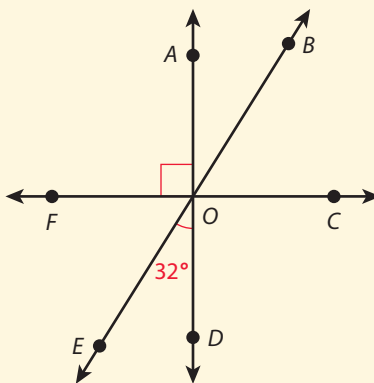


Problem Solving with Angles

Use What You Know

In previous grades you learned about lines and angles. Take a look at this problem.

Three lines, $\overleftrightarrow{AD}$, $\overleftrightarrow{BE}$, and $\overleftrightarrow{CF}$ intersect at point O as shown in the diagram. $\overleftrightarrow{AD}$ is perpendicular to $\overleftrightarrow{FC}$. $\angle EOD$ measures 32° . What is the measure of $\angle AOB$?



Use the math you already know to solve the problem.

- a. What is the measure of $\angle FOD$? How do you know?

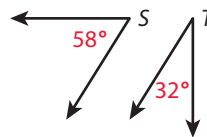
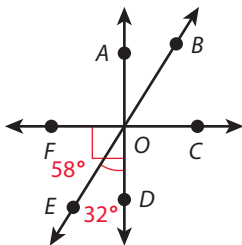
- b. Name two adjacent angles that together form $\angle FOD$. What is the sum of their measures?

- c. What is the measure of $\angle FOE$? Explain.

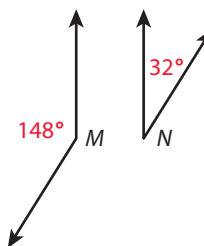
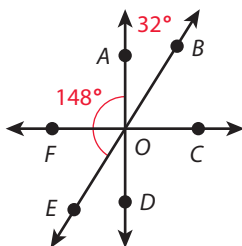
- d. Together, $\angle FOE$, $\angle FOA$, and $\angle AOB$ form a line or a straight angle that measures 180° . Explain how you can find the measure of $\angle AOB$.

Find Out More

On the previous page, $\angle FOE$ and $\angle EOD$ form a right angle. The sum of their measures is 90° . $\angle FOE$ measures 58° , and $\angle EOD$ measures 32° . Two angles whose measures add to 90° are **complementary angles**. Complementary angles don't have to be adjacent. $\angle S$ and $\angle T$ are complementary angles.



On the previous page, $\angle EOA$ and $\angle AOB$ form a straight line. The sum of their measures is 180° . $\angle EOA$ measures 148° , and $\angle AOB$ measures 32° . Two angles whose measures add to 180° are **supplementary angles**. Supplementary angles don't have to be adjacent. $\angle M$ and $\angle N$ are supplementary angles.



When two lines intersect, like $\overleftrightarrow{AD}$ and $\overleftrightarrow{BE}$ on the previous page, they form pairs of **vertical angles**. $\angle AOB$ and $\angle EOD$ are vertical (or opposite) angles. They are the non-adjacent angles formed by the intersecting lines. Vertical angles have the same measure. Both $\angle AOB$ and $\angle EOD$ measure 32° .

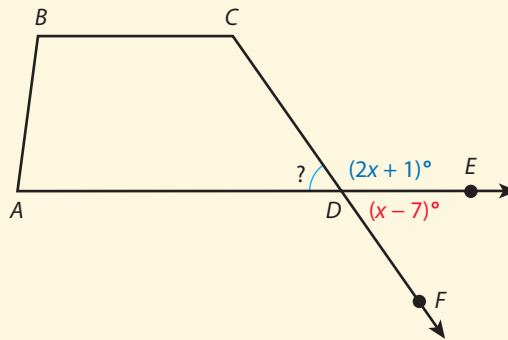
Reflect

- Look at the diagram on the previous page. What can you say about $\angle FOE$ and $\angle BOC$? What can you say about $\angle AOB$ and $\angle EOD$?

Learn About **Using Supplementary and Vertical Angles**

Read the problem below. Then explore how to use facts about supplementary and vertical angles to find the measures of angles in a figure.

In the figure shown, what is the measure of $\angle ADC$?



Model It You can use the diagram and facts about angles to write an equation.

$\angle CDE$ and $\angle EDF$ are supplementary angles.

$$(2x + 1) + (x - 7) = 180$$

Solve It You can solve the equation to find the value of x .

$$2x + 1 + x - 7 = 180$$

$$3x - 6 = 180$$

$$3x = 186$$

$$x = 62$$

Connect It Now you will find the measure of $\angle ADC$.

2 Look at *Model It*. How do you know that $\angle CDE$ and $\angle EDF$ are supplementary?

3 How do you know that the measures of $\angle CDE$ and $\angle EDF$ add to 180° ?

4 Look at *Solve It*. Give reasons for the steps used to solve the equation. Write the reason next to each step.

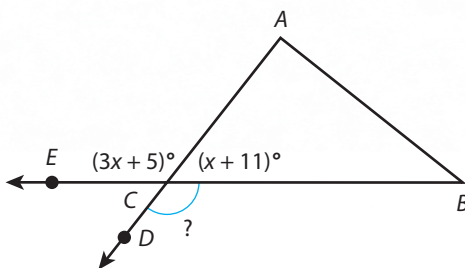
5 Since you know that $x = 62$, what are the measures of $\angle CDE$ and $\angle EDF$? Show your work.

6 What is the measure of $\angle ADC$? _____ Explain your reasoning.

7 What facts about angles can you use to find the unknown angle measures?

Try It Use what you just learned about supplementary and vertical angles to solve this problem. Show your work on a separate sheet of paper.

8 In triangle ABC , the measure of $\angle ACB$ is $(x + 11)^\circ$ and the measure of $\angle ACE$ is $(3x + 5)^\circ$.



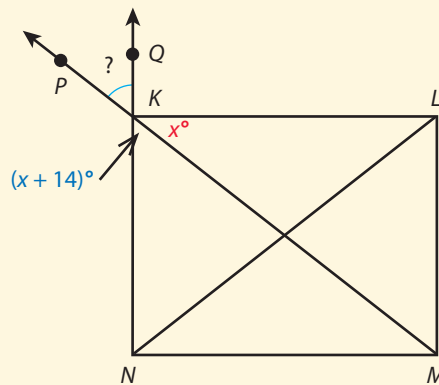
Find the measure of $\angle DCB$. _____ Find the measure of $\angle ECD$. _____

Learn About

Using Complementary and Vertical Angles

Read the problem below. Then use what you know about complementary and vertical angles to find the measures of angles in the figure.

In rectangle $KLMN$, $\overline{NK}$ and $\overline{MK}$ are extended as shown in the diagram below. The measure of $\angle MKL$ is x° , and the measure of $\angle NKM$ is $(x + 14)^\circ$. Find the measure of $\angle PKQ$.



Model It You can use the diagram and facts about angles to write an equation.

$\angle MKL$ and $\angle NKM$ are complementary angles.

$$x + (x + 14) = 90$$

Solve It You can solve the equation to find the value of x .

$$x + x + 14 = 90$$

$$2x + 14 = 90$$

$$2x = 76$$

$$x = 38$$

Connect It Now you will find the measure of $\angle PKQ$.

9 Look at *Model It*. How do you know that $\angle MKL$ and $\angle NKM$ are complementary?

10 Why do the measures of $\angle MKL$ and $\angle NKM$ add to 90° ?

11 Look at *Solve It*. Give reasons for the steps used to solve the equation. Write the reason next to each step.

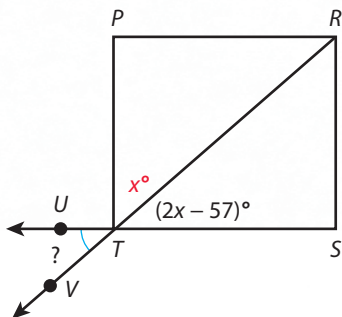
12 Since you know that $x = 38$, what are the measures of $\angle MKL$ and $\angle NKM$? Show your work.

13 What is the measure of $\angle PKQ$? _____ Explain your reasoning.

14 What facts about angles can you use to find the unknown angle measures on the previous page?

Try It Use what you just learned about complementary and vertical angles to solve this problem. Show your work on a separate sheet of paper.

15 In rectangle $PRST$, $\overline{ST}$ and $\overline{RT}$ are extended as shown in the diagram below. The measure of $\angle PTR$ is x° and the measure of $\angle RTS$ is $(2x - 57)^\circ$.



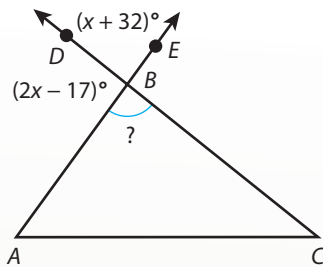
Find the measure of $\angle UTV$. _____ Find the measure of $\angle STV$. _____

Practice Problem Solving with Angles

Study the example below. Then solve problems 16–18.

Example

In triangle ABC , $\overline{AB}$ and $\overline{CB}$ are extended as shown. The measure of $\angle ABD$ is $(2x - 17)^\circ$ and the measure of $\angle DBE$ is $(x + 32)^\circ$. Find the measure of $\angle ABC$.



Look at how you could solve this problem using the properties of supplementary and vertical angles.

$$(2x - 17) + (x + 32) = 180; 3x + 15 = 180; 3x = 165; x = 55$$

Solution $m\angle ABC = m\angle DBE = 55^\circ + 32^\circ = 87^\circ$



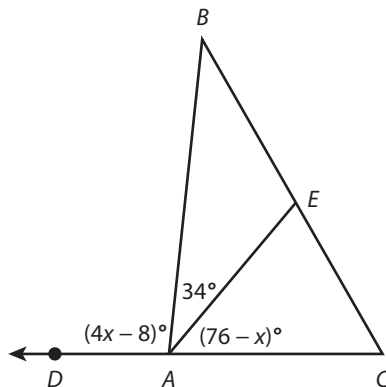
The student wrote and solved an equation using facts about supplementary and vertical angles.



Pair/Share

How can you recognize supplementary and vertical angles?

16 Find the value of x in the diagram below.



Show your work.

Solution _____



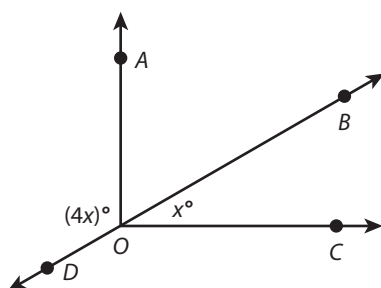
What is the measure of a straight angle?



Pair/Share

How could you check your answer?

- 17 In the diagram below, $\overrightarrow{OA} \perp \overrightarrow{OC}$. Find the value of x . Show your work.



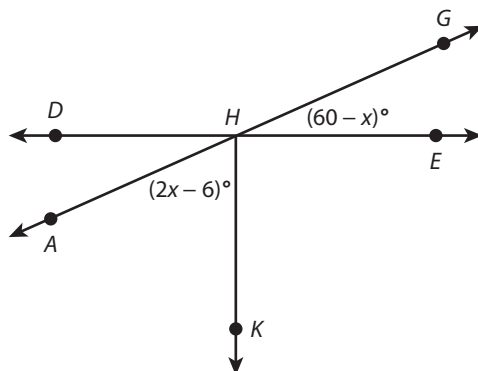
How can you express the measure of $\angle AOB$?

Pair/Share

Explain the steps you took to solve the problem.

Solution _____

- 18 In the diagram below, $\overleftrightarrow{DE} \perp \overleftrightarrow{HK}$. Find the value of x . Circle the letter of the correct answer.



Could you use the property of vertical angles to write an equation?

- A 42°
- B 36°
- C 33°
- D 22°

Jeb chose **D** as the correct answer. How did he get that answer?

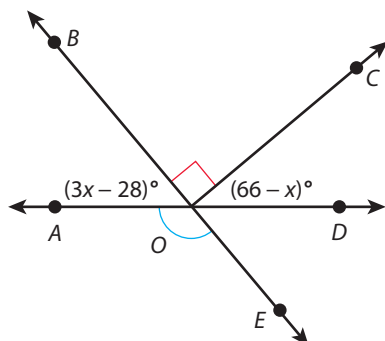
Pair/Share

Talk about the problem and then write your answer together.

Practice Problem Solving with Angles

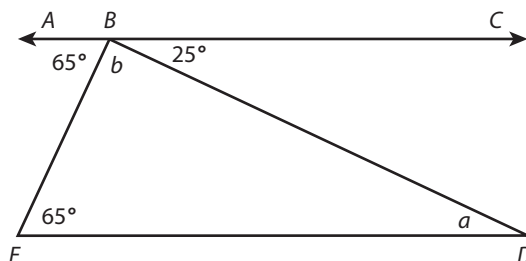
Solve the problems.

- 1 Find the measure of $\angle AOE$ in the diagram below.



- A 90°
- B 100°
- C 120°
- D 130°

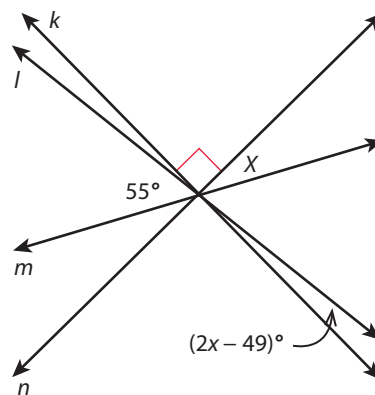
- 2 In the diagram below, $\overleftrightarrow{AC}$ intersects $\triangle BDE$ at B . Choose *True* or *False* for each statement.



- a. $\angle ABE$ and $\angle CBD$ are complementary. ☐ True ☐ False
- b. $65^\circ + b + 25^\circ = 180^\circ$ ☐ True ☐ False
- c. $\angle ABE$ and $\angle CBD$ are vertical angles. ☐ True ☐ False

- 3** Four straight lines k , l , m , and n intersect as shown in the diagram. Lines k and n are perpendicular. Find x .

- A** 23°
B 28°
C 53°
D 55°



- 4 Part A** Decide if each statement is always true, sometimes true, or never true. Circle your answer.

- I. The sum of the measures of two supplementary angles is 90° .

always true sometimes true never true

- II. Two adjacent angles are supplementary.

always true sometimes true never true

- III. If the measure of an acute angle is represented by x , then the measure of its complement is represented by $90 - x$.

always true sometimes true never true

Part B Look at your answers in Part A. If you chose “sometimes true” for an answer, draw a figure to show an example where the statement is true and another figure to show an example where the statement is not true.

Self Check Go back and see what you can check off on the Self Check on page 201.