPLE 3 Constructing a Quadrilateral

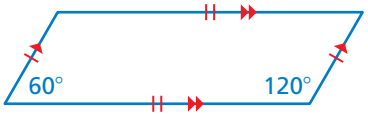
Draw a parallelogram with a 60° angle and a 120° angle.

Step 1: Draw a line.

Step 2: Draw a 60° angle and a 120° angle that each have one side on the line.



Step 3: Draw the remaining side. Make sure that both pairs of opposite sides are parallel and congruent.



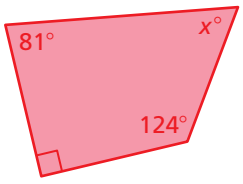
On Your Own

Now You're Ready
Exercises 10–12 and 14–17

Find the value of x.

4.

5.



6. Draw a right trapezoid whose parallel sides have lengths of 3 centimeters and 5 centimeters.

12.4 Exercises

Check It Out
Help with Homework
BigIdeasMath.com

Vocabulary and Concept Check

1. **VOCABULARY** Which statements are true?

   a. All squares are rectangles.
   b. All squares are parallelograms.
   c. All rectangles are parallelograms.
   d. All squares are rhombuses.
   e. All rhombuses are parallelograms.

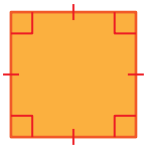
2. **REASONING** Name two types of quadrilaterals with four right angles.

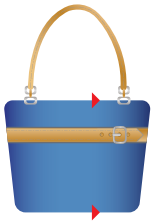
3. **WHICH ONE DOESN'T BELONG?** Which type of quadrilateral does *not* belong with the other three? Explain your reasoning.

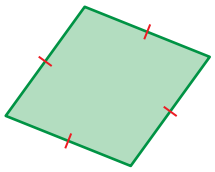
rectangle | parallelogram | square | kite

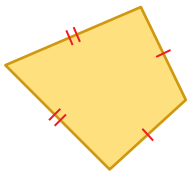
Practice and Problem Solving

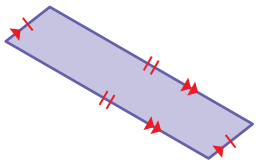
Classify the quadrilateral.

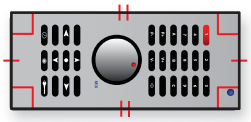
1 4. 

5. 

6. 

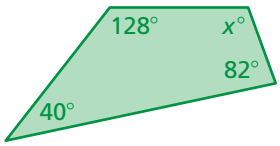
7. 

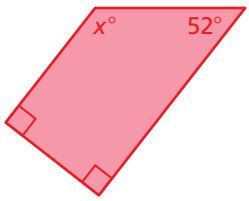
8. 

9. 

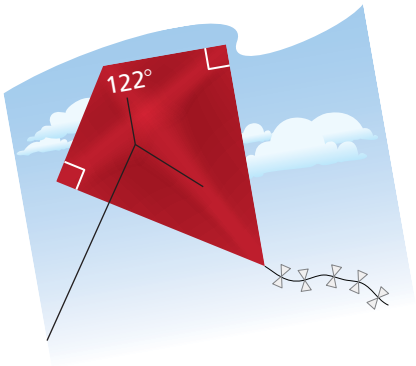
Find the value of x.

2 10. 

11. 

12. 

13. **KITE MAKING** What is the measure of the angle at the tail end of the kite?



Draw a quadrilateral with the given description.

3 **14.** a trapezoid with a pair of congruent, nonparallel sides

15. a rhombus with 3-centimeter sides and two 100° angles

16. a parallelogram with a 45° angle and a 135° angle

17. a parallelogram with a 75° angle and a 4-centimeter side

Copy and complete using *always*, *sometimes*, or *never*.

18. A square is __?__ a rectangle.

19. A square is __?__ a rhombus.

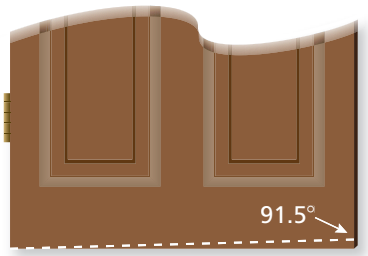
20. A rhombus is __?__ a square.

21. A parallelogram is __?__ a trapezoid.

22. A trapezoid is __?__ a kite.

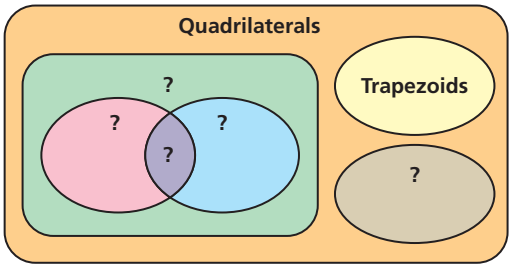
23. A rhombus is __?__ a rectangle.

24. **DOOR** The dashed line shows how you cut the bottom of a rectangular door so it opens more easily.



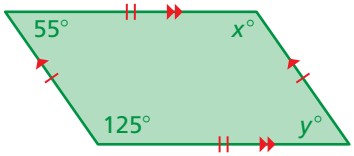
a. Identify the new shape of the door. Explain.

b. What is the new angle at the bottom left side of the door? Explain.



25. **VENN DIAGRAM** The diagram shows that some quadrilaterals are trapezoids, and all trapezoids are quadrilaterals. Copy the diagram. Fill in the names of the types of quadrilaterals to show their relationships.

26. **Structure** Consider the parallelogram.



a. Find the values of x and y.

b. Make a conjecture about opposite angles in a parallelogram.

c. In polygons, consecutive interior angles share a common side. Make a conjecture about consecutive interior angles in a parallelogram.

Fair Game Review *What you learned in previous grades & lessons*

Write the ratio as a fraction in simplest form. *(Skills Review Handbook)*

27. 3 turnovers : 12 assists

28. 18 girls to 27 boys

29. 42 pens : 35 pencils

30. **MULTIPLE CHOICE** Computer sales decreased from 40 to 32. What is the percent of decrease? *(Skills Review Handbook)*

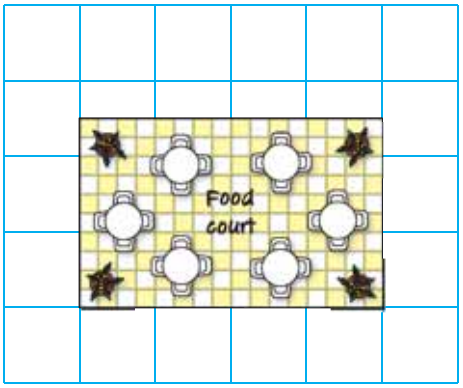
Ⓐ 8% Ⓑ 20% Ⓒ 25% Ⓓ 80%

12.5 Scale Drawings

Essential Question How can you enlarge or reduce a drawing proportionally?

1 ACTIVITY: Comparing Measurements

Work with a partner. The diagram shows a food court at a shopping mall. Each centimeter in the diagram represents 40 meters.



a. Find the length and the width of the drawing of the food court.

length: ____ cm width: ____ cm

b. Find the actual length and width of the food court. Explain how you found your answers.

length: ____ m width: ____ m

c. Find the ratios $\frac{\text{drawing length}}{\text{actual length}}$ and $\frac{\text{drawing width}}{\text{actual width}}$. What do you notice?

2 ACTIVITY: Recreating a Drawing

Work with a partner. Draw the food court in Activity 1 on the grid paper so that each centimeter represents 20 meters.

a. What happens to the size of the drawing?

b. Find the length and the width of your drawing. Compare these dimensions to the dimensions of the original drawing in Activity 1.

Common Core

Geometry

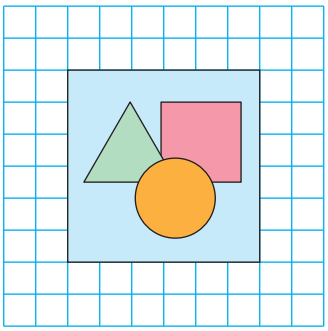
In this lesson, you will

- use scale drawings to find actual distances.
- find scale factors.
- use scale drawings to find actual perimeters and areas.
- recreate scale drawings at a different scale.

Learning Standard 7.G.1

3 ACTIVITY: Comparing Measurements

Work with a partner. The diagram shows a sketch of a painting. Each unit in the sketch represents 8 inches.



a. Find the length and the width of the sketch.

length: ____ units width: ____ units

b. Find the actual length and width of the painting. Explain how you found your answers.

length: ____ in. width: ____ in.

c. Find the ratios $\frac{\text{sketch length}}{\text{actual length}}$ and $\frac{\text{sketch width}}{\text{actual width}}$.

What do you notice?

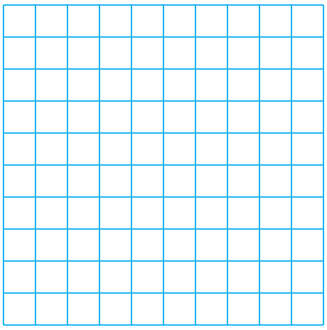
4 ACTIVITY: Recreating a Drawing

Math Practice 6

Specify Units

How do you know whether to use feet or units for each measurement?

Work with a partner. Let each unit in the grid paper represent 2 feet. Now sketch the painting in Activity 3 onto the grid paper.



a. What happens to the size of the sketch?

b. Find the length and the width of your sketch. Compare these dimensions to the dimensions of the original sketch in Activity 3.

What Is Your Answer?

5. **IN YOUR OWN WORDS** How can you enlarge or reduce a drawing proportionally?

6. Complete the table for both the food court and the painting.

	Actual Object	Original Drawing	Your Drawing
Perimeter			
Area			

Compare the measurements in each table. What conclusions can you make?

7. **RESEARCH** Look at some maps in your school library or on the Internet. Make a list of the different scales used on the maps.

8. When you view a map on the Internet, how does the scale change when you zoom out? How does the scale change when you zoom in?

Practice Use what you learned about enlarging or reducing drawings to complete Exercises 4–7 on page 535.

12.5 Lesson

Check It Out
Lesson Tutorials
BigIdeasMath.com

Key Vocabulary
scale drawing, *p. 532*
scale model, *p. 532*
scale, *p. 532*
scale factor, *p. 533*

Key Ideas

Scale Drawings and Models

A **scale drawing** is a proportional, two-dimensional drawing of an object. A **scale model** is a proportional, three-dimensional model of an object.

Scale

The measurements in scale drawings and models are proportional to the measurements of the actual object. The **scale** gives the ratio that compares the measurements of the drawing or model with the actual measurements.

$\frac{1 \text{ in.}}{10 \text{ mi}}$ ← drawing distance; ← actual distance

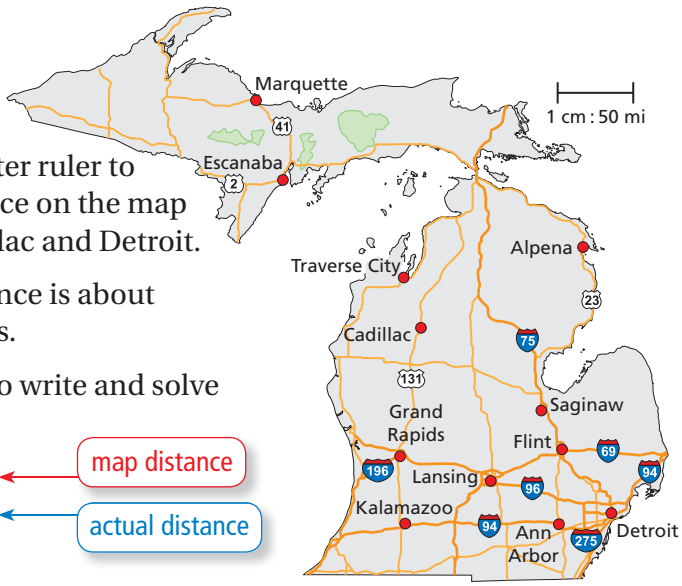
$1 \text{ in.} : 10 \text{ mi}$ (drawing : actual)

Study Tip

Scales are written so that the drawing distance comes first in the ratio.

EXAMPLE 1 Finding an Actual Distance

What is the actual distance d between Cadillac and Detroit?



Step 1: Use a centimeter ruler to find the distance on the map between Cadillac and Detroit.

The map distance is about 3.5 centimeters.

Step 2: Use the scale to write and solve a proportion.

$\frac{1 \text{ cm}}{50 \text{ mi}} = \frac{3.5 \text{ cm}}{d \text{ mi}}$ ← map distance; ← actual distance

$d = 50 \cdot 3.5$ Cross Products Property

$d = 175$ Multiply.

∴ So, the distance between Cadillac and Detroit is about 175 miles.

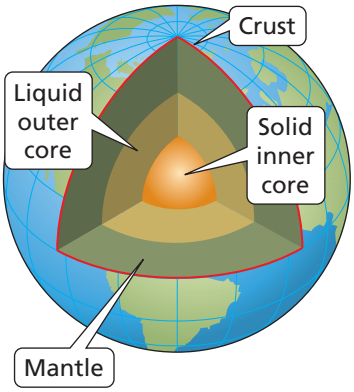
On Your Own

1. What is the actual distance between Traverse City and Marquette?

Now You're Ready
Exercises 8–11

EXAMPLE 2 Finding a Distance in a Model

The liquid outer core of Earth is 2300 kilometers thick. A scale model of the layers of Earth has a scale of 1 in. : 500 km. How thick is the liquid outer core of the model?



(A) 0.2 in. (B) 4.6 in. (C) 0.2 km (D) 4.6 km

$$\frac{1 \text{ in.}}{500 \text{ km}} = \frac{x \text{ in.}}{2300 \text{ km}}$$ ← model thickness; ← actual thickness

$$\frac{1 \text{ in.}}{500 \text{ km}} \cdot 2300 \text{ km} = \frac{x \text{ in.}}{2300 \text{ km}} \cdot 2300 \text{ km}$$ Multiplication Property of Equality

$$4.6 = x$$ Simplify.

∴ So, the liquid outer core of the model is 4.6 inches thick. The correct answer is (B).

On Your Own

2. The mantle of Earth is 2900 kilometers thick. How thick is the mantle of the model?

A scale can be written without units when the units are the same. A scale without units is called a **scale factor**.

EXAMPLE 3 Finding a Scale Factor

A scale model of the Sergeant Floyd Monument is 10 inches tall. The actual monument is 100 feet tall.

a. What is the scale of the model?

$$\frac{\text{model height}}{\text{actual height}} = \frac{10 \text{ in.}}{100 \text{ ft}} = \frac{1 \text{ in.}}{10 \text{ ft}}$$

∴ The scale is 1 in. : 10 ft.

b. What is the scale factor of the model?

Write the scale with the same units. Use the fact that 1 ft = 12 in.

$$\text{scale factor} = \frac{1 \text{ in.}}{10 \text{ ft}} = \frac{1 \text{ in.}}{120 \text{ in.}} = \frac{1}{120}$$

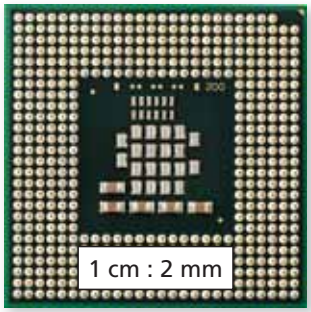
∴ The scale factor is 1 : 120.

On Your Own

3. A drawing has a scale of 1 mm : 20 cm. What is the scale factor of the drawing?

Now You're Ready
Exercises 12–16

EXAMPLE 4 Finding an Actual Perimeter and Area



The scale drawing of a computer chip helps you see the individual components on the chip.

a. Find the perimeter and the area of the computer chip in the scale drawing.

When measured using a centimeter ruler, the scale drawing of the computer chip has a side length of 4 centimeters.

So, the perimeter of the computer chip in the scale drawing is $4(4) = 16$ centimeters, and the area is $4^2 = 16$ square centimeters.

b. Find the actual perimeter and area of the computer chip.

$$\frac{1 \text{ cm}}{2 \text{ mm}} = \frac{4 \text{ cm}}{s \text{ mm}}$$ ← drawing distance; ← actual distance

$s = 2 \cdot 4$ Cross Products Property

$s = 8$ Multiply.

The side length of the actual computer chip is 8 millimeters.

So, the actual perimeter of the computer chip is $4(8) = 32$ millimeters, and the actual area is $8^2 = 64$ square millimeters.

c. Compare the ratios $\frac{\text{drawing perimeter}}{\text{actual perimeter}}$ and $\frac{\text{drawing area}}{\text{actual area}}$ to the scale factor.

Use the fact that 1 cm = 10 mm.

$$\text{scale factor} = \frac{1 \text{ cm}}{2 \text{ mm}} = \frac{10 \text{ mm}}{2 \text{ mm}} = \frac{5}{1}$$

$$\frac{\text{drawing perimeter}}{\text{actual perimeter}} = \frac{16 \text{ cm}}{32 \text{ mm}} = \frac{1 \text{ cm}}{2 \text{ mm}} = \frac{5}{1}$$

$$\frac{\text{drawing area}}{\text{actual area}} = \frac{16 \text{ cm}^2}{64 \text{ mm}^2} = \frac{1 \text{ cm}^2}{4 \text{ mm}^2} = \left(\frac{1 \text{ cm}}{2 \text{ mm}}\right)^2 = \left(\frac{5}{1}\right)^2$$

So, the ratio of the perimeters is equal to the scale factor, and the ratio of the areas is equal to the square of the scale factor.

Study Tip

The ratios tell you that the perimeter of the drawing is 5 times the actual perimeter, and the area of the drawing is $5^2 = 25$ times the actual area.

On Your Own

Now You're Ready
Exercises 22 and 23

4. **WHAT IF?** The scale of the drawing of the computer chip is 1 cm : 3 mm. How do the answers in parts (a)–(c) change? Justify your answer.

12.5 Exercises

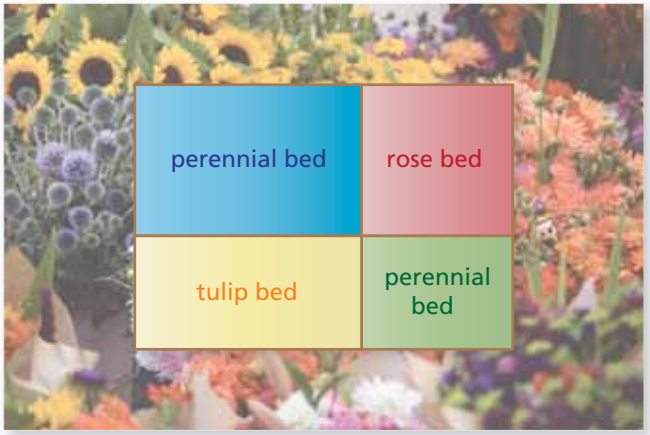
Check It Out
Help with Homework
BigIdeasMath.com

Vocabulary and Concept Check

1. **VOCABULARY** Compare and contrast the terms *scale* and *scale factor*.
2. **CRITICAL THINKING** The scale of a drawing is 2 cm : 1 mm. Is the scale drawing *larger* or *smaller* than the actual object? Explain.
3. **REASONING** How would you find the scale factor of a drawing that shows a length of 4 inches when the actual object is 8 feet long?

Practice and Problem Solving

Use the drawing and a centimeter ruler. Each centimeter in the drawing represents 5 feet.



4. What is the actual length of the flower garden?
5. What are the actual dimensions of the rose bed?
6. What are the actual perimeters of the perennial beds?
7. The area of the tulip bed is what percent of the area of the rose bed?

Use the map in Example 1 to find the actual distance between the cities.

1 8. Kalamazoo and Ann Arbor
9. Lansing and Flint
10. Grand Rapids and Escanaba
11. Saginaw and Alpena

Find the missing dimension. Use the scale factor 1 : 12.

	Item	Model	Actual
2 3 12.	Mattress	Length: 6.25 in.	Length: _____ in.
13.	Corvette	Length: _____ in.	Length: 15 ft
14.	Water tower	Depth: 32 cm	Depth: _____ m
15.	Wingspan	Width: 5.4 ft	Width: _____ yd
16.	Football helmet	Diameter: _____ mm	Diameter: 21 cm

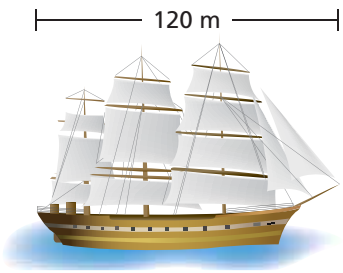
17. **ERROR ANALYSIS** A scale is 1 cm : 20 m. Describe and correct the error in finding the actual distance that corresponds to 5 centimeters.

✗ $\frac{1\text{ cm}}{20\text{ m}} = \frac{x\text{ m}}{5\text{ cm}}$

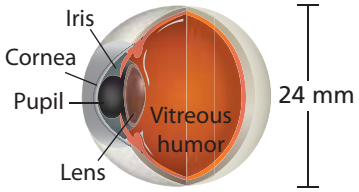
$x = 0.25$ m

Use a centimeter ruler to measure the segment shown. Find the scale of the drawing.

18.



19.



20. REASONING You know the length and the width of a scale model. What additional information do you need to know to find the scale of the model?

21. OPEN-ENDED You are in charge of creating a billboard advertisement with the dimensions shown.

a. Choose a product. Then design the billboard using words and a picture.

b. What is the scale factor of your design?

22. CENTRAL PARK Central Park is a rectangular park in New York City.

a. Find the perimeter and the area of Central Park in the scale drawing.

b. Find the actual perimeter and area of Central Park.

23. ICON You are designing an icon for a mobile app.

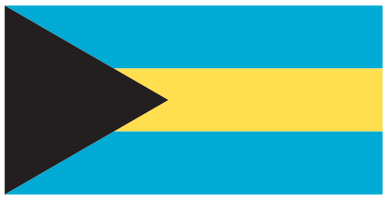
a. Find the perimeter and the area of the icon in the scale drawing.

b. Find the actual perimeter and area of the icon.

24. CRITICAL THINKING Use the results of Exercises 22 and 23 to make a conjecture about the relationship between the scale factor of a drawing and the ratios $\frac{\text{drawing perimeter}}{\text{actual perimeter}}$ and $\frac{\text{drawing area}}{\text{actual area}}$.

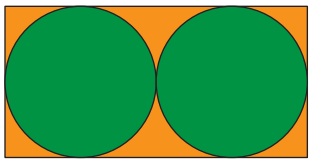
Recreate the scale drawing so that it has a scale of 1 cm : 4 m.

25.

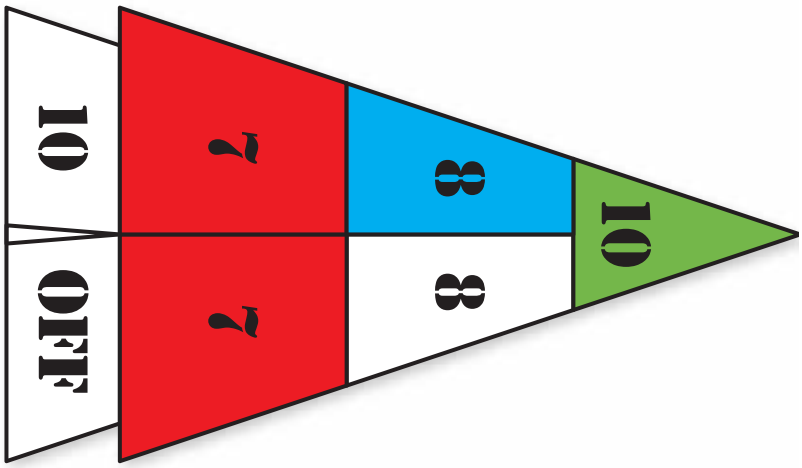


1 cm : 8 m

26.



1 cm : 2 m



The shuffleboard diagram has a scale of 1 cm : 1 ft. Find the actual area of the region.

27. red region

28. blue region

29. green region

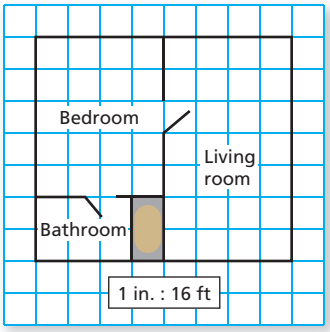
30. **BLUEPRINT** In a blueprint, each square has a side length of $\frac{1}{4}$ inch.

a. Ceramic tile costs $5 per square foot. How much would it cost to tile the bathroom?

b. Carpet costs $18 per square yard. How much would it cost to carpet the bedroom and living room?

c. Which has a greater unit cost, the tile or the carpet? Explain.

Reduced Drawing of Blueprint



31. **Modeling** You are making a scale model of the solar system. The radius of Earth is 6378 kilometers. The radius of the Sun is 695,500 kilometers. Is it reasonable to choose a baseball as a model of Earth? Explain your reasoning.

Fair Game Review What you learned in previous grades & lessons

Plot and label the ordered pair in a coordinate plane. *(Skills Review Handbook)*

32. $A(-4, 3)$ **33.** $B(2, -6)$ **34.** $C(5, 1)$ **35.** $D(-3, -7)$

36. **MULTIPLE CHOICE** Which set of numbers is ordered from least to greatest? *(Skills Review Handbook)*

Ⓐ $\frac{7}{20}$, 32%, 0.45 Ⓑ 17%, 0.21, $\frac{3}{25}$ Ⓒ 0.88, $\frac{7}{8}$, 93% Ⓓ 57%, $\frac{11}{16}$, 5.7

12.4–12.5 Quiz

Check It Out
Progress Check
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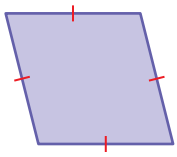
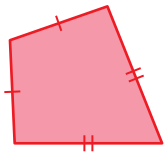
Classify the quadrilateral. *(Section 12.4)*

1.

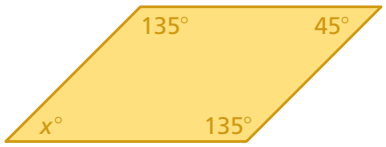


2.

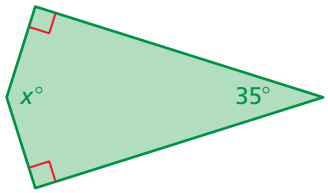


Find the value of x. *(Section 12.4)*

3.



4.



Draw a quadrilateral with the given description. *(Section 12.4)*

5. a rhombus with 2-centimeter sides and two 50° angles

6. a parallelogram with a 65° angle and a 5-centimeter side

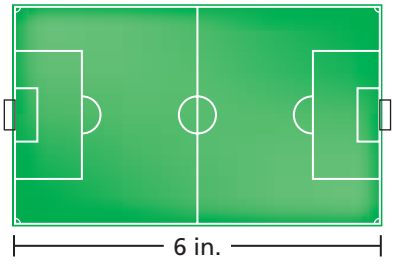
Find the missing dimension. Use the scale factor 1 : 20. *(Section 12.5)*

	Item	Model	Actual
7.	Basketball player	Height: ____ in.	Height: 90 in.
8.	Dinosaur	Length: 3.75 ft	Length: ____ ft

9. SHED The side of the storage shed is in the shape of a trapezoid. Find the value of x. *(Section 12.4)*

10. DOLPHIN A dolphin in an aquarium is 12 feet long. A scale model of the dolphin is $3\frac{1}{2}$ inches long. What is the scale factor of the model? *(Section 12.5)*

11. SOCCER A scale drawing of a soccer field is shown. The actual soccer field is 300 feet long. *(Section 12.5)*



a. What is the scale of the drawing?

b. What is the scale factor of the drawing?

12 Chapter Review

Check It Out
Vocabulary Help
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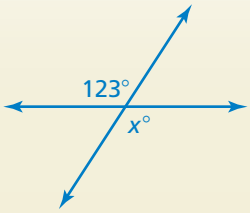
Review Key Vocabulary

adjacent angles, *p. 504*
vertical angles, *p. 504*
congruent angles, *p. 504*
complementary angles, *p. 510*
supplementary angles, *p. 510*
congruent sides, *p. 516*
kite, *p. 526*
scale drawing, *p. 532*
scale model, *p. 532*
scale, *p. 532*
scale factor, *p. 533*

Review Examples and Exercises

12.1 Adjacent and Vertical Angles *(pp. 502–507)*

Tell whether the angles are *adjacent* or *vertical*. Then find the value of x.



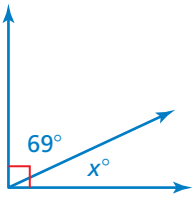
The angles are vertical angles. Because vertical angles are congruent, the angles have the same measure.

∴ So, the value of x is 123.

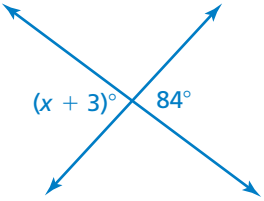
Exercises

Tell whether the angles are *adjacent* or *vertical*. Then find the value of x.

1.

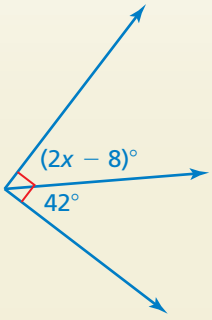


2.



12.2 Complementary and Supplementary Angles *(pp. 508–513)*

Tell whether the angles are *complementary* or *supplementary*. Then find the value of x.



The two angles make up a right angle. So, the angles are complementary angles, and the sum of their measures is 90°.

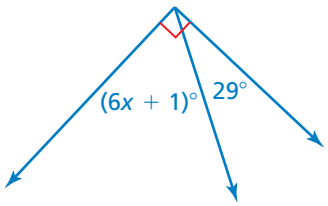
$(2x - 8) + 42 = 90$ Write equation.
$2x + 34 = 90$ Combine like terms.
$2x = 56$ Subtract 34 from each side.
$x = 28$ Divide each side by 2.

∴ So, the value of x is 28.

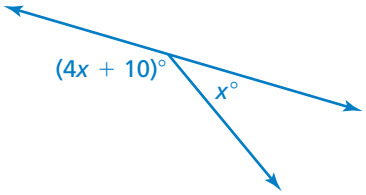
Exercises

Tell whether the angles are *complementary* or *supplementary*. Then find the value of *x*.

3.



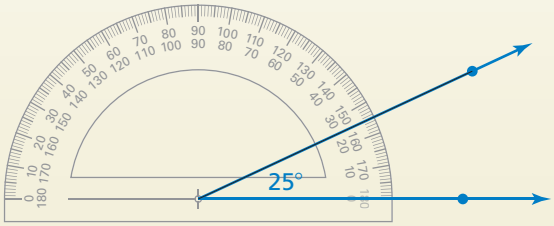
4.



12.3 Triangles *(pp. 514–521)*

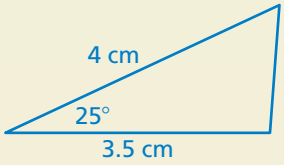
Draw a triangle with a 3.5-centimeter side and a 4-centimeter side that meet at a 25° angle. Then classify the triangle.

Step 1: Use a protractor to draw a 25° angle.



Step 2: Use a ruler to mark 3.5 centimeters on one ray and 4 centimeters on the other ray.

Step 3: Draw the third side to form the triangle.



∴ The triangle is an obtuse scalene triangle.

Exercises

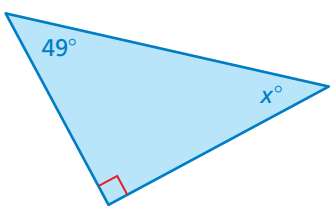
Draw a triangle with the given description.

5. a triangle with angle measures of 40°, 50°, and 90°

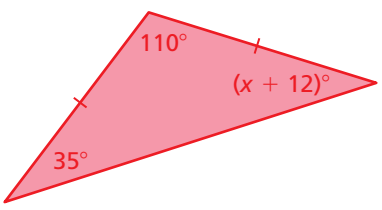
6. a triangle with a 3-inch side and a 4-inch side that meet at a 30° angle

Find the value of *x*. Then classify the triangle.

7.



8.

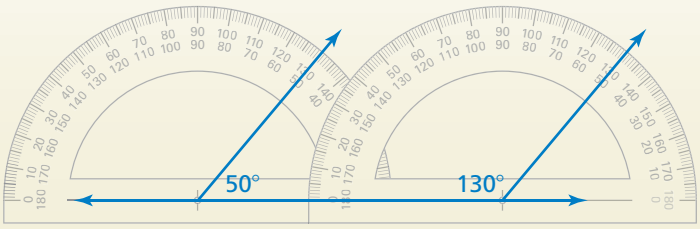


12.4 Quadrilaterals *(pp. 524–529)*

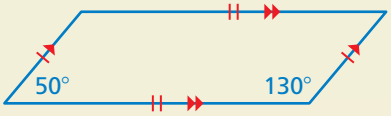
Draw a parallelogram with a 50° angle and a 130° angle.

Step 1: Draw a line.

Step 2: Draw a 50° angle and a 130° angle that each have one side on the line.



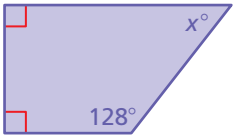
Step 3: Draw the remaining side. Make sure that both pairs of opposite sides are parallel and congruent.



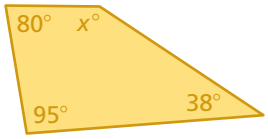
Exercises

Find the value of x.

9.



10.



11. Draw a rhombus with 5-centimeter sides and two 120° angles.

12.5 Scale Drawings *(pp. 530–537)*

A lighthouse is 160 feet tall. A scale model of the lighthouse has a scale of 1 in. : 8 ft. How tall is the model of the lighthouse?

$$\frac{1 \text{ in.}}{8 \text{ ft}} = \frac{x \text{ in.}}{160 \text{ ft}}$$ ← model height; ← actual height

$$\frac{1 \text{ in.}}{8 \cancel{\text{ ft}}} \cdot 160 \cancel{\text{ ft}} = \frac{x \text{ in.}}{160 \text{ ft}} \cdot 160 \text{ ft} \quad \text{Multiplication Property of Equality}$$

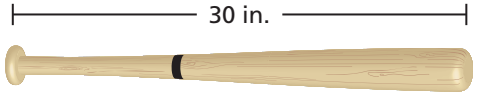
$$20 = x \quad \text{Simplify.}$$

∴ So, the model of the lighthouse is 20 inches tall.

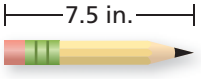
Exercises

Use a centimeter ruler to measure the segment shown. Find the scale of the drawing.

12.



13.



12 Chapter Test

Check It Out
Test Practice
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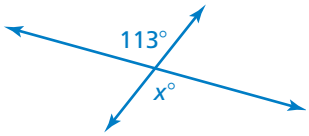
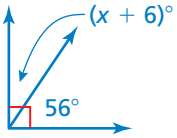
Tell whether the angles are *adjacent* or *vertical*. Then find the value of x.

1.

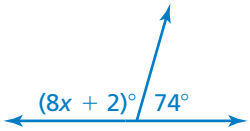


2.

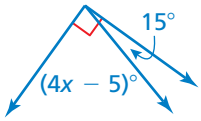


Tell whether the angles are *complementary* or *supplementary*. Then find the value of x.

3.



4.



Draw a triangle with the given angle measures. Then classify the triangle.

5. 10°, 80°, 90°

6. 30°, 40°, 110°

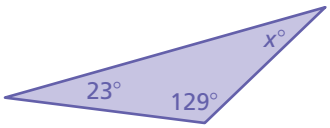
Draw a triangle with the given description.

7. a triangle with a 5-inch side and a 6-inch side that meet at a 50° angle

8. a right isosceles triangle

Find the value of x. Then classify the triangle.

9.



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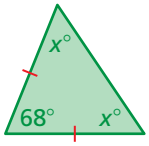

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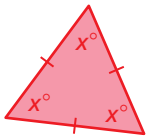
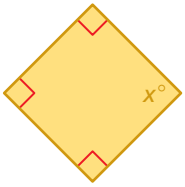


Find the value of x.

12.



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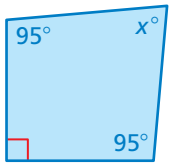

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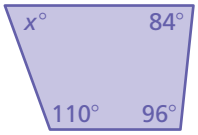
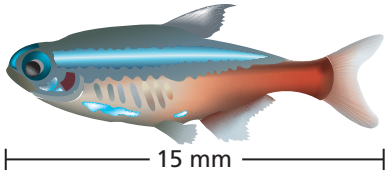


Draw a quadrilateral with the given description.

15. a rhombus with 6-centimeter sides and two 80° angles

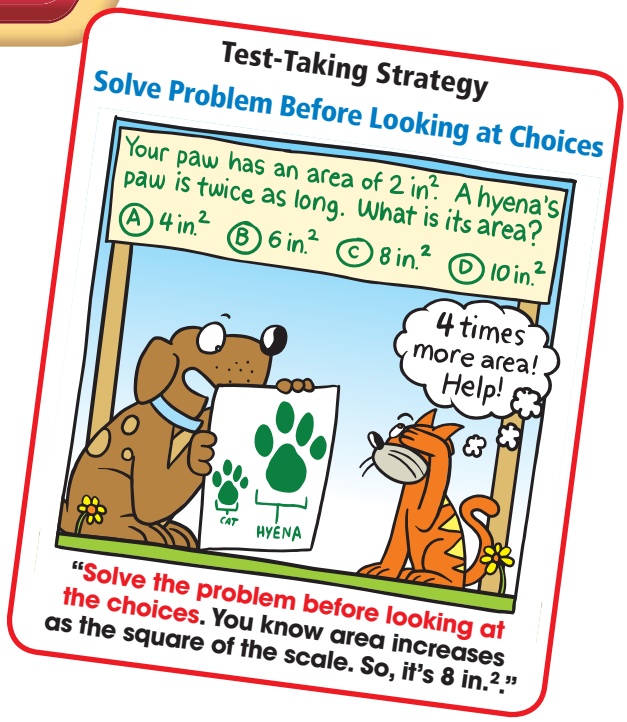
16. a parallelogram with a 20° angle and a 160° angle

17. **FISH** Use a centimeter ruler to measure the fish. Find the scale factor of the drawing.

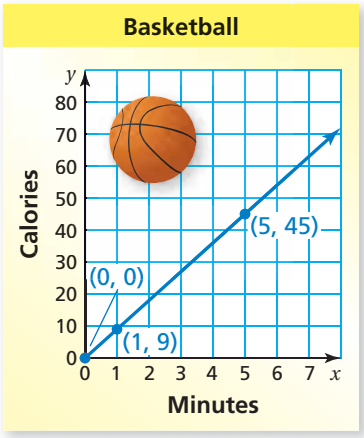


18. **CAD** An engineer is using computer-aided design (CAD) software to design a component for a space shuttle. The scale of the drawing is 1 cm : 60 in. The actual length of the component is 12.5 feet. What is the length of the component in the drawing?

12 Standards Assessment



1. The number of calories you burn by playing basketball is proportional to the number of minutes you play. Which of the following is a valid interpretation of the graph below? *(7.RP.2d)*



A. The unit rate is $\frac{1}{9}$ calorie per minute.

B. You burn 5 calories by playing basketball for 45 minutes.

C. You do not burn any calories if you do not play basketball for at least 1 minute.

D. You burn an additional 9 calories for each minute of basketball you play.

2. A lighting store is holding a clearance sale. The store is offering discounts on all the lamps it sells. As the sale progresses, the store will increase the percent of discount it is offering.

You want to buy a lamp that has an original price of $40. You will buy the lamp when its price is marked down to $10. What percent discount will you have received? *(7.RP.3)*

3. What is the value of the expression below? *(7.NS.1c)*

$$2 - 6 - (-9)$$

F. -13

G. -5

H. 5

I. 13

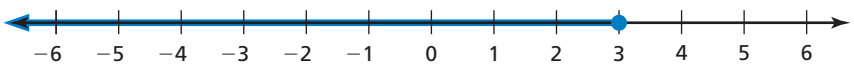
4. What is the solution to the proportion below? *(7.RP.2c)*

$$\frac{8}{12} = \frac{x}{18}$$

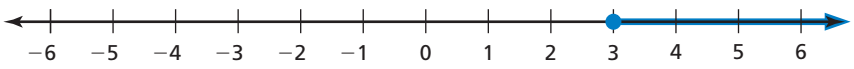
5. Which graph represents the inequality below? *(7.EE.4b)*

$$-5 - 6x \leq -23$$

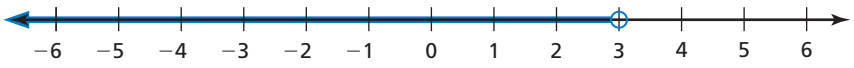
A.



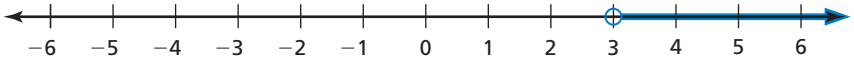
B.



C.



D.



6. You are building a scale model of a park that is planned for a city. The model uses the scale below.

1 centimeter = 2 meters

The park will have a rectangular reflecting pool with a length of 20 meters and a width of 12 meters. In your scale model, what will be the area of the reflecting pool? *(7.G.1)*

F. 60 cm^2

G. 120 cm^2

H. 480 cm^2

I. 960 cm^2

7. The quantities x and y are proportional. What is the missing value in the table? *(7.RP.2a)*

x	*y*
$\frac{5}{7}$	10
$\frac{9}{7}$	18
$\frac{15}{7}$	30
4	

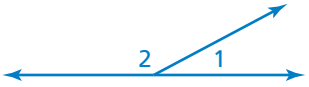
A. 38

B. 42

C. 46

D. 56

8. $\angle 1$ and $\angle 2$ form a straight angle. $\angle 1$ has a measure of 28°. What is the measure of $\angle 2$? *(7.G.5)*



F. 62°

G. 118°

H. 152°

I. 208°

9. Brett solved the equation in the box below. *(7.EE.4a)*

$$\frac{c}{5} - (-15) = -35$$
$$\frac{c}{5} + 15 = -35$$
$$\frac{c}{5} + 15 - 15 = -35 - 15$$
$$\frac{c}{5} = -50$$
$$\frac{c}{5} = \frac{-50}{5}$$
$$c = -10$$

What should Brett do to correct the error that he made?

A. Subtract 15 from -35 to get -20.

B. Rewrite $\frac{c}{5} - (-15)$ as $\frac{c}{5} - 15$.

C. Multiply each side of the equation by 5 to get $c = -250$.

D. Multiply each side of the equation by -5 to get $c = 250$.

10. A map of the state where Donna lives has the scale shown below. *(7.G.1)*

Think
Solve
Explain

$$\frac{1}{2} \text{ inch} = 10 \text{ miles}$$

Part A Donna measured the distance between her town and the state capital on the map. Her measurement was $4\frac{1}{2}$ inches. Based on Donna's measurement, what is the actual distance, in miles, between her town and the state capital? Show your work and explain your reasoning.

Part B Donna wants to mark her favorite campsite on the map. She knows that the campsite is 65 miles north of her town. What distance on the map, in inches, represents an actual distance of 65 miles? Show your work and explain your reasoning.