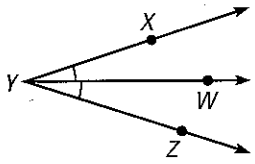
An **angle bisector** is a ray that divides an angle into two angles that are congruent. In the activity on page 27, $\overrightarrow{BD}$ bisects $\angle ABC$. So, $\angle ABD \cong \angle DBC$ and $m\angle ABD = m\angle DBC$.

EXAMPLE 5 Double an angle measure

In the diagram at the right, $\overrightarrow{YW}$ bisects $\angle XYZ$, and $m\angle XYW = 18°$. Find $m\angle XYZ$.



Solution

By the Angle Addition Postulate, $m\angle XYZ = m\angle XYW + m\angle WYZ$. Because $\overrightarrow{YW}$ bisects $\angle XYZ$, you know that $\angle XYW \cong \angle WYZ$.

So, $m\angle XYW = m\angle WYZ$, and you can write

$$m\angle XYZ = m\angle XYW + m\angle WYZ = 18° + 18° = 36°.$$

✓ GUIDED PRACTICE for Example 5

7. Angle MNP is a straight angle, and $\overrightarrow{NQ}$ bisects $\angle MNP$. Draw $\angle MNP$ and $\overrightarrow{NQ}$. Use arcs to mark the congruent angles in your diagram, and give the angle measures of these congruent angles.

1.4 EXERCISES

HOMEWORK KEY

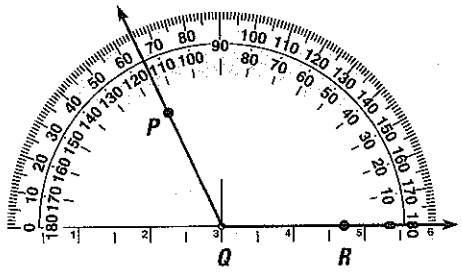
○ = **WORKED-OUT SOLUTIONS** on p. WS1 for Exs. 15, 23, and 53

★ = **STANDARDIZED TEST PRACTICE** Exs. 2, 21, 27, 43, and 62

SKILL PRACTICE

1. **VOCABULARY** Sketch an example of each of the following types of angles: acute, obtuse, right, and straight.

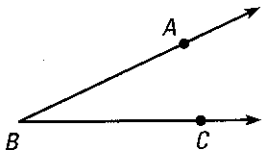
2. ★ **WRITING** *Explain* how to find the measure of $\angle PQR$, shown at the right.



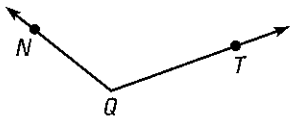
EXAMPLE 1 on p. 24 for Exs. 3–6

NAMING ANGLES AND ANGLE PARTS **In Exercises 3–5, write three names for the angle shown. Then name the vertex and sides of the angle.**

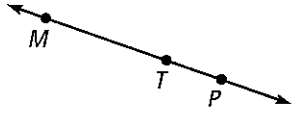
3.



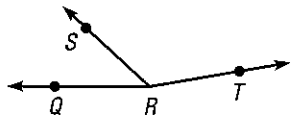
4.



5.



6. **NAMING ANGLES** Name three different angles in the diagram at the right.



EXAMPLE 2 on p. 25 for Exs. 7–21

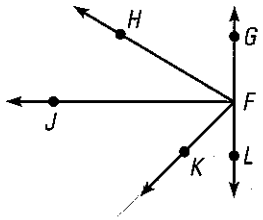
CLASSIFYING ANGLES **Classify the angle with the given measure as *acute, obtuse, right,* or *straight.***

7. $m\angle W = 180°$ 8. $m\angle X = 30°$ 9. $m\angle Y = 90°$ 10. $m\angle Z = 95°$

MEASURING ANGLES **Trace the diagram and extend the rays. Use a protractor to find the measure of the given angle. Then classify the angle as *acute, obtuse, right,* or *straight.***

11. $\angle JFL$ 12. $\angle GFH$

13. $\angle GFK$ 14. $\angle GFL$

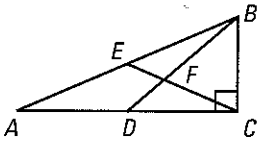


NAMING AND CLASSIFYING **Give another name for the angle in the diagram below. Tell whether the angle appears to be *acute, obtuse, right,* or *straight.***

15. $\angle ACB$ 16. $\angle ABC$

17. $\angle BFD$ 18. $\angle AEC$

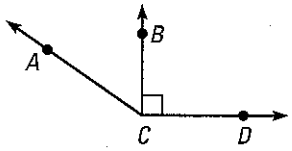
19. $\angle BDC$ 20. $\angle BEC$



21. ★ **MULTIPLE CHOICE** Which is a correct name for the obtuse angle in the diagram?

Ⓐ $\angle ACB$ Ⓑ $\angle ACD$

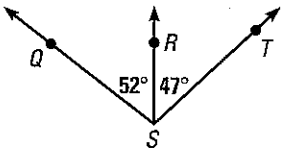
Ⓒ $\angle BCD$ Ⓓ $\angle C$

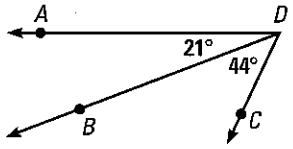


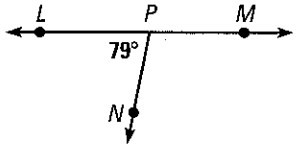
EXAMPLE 3 on p. 26 for Exs. 22–27

ANGLE ADDITION POSTULATE **Find the indicated angle measure.**

22. $m\angle QST =$? 23. $m\angle ADC =$? 24. $m\angle NPM =$?

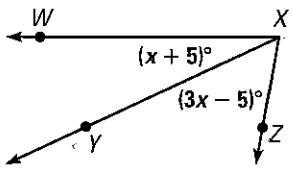




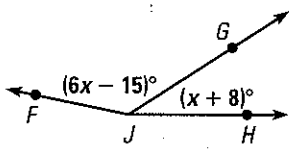


ALGEBRA **Use the given information to find the indicated angle measure.**

25. Given $m\angle WXZ = 80°$, find $m\angle YXZ$.



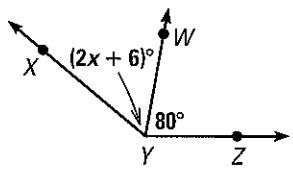
26. Given $m\angle FJH = 168°$, find $m\angle FJG$.



27. ★ **MULTIPLE CHOICE** In the diagram, the measure of $\angle XYZ$ is 140°. What is the value of x?

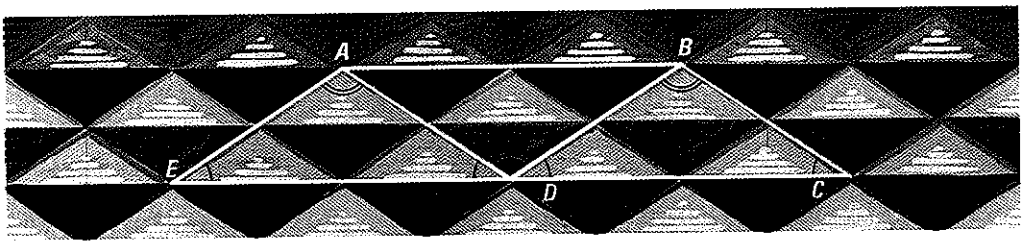
Ⓐ 27 Ⓑ 33

Ⓒ 67 Ⓓ 73



EXAMPLE 4
on p. 27
for Ex. 28

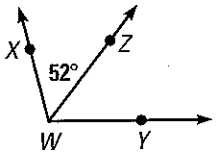
28. CONGRUENT ANGLES In the photograph below, $m\angle AED = 34°$ and $m\angle EAD = 112°$. Identify the congruent angles in the diagram. Then find $m\angle BDC$ and $m\angle ADB$.



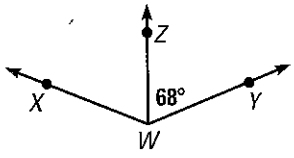
EXAMPLE 5
on p. 28
for Exs. 29–32

ANGLE BISECTORS Given that $\overrightarrow{WZ}$ bisects $\angle XWY$, find the two angle measures not given in the diagram.

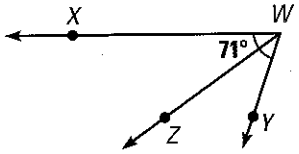
29.



30.



31.



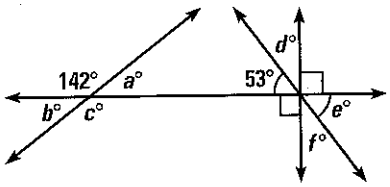
32. ERROR ANALYSIS $\overrightarrow{KM}$ bisects $\angle JKL$ and $m\angle JKM = 30°$. *Describe* and correct the error made in stating that $m\angle JKL = 15°$. Draw a sketch to support your answer.

FINDING ANGLE MEASURES Find the indicated angle measure.

33. $a°$ **34.** $b°$

35. $c°$ **36.** $d°$

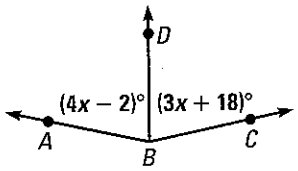
37. $e°$ **38.** $f°$



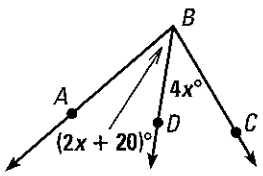
39. ERROR ANALYSIS A student states that $\overrightarrow{AD}$ can bisect $\angle AGC$. *Describe* and correct the student's error. Draw a sketch to support your answer.

ALGEBRA In each diagram, $\overrightarrow{BD}$ bisects $\angle ABC$. Find $m\angle ABC$.

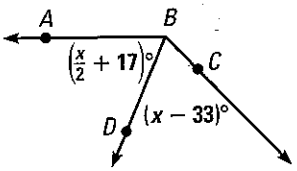
40.



41.



42.



43. ★ SHORT RESPONSE You are measuring $\angle PQR$ with a protractor. When you line up $\overrightarrow{QR}$ with the 20° mark, $\overrightarrow{QP}$ lines up with the 80° mark. Then you move the protractor so that $\overrightarrow{QR}$ lines up with the 15° mark. What mark does $\overrightarrow{QP}$ line up with? *Explain*.

ALGEBRA Plot the points in a coordinate plane and draw $\angle ABC$. Classify the angle. Then give the coordinates of a point that lies in the interior of the angle.

44. $A(3, 3), B(0, 0), C(3, 0)$

45. $A(-5, 4), B(1, 4), C(-2, -2)$

46. $A(-5, 2), B(-2, -2), C(4, -3)$

47. $A(-3, -1), B(2, 1), C(6, -2)$

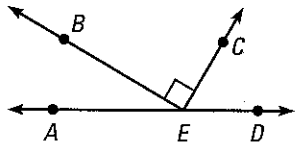
○ = WORKED-OUT SOLUTIONS on p. WS1

★ = STANDARDIZED TEST PRACTICE

48. ALGEBRA Let $(2x - 12)°$ represent the measure of an acute angle. What are the possible values of x?

49. CHALLENGE $\overrightarrow{SQ}$ bisects $\angle RST$, $\overrightarrow{SP}$ bisects $\angle RSQ$, and $\overrightarrow{SV}$ bisects $\angle RSP$. The measure of $\angle VSP$ is 17°. Find $m\angle TSQ$. *Explain.*

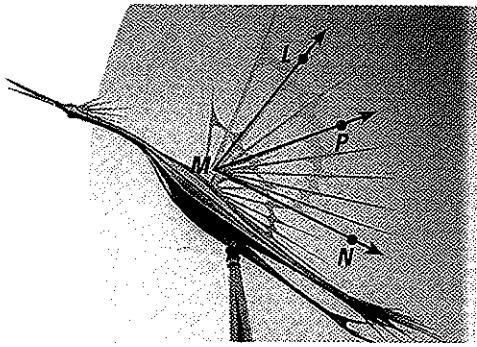
50. FINDING MEASURES In the diagram, $m\angle AEB = \frac{1}{2} \cdot m\angle CED$, and $\angle AED$ is a straight angle. Find $m\angle AEB$ and $m\angle CED$.



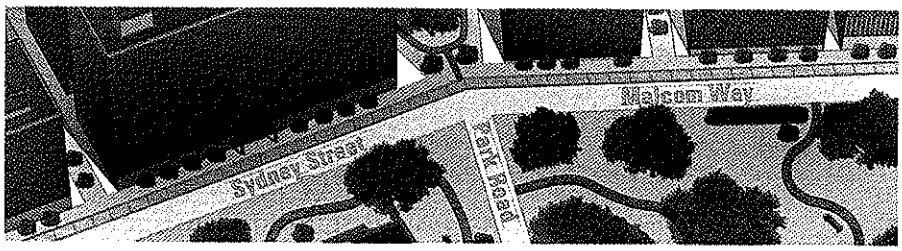
PROBLEM SOLVING

51. SCULPTURE In the sculpture shown in the photograph, suppose the measure of $\angle LMN$ is 79° and the measure of $\angle PMN$ is 47°. What is the measure of $\angle LMP$?

@HomeTutor for problem solving help at classzone.com



52. MAP The map shows the intersection of three roads. Malcom Way intersects Sydney Street at an angle of 162°. Park Road intersects Sydney Street at an angle of 87°. Find the angle at which Malcom Way intersects Park Road.



@HomeTutor for problem solving help at classzone.com

EXAMPLES 4 and 5 on pp. 27–28 for Exs. 53–55

CONSTRUCTION In Exercises 53–55, use the photograph of a roof truss.

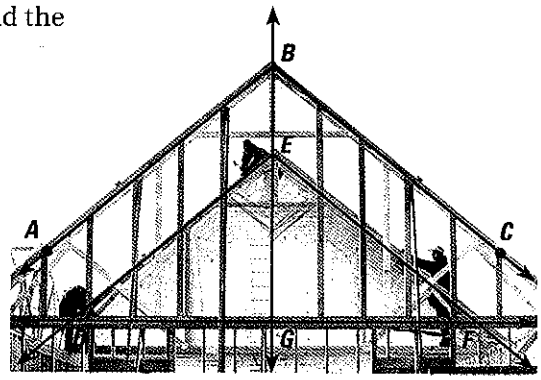
53. In the roof truss, $\overrightarrow{BG}$ bisects $\angle ABC$ and $\angle DEF$, $m\angle ABC = 112°$, and $\angle ABC \cong \angle DEF$. Find the measure of the following angles.

a. $m\angle DEF$ **b.** $m\angle ABG$

c. $m\angle CBG$ **d.** $m\angle DEG$

54. In the roof truss, $\overrightarrow{GB}$ bisects $\angle DGF$. Find $m\angle DGE$ and $m\angle FGE$.

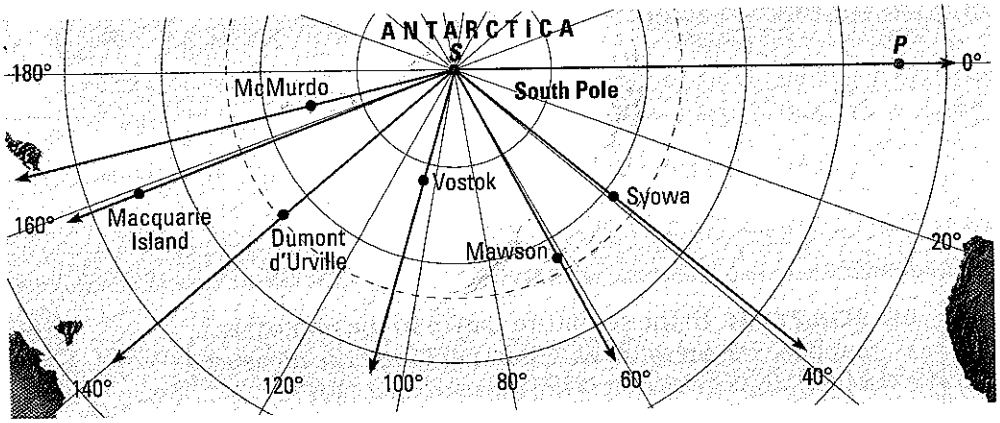
55. Name an example of each of the following types of angles: *acute*, *obtuse*, *right*, and *straight*.



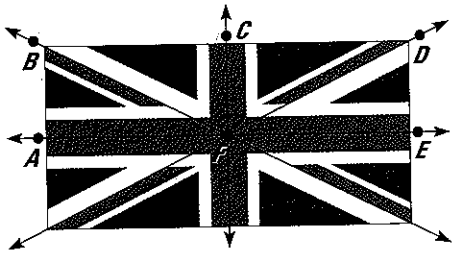
GEOGRAPHY For the given location on the map, estimate the measure of $\angle PSL$, where P is on the Prime Meridian (0° longitude), S is the South Pole, and L is the location of the indicated research station.

56. Macquarie Island **57.** Dumont d'Urville **58.** McMurdo

59. Mawson **60.** Syowa **61.** Vostok



62. ★ **EXTENDED RESPONSE** In the flag shown, $\angle AFE$ is a straight angle and $\overrightarrow{FC}$ bisects $\angle AFE$ and $\angle BFD$.

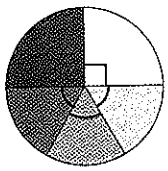


a. Which angles are acute? obtuse? right?

b. Identify the congruent angles.

c. If $m\angle AFB = 26°$, find $m\angle DFE$, $m\angle BFC$, $m\angle CFD$, $m\angle AFC$, $m\angle AFD$, and $m\angle BFD$. *Explain.*

63. **CHALLENGE** Create a set of data that could be represented by the circle graph at the right. *Explain* your reasoning.



MIXED REVIEW

PREVIEW
Prepare for Lesson 1.5 in Ex. 64.

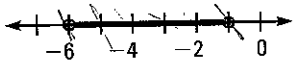
64. You and a friend go out to dinner and each pay for your own meal. The total cost of the two meals is $25. Your meal cost $4 more than your friend's meal. How much does each meal cost? *(p. 894)*

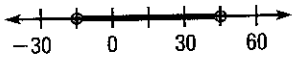
Graph the inequality on a number line. Tell whether the graph is a *segment*, a *ray* or *rays*, a *point*, or a *line*. *(p. 2)*

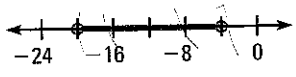
65. $x \leq -8$ **66.** $x \geq 6$ **67.** $-3 \leq x \leq 5$

68. $x \geq -7$ and $x \leq -1$ **69.** $x \geq -2$ or $x \leq 4$ **70.** $|x| \geq 0$

Find the coordinate of the midpoint of the segment. *(p. 15)*

71. 

72. 

73. 

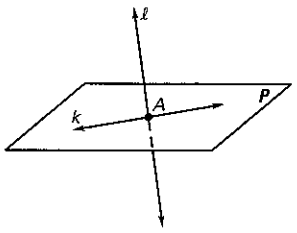
EXTRA PRACTICE for Lesson 1.4, p. 896 **ONLINE QUIZ** at classzone.com

Selected Answers

Chapter 1

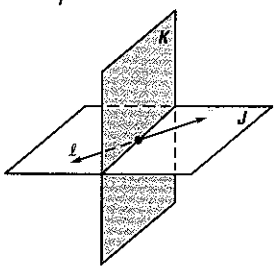
1.1 Skill Practice (pp. 5–7) **1. a.** point Q **b.** line segment MN **c.** ray ST **d.** line FG **3.** $\overleftrightarrow{QW}$, line g **5.** *Sample answer:* points R, Q, S; point T **7.** Yes; through any three points not on the same line, there is exactly one plane. **9.** $\overrightarrow{VY}$, $\overrightarrow{VX}$, $\overrightarrow{VZ}$, $\overrightarrow{VW}$ **11.** $\overrightarrow{WX}$

15. *Sample:*

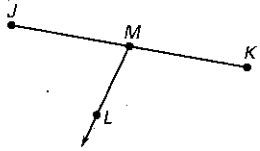


17. point R **19.** $\overleftrightarrow{RS}$ **21.** yes; yes

23. *Sample:*

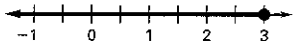


25. *Sample:*

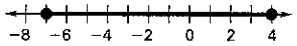


27. on the line **29.** not on the line **31.** on the line

33. ray

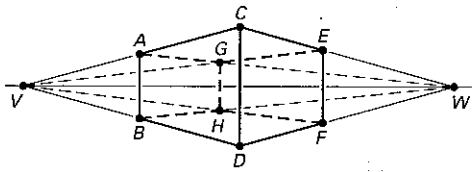


35. segment



1.1 Problem Solving (pp. 7–8) **41.** intersection of a line and a plane **43.** Four points are not necessarily coplanar; no; three points determine a unique plane.

45. a–c.



1.2 Skill Practice (pp. 12–13) **1.** $\overline{MN}$ means segment MN while MN is the length of $\overline{MN}$. **3.** 2.1 cm **5.** 3.5 cm **7.** 44 **9.** 23 **11.** 13 **13.** congruent **15.** not congruent **17.** 7 **19.** 9 **21.** 10 **23.** 20 **25.** 30 **29.** $(3x - 16) + (4x - 8) = 60$; 12; 20, 40

1.2 Problem Solving (pp. 13–14)

33. a. 1883 mi **b.** about 50 mi/h

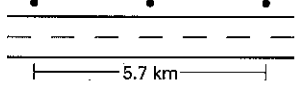
35. a. *Sample:*

b. 21 ft

1.3 Skill Practice (pp. 19–20) **1.** Distance Formula **3.** $10\frac{1}{4}$ in. **5.** 26 cm **7.** $4\frac{3}{4}$ in. **9.** $2\frac{3}{8}$ in. **11.** 10 **13.** 1 **15.** 70 **17.** (5, 5) **19.** (1, 4) **21.** $\left(1\frac{1}{2}, -1\right)$ **23.** $\left(\frac{m}{2}, \frac{n}{2}\right)$; when x_2 and y_2 are replaced by zero in the Midpoint Formula and x_1 and y_1 are replaced by m and n the result is $\left(\frac{m}{2}, \frac{n}{2}\right)$. **25.** $(-3, 10)$ **27.** $(4, 8)$ **29.** $(-18, 22)$ **31.** 4.5 **33.** 5.7 **35.** 7; $-\frac{1}{2}$ **37.** 40; 5 **39.** 9; $-3\frac{1}{2}$ **43.** $AB = 3\sqrt{5}$, $CD = 2\sqrt{10}$; not congruent **45.** $JK = 8\sqrt{2}$, $LM = \sqrt{130}$; not congruent

1.3 Problem Solving (pp. 21–22)

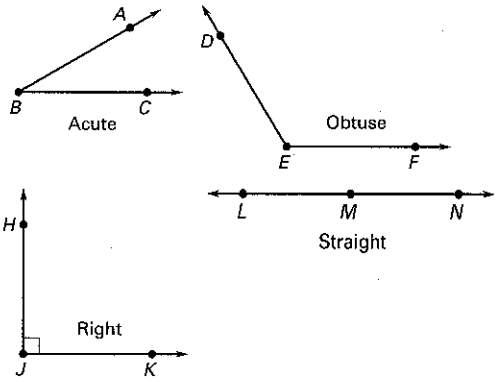
49. 2.85 km



51. objects B and D; objects A and C **53. a.** 191 yd **b.** 40 yd **c.** About 1.5 min; find the total distance, about 230 yards, and divide by 150 yards per minute.

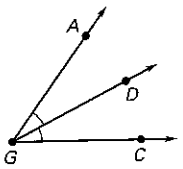
1.4 Skill Practice (pp. 28–31)

1. *Sample:*

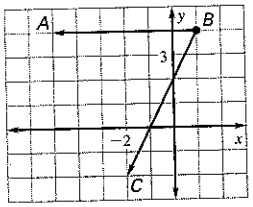


3. $\angle ABC$, $\angle B$, $\angle CBA$; B, $\overrightarrow{BA}$, $\overrightarrow{BC}$ **5.** $\angle MTP$, $\angle T$, $\angle PTM$; T, $\overrightarrow{TM}$, $\overrightarrow{TP}$ **7.** straight **9.** right **11.** 90°; right **13.** 135°; obtuse **15–19.** Sample answers are given. **15.** $\angle BCA$; right **17.** $\angle DFB$; straight **19.** $\angle CDB$; acute **23.** 65° **25.** 55° **29.** $m\angle XWY = 104°$, $m\angle ZWY = 52°$

31. $m\angle XWZ = 35.5°$, $m\angle YWZ = 35.5°$ **33.** 38°
35. 142° **37.** 53°
39. If a ray bisects $\angle AGC$, then its endpoint must be point G. *Sample:*

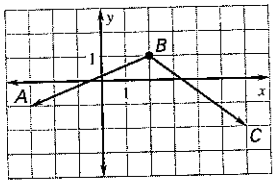


41. 80° **43.** 75°; both angle measures are 5° less.
45.



Acute.
Sample answer: (−2, 0)

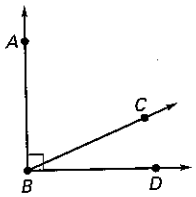
47.



Obtuse.
Sample answer: (2, 0)

1.4 Problem Solving (pp. 31–32) **51.** 32° **53. a.** 112° **b.** 56° **c.** 56° **d.** 56° **55.** *Sample answer:* acute: $\angle ABG$, obtuse: $\angle ABC$, right: $\angle DGE$, straight: $\angle DGF$
57. about 140° **59.** about 62° **61.** about 107°

1.5 Skill Practice (pp. 38–40)
1.

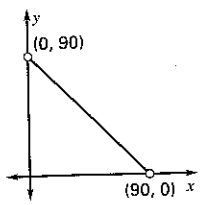


No. *Sample answer:* Any two angles whose angle measures add up to 90° are complementary, but they do not have to have a common vertex and side.

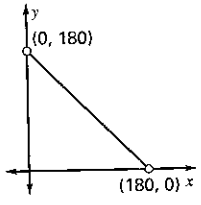
3. adjacent **5.** adjacent **7.** $\angle GLH$ and $\angle HLJ$, $\angle GLJ$ and $\angle JLK$ **9.** 69° **11.** 85° **13.** 25° **15.** 153° **17.** 135°, 45° **19.** 54°, 36° **21.** linear pair **23.** vertical angles **25.** linear pair **27.** neither **29.** The angles are complementary so they should be equal to 90°; $x + 3x = 90°$, $4x = 90$, $x = 22.5$. **31.** 10, 35 **33.** 55, 30 **35.** Never; a straight angle is 180°, and it is not possible to have a complement of an angle that is 180°. **37.** Always; the sum of complementary angles is 90°, so each angle must be less than 90°, making them acute. **39.** 71°, 19° **41.** 68°, 22° **43.** 58°, 122°

1.5 Problem Solving (pp. 40–41) **47.** neither
49–51. Sample answers are given. **49.** $\angle FGB$, $\angle BGC$ **51.** $\angle AGE$, $\angle EGD$ **53.** *Sample answer:* Subtract 90° from $m\angle FGB$. **55. a.** $y_1 = 90 - x$, $0 < x < 90$; $y_2 = 180 - x$, $0 < x < 180$; the measure of the complement must be less than 90° and the measure of its supplement must be less than 180°.

55. b.

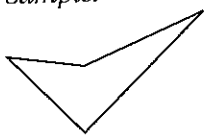


$0 < y_1 < 90$

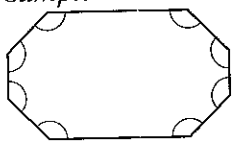


$0 < y_2 < 180$

1.6 Skill Practice (pp. 44–46) **1.** An n-gon is a polygon with n sides. **3.** polygon; concave **5.** polygon; convex **9.** Pentagon; regular; it has 5 congruent sides and angles. **11.** Triangle; none of these; the sides and/or the angles are not all congruent. **13.** Quadrilateral; equiangular; it has 4 congruent angles.
15. 8 in. **17.** 3 ft **19.** sometimes **21.** never **23.** never
25. *Sample:*



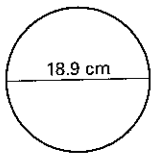
27. *Sample:*



29. 1

1.6 Problem Solving (pp. 46–47) **33.** triangle; regular **35.** octagon; regular **39.** 105 mm; each side of the button is 15 millimeters long, so the perimeter of the button is 15(7) = 105 millimeters. **41. a.** 3 **b.** 5 **c.** 6 **d.** 8

1.7 Skill Practice (pp. 52–54) **1.** *Sample answer:* The diameter is twice the radius. **3.** (52)(9) must be divided by 2; $\frac{52(9)}{2} = 234$ ft^2. **5.** 22.4 m, 29.4 m^2
7. 180 yd, 1080 yd^2 **9.** 36 cm, 36 cm^2 **11.** 84.8 cm, 572.3 cm^2 **13.** 76.0 cm, 459.7 cm^2
15.



59.3 cm, 280.4 cm^2

17. 12.4 **21.** 1.44 **23.** 8,000,000 **25.** 3,456 **27.** 14.5 m **29.** 4.5 in. **31.** 6 in., 3 in. **33.** Octagon; dodecagon; the square has 4 sides, so a polygon with the same side length and twice the perimeter would have to have 2(4) = 8 sides, an octagon; a polygon with the same side length and three times the perimeter would have to have 4(3) = 12 sides, a dodecagon. **35.** $\sqrt{346}$ in. **37.** $5\sqrt{42}$ km

1.7 Problem Solving (pp. 54–56) **41.** 1350 yd^2; 450 ft **43. a.** 15 in. **b.** 6 in.; the spoke is 21 inches long from the center to the tip, and it is 15 inches from the center to the outer edge, so 21 − 15 = 6 inches is the length of the handle.

SELECTED ANSWERS