

# Lesson 1 Lines

## Vocabulary Start-Up



When two lines intersect in a plane and form right angles they are called **perpendicular lines**. Two lines are called **parallel lines** when they are in the same plane and do not intersect.

Complete the graphic organizer.

	Parallel Lines	Perpendicular Lines
Symbols		⊥
Define it in your own words	  	  
Draw it	  	  
Describe a real-world example of it	  	  

### Essential Question

HOW can algebraic concepts be applied to geometry?

### Vocabulary

- perpendicular lines
- parallel lines
- transversal
- interior angles
- exterior angles
- alternate interior angles
- alternate exterior angles
- corresponding angles

#### Math Symbols

|| is parallel to  
 ⊥ is perpendicular to  
 $m\angle 1$  the measure of  $\angle 1$

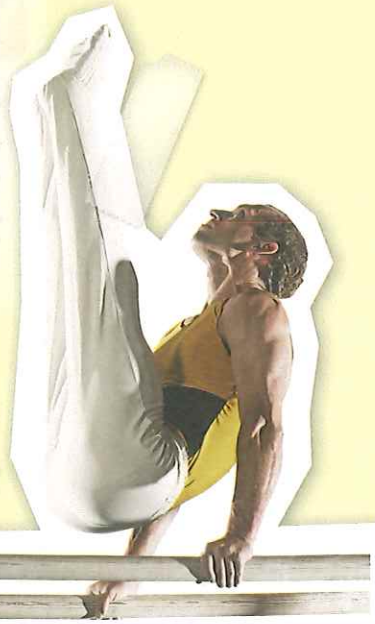
### Common Core State Standards

**Content Standards**  
 8.G.5

**MP Mathematical Practices**  
 1, 3, 4

## Real-World Link

A gymnastic event in the Summer Olympics involves the parallel bars. The women compete on uneven parallel bars and the men compete on the parallel bars like the one shown. Circle the parallel lines shown in the photo at the right.



Which **MP Mathematical Practices** did you use?

Shade the circle(s) that applies.

- |  |   |
|--|---|
| <input type="checkbox"/> ① Persevere with Problems | <input type="checkbox"/> ⑤ Use Math Tools         |
| <input type="checkbox"/> ② Reason Abstractly       | <input type="checkbox"/> ⑥ Attend to Precision    |
| <input type="checkbox"/> ③ Construct an Argument   | <input type="checkbox"/> ⑦ Make Use of Structure  |
| <input type="checkbox"/> ④ Model with Mathematics  | <input type="checkbox"/> ⑧ Use Repeated Reasoning |



## Key Concept

# Transversals and Angles

### Work Zone

### Angles

Read  $m\angle 1$  as the measure of angle 1.

### Parallel and Perpendicular Lines

Read  $m \perp n$  as line  $m$  is perpendicular to line  $n$ .  
Read  $p \parallel q$  as line  $p$  is parallel to line  $q$ .

A line that intersects two or more lines is called a **transversal**, and eight angles are formed.

**Interior angles** lie inside the lines.

**Examples:**  $\angle 3, \angle 4, \angle 5, \angle 6$

**Exterior angles** lie outside the lines.

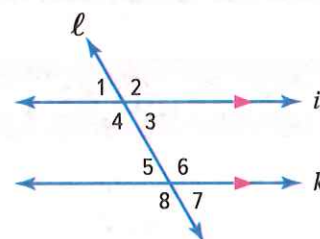
**Examples:**  $\angle 1, \angle 2, \angle 7, \angle 8$

**Alternate interior angles** are interior angles that lie on opposite sides of the transversal. When the lines are parallel, their measures are equal. **Examples:**  $m\angle 4 = m\angle 6, m\angle 3 = m\angle 5$

**Alternate exterior angles** are exterior angles that lie on opposite sides of the transversal. When the lines are parallel, their measures are equal.

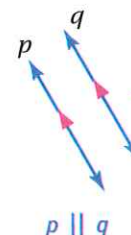
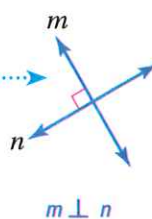
**Examples:**  $m\angle 1 = m\angle 7, m\angle 2 = m\angle 8$

**Corresponding angles** are those angles that are in the same position on the two lines in relation to the transversal. When the lines are parallel, their measures are equal. **Examples:**  $m\angle 1 = m\angle 5, m\angle 2 = m\angle 6, m\angle 4 = m\angle 8, m\angle 3 = m\angle 7$



Special notation is used to indicate perpendicular and parallel lines.

A red right angle symbol indicates that lines  $m$  and  $n$  are perpendicular.



Red arrowheads indicate that lines  $p$  and  $q$  are parallel.

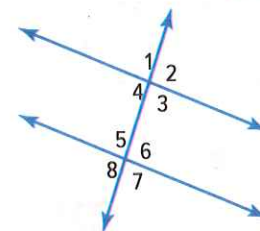
## Examples

Tutor

Classify each pair of angles in the figure as **alternate interior**, **alternate exterior**, or **corresponding**.

1.  $\angle 1$  and  $\angle 7$

$\angle 1$  and  $\angle 7$  are exterior angles that lie on opposite sides of the transversal. They are alternate exterior angles.

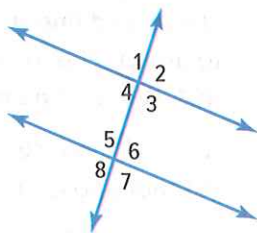


2.  $\angle 2$  and  $\angle 6$

$\angle 2$  and  $\angle 6$  are in the same position on the two lines. They are corresponding angles.

**Got It?** Do this problem to find out.

- a. Classify the relationship between  $\angle 4$  and  $\angle 6$ . Explain.

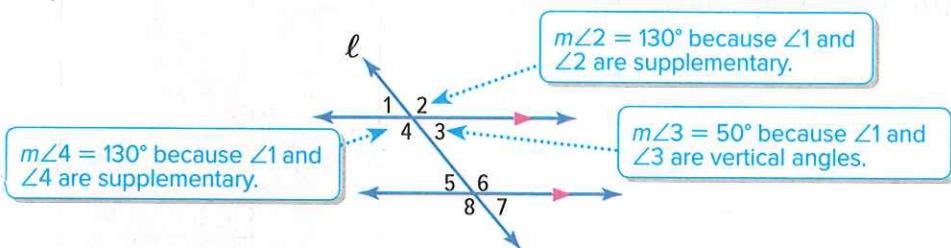


Show your work.

a. \_\_\_\_\_

**Find Missing Angle Measures**

When two parallel lines are cut by a transversal, special angle relationships exist. If you know the measure of one of the angles, you can find the measures of all of the angles. Suppose you know that  $m\angle 1 = 50^\circ$ . You can use that to find the measures of angles 2, 3, and 4.



**STOP and Reflect**

In the figure, how do you know that  $m\angle 5 = 50^\circ$ ? Explain below.



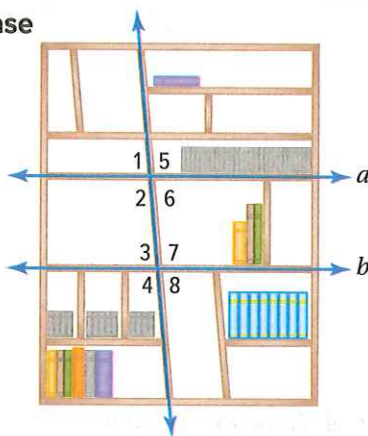
**Example**



- 3.** A furniture designer built the bookcase shown. Line  $a$  is parallel to line  $b$ . If  $m\angle 2 = 105^\circ$ , find  $m\angle 6$  and  $m\angle 3$ . Justify your answer.

Since  $\angle 2$  and  $\angle 6$  are supplementary, the sum of their measures is  $180^\circ$ .  
 $m\angle 6 = 180^\circ - 105^\circ$  or  $75^\circ$

Since  $\angle 6$  and  $\angle 3$  are interior angles that lie on opposite sides of the transversal, they are alternate interior angles. The measures of alternate interior angles are equal.  $m\angle 3 = 75^\circ$



Show your work.

b. \_\_\_\_\_

**Got It?** Do this problem to find out.

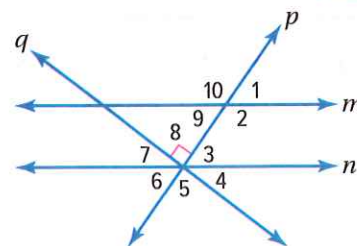
- b. Refer to the situation above. Find  $m\angle 4$ . Justify your answer.





## Example

4. In the figure, line  $m$  is parallel to line  $n$ , and line  $q$  is perpendicular to line  $p$ . The measure of  $\angle 1$  is  $40^\circ$ . What is the measure of  $\angle 7$ ?



Since  $\angle 1$  and  $\angle 6$  are alternate exterior angles,  $m\angle 6 = 40^\circ$ .

Since  $\angle 6$ ,  $\angle 7$ , and  $\angle 8$  form a straight line, the sum of their measures is  $180^\circ$ .

$$40 + 90 + m\angle 7 = 180$$

So,  $m\angle 7$  is  $50^\circ$ .

## Guided Practice



1. Refer to the porch stairs shown. Line  $m$  is parallel to line  $n$  and  $m\angle 7$  is  $35^\circ$ . Find the measure of  $\angle 1$ . Justify your answer. (Example 3)

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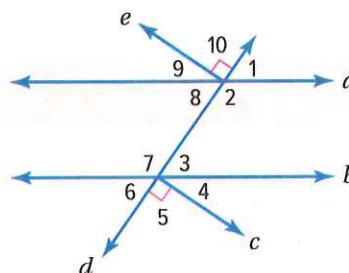


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Refer to the figure at the right. Line  $a$  is parallel to line  $b$  and  $m\angle 2$  is  $135^\circ$ . Find each given angle measure. Justify your answer. (Examples 1, 2, and 4)



2.  $m\angle 9$  \_\_\_\_\_

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3.  $m\angle 7$  \_\_\_\_\_

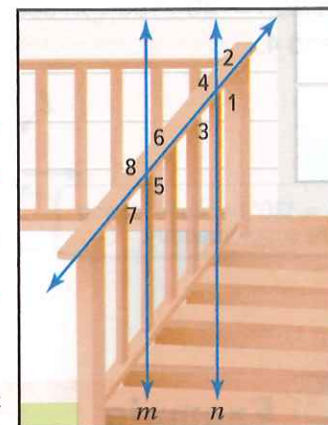
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4. **Building on the Essential Question** How are the measures of the angles related when parallel lines are cut by a transversal?

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### Rate Yourself!

How confident are you about lines and angles? Check the box that applies.



For more help, go online to access a Personal Tutor.



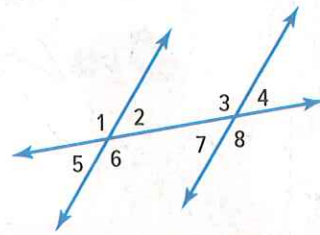
# Independent Practice

Go online for Step-by-Step Solutions



Classify each pair of angles as *alternate interior*, *alternate exterior*, or *corresponding*. (Examples 1 and 2)

- $\angle 2$  and  $\angle 4$  \_\_\_\_\_
- $\angle 4$  and  $\angle 5$  \_\_\_\_\_

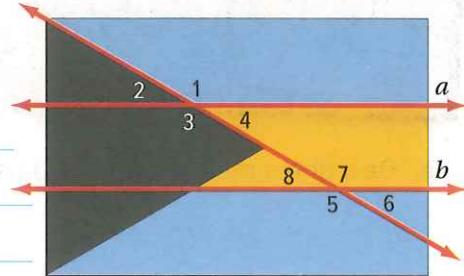


3 In the flag shown at the right, line  $a$  is parallel to line  $b$ . If  $m\angle 1 = 150^\circ$ , find  $m\angle 4$  and  $m\angle 7$ . Justify your answers. (Example 3)

\_\_\_\_\_

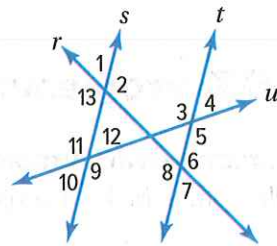
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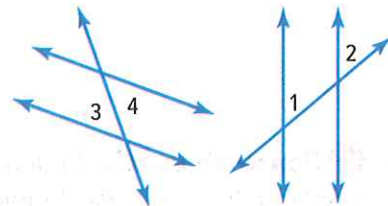
Refer to the figure at the right. Line  $s$  is parallel to line  $t$ ,  $m\angle 2$  is  $110^\circ$  and  $m\angle 11$  is  $137^\circ$ . Find each given angle measure. Justify your answer. (Example 4)

- $m\angle 7$  \_\_\_\_\_
- $m\angle 8$  \_\_\_\_\_
- $m\angle 3$  \_\_\_\_\_



7. The parallel lines at the right are cut by a transversal. Find the value of  $x$ .

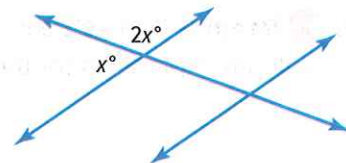
- Angles 1 and 2 are corresponding angles,  $m\angle 1 = 45^\circ$ , and  $m\angle 2 = (x + 25)^\circ$ . \_\_\_\_\_
- Angles 3 and 4 are alternate interior angles,  $m\angle 3 = 2x^\circ$ , and  $m\angle 4 = 80^\circ$ . \_\_\_\_\_

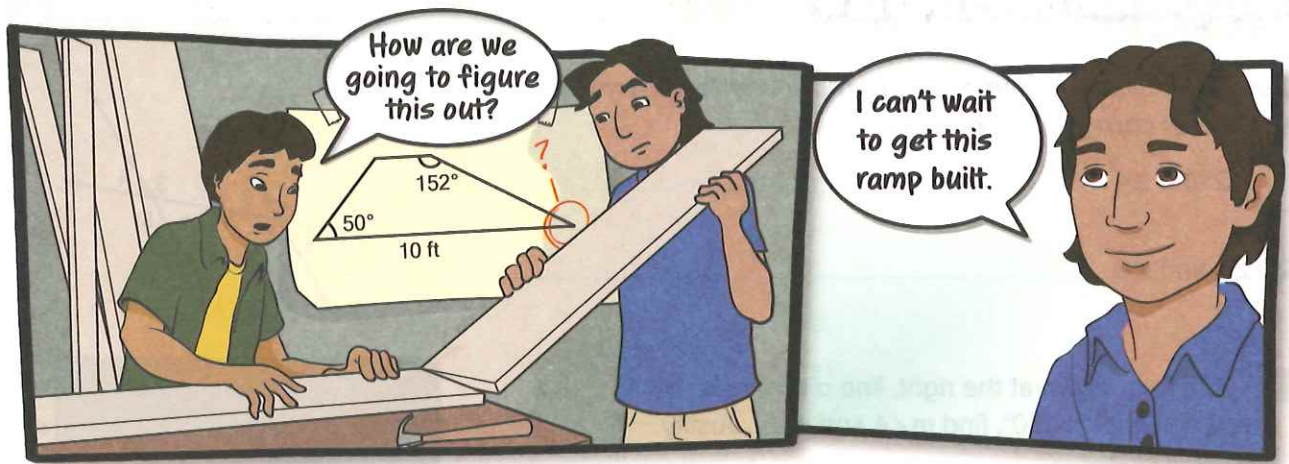


8. Describe a method you could use to find the value of  $x$  in the figure at the right without using a protractor.

\_\_\_\_\_

\_\_\_\_\_





a. Describe a method you could use to find the missing angle.

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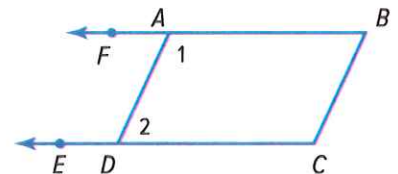
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b. Use your method from part a to find the measure of the missing angle.

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**H.O.T. Problems** Higher Order Thinking

10. **MP Persevere with Problems** Quadrilateral  $ABCD$  is a parallelogram. Make a conjecture about the relationship of  $\angle 1$  and  $\angle 2$ . Justify your reasoning.




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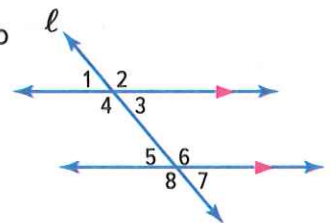


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11. **MP Reason Inductively** If two parallel lines are cut by a transversal, what relationship exists between interior angles that are on the same side of the transversal?

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12. **MP Reason Inductively** Suppose  $m\angle 1 = x^\circ$ . Use an informal argument to write an expression for the measure of  $\angle 6$  in the diagram at the right.




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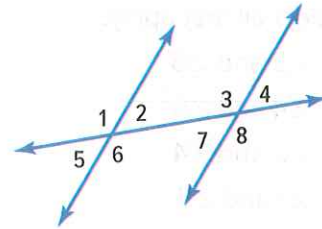
# Extra Practice

Classify each pair of angles as *alternate interior*, *alternate exterior*, or *corresponding*.

13.  $\angle 3$  and  $\angle 6$  alternate interior

$\angle 3$  and  $\angle 6$  are interior angles that lie on opposite sides of the transversal. They are alternate interior angles

Homework Help

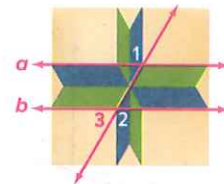


14.  $\angle 1$  and  $\angle 3$  \_\_\_\_\_

15.  $\angle 2$  and  $\angle 7$  \_\_\_\_\_

16. In the quilt design at the right, line  $a$  is parallel to line  $b$ . If  $m\angle 1 = 120^\circ$ , find  $m\angle 2$  and  $m\angle 3$ .

Justify your answers. \_\_\_\_\_  
 \_\_\_\_\_  
 \_\_\_\_\_

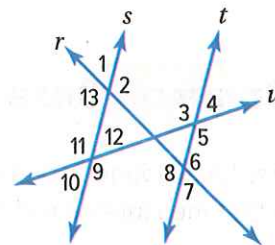


Refer to the figure at the right. Line  $s$  is parallel to line  $t$ ,  $m\angle 2$  is  $110^\circ$  and  $m\angle 11$  is  $137^\circ$ . Find each given angle measure. Justify your answer.

17.  $m\angle 6$  \_\_\_\_\_  
 \_\_\_\_\_

18.  $m\angle 13$  \_\_\_\_\_  
 \_\_\_\_\_

19.  $m\angle 4$  \_\_\_\_\_  
 \_\_\_\_\_

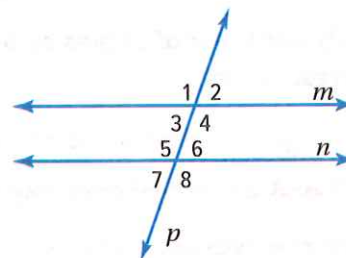


20. **MP Model with Mathematics** Draw a pair of parallel lines cut by a transversal. Estimate the measure of one angle and label it. Without using a protractor, label all the other angles with their approximate measure.

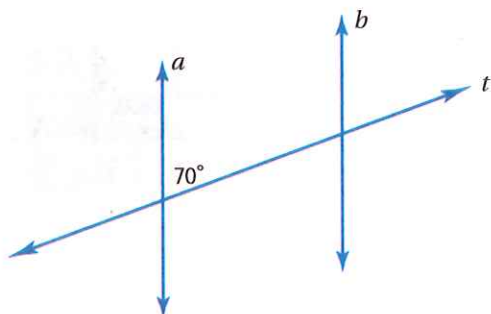


21. Lines  $m$  and  $n$  are parallel and cut by the transversal  $p$ . Which of the following pairs of angles represent corresponding angles? Select all that apply.

- $\angle 2$  and  $\angle 6$
- $\angle 4$  and  $\angle 6$
- $\angle 3$  and  $\angle 4$
- $\angle 1$  and  $\angle 5$



22. Lines  $a$  and  $b$  are parallel and cut by the transversal  $t$ . Label each of the 7 unknown angles with the correct angle measure.



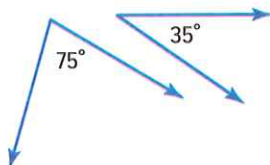
## Common Core Spiral Review

23. A poster has a triangular image with a base that measure 4 inches, and a height that measures 8 inches. What is the area of the poster? **6.G.1**

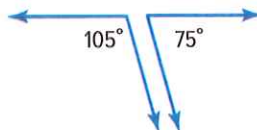
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Classify each pair of angles as *complementary*, *supplementary*, or *neither*. **7.G.5**

24. \_\_\_\_\_



25. \_\_\_\_\_



26. \_\_\_\_\_

