Vertical and Adjacent Angles

I Can... identify vertical and adjacent angles, and use them to write and solve equations to find unknown angle measures.

What Vocabulary Will You Learn?
acute angle
adjacent angles
congruent
obtuse angle
right angle
straight angle
vertex
vertical angles
zero angle

Learn Angles

The hands on a clock form an angle with the **vertex** at the center of the clock where the hands meet. At different times of day, the angle formed by the hands could be **obtuse**, **acute**, **right**, **straight**, or **zero**.

Draw the hands of each clock to represent each type of angle.

Types of Angles		
	obtuse	greater than 90°, less than 180°
	acute	less than 90°, greater than 0°
	right	exactly 90°
	straight	exactly 180°
	zero	exactly 0°

بسم الله الرحمن الرحيم
(اجيال المستقبل التعليمية)
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Talk About It!
Is it possible for an angle to have a measure greater than 180°? Explain.

yes, at 8:00 on a clock the angle shown from 12:00 to 8:00 going clockwise is greater than 180

Learn Name Angles

An angle can be named using three capital letters. These letters come from three points labeled on the angle—one point from the vertex and one point from each ray. The middle letter must be the vertex of the angle.

The symbol for angle is $\angle$. An angle named $\angle XYZ$ is read *angle XYZ*.

An angle can be named using only one letter, the vertex. An angle can also be named by placing a number in the interior of the angle near the vertex.

(continued on next page)

Your Notes

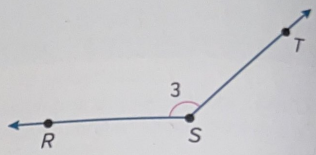
Talk About It!

A classmate states that the angle is named $\angle RTS$. Explain why this is incorrect.

The angle can be named in four ways.

$\angle RST$, $\angle S$,

$\angle 3$, $\angle TSR$

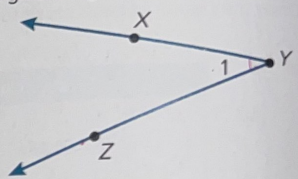


Example 1 Name Angles

Name the angle in four ways.

Select all of the correct names for the given angle.

- ☑ $\angle 1$
- ☑ $\angle ZYX$
- ☑ $\angle XYZ$
- ☐ $\angle X$
- ☐ $\angle XZY$
- ☑ $\angle Y$
- ☐ $\angle ZXY$
- ☐ $\angle Z$



So, the angle can be named by the vertex, three points on the angle with a specified order, and a number in the interior of the angle.

Talk About It!

Why is $\angle XZY$ not a correct name for the angle?

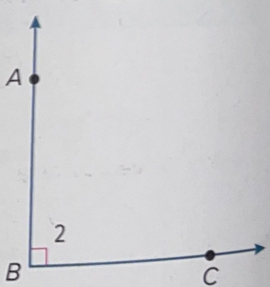
Check

Name the angle in four ways.

$\angle 2$ $\angle B$

$\angle ABC$

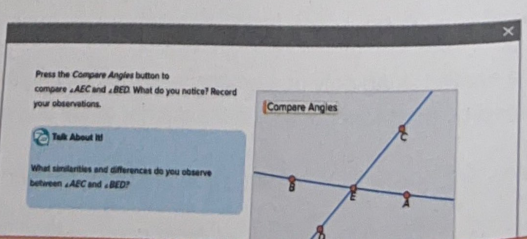
$\angle CBA$



Go Online You can complete an Extra Example online.

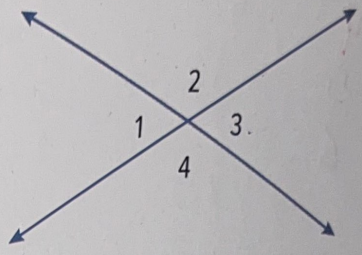
Explore Vertical and Adjacent Angle Pairs

Online Activity You will use Web Sketchpad to explore attributes of vertical and adjacent angles.



Learn Identify Vertical Angles

Two angles are **vertical angles** if they are opposite angles formed by the intersection of two lines. Vertical angles are **congruent,** or have the same measure.



Angle 1 is congruent to angle 3.

$\angle 1 \cong \angle 3$

Angle 2 is congruent to angle 4.

$\angle 2 \cong \angle 4$

The measure of angle 1 is equal to the measure of angle 3.

$m\angle 1 = m\angle 3$

The measure of angle 2 is equal to the measure of angle 4.

$m\angle 2 = m\angle 4$

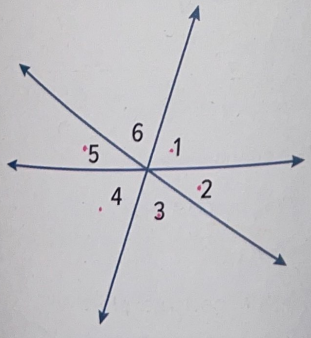
Special notation is used to indicate the measure of an angle. Read $m\angle 1$ as *the measure of angle 1.*

Talk About It!

Vertical angles share a common point. How can you name or describe that point to a classmate?

Example 2 Identify Vertical Angles

Identify the vertical angle pairs in the figure.



$\angle 1$ is vertical to $\angle$ 4.

$\angle 2$ is vertical to $\angle$ 5.

$\angle 3$ is vertical to $\angle$ 6.

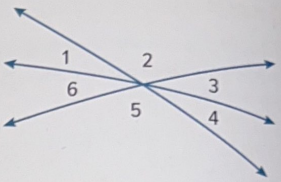
So, the vertical angle pairs are $\angle 1$ and $\angle 4$, $\angle 2$ and $\angle 5$, and $\angle 3$ and $\angle 6$.

Talk About It!

A classmate stated that $\angle 2$ and $\angle 6$ are vertical angles since they share the same vertex and are on opposite sides of the horizontal line. Make an argument that shows why this reasoning is incorrect.

Check

Identify the vertical angle pairs by writing each angle label from the diagram by its corresponding vertical angle.



$\angle 1$ is vertical to $\angle$ 4.

$\angle 2$ is vertical to $\angle$ 5.

$\angle 3$ is vertical to $\angle$ 6.

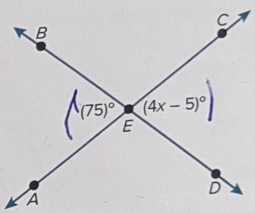
Go Online You can complete an Extra Example online.

Learn Use Vertical Angles to Find Missing Values

Go Online Watch the animation to see how to find missing values using vertical angles.

The animation shows how to write and solve an equation to find the value of x.

$75 = 4x - 5$



Vertical angles are congruent → Equal

Angle AEB and angle CED are vertical angles.

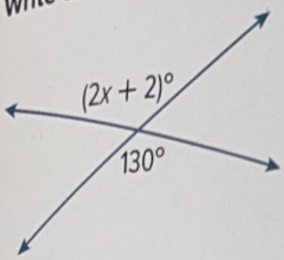
$\angle AEB \cong \angle CED$	Vertical angles are congruent.
$m\angle AEB = m\angle CED$	Definition of congruence
$75 = 4x - 5$	$m\angle AEB = 75°$, $m\angle CED = (4x - 5)°$
$+5 \quad +5$	Add 5 to each side.
$80 = 4x$	Simplify.
$\frac{80}{4} = \frac{4x}{4}$	Divide each side by 4.
$20 = x$	Simplify.

So, the value of x is 20.

Talk About It!
How can you check your solution?

Example 3 Use Vertical Angles to Find Missing Values

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



Part A Write an equation.

Because the two angles are vertical angles, they are congruent. Write an equation showing that the two angle measures are equivalent.

$2x+2 = 130$

Part B Solve the equation.

$2x + 2 = 130$ Write the equation.

$-2 \quad -2$ Subtract 2 from each side.

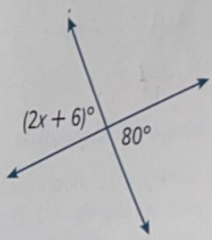
$2x = 128$ Simplify.

$x = 64$ Divide each side by 2.

So, $x = 64$.

Check

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



$2x+6 = 80$

$-6 \quad -6$

$2x = 74$

$\frac{2x}{2} = \frac{74}{2}$

$x = 37$

Part A Write an equation.

Part B Solve the equation.

Show your work here

Think About It!

What is the relationship between the two angles shown?

They are vertical angles

Talk About It!

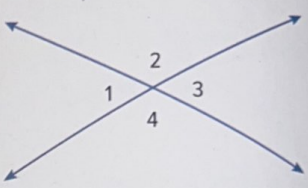
How can you use the value of x to check your solution?

Go Online You can complete an Extra Example online.

Learn Identify Adjacent Angles

Two angles are **adjacent angles** if they share a common vertex, a common side, and do not overlap.

The diagram shows four pairs of adjacent angles.



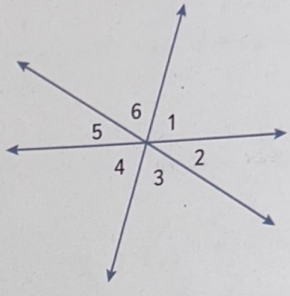
$\angle 1$ and $\angle 2$

$\angle 2$ and $\angle 3$

$\angle 3$ and $\angle 4$

$\angle 4$ and $\angle 1$

The diagram below shows three intersecting lines.



Which angles are adjacent to $\angle 2$? $\angle 1$ and $\angle 3$

Which angles are adjacent to $\angle 5$? $\angle 4$ and $\angle 6$

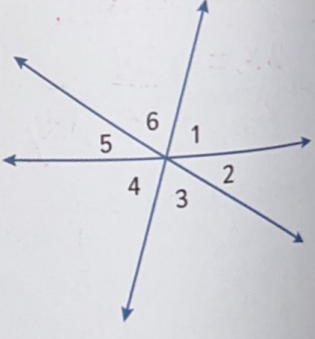
Talk About It!
Where have you heard the term *adjacent* before? How can you remember what it means in geometry?

Talk About It!
A classmate stated that $\angle 4$ and $\angle 5$ are adjacent. Do you agree? Justify your reasoning.

Example 4 Identify Adjacent Angles

Name the angles that are adjacent to $\angle 1$.

Because $\angle 1$ shares a common side and vertex with $\angle 2$, they are adjacent angles.



What other angle shares a side and vertex with $\angle 1$? $\angle 6$

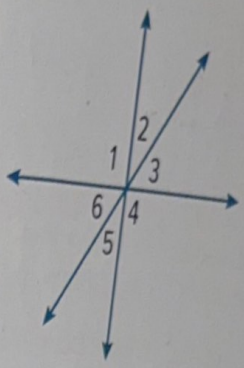
So, $\angle 2$ and $\angle 6$ are adjacent to $\angle 1$.

Talk About It!
A classmate stated that $\angle 4$ and $\angle 2$ are also adjacent. Do you agree? Justify your reasoning.

Check

Select all of the angles that are adjacent to $\angle 3$.

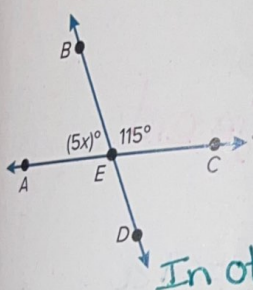
- ☐ $\angle 1$
- ☑ $\angle 2$
- ☐ $\angle 3$
- ☑ $\angle 4$
- ☐ $\angle 5$
- ☐ $\angle 6$



Go Online You can complete an Extra Example online.

Learn Use Adjacent Angles to Find Missing Values

Go Online Watch the animation to see how to use adjacent angles to find a missing value.



two angles are adjacent If they have a common side and a common vertex

In other words, adjacent angles are directly next to each other and do not overlap

Angle AEB and angle BEC are adjacent angles.

$m\angle AEB + m\angle BEC = 180$ The adjacent angles form a straight angle. The sum is 180°.

$5x + 115 = 180$ $m\angle AEB = (5x)°$, $m\angle BEC = 115°$

$-115 \quad -115$ Subtract 115 from each side.

$5x = 65$ Simplify.

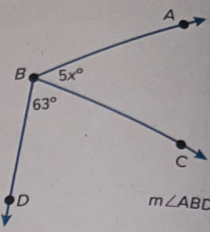
$\frac{5x}{5} = \frac{65}{5}$ Divide each side by 5.

$x = 13$ Simplify.

So, the value of x is 13.

Example 5 Use Adjacent Angles to Find Missing Values

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



$m\angle ABD = 128°$

The diagram shows that $m\angle ABC + m\angle CBD = m\angle ABD$.

$m\angle ABC + m\angle CBD = m\angle ABD$	Write the equation.
$5x + 63 = 128$	$m\angle ABC = 5x°$, $m\angle CBD = 63°$, $m\angle ABD = 128°$
$-63 \quad -63$	Subtract 63 from each side.
$5x = 65$	Simplify.
$\frac{5x}{5} = \frac{65}{5}$	Divide each side by 5.
$x = 13$	Simplify.

So, $x = 13$.

Talk About It!
How can you use the value of x to find the measure of $\angle ABC$?

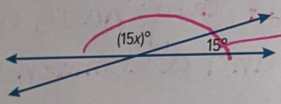
Substitute the value of x into the expression 5x and simplify

Talk About It!
A classmate found the value of x by setting the sum of the angle measures equal to 180. Explain your classmate's error.

The sum of the angles measures of adjacent angles it is given that the total angle measure 128. Therefore the sum of the angles measures equals 128°

Check

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



Adjecent

Part A Write an equation. $15x + 15 = 180$ $-15 \quad -15$

Part B Solve the equation. 165

Show your work here

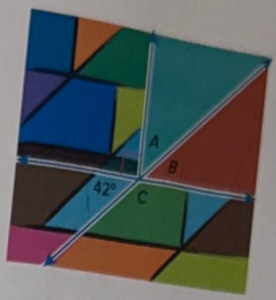
$\frac{15x}{15} = \frac{165}{15}$

$x =$

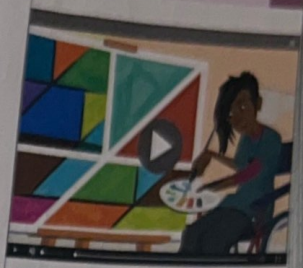
Go Online You can complete an Extra Example online.

Apply Art

Tamika is using lines and angles to create abstract art. She needs to find the measure of $\angle A$ to continue the pattern in the art. What is the measure of $\angle A$?



Go Online
Watch the animation.



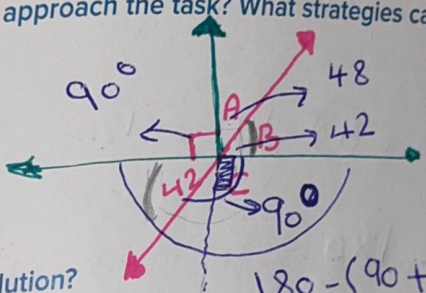
1 What is the task?

Make sure you understand exactly what question to answer or problem to solve. You may want to read the problem three times. Discuss these questions with a partner.

First Time Describe the context of the problem, in your own words.
Second Time What mathematics do you see in the problem?
Third Time What are you wondering about?

2 How can you approach the task? What strategies can you use?

Record your observations here



180 - (90 + 42)

3 What is your solution?

Use your strategy to solve the problem.

Show your work here

$\angle B = 42$

$\angle A = 48$

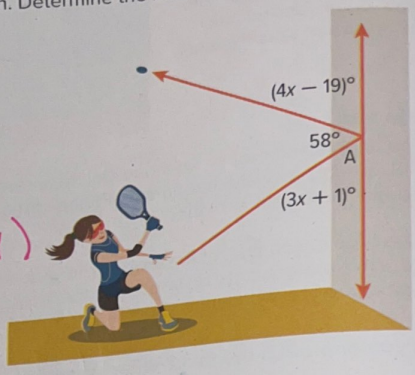
4 How can you show your solution is reasonable?

Write About It! Write an argument that can be used to defend your solution.

Talk About It!
How can you solve the problem another way?

Check

While playing racquetball, Tia bounced the ball off the wall at the angle shown. Determine the measure of $\angle A$.



(3X+1+58+4X-19) = 180

The measure of $\angle A$ is _____

m< (3x+1) + 58 + (4x) - 19 = 180

7x + 40 = 180

-40 -40

7x/7 = 140/7

x = 20

SO <A = (3x+1)

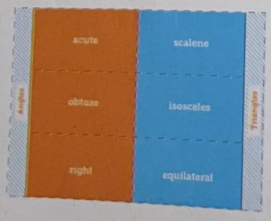
<A (3X20)+1 = 61°

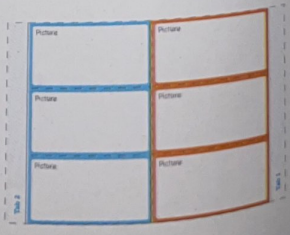
Aya Hamed

050 717 5602

Go Online You can complete an Extra Example online.

Foldables It's time to update your Foldable, located in the Module Review, based on what you learned in this lesson. If you haven't already assembled your Foldable, you can find the instructions on page FL1.



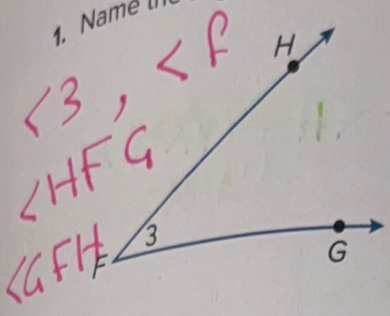


Name Mrs/ Aya Mohamed Period GR7 Date 2014

Practice

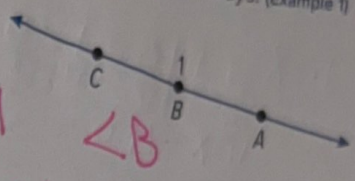
Go Online You can complete your homework online.

1. Name the angle in four ways. (Example 1)



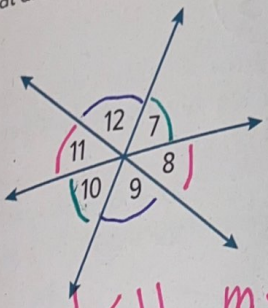
<3, <F
<HFG
<GFH

2. Name the angle in four ways. (Example 1)



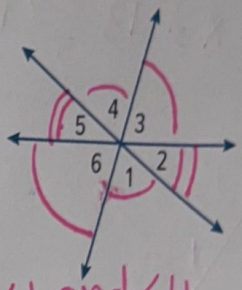
<1 <B
<CBA
<ABC

3. Refer to the diagram below. Identify three pairs of vertical angles. Name all the angles that are adjacent to ∠10. (Examples 2 and 4)



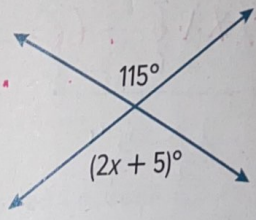
<8 and <11
<7 and <10
m<9 and <12

4. Identify three pairs of vertical angles. Name all the angles that are adjacent to ∠3. (Examples 2 and 4)



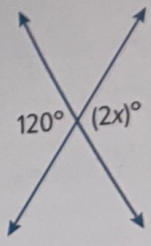
<1 and <4 <2 and <5
<3 and <6 <2 and <4

5. Write and solve an equation to find the value of x. (Example 3)



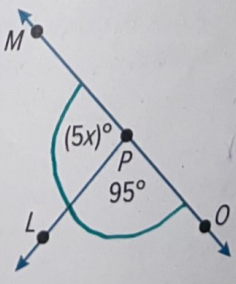
115 = 2x + 5
-5 -5
110/2 = 2x/2
x = 55

6. Write and solve an equation to find the value of x. (Example 3)



120/2 = 2x/2
x = 60

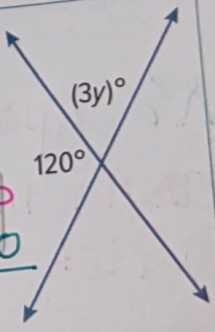
7. Write and solve an equation to find the value of x. (Example 5)



5x + 95 = 180
-95 -95
5x/5 = 85/5
x = 17

Test Practice

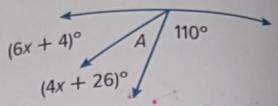
8. **Open Response** Write and solve an equation to find the value of y.



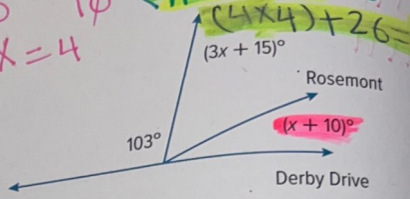
120 + 3y = 180
-120 -120
3y/3 = 60/3
y = 20

Apply

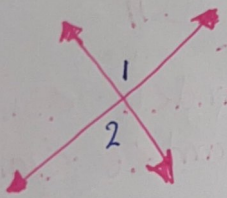
9. Levi was designing a kite. He needs to determine the measure of $\angle A$ before cutting the fabric. What is the measure of angle A?



10. Jess was drawing a map of her neighborhood. What is the measure of the angle of the intersection between Derby Drive and Rosemont?

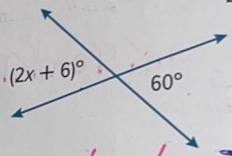


11. Draw and label a pair of vertical angles.



12. **Find the Error** A student was finding the value of x. Identify the student's error and correct it.

$$2x + 6 + 60 = 180$$
$$2x + 66 = 180$$
$$2x = 114$$
$$x = 57$$



13. **Be Precise** A student said that the sum of the measures of a pair of adjacent angles must equal 180°. Is the student correct? Write an argument that can be used to defend your solution.

14. **Reason Abstractly** Determine if the following statement is *true* or *false*. If true, provide a diagram. If false, explain.

A pair of acute angles can also be adjacent angles.