



### Explore It!

The intersecting skis form four angles.



## Lesson 8-4

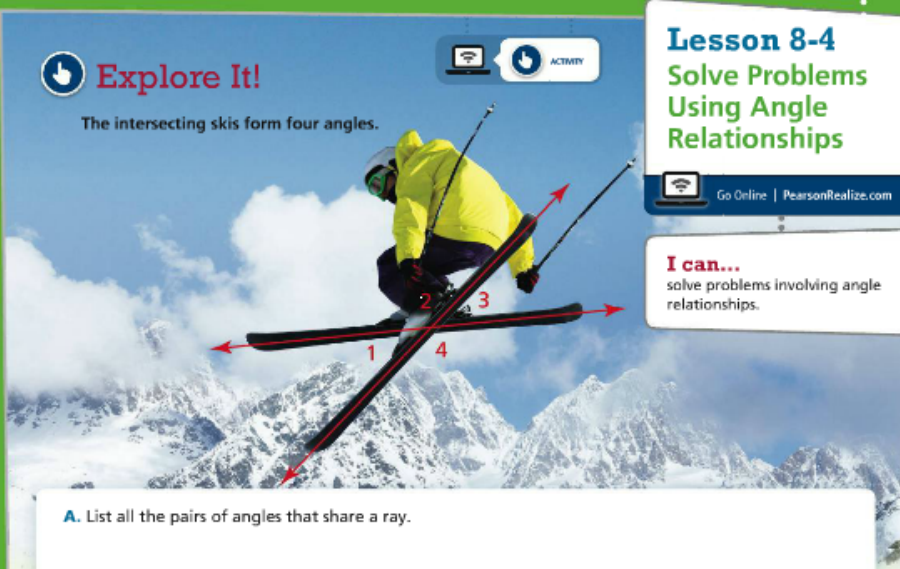
### Solve Problems Using Angle Relationships



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#### I can...

solve problems involving angle relationships.



A. List all the pairs of angles that share a ray.

B. Suppose the measure of  $\angle 1$  increases. What happens to the size of  $\angle 2$ ?  $\angle 3$ ?

C. How does the sum of the measures of  $\angle 1$  and  $\angle 2$  change when one ski moves? Explain.

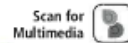
#### Focus on math practices

**Construct Arguments** Why does the sum of all four angle measures stay the same when one of the skis moves?

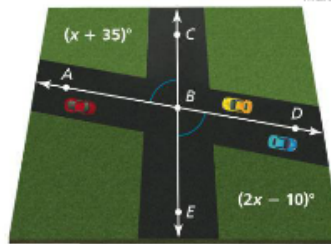
**Essential Question** How are angles formed by intersecting lines related?



**EXAMPLE 1** Solve Problems Involving Adjacent and Vertical Angles



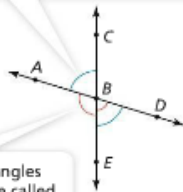
A skewed intersection has two roads that intersect at more than 20 degrees away from 90°. Determine whether the road intersection shown is skewed by finding the measures of  $\angle ABC$  and  $\angle DBE$ .



**Look for Relationships** What angle measures would a skewed intersection have?

Examine how the angles are related.

Angles opposite each other are called **vertical angles**. Vertical angles have equal measures.  $\angle ABC$  and  $\angle DBE$  are vertical angles.



Non-overlapping angles that share a ray are called **adjacent angles**.  $\angle ABE$  and  $\angle EBD$  are adjacent angles, sharing ray  $BE$ .

Write and solve an equation to find the value of  $x$ .

Read "m" as "the measure of" the named angle.

$$m\angle ABC = m\angle DBE$$

$$x + 35 = 2x - 10$$

$$x + 35 + 10 = 2x - 10 + 10$$

$$x + 45 = 2x$$

$$x - x + 45 = 2x - x$$

$$45 = x$$

Find the measure of an angle in the intersection.

$$\begin{aligned} m\angle ABC &= (x + 35)^\circ \\ &= (45 + 35)^\circ \\ &= 80^\circ \end{aligned}$$

$\angle ABC$  and  $\angle DBE$  both measure  $80^\circ$ .

Since  $80^\circ$  is within  $20^\circ$  of  $90^\circ$ , the road intersection is not skewed.

**Try It!**

$\angle MNQ$  and  $\angle PNR$  are vertical angles. What is the value of  $x$ ?

Vertical angles are , so the equation  can be

used to find  $x$ . The value of  $x$  is .



**Convince Me!** Why can you use an equation when solving for  $x$  in the diagram?

**EXAMPLE 2**

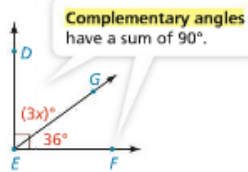


**Solve Problems Involving Complementary and Supplementary Angles**



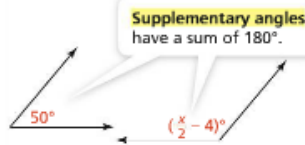
ACTIVITY ASSESS

a. Ray  $EG$  splits right angle  $DEF$  into two angles,  $\angle DEG$  and  $\angle GEF$ . Find the value of  $x$ .



$$\begin{aligned} m\angle DEG + m\angle GEF &= 90 \\ 3x + 36 &= 90 \\ 3x + 36 - 36 &= 90 - 36 \\ 3x &= 54 \\ \frac{3x}{3} &= \frac{54}{3} \\ x &= 18 \end{aligned}$$

b. The two angles shown are *supplementary angles*. Find the value of  $x$ .



$$\begin{aligned} \left(\frac{x}{2} - 4\right) + 50 &= 180 \\ \frac{x}{2} + 46 &= 180 \\ \frac{x}{2} + 46 - 46 &= 180 - 46 \\ \frac{x}{2} &= 134 \\ 2 \cdot \frac{x}{2} &= 2 \cdot 134 \\ x &= 268 \end{aligned}$$

**EXAMPLE 3**



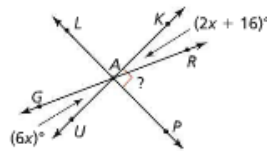
**Find the Measure of an Unknown Angle**

Find the measure of  $\angle PAR$ .

**STEP 1** Use vertical angles to find the value of  $x$ .

$$\begin{aligned} m\angle UAG &= m\angle KAR \\ 6x &= 2x + 16 \\ 6x - 2x &= 2x - 2x + 16 \\ 4x &= 16 \\ \frac{4x}{4} &= \frac{16}{4} \\ x &= 4 \end{aligned}$$

$$\begin{aligned} m\angle UAG &= (6x)^\circ \\ &= (6 \cdot 4)^\circ = 24^\circ \\ \text{So } m\angle KAR &= 24^\circ. \end{aligned}$$



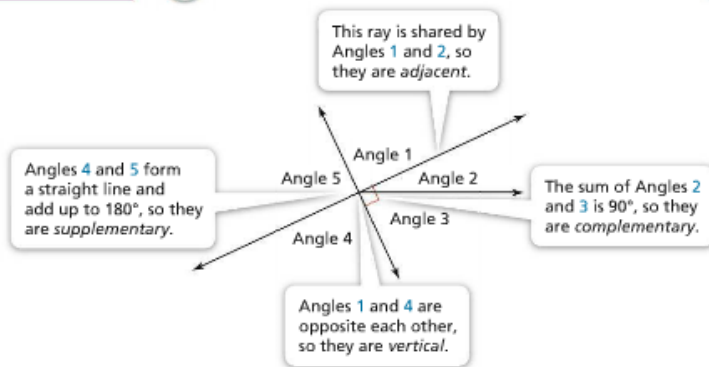
**STEP 2** Use complementary angles to find the measure of  $\angle PAR$ .

$$\begin{aligned} m\angle KAR + m\angle PAR &= 90^\circ \\ 24^\circ + m\angle PAR &= 90^\circ \\ m\angle PAR &= 66^\circ \end{aligned}$$

**Try It!**

$m\angle 1$  is 4 times  $m\angle 2$ .  $\angle 1$  and  $\angle 2$  are complementary.  $\angle 1$  and  $\angle 3$  are vertical angles.  $\angle 3$  and  $\angle 4$  are supplementary. What are the measures of the four angles?

**KEY CONCEPT**

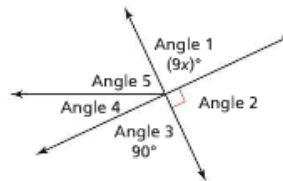


**Do You Understand?**

- Essential Question** How are angles formed by intersecting lines related?
- Use Structure** Can vertical angles also be adjacent angles? Explain.
- Reasoning** Do complementary and supplementary angles also have to be adjacent angles? Explain.

**Do You Know How?**

Use the diagram below for 4–6.



- List two pairs of adjacent angles.
- List all pairs of vertical angles.
- If  $\angle 1$  and  $\angle 3$  are the same measure, what is the value of  $x$ ?

Name: \_\_\_\_\_

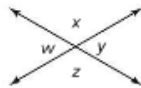


### Practice & Problem Solving

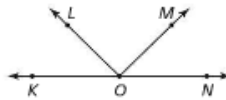


Scan for Multimedia

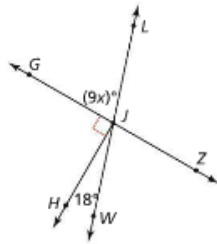
7. List each angle adjacent to  $\angle w$ .



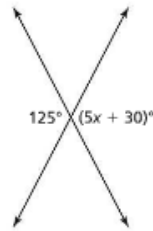
8. List two pairs of adjacent angles.



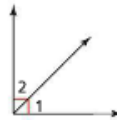
9. Find the value of  $x$ .



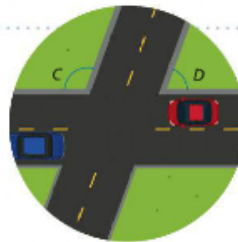
10. Find the value of  $x$ .



11.  $\angle 1$  and  $\angle 2$  are complementary angles. The measure of  $\angle 1$  is  $42^\circ$ . The measure of  $\angle 2$  is  $(3x)^\circ$ . Find the value of  $x$ .

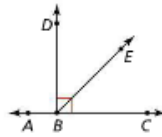


12. Two streets form an intersection.  $\angle C$  and  $\angle D$  are supplementary angles. If the measure of  $\angle C$  is  $128^\circ$  and the measure of  $\angle D$  is two times the value of  $x$ , what is the value of  $x$ ?



13. If  $\angle A$  and  $\angle B$  are supplementary angles and  $\angle A$  is three times as large as  $\angle B$ , find the measures of  $\angle A$  and  $\angle B$ .

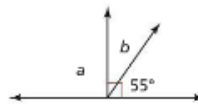
14. **Higher Order Thinking** The measure of  $\angle DBE$  is  $(0.1x - 22)^\circ$  and the measure of  $\angle CBE$  is  $(0.3x - 54)^\circ$ . Find the value of  $x$ .



15. **Reasoning**  $\angle 1$  and an angle that measures  $50^\circ$  are supplementary. Another angle that measures  $50^\circ$  and  $\angle 3$  are supplementary. Show that  $m\angle 1$  and  $m\angle 3$  are equal.

**Assessment Practice**

16. Using the diagram at the right, Martin incorrectly writes  $m\angle b = 125^\circ$ .



**PART A**

Find the correct measure of  $\angle b$ .

**PART B**

What mistake did he likely make?

- Ⓐ He subtracted  $55^\circ$  from  $90^\circ$  instead of  $180^\circ$ .
  - Ⓑ He subtracted  $55^\circ$  from  $180^\circ$  instead of  $90^\circ$ .
  - Ⓒ He added  $55^\circ$  to  $180^\circ$  instead of  $90^\circ$ .
  - Ⓓ He added  $55^\circ$  to  $90^\circ$  instead of  $180^\circ$ .
17. In the diagram at the right,  $m\angle 1 = (133 - y)^\circ$ ,  $m\angle 2 = 22^\circ$ , and  $m\angle 3 = (x + 48)^\circ$ . Find the values of  $x$  and  $y$ .

