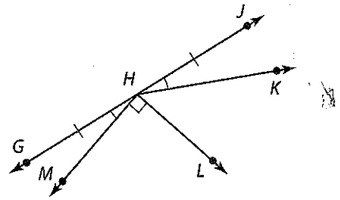
StudyTip

Additional Information
Additional information for a figure may be given using congruent angle markings, congruent segment markings, or right angle symbols.

Example 4

Determine whether each statement can be assumed from the figure. Explain.



a. $\angle KHJ$ and $\angle GHM$ are complementary.

No; they are congruent, but we do not know anything about their exact measures.

b. $\angle GHK$ and $\angle JHK$ are a linear pair.

Yes; they are adjacent angles whose noncommon sides are opposite rays.

c. $\overrightarrow{HL}$ is perpendicular to $\overrightarrow{HM}$.

Yes; the right angle symbol in the figure indicates that $\overrightarrow{HL} \perp \overrightarrow{HM}$.

GuidedPractice

4A. $\angle GHL$ and $\angle LHJ$ are supplementary.

4B. $\angle GHM$ and $\angle MHK$ are adjacent angles.

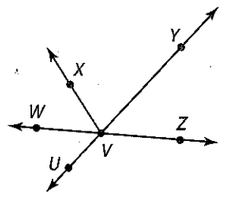
Check Your Understanding

= Step-by-Step Solutions begin on page R14.

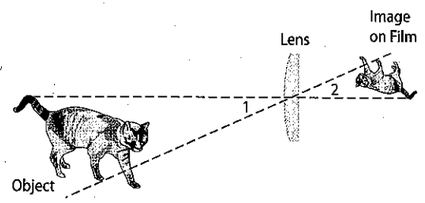
Example 1 **Name an angle pair that satisfies each condition.**

1. two acute vertical angles

2. two obtuse adjacent angles



Examples 1–2 **3. CAMERAS** Cameras use lenses and light to capture images.



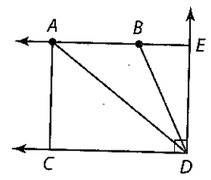
a. What type of angles are formed by the object and its image?

b. If the measure of $\angle 2$ is 15, what is the measure of $\angle 1$?

Examples 2–3 **4. ALGEBRA** The measures of two complementary angles are $7x + 17$ and $3x - 20$. Find the measures of the angles.

ALGEBRA Lines x and y intersect to form adjacent angles 2 and 3. If $m\angle 2 = 3a - 27$ and $m\angle 3 = 2b + 14$, find the values of a and b so that x is perpendicular to y.

Example 4 **Determine whether each statement can be assumed from the figure. Explain.**



6. $\angle CAD$ and $\angle DAB$ are complementary.

7. $\angle EDB$ and $\angle BDA$ are adjacent, but they are neither complementary nor supplementary.

Practice and Problem Solving

Extra Practice is on page R1.

Examples 1–2 **Name an angle or angle pair that satisfies each condition.**

8. two adjacent angles

9. two acute vertical angles

10. two obtuse vertical angles

11. two complementary adjacent angles

12. two complementary nonadjacent angles

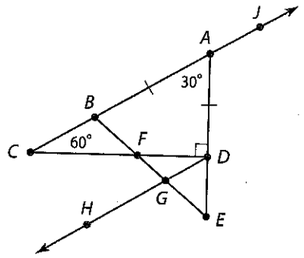
13. two supplementary adjacent angles

14. a linear pair whose vertex is F

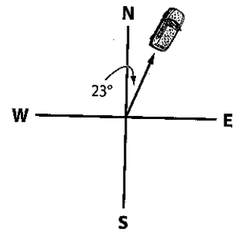
15. an angle complementary to $\angle FDG$

16. an angle supplementary to $\angle CBF$

17. an angle supplementary to $\angle JAE$

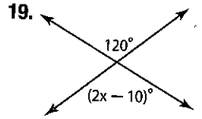


18. CCSS REASONING You are using a compass to drive 23° east of north. Express your direction in another way using an acute angle and two of the four directions: north, south, east, and west. Explain your reasoning.



Example 2 **Find the value of each variable.**

19.



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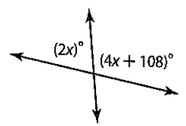

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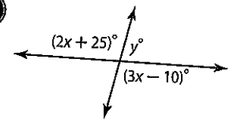

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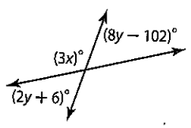

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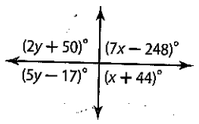

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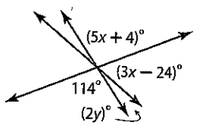


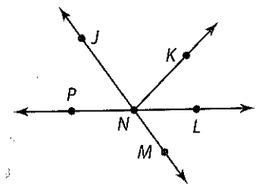
25. ALGEBRA $\angle E$ and $\angle F$ are supplementary. The measure of $\angle E$ is 54 more than the measure of $\angle F$. Find the measures of each angle.

26. ALGEBRA The measure of an angle's supplement is 76 less than the measure of the angle. Find the measure of the angle and its supplement.

27. ALGEBRA The measure of the supplement of an angle is 40 more than two times the measure of the complement of the angle. Find the measure of the angle.

28. ALGEBRA $\angle 3$ and $\angle 4$ form a linear pair. The measure of $\angle 3$ is four more than three times the measure of $\angle 4$. Find the measure of each angle.

Example 3 **ALGEBRA Use the figure at the right.**



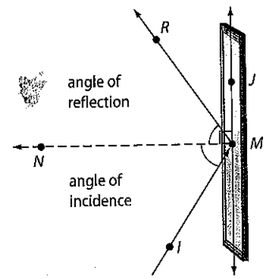
29. If $m\angle KNL = 6x - 4$ and $m\angle LNM = 4x + 24$, find the value of x so that $\angle KNM$ is a right angle.

30. If $m\angle JNP = 3x - 15$ and $m\angle JNL = 5x + 59$, find the value of x so that $\angle JNP$ and $\angle JNL$ are supplements of each other.

31. If $m\angle LNM = 8x + 12$ and $m\angle JNL = 12x - 32$, find $m\angle JNP$.

32. If $m\angle JNP = 2x + 3$, $m\angle KNL = 3x - 17$, and $m\angle KNJ = 3x + 34$, find the measure of each angle.

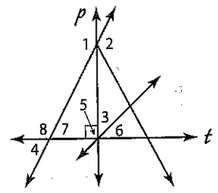
33. PHYSICS As a ray of light meets a mirror, the light is reflected. The angle at which the light strikes the mirror is the *angle of incidence*. The angle at which the light is reflected is the *angle of reflection*. The angle of incidence and the angle of reflection are congruent. In the diagram at the right, if $m\angle RMI = 106$, find the angle of reflection and $m\angle RMJ$.



34. ALGEBRA Rays AB and BC are perpendicular. Point D lies in the interior of $\angle ABC$. If $m\angle ABD = 3r + 5$ and $m\angle DBC = 5r - 27$, find $m\angle ABD$ and $m\angle DBC$.

35. ALGEBRA $\overleftrightarrow{WX}$ and $\overleftrightarrow{YZ}$ intersect at point V. If $m\angle WVY = 4a + 58$ and $m\angle XVY = 2b - 18$, find the values of a and b so that $\overleftrightarrow{WX}$ is perpendicular to $\overleftrightarrow{YZ}$.

Example 4 **Determine whether each statement can be assumed from the figure. Explain.**



36. $\angle 4$ and $\angle 7$ are vertical angles.

37. $\angle 4$ and $\angle 8$ are supplementary.

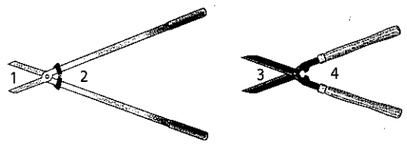
38. $p \perp t$

39. $\angle 3 \cong \angle 6$

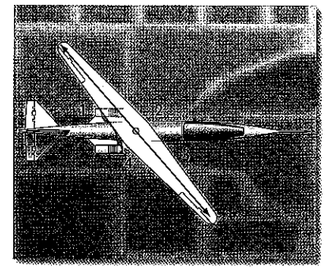
40. $\angle 5 \cong \angle 3 + \angle 6$

41. $\angle 5$ and $\angle 7$ form a linear pair.

42. ARGUMENTS In the diagram of the pruning shears shown, $m\angle 1 = m\angle 3$. What conclusion can you reach about the relationship between $\angle 4$ and $\angle 2$? Explain.



FLIGHT The wing of the aircraft shown can pivot up to 60° in either direction from the perpendicular position.



43. Identify a pair of vertical angles.

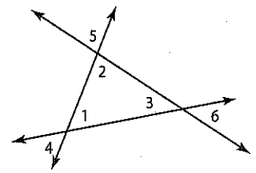
44. Identify two pairs of supplementary angles.

45. If $m\angle 1 = 110$, what is $m\angle 3$? $m\angle 4$?

46. What is the minimum possible value for $m\angle 2$? the maximum?

47. Is there a wing position in which none of the angles are obtuse? Explain.

48. MULTIPLE REPRESENTATIONS In this problem, you will explore the relationship between the sum of the interior angles of a triangle and the angles vertical to them.



a. Geometric Draw three sets of three intersecting lines and label each as shown.

b. Tabular For each set of lines, measure and record $m\angle 1$, $m\angle 2$, and $m\angle 3$ in a table. Record $m\angle 1 + m\angle 2 + m\angle 3$ in a separate column.

c. Verbal Explain how you can find $m\angle 4$, $m\angle 5$, and $m\angle 6$ when you know $m\angle 1$, $m\angle 2$, and $m\angle 3$.

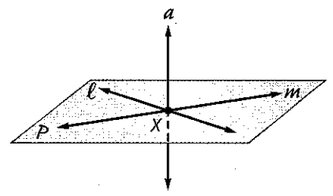
d. Algebraic Write an equation that relates $m\angle 1 + m\angle 2 + m\angle 3$ to $m\angle 4 + m\angle 5 + m\angle 6$. Then use substitution to write an equation that relates $m\angle 4 + m\angle 5 + m\angle 6$ to an integer.

H.O.T. Problems Use Higher-Order Thinking Skills

49. REASONING Are there angles that do not have a complement? Explain.

50. OPEN ENDED Draw a pair of intersecting lines that forms a pair of complementary angles. Explain your reasoning.

51. CHALLENGE If a line, line segment, or ray is perpendicular to a plane, it is perpendicular to every line, line segment, or ray in the plane that intersects it.



a. If a line is perpendicular to each of two intersecting lines at their point of intersection, then the line is perpendicular to the plane determined by them. If line a is perpendicular to line ℓ and line m at point X, what must also be true?

b. If a line is perpendicular to a plane, then any line perpendicular to the given line at the point of intersection with the given plane is in the given plane. If line a is perpendicular to plane P and line m at point X, what must also be true?

c. If a line is perpendicular to a plane, then every plane containing the line is perpendicular to the given plane. If line a is perpendicular to plane P, what must also be true?

52. WRITING IN MATH Describe three different ways you can determine that an angle is a right angle.