# Angles and Parallel Lines

What You'll Learn

To identify parallel lines and the angles formed by parallel lines and transversals

Why Learn This?

Carpenters must know about angles and parallel lines in order to make correct measurements and cuts.
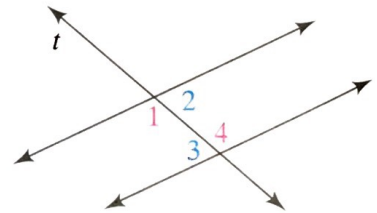
A line that intersects two other lines at different points is a **transversal**. In the diagrams below, line *t* is a transversal. Some pairs of angles formed by two lines and a transversal have special names.
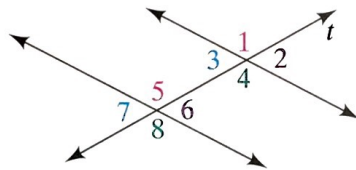
Corresponding angles lie on the same side of the transversal and in corresponding positions.

∠1 and ∠5   ∠2 and ∠6
∠3 and ∠7   ∠4 and ∠8

Alternate interior angles lie within a pair of lines and on opposite sides of the transversal.

∠1 and ∠4   ∠2 and ∠3

EXAMPLE   Identifying Angles

1 Identify a pair of corresponding angles and a pair of alternate interior angles.

∠1 and ∠3 are corresponding angles.

∠2 and ∠7 are alternate interior angles.
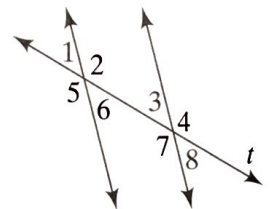
✓ Quick Check

1. Use the diagram in Example 1. Identify each pair of angles as *corresponding, alternate interior,* or *neither.*

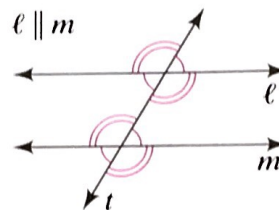   a. ∠3, ∠6   b. ∠5, ∠7   c. ∠1, ∠8

Vocabulary Tip

Recall that parallel lines lie in the same plane and do not intersect.

KEY CONCEPTS Transversals and Parallel Lines

When a transversal intersects two parallel lines,
- corresponding angles are congruent, and
- alternate interior angles are congruent.

$\ell \parallel m$

EXAMPLE Finding Angle Measures

2 **Gridded Response** A carpenter wants to make the hat rack at the left and needs to find all the angle measurements. He knows that line r is parallel to line s, and $m\angle 4 = 63°$. What is $m\angle 5$ measured in degrees?

$m\angle 5 = m\angle 4 = 63°$ ← **Alternate interior angles are congruent.**

The correct answer is 63 degrees.

✓ Quick Check

2. In Example 2, $m\angle 3 = 117°$. Find $m\angle 6$ and $m\angle 7$.

When a transversal intersects two parallel lines, some pairs of angles are congruent. The reverse is also true. If the corresponding angles or the alternate interior angles are congruent, the lines are parallel.

To show that $\overleftrightarrow{AB}$ is parallel to $\overleftrightarrow{CD}$, you write $\overleftrightarrow{AB} \parallel \overleftrightarrow{CD}$.
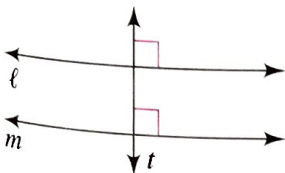
EXAMPLE Identifying Parallel Lines

3 In the diagram at the right, $m\angle 1 = 60°$, $m\angle 2 = 60°$, and $m\angle 3 = 60°$. Explain how you know $\overleftrightarrow{LP} \parallel \overleftrightarrow{MN}$ and $\overleftrightarrow{LM} \parallel \overleftrightarrow{PN}$.

$\overleftrightarrow{LP} \parallel \overleftrightarrow{MN}$ because $\angle 1$ and $\angle 2$ are congruent corresponding angles. $\overleftrightarrow{LM} \parallel \overleftrightarrow{PN}$ because $\angle 1$ and $\angle 3$ are congruent alternate interior angles.
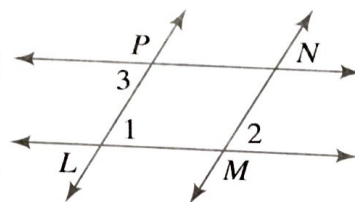
✓ Quick Check

3. Transversal t at the left is perpendicular to lines ℓ and m. Explain how you know $\ell \parallel m$.
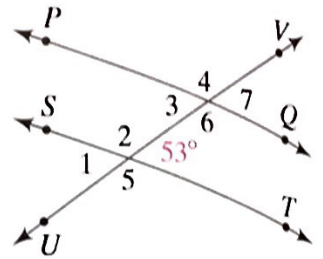
The reasoning used in Example 3 is called *deductive reasoning*. Deductive reasoning is the logical process of drawing conclusions from given facts.

In the diagram at the right, $\overleftrightarrow{PQ} \parallel \overleftrightarrow{ST}$.

1. Name a pair of corresponding angles.

2. Name a pair of alternate interior angles.

3. Which line is the transversal?

4. What other angles have measures of 53°?

5. **Reasoning** Is the following statement *true* or *false*? Corresponding angles can also be alternate interior angles. Explain.
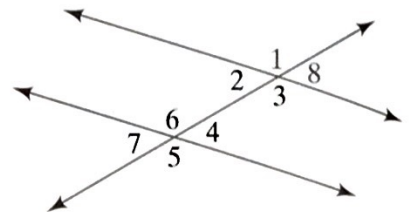
Homework Exercises

For more exercises, see Extra Skills and Word Problems.

Identify the angles as *corresponding, alternate interior,* or *neither.*

6. ∠6, ∠3

7. ∠8, ∠4

8. ∠2, ∠1

9. ∠2, ∠4

10. ∠1, ∠5

11. ∠2, ∠7

12. ∠3, ∠5

13. ∠4, ∠3

In the diagram, $\ell \parallel m$. If $m\angle 3 = 122°$, find the measure of each angle.

14. ∠4

15. ∠2

16. ∠6

17. ∠7

18. ∠8

19. ∠5
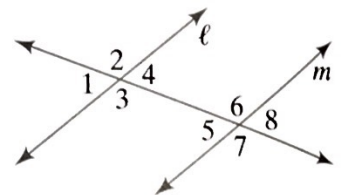
For each diagram, explain how you know $a \parallel b$.

20.

21.

22.

23. **Guided Problem Solving** Two lines are cut by a transversal. The corresponding angles are not congruent. Are the two lines parallel?
   • **Understand the Problem** If a transversal cuts two parallel lines, corresponding angles are congruent. The question is, are two lines parallel if corresponding angles are not congruent?
   • **Make a Plan** Draw pictures of corresponding angles that are not congruent. Conclude whether or not the two lines are parallel.
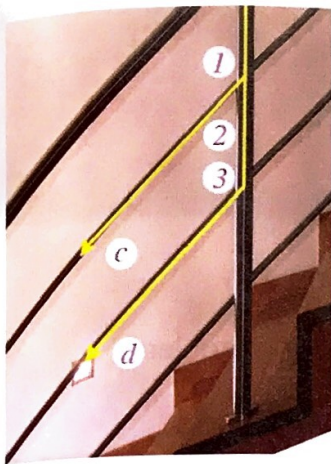
24. Architecture The railings in the photo at the left are parallel. If $m\angle 1 = 138°$, find $m\angle 2$ and $m\angle 3$.

Which pairs of lines, if any, are parallel? Explain.

25.

26.

27.
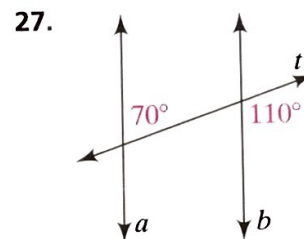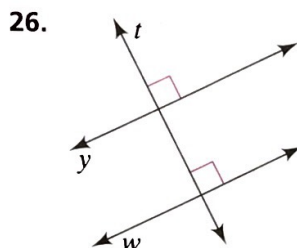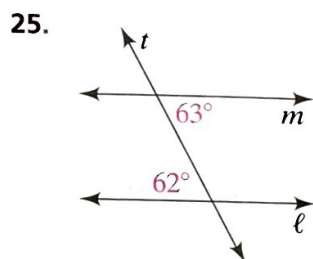
28. Writing in Math A transversal t cuts parallel lines m and n. If t is perpendicular to m, what is the relationship between t and n?

Use the diagram at the right for Exercises 29–30.

29. Find the measure of each numbered angle.

30. *Alternate exterior angles* lie outside a pair of lines and on opposite sides of a transversal. What do you notice about the measures of alternate exterior angles of parallel lines?
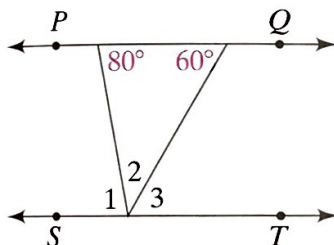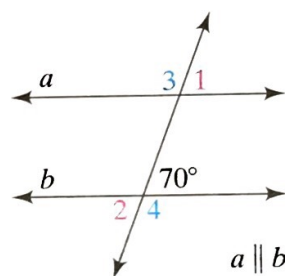
31. a. In the diagram at the left, $\overleftrightarrow{PQ} \parallel \overleftrightarrow{ST}$. Find the measure of each numbered angle.
**b.** What is the sum of the angle measures of the triangle?

32. Challenge Which pair of angles is always congruent?
- Ⓐ alternate interior angles
- Ⓒ corresponding angles
- Ⓑ vertical angles
- Ⓓ alternate exterior angles

Gridded Response

33. In the diagram at the right, line ℓ is parallel to line m. What is the measure, in degrees, of $\angle 1$?

34. What is the slope of the line that passes through the points $(0, 1)$ and $(2, 9)$?

35. Amy sells wooden coasters online. The function $t = 5c + 4$ represents the total cost t, in dollars, of a customer's order when he or she buys c coasters. One of Amy's customers buys 6 coasters. What is the total cost, in dollars, of the order?
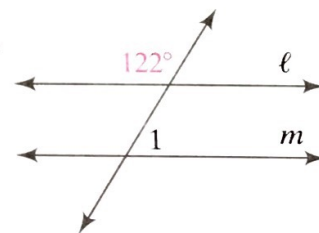
Find each cube root.

36. $\sqrt[3]{27}$

37. $\sqrt[3]{1,000}$

38. $\sqrt[3]{216}$