5.5 Parallel Lines and Transversals
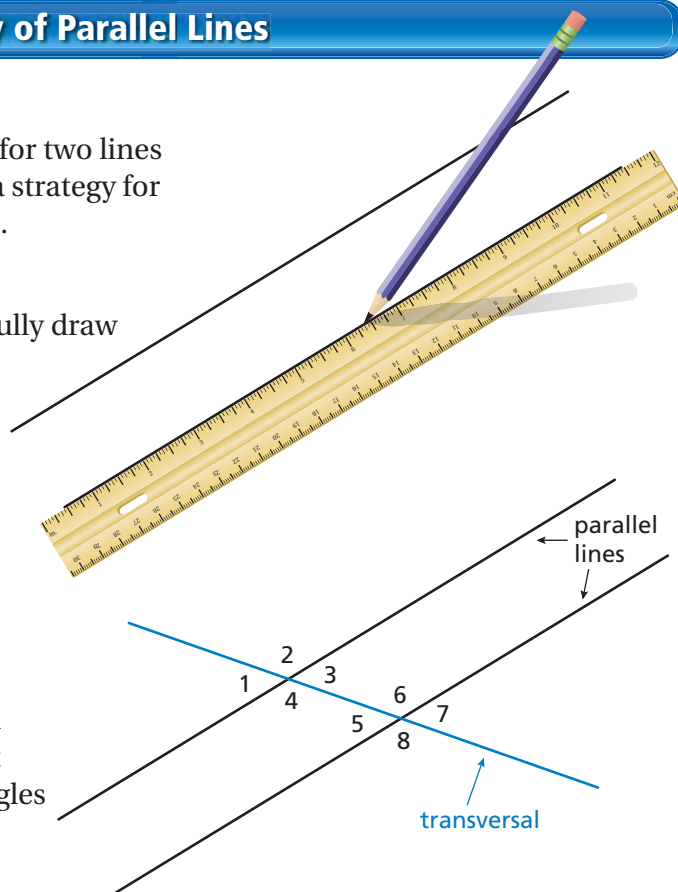
Essential Question How can you use properties of parallel lines to solve real-life problems?

1 ACTIVITY: A Property of Parallel Lines

Work with a partner.

- Talk about what it means for two lines to be parallel. Decide on a strategy for drawing two parallel lines.

- Use your strategy to carefully draw two lines that are parallel.

- Now, draw a third line that intersects the two parallel lines. This line is called a **transversal**.

- The two parallel lines and the transversal form eight angles. Which of these angles have equal measures? Explain your reasoning.

parallel lines

transversal

2 ACTIVITY: Creating Parallel Lines
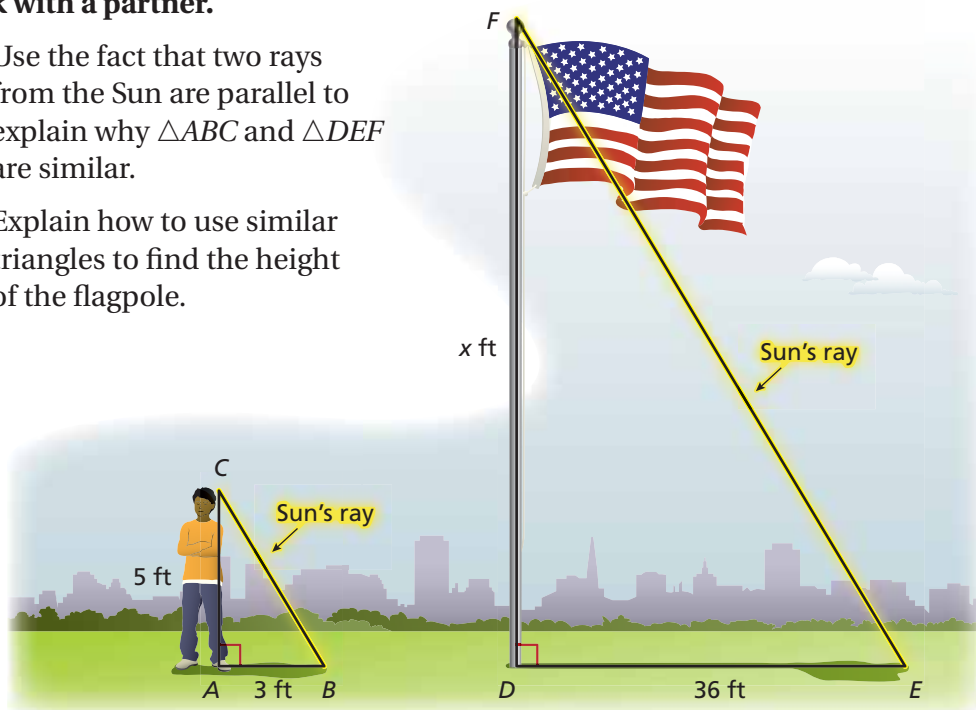
Work with a partner.

a. If you were building the house in the photograph, how could you make sure that the studs are parallel to each other?

b. Identify sets of parallel lines and transversals in the photograph.

Studs

3 ACTIVITY: Indirect Measurement

Work with a partner.

a. Use the fact that two rays from the Sun are parallel to explain why $\triangle ABC$ and $\triangle DEF$ are similar.

b. Explain how to use similar triangles to find the height of the flagpole.

F

x ft

Sun's ray

C

Sun's ray

5 ft

A　3 ft　*B*

D　36 ft　*E*

What Is Your Answer?

4. IN YOUR OWN WORDS How can you use properties of parallel lines to solve real-life problems? Describe some examples.

5. INDIRECT MEASUREMENT PROJECT Work with a partner or in a small group.

a. Explain why the process in Activity 3 is called "indirect" measurement.

b. Use indirect measurement to measure the height of something outside your school (a tree, a building, a flagpole). Before going outside, decide what you need to take with you to do the measurement.

c. Draw a diagram of the indirect measurement process you used. In the diagram, label the lengths that you actually measured and also the lengths that you calculated.

Practice

Use what you learned about parallel lines and transversals to complete Exercises 3–6 on page 217.
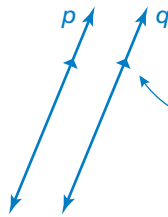
5.5 Lesson

Key Vocabulary

perpendicular lines,
  p. 214
transversal, p. 214
interior angles,
  p. 215
exterior angles,
  p. 215

Lines in the same plane that do not intersect are called parallel lines. Lines that intersect at right angles are called **perpendicular lines**.

Indicates lines ℓ and m are perpendicular.
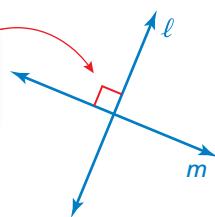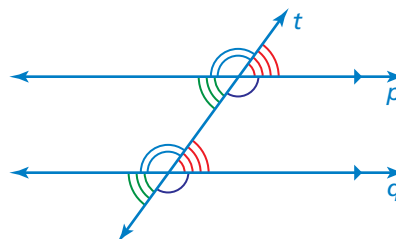
Indicates lines p and q are parallel.

A line that intersects two or more lines is called a **transversal**. When parallel lines are cut by a transversal, several pairs of congruent angles are formed.

Key Idea

Study Tip

Corresponding angles lie on the same side of the transversal in corresponding positions.

Corresponding Angles

When a transversal intersects parallel lines, corresponding angles are congruent.

Corresponding angles

EXAMPLE 1   Finding Angle Measures
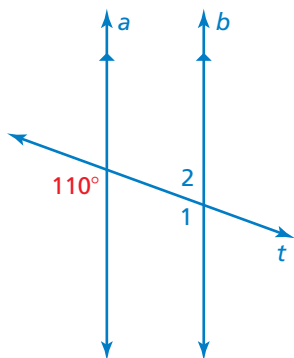
Use the figure to find the measures of (a) ∠1 and (b) ∠2.

a. ∠1 and the 110° angle are corresponding angles. They are congruent.

So, the measure of ∠1 is 110°.

b. ∠1 and ∠2 are supplementary.

$$\angle 1 + \angle 2 = 180°$$ Definition of supplementary angles

$$110° + \angle 2 = 180°$$ Substitute 110° for ∠1.
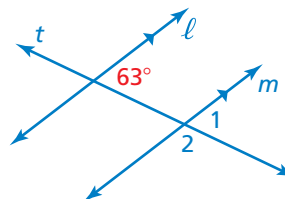
$$\angle 2 = 70°$$ Subtract 110° from each side.

So, the measure of ∠2 is 70°.

On Your Own

Now You're Ready
Exercises 7–9

Use the figure to find the measure of the angle. Explain your reasoning.

1. ∠1   **2.** ∠2

EXAMPLE **2**   **Using Corresponding Angles**
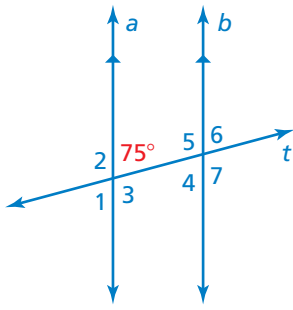
Use the figure to find the measures of the numbered angles.

∠1: ∠1 and the 75° angle are vertical angles. They are congruent.

⋮ So, the measure of ∠1 is 75°.

∠2 and ∠3: The 75° angle is supplementary to both ∠2 and ∠3.

$$75° + ∠2 = 180°$$ Definition of supplementary angles

$$∠2 = 105°$$ Subtract 75° from each side.

⋮ So, the measures of ∠2 and ∠3 are 105°.

∠4, ∠5, ∠6, and ∠7: Using corresponding angles, the measures of ∠4 and ∠6 are 75°, and the measures of ∠5 and ∠7 are 105°.

On Your Own

Now You're Ready
Exercises 15–17

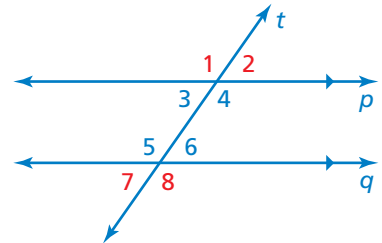**3.** Use the figure to find the measures of the numbered angles.
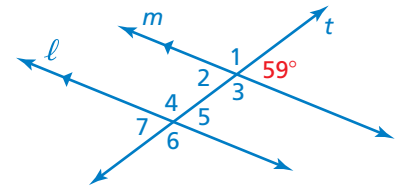
When two parallel lines are cut by a transversal, four **interior angles** are formed on the inside of the parallel lines and four **exterior angles** are formed on the outside of the parallel lines.

∠3, ∠4, ∠5, and ∠6 are interior angles.
∠1, ∠2, ∠7, and ∠8 are exterior angles.

EXAMPLE **3**   **Standardized Test Practice**

A store owner uses pieces of tape to paint a window advertisement. The letters are slanted at an 80° angle. What is the measure of ∠1?

   Ⓐ 80°   Ⓑ 100°   Ⓒ 110°   Ⓓ 120°

Because all of the letters are slanted at an 80° angle, the dashed lines are parallel. The piece of tape is the transversal.

Using the corresponding angles, the 80° angle is congruent to the angle that is supplementary to ∠1, as shown.
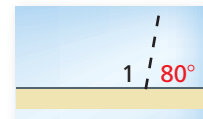
⋮ The measure of ∠1 is 180° − 80° = 100°. The correct answer is Ⓑ.

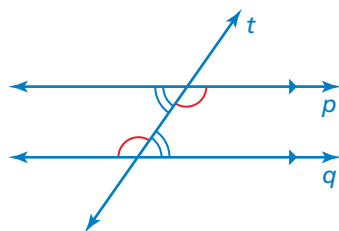**4. WHAT IF?** In Example 3, the letters are slanted at a 65° angle. What is the measure of ∠1?
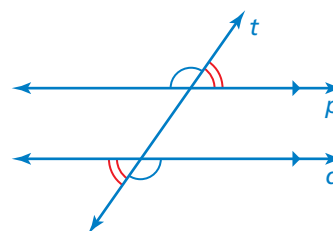
Key Idea

Alternate Interior Angles and Alternate Exterior Angles

When a transversal intersects parallel lines, alternate interior angles are congruent and alternate exterior angles are congruent.

Study Tip

Alternate interior angles and alternate exterior angles lie on opposite sides of the transversal.

Alternate interior angles　　**Alternate exterior angles**

EXAMPLE 4 Identifying Alternate Interior and Alternate Exterior Angles

The photo shows a portion of an airport. Describe the relationship between each pair of angles.

a. ∠3 and ∠6

∠3 and ∠6 are alternate exterior angles.

So, ∠3 is congruent to ∠6.

b. ∠2 and ∠7

∠2 and ∠7 are alternate interior angles.

So, ∠2 is congruent to ∠7.

On Your Own

Now You're Ready
Exercises 20 and 21

In Example 4, the measure of ∠4 is 84°. Find the measure of the angle. Explain your reasoning.

5. ∠3　　　**6.** ∠5　　　**7.** ∠6

✓ Vocabulary and Concept Check

1. **VOCABULARY** Draw two parallel lines and a transversal. Label a pair of corresponding angles.

2. **WHICH ONE DOES NOT BELONG?** Which statement does *not* belong with the other three? Explain your reasoning. Refer to the figure for Exercises 3–6.

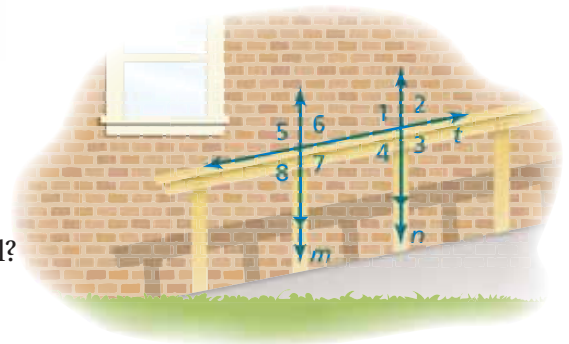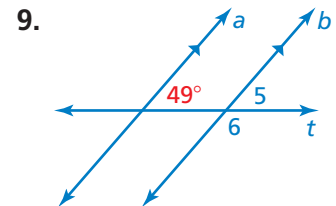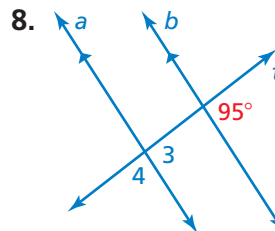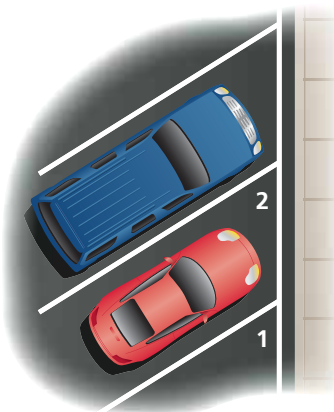 | The measure of $\angle 2$ | The measure of $\angle 5$ |
   |---|---|
   | The measure of $\angle 6$ | The measure of $\angle 8$ |

Practice and Problem Solving

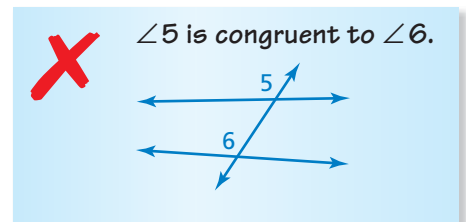**In Exercises 3–6, use the figure.**

3. Identify the parallel lines.

4. Identify the transversal.

5. How many angles are formed by the transversal?

6. Which of the angles are congruent?

Use the figure to find the measures of the numbered angles.

① 7.

8.

9.
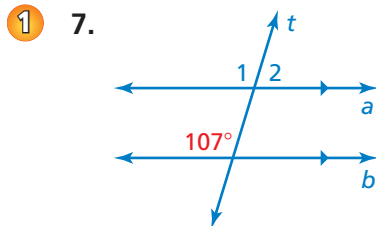
10. **ERROR ANALYSIS** Describe and correct the error in describing the relationship between the angles.

    ✗ $\angle 5$ is congruent to $\angle 6$.

11. **PARKING** The painted lines that separate parking spaces are parallel. The measure of $\angle 1$ is 60°. What is the measure of $\angle 2$? Explain.

12. **OPEN-ENDED** Describe two real-life situations that use parallel lines.

13. **PROJECT** Draw two horizontal lines and a transversal on a piece of notebook paper. Label the angles as shown. Use a pair of scissors to cut out the angles. Compare the angles to determine which angles are congruent.
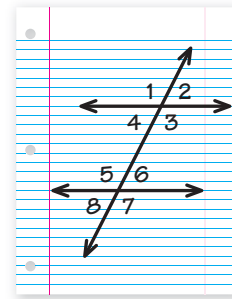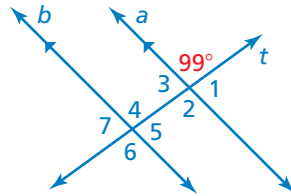
14. **REASONING** Refer to the figure for Exercise 13. What is the least number of angle measures you need to know in order to find the measure of every angle? Explain your reasoning.

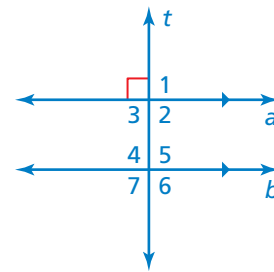**Use the figure to find the measures of the numbered angles. Explain your reasoning.**

2 15.
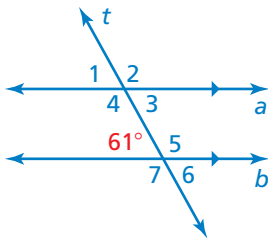
16.

17.

Complete the statement. Explain your reasoning.

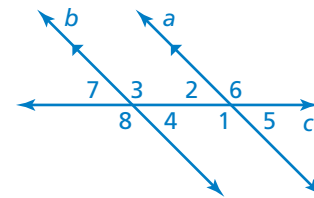3 18. If the measure of ∠1 = 124°, then the measure of ∠4 = [   ].

19. If the measure of ∠2 = 48°, then the measure of ∠3 = [   ].

4 20. If the measure of ∠4 = 55°, then the measure of ∠2 = [   ].

21. If the measure of ∠6 = 120°, then the measure of ∠8 = [   ].

22. If the measure of ∠7 = 50.5°, then the measure of ∠6 = [   ].

23. If the measure of ∠3 = 118.7°, then the measure of ∠2 = [   ].

24. **RAINBOW** A rainbow is formed when sunlight reflects off raindrops at different angles. For blue light, the measure of ∠2 is 40°. What is the measure of ∠1?
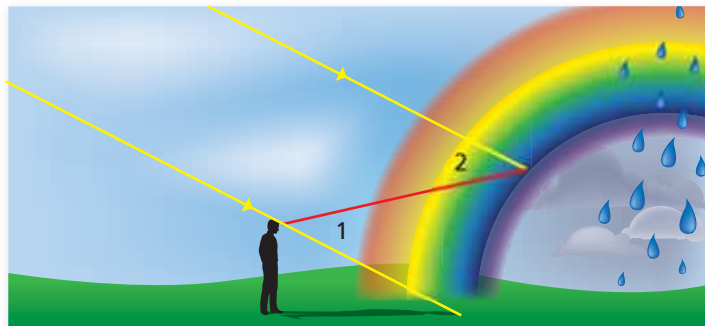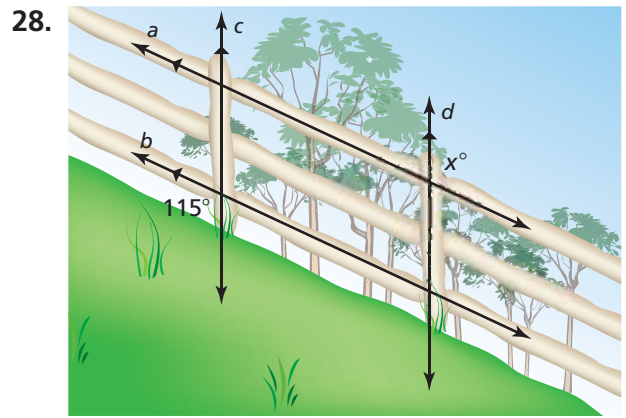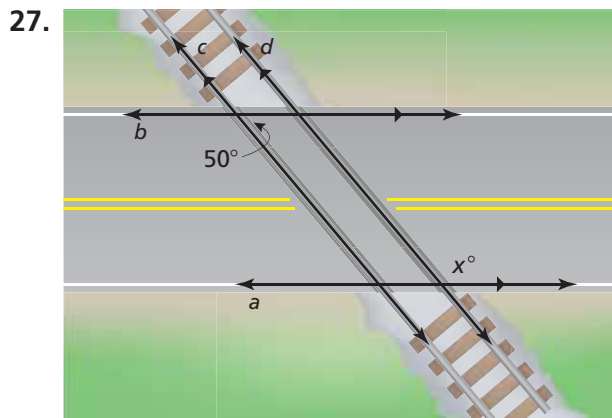
25. **REASONING** If a transversal is perpendicular to two parallel lines, what can you conclude about the angles formed? Explain.

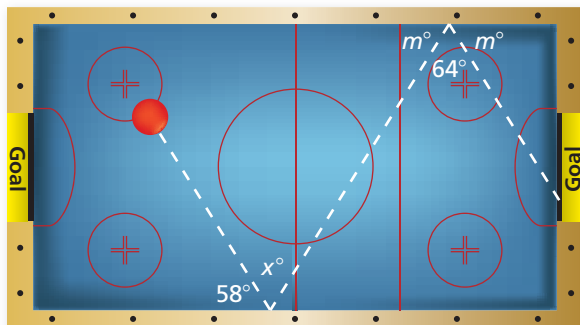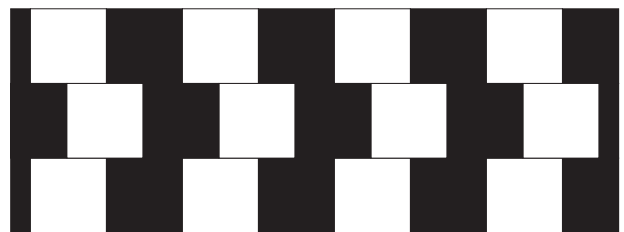26. **WRITING** Describe two ways you can show that ∠1 is congruent to ∠7.
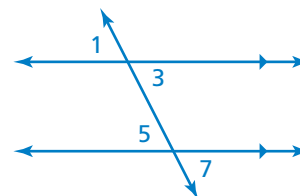
CRITICAL THINKING Find the value of x.

27.

28.

29. OPTICAL ILLUSION Refer to the figure.

    a. Do the horizontal lines appear to be parallel? Explain.

    b. Draw your own optical illusion using parallel lines.

30. **Geometry** The figure shows the angles used to make a double bank shot in an air hockey game.

    a. Find the value of x.

    b. Can you still get the red puck in the goal if x is increased by a little? by a lot? Explain.

Fair Game Review What you learned in previous grades & lessons

Evaluate the expression.

31. $4 + 3^2$ **32.** $5(2)^2 - 6$ **33.** $11 + (-7)^2 - 9$ **34.** $8 \div 2^2 + 1$

35. MULTIPLE CHOICE The volume of the cylinder is 20π cubic inches. What is the radius of the base?

    (A) 1 inch   **(B)** 2 inches

    (C) 3 inches   **(D)** 4 inches

5 in.