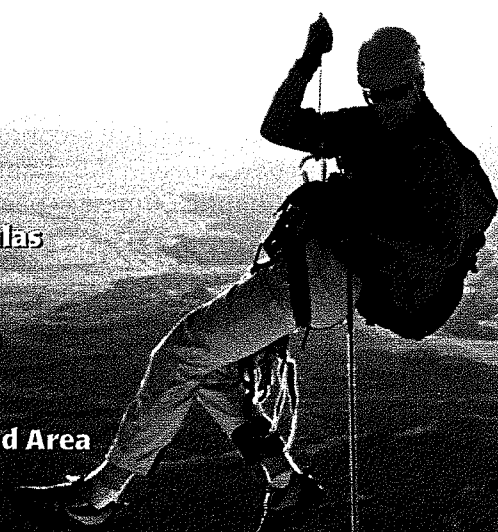


Geo

1

Essentials of Geometry

- 1.1 Identify Points, Lines, and Planes
- 1.2 Use Segments and Congruence
- 1.3 Use Midpoint and Distance Formulas
- 1.4 Measure and Classify Angles
- 1.5 Describe Angle Pair Relationships
- 1.6 Classify Polygons
- 1.7 Find Perimeter, Circumference, and Area



Before

In previous courses, you learned the following skills, which you'll use in Chapter 1: finding measures, evaluating expressions, and solving equations.

Prerequisite Skills

VOCABULARY CHECK

Copy and complete the statement.

1. The distance around a rectangle is called its ?, and the distance around a circle is called its ?.
2. The number of square units covered by a figure is called its ?.

SKILLS AND ALGEBRA CHECK

Evaluate the expression. (Review p. 870 for 1.2, 1.3, 1.7.)

3. $|4 - 6|$
4. $|3 - 11|$
5. $|-4 + 5|$
6. $|-8 - 10|$

Evaluate the expression when $x = 2$. (Review p. 870 for 1.3–1.6.)

7. $5x$
8. $20 - 8x$
9. $-18 + 3x$
10. $-5x - 4 + 2x$

Solve the equation. (Review p. 875 for 1.2–1.7.)

11. $274 = -2z$
12. $8x + 12 = 60$
13. $2y - 5 + 7y = -32$
14. $6p + 11 + 3p = -7$
15. $8m - 5 = 25 - 2m$
16. $-2n + 18 = 5n - 24$

@HomeTutor Prerequisite skills practice at classzone.com

Now

In Chapter 1, you will apply the big ideas listed below and reviewed in the Chapter Summary on page 59. You will also use the key vocabulary listed below.

Big Ideas

- 1 Describing geometric figures
- 2 Measuring geometric figures
- 3 Understanding equality and congruence

KEY VOCABULARY

- undefined terms, *p. 2*
point, line, plane
- defined terms, *p. 3*
- line segment, endpoints, *p. 3*
- ray, opposite rays, *p. 3*
- postulate, axiom, *p. 9*
- congruent segments, *p. 11*
- midpoint, *p. 15*
- segment bisector, *p. 15*
- acute, right, obtuse, straight angles, *p. 25*
- congruent angles, *p. 26*
- angle bisector, *p. 28*
- linear pair, *p. 37*
- vertical angles, *p. 37*
- polygon, *p. 42*
- convex, concave, *p. 42*
- *n*-gon, *p. 43*
- equilateral, equiangular, regular, *p. 43*

Why?

Geometric figures can be used to represent real-world situations. For example, you can show a climber's position along a stretched rope by a point on a line segment.

Animated Geometry

The animation illustrated below for Exercise 35 on page 14 helps you answer this question: How far must a climber descend to reach the bottom of a cliff?

Your goal is to find the distance from a climber's position to the bottom of a cliff.

AC is 52 feet and AB is 31 feet. How much farther must the climber descend to reach the bottom of the cliff? Enter your answer in the box below and click "Check Answer."

Distance the climber has to descend = feet. Check Answer

Use the given information to enter a distance. Then check your answer.

Animated Geometry at classzone.com

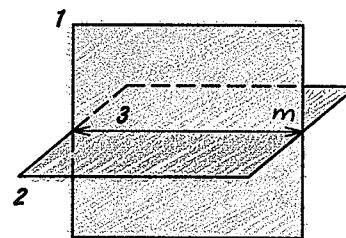
Other animations for Chapter 1: pages 3, 21, 25, 43, and 52

EXAMPLE 4 Sketch intersections of planes

Sketch two planes that intersect in a line.

Solution

- STEP 1** Draw a vertical plane. Shade the plane.
- STEP 2** Draw a second plane that is horizontal. Shade this plane a different color. Use dashed lines to show where one plane is hidden.
- STEP 3** Draw the line of intersection.

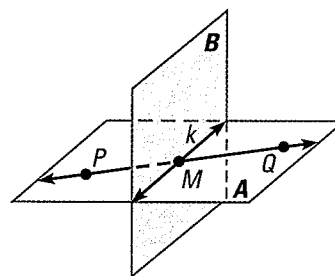


✓ GUIDED PRACTICE for Examples 3 and 4

4. Sketch two different lines that intersect a plane at the same point.

Use the diagram at the right.

5. Name the intersection of \overleftrightarrow{PQ} and line k .
6. Name the intersection of plane A and plane B .
7. Name the intersection of line k and plane A .



1.1 EXERCISES

HOMEWORK KEY

- = WORKED-OUT SOLUTIONS
on p. WS1 for Exs. 15, 19, and 43
- ★ = STANDARDIZED TEST PRACTICE
Exs. 2, 7, 13, 16, and 43

SKILL PRACTICE

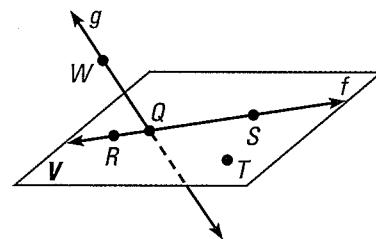
1. **VOCABULARY** Write in words what each of the following symbols means.

a. Q b. \overline{MN} c. \overleftrightarrow{ST} d. \overleftrightarrow{FG}

2. ★ **WRITING** Compare collinear points and coplanar points. Are collinear points also coplanar? Are coplanar points also collinear? Explain.

NAMING POINTS, LINES, AND PLANES In Exercises 3–7, use the diagram.

3. Give two other names for \overleftrightarrow{WQ} .
4. Give another name for plane V .
5. Name three points that are collinear. Then name a fourth point that is *not* collinear with these three points.
6. Name a point that is *not* coplanar with R , S , and T .
7. ★ **WRITING** Is point W coplanar with points Q and R ? Explain.



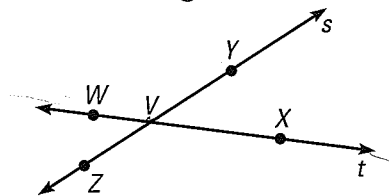
EXAMPLE 1
on p. 3
for Exs. 3–7

EXAMPLE 2

on p. 4
for Exs. 8–13

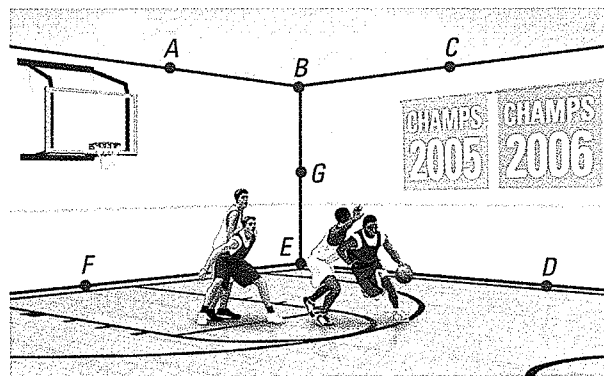
NAMING SEGMENTS AND RAYS In Exercises 8–12, use the diagram.

8. What is another name for \overline{ZY} ?
9. Name all rays with endpoint V .
10. Name two pairs of opposite rays.
11. Give another name for \overrightarrow{WV} .



12. **ERROR ANALYSIS** A student says that \overrightarrow{VW} and \overrightarrow{VZ} are opposite rays because they have the same endpoint. Describe the error.
13. **★ MULTIPLE CHOICE** Which statement about the diagram at the right is true?

- (A) $A, B,$ and C are collinear.
- (B) $C, D, E,$ and G are coplanar.
- (C) B lies on \overrightarrow{GE} .
- (D) \overrightarrow{EF} and \overrightarrow{ED} are opposite rays.



EXAMPLES

3 and 4

on pp. 4–5
for Exs. 14–23

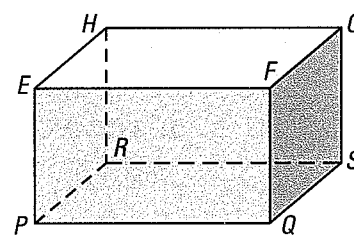
SKETCHING INTERSECTIONS Sketch the figure described.

14. Three lines that lie in a plane and intersect at one point
- (15) One line that lies in a plane, and one line that does not lie in the plane
16. **★ MULTIPLE CHOICE** Line AB and line CD intersect at point E . Which of the following are opposite rays?

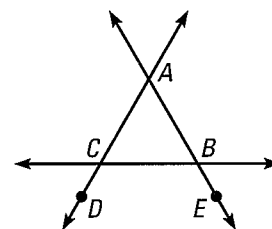
- (A) \overrightarrow{EC} and \overrightarrow{ED}
- (B) \overrightarrow{CE} and \overrightarrow{DE}
- (C) \overrightarrow{AB} and \overrightarrow{BA}
- (D) \overrightarrow{AE} and \overrightarrow{BE}

READING DIAGRAMMS In Exercises 17–22, use the diagram at the right.

17. Name the intersection of \overleftrightarrow{PR} and \overleftrightarrow{HR} .
18. Name the intersection of plane EFG and plane FGS .
- (19) Name the intersection of plane PQS and plane HGS .
20. Are points $P, Q,$ and F collinear? Are they coplanar?
21. Are points P and G collinear? Are they coplanar?
22. Name three planes that intersect at point E .



23. **SKETCHING PLANES** Sketch plane J intersecting plane K . Then draw a line l in plane J that intersects plane K at a single point.
24. **NAMING RAYS** Name 10 different rays in the diagram at the right. Then name 2 pairs of opposite rays.
25. **SKETCHING** Draw three noncollinear points $J, K,$ and L . Sketch \overline{JK} and add a point M on \overline{JK} . Then sketch \overrightarrow{ML} .
26. **SKETCHING** Draw two points P and Q . Then sketch \overrightarrow{PQ} . Add a point R on the ray so that Q is between P and R .



REVIEW
ALGEBRA

For help with equations of lines, see p. 878.

37. ALGEBRA In Exercises 27–32, you are given an equation of a line and a point. Use substitution to determine whether the point is on the line.

27. $y = x - 4$; $A(5, 1)$

28. $y = x + 1$; $A(1, 0)$

29. $y = 3x + 4$; $A(7, 1)$

30. $y = 4x + 2$; $A(1, 6)$

31. $y = 3x - 2$; $A(-1, -5)$

32. $y = -2x + 8$; $A(-4, 0)$

GRAPHING Graph the inequality on a number line. Tell whether the graph is a *segment*, a *ray* or *rays*, a *point*, or a *line*.

33. $x \leq 3$

34. $x \geq -4$

35. $-7 \leq x \leq 4$

36. $x \geq 5$ or $x \leq -2$

37. $x \geq -1$ or $x \leq 5$

38. $|x| \leq 0$

39. CHALLENGE Tell whether each of the following situations involving three planes is possible. If a situation is possible, make a sketch.

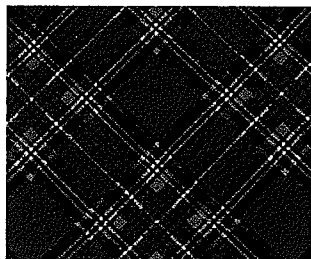
- None of the three planes intersect.
- The three planes intersect in one line.
- The three planes intersect in one point.
- Two planes do not intersect. The third plane intersects the other two.
- Exactly two planes intersect. The third plane does not intersect the other two.

PROBLEM SOLVING

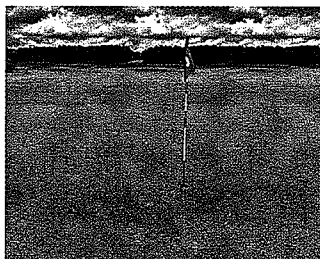
EXAMPLE 3
on p. 4
for Exs. 40–42

EVERYDAY INTERSECTIONS What kind of geometric intersection does the photograph suggest?

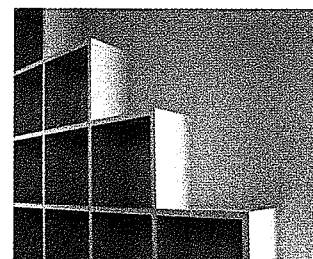
40.



41.



42.



43. ★ SHORT RESPONSE Explain why a four-legged table may rock from side to side even if the floor is level. Would a three-legged table on the same level floor rock from side to side? Why or why not?

@HomeTutor for problem solving help at classzone.com

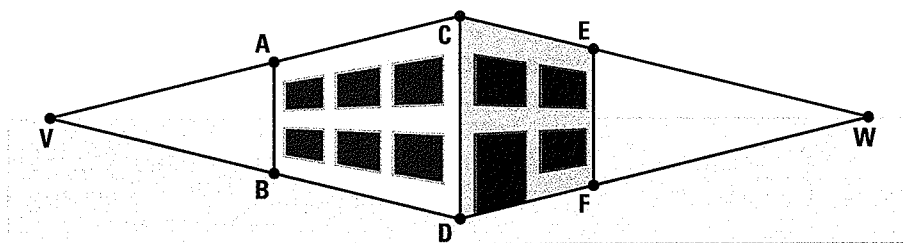
44. SURVEYING A surveying instrument is placed on a tripod. The tripod has three legs whose lengths can be adjusted.

- When the tripod is sitting on a level surface, are the tips of the legs coplanar?
- Suppose the tripod is used on a sloping surface. The length of each leg is adjusted so that the base of the surveying instrument is level with the horizon. Are the tips of the legs coplanar? Explain.

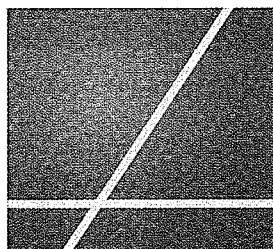
@HomeTutor for problem solving help at classzone.com



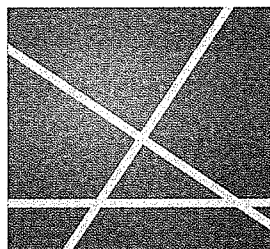
45. **MULTI-STEP PROBLEM** In a *perspective drawing*, lines that do not intersect in real life are represented by lines that appear to intersect at a point far away on the horizon. This point is called a *vanishing point*. The diagram shows a drawing of a house with two vanishing points.



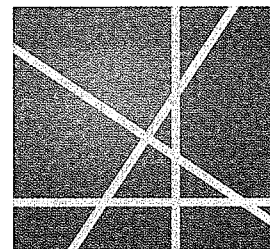
- Trace the black line segments in the drawing. Using lightly dashed lines, join points A and B to the vanishing point W . Join points E and F to the vanishing point V .
 - Label the intersection of \overleftrightarrow{EV} and \overleftrightarrow{AW} as G . Label the intersection of \overleftrightarrow{FV} and \overleftrightarrow{BW} as H .
 - Using heavy dashed lines, draw the hidden edges of the house: \overline{AG} , \overline{EG} , \overline{BH} , \overline{FH} , and \overline{GH} .
46. **CHALLENGE** Each street in a particular town intersects every existing street exactly one time. Only two streets pass through each intersection.



2 streets



3 streets



4 streets

- A traffic light is needed at each intersection. How many traffic lights are needed if there are 5 streets in the town? 6 streets?
- Describe a pattern you can use to find the number of additional traffic lights that are needed each time a street is added to the town.

MIXED REVIEW

Find the difference. (p. 869)

47. $-15 - 9$

48. $6 - 10$

49. $-25 - (-12)$

50. $13 - 20$

51. $16 - (-4)$

52. $-5 - 15$

Evaluate the expression. (p. 870)

53. $5 \cdot |-2 + 1|$

54. $|-8 + 7| - 6$

55. $-7 \cdot |8 - 10|$

Plot the point in a coordinate plane. (p. 878)

56. $A(2, 4)$

57. $B(-3, 6)$

58. $E(6, 7.5)$

PREVIEW

Prepare for
Lesson 1.2
in Exs. 53–58.

1.2 EXERCISES

HOMEWORK KEY

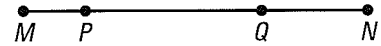
○ = WORKED-OUT SOLUTIONS
on p. WS1 for Exs. 13, 17, and 33

★ = STANDARDIZED TEST PRACTICE
Exs. 2, 20, 27, and 34

SKILL PRACTICE

In Exercises 1 and 2, use the diagram at the right.

1. **VOCABULARY** Explain what \overline{MN} means and what MN means.

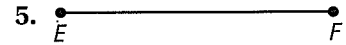
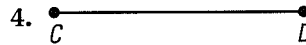
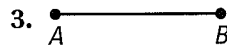


2. ★ **WRITING** Explain how you can find PN if you know PQ and QN . How can you find PN if you know MP and MN ?

EXAMPLE 1

on p. 9
for Exs. 3–5

MEASUREMENT Measure the length of the segment to the nearest tenth of a centimeter.



EXAMPLES 2 and 3

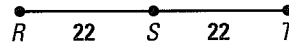
on pp. 10–11
for Exs. 6–12

SEGMENT ADDITION POSTULATE Find the indicated length.

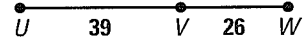
6. Find MP .



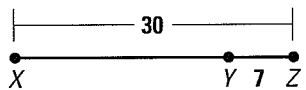
7. Find RT .



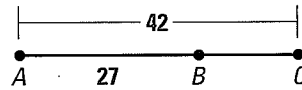
8. Find UW .



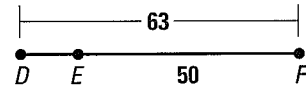
9. Find XY .



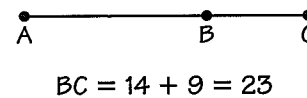
10. Find BC .



11. Find DE .



12. **ERROR ANALYSIS** In the figure at the right, $AC = 14$ and $AB = 9$. Describe and correct the error made in finding BC .



EXAMPLE 4

on p. 11
for Exs. 13–19

CONGRUENCE In Exercises 13–15, plot the given points in a coordinate plane. Then determine whether the line segments named are congruent.

13. $A(0, 1)$, $B(4, 1)$, $C(1, 2)$, $D(1, 6)$; \overline{AB} and \overline{CD}

14. $J(-6, -8)$, $K(-6, 2)$, $L(-2, -4)$, $M(-6, -4)$; \overline{JK} and \overline{LM}

15. $R(-200, 300)$, $S(200, 300)$, $T(300, -200)$, $U(300, 100)$; \overline{RS} and \overline{TU}

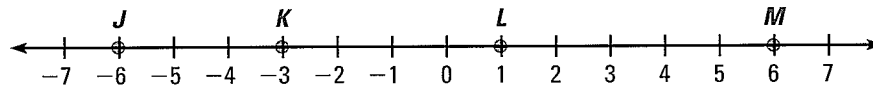
ALGEBRA Use the number line to find the indicated distance.

16. JK

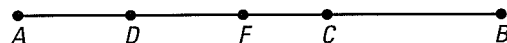
17. JL

18. JM

19. KM

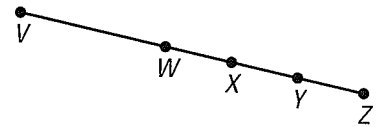


20. ★ **SHORT RESPONSE** Use the diagram. Is it possible to use the Segment Addition Postulate to show that $FB > CB$ or that $AC > DB$? Explain.



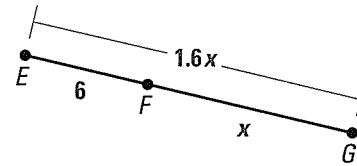
FINDING LENGTHS In the diagram, points $V, W, X, Y,$ and Z are collinear, $VZ = 52, XZ = 20,$ and $WX = XY = YZ.$ Find the indicated length.

21. WX 22. VW 23. WY
 24. VX 25. WZ 26. VY



27. **★ MULTIPLE CHOICE** Use the diagram. What is the length of \overline{EG} ?

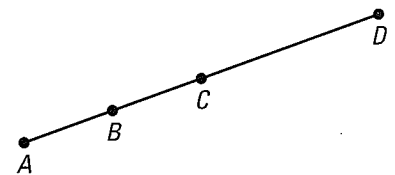
- (A) 1 (B) 4.4
 (C) 10 (D) 16



(M) ALGEBRA Point S is between R and T on $\overline{RT}.$ Use the given information to write an equation in terms of $x.$ Solve the equation. Then find RS and $ST.$

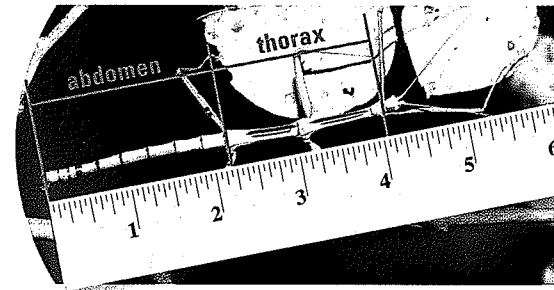
28. $RS = 2x + 10$ 29. $RS = 3x - 16$ 30. $RS = 2x - 8$
 $ST = x - 4$ $ST = 4x - 8$ $ST = 3x - 10$
 $RT = 21$ $RT = 60$ $RT = 17$

31. **CHALLENGE** In the diagram, $\overline{AB} \cong \overline{BC}, \overline{AC} \cong \overline{CD},$ and $AD = 12.$ Find the lengths of all the segments in the diagram. Suppose you choose one of the segments at random. What is the probability that the measure of the segment is greater than 3? *Explain.*



PROBLEM SOLVING

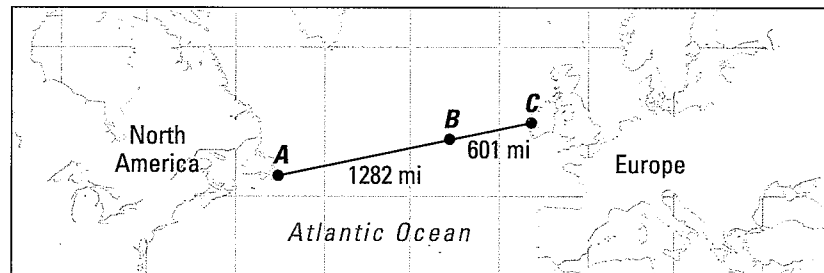
32. **SCIENCE** The photograph shows an insect called a walkingstick. Use the ruler to estimate the length of the abdomen and the length of the thorax to the nearest $\frac{1}{4}$ inch. About how much longer is the walkingstick's abdomen than its thorax?



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EXAMPLE 2
 on p. 10
 for Ex. 33

(33) MODEL AIRPLANE In 2003, a remote-controlled model airplane became the first ever to fly nonstop across the Atlantic Ocean. The map shows the airplane's position at three different points during its flight.



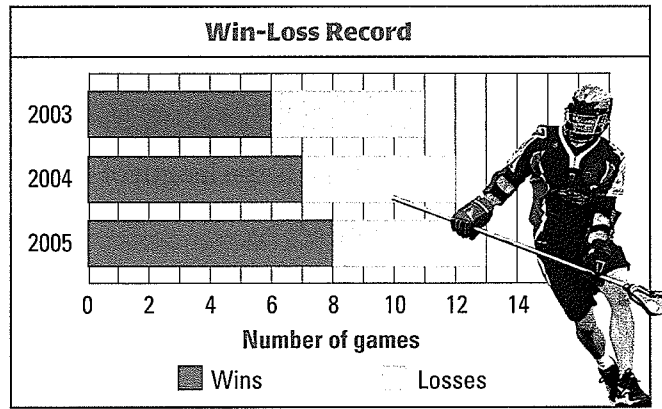
- A** Leave Cape Spear, Newfoundland
B Approximate position after about 1 day
C Land at Mannin Bay, Ireland, after nearly 38 hours

- a. Find the total distance the model airplane flew.
 b. The model airplane's flight lasted nearly 38 hours. Estimate the airplane's average speed in miles per hour.

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34. ★ **SHORT RESPONSE** The bar graph shows the win-loss record for a lacrosse team over a period of three years.

- Use the scale to find the length of the yellow bar for each year. What does the length represent?
- For each year, find the percent of games lost by the team.
- Explain* how you are applying the Segment Addition Postulate when you find information from a stacked bar graph like the one shown.



35. **MULTI-STEP PROBLEM** A climber uses a rope to descend a vertical cliff. Let A represent the point where the rope is secured at the top of the cliff, let B represent the climber's position, and let C represent the point where the rope is secured at the bottom of the cliff.

- Model** Draw and label a line segment that represents the situation.
- Calculate** If AC is 52 feet and AB is 31 feet, how much farther must the climber descend to reach the bottom of the cliff?

at classzone.com

36. **CHALLENGE** Four cities lie along a straight highway in this order: City A, City B, City C, and City D. The distance from City A to City B is 5 times the distance from City B to City C. The distance from City A to City D is 2 times the distance from City A to City B. Copy and complete the mileage chart.

	City A	City B	City C	City D
City A		?	?	?
City B	?		?	?
City C	?	?		10 mi
City D	?	?	?	

MIXED REVIEW

PREVIEW

Prepare for
Lesson 1.3
in Exs. 37–42.

Simplify the expression. Write your answer in simplest radical form. (p. 874)

37. $\sqrt{45 + 99}$

38. $\sqrt{14 + 36}$

39. $\sqrt{42 + (-2)^2}$

Solve the equation. (p. 875)

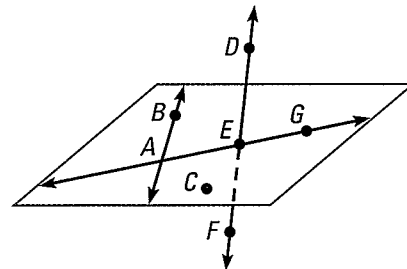
40. $4m + 5 = 7 + 6m$

41. $13 - 4h = 3h - 8$

42. $17 + 3x = 18x - 28$

Use the diagram to decide whether the statement is true or false. (p. 2)

- Points A , C , E , and G are coplanar.
- \overleftrightarrow{DF} and \overleftrightarrow{AG} intersect at point E .
- \overrightarrow{AE} and \overrightarrow{EG} are opposite rays.



1.3 EXERCISES

HOMEWORK KEY

○ = WORKED-OUT SOLUTIONS
on p. WS1 for Exs. 15, 35, and 49

★ = STANDARDIZED TEST PRACTICE
Exs. 2, 23, 34, 41, 42, and 53

SKILL PRACTICE

1. **VOCABULARY** Copy and complete: To find the length of \overline{AB} , with endpoints $A(-7, 5)$ and $B(4, -6)$, you can use the .

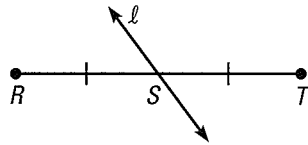
2. ★ **WRITING** Explain what it means to bisect a segment. Why is it impossible to bisect a line?

EXAMPLE 1

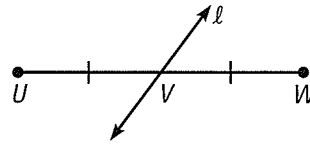
on p. 15
for Exs. 3–10

FINDING LENGTHS Line ℓ bisects the segment. Find the indicated length.

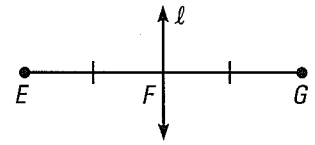
3. Find RT if $RS = 5\frac{1}{8}$ in.



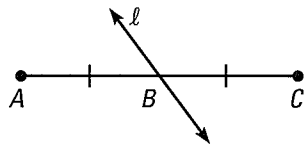
4. Find UW if $VW = \frac{5}{8}$ in.



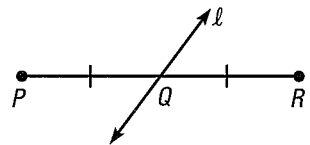
5. Find EG if $EF = 13$ cm.



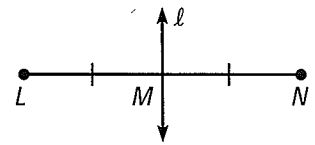
6. Find BC if $AC = 19$ cm.



7. Find QR if $PR = 9\frac{1}{2}$ in.



8. Find LM if $LN = 137$ mm.



9. **SEGMENT BISECTOR** Line RS bisects \overline{PQ} at point R . Find RQ if $PQ = 4\frac{3}{4}$ inches.

10. **SEGMENT BISECTOR** Point T bisects \overline{UV} . Find UV if $UT = 2\frac{7}{8}$ inches.

EXAMPLE 2

on p. 16
for Exs. 11–16

ALGEBRA In each diagram, M is the midpoint of the segment. Find the indicated length.

11. Find AM .



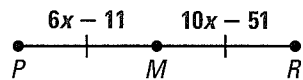
12. Find EM .



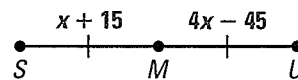
13. Find JM .



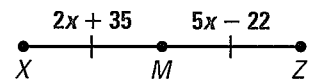
14. Find PR .



15. Find SU .



16. Find XZ .



EXAMPLE 3

on p. 17
for Exs. 17–30

FINDING MIDPOINTS Find the coordinates of the midpoint of the segment with the given endpoints.

17. $C(3, 5)$ and $D(7, 5)$

18. $E(0, 4)$ and $F(4, 3)$

19. $G(-4, 4)$ and $H(6, 4)$

20. $J(-7, -5)$ and $K(-3, 7)$

21. $P(-8, -7)$ and $Q(11, 5)$

22. $S(-3, 3)$ and $T(-8, 6)$

23. ★ **WRITING** Develop a formula for finding the midpoint of a segment with endpoints $A(0, 0)$ and $B(m, n)$. Explain your thinking.

24. **ERROR ANALYSIS** Describe the error made in finding the coordinates of the midpoint of a segment with endpoints $S(8, 3)$ and $T(2, -1)$.

$$\left(\frac{8-2}{2}, \frac{3-(-1)}{2}\right) = (3, 2)$$

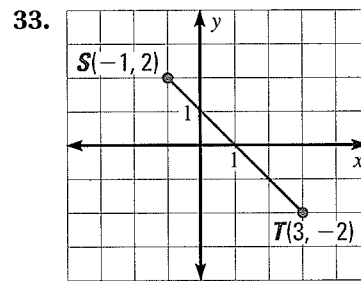
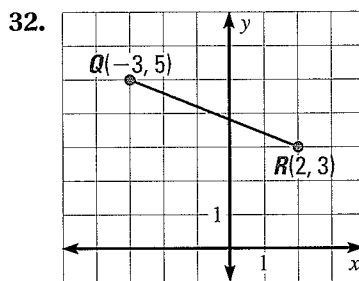
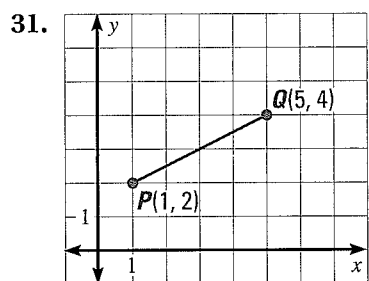


FINDING ENDPOINTS Use the given endpoint R and midpoint M of \overline{RS} to find the coordinates of the other endpoint S .

25. $R(3, 0), M(0, 5)$ 26. $R(5, 1), M(1, 4)$ 27. $R(6, -2), M(5, 3)$
 28. $R(-7, 11), M(2, 1)$ 29. $R(4, -6), M(-7, 8)$ 30. $R(-4, -6), M(3, -4)$

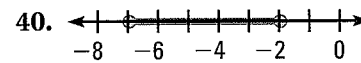
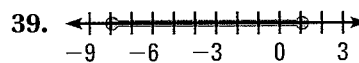
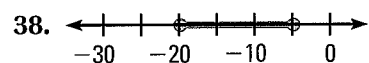
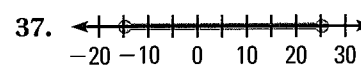
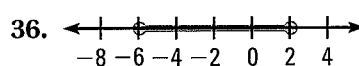
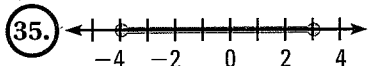
EXAMPLE 4
 on p. 18
 for Exs. 31–34

DISTANCE FORMULA Find the length of the segment. Round to the nearest tenth of a unit.



34. **★ MULTIPLE CHOICE** The endpoints of \overline{MN} are $M(-3, -9)$ and $N(4, 8)$. What is the approximate length of \overline{MN} ?
 (A) 1.4 units (B) 7.2 units (C) 13 units (D) 18.4 units

NUMBER LINE Find the length of the segment. Then find the coordinate of the midpoint of the segment.



41. **★ MULTIPLE CHOICE** The endpoints of \overline{LF} are $L(-2, 2)$ and $F(3, 1)$. The endpoints of \overline{JR} are $J(1, -1)$ and $R(2, -3)$. What is the approximate difference in the lengths of the two segments?
 (A) 2.24 (B) 2.86 (C) 5.10 (D) 7.96
42. **★ SHORT RESPONSE** One endpoint of \overline{PQ} is $P(-2, 4)$. The midpoint of \overline{PQ} is $M(1, 0)$. Explain how to find PQ .

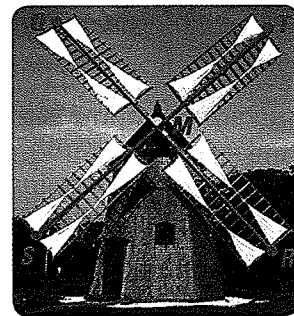
COMPARING LENGTHS The endpoints of two segments are given. Find each segment length. Tell whether the segments are congruent.

43. \overline{AB} : $A(0, 2), B(-3, 8)$ 44. \overline{EF} : $E(1, 4), F(5, 1)$ 45. \overline{JK} : $J(-4, 0), K(4, 8)$
 \overline{CD} : $C(-2, 2), D(0, -4)$ \overline{GH} : $G(-3, 1), H(1, 6)$ \overline{LM} : $L(-4, 2), M(3, -7)$
46. **ⓧ ALGEBRA** Points $S, T,$ and P lie on a number line. Their coordinates are 0, 1, and x , respectively. Given $SP = PT$, what is the value of x ?
47. **CHALLENGE** M is the midpoint of \overline{JK} , $JM = \frac{x}{8}$, and $JK = \frac{3x}{4} - 6$. Find MK .

PROBLEM SOLVING

EXAMPLE 1
on p. 15
for Ex. 48

48. **WINDMILL** In the photograph of a windmill, \overline{ST} bisects \overline{QR} at point M . The length of \overline{QM} is $18\frac{1}{2}$ feet. Find QR and MR .

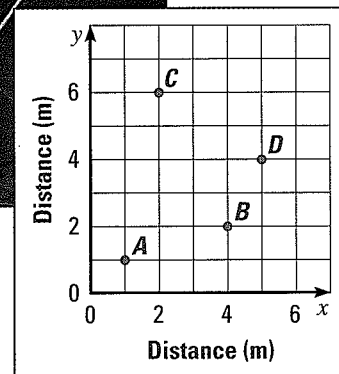
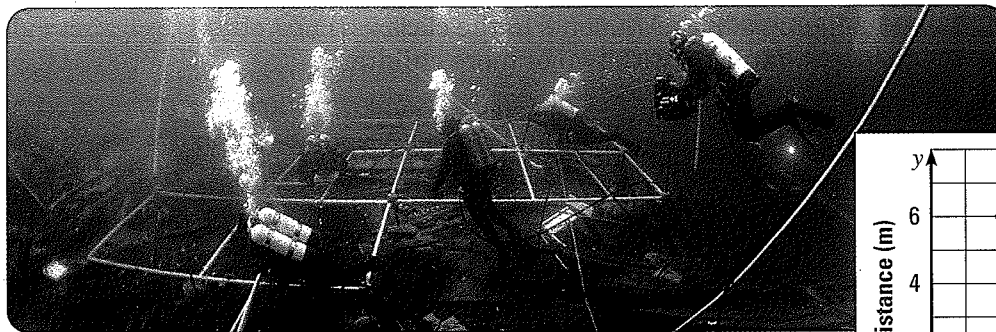


@HomeTutor for problem solving help at classzone.com

49. **DISTANCES** A house and a school are 5.7 kilometers apart on the same straight road. The library is on the same road, halfway between the house and the school. Draw a sketch to represent this situation. Mark the locations of the house, school, and library. How far is the library from the house?

@HomeTutor for problem solving help at classzone.com

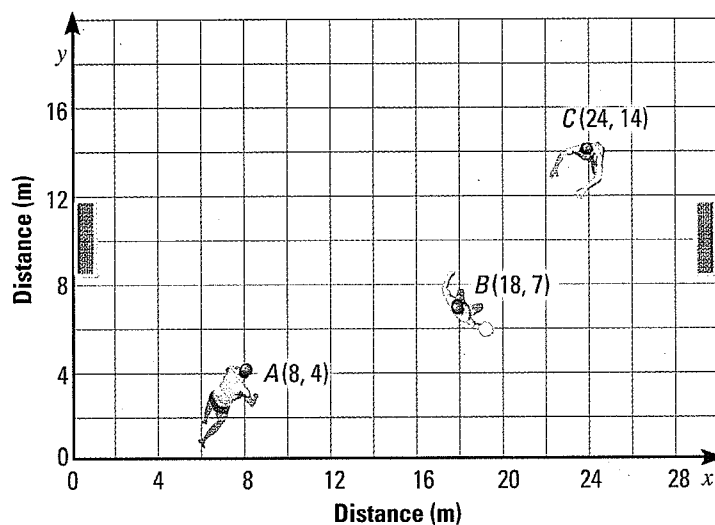
ARCHAEOLOGY The points on the diagram show the positions of objects at an underwater archaeological site. Use the diagram for Exercises 50 and 51.



50. Find the distance between each pair of objects. Round to the nearest tenth of a meter if necessary.
- | | | |
|----------------|----------------|----------------|
| a. A and B | b. B and C | c. C and D |
| d. A and D | e. B and D | f. A and C |
51. Which two objects are closest to each other? Which two are farthest apart?

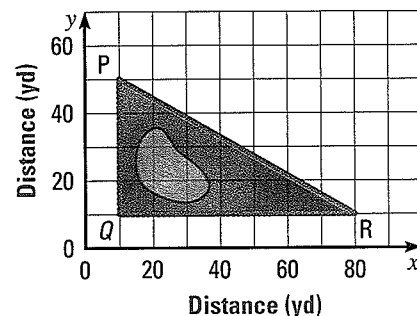
Animated Geometry at classzone.com

52. **WATER POLO** The diagram shows the positions of three players during part of a water polo match. Player A throws the ball to Player B , who then throws it to Player C . How far did Player A throw the ball? How far did Player B throw the ball? How far would Player A have thrown the ball if he had thrown it directly to Player C ? Round all answers to the nearest tenth of a meter.



53. ★ **EXTENDED RESPONSE** As shown, a path goes around a triangular park.

- Find the distance around the park to the nearest yard.
- A new path and a bridge are constructed from point Q to the midpoint M of \overline{PR} . Find QM to the nearest yard.
- A man jogs from P to Q to M to R to Q and back to P at an average speed of 150 yards per minute. About how many minutes does it take? *Explain.*

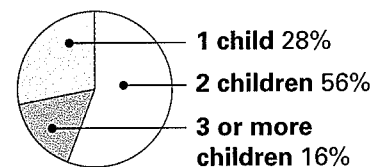


54. **CHALLENGE** \overline{AB} bisects \overline{CD} at point M , \overline{CD} bisects \overline{AB} at point M , and $AB = 4 \cdot CM$. Describe the relationship between AM and CD .

MIXED REVIEW

The graph shows data about the number of children in the families of students in a math class. (p. 888)

- What percent of the students in the class belong to families with two or more children?
- If there are 25 students in the class, how many students belong to families with two children?



PREVIEW

Prepare for Lesson 1.4 in Exs. 57–59.

Solve the equation. (p. 875)

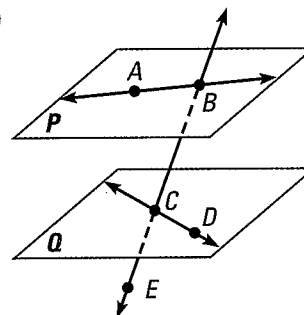
57. $3x + 12 + x = 20$

58. $9x + 2x + 6 - x = 10$

59. $5x - 22 - 7x + 2 = 40$

In Exercises 60–64, use the diagram at the right. (p. 2)

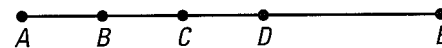
- Name all rays with endpoint B .
- Name all the rays that contain point C .
- Name a pair of opposite rays.
- Name the intersection of \overleftrightarrow{AB} and \overleftrightarrow{BC} .
- Name the intersection of \overleftrightarrow{BC} and plane P .



QUIZ for Lessons 1.1–1.3

- Sketch two lines that intersect the same plane at two different points. The lines intersect each other at a point not in the plane. (p. 2)

In the diagram of collinear points, $AE = 26$, $AD = 15$, and $AB = BC = CD$. Find the indicated length. (p. 9)

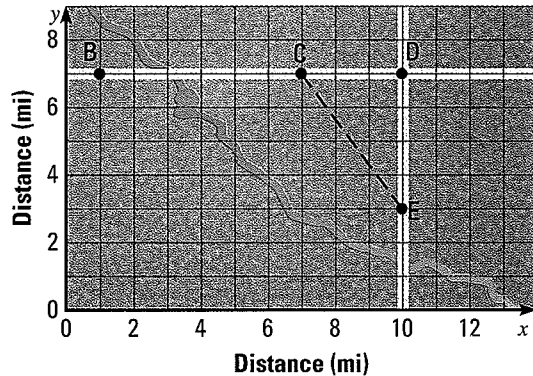


- DE
- AB
- AC
- BD
- CE
- BE
- The endpoints of \overline{RS} are $R(-2, -1)$ and $S(2, 3)$. Find the coordinates of the midpoint of \overline{RS} . Then find the distance between R and S . (p. 15)



Lessons 1.1–1.3

1. **MULTI-STEP PROBLEM** The diagram shows existing roads (\overline{BD} and \overline{DE}) and a new road (\overline{CE}) under construction.

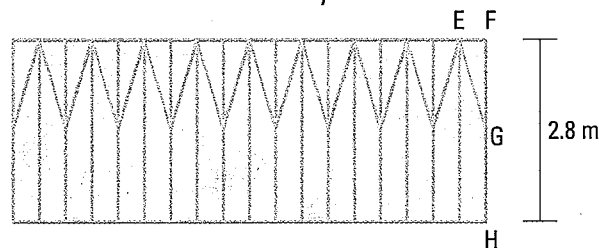


- If you drive from point B to point E on existing roads, how far do you travel?
- If you use the new road as you drive from B to E , about how far do you travel? Round to the nearest tenth of a mile if necessary.
- About how much shorter is the trip from B to E if you use the new road?

2. **GRIDDED ANSWER** Point M is the midpoint of \overline{PQ} . If $PM = 23x + 5$ and $MQ = 25x - 4$, find the length of \overline{PQ} .

3. **GRIDDED ANSWER** You are hiking on a trail that lies along a straight railroad track. The total length of the trail is 5.4 kilometers. You have been hiking for 45 minutes at an average speed of 2.4 kilometers per hour. How much farther (in kilometers) do you need to hike to reach the end of the trail?

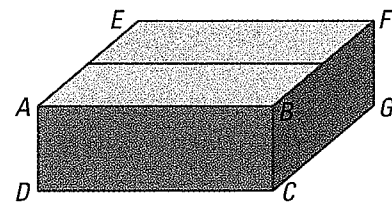
4. **SHORT RESPONSE** The diagram below shows the frame for a wall. \overline{FH} represents a vertical board, and \overline{EG} represents a brace. If $FG = 143$ cm, does the brace bisect \overline{FH} ? If not, how long should \overline{FG} be so that the brace does bisect \overline{FH} ? Explain.



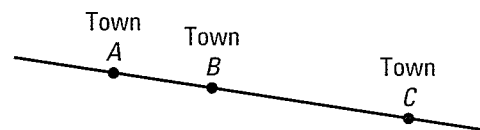
5. **SHORT RESPONSE** Point E is the midpoint of \overline{AB} and the midpoint of \overline{CD} . The endpoints of \overline{AB} are $A(-4, 5)$ and $B(6, -5)$. The coordinates of point C are $(2, 8)$. Find the coordinates of point D . Explain how you got your answer.

6. **OPEN-ENDED** The distance around a figure is its *perimeter*. Choose four points in a coordinate plane that can be connected to form a rectangle with a perimeter of 16 units. Then choose four other points and draw a different rectangle that has a perimeter of 16 units. Show how you determined that each rectangle has a perimeter of 16 units.

7. **SHORT RESPONSE** Use the diagram of a box. What are all the names that can be used to describe the plane that contains points B , F , and C ? Name the intersection of planes ABC and BFE . Explain.



8. **EXTENDED RESPONSE** Jill is a salesperson who needs to visit towns A , B , and C . On the map below, $AB = 18.7$ km and $BC = 2AB$. Assume Jill travels along the road shown.

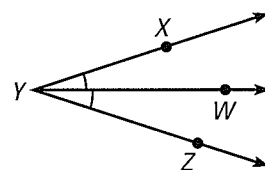


- Find the distance Jill travels if she starts at Town A , visits Towns B and C , and then returns to Town A .
- About how much time does Jill spend driving if her average driving speed is 70 kilometers per hour?
- Jill needs to spend 2.5 hours in each town. Can she visit all three towns and return to Town A in an 8 hour workday? Explain.

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 $m\angle XYW = 18^\circ$. 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

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

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

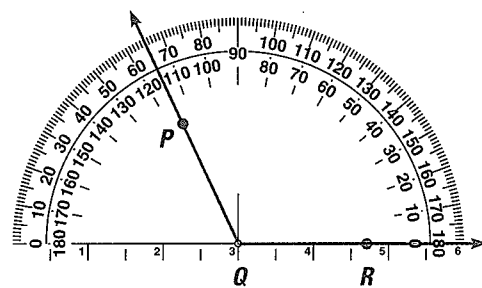
HOMEWORK KEY

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

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

SKILL PRACTICE

- VOCABULARY** Sketch an example of each of the following types of angles: acute, obtuse, right, and straight.
- ★ **WRITING** Explain how to find the measure of $\angle PQR$, shown at the right.

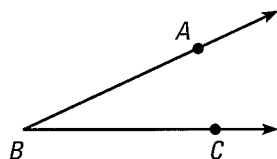


EXAMPLE 1

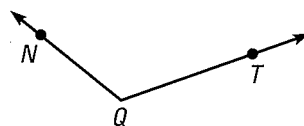
on p. 24
for Exs. 3–6

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.

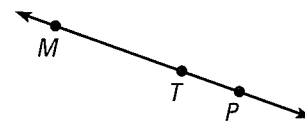
3.



4.

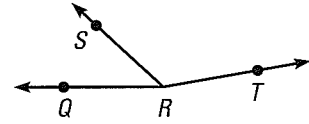


5.



EXAMPLE 2
on p. 25
for Exs. 7–21

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

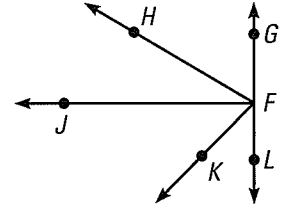


CLASSIFYING ANGLES Classify the angle with the given measure as *acute*, *obtuse*, *right*, or *straight*.

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

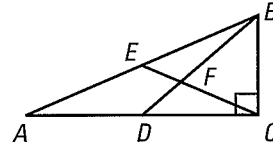
MEASURING ANGLES Trace the diagram and extend the rays. Use a protractor to find the measure of the given angle. Then classify the angle as *acute*, *obtuse*, *right*, or *straight*.

11. $\angle JFL$ 12. $\angle GFH$
13. $\angle GFK$ 14. $\angle GFL$



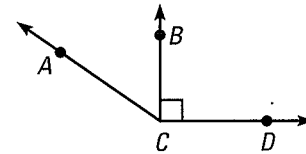
NAMING AND CLASSIFYING Give another name for the angle in the diagram below. Tell whether the angle appears to be *acute*, *obtuse*, *right*, or *straight*.

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?

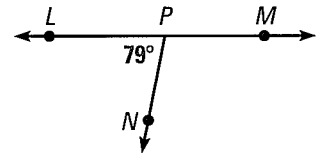
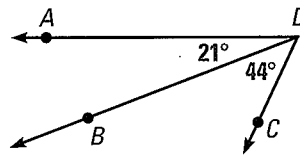
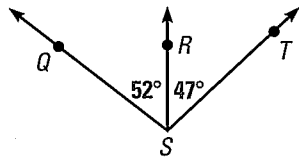
- (A) $\angle ACB$ (B) $\angle ACD$
(C) $\angle BCD$ (D) $\angle C$



EXAMPLE 3
on p. 26
for Exs. 22–27

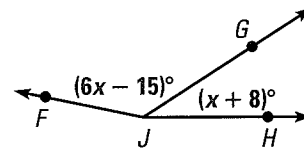
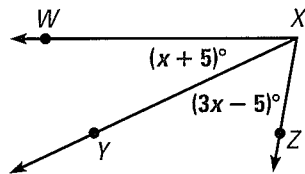
ANGLE ADDITION POSTULATE Find the indicated angle measure.

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



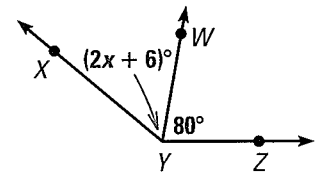
ALGEBRA Use the given information to find the indicated angle measure.

25. Given $m\angle WXZ = 80^\circ$, find $m\angle YXZ$. 26. Given $m\angle FJH = 168^\circ$, find $m\angle FJG$.



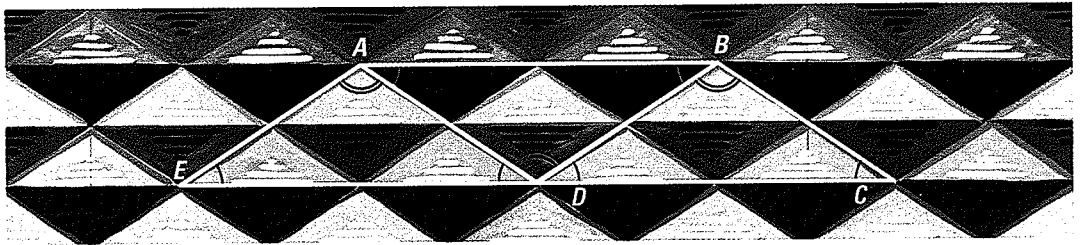
27. ★ **MULTIPLE CHOICE** In the diagram, the measure of $\angle XYZ$ is 140° . What is the value of x ?

- (A) 27 (B) 33
(C) 67 (D) 73



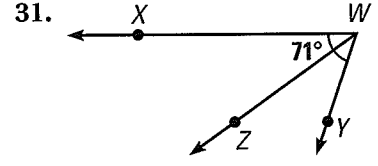
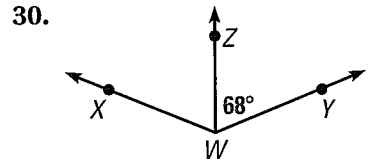
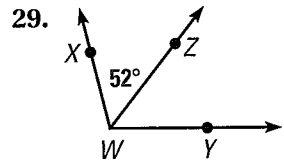
EXAMPLE 4
 on p. 27
 for Ex. 28

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



EXAMPLE 5
 on p. 18
 for Exs. 29–32

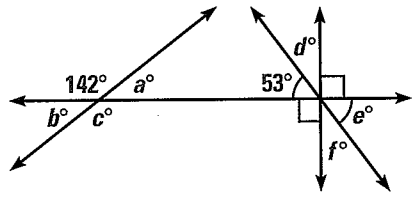
ANGLE BISECTORS Given that \vec{WZ} bisects $\angle XWY$, find the two angle measures not given in the diagram.



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

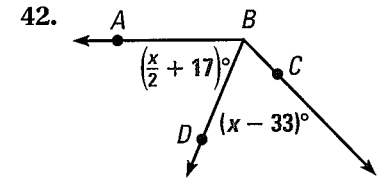
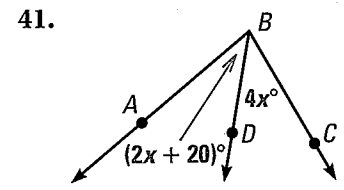
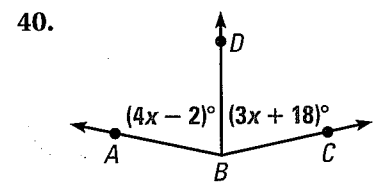
FINDING ANGLE MEASURES Find the indicated angle measure.

- 33. a°
- 34. b°
- 35. c°
- 36. d°
- 37. e°
- 38. f°



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

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

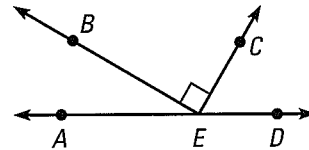


43. ★ SHORT RESPONSE You are measuring $\angle PQR$ with a protractor. When you line up \vec{QR} with the 20° mark, \vec{QP} lines up with the 80° mark. Then you move the protractor so that \vec{QR} lines up with the 15° mark. What mark does \vec{QP} line up with? Explain.

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

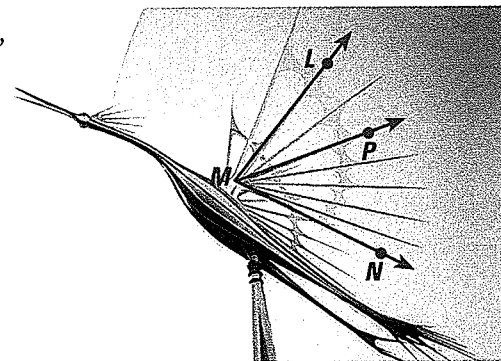
48. **ALGEBRA** Let $(2x - 12)^\circ$ represent the measure of an acute angle. What are the possible values of x ?
49. **CHALLENGE** \overrightarrow{SQ} bisects $\angle RST$, \overrightarrow{SP} bisects $\angle RSQ$, and \overrightarrow{SV} bisects $\angle RSP$. The measure of $\angle VSP$ is 17° . Find $m\angle TSQ$. 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 $m\angle CED$.



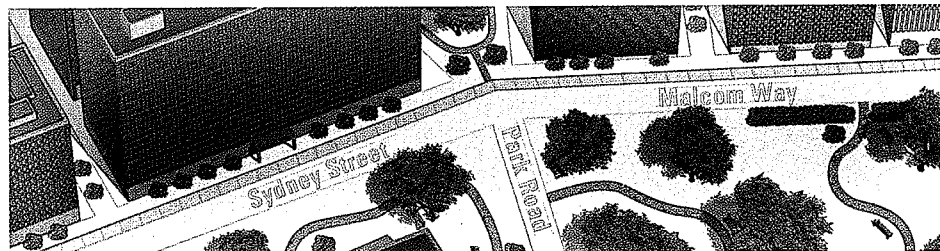
PROBLEM SOLVING

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 $\angle LMP$?

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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.



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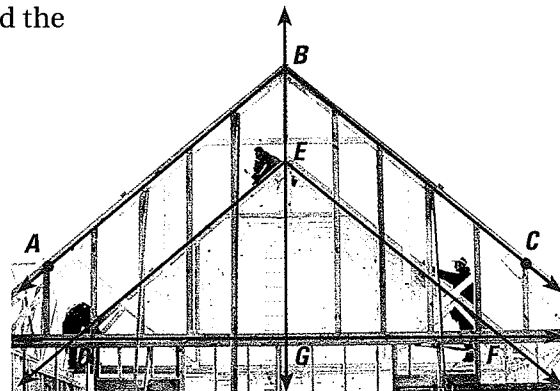
EXAMPLES
4 and 5
on pp. 27–28
for Exs. 53–55

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

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

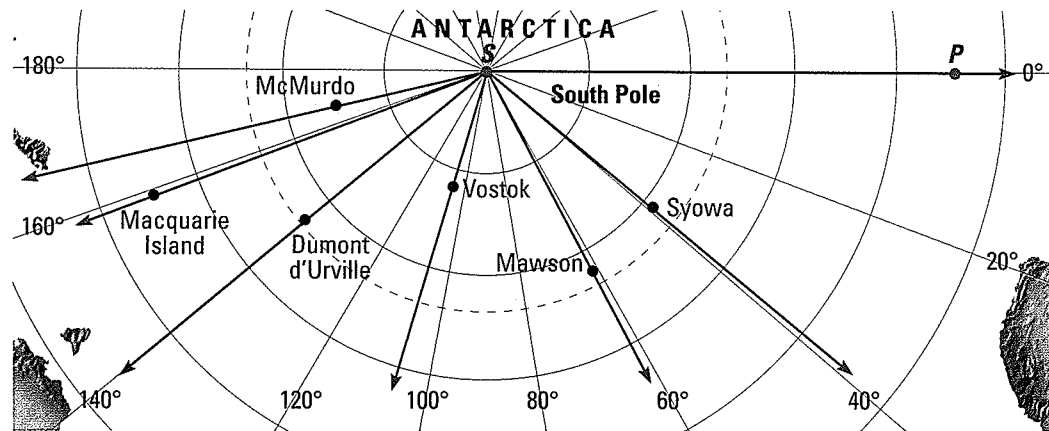
- a. $m\angle DEF$ b. $m\angle ABG$
c. $m\angle CBG$ d. $m\angle DEG$

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*.



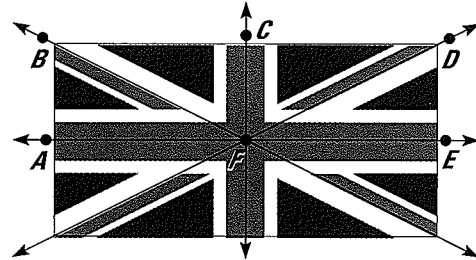
GEOGRAPHY For the given location on the map, estimate the measure of $\angle PSL$, where P is on the Prime Meridian (0° longitude), S is the South Pole, and L is the location of the indicated research station.

- | | | |
|----------------------|----------------------|-------------|
| 56. Macquarie Island | 57. Dumont d'Urville | 58. McMurdo |
| 59. Mawson | 60. Syowa | 61. Vostok |

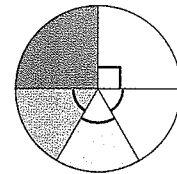


62. ★ **EXTENDED RESPONSE** In the flag shown, $\angle AFE$ is a straight angle and \overrightarrow{FC} bisects $\angle AFE$ and $\angle BFD$.

- Which angles are acute? obtuse? right?
- Identify the congruent angles.
- If $m\angle AFB = 26^\circ$, 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. |
|-----|-----|-----|

1.4 Copy and Bisect Segments and Angles

MATERIALS • compass • straightedge

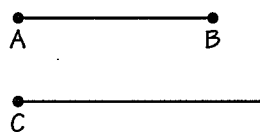
QUESTION How can you copy and bisect segments and angles?

A **construction** is a geometric drawing that uses a limited set of tools, usually a *compass* and *straightedge*. You can use a compass and straightedge (a ruler without marks) to construct a segment that is congruent to a given segment, and an angle that is congruent to a given angle.

EXPLORE 1 Copy a segment

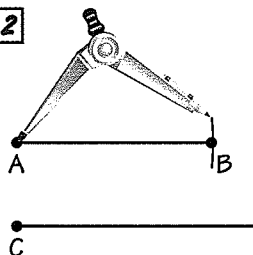
Use the following steps to construct a segment that is congruent to \overline{AB} .

STEP 1



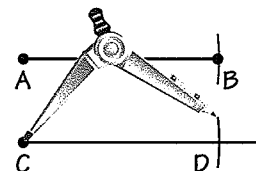
Draw a segment Use a straightedge to draw a segment longer than \overline{AB} . Label point C on the new segment.

STEP 2



Measure length Set your compass at the length of \overline{AB} .

STEP 3

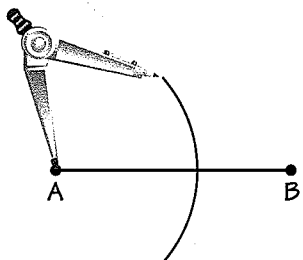


Copy length Place the compass at C . Mark point D on the new segment. $\overline{CD} \cong \overline{AB}$.

EXPLORE 2 Bisect a segment

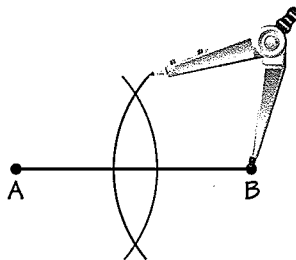
Use the following steps to construct a bisector of \overline{AB} and to find the midpoint M of \overline{AB} .

STEP 1



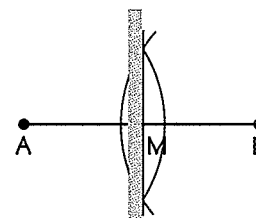
Draw an arc Place the compass at A . Use a compass setting that is greater than half the length of \overline{AB} . Draw an arc.

STEP 2



Draw a second arc Keep the same compass setting. Place the compass at B . Draw an arc. It should intersect the other arc at two points.

STEP 3

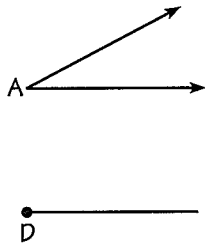


Bisect segment Draw a segment through the two points of intersection. This segment bisects \overline{AB} at M , the midpoint of \overline{AB} .

EXPLORE 3 Copy an angle

Use the following steps to construct an angle that is congruent to $\angle A$. In this construction, the *radius* of an arc is the distance from the point where the compass point rests (the *center* of the arc) to a point on the arc drawn by the compass.

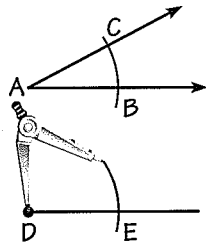
STEP 1



Draw a segment

Draw a segment. Label a point D on the segment.

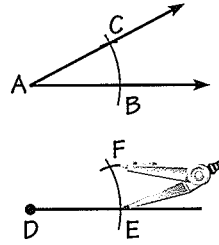
STEP 2



Draw arcs

Draw an arc with center A . Using the same radius, draw an arc with center D .

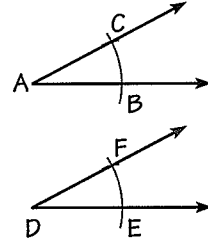
STEP 3



Draw arcs

Label B , C , and E . Draw an arc with radius BC and center E . Label the intersection F .

STEP 4



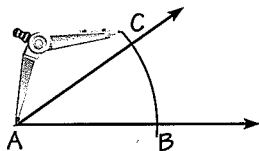
Draw a ray

Draw \overrightarrow{DF} .
 $\angle EDF \cong \angle BAC$.

EXPLORE 4 Bisect an angle

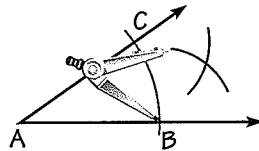
Use the following steps to construct an angle bisector of $\angle A$.

STEP 1



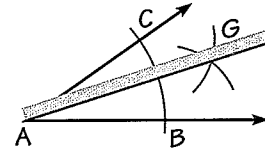
Draw an arc Place the compass at A . Draw an arc that intersects both sides of the angle. Label the intersections C and B .

STEP 2



Draw arcs Place the compass at C . Draw an arc. Then place the compass point at B . Using the same radius, draw another arc.

STEP 3



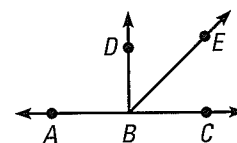
Draw a ray Label the intersection G . Use a straightedge to draw a ray through A and G . \overrightarrow{AG} bisects $\angle A$.

DRAW CONCLUSIONS Use your observations to complete these exercises

1. Describe how you could use a compass and a straightedge to draw a segment that is twice as long as a given segment.
2. Draw an obtuse angle. Copy the angle using a compass and a straightedge. Then bisect the angle using a compass and straightedge.

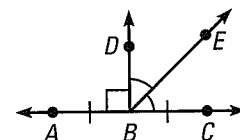
Interpreting a Diagram

There are some things you can conclude from a diagram, and some you cannot. For example, here are some things that you **can conclude** from the diagram at the right:



- All points shown are coplanar.
- Points A, B, and C are collinear, and B is between A and C.
- \overleftrightarrow{AC} , \overleftrightarrow{BD} , and \overleftrightarrow{BE} intersect at point B.
- $\angle DBE$ and $\angle EBC$ are adjacent angles, and $\angle ABC$ is a straight angle.
- Point E lies in the interior of $\angle DBC$.

In the diagram above, you **cannot conclude** that $\overline{AB} \cong \overline{BC}$, that $\angle DBE \cong \angle EBC$, or that $\angle ABD$ is a right angle. This information must be indicated, as shown at the right.



1.5 EXERCISES

HOMEWORK KEY

- = WORKED-OUT SOLUTIONS on p. WS1 for Exs. 9, 21, and 47
- ★ = STANDARDIZED TEST PRACTICE Exs. 2, 16, 30, and 53
- ◆ = MULTIPLE REPRESENTATIONS Ex. 55

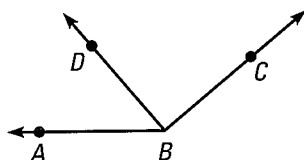
SKILL PRACTICE

- VOCABULARY** Sketch an example of adjacent angles that are complementary. Are all complementary angles adjacent angles? *Explain.*
- ★ WRITING** Are all linear pairs supplementary angles? Are all supplementary angles linear pairs? *Explain.*

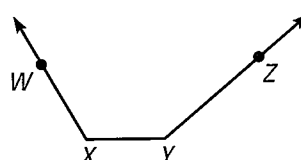
EXAMPLE 1
on p. 35
for Exs. 3–7

IDENTIFYING ANGLES Tell whether the indicated angles are adjacent.

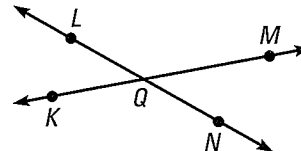
3. $\angle ABD$ and $\angle DBC$



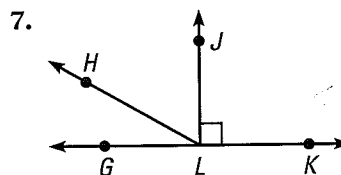
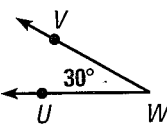
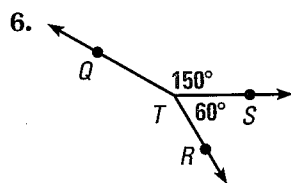
4. $\angle WXY$ and $\angle XYZ$



5. $\angle LQM$ and $\angle NQM$



IDENTIFYING ANGLES Name a pair of complementary angles and a pair of supplementary angles.



EXAMPLE 2

on p. 36
for Exs. 8–16

COMPLEMENTARY ANGLES $\angle 1$ and $\angle 2$ are complementary angles. Given the measure of $\angle 1$, find $m\angle 2$.

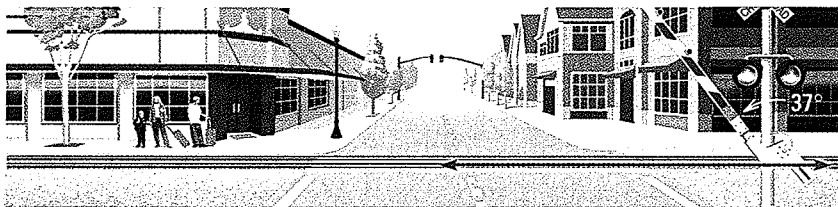
8. $m\angle 1 = 43^\circ$ 9. $m\angle 1 = 21^\circ$ 10. $m\angle 1 = 89^\circ$ 11. $m\angle 1 = 5^\circ$

SUPPLEMENTARY ANGLES $\angle 1$ and $\angle 2$ are supplementary angles. Given the measure of $\angle 1$, find $m\angle 2$.

12. $m\angle 1 = 60^\circ$ 13. $m\angle 1 = 155^\circ$ 14. $m\angle 1 = 130^\circ$ 15. $m\angle 1 = 27^\circ$

16. **★ MULTIPLE CHOICE** The arm of a crossing gate moves 37° from vertical. How many more degrees does the arm have to move so that it is horizontal?

- (A) 37°
(B) 53°
(C) 90°
(D) 143°



EXAMPLE 3

on p. 36
for Exs. 17–19

ALGEBRA Find $m\angle DEG$ and $m\angle GEF$.

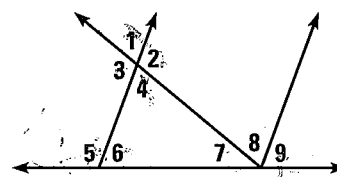
17. 18. 19.

EXAMPLE 4

on p. 37
for Exs. 20–27

IDENTIFYING ANGLE PAIRS Use the diagram below. Tell whether the angles are *vertical angles*, a *linear pair*, or *neither*.

20. $\angle 1$ and $\angle 4$ 21. $\angle 1$ and $\angle 2$
22. $\angle 3$ and $\angle 5$ 23. $\angle 2$ and $\angle 3$
24. $\angle 7, \angle 8,$ and $\angle 9$ 25. $\angle 5$ and $\angle 6$
26. $\angle 6$ and $\angle 7$ 27. $\angle 5$ and $\angle 9$

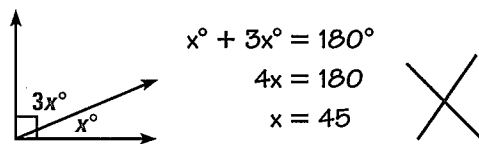


EXAMPLE 5

on p. 37
for Exs. 28–30

28. **ALGEBRA** Two angles form a linear pair. The measure of one angle is 4 times the measure of the other angle. Find the measure of each angle.

29. **ERROR ANALYSIS** Describe and correct the error made in finding the value of x .



30. **★ MULTIPLE CHOICE** The measure of one angle is 24° greater than the measure of its complement. What are the measures of the angles?

- (A) 24° and 66° (B) 24° and 156° (C) 33° and 57° (D) 78° and 102°

ALGEBRA Find the values of x and y .

31. 32. 33.

REASONING Tell whether the statement is *always*, *sometimes*, or *never* true. Explain your reasoning.

34. An obtuse angle has a complement.
35. A straight angle has a complement.
36. An angle has a supplement.
37. The complement of an acute angle is an acute angle.
38. The supplement of an acute angle is an obtuse angle.

FINDING ANGLES $\angle A$ and $\angle B$ are complementary. Find $m\angle A$ and $m\angle B$.

- | | | |
|---|--|--|
| 39. $m\angle A = (3x + 2)^\circ$
$m\angle B = (x - 4)^\circ$ | 40. $m\angle A = (15x + 3)^\circ$
$m\angle B = (5x - 13)^\circ$ | 41. $m\angle A = (11x + 24)^\circ$
$m\angle B = (x + 18)^\circ$ |
|---|--|--|

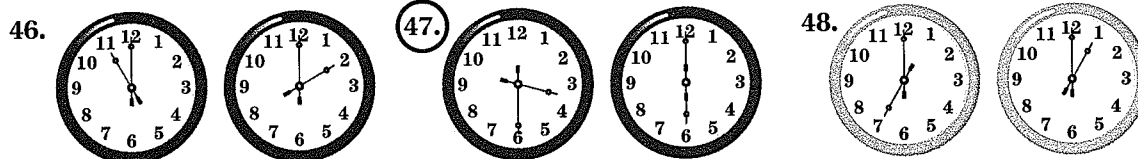
FINDING ANGLES $\angle A$ and $\angle B$ are supplementary. Find $m\angle A$ and $m\angle B$.

- | | | |
|---|---|--|
| 42. $m\angle A = (8x + 100)^\circ$
$m\angle B = (2x + 50)^\circ$ | 43. $m\angle A = (2x - 20)^\circ$
$m\angle B = (3x + 5)^\circ$ | 44. $m\angle A = (6x + 72)^\circ$
$m\angle B = (2x + 28)^\circ$ |
|---|---|--|

45. **CHALLENGE** You are given that $\angle GHJ$ is a complement of $\angle RST$ and $\angle RST$ is a supplement of $\angle ABC$. Let $m\angle GHJ$ be x° . What is the measure of $\angle ABC$? Explain your reasoning.

PROBLEM SOLVING

IDENTIFYING ANGLES Tell whether the two angles shown are *complementary*, *supplementary*, or *neither*.



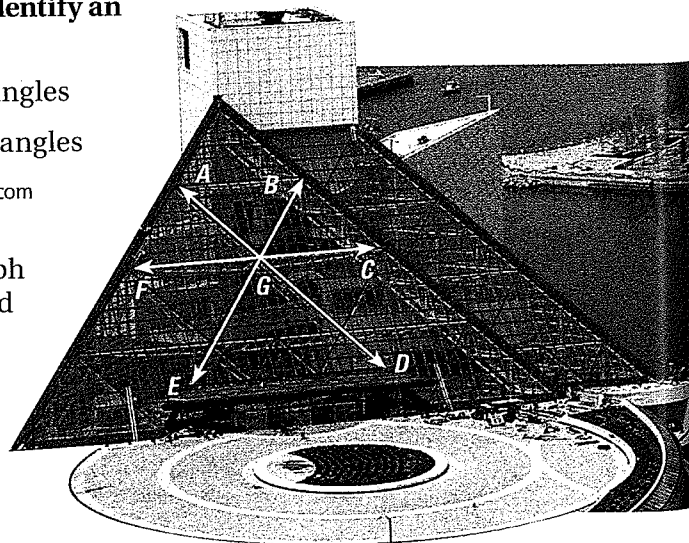
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ARCHITECTURE The photograph shows the Rock and Roll Hall of Fame in Cleveland, Ohio. Use the photograph to identify an example of the indicated type of angle pair.

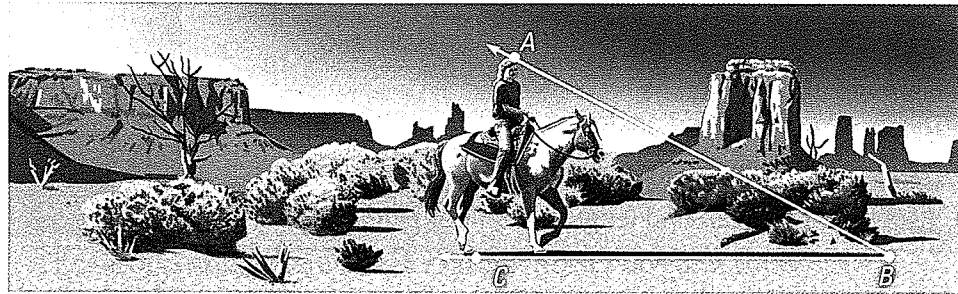
- | | |
|--------------------------|---------------------|
| 49. Supplementary angles | 50. Vertical angles |
| 51. Linear pair | 52. Adjacent angles |

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53. **★ SHORT RESPONSE** Use the photograph shown at the right. Given that $\angle FGB$ and $\angle BGC$ are supplementary angles, and $m\angle FGB = 120^\circ$, explain how to find the measure of the complement of $\angle BGC$.



54. **SHADOWS** The length of a shadow changes as the sun rises. In the diagram below, the length of \overline{CB} is the length of a shadow. The end of the shadow is the vertex of $\angle ABC$, which is formed by the ground and the sun's rays. Describe how the shadow and angle change as the sun rises.



55. **MULTIPLE REPRESENTATIONS** Let x° be an angle measure. Let y_1° be the measure of a complement of the angle and let y_2° be the measure of a supplement of the angle.
- Writing an Equation** Write equations for y_1 as a function of x , and for y_2 as a function of x . What is the domain of each function? Explain.
 - Drawing a Graph** Graph each function and describe its range.
56. **CHALLENGE** The sum of the measures of two complementary angles exceeds the difference of their measures by 86° . Find the measure of each angle. Explain how you found the angle measures.

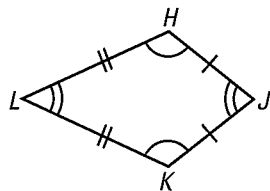
MIXED REVIEW

Make a table of values and graph the function. (p. 884)

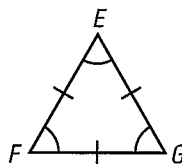
57. $y = 5 - x$ 58. $y = 3x$ 59. $y = x^2 - 1$ 60. $y = -2x^2$

In each figure, name the congruent sides and congruent angles. (pp. 9, 24)

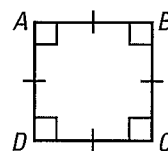
61.



62.



63.

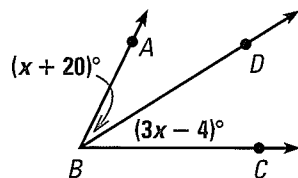


PREVIEW
Prepare for
Lesson 1.6 in
Exs. 61–63.

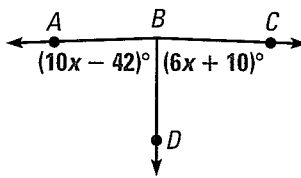
QUIZ for Lessons 1.4–1.5

In each diagram, \overrightarrow{BD} bisects $\angle ABC$. Find $m\angle ABD$ and $m\angle DBC$. (p. 24)

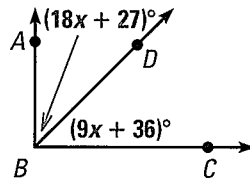
1.



2.



3.



Find the measure of (a) the complement and (b) the supplement of $\angle 1$. (p. 35)

4. $m\angle 1 = 47^\circ$ 5. $m\angle 1 = 19^\circ$ 6. $m\angle 1 = 75^\circ$ 7. $m\angle 1 = 2^\circ$

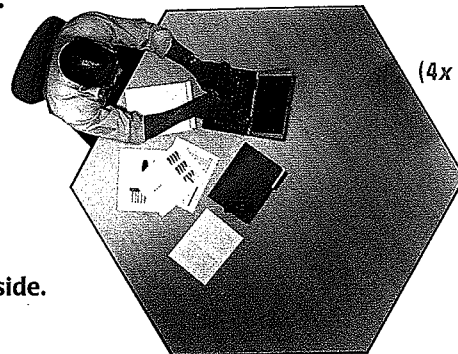
EXAMPLE 3 Find side lengths

READ VOCABULARY
Hexagonal means
"shaped like a hexagon."

ALGEBRA A table is shaped like a regular hexagon. The expressions shown represent side lengths of the hexagonal table. Find the length of a side.

$$(3x + 6) \text{ in.}$$

$$(4x - 2) \text{ in.}$$



Solution

First, write and solve an equation to find the value of x . Use the fact that the sides of a regular hexagon are congruent.

$$3x + 6 = 4x - 2 \quad \text{Write equation.}$$

$$6 = x - 2 \quad \text{Subtract } 3x \text{ from each side.}$$

$$8 = x \quad \text{Add 2 to each side.}$$

Then find a side length. Evaluate one of the expressions when $x = 8$.

$$3x + 6 = 3(8) + 6 = 30$$

▶ The length of a side of the table is 30 inches.



GUIDED PRACTICE for Example 3

3. The expressions $8y^\circ$ and $(9y - 15)^\circ$ represent the measures of two of the angles in the table in Example 3. Find the measure of an angle.

1.6 EXERCISES

HOMEWORK KEY

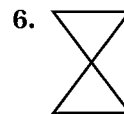
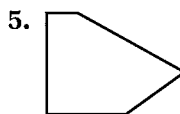
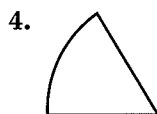
○ = WORKED-OUT SOLUTIONS
on p. WS1 for Exs. 13, 19, and 33

★ = STANDARDIZED TEST PRACTICE
Exs. 2, 7, 37, 39, and 40

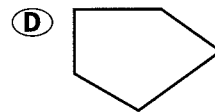
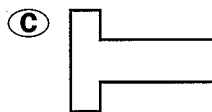
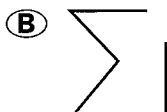
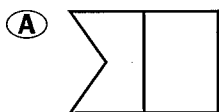
SKILL PRACTICE

- VOCABULARY** Explain what is meant by the term n -gon.
- ★ **WRITING** Imagine that you can tie a string tightly around a polygon. If the polygon is convex, will the length of the string be equal to the distance around the polygon? What if the polygon is concave? Explain.

IDENTIFYING POLYGONS Tell whether the figure is a polygon. If it is not, explain why. If it is a polygon, tell whether it is *convex* or *concave*.

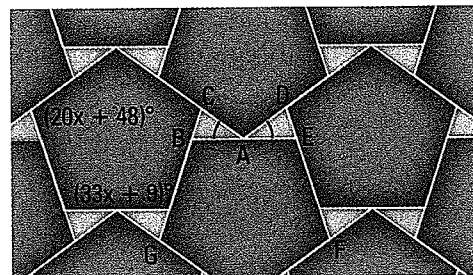


7. ★ **MULTIPLE CHOICE** Which of the figures is a concave polygon?



EXAMPLE 1
on p. 42
for Exs. 3–7

31. **CHALLENGE** Regular pentagonal tiles and triangular tiles are arranged in the pattern shown. The pentagonal tiles are all the same size and shape and the triangular tiles are all the same size and shape. Find the angle measures of the triangular tiles. Explain your reasoning.

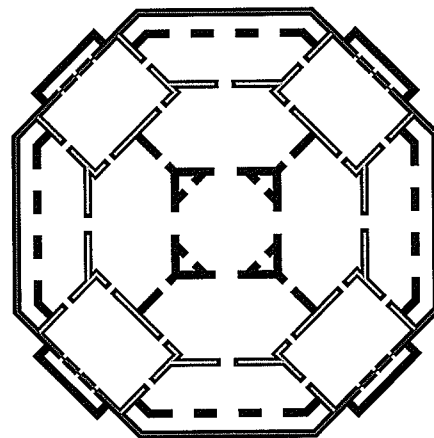


PROBLEM SOLVING

32. **ARCHITECTURE** Longwood House, shown in the photograph on page 42, is located in Natchez, Mississippi. The diagram at the right shows the floor plan of a part of the house.

- Tell whether the red polygon in the diagram is *convex* or *concave*.
- Classify the red polygon and tell whether it appears to be regular.

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EXAMPLE 2
on p. 43
for Exs. 33–36

- SIGNS** Each sign suggests a polygon. Classify the polygon by the number of sides. Tell whether it appears to be *equilateral*, *equiangular*, or *regular*.

33.



34.



35.



36.



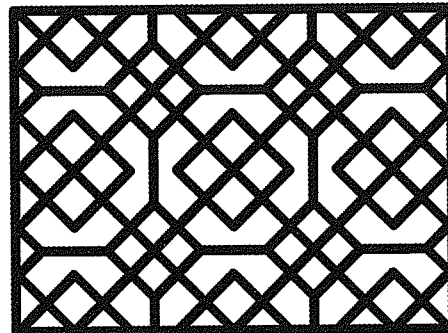
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37. **★ MULTIPLE CHOICE** Two vertices of a regular quadrilateral are $A(0, 4)$ and $B(0, -4)$. Which of the following could be the other two vertices?

- (A) $C(4, 4)$ and $D(4, -4)$ (B) $C(-4, 4)$ and $D(-4, -4)$
(C) $C(8, -4)$ and $D(8, 4)$ (D) $C(0, 8)$ and $D(0, -8)$

38. **MULTI-STEP PROBLEM** The diagram shows the design of a lattice made in China in 1850.

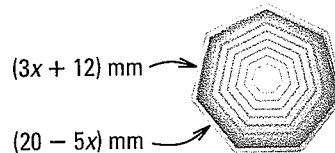
- Sketch five different polygons you see in the diagram. Classify each polygon by the number of sides.
- Tell whether each polygon you sketched is concave or convex, and whether the polygon appears to be equilateral, equiangular, or regular.



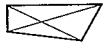
EXAMPLE 3

on p. 44
for Ex. 39

39. ★ **SHORT RESPONSE** The shape of the button shown is a regular polygon. The button has a border made of silver wire. How many millimeters of silver wire are needed for this border? *Explain.*

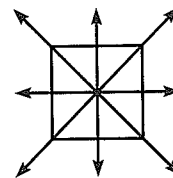


40. ★ **EXTENDED RESPONSE** A segment that joins two nonconsecutive vertices of a polygon is called a *diagonal*. For example, a quadrilateral has two diagonals, as shown below.

Type of polygon	Diagram	Number of sides	Number of diagonals
Quadrilateral		4	2
Pentagon	?	?	?
Hexagon	?	?	?
Heptagon	?	?	?

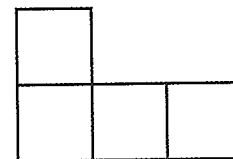
- a. Copy and complete the table. *Describe* any patterns you see.
b. How many diagonals does an octagon have? a nonagon? *Explain.*
c. The expression $\frac{n(n-3)}{2}$ can be used to find the number of diagonals in an n -gon. Find the number of diagonals in a 60-gon.

41. **LINE SYMMETRY** A figure has *line symmetry* if it can be folded over exactly onto itself. The fold line is called the *line of symmetry*. A regular quadrilateral has four lines of symmetry, as shown. Find the number of lines of symmetry in each polygon.



regular quadrilateral
4 lines of symmetry

- a. A regular triangle b. A regular pentagon
c. A regular hexagon d. A regular octagon
42. **CHALLENGE** The diagram shows four identical squares lying edge-to-edge. Sketch all the different ways you can arrange four squares edge-to-edge. Sketch all the different ways you can arrange five identical squares edge-to-edge.



MIXED REVIEW

PREVIEW

Prepare for
Lesson 1.7
in Exs. 43–51.

Solve the equation.

43. $\frac{1}{2}(35)b = 140$ (p. 875)

44. $x^2 = 144$ (p. 882)

45. $3.14r^2 = 314$ (p. 882)

Copy and complete the statement. (p. 886)

46. 500 m = cm

47. 12 mi = ft

48. 672 in. = yd

49. 1200 km = m

50. $4\frac{1}{2}$ ft = yd

51. 3800 m = km

Find the distance between the two points. (p. 15)

52. $D(-13, 13), E(0, -12)$

53. $F(-9, -8), G(-9, 7)$

54. $H(10, 5), J(-2, -2)$

1.7 Investigate Perimeter and Area

MATERIALS • graph paper • graphing calculator

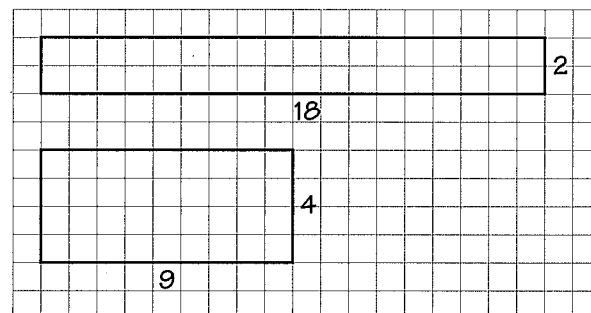
QUESTION How can you use a graphing calculator to find the smallest possible perimeter for a rectangle with a given area?

You can use the formulas below to find the perimeter P and the area A of a rectangle with length l and width w .

$$P = 2l + 2w \qquad A = lw$$

EXPLORE Find perimeters of rectangles with fixed areas

STEP 1 *Draw rectangles* Draw different rectangles, each with an area of 36 square units. Use lengths of 2, 4, 6, 8, 10, 12, 14, 16, and 18 units.



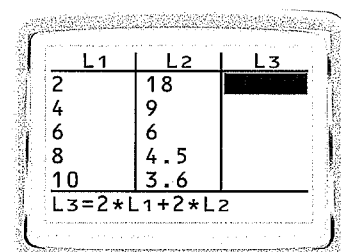
STEP 2 *Enter data* Use the STATISTICS menu on a graphing calculator. Enter the rectangle lengths in List 1. Use the keystrokes below to calculate and enter the rectangle widths and perimeters in Lists 2 and 3.

Keystrokes for entering widths in List 2:

36 \div 2^{nd} [L1] ENTER

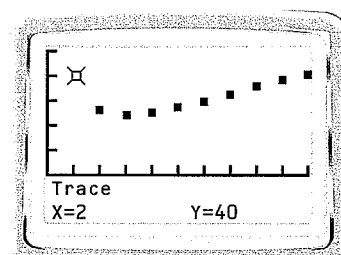
Keystrokes for entering perimeters in List 3:

2 \times 2^{nd} [L1] $+$ 2 \times 2^{nd} [L2] ENTER



STEP 3 *Make a scatter plot* Make a scatter plot using the lengths from List 1 as the x -values and the perimeters from List 3 as the y -values. Choose an appropriate viewing window. Then use the *trace* feature to see the coordinates of each point.

How does the graph show which of your rectangles from Step 1 has the smallest perimeter?

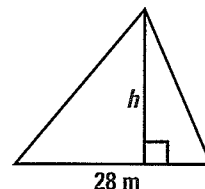


DRAW CONCLUSIONS Use your observations to complete these exercises

- Repeat the steps above for rectangles with areas of 64 square units.
- Based on the Explore and your results from Exercise 1, what do you notice about the shape of the rectangle with the smallest perimeter?

EXAMPLE 5 Find unknown length

The base of a triangle is 28 meters. Its area is 308 square meters. Find the height of the triangle.



Solution

$$A = \frac{1}{2}bh \quad \text{Write formula for the area of a triangle.}$$

$$308 = \frac{1}{2}(28)h \quad \text{Substitute 308 for } A \text{ and 28 for } b.$$

$$22 = h \quad \text{Solve for } h.$$

▶ The height is 22 meters.



GUIDED PRACTICE for Example 5

7. The area of a triangle is 64 square meters, and its height is 16 meters. Find the length of its base.

1.7 EXERCISES

HOMework KEY

○ = WORKED-OUT SOLUTIONS
on p. WS2 for Exs. 7, 21, and 41

★ = STANDARDIZED TEST PRACTICE
Exs. 2, 19, 26, 38, and 45

◆ = MULTIPLE REPRESENTATIONS
Ex. 44

SKILL PRACTICE

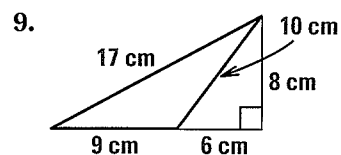
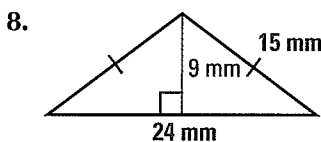
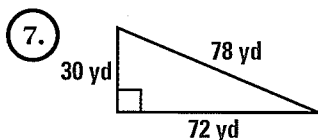
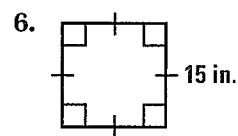
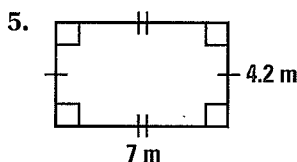
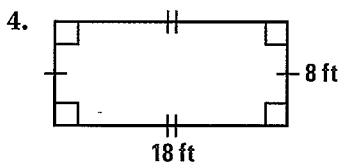
- VOCABULARY** How are the diameter and radius of a circle related?
- ★ **WRITING** Describe a real-world situation in which you would need to find a perimeter, and a situation in which you would need to find an area. What measurement units would you use in each situation?
- ERROR ANALYSIS** Describe and correct the error made in finding the area of a triangle with a height of 9 feet and a base of 52 feet.

$$A = 52(9) = 468 \text{ ft}^2$$



EXAMPLE 1
on p. 49
for Exs. 3–10

PERIMETER AND AREA Find the perimeter and area of the shaded figure.



Animated Geometry at classzone.com

EXAMPLE 2

on p. 50
for Exs. 11–15

- 10. DRAWING A DIAGRAM** The base of a triangle is 32 feet. Its height is $16\frac{1}{2}$ feet. Sketch the triangle and find its area.

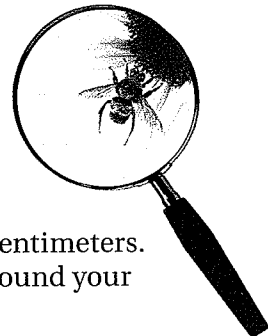
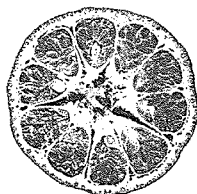
CIRCUMFERENCE AND AREA Use the given diameter d or radius r to find the circumference and area of the circle. Round to the nearest tenth.

11. $d = 27$ cm

12. $d = 5$ in.

13. $r = 12.1$ cm

14. $r = 3.9$ cm

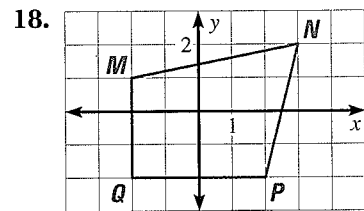
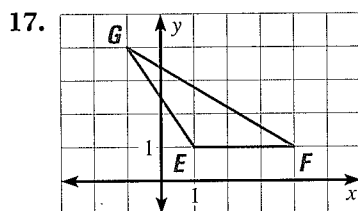
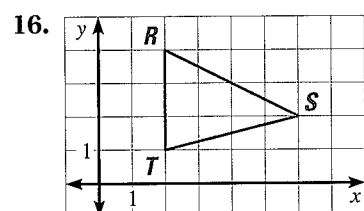


- 15. DRAWING A DIAGRAM** The diameter of a circle is 18.9 centimeters. Sketch the circle and find its circumference and area. Round your answers to the nearest tenth.

EXAMPLE 3

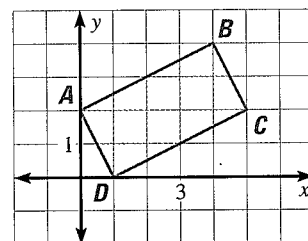
on p. 50
for Exs. 16–19

DISTANCE FORMULA Find the perimeter of the figure. Round to the nearest tenth of a unit.



- 19. ★ MULTIPLE CHOICE** What is the approximate area (in square units) of the rectangle shown at the right?

- (A) 6.7 (B) 8.0
(C) 9.0 (D) 10.0

**EXAMPLE 4**

on p. 51
for Exs. 20–26

CONVERTING UNITS Copy and complete the statement.

20. $187 \text{ cm}^2 = \underline{\quad} \text{ m}^2$

21. $13 \text{ ft}^2 = \underline{\quad} \text{ yd}^2$

22. $18 \text{ in.}^2 = \underline{\quad} \text{ ft}^2$

23. $8 \text{ km}^2 = \underline{\quad} \text{ m}^2$

24. $12 \text{ yd}^2 = \underline{\quad} \text{ ft}^2$

25. $24 \text{ ft}^2 = \underline{\quad} \text{ in.}^2$

- 26. ★ MULTIPLE CHOICE** A triangle has an area of 2.25 square feet. What is the area of the triangle in square inches?

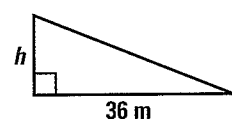
- (A) 27 in.^2 (B) 54 in.^2 (C) 144 in.^2 (D) 324 in.^2

EXAMPLE 5

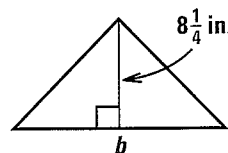
on p. 52
for Exs. 27–30

UNKNOWN MEASURES Use the information about the figure to find the indicated measure.

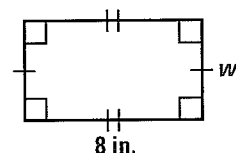
27. Area = 261 m^2
Find the height h .



28. Area = 66 in.^2
Find the base b .



29. Perimeter = 25 in.
Find the width w .

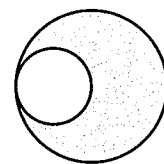


30. **UNKNOWN MEASURE** The width of a rectangle is 17 inches. Its perimeter is 102 inches. Find the length of the rectangle.
31. **ALGEBRA** The area of a rectangle is 18 square inches. The length of the rectangle is twice its width. Find the length and width of the rectangle.
32. **ALGEBRA** The area of a triangle is 27 square feet. Its height is three times the length of its base. Find the height and base of the triangle.
33. **ALGEBRA** Let x represent the side length of a square. Find a regular polygon with side length x whose perimeter is twice the perimeter of the square. Find a regular polygon with side length x whose perimeter is three times the length of the square. *Explain* your thinking.

FINDING SIDE LENGTHS Find the side length of the square with the given area. Write your answer as a radical in simplest form.

34. $A = 184 \text{ cm}^2$ 35. $A = 346 \text{ in.}^2$ 36. $A = 1008 \text{ mi}^2$ 37. $A = 1050 \text{ km}^2$

38. **★ SHORT RESPONSE** In the diagram, the diameter of the yellow circle is half the diameter of the red circle. What fraction of the area of the red circle is *not* covered by the yellow circle? *Explain*.



39. **CHALLENGE** The area of a rectangle is 30 cm^2 and its perimeter is 26 cm. Find the length and width of the rectangle.

PROBLEM SOLVING

EXAMPLES
1 and 2
on pp. 49–50
for Exs. 40–41

40. **WATER LILIES** The giant Amazon water lily has a lily pad that is shaped like a circle. Find the circumference and area of a lily pad with a diameter of 60 inches. Round your answers to the nearest tenth.

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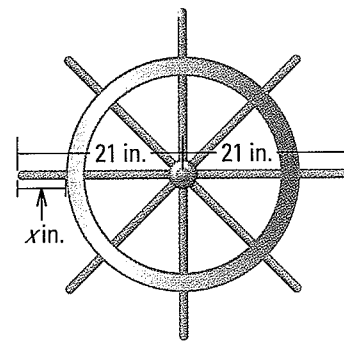
41. **LAND** You are planting grass on a rectangular plot of land. You are also building a fence around the edge of the plot. The plot is 45 yards long and 30 yards wide. How much area do you need to cover with grass seed? How many feet of fencing do you need?

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EXAMPLE 4
on p. 51
for Ex. 42

42. **MULTI-STEP PROBLEM** Chris is installing a solar panel. The maximum amount of power the solar panel can generate in a day depends in part on its area. On a sunny day in the city where Chris lives, each square meter of the panel can generate up to 125 watts of power. The flat rectangular panel is 84 centimeters long and 54 centimeters wide.
- Find the area of the solar panel in square meters.
 - What is the maximum amount of power (in watts) that the panel could generate if its area was 1 square meter? 2 square meters? *Explain*.
 - Estimate the maximum amount of power Chris's solar panel can generate. *Explain* your reasoning.

43. **MULTI-STEP PROBLEM** The eight spokes of a ship's wheel are joined at the wheel's center and pass through a large wooden circle, forming handles on the outside of the circle. From the wheel's center to the tip of the handle, each spoke is 21 inches long.



- The circumference of the outer edge of the large wooden circle is 94 inches. Find the radius of the outer edge of the circle to the nearest inch.
 - Find the length x of a handle on the wheel. *Explain.*
44. **MULTIPLE REPRESENTATIONS** Let x represent the length of a side of a square. Let y_1 and y_2 represent the perimeter and area of that square.

- a. **Making a Table** Copy and complete the table.

Length, x	1	2	5	10	25
Perimeter, y_1	?	?	?	?	?
Area, y_2	?	?	?	?	?

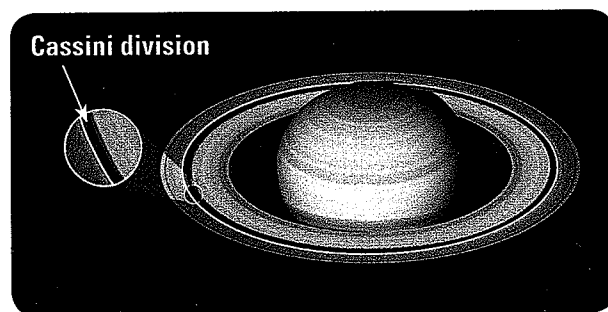
- Making a Graph** Use the completed table to write two sets of ordered pairs: (x, y_1) and (x, y_2) . Graph each set of ordered pairs.
 - Analyzing Data** *Describe* any patterns you see in the table from part (a) and in the graphs from part (b).
45. **★ EXTENDED RESPONSE** The photograph at the right shows the Crown Fountain in Chicago, Illinois. At this fountain, images of faces appear on a large screen. The images are created by light-emitting diodes (LEDs) that are clustered in groups called modules. The LED modules are arranged in a rectangular grid.

- The rectangular grid is approximately 7 meters wide and 15.2 meters high. Find the area of the grid.
- Suppose an LED module is a square with a side length of 4 centimeters. How many rows and how many columns of LED modules would be needed to make the Crown Fountain screen? *Explain* your reasoning.

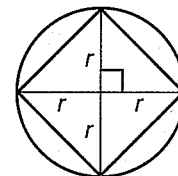


46. **ASTRONOMY** The diagram shows a gap in Saturn's circular rings. This gap is known as the *Cassini division*. In the diagram, the red circle represents the ring that borders the inside of the Cassini division. The yellow circle represents the ring that borders the outside of the division.

- The radius of the red ring is 115,800 kilometers. The radius of the yellow ring is 120,600 kilometers. Find the circumference of the red ring and the circumference of the yellow ring. Round your answers to the nearest hundred kilometers.
- Compare the circumferences of the two rings. About how many kilometers greater is the yellow ring's circumference than the red ring's circumference?



47. **CHALLENGE** In the diagram at the right, how many times as great is the area of the circle as the area of the square? *Explain* your reasoning.



48. **ALGEBRA** You have 30 yards of fencing with which to make a rectangular pen. Let x be the length of the pen.
- Write an expression for the width of the pen in terms of x . Then write a formula for the area y of the pen in terms of x .
 - You want the pen to have the greatest possible area. What length and width should you use? *Explain* your reasoning.

MIXED REVIEW

PREVIEW

Prepare for
Lesson 2.1
in Exs. 49–50.

49. Use the equation $y = 2x + 1$ to copy and complete the table of values. (p. 884)

x	1	2	3	4	5
y	?	?	?	?	?

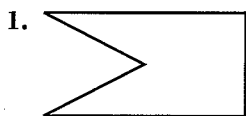
50. Each number in a pattern is 6 less than the previous number. The first number in the pattern is 100. Write the next three numbers. (p. 894)

In Exercises 51 and 52, draw a diagram to represent the problem. Then find the indicated measure. (p. 42)

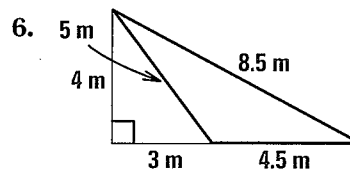
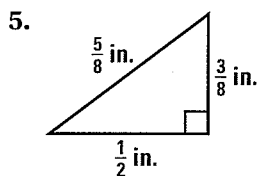
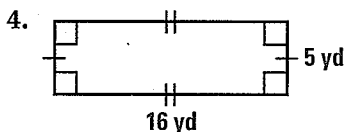
- The lengths (in inches) of two sides of a regular triangle are given by the expressions $5x + 40$ and $8x - 13$. Find the length of a side of the triangle.
- The measures of two angles of an equiangular hexagon are $12x^\circ$ and $(10x + 20)^\circ$. Find the measure of an angle of the hexagon.

QUIZ for Lessons 1.6–1.7

Tell whether the figure is a polygon. If it is not, *explain* why. If it is a polygon, tell whether it is *convex* or *concave*. (p. 42)

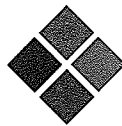


Find the perimeter and area of the shaded figure. (p. 49)



- GARDENING** You are spreading wood chips on a rectangular garden. The garden is $3\frac{1}{2}$ yards long and $2\frac{1}{2}$ yards wide. One bag of wood chips covers 10 square feet. How many bags of wood chips do you need? (p. 49)

Another Way to Solve Example 4, page 51



MULTIPLE REPRESENTATIONS In Example 4 on page 51, you saw how to use an equation to solve a problem about a skating rink. *Looking for a pattern* can help you write an equation.

PROBLEM

SKATING RINK An ice-resurfacing machine is used to smooth the surface of the ice at a skating rink. The machine can resurface about 270 square yards of ice in one minute. About how many minutes does it take the machine to resurface a rectangular skating rink that is 200 feet long and 90 feet wide?

METHOD

Using a Pattern You can use a table to look for a pattern.

STEP 1 Find the area of the rink in square yards. In Example 4 on page 51, you found that the area was 2000 square yards.

STEP 2 Make a table that shows the relationship between the time spent resurfacing the ice and the area resurfaced. Look for a pattern.

Time (min)	Area resurfaced (yd ²)
1	$1 \cdot 270 = 270$
2	$2 \cdot 270 = 540$
t	$t \cdot 270 = A$

Use the pattern to write an equation for the area A that has been resurfaced after t minutes.

STEP 3 Use the equation to find the time t (in minutes) that it takes the machine to resurface 2000 square yards of ice.

$$\begin{aligned} 270t &= A \\ 270t &= 2000 \\ t &\approx 7.4 \end{aligned}$$

► It takes about 7 minutes.

PRACTICE

- PLOWING** A square field is $\frac{1}{8}$ mile long on each side. A tractor can plow about 180,000 square feet per hour. To the nearest tenth of an hour, about how long does it take to plow the field? (1 mi = 5280 ft.)
- ERROR ANALYSIS** To solve Exercise 1 above, a student writes the equation $660 = 180,000t$, where t is the number of hours spent plowing. *Describe* and correct the error in the equation.
- PARKING LOT** A rectangular parking lot is 110 yards long and 45 yards wide. It costs about \$.60 to pave each square foot of the parking lot with asphalt. About how much will it cost to pave the parking lot?
- WALKING** A circular path has a diameter of 120 meters. Your average walking speed is 4 kilometers per hour. About how many minutes will it take you to walk around the path 3 times?

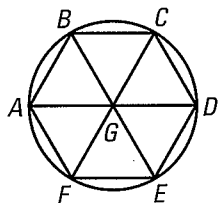


Lessons 1.4–1.7

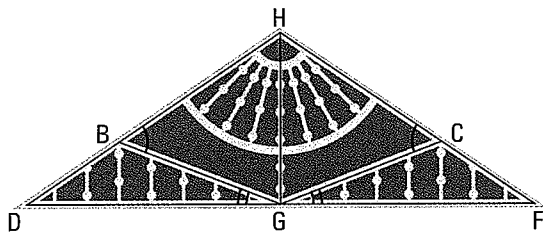
1. MULTI-STEP PROBLEM You are covering the rectangular roof of a shed with shingles. The roof is a rectangle that is 4 yards long and 3 yards wide. Asphalt shingles cost \$.75 per square foot and wood shingles cost \$1.15 per square foot.

- Find the area of the roof in square feet.
- Find the cost of using asphalt shingles and the cost of using wood shingles.
- About how much more will you pay to use wood shingles for the roof?

2. OPEN-ENDED In the window below, name a convex polygon and a concave polygon. Classify each of your polygons by the number of sides.



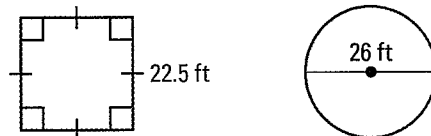
3. EXTENDED RESPONSE The diagram shows a decoration on a house. In the diagram, $\angle HGD$ and $\angle HGF$ are right angles, $m\angle DGB = 21^\circ$, $m\angle HBG = 55^\circ$, $\angle DGB \cong \angle FGC$, and $\angle HBG \cong \angle HCG$.



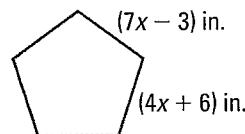
- List two pairs of complementary angles and five pairs of supplementary angles.
- Find $m\angle FGC$, $m\angle BGH$, and $m\angle HGC$. Explain your reasoning.
- Find $m\angle HCG$, $m\angle DBG$, and $m\angle FCG$. Explain your reasoning.

4. GRIDDED ANSWER $\angle 1$ and $\angle 2$ are supplementary angles, and $\angle 1$ and $\angle 3$ are complementary angles. Given $m\angle 1$ is 28° less than $m\angle 2$, find $m\angle 3$ in degrees.

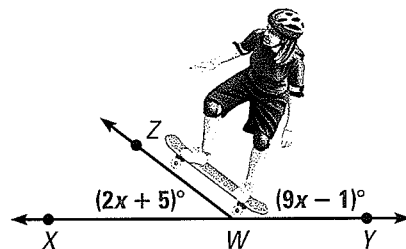
5. EXTENDED RESPONSE You use bricks to outline the borders of the two gardens shown below. Each brick is 10 inches long.



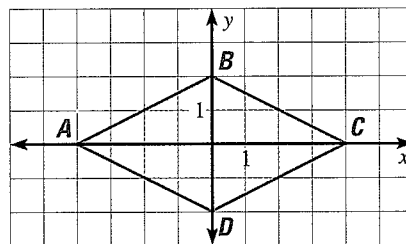
- You lay the bricks end-to-end around the border of each garden. How many bricks do you need for each garden? Explain.
 - The bricks are sold in bundles of 100. How many bundles should you buy? Explain.
- 6. SHORT RESPONSE** The frame of a mirror is a regular pentagon made from pieces of bamboo. Use the diagram to find how many feet of bamboo are used in the frame.



7. GRIDDED ANSWER As shown in the diagram, a skateboarder tilts one end of a skateboard. Find $m\angle ZWX$ in degrees.



8. SHORT RESPONSE Use the diagram below.



- Find the perimeter of quadrilateral $ABCD$.
- Find the area of triangle ABC and the area of triangle ADC . What is the area of quadrilateral $ABCD$? Explain.





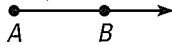
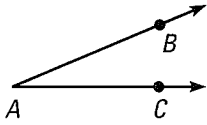
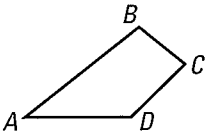
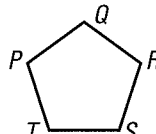
BIG IDEAS

For Your Notebook

Big Idea 1

Describing Geometric Figures

You learned to identify and classify geometric figures.

Point A 	Line \overleftrightarrow{AB} 	Plane M 	Segment \overline{AB} 
Ray \overrightarrow{AB} 	Angle A ($\angle A$, $\angle BAC$, or $\angle CAB$) 	Polygon  Quadrilateral ABCD	 Pentagon PQRST

Big Idea 2

Measuring Geometric Figures

SEGMENTS You measured segments in the coordinate plane.

Distance Formula

Distance between $A(x_1, y_1)$ and $B(x_2, y_2)$:

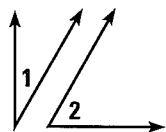
$$AB = \sqrt{(x_1 - x_2)^2 + (y_1 - y_2)^2}$$

Midpoint Formula

Coordinates of midpoint M of \overline{AB} , with endpoints $A(x_1, y_1)$ and $B(x_2, y_2)$:

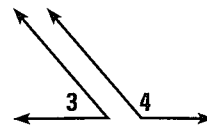
$$M\left(\frac{x_1 + x_2}{2}, \frac{y_1 + y_2}{2}\right)$$

ANGLES You classified angles and found their measures.



Complementary angles

$$m\angle 1 + m\angle 2 = 90^\circ$$



Supplementary angles

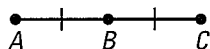
$$m\angle 3 + m\angle 4 = 180^\circ$$

FORMULAS Perimeter and area formulas are reviewed on page 49.

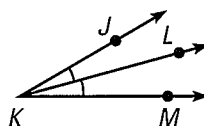
Big Idea 3

Understanding Equality and Congruence

Congruent segments have equal lengths. Congruent angles have equal measures.



$$\overline{AB} \cong \overline{BC} \text{ and } AB = BC$$



$$\angle JKL \cong \angle LKM \text{ and } m\angle JKL = m\angle LKM$$

REVIEW KEY VOCABULARY

For a list of postulates and theorems, see pp. 926–931.

- undefined terms, p. 2
point, line, plane
- collinear, coplanar points, p. 2
- defined terms, p. 3
- line segment, endpoints, p. 3
- ray, opposite rays, p. 3
- intersection, p. 4
- postulate, axiom, p. 9
- coordinate, p. 9
- distance, p. 9
- between, p. 10
- congruent segments, p. 11
- midpoint, p. 15
- segment bisector, p. 15
- angle, p. 24
sides, vertex, measure
- acute, right, obtuse, straight, p. 25
- congruent angles, p. 26
- angle bisector, p. 28
- construction, p. 33
- complementary angles, p. 35
- supplementary angles, p. 35
- adjacent angles, p. 35
- linear pair, p. 37
- vertical angles, p. 37
- polygon, p. 42
side, vertex
- convex, concave, p. 42
- n -gon, p. 43
- equilateral, equiangular, regular, p. 43

VOCABULARY EXERCISES

1. Copy and complete: Points A and B are the ? of \overline{AB} .
2. Draw an example of a *linear pair*.
3. If Q is between points P and R on \overleftrightarrow{PR} , and $PQ = QR$, then Q is the ? of \overleftrightarrow{PR} .

REVIEW EXAMPLES AND EXERCISES

Use the review examples and exercises below to check your understanding of the concepts you have learned in each lesson of Chapter 1.

1.1 Identify Points, Lines, and Planes

pp. 2–8

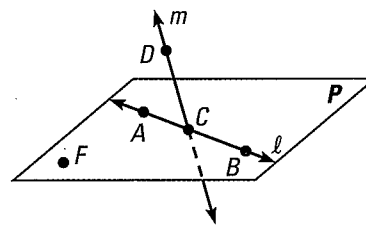
EXAMPLE

Use the diagram shown at the right.

Another name for \overleftrightarrow{CD} is line m .

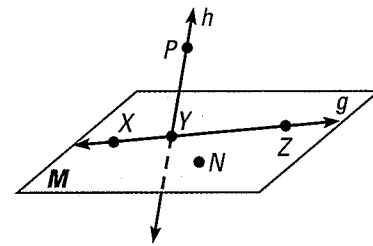
Points A , B , and C are collinear.

Points A , B , C , and F are coplanar.



EXERCISES

4. Give another name for line g .
5. Name three points that are *not* collinear.
6. Name four points that are coplanar.
7. Name a pair of opposite rays.
8. Name the intersection of line h and plane M .



EXAMPLES 1, 2, and 3
on pp. 3–4
for Exs. 4–8

1.2 Use Segments and Congruence

pp. 9–14

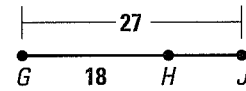
EXAMPLE

Find the length of \overline{HJ} .

$$GJ = GH + HJ \quad \text{Segment Addition Postulate}$$

$$27 = 18 + HJ \quad \text{Substitute 27 for } GJ \text{ and 18 for } GH.$$

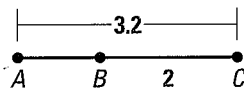
$$9 = HJ \quad \text{Subtract 18 from each side.}$$



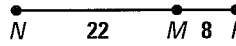
EXERCISES

Find the indicated length.

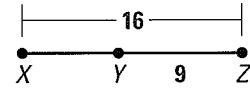
9. Find AB .



10. Find NP .



11. Find XY .



12. The endpoints of \overline{DE} are $D(-4, 11)$ and $E(-4, -13)$. The endpoints of \overline{GH} are $G(-14, 5)$ and $H(-9, 5)$. Are \overline{DE} and \overline{GH} congruent? *Explain.*

EXAMPLES
2, 3, and 4
on pp. 10–11
for Exs. 9–12

1.3 Use Midpoint and Distance Formulas

pp. 15–22

EXAMPLE

\overline{EF} has endpoints $E(1, 4)$ and $F(3, 2)$. Find (a) the length of \overline{EF} rounded to the nearest tenth of a unit, and (b) the coordinates of the midpoint M of \overline{EF} .

a. Use the Distance Formula.

$$EF = \sqrt{(3 - 1)^2 + (2 - 4)^2} = \sqrt{2^2 + (-2)^2} = \sqrt{8} \approx 2.8 \text{ units}$$

b. Use the Midpoint Formula.

$$M\left(\frac{1 + 3}{2}, \frac{4 + 2}{2}\right) = M(2, 3)$$

EXERCISES

13. Point M is the midpoint of \overline{JK} . Find JK when $JM = 6x - 7$ and $MK = 2x + 3$.

In Exercises 14–17, the endpoints of a segment are given. Find the length of the segment rounded to the nearest tenth. Then find the coordinates of the midpoint of the segment.

14. $A(2, 5)$ and $B(4, 3)$

15. $F(1, 7)$ and $G(6, 0)$

16. $H(-3, 9)$ and $J(5, 4)$

17. $K(10, 6)$ and $L(0, -7)$

18. Point $C(3, 8)$ is the midpoint of \overline{AB} . One endpoint is $A(-1, 5)$. Find the coordinates of endpoint B .

19. The endpoints of \overline{EF} are $E(2, 3)$ and $F(8, 11)$. The midpoint of \overline{EF} is M . Find the length of \overline{EM} .

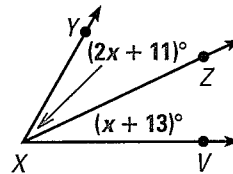
EXAMPLES
2, 3, and 4
on pp. 16–18
for Exs. 13–19

1.4 Measure and Classify Angles

pp. 24–32

EXAMPLE

Given that $m\angle YXV$ is 60° ,
find $m\angle YXZ$ and $m\angle ZXV$.



STEP 1 Find the value of x .

$$m\angle YXV = m\angle YXZ + m\angle ZXV$$

$$60^\circ = (2x + 11)^\circ + (x + 13)^\circ$$

$$x = 12$$

Angle Addition Postulate

Substitute angle measures.

Solve for x .

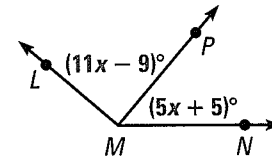
STEP 2 Evaluate the given expressions when $x = 12$.

$$m\angle YXZ = (2x + 11)^\circ = (2 \cdot 12 + 11)^\circ = 35^\circ$$

$$m\angle ZXV = (x + 13)^\circ = (12 + 13)^\circ = 25^\circ$$

EXERCISES

20. In the diagram shown at the right, $m\angle LMN = 140^\circ$.
Find $m\angle PMN$.



21. \vec{VZ} bisects $\angle UVW$, and $m\angle UVZ = 81^\circ$. Find
 $m\angle UVW$. Then classify $\angle UVW$ by its angle measure.

EXAMPLES
3 and 5
on pp. 26, 28
for Exs. 20–21

1.5 Describe Angle Pair Relationships

pp. 35–41

EXAMPLE

a. $\angle 1$ and $\angle 2$ are complementary angles. Given that $m\angle 1 = 37^\circ$, find $m\angle 2$.

$$m\angle 2 = 90^\circ - m\angle 1 = 90^\circ - 37^\circ = 53^\circ$$

b. $\angle 3$ and $\angle 4$ are supplementary angles. Given that $m\angle 3 = 106^\circ$, find $m\angle 4$.

$$m\angle 4 = 180^\circ - m\angle 3 = 180^\circ - 106^\circ = 74^\circ$$

EXERCISES

$\angle 1$ and $\angle 2$ are complementary angles. Given the measure of $\angle 1$, find $m\angle 2$.

22. $m\angle 1 = 12^\circ$

23. $m\angle 1 = 83^\circ$

24. $m\angle 1 = 46^\circ$

25. $m\angle 1 = 2^\circ$

$\angle 3$ and $\angle 4$ are supplementary angles. Given the measure of $\angle 3$, find $m\angle 4$.

26. $m\angle 3 = 116^\circ$

27. $m\angle 3 = 56^\circ$

28. $m\angle 3 = 89^\circ$

29. $m\angle 3 = 12^\circ$

30. $\angle 1$ and $\angle 2$ are complementary angles. Find the measures of the angles
when $m\angle 1 = (x - 10)^\circ$ and $m\angle 2 = (2x + 40)^\circ$.

31. $\angle 1$ and $\angle 2$ are supplementary angles. Find the measures of the angles
when $m\angle 1 = (3x + 50)^\circ$ and $m\angle 2 = (4x + 32)^\circ$. Then classify $\angle 1$ by its
angle measure.

EXAMPLES
2 and 3
on p. 36
for Exs. 22–31

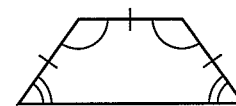
1.6 Classify Polygons

pp. 42–47

EXAMPLE

Classify the polygon by the number of sides. Tell whether it is equilateral, equiangular, or regular. *Explain.*

The polygon has four sides, so it is a quadrilateral. It is not equiangular or equilateral, so it is not regular.

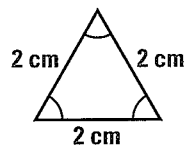


EXERCISES

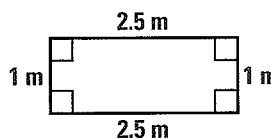
Classify the polygon by the number of sides. Tell whether it is equilateral, equiangular, or regular. *Explain.*

EXAMPLES
2 and 3
on pp. 43–44
for Exs. 32–35

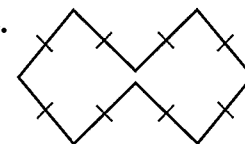
32.



33.



34.



35. Pentagon $ABCDE$ is a regular polygon. The length of \overline{BC} is represented by the expression $5x - 4$. The length of \overline{DE} is represented by the expression $2x + 11$. Find the length of \overline{AB} .

1.7 Find Perimeter, Circumference, and Area

pp. 49–56

EXAMPLE

The diameter of a circle is 10 feet. Find the circumference and area of the circle. Round to the nearest tenth.

The radius is half of the diameter, so $r = \frac{1}{2}(10) = 5$ ft.

Circumference

$$C = 2\pi r \approx 2(3.14)(5) = 31.4 \text{ ft}$$

Area

$$A = \pi r^2 \approx 3.14(5^2) = 78.5 \text{ ft}^2$$

EXERCISES

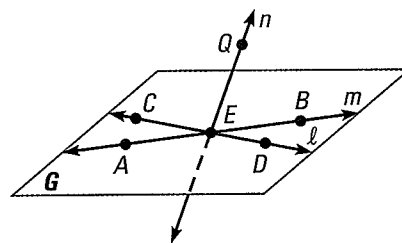
In Exercises 36–38, find the perimeter (or circumference) and area of the figure described. If necessary, round to the nearest tenth.

EXAMPLES
1, 2, and 3
on pp. 49–50
for Exs. 36–40

36. Circle with diameter 15.6 meters
37. Rectangle with length $4\frac{1}{2}$ inches and width $2\frac{1}{2}$ inches
38. Triangle with vertices $U(1, 2)$, $V(-8, 2)$, and $W(-4, 6)$
39. The height of a triangle is 18.6 meters. Its area is 46.5 square meters. Find the length of the triangle's base.
40. The area of a circle is 320 square meters. Find the radius of the circle. Then find the circumference. Round your answers to the nearest tenth.

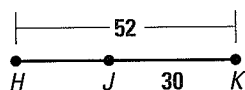
Use the diagram to decide whether the statement is *true* or *false*.

- Point A lies on line m .
- Point D lies on line n .
- Points $B, C, E,$ and Q are coplanar.
- Points $C, E,$ and B are collinear.
- Another name for plane G is plane QEC .

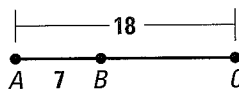


Find the indicated length.

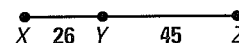
6. Find HJ .



7. Find BC .



8. Find XZ .

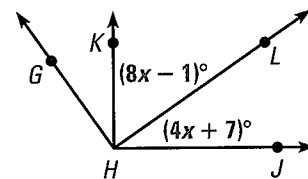


In Exercises 9–11, find the distance between the two points.

- $T(3, 4)$ and $W(2, 7)$
- $C(5, 10)$ and $D(6, -1)$
- $M(-8, 0)$ and $N(-1, 3)$
- The midpoint of \overline{AB} is $M(9, 7)$. One endpoint is $A(3, 9)$. Find the coordinates of endpoint B .
- Line t bisects \overline{CD} at point M , $CM = 3x$, and $MD = 27$. Find CD .

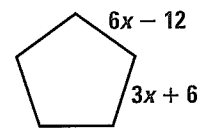
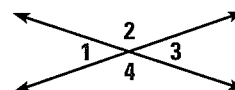
In Exercises 14 and 15, use the diagram.

- Trace the diagram and extend the rays. Use a protractor to measure $\angle GHJ$. Classify it as *acute*, *obtuse*, *right*, or *straight*.
- Given $m\angle KHJ = 90^\circ$, find $m\angle LHJ$.
- The measure of $\angle QRT$ is 154° , and \overrightarrow{RS} bisects $\angle QRT$. What are the measures of $\angle QRS$ and $\angle SRT$?



In Exercises 17 and 18, use the diagram at the right.

- Name four linear pairs.
- Name two pairs of vertical angles.
- The measure of an angle is 64° . What is the measure of its complement? What is the measure of its supplement?
- A convex polygon has half as many sides as a concave 10-gon. Draw the concave polygon and the convex polygon. Classify the convex polygon by the number of sides it has.
- Find the perimeter of the regular pentagon shown at the right.
- CARPET** You can afford to spend \$300 to carpet a room that is 5.5 yards long and 4.5 yards wide. The cost to purchase and install the carpet you like is \$1.50 per square foot. Can you afford to buy this carpet? *Explain.*



SOLVE LINEAR EQUATIONS AND WORD PROBLEMS**xy EXAMPLE 1** *Solve linear equations*Solve the equation $-3(x + 5) + 4x = 25$.

$$-3(x + 5) + 4x = 25 \quad \text{Write original equation.}$$

$$-3x - 15 + 4x = 25 \quad \text{Use the Distributive Property.}$$

$$x - 15 = 25 \quad \text{Group and combine like terms.}$$

$$x = 40 \quad \text{Add 15 to each side.}$$

xy EXAMPLE 2 *Solve a real-world problem*

MEMBERSHIP COSTS A health club charges an initiation fee of \$50. Members then pay \$45 per month. You have \$400 to spend on a health club membership. For how many months can you afford to be a member?

Let n represent the number of months you can pay for a membership.

$$\$400 = \text{Initiation fee} + (\text{Monthly Rate} \times \text{Number of Months})$$

$$400 = 50 + 45n \quad \text{Substitute.}$$

$$350 = 45n \quad \text{Subtract 50 from each side.}$$

$$7.8 = n \quad \text{Divide each side by 45.}$$

▶ You can afford to be a member at the health club for 7 months.

EXERCISES**EXAMPLE 1**

for Exs. 1–9

Solve the equation.

1. $9y + 1 - y = 49$

2. $5z + 7 + z = -8$

3. $-4(2 - t) = -16$

4. $7a - 2(a - 1) = 17$

5. $\frac{4x}{3} + 2(3 - x) = 5$

6. $\frac{2x - 5}{7} = 4$

7. $9c - 11 = -c + 29$

8. $2(0.3r + 1) = 23 - 0.1r$

9. $5(k + 2) = 3(k - 4)$

EXAMPLE 2

for Exs. 10–12

10. **GIFT CERTIFICATE** You have a \$50 gift certificate at a store. You want to buy a book that costs \$8.99 and boxes of stationery for your friends. Each box costs \$4.59. How many boxes can you buy with your gift certificate?

11. **CATERING** It costs \$350 to rent a room for a party. You also want to hire a caterer. The caterer charges \$8.75 per person. How many people can come to the party if you have \$500 to spend on the room and the caterer?

12. **JEWELRY** You are making a necklace out of glass beads. You use one bead that is $1\frac{1}{2}$ inches long and smaller beads that are each $\frac{3}{4}$ inch long. The necklace is 18 inches long. How many smaller beads do you need?