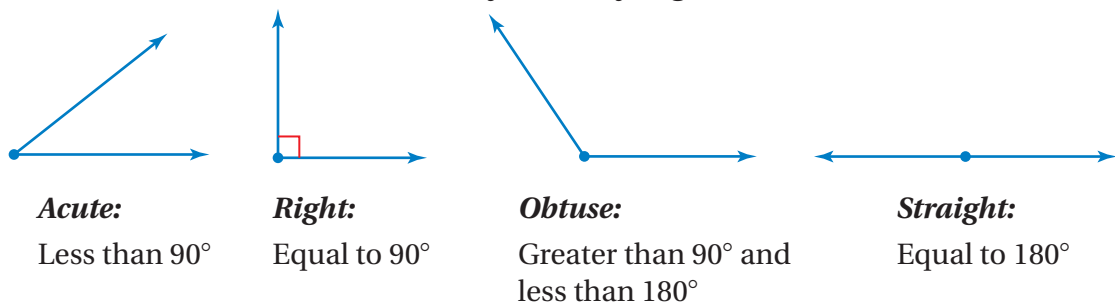


# 7.1 Adjacent and Vertical Angles

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

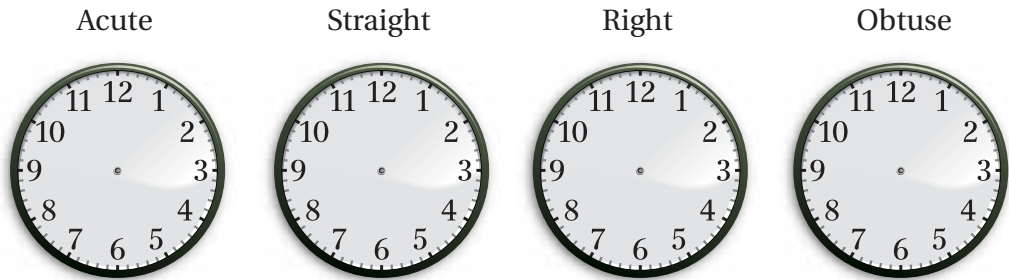
## Classification of Angles



### 1 ACTIVITY: Drawing Angles

Work with a partner.

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



- 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.



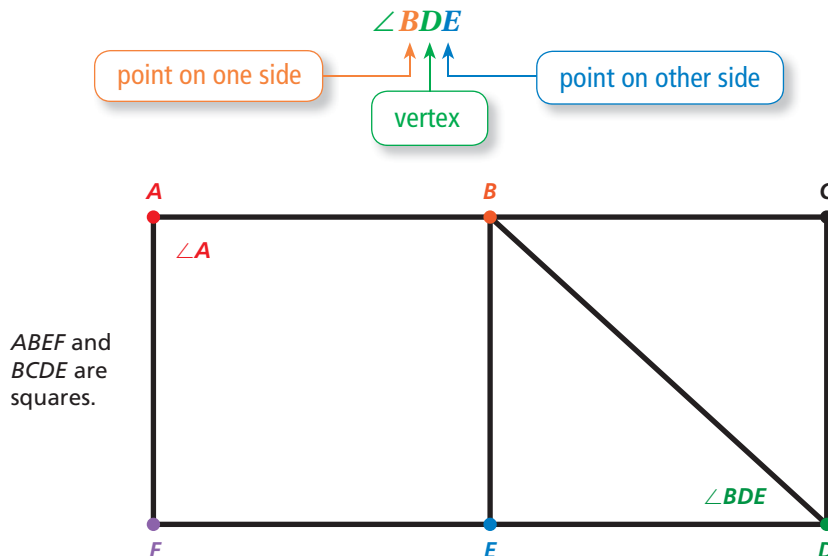
## 2 ACTIVITY: Naming Angles

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.



- Name all the right angles, acute angles, and obtuse angles.
- Which pairs of angles do you think are *adjacent*? Explain.

## 3 ACTIVITY: Measuring Angles

Work with a partner.

- How many angles are formed by the intersecting roads? Number the angles.
- CHOOSE TOOLS** Measure each angle formed by the intersecting roads. What do you notice?



### What Is Your Answer?

- IN YOUR OWN WORDS** What can you conclude about the angles formed by two intersecting lines?
- 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 274.

### Key Vocabulary

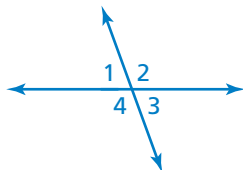
adjacent angles,  
p. 272  
vertical angles, p. 272  
congruent angles,  
p. 272

## Key Ideas

### Adjacent Angles

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

#### Examples



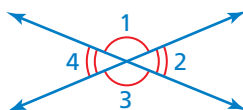
$\angle 1$  and  $\angle 2$  are adjacent.

$\angle 2$  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.

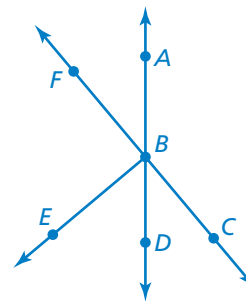
$\angle ABC$  and  $\angle ABF$  share a common side and have the same vertex  $B$ .

∴ 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.

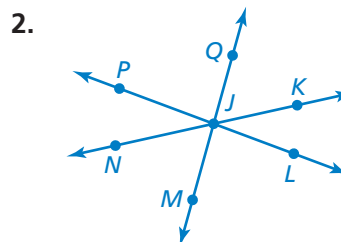
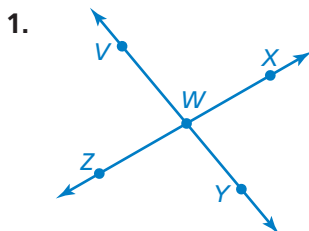
∴ So,  $\angle ABF$  and  $\angle CBD$  are vertical angles.



### On Your Own

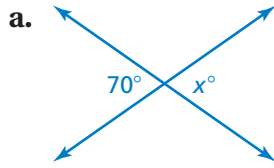
Now You're Ready  
Exercises 5 and 6

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



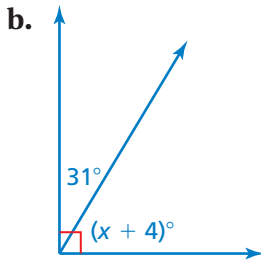
## EXAMPLE 2 Using Adjacent and Vertical Angles

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 70.



The angles are adjacent angles. Because the angles make up a right angle, the sum of their measures is  $90^\circ$ .

$$(x + 4) + 31 = 90 \quad \text{Write equation.}$$

$$x + 35 = 90 \quad \text{Combine like terms.}$$

$$x = 55 \quad \text{Subtract 35 from each side.}$$

So, the value of  $x$  is 55.

### Remember

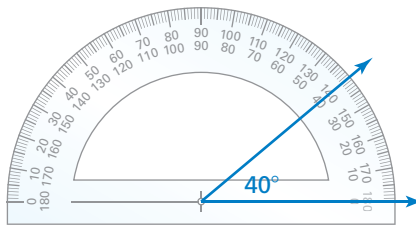


You can add angle measures. When two or more adjacent angles form a larger angle, the sum of the measures of the smaller angles is equal to the measure of the larger angle.

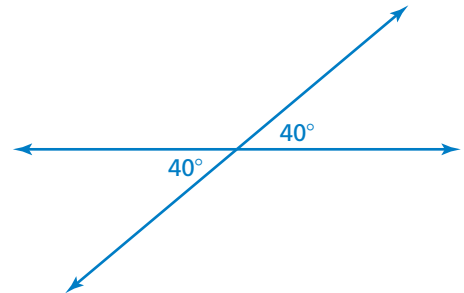
## EXAMPLE 3 Constructing Angles

Draw a pair of vertical angles with a measure of  $40^\circ$ .

**Step 1:** Use a protractor to draw a  $40^\circ$  angle.

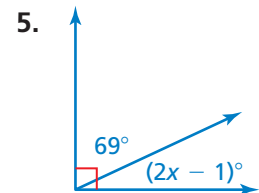
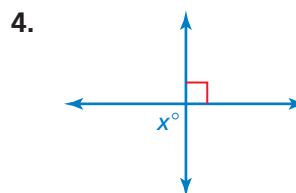
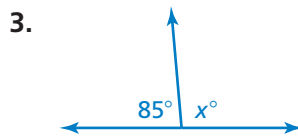


**Step 2:** Use a straightedge to extend the sides to form two intersecting lines.



### On Your Own

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



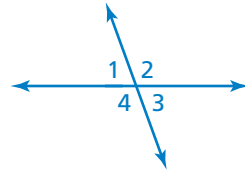
6. Draw a pair of vertical angles with a measure of  $75^\circ$ .

Now You're Ready  
Exercises 8–17

# 7.1 Exercises

## Vocabulary and Concept Check

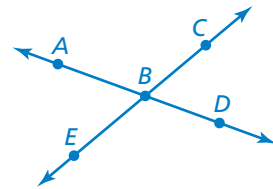
- VOCABULARY** When two lines intersect, how many pairs of vertical angles are formed? How many pairs of adjacent angles are formed?
- REASONING** Identify the congruent angles in the figure. Explain your reasoning.



## Practice and Problem Solving

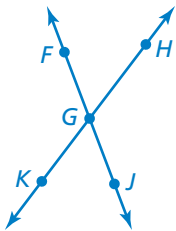
Use the figure at the right.

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

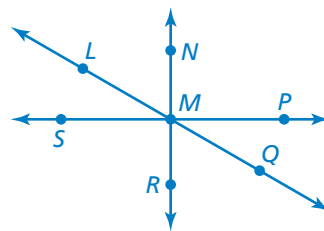


Name two pairs of adjacent angles and two pairs of vertical angles in the figure.

1 5.



6.



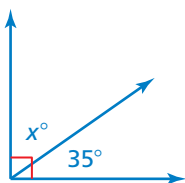
- ERROR ANALYSIS** Describe and correct the error in naming a pair of vertical angles.

**X**

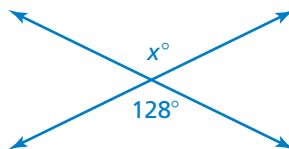
$\angle ACB$  and  $\angle BCD$  are vertical angles.

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

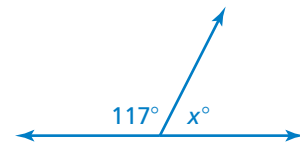
2 8.



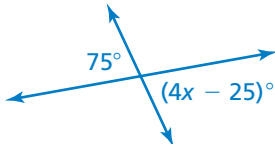
9.



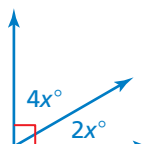
10.



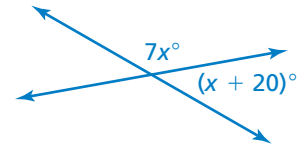
11.



12.



13.



Draw a pair of vertical angles with the given measure.

3 14.  $25^\circ$

15.  $85^\circ$

16.  $110^\circ$

17.  $135^\circ$



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  $135^\circ$ .

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  $70^\circ$ , the measure of  $\angle 3$  is  $110^\circ$ .

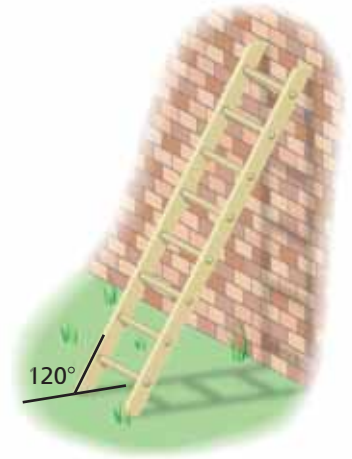
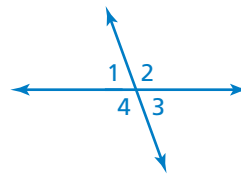
22. When the measure of  $\angle 4$  is  $120^\circ$ , the measure of  $\angle 1$  is  $60^\circ$ .

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  $180^\circ$ .

26. **Structure** For safety reasons, a ladder should make a  $15^\circ$  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 4.3)

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  $(6, 8)$ ? (Section 5.5)

(A)  $\frac{4}{5}$

(B)  $\frac{5}{4}$

(C)  $\frac{4}{3}$

(D)  $\frac{3}{2}$