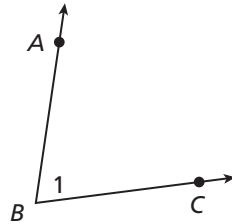


Pairs of Angles

Going Deeper

Essential question: *How can you use angle pairs to solve problems?*

Recall that two rays with a common endpoint form an angle. The two rays form the sides of the angle, and the common endpoint marks the vertex. You can name an angle several ways: by its vertex, by a point on each ray and the vertex, or by a number.



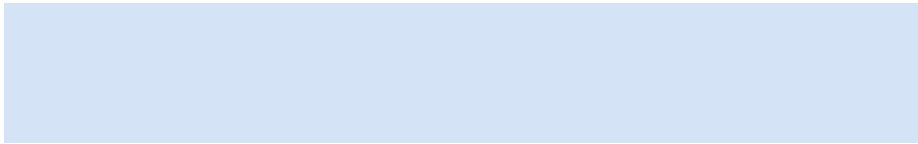
Angle names: $\angle ABC$, $\angle CBA$, $\angle B$, $\angle 1$

It is useful to work with pairs of angles and to understand how pairs of angles relate to each other. **Congruent angles** are angles that have the same measure.

G-CO.1.1

1 EXPLORE Measuring Angles

- A** Using a ruler, draw a pair of intersecting lines. Label each angle from 1 to 4.



- B** Use a protractor to help you complete the chart.

Angle	Measure of Angle
$m\angle 1$	
$m\angle 2$	
$m\angle 3$	
$m\angle 4$	
$m\angle 1 + m\angle 2$	
$m\angle 2 + m\angle 3$	
$m\angle 3 + m\angle 4$	
$m\angle 4 + m\angle 1$	

REFLECT

- 1a. Conjecture** Share your results with other students. Make a conjecture about pairs of angles that are opposite of each other. Make a conjecture about pairs of angles that are next to each other.

Vertical angles are the opposite angles formed by two intersecting lines. Vertical angles are congruent because the angles have the same measure. **Adjacent angles** are pairs of angles that share a vertex and one side but do not overlap.

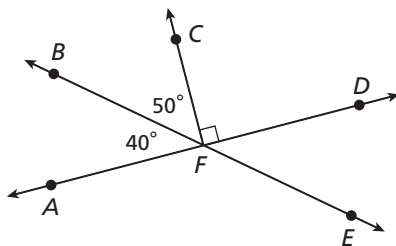
Complementary angles are two angles whose measures have a sum of 90° .

Supplementary angles are two angles whose measures have a sum of 180° . You have discovered in Explore 1 that adjacent angles formed by two intersecting lines are supplementary.

G-CO.3.9

2 EXAMPLE Identifying Angles and Angle Pairs

Use the diagram below.



- A Name a pair of adjacent angles. _____
- B Name a pair of vertical angles. _____
- C Name a pair of complementary angles. _____
- D Name an angle that is supplementary to $\angle CFE$. _____
- E Name an angle that is supplementary to $\angle BFD$. _____
- F Name an angle that is supplementary to $\angle CFD$. _____
- G Name a pair of non-adjacent angles that are complementary. _____

REFLECT

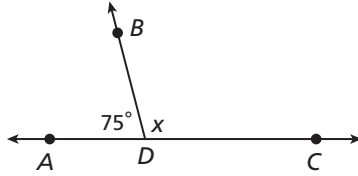
2a. What is the measure of $\angle DFE$? Explain how you found the measure.

2b. Are $\angle CFB$ and $\angle DFE$ vertical angles? Why or why not?

2c. Are $\angle BFD$ and $\angle AFE$ vertical angles? Why or why not?

Find the measure of each angle.

A $\angle BDC$



$\angle BDC$ and _____ are _____ angles.

The sum of their measures is _____.

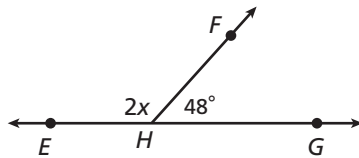
Write an equation to help you find the measure of $\angle BDC$.

$$75 + x = \underline{\hspace{2cm}}$$

In the box, solve the equation for x .

$$m\angle BDC = \boxed{\hspace{1cm}}.$$

B $\angle EHF$



$\angle EHF$ and _____ are _____ angles.

The sum of their measures is _____.

In the box, write and solve an equation to help you find $m\angle EHF$.

$$m\angle EHF = \boxed{\hspace{1cm}}.$$

REFLECT

3a. A friend claims that two acute angles are complementary and their measures are $2x^\circ$ and $(30 - 5x)^\circ$. If your friend is right, what equation must be true?

3b. Solve the equation you found and interpret the answer. Evaluate your friend's claim.

PRACTICE

Use the figure for Exercises 1–5.

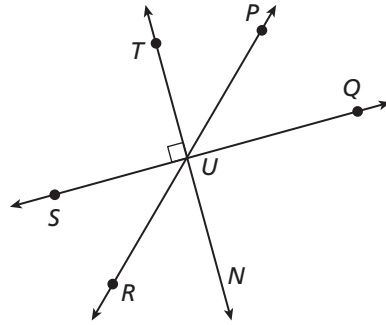
1. $m\angle QUP + m\angle PUT =$ _____

2. Name a pair of supplementary angles.

3. Name a pair of vertical angles.

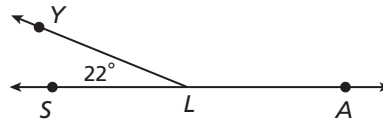
4. Name a pair of adjacent angles.

5. What is the measure of $\angle QUN$? Explain your answer.

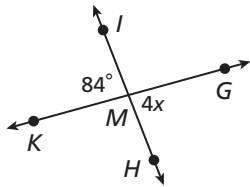


Solve for the indicated angle measure or variable.

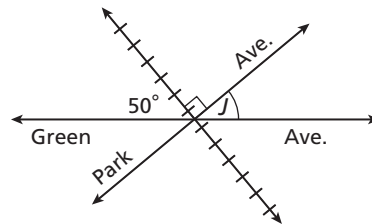
6. $m\angle YLA =$ _____



7. $x =$ _____



8. The railroad tracks meet the road as shown. The town will allow a parking lot at angle J if the measure of angle J is greater than 38° . Can a parking lot be built at angle J ? Why or why not?



9. **Error Analysis** A student states that when the sum of two angle measures equals 180° , the two angles are complementary. Explain why the student is incorrect.

Additional Practice

- $\angle PQR$ and $\angle SQR$ form a linear pair. Find the sum of their measures. _____
- Name the ray that $\angle PQR$ and $\angle SQR$ share. _____

Use the figures for Exercises 3 and 4.

3. supplement of $\angle Z$ _____

4. complement of $\angle Y$ _____



- An angle measures 12 degrees less than three times its supplement. Find the measure of the angle. _____
- An angle is its own complement. Find the measure of a supplement to this angle. _____
- $\angle DEF$ and $\angle FEG$ are complementary. $m\angle DEF = (3x - 4)^\circ$, and $m\angle FEG = (5x + 6)^\circ$.

Find the measures of both angles. _____

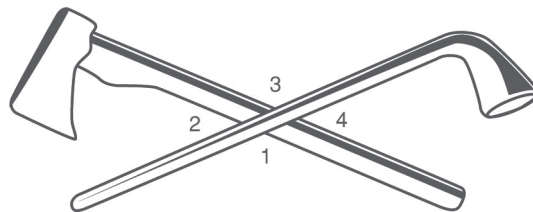
- $\angle DEF$ and $\angle FEG$ are supplementary. $m\angle DEF = (9x + 1)^\circ$, and $m\angle FEG = (8x + 9)^\circ$.

Find the measures of both angles. _____

Use the figure for Exercises 9 and 10.

In 2004, several nickels were minted to commemorate the Louisiana Purchase and Lewis and Clark's expedition into the American West. One nickel shows a pipe and a hatchet crossed to symbolize peace between the American government and Native American tribes.

- Name a pair of vertical angles.



- Name a linear pair of angles.

- $\angle ABC$ and $\angle CBD$ form a linear pair and have equal measures. Tell if $\angle ABC$ is acute, right, or obtuse.

- $\angle KLM$ and $\angle MLN$ are complementary. \overline{LM} bisects $\angle KLN$. Find the measures of $\angle KLM$ and $\angle MLN$.

Problem Solving

Use the drawing of part of the Eiffel Tower for Exercises 1–5.

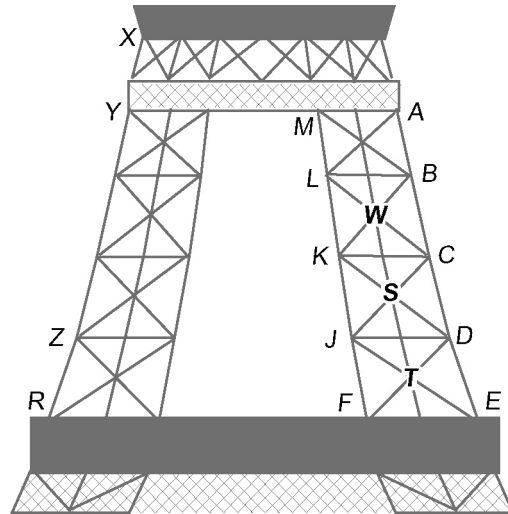
1. Name a pair of angles that appear to be complementary.

2. Name a pair of supplementary angles.

3. If $m\angle CSW = 45^\circ$, what is $m\angle JST$? How do you know?

4. If $m\angle FKB = 135^\circ$, what is $m\angle BKL$? How do you know?

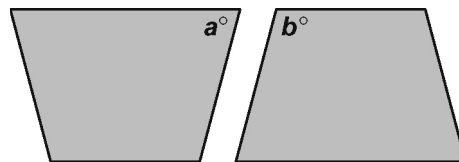
5. Name three angles whose measures sum to 180° .



Choose the best answer.

6. A landscaper uses paving stones for a walkway. Which are possible angle measures for a° and b° so that the stones do not have space between them?

- A $50^\circ, 100^\circ$ C $75^\circ, 105^\circ$
 B $45^\circ, 45^\circ$ D $90^\circ, 80^\circ$



7. The angle formed by a tree branch and the part of the trunk above it is 68° . What is the measure of the angle that is formed by the branch and the part of the trunk below it?

- F 22° H 158°
 G 112° J 180°

8. $\angle R$ and $\angle S$ are complementary. If $m\angle R = (7 + 3x)^\circ$ and $m\angle S = (2x + 13)^\circ$, which is a true statement?

- A $\angle R$ is acute. C $\angle R$ and $\angle S$ are right angles.
 B $\angle R$ is obtuse. D $m\angle S > m\angle R$