

Geo

3

Parallel and Perpendicular Lines

- 3.1 Identify Pairs of Lines and Angles
- 3.2 Use Parallel Lines and Transversals
- 3.3 Prove Lines are Parallel
- 3.4 Find and Use Slopes of Lines
- 3.5 Write and Graph Equations of Lines
- 3.6 Prove Theorems About Perpendicular Lines

Before

In previous chapters, you learned the following skills, which you'll use in Chapter 3: describing angle pairs, using properties and postulates, using angle pair relationships, and sketching a diagram.

Prerequisite Skills

VOCABULARY CHECK

Copy and complete the statement.

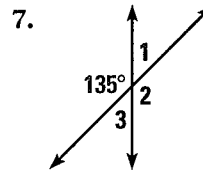
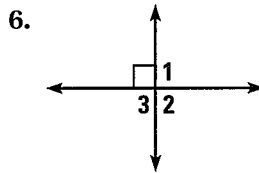
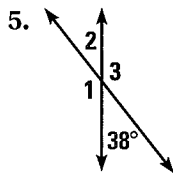
1. Adjacent angles share a common ? and ?.
2. Two angles are ? angles if the sum of their measures is 180° .

SKILLS AND ALGEBRA CHECK

The midpoint of \overline{AB} is M . Find AB . (Review p. 15 for 3.2.)

3. $AM = 5x - 2$, $MB = 2x + 7$
4. $AM = 4z + 1$, $MB = 6z - 11$

Find the measure of each numbered angle. (Review p. 124 for 3.2, 3.3.)



Sketch a diagram for each statement. (Review pp. 2, 96 for 3.3.)

8. \overrightarrow{QR} is perpendicular to \overrightarrow{WX} .
9. Lines m and n intersect at point P .

@HomeTutor Prerequisite skills practice at classzone.com

Now

In Chapter 3, you will apply the big ideas listed below and reviewed in the Chapter Summary on page 201. You will also use the key vocabulary listed below.

Big Ideas

- 1 Using properties of parallel and perpendicular lines
- 2 Proving relationships using angle measures
- 3 Making connections to lines in algebra

KEY VOCABULARY

- parallel lines, p. 147
- skew lines, p. 147
- parallel planes, p. 147
- transversal, p. 149
- corresponding angles, p. 149
- alternate interior angles, p. 149
- alternate exterior angles, p. 149
- consecutive interior angles, p. 149
- paragraph proof, p. 163
- slope, p. 171
- slope-intercept form, p. 180
- standard form, p. 182
- distance from a point to a line, p. 192

Why?

You can use slopes of lines to determine steepness of lines. For example, you can compare the slopes of roller coasters to determine which is steeper.

Animated Geometry

The animation illustrated below for Example 5 on page 174 helps you answer this question: How steep is a roller coaster?

The screenshot shows an interactive animation. On the left, a 3D view of a roller coaster track is shown with a car at the start. Below it, a text box reads: "A roller coaster track rises a given distance over a given horizontal distance." On the right, a 2D graph plots Height (ft) on the y-axis (0, 41, 62) against Horizontal distance (ft) on the x-axis (0, 62, 100, 200, 300, 400, 500, 600, 700). The graph shows a roller coaster track with a straight line segment from (0,0) to (80,41) and a curved segment from (80,41) to (205,205). Below the graph are two tables for data entry:

Magnum XI-200	
Rise	41
Run	80
Maximum Height	205
Slope	.5

Other roller coaster	
Rise	
Run	

Below the tables is a "Check Answer" button. At the bottom of the right panel, a text box reads: "For each track, use the vertical rise and the horizontal run to find the slope."

Animated Geometry at classzone.com

Other animations for Chapter 3: pages 148, 155, 163, and 181

3.1 Draw and Interpret Lines

MATERIALS • pencil • straightedge • lined paper

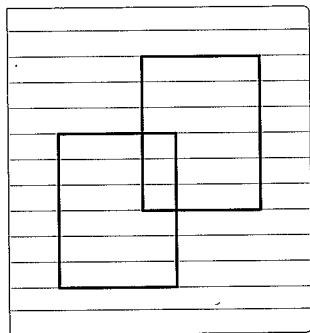
QUESTION How are lines related in space?

You can use a straightedge to draw a representation of a three-dimensional figure to explore lines in space.

EXPLORE Draw lines in space

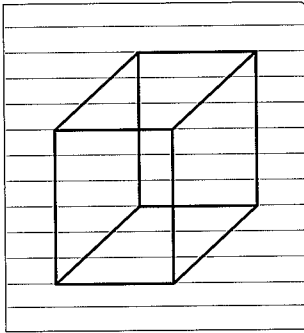
STEP 1 Draw rectangles

Use a straightedge to draw two identical rectangles.



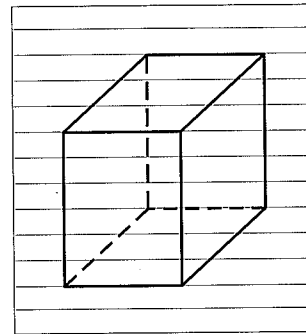
STEP 2 Connect corners

Connect the corresponding corners of the rectangles.



STEP 3 Erase parts

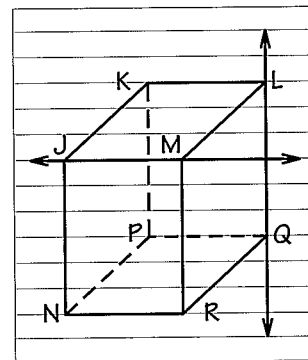
Erase parts of "hidden" lines to form dashed lines.



DRAW CONCLUSIONS Use your observations to complete these exercises

Using your sketch from the steps above, label the corners as shown at the right. Then extend \overleftrightarrow{JM} and \overleftrightarrow{LQ} . Add lines to the diagram if necessary.

- Will \overleftrightarrow{JM} and \overleftrightarrow{LQ} ever intersect in space? (Lines that intersect on the page do not necessarily intersect in space.)
- Will the pair of lines intersect in space?
 - \overleftrightarrow{JK} and \overleftrightarrow{NR}
 - \overleftrightarrow{QR} and \overleftrightarrow{MR}
 - \overleftrightarrow{LM} and \overleftrightarrow{MR}
 - \overleftrightarrow{KL} and \overleftrightarrow{NQ}
- Does the pair of lines lie in one plane?
 - \overleftrightarrow{JK} and \overleftrightarrow{QR}
 - \overleftrightarrow{QR} and \overleftrightarrow{MR}
 - \overleftrightarrow{JN} and \overleftrightarrow{LR}
 - \overleftrightarrow{JL} and \overleftrightarrow{NQ}
- Do pairs of lines that intersect in space also lie in the same plane?
Explain your reasoning.
- Draw a rectangle that is not the same as the one you used in the Explore. Repeat the three steps of the Explore. Will any of your answers to Exercises 1–3 change?



3.1 EXERCISES

HOMEWORK KEY

○ = WORKED-OUT SOLUTIONS
on p. WS3 for Exs. 11, 25, and 35

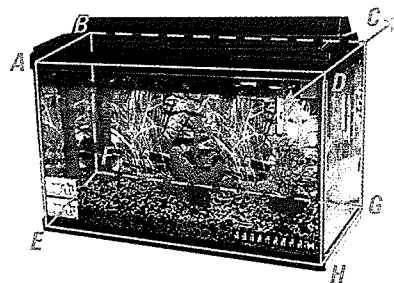
★ = STANDARDIZED TEST PRACTICE
Exs. 2, 28, 36, 37, and 39

SKILL PRACTICE

- VOCABULARY** Copy and complete: A line that intersects two other lines is a ?.
- ★ **WRITING** A table is set for dinner. Can the legs of the table and the top of the table lie in parallel planes? *Explain* why or why not.

EXAMPLE 1
on p. 147
for Exs. 3–6

IDENTIFYING RELATIONSHIPS Think of each segment in the diagram as part of a line. Which line(s) or plane(s) contain point *B* and appear to fit the description?

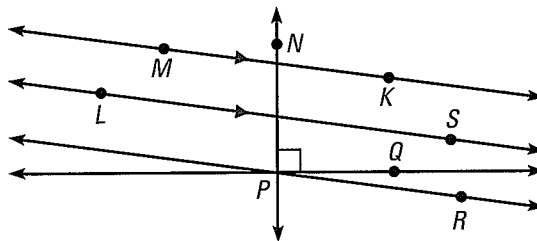


- Line(s) parallel to \overleftrightarrow{CD}
- Line(s) perpendicular to \overleftrightarrow{CD}
- Line(s) skew to \overleftrightarrow{CD}
- Plane(s) parallel to plane *CDH*

EXAMPLE 2
on p. 148
for Exs. 7–10

PARALLEL AND PERPENDICULAR LINES Use the markings in the diagram.

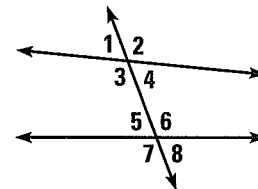
- Name a pair of parallel lines.
- Name a pair of perpendicular lines.
- Is $\overleftrightarrow{PN} \parallel \overleftrightarrow{KM}$? *Explain*.
- Is $\overleftrightarrow{PR} \perp \overleftrightarrow{NP}$? *Explain*.



EXAMPLE 3
on p. 149
for Exs. 11–15

ANGLE RELATIONSHIPS Identify all pairs of angles of the given type.

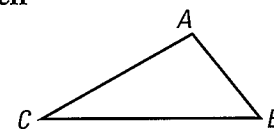
- | | |
|------------------------|--------------------------|
| 11. Corresponding | 12. Alternate interior |
| 13. Alternate exterior | 14. Consecutive interior |



- ERROR ANALYSIS** Describe and correct the error in saying that $\angle 1$ and $\angle 8$ are corresponding angles in the diagram for Exercises 11–14.

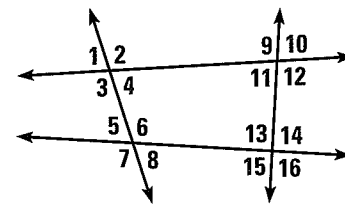
APPLYING POSTULATES How many lines can be drawn that fit each description? Copy the diagram and sketch all the lines.

- Lines through *B* and parallel to \overleftrightarrow{AC}
- Lines through *A* and perpendicular to \overleftrightarrow{BC}



USING A DIAGRAM Classify the angle pair as *corresponding*, *alternate interior*, *alternate exterior*, or *consecutive interior* angles.

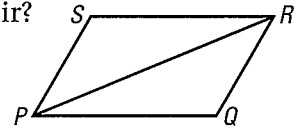
- | | |
|--------------------------------|---------------------------------|
| 18. $\angle 5$ and $\angle 1$ | 19. $\angle 11$ and $\angle 13$ |
| 20. $\angle 6$ and $\angle 13$ | 21. $\angle 10$ and $\angle 15$ |
| 22. $\angle 2$ and $\angle 11$ | 23. $\angle 8$ and $\angle 4$ |



ANALYZING STATEMENTS Copy and complete the statement with *sometimes*, *always*, or *never*. Sketch examples to *justify* your answer.

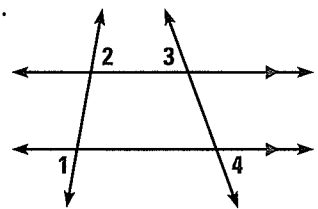
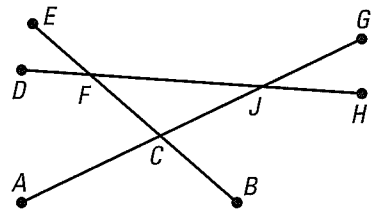
24. If two lines are parallel, then they are ? coplanar.
 25. If two lines are not coplanar, then they ? intersect.
 26. If three lines intersect at one point, then they are ? coplanar.
 27. If two lines are skew to a third line, then they are ? skew to each other.
 28. ★ **MULTIPLE CHOICE** $\angle RPQ$ and $\angle PRS$ are what type of angle pair?

- (A) Corresponding (B) Alternate interior
 (C) Alternate exterior (D) Consecutive interior



ANGLE RELATIONSHIPS Copy and complete the statement. List all possible correct answers.

29. $\angle BCG$ and ? are corresponding angles.
 30. $\angle BCG$ and ? are consecutive interior angles.
 31. $\angle FCJ$ and ? are alternate interior angles.
 32. $\angle FCA$ and ? are alternate exterior angles.
 33. **CHALLENGE** Copy the diagram at the right and extend the lines.
 a. Measure $\angle 1$ and $\angle 2$.
 b. Measure $\angle 3$ and $\angle 4$.
 c. Make a conjecture about alternate exterior angles formed when parallel lines are cut by transversals.



PROBLEM SOLVING

EXAMPLE 2
 on p. 148
 for Exs. 34–35

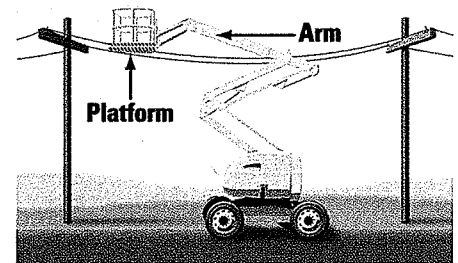
CONSTRUCTION Use the picture of the cherry-picker for Exercises 34 and 35.

34. Is the platform *perpendicular*, *parallel*, or *skew* to the ground?

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35. Is the arm *perpendicular*, *parallel*, or *skew* to a telephone pole?

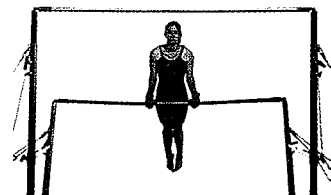
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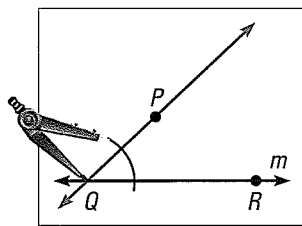
36. ★ **OPEN-ENDED MATH** Describe two lines in your classroom that are parallel, and two lines that are skew.

37. ★ **MULTIPLE CHOICE** What is the best description of the horizontal bars in the photo?

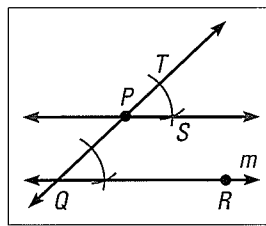
- (A) Parallel (B) Perpendicular
 (C) Skew (D) Intersecting



38. **CONSTRUCTION** Use these steps to construct a line through a given point P that is parallel to a given line m .



STEP 1 Draw points Q and R on m . Draw \overrightarrow{PQ} . Draw an arc with the compass point at Q so it crosses \overrightarrow{QP} and \overrightarrow{QR} .



STEP 2 Copy $\angle PQR$ on \overrightarrow{QP} . Be sure the two angles are corresponding. Label the new angle $\angle TPS$. Draw \overrightarrow{PS} . $\overrightarrow{PS} \parallel \overrightarrow{QR}$.

39. ★ **SHORT RESPONSE** Two lines are cut by a transversal. Suppose the measure of a pair of alternate interior angles is 90° . Explain why the measure of all four interior angles must be 90° .

TREE HOUSE In Exercises 40–42, use the photo to decide whether the statement is *true* or *false*.

40. The plane containing the floor of the tree house is parallel to the ground.
41. All of the lines containing the railings of the staircase, such as \overrightarrow{AB} , are skew to the ground.
42. All of the lines containing the *balusters*, such as \overrightarrow{CD} , are perpendicular to the plane containing the floor of the tree house.



CHALLENGE Draw the figure described.

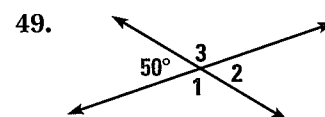
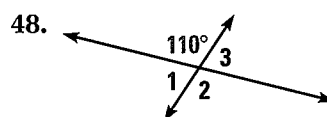
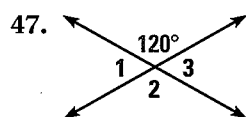
43. Lines l and m are skew, lines l and n are skew, and lines m and n are parallel.
44. Line l is parallel to plane A , plane A is parallel to plane B , and line l is not parallel to plane B .

MIXED REVIEW

Use the Law of Detachment to make a valid conclusion. (p. 87)

45. If the measure of an angle is less than 90° , then the angle is acute. The measure of $\angle A$ is 46° .
46. If a food has less than 140 milligrams of sodium per serving, then it is low sodium. A serving of soup has 90 milligrams of sodium per serving.

Find the measure of each numbered angle. (p. 124)



PREVIEW
Prepare for
Lesson 3.2
in Exs. 47–49.

3.2 EXERCISES

HOMEWORK KEY

○ = WORKED-OUT SOLUTIONS on p. WS3 for Exs. 5, 9, and 39

★ = STANDARDIZED TEST PRACTICE Exs. 2, 3, 21, 33, 39, and 40

SKILL PRACTICE

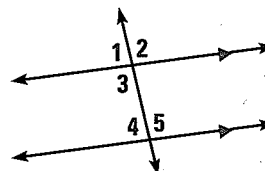
EXAMPLES 1 and 2
on pp. 154–155
for Exs. 3–16

1. **VOCABULARY** Draw a pair of parallel lines and a transversal. Label a pair of corresponding angles.

2. ★ **WRITING** Two parallel lines are cut by a transversal. Which pairs of angles are congruent? Which pairs of angles are supplementary?

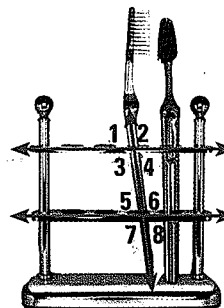
3. ★ **MULTIPLE CHOICE** In the figure at the right, which angle has the same measure as $\angle 1$?

- (A) $\angle 2$ (B) $\angle 3$
(C) $\angle 4$ (D) $\angle 5$



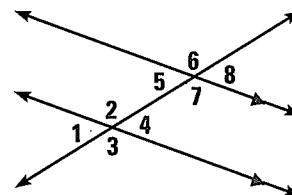
USING PARALLEL LINES Find the angle measure. Tell which postulate or theorem you use.

4. If $m\angle 4 = 65^\circ$, then $m\angle 1 = ?$.
 5. If $m\angle 7 = 110^\circ$, then $m\angle 2 = ?$.
 6. If $m\angle 5 = 71^\circ$, then $m\angle 4 = ?$.
 7. If $m\angle 3 = 117^\circ$, then $m\angle 5 = ?$.
 8. If $m\angle 8 = 54^\circ$, then $m\angle 1 = ?$.

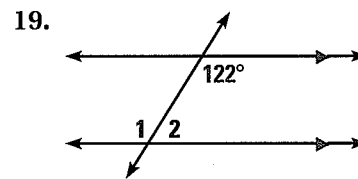
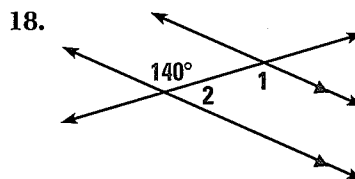
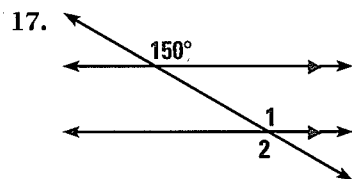


USING POSTULATES AND THEOREMS What postulate or theorem justifies the statement about the diagram?

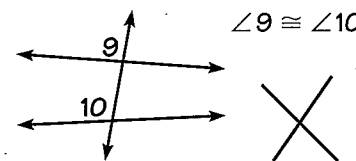
9. $\angle 1 \cong \angle 5$ 10. $\angle 4 \cong \angle 5$
 11. $\angle 2 \cong \angle 7$ 12. $\angle 2$ and $\angle 5$ are supplementary.
 13. $\angle 3 \cong \angle 6$ 14. $\angle 3 \cong \angle 7$
 15. $\angle 1 \cong \angle 8$ 16. $\angle 4$ and $\angle 7$ are supplementary.



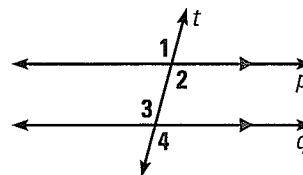
USING PARALLEL LINES Find $m\angle 1$ and $m\angle 2$. Explain your reasoning.



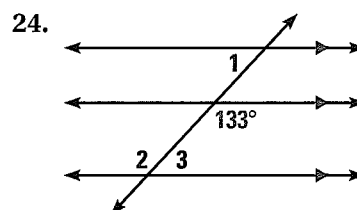
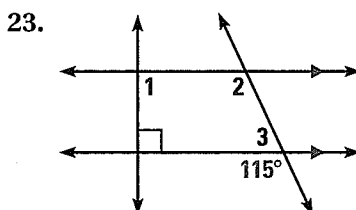
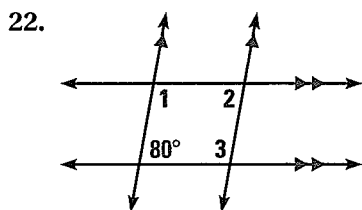
20. **ERROR ANALYSIS** A student concludes that $\angle 9 \cong \angle 10$ by the Corresponding Angles Postulate. Describe and correct the error in this reasoning.



21. ★ **SHORT RESPONSE** Given $p \parallel q$, describe two methods you can use to show that $\angle 1 \cong \angle 4$.

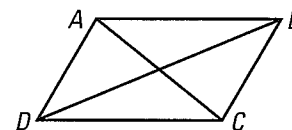


USING PARALLEL LINES Find $m\angle 1$, $m\angle 2$, and $m\angle 3$. Explain your reasoning.

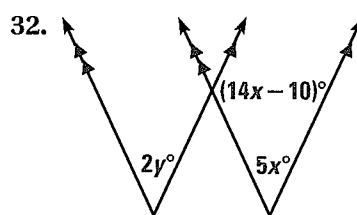
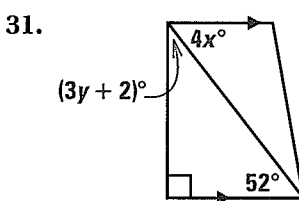
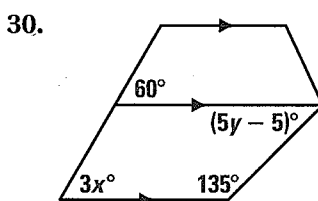
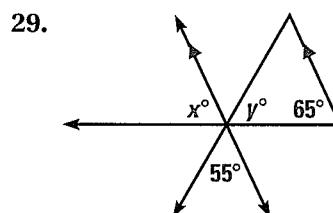
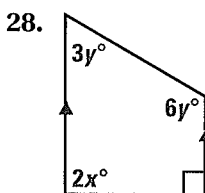
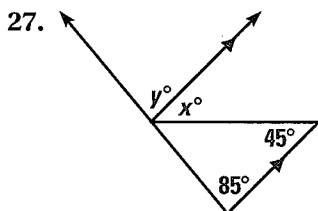


ANGLES Use the diagram at the right.

25. Name two pairs of congruent angles if \vec{AB} and \vec{DC} are parallel.
 26. Name two pairs of supplementary angles if \vec{AD} and \vec{BC} are parallel.

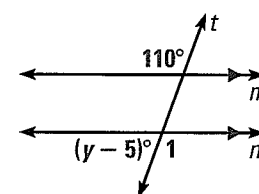


XIV ALGEBRA Find the values of x and y .



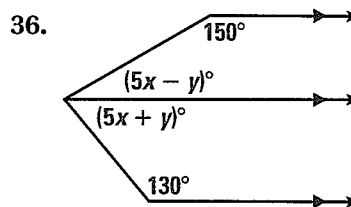
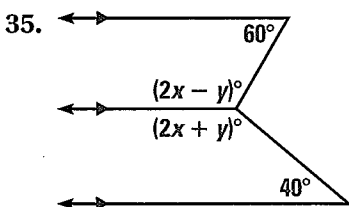
33. ★ **MULTIPLE CHOICE** What is the value of y in the diagram?

- (A) 70 (B) 75
 (C) 110 (D) 115



34. **DRAWING** Draw a four-sided figure with sides \overline{MN} and \overline{PQ} , such that $\overline{MN} \parallel \overline{PQ}$, $\overline{MP} \parallel \overline{NQ}$, and $\angle MNQ$ is an acute angle. Which angle pairs formed are congruent? Explain your reasoning.

CHALLENGE Find the values of x and y .



PROBLEM SOLVING

EXAMPLE 3

on p. 156
for Ex. 37

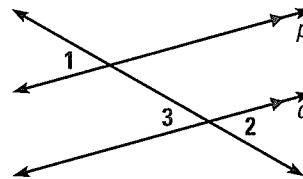
- 37. PROVING THEOREM 3.2** If two parallel lines are cut by a transversal, then the pairs of alternate exterior angles are congruent. Use the steps below to write a proof of the Alternate Exterior Angles Theorem.

GIVEN $\triangleright p \parallel q$

PROVE $\triangleright \angle 1 \cong \angle 2$

- a. Show that $\angle 1 \cong \angle 3$.
- b. Then show that $\angle 1 \cong \angle 2$.

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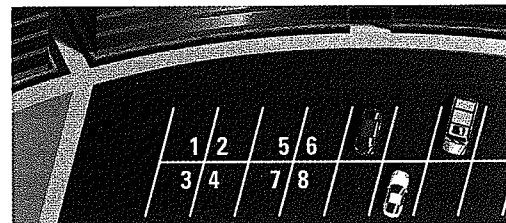
EXAMPLE 4

on p. 156
for Exs. 38–40

- 38. PARKING LOT** In the diagram, the lines dividing parking spaces are parallel. The measure of $\angle 1$ is 110° .

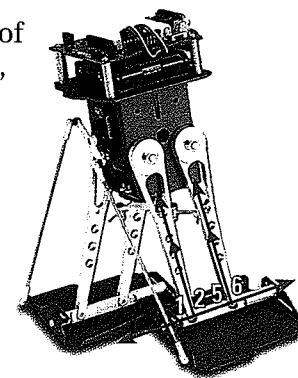
- a. Identify the angle(s) congruent to $\angle 1$.
- b. Find $m\angle 6$.

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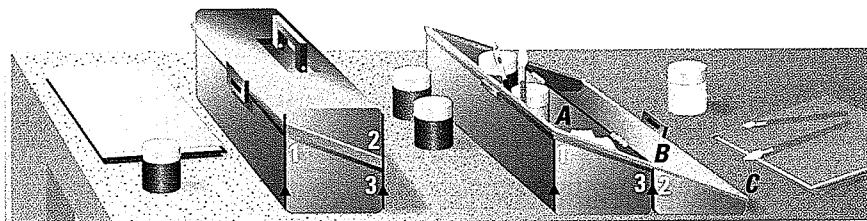


- 39. ★ SHORT RESPONSE** The *Toddler*TM is a walking robot. Each leg of the robot has two parallel bars and a foot. When the robot walks, the leg bars remain parallel as the foot slides along the surface.

- a. As the legs move, are there pairs of angles that are always congruent? always supplementary? If so, which angles?
- b. *Explain* how having parallel leg bars allows the robot's foot to stay flat on the floor as it moves.



- 40. ★ EXTENDED RESPONSE** You are designing a box like the one below.

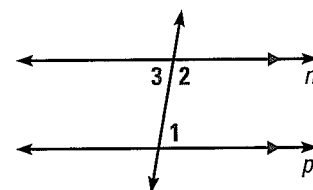


- a. The measure of $\angle 1$ is 70° . What is $m\angle 2$? What is $m\angle 3$?
- b. *Explain* why $\angle ABC$ is a straight angle.
- c. **What If?** If $m\angle 1$ is 60° , will $\angle ABC$ still be a straight angle? Will the opening of the box be *more steep* or *less steep*? *Explain*.

- 41. PROVING THEOREM 3.3** If two parallel lines are cut by a transversal, then the pairs of consecutive interior angles are supplementary. Write a proof of the Consecutive Interior Angles Theorem.

GIVEN $\triangleright n \parallel p$

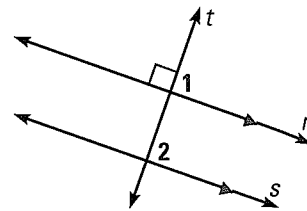
PROVE $\triangleright \angle 1$ and $\angle 2$ are supplementary.



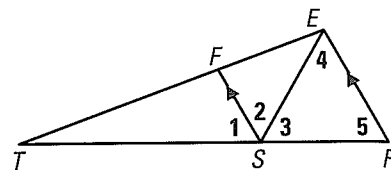
42. **PROOF** The Perpendicular Transversal Theorem (page 192) states that if a transversal is perpendicular to one of two parallel lines, then it is perpendicular to the other. Write a proof of the Perpendicular Transversal Theorem.

GIVEN $\triangleright t \perp r, r \parallel s$

PROVE $\triangleright t \perp s$



43. **CHALLENGE** In the diagram, $\angle 4 \cong \angle 5$. \overline{SE} bisects $\angle RSF$. Find $m\angle 1$. Explain your reasoning.

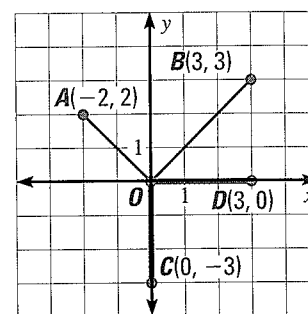


MIXED REVIEW

44. Find the length of each segment in the coordinate plane at the right. Which segments are congruent? (p. 15)

Are angles with the given measures *complementary*, *supplementary*, or *neither*? (p. 35)

45. $m\angle 1 = 62^\circ$, $m\angle 2 = 128^\circ$ 46. $m\angle 3 = 130^\circ$, $m\angle 4 = 70^\circ$ 47. $m\angle 5 = 44^\circ$, $m\angle 6 = 46^\circ$



Find the perimeter of the equilateral figure with the given side length. (pp. 42, 49)

48. Pentagon, 20 cm 49. Octagon, 2.5 ft 50. Decagon, 33 in.

PREVIEW

Prepare for
Lesson 3.3
in Exs. 51–52.

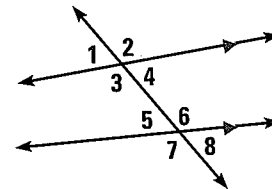
Write the converse of the statement. Is the converse true? (p. 79)

51. Three points are collinear if they lie on the same line.
52. If the measure of an angle is 119° , then the angle is obtuse.

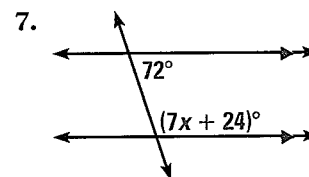
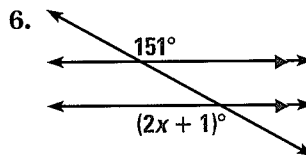
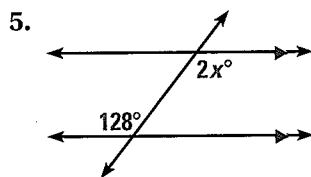
QUIZ for Lessons 3.1–3.2

Copy and complete the statement. (p. 147)

- $\angle 2$ and $\underline{\quad ? \quad}$ are corresponding angles.
- $\angle 3$ and $\underline{\quad ? \quad}$ are consecutive interior angles.
- $\angle 3$ and $\underline{\quad ? \quad}$ are alternate interior angles.
- $\angle 2$ and $\underline{\quad ? \quad}$ are alternate exterior angles.



Find the value of x . (p. 154)



3.3 EXERCISES

HOMEWORK KEY

○ = WORKED-OUT SOLUTIONS
on p. WS3 for Exs. 11, 29, and 37

★ = STANDARDIZED TEST PRACTICE
Exs. 2, 16, 23, 24, 33, and 39

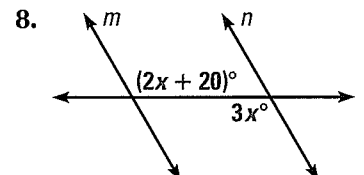
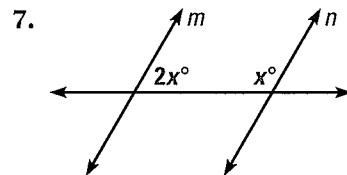
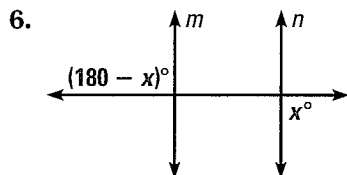
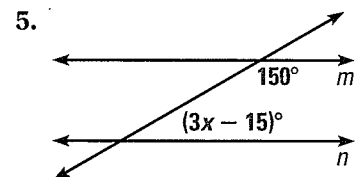
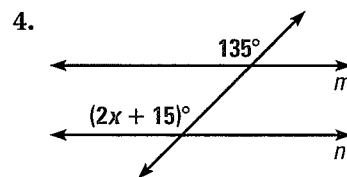
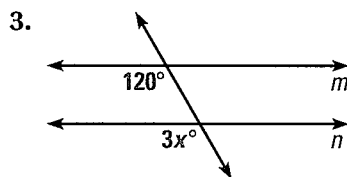
SKILL PRACTICE

- VOCABULARY** Draw a pair of parallel lines with a transversal. Identify all pairs of *alternate exterior angles*.
- ★ **WRITING** Use the theorems from the previous lesson and the converses of those theorems in this lesson. Write three biconditionals about parallel lines and transversals.

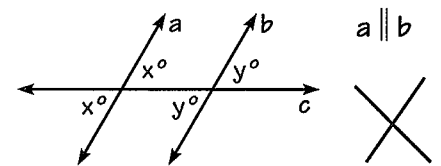
EXAMPLE 1

on p. 161
for Exs. 3–9

39 **ALGEBRA** Find the value of x that makes $m \parallel n$.



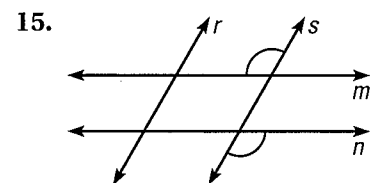
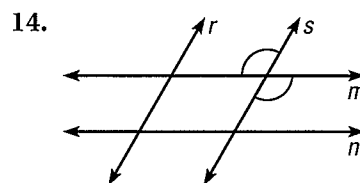
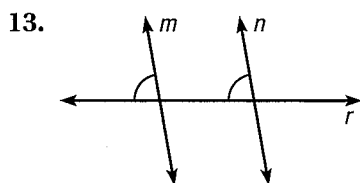
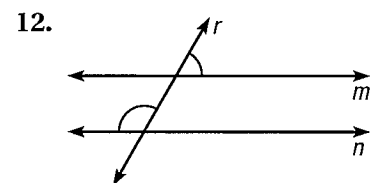
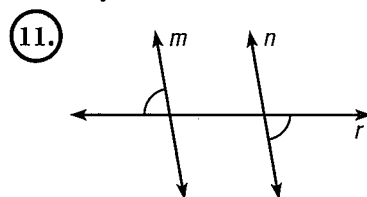
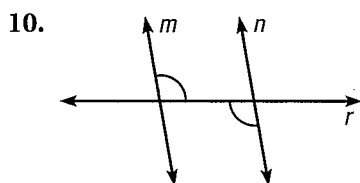
9. **ERROR ANALYSIS** A student concluded that lines a and b are parallel. Describe and correct the student's error.



EXAMPLE 2

on p. 162
for Exs. 10–17

IDENTIFYING PARALLEL LINES Is there enough information to prove $m \parallel n$? If so, state the postulate or theorem you would use.

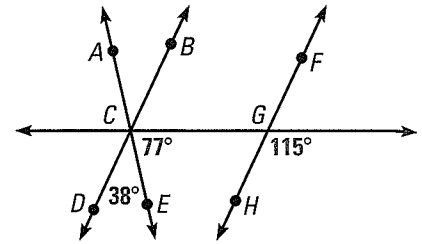


16. ★ **OPEN-ENDED MATH** Use lined paper to draw two parallel lines cut by a transversal. Use a protractor to measure one angle. Find the measures of the other seven angles without using the protractor. Give a theorem or postulate you use to find each angle measure.

EXAMPLE 3
 on p. 163
 for Ex. 18

17. **MULTI-STEP PROBLEM** Complete the steps below to determine whether \overleftrightarrow{DB} and \overleftrightarrow{HF} are parallel.

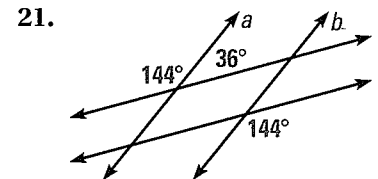
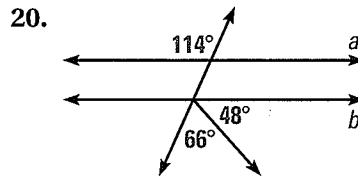
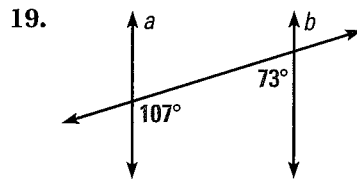
- Find $m\angle DCG$ and $m\angle CGH$.
- Describe the relationship between $\angle DCG$ and $\angle CGH$.
- Are \overleftrightarrow{DB} and \overleftrightarrow{HF} parallel? Explain your reasoning.



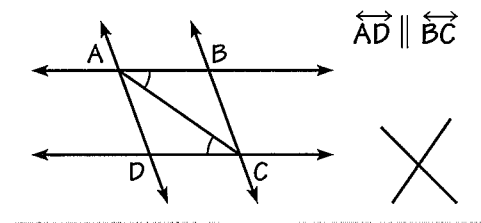
18. **PLANNING A PROOF** Use these steps to plan a proof of the Consecutive Interior Angles Converse, as stated on page 162.

- Draw a diagram you can use in a proof of the theorem.
- Write the GIVEN and PROVE statements.

REASONING Can you prove that lines a and b are parallel? If so, explain how.

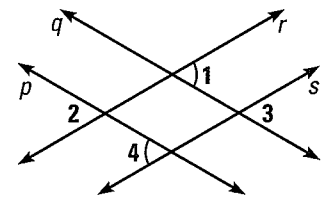


22. **ERROR ANALYSIS** A student decided that $\overleftrightarrow{AD} \parallel \overleftrightarrow{BC}$ based on the diagram below. Describe and correct the student's error.



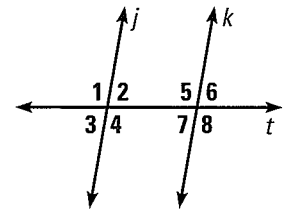
23. **★ MULTIPLE CHOICE** Use the diagram at the right. You know that $\angle 1 \cong \angle 4$. What can you conclude?

- $p \parallel q$
- $r \parallel s$
- $\angle 2 \cong \angle 3$
- None of the above



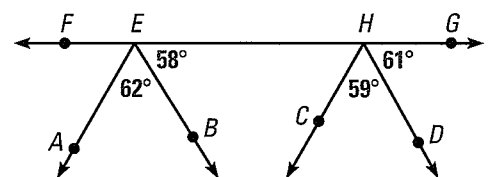
REASONING Use the diagram at the right for Exercises 24 and 25.

24. **★ SHORT RESPONSE** In the diagram, assume $j \parallel k$. How many angle measures must be given in order to find the measure of every angle? Explain your reasoning.



25. **PLANNING A PROOF** In the diagram, assume $\angle 1$ and $\angle 7$ are supplementary. Write a plan for a proof showing that lines j and k are parallel.

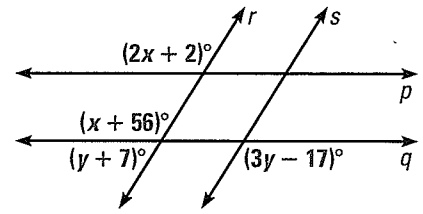
26. **REASONING** Use the diagram at the right. Which rays are parallel? Which rays are not parallel? Justify your conclusions.



27. **VISUAL REASONING** A point R is not in plane ABC .
- How many lines through R are perpendicular to plane ABC ?
 - How many lines through R are parallel to plane ABC ?
 - How many planes through R are parallel to plane ABC ?

28. **CHALLENGE** Use the diagram.

- Find x so that $p \parallel q$.
- Find y so that $r \parallel s$.
- Can r be parallel to s and p be parallel to q at the same time? *Explain.*

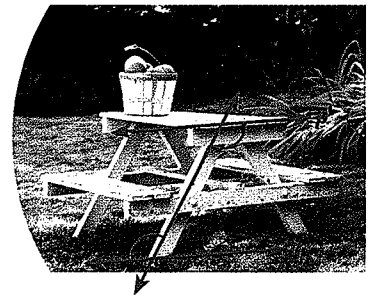


PROBLEM SOLVING

EXAMPLE 2
on p. 162
for Exs. 29–30

29. **PICNIC TABLE** How do you know that the top of the picnic table is parallel to the ground?

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30. **KITEBOARDING** The diagram of the control bar of the kite shows the angles formed between the control bar and the kite lines. How do you know that n is parallel to m ?

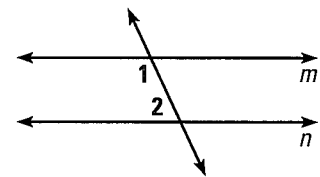


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31. **DEVELOPING PROOF** Copy and complete the proof.

GIVEN $\triangleright m\angle 1 = 115^\circ, m\angle 2 = 65^\circ$

PROVE $\triangleright m \parallel n$



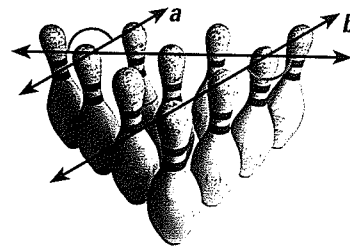
STATEMENTS

- $m\angle 1 = 115^\circ$ and $m\angle 2 = 65^\circ$
- $115^\circ + 65^\circ = 180^\circ$
- $m\angle 1 + m\angle 2 = 180^\circ$
- $\angle 1$ and $\angle 2$ are supplementary.
- $m \parallel n$

REASONS

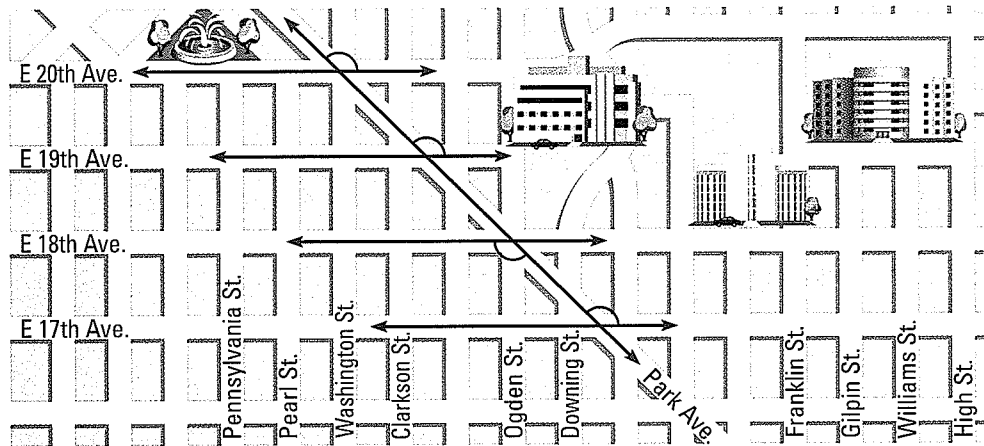
- Given
- Addition
- ?
- ?
- ?

32. **BOWLING PINS** How do you know that the bowling pins are set up in parallel lines?



EXAMPLE 5
on p. 164
for Ex. 33

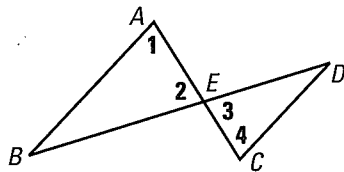
33. **★ SHORT RESPONSE** The map shows part of Denver, Colorado. Use the markings on the map. Are the numbered streets parallel to one another? *Explain* how you can tell.



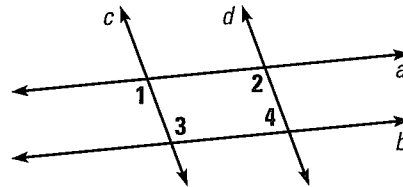
EXAMPLE 3
on p. 163
for Exs. 34–35

PROOF Use the diagram and the given information to write a two-column or paragraph proof.

34. **GIVEN** $\angle 1 \cong \angle 2, \angle 3 \cong \angle 4$
PROVE $\overline{AB} \parallel \overline{CD}$



35. **GIVEN** $a \parallel b, \angle 2 \cong \angle 3$
PROVE $c \parallel d$

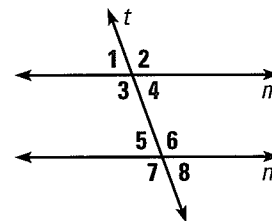


EXAMPLE 4
on p. 163
for Exs. 36–37

PROOF In Exercises 36 and 37, use the diagram to write a paragraph proof.

36. **PROVING THEOREM 3.5** Prove the Alternate Exterior Angles Converse.

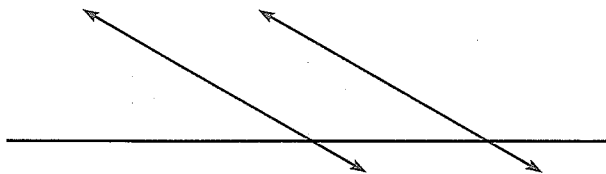
37. **PROVING THEOREM 3.6** Prove the Consecutive Interior Angles Converse.



38. **MULTI-STEP PROBLEM** Use these steps to prove Theorem 3.7, the Transitive Property of Parallel Lines.

- Copy the diagram in the Theorem box on page 164. Draw a transversal through all three lines.
- Write the GIVEN and PROVE statements.
- Use the properties of angles formed by parallel lines and transversals to prove the theorem.

39. ★ **EXTENDED RESPONSE** Architects and engineers make drawings using a plastic triangle with angle measures 30° , 60° , and 90° . The triangle slides along a fixed horizontal edge.



- Explain why the blue lines shown are parallel.
- Explain how the triangle can be used to draw vertical parallel lines.

REASONING Use the diagram below in Exercises 40–44. How would you show that the given lines are parallel?

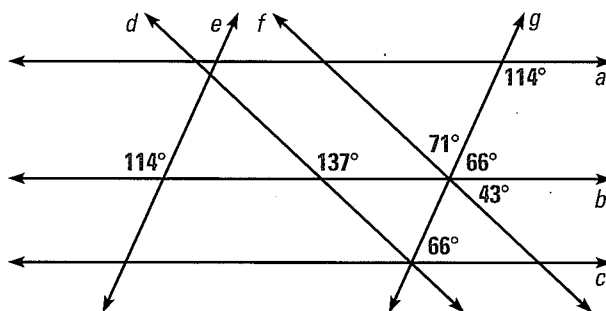
40. a and b

41. b and c

42. d and f

43. e and g

44. a and c



45. **CHALLENGE** Use these steps to investigate the angle bisectors of corresponding angles.

- Construction** Use a compass and straightedge or geometry drawing software to construct line l , point P not on l , and line n through P parallel to l . Construct point Q on l and construct \overline{PQ} . Choose a pair of alternate interior angles and construct their angle bisectors.
- Write a Proof** Are the angle bisectors parallel? Make a conjecture. Write a proof of your conjecture.

MIXED REVIEW

Solve the equation. (p. 875)

46. $\frac{3}{4}x = -1$

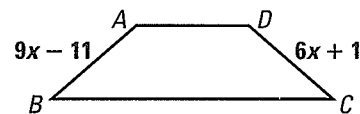
47. $\frac{-2}{3}x = -1$

48. $\frac{1}{5}x = -1$

49. $-6x = -1$

50. You can choose one of eight sandwich fillings and one of four kinds of bread. How many different sandwiches are possible? (p. 891)

51. Find the value of x if $\overline{AB} \cong \overline{AD}$ and $\overline{CD} \cong \overline{AD}$.
Explain your steps. (p. 112)



Simplify the expression.

52. $\frac{-7-2}{8-(-4)}$ (p. 870)

53. $\frac{0-(-3)}{1-6}$ (p. 870)

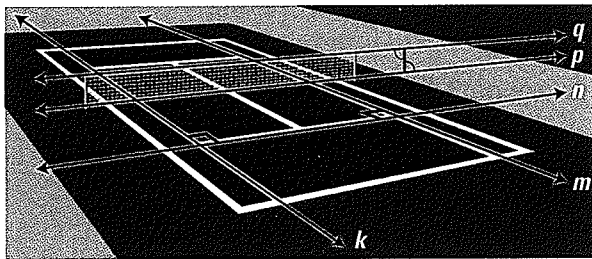
54. $\frac{3x-x}{-4x+2x}$ (p. 139)

PREVIEW
Prepare for
Lesson 3.4 in
Exs. 52–54.

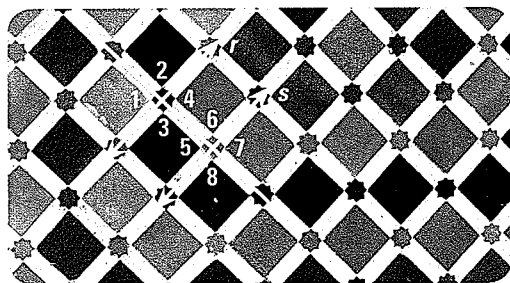


Lessons 3.1–3.3

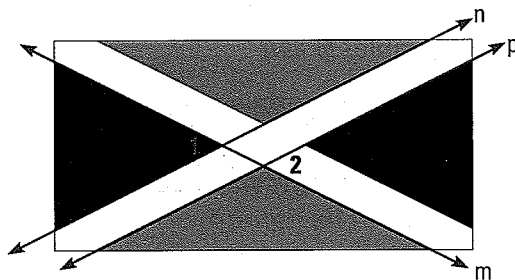
1. **MULTI-STEP PROBLEM** Use the diagram of the tennis court below.



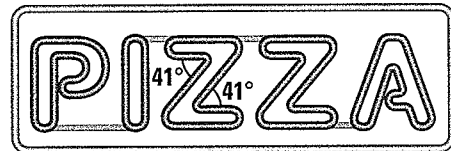
- Identify two pairs of parallel lines so each pair is on a different plane.
 - Identify a pair of skew lines.
 - Identify two pairs of perpendicular lines.
2. **MULTI-STEP PROBLEM** Use the picture of the tile floor below.



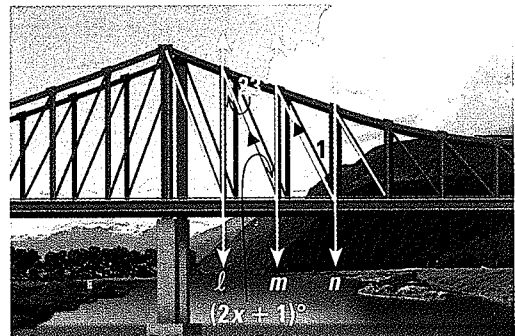
- Name the kind of angle pair each angle forms with $\angle 1$.
 - Lines r and s are parallel. Name the angles that are congruent to $\angle 3$.
3. **OPEN-ENDED** The flag of Jamaica is shown. Given that $n \parallel p$ and $m \angle 1 = 53^\circ$, determine the measure of $\angle 2$. *Justify* each step in your argument, labeling any angles needed for your justification.



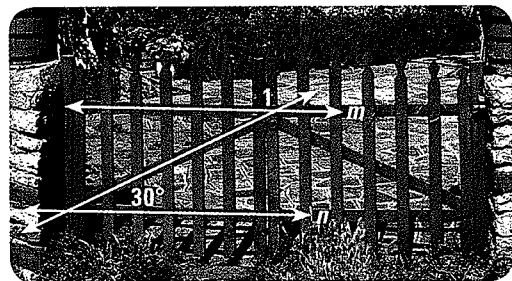
4. **SHORT RESPONSE** A neon sign is shown below. Are the top and the bottom of the Z parallel? *Explain* how you know.



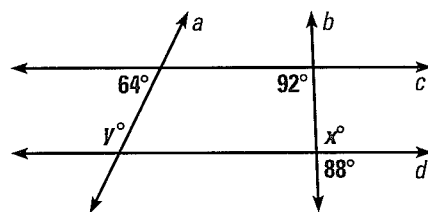
5. **EXTENDED RESPONSE** Use the diagram of the bridge below.



- Find the value of x that makes lines l and m parallel.
 - Suppose that $l \parallel m$ and $l \parallel n$. Find $m \angle 1$. *Explain* how you found your answer. Copy the diagram and label any angles you need for your explanation.
6. **GRIDDED ANSWER** In the photo of the picket fence, $m \parallel n$. What is $m \angle 1$ in degrees?



7. **SHORT RESPONSE** Find the values of x and y . *Explain* your steps.



3.4 EXERCISES

HOMEWORK KEY

- = WORKED-OUT SOLUTIONS on p. WS3 for Exs. 7, 13, and 35
- ★ = STANDARDIZED TEST PRACTICE Exs. 2, 34, 35, and 41
- ◆ = MULTIPLE REPRESENTATIONS Ex. 37

SKILL PRACTICE

1. **VOCABULARY** Describe what is meant by the slope of a nonvertical line.

2. ★ **WRITING** What happens when you apply the slope formula to a horizontal line? What happens when you apply it to a vertical line?

EXAMPLE 1

on p. 171
for Exs. 3–12

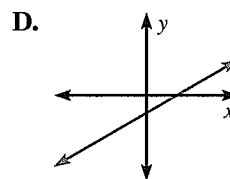
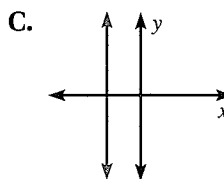
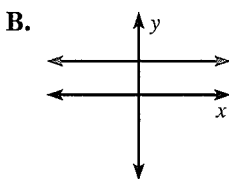
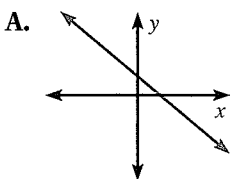
MATCHING Match the description of the slope of a line with its graph.

3. m is positive.

4. m is negative.

5. m is zero.

6. m is undefined.



FINDING SLOPE Find the slope of the line that passes through the points.

7. (3, 5), (5, 6)

8. (-2, 2), (2, -6)

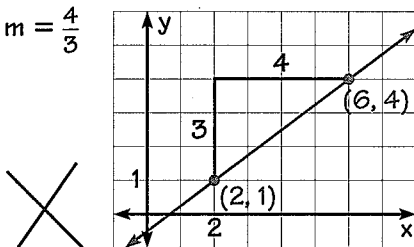
9. (-5, -1), (3, -1)

10. (2, 1), (0, 6)

ERROR ANALYSIS Describe and correct the error in finding the slope of the line.

11.

$$m = \frac{4}{3}$$



12.

Slope of the line through (2, 7) and (4, 5)

$$m = \frac{y_2 - y_1}{x_2 - x_1} = \frac{7 - 5}{4 - 2} = \frac{2}{2} = 1$$



EXAMPLES

2 and 3

on pp. 172–173
for Exs. 13–18

TYPES OF LINES Tell whether the lines through the given points are *parallel*, *perpendicular*, or *neither*. Justify your answer.

13. Line 1: (1, 0), (7, 4)
Line 2: (7, 0), (3, 6)

14. Line 1: (-3, 1), (-7, -2)
Line 2: (2, -1), (8, 4)

15. Line 1: (-9, 3), (-5, 7)
Line 2: (-11, 6), (-7, 2)

GRAPHING Graph the line through the given point with the given slope.

16. $P(3, -2)$, slope $-\frac{1}{6}$

17. $P(-4, 0)$, slope $\frac{5}{2}$

18. $P(0, 5)$, slope $\frac{2}{3}$

EXAMPLES

4 and 5

on pp. 173–174
for Exs. 19–22

STEEPNESS OF A LINE Tell which line through the given points is steeper.

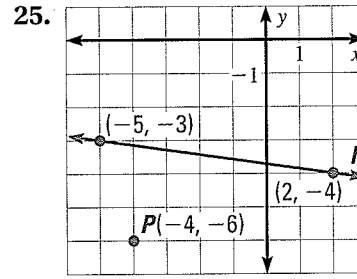
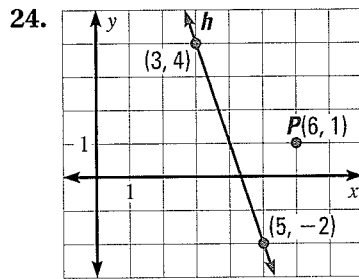
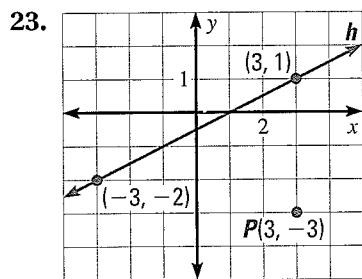
19. Line 1: (-2, 3), (3, 5)
Line 2: (3, 1), (6, 5)

20. Line 1: (-2, -1), (1, -2)
Line 2: (-5, -3), (-1, -4)

21. Line 1: (-4, 2), (-3, 6)
Line 2: (1, 6), (3, 8)

22. **REASONING** Use your results from Exercises 19–21. Describe a way to determine which of two lines is steeper without graphing them.

PERPENDICULAR LINES Find the slope of line n perpendicular to line h and passing through point P . Then copy the graph and graph line n .



26. **REASONING** Use the concept of slope to decide whether the points $(-3, 3)$, $(1, -2)$, and $(4, 0)$ lie on the same line. *Explain* your reasoning and include a diagram.

GRAPHING Graph a line with the given description.

27. Through $(0, 2)$ and parallel to the line through $(-2, 4)$ and $(-5, 1)$
 28. Through $(1, 3)$ and perpendicular to the line through $(-1, -1)$ and $(2, 0)$
 29. Through $(-2, 1)$ and parallel to the line through $(3, 1)$ and $(4, -\frac{1}{2})$

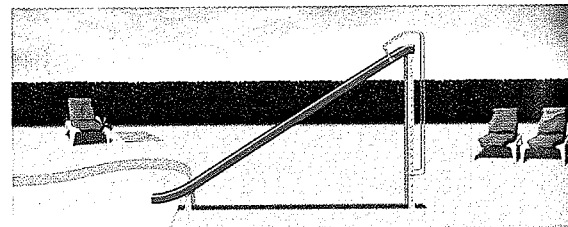
CHALLENGE Find the unknown coordinate so the line through the points has the given slope.

30. $(-3, 2)$, $(0, y)$; slope -2 31. $(-7, -4)$, $(x, 0)$; slope $\frac{1}{3}$ 32. $(4, -3)$, $(x, 1)$; slope -4

PROBLEM SOLVING

33. **WATER SLIDE** The water slide is 6 feet tall, and the end of the slide is 9 feet from the base of the ladder. About what slope does the slide have?

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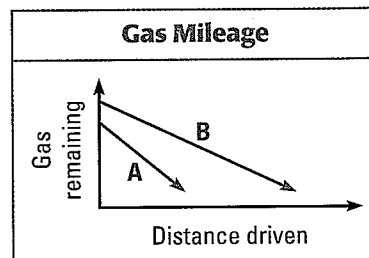


EXAMPLE 5
 on p. 174
 for Exs. 34–37

34. **★ MULTIPLE CHOICE** Which car has better gas mileage?

- (A) A (B) B
 (C) Same rate (D) Cannot be determined

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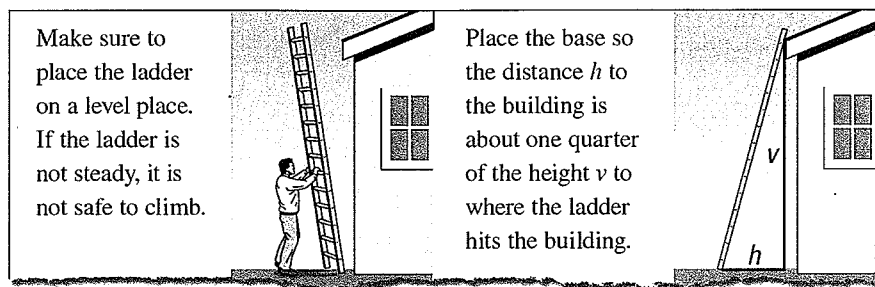
35. **★ SHORT RESPONSE** Compare the graphs of the three lines described below. Which is most steep? Which is the least steep? Include a sketch in your answer.

Line a : through the point $(3, 0)$ with a y -intercept of 4

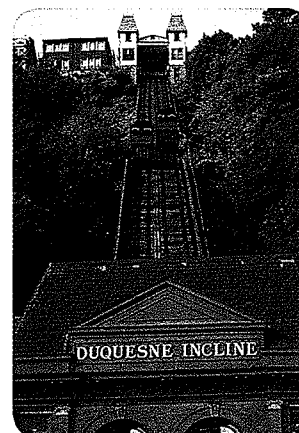
Line b : through the point $(3, 0)$ with a y -intercept greater than 4

Line c : through the point $(3, 0)$ with a y -intercept between 0 and 4

36. **MULTI-STEP PROBLEM** Ladder safety guidelines include the following recommendation about ladder placement. The horizontal distance h between the base of the ladder and the object the ladder is resting against should be about one quarter of the vertical distance v between the ground and where the ladder rests against the object.



- a. Find the recommended slope for a ladder.
- b. Suppose the base of a ladder is 6 feet away from a building. The ladder has the recommended slope. Find v .
- c. Suppose a ladder is 34 feet from the ground where it touches a building. The ladder has the recommended slope. Find h .
37. **MULTIPLE REPRESENTATIONS** The Duquesne (pronounced “du-KAYN”) Incline was built in 1888 in Pittsburgh, Pennsylvania, to move people up and down a mountain there. On the incline, you move about 29 feet vertically for every 50 feet you move horizontally. When you reach the top of the hill, you have moved a horizontal distance of about 700 feet.
- a. **Making a Table** Make a table showing the vertical distance that the incline moves for each 50 feet of horizontal distance during its climb. How high is the incline at the top?
- b. **Drawing a Graph** Write a fraction that represents the slope of the incline’s climb path. Draw a graph to show the climb path.
- c. **Comparing Slopes** The Burgenstock Incline in Switzerland moves about 144 vertical feet for every 271 horizontal feet. Write a fraction to represent the slope of this incline’s path. Which incline is steeper, the *Burgenstock* or the *Duquesne*?
38. **PROVING THEOREM 3.7** Use slopes of lines to write a paragraph proof of the Transitive Property of Parallel Lines on page 164.

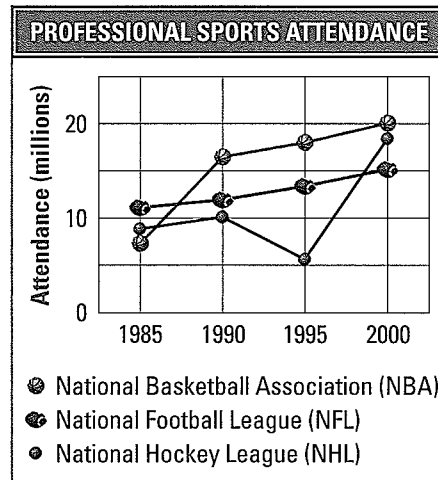


AVERAGE RATE OF CHANGE In Exercises 39 and 40, slope can be used to describe an *average rate of change*. To write an average rate of change, rewrite the slope fraction so the denominator is one.

39. **BUSINESS** In 2000, a business made a profit of \$8500. In 2006, the business made a profit of \$15,400. Find the average rate of change in dollars per year from 2000 to 2006.
40. **ROCK CLIMBING** A rock climber begins climbing at a point 400 feet above sea level. It takes the climber 45 minutes to climb to the destination, which is 706 feet above sea level. Find the average rate of change in feet per minute for the climber from start to finish.

41. ★ **EXTENDED RESPONSE** The line graph shows the regular season attendance (in millions) for three professional sports organizations from 1985 to 2000.

- During which five-year period did the NBA attendance increase the most? Estimate the rate of change for this five-year period in people per year.
- During which five-year period did the NHL attendance increase the most? Estimate the rate of change for this five-year period in people per year.
- Interpret** The line graph for the NFL seems to be almost linear between 1985 and 2000. Write a sentence about what this means in terms of the real-world situation.



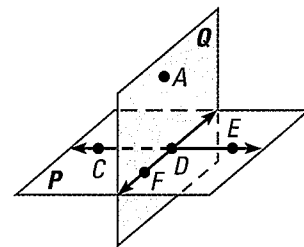
42. **CHALLENGE** Find two values of k such that the points $(-3, 1)$, $(0, k)$, and $(k, 5)$ are collinear. *Explain* your reasoning.

MIXED REVIEW

- Is the point $(-1, -7)$ on the line $y = 2x - 5$? *Explain.* (p. 878)
- Find the intercepts of the graph of $y = -3x + 9$. (p. 879)

Use the diagram to write two examples of each postulate. (p. 96)

- Through any two points there exists exactly one line.
- Through any three noncollinear points there exists exactly one plane.



PREVIEW

Prepare for
Lesson 3.5 in
Exs. 47–49.

Solve the equation for y . Write a reason for each step. (p. 105)

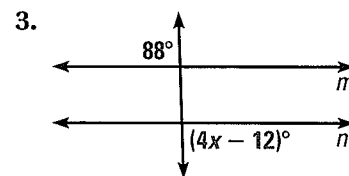
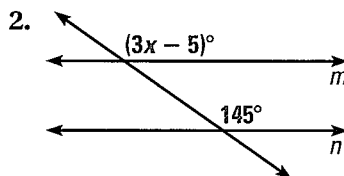
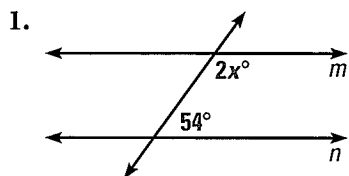
47. $6x + 4y = 40$

48. $\frac{1}{2}x - \frac{5}{4}y = -10$

49. $16 - 3y = 24x$

QUIZ for Lessons 3.3–3.4

Find the value of x that makes $m \parallel n$. (p. 161)



Find the slope of the line that passes through the given points. (p. 171)

4. $(1, -1), (3, 3)$

5. $(1, 2), (4, 5)$

6. $(-3, -2), (-7, -6)$

3.4 Investigate Slopes

MATERIALS • graphing calculator or computer

QUESTION How can you verify the Slopes of Parallel Lines Postulate?

You can verify the postulates you learned in Lesson 3.4 using geometry drawing software.

EXAMPLE Verify the Slopes of Parallel Lines Postulate

STEP 1 Show axes Show the x -axis and the y -axis by choosing Hide/Show Axes from the F5 menu.

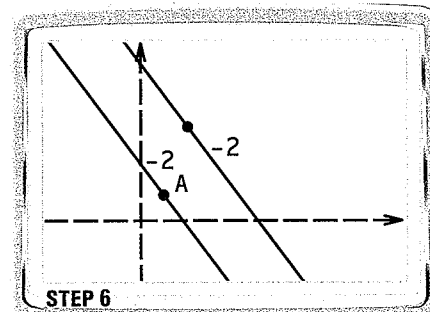
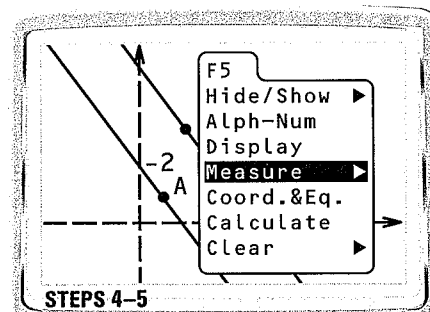
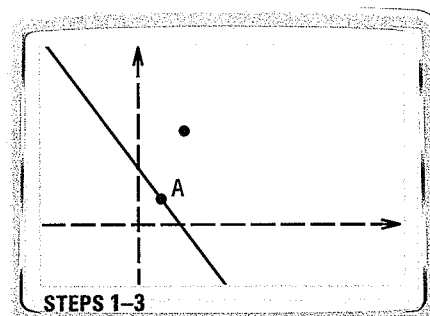
STEP 2 Draw line Draw a line by choosing Line from the F2 menu. Do not use one of the axes as your line. Choose a point on the line and label it A.

STEP 3 Graph point Graph a point not on the line by choosing Point from the F2 menu.

STEP 4 Draw parallel line Choose Parallel from the F3 menu and select the line. Then select the point not on the line.

STEP 5 Measure slopes Select one line and choose Measure Slope from the F5 menu. Repeat this step for the second line.

STEP 6 Move line Drag point A to move the line. What do you expect to happen?



PRACTICE

- Use geometry drawing software to verify the Slopes of Perpendicular Lines Postulate.
 - Construct a line and a point not on that line. Use Steps 1-3 from the Example above.
 - Construct a line that is perpendicular to your original line and passes through the given point.
 - Measure the slopes of the two lines. Multiply the slopes. What do you expect the product of the slopes to be?
- WRITING** Use the arrow keys to move your line from Exercise 1. Describe what happens to the product of the slopes when one of the lines is vertical. Explain why this happens.

3.5 EXERCISES

HOMWORK KEY

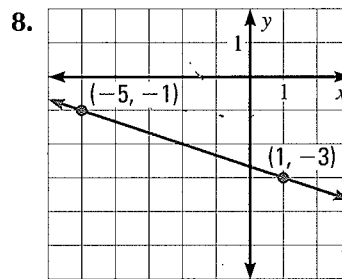
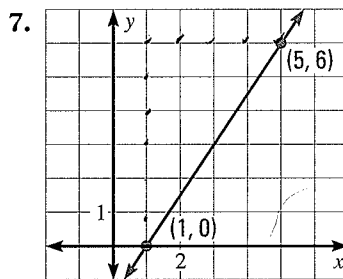
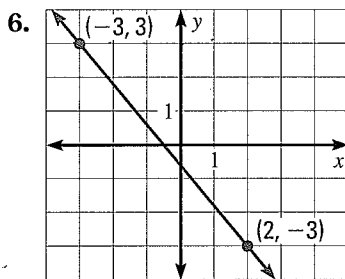
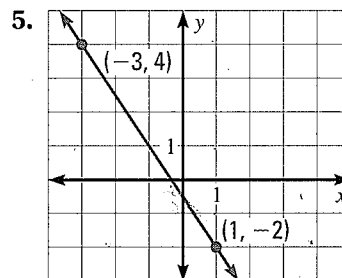
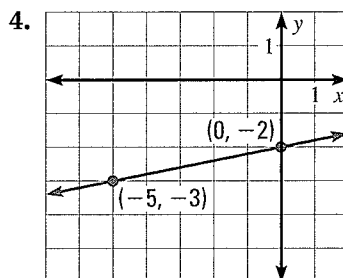
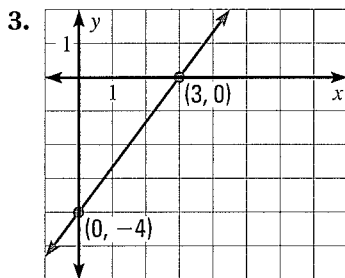
- = WORKED-OUT SOLUTIONS
on p. WS4 for Exs. 17, 23, and 61
- ★ = STANDARDIZED TEST PRACTICE
Exs. 2, 9, 29, 64, and 65

SKILL PRACTICE

- VOCABULARY** What does *intercept* mean in the expression *slope-intercept form*?
- ★ **WRITING** Explain how you can use the standard form of a linear equation to find the intercepts of a line.

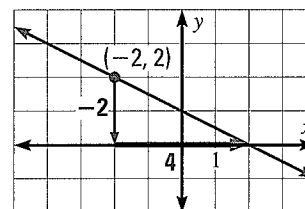
EXAMPLE 1
on p. 180
for Exs. 3–22

WRITING EQUATIONS Write an equation of the line shown.



9. ★ **MULTIPLE CHOICE** Which equation is an equation of the line in the graph?

- (A) $y = -\frac{1}{2}x$ (B) $y = -\frac{1}{2}x + 1$
(C) $y = -2x$ (D) $y = -2x + 1$



WRITING EQUATIONS Write an equation of the line with the given slope m and y -intercept b .

10. $m = -5, b = -12$ 11. $m = 3, b = 2$ 12. $m = 4, b = -6$
13. $m = -\frac{5}{2}, b = 0$ 14. $m = \frac{4}{9}, b = -\frac{2}{9}$ 15. $m = -\frac{11}{5}, b = -12$

WRITING EQUATIONS Write an equation of the line that passes through the given point P and has the given slope m .

16. $P(-1, 0), m = -1$ (17) $P(5, 4), m = 4$ 18. $P(6, -2), m = 3$
19. $P(-8, -2), m = -\frac{2}{3}$ 20. $P(0, -3), m = -\frac{1}{6}$ 21. $P(-13, 7), m = 0$

22. **WRITING EQUATIONS** Write an equation of a line with undefined slope that passes through the point $(3, -2)$.

EXAMPLE 2

on p. 180
for Exs. 23–29

PARALLEL LINES Write an equation of the line that passes through point P and is parallel to the line with the given equation.

23. $P(0, -1), y = -2x + 3$ 24. $P(-7, -4), y = 16$ 25. $P(3, 8), y - 1 = \frac{1}{5}(x + 4)$
 26. $P(-2, 6), x = -5$ 27. $P(-2, 1), 10x + 4y = -8$ 28. $P(4, 0), -x + 2y = 12$
 29. ★ **MULTIPLE CHOICE** Line a passes through points $(-2, 1)$ and $(2, 9)$. Which equation is an equation of a line parallel to line a ?

- (A) $y = -2x + 5$ (B) $y = -\frac{1}{2}x + 5$ (C) $y = \frac{1}{2}x - 5$ (D) $y = 2x - 5$

EXAMPLE 3

on p. 181
for Exs. 30–35

PERPENDICULAR LINES Write an equation of the line that passes through point P and is perpendicular to the line with the given equation.

30. $P(0, 0), y = -9x - 1$ 31. $P(-1, 1), y = \frac{7}{3}x + 10$ 32. $P(4, -6), y = -3$
 33. $P(2, 3), y - 4 = -2(x + 3)$ 34. $P(0, -5), x = 20$ 35. $P(-8, 0), 3x - 5y = 6$

EXAMPLE 5

on p. 182
for Exs. 36–45

GRAPHING EQUATIONS Graph the equation.

36. $8x + 2y = -10$ 37. $x + y = 1$ 38. $4x - y = -8$
 39. $-x + 3y = -9$ 40. $y - 2 = -1$ 41. $y + 2 = x - 1$
 42. $x + 3 = -4$ 43. $2y - 4 = -x + 1$ 44. $3(x - 2) = -y - 4$

45. **ERROR ANALYSIS** Describe and correct the error in finding the x - and y -intercepts of the graph of $5x - 3y = -15$.

To find the x -intercept,
let $x = 0$:

$$5x - 3y = -15$$

$$5(0) - 3y = -15$$

$$y = 5$$



To find the y -intercept,
let $y = 0$:

$$5x - 3y = -15$$

$$5x - 3(0) = -15$$

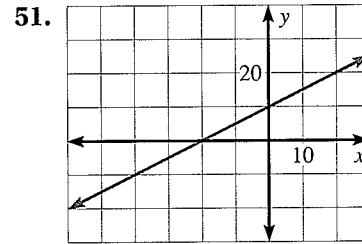
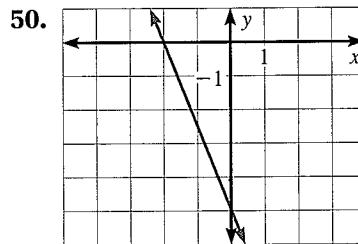
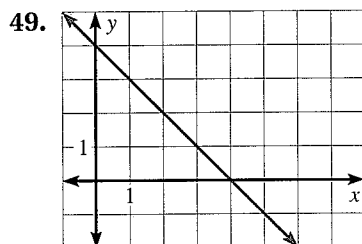
$$x = -3$$



IDENTIFYING PARALLEL LINES Which lines are parallel, if any?

46. $y = 3x - 4$ 47. $x + 2y = 9$ 48. $x - 6y = 10$
 $x + 3y = 6$ $y = 0.5x + 7$ $6x - y = 11$
 $3(x + 1) = y - 2$ $-x + 2y = -5$ $x + 6y = 12$

USING INTERCEPTS Identify the x - and y -intercepts of the line. Use the intercepts to write an equation of the line.



52. **INTERCEPTS** A line passes through the points $(-10, -3)$ and $(6, 1)$. Where does the line intersect the x -axis? Where does the line intersect the y -axis?

SOLUTIONS TO EQUATIONS Graph the linear equations. Then use the graph to estimate how many solutions the equations share.

53. $y = 4x + 9$
 $4x - y = 1$

54. $3y + 4x = 16$
 $2x - y = 18$

55. $y = -5x + 6$
 $10x + 2y = 12$

56. **ALGEBRA** Solve Exercises 53–55 algebraically. (For help, see Skills Review Handbook, p. 880.) Make a conjecture about how the solution(s) can tell you whether the lines intersect, are parallel, or are the same line.

57. **ALGEBRA** Find a value for k so that the line through $(-1, k)$ and $(-7, -2)$ is parallel to the line with equation $y = x + 1$.

58. **ALGEBRA** Find a value for k so that the line through $(k, 2)$ and $(7, 0)$ is perpendicular to the line with equation $y = x - \frac{28}{5}$.

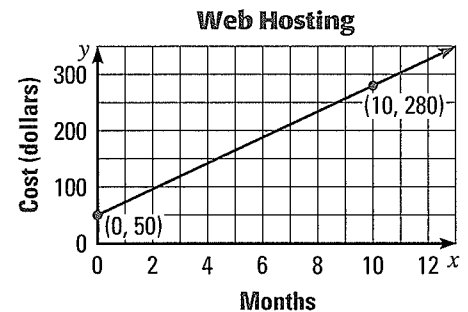
59. **CHALLENGE** Graph the points $R(-7, -3)$, $S(-2, 3)$, and $T(10, -7)$. Connect them to make $\triangle RST$. Write an equation of the line containing each side. Explain how you can use slopes to show that $\triangle RST$ has one right angle.

PROBLEM SOLVING

EXAMPLE 4
 on p. 182
 for Exs. 60–61

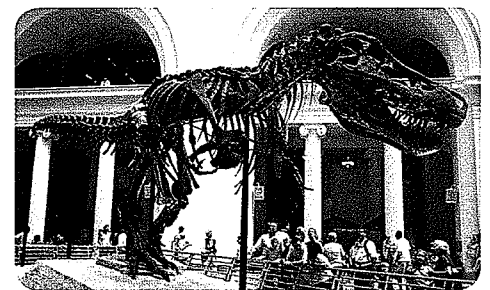
60. **WEB HOSTING** The graph models the total cost of using a web hosting service for several months. Write an equation of the line. Tell what the slope and y -intercept mean in this situation. Then find the total cost of using the web hosting service for one year.

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61. **SCIENCE** Scientists believe that a Tyrannosaurus Rex weighed about 2000 kilograms by age 14. It then had a growth spurt for four years, gaining 2.1 kilograms per day. Write an equation to model this situation. What are the slope and y -intercept? Tell what the slope and y -intercept mean in this situation.

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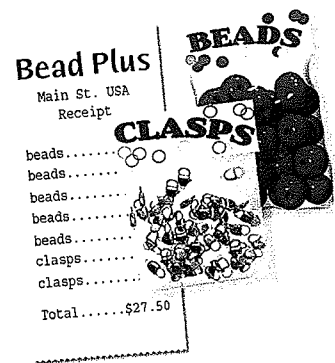
Field Museum, Chicago, Illinois

EXAMPLE 6
 on p. 183
 for Exs. 62–65

62. **MULTI-STEP PROBLEM** A national park has two options: a \$50 pass for all admissions during the year, or a \$4 entrance fee each time you enter.

- Model** Write an equation to model the cost of going to the park for a year using a pass and another equation for paying a fee each time.
- Graph** Graph both equations you wrote in part (a).
- Interpret** How many visits do you need to make for the pass to be cheaper? Explain.

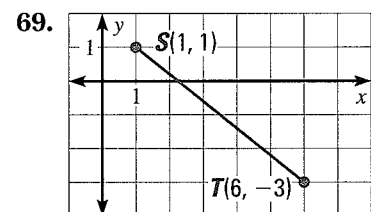
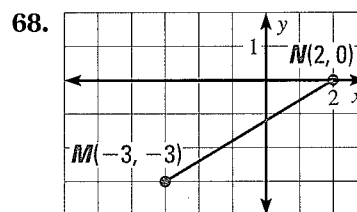
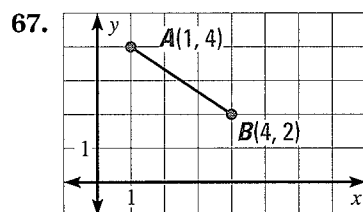
63. **PIZZA COSTS** You are buying slices of pizza for you and your friends. A small slice costs \$2 and a large slice costs \$3. You have \$24 to spend. Write an equation in standard form $Ax + By = C$ that models this situation. What do the values of A , B , and C mean in this situation?
64. **★ SHORT RESPONSE** You run at a rate of 4 miles per hour and your friend runs at a rate of 3.5 miles per hour. Your friend starts running 10 minutes before you, and you run for a half hour on the same path. Will you catch up to your friend? Use a graph to support your answer.
65. **★ EXTENDED RESPONSE** Audrey and Sara are making jewelry. Audrey buys 2 bags of beads and 1 package of clasps for a total of \$13. Sara buys 5 bags of beads and 2 packages of clasps for a total of \$27.50.
- Let b be the price of one bag of beads and let c be the price of one package of clasps. Write equations to represent the total cost for Audrey and the total cost for Sara.
 - Graph the equations from part (a).
 - Explain the meaning of the intersection of the two lines in terms of the real-world situation.
66. **CHALLENGE** Michael is deciding which gym membership to buy. Points (2, 112) and (4, 174) give the cost of gym membership at one gym after two and four months. Points (1, 62) and (3, 102) give the cost of gym membership at a second gym after one and three months. Write equations to model the cost of each gym membership. At what point do the graphs intersect, if they intersect? Which gym is cheaper? Explain.



MIXED REVIEW

PREVIEW
Prepare for
Lesson 3.6
in Exs. 67–69.

Find the length of each segment. Round to the nearest tenth of a unit. (p. 15)



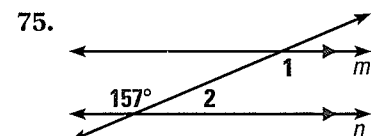
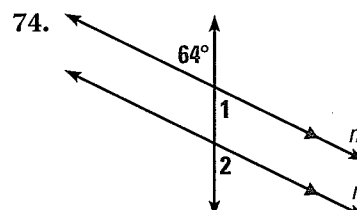
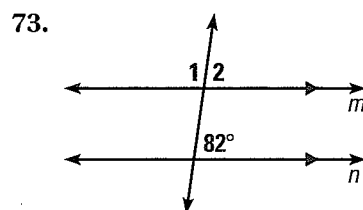
Describe the pattern in the numbers. Write the next number in the pattern. (p. 72)

70. $-2, -7, -12, -17, \dots$

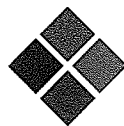
71. $4, 8, 16, 32, \dots$

72. $101, 98, 95, 92, \dots$

Find $m\angle 1$ and $m\angle 2$. Explain your reasoning. (p. 154)



Another Way to Solve Example 6, page 183



MULTIPLE REPRESENTATIONS In Example 6 on page 183, you saw how to graph equations to solve a problem about renting DVDs. Another way you can solve the problem is *using a table*. Alternatively, you can use the equations to solve the problem *algebraically*.

PROBLEM

DVD RENTAL You can rent DVDs at a local store for \$4.00 each. An Internet company offers a flat fee of \$15.00 per month for as many rentals as you want. How many DVDs do you need to rent to make the online rental a better buy?

METHOD 1

Using a Table You can make a table to answer the question.

STEP 1 Make a table representing each rental option.

DVDs rented	Renting locally	Renting online
1	\$4	\$15
2	\$8	\$15

STEP 2 Add rows to your table until you see a pattern.

DVDs rented	Renting locally	Renting online
1	\$4	\$15
2	\$8	\$15
3	\$12	\$15
4	\$16	\$15
5	\$20	\$15
6	\$24	\$15

STEP 3 Analyze the table. Notice that the values in the second column (the cost of renting locally) are less than the values in the third column (the cost of renting online) for three or fewer DVDs. However, the values in the second column are greater than those in the third column for four or more DVDs.

- ▶ It is cheaper to rent locally if you rent 3 or fewer DVDs per month. If you rent 4 or more DVDs per month, it is cheaper to rent online.

METHOD 2

Using Algebra You can solve one of the equations for one of its variables. Then substitute that expression for the variable in the other equation.

STEP 1 Write an equation for each rental option.

Cost of one month's rental online: $y = 15$

Cost of one month's rental locally: $y = 4x$, where x represents the number of DVDs rented

STEP 2 Substitute the value of y from one equation into the other equation.

$$y = 4x$$

$$15 = 4x \quad \text{Substitute 15 for } y.$$

$$3.75 = x \quad \text{Divide each side by 4.}$$

STEP 3 Analyze the solution of the equation. If you could rent 3.75 DVDs, your cost for local and online rentals would be the same. However, you can only rent a whole number of DVDs. Look at what happens when you rent 3 DVDs and when you rent 4 DVDs, the whole numbers just less than and just greater than 3.75.

► It is cheaper to rent locally if you rent 3 or fewer DVDs per month. If you rent 4 or more DVDs per month, it is cheaper to rent online.

PRACTICE

- IN-LINE SKATES** You can rent in-line skates for \$5 per hour, or buy a pair of skates for \$130. How many hours do you need to skate for the cost of buying skates to be cheaper than renting them?
- WHAT IF?** Suppose the in-line skates in Exercise 1 also rent for \$12 per day. How many days do you need to skate for the cost of buying skates to be cheaper than renting them?
- BUTTONS** You buy a button machine for \$200 and supplies to make one hundred fifty buttons for \$30. Suppose you charge \$2 for a button. How many buttons do you need to sell to earn back what you spent?
- MANUFACTURING** A company buys a new widget machine for \$1200. It costs \$5 to make each widget. The company sells each widget for \$15. How many widgets do they need to sell to earn back the money they spent on the machine?
- WRITING** Which method(s) did you use to solve Exercises 1–4? *Explain* your choice(s).
- MONEY** You saved \$1000. If you put this money in a savings account, it will earn 1.5% annual interest. If you put the \$1000 in a certificate of deposit (CD), it will earn 3% annual interest. To earn the most money, does it ever make sense to put your money in the savings account? *Explain*.

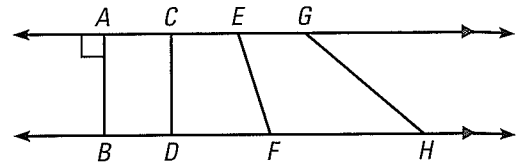
3.6 EXERCISES

HOMWORK KEY

○ = WORKED-OUT SOLUTIONS
on p. WS4 for Exs. 19, 23, and 29
★ = STANDARDIZED TEST PRACTICE
Exs. 11, 12, 21, 22, and 30

SKILL PRACTICE

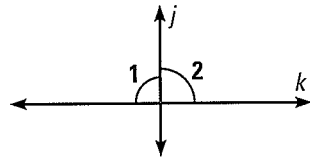
1. **VOCABULARY** The length of which segment shown is called the distance between the two parallel lines? *Explain.*



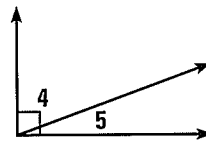
EXAMPLES 1 and 2
on p. 191
for Exs. 2–7

JUSTIFYING STATEMENTS Write the theorem that justifies the statement.

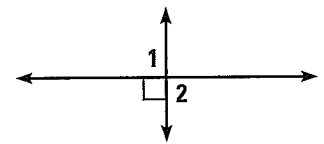
2. $j \perp k$



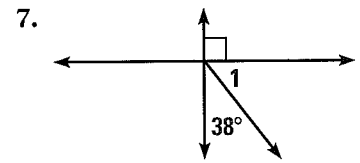
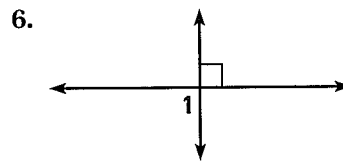
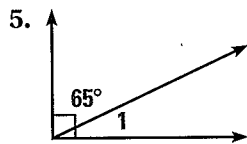
3. $\angle 4$ and $\angle 5$ are complementary.



4. $\angle 1$ and $\angle 2$ are right angles.

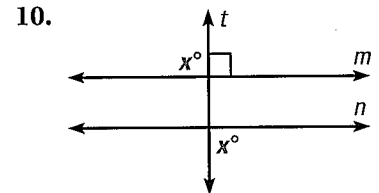
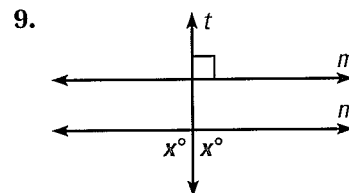
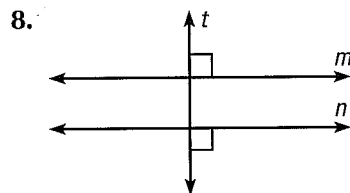


APPLYING THEOREMS Find $m\angle 1$.



EXAMPLE 3
on p. 192
for Exs. 8–12

SHOWING LINES PARALLEL *Explain* how you would show that $m \parallel n$.

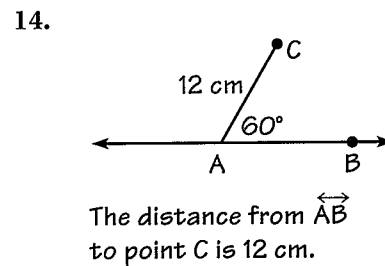
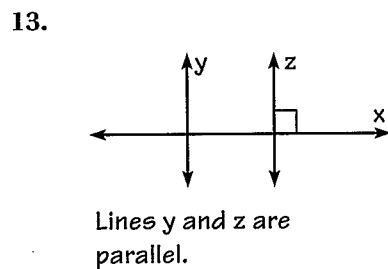


11. ★ **SHORT RESPONSE** *Explain* how to draw two parallel lines using only a straightedge and a protractor.

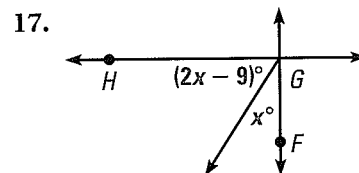
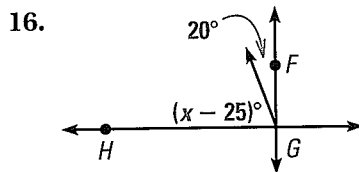
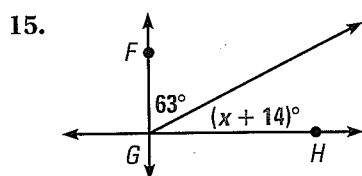
12. ★ **SHORT RESPONSE** *Describe* how you can fold a sheet of paper to create two parallel lines that are perpendicular to the same line.

EXAMPLES 3 and 4
on pp. 192–193
for Exs. 13–14

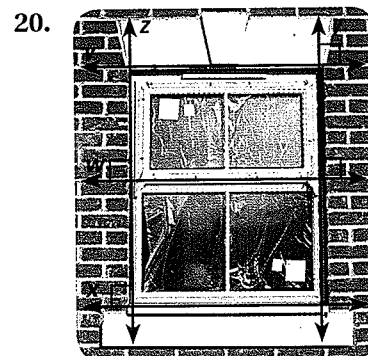
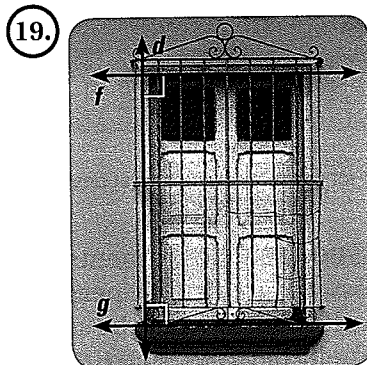
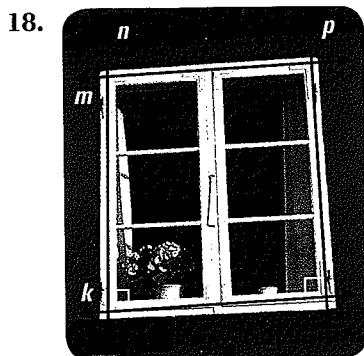
ERROR ANALYSIS *Explain* why the statement about the figure is incorrect.



FINDING ANGLE MEASURES In the diagram, $\overleftrightarrow{FG} \perp \overleftrightarrow{GH}$. Find the value of x .

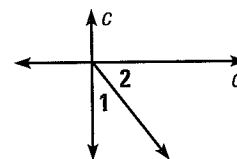


DRAWING CONCLUSIONS Determine which lines, if any, must be parallel. Explain your reasoning.



21. **★ MULTIPLE CHOICE** Which statement must be true if $c \perp d$?

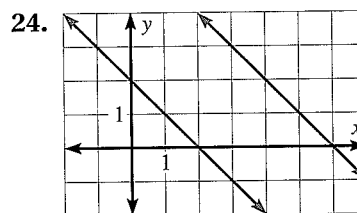
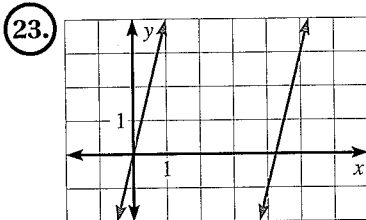
- (A) $m\angle 1 + m\angle 2 = 90^\circ$ (B) $m\angle 1 + m\angle 2 < 90^\circ$
 (C) $m\angle 1 + m\angle 2 > 90^\circ$ (D) Cannot be determined



22. **★ WRITING** Explain why the distance between two lines is only defined for parallel lines.

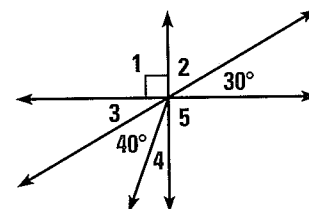
EXAMPLE 4
 on p. 193
 for Exs. 23–24

FINDING DISTANCES Use the Distance Formula to find the distance between the two parallel lines. Round to the nearest tenth, if necessary.



25. **CONSTRUCTION** You are given a line n and a point P not on n . Use a compass to find two points on n equidistant from P . Then use the steps for the construction of a segment bisector (page 33) to construct a line perpendicular to n through P .

26. **FINDING ANGLES** Find all the unknown angle measures in the diagram at the right. Justify your reasoning for each angle measure.

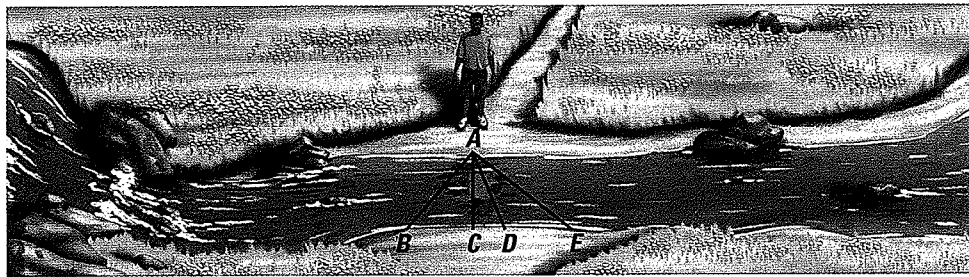


27. **FINDING DISTANCES** Find the distance between the lines with the equations $y = \frac{3}{2}x + 4$ and $-3x + 2y = -1$.

28. **CHALLENGE** Describe how you would find the distance from a point to a plane. Can you find the distance from a line to a plane? Explain.

PROBLEM SOLVING

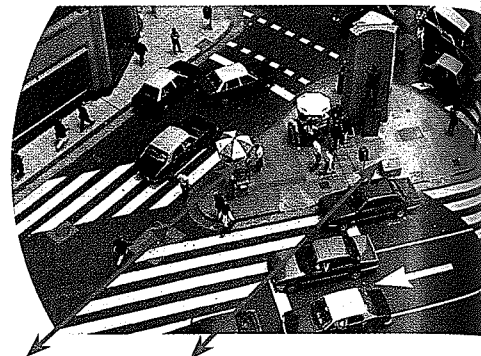
29. **STREAMS** You are trying to cross a stream from point A. Which point should you jump to in order to jump the shortest distance? *Explain.*



for problem solving help at classzone.com

30. **★ SHORT RESPONSE** The segments that form the path of a crosswalk are usually perpendicular to the crosswalk. Sketch what the segments would look like if they were perpendicular to the crosswalk. Which method requires less paint? *Explain.*

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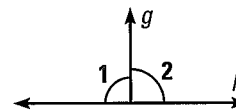


EXAMPLE 2
on p. 191
for Exs. 31–34

31. **PROVING THEOREM 3.8** Copy and complete the proof that if two lines intersect to form a linear pair of congruent angles, then the lines are perpendicular.

GIVEN ▶ $\angle 1$ and $\angle 2$ are a linear pair.
 $\angle 1 \cong \angle 2$

PROVE ▶ $g \perp h$



STATEMENTS

1. $\angle 1$ and $\angle 2$ are a linear pair.
2. $\angle 1$ and $\angle 2$ are supplementary.
3. $?$
4. $\angle 1 \cong \angle 2$
5. $m\angle 1 = m\angle 2$
6. $m\angle 1 + m\angle 1 = 180^\circ$
7. $2(m\angle 1) = 180^\circ$
8. $m\angle 1 = 90^\circ$
9. $?$
10. $g \perp h$

REASONS

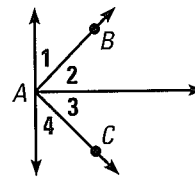
1. Given
2. $?$
3. Definition of supplementary angles
4. Given
5. $?$
6. Substitution Property of Equality
7. Combine like terms.
8. $?$
9. Definition of a right angle
10. $?$

PROVING THEOREMS Write a proof of the given theorem.

32. Theorem 3.9
33. Theorem 3.11, Perpendicular Transversal Theorem
34. Theorem 3.12, Lines Perpendicular to a Transversal Theorem

CHALLENGE Suppose the given statement is true. Determine whether $\vec{AB} \perp \vec{AC}$.

35. $\angle 1$ and $\angle 2$ are congruent.
36. $\angle 3$ and $\angle 4$ are complementary.
37. $m\angle 1 = m\angle 3$ and $m\angle 2 = m\angle 4$
38. $m\angle 1 = 40^\circ$ and $m\angle 4 = 50^\circ$

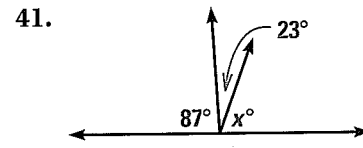
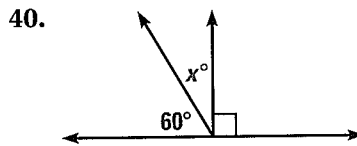
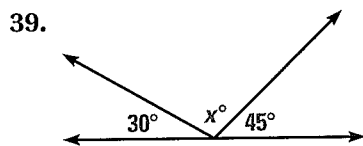


MIXED REVIEW

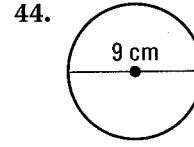
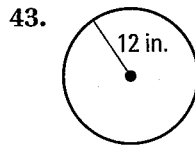
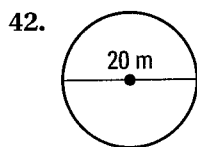
PREVIEW

Prepare for
Lesson 4.1
in Exs. 39–41.

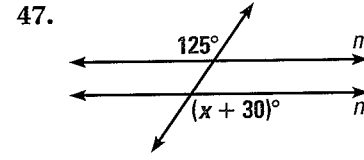
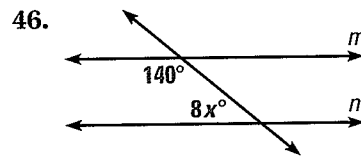
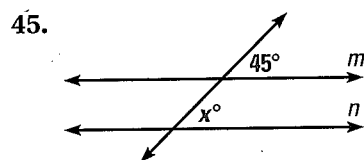
Find the value of x . (p. 24)



Find the circumference and area of the circle. Round to the nearest tenth.
(p. 49)



Find the value of x that makes $m \parallel n$. (p. 161)



QUIZ for Lessons 3.5–3.6

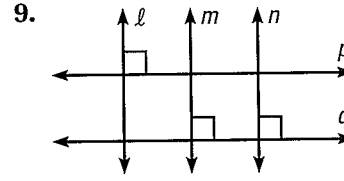
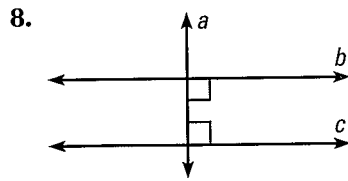
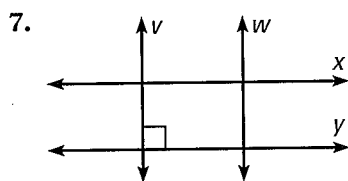
Write an equation of the line that passes through point P and is parallel to the line with the given equation. (p. 180)

1. $P(0, 0)$, $y = -3x + 1$
2. $P(-5, -6)$, $y - 8 = 2x + 10$
3. $P(1, -2)$, $x = 15$

Write an equation of the line that passes through point P and is perpendicular to the line with the given equation. (p. 180)

4. $P(3, 4)$, $y = 2x - 1$
5. $P(2, 5)$, $y = -6$
6. $P(4, 0)$, $12x + 3y = 9$

Determine which lines, if any, must be parallel. Explain. (p. 190)



Extension

Use after Lesson 3.6

Taxicab Geometry

GOAL Find distances in a non-Euclidean geometry.

Key Vocabulary

- taxicab geometry

HISTORY NOTE

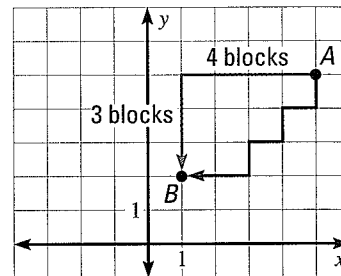
Euclidean geometry is named after a Greek mathematician. Euclid (circa third century B.C.) used postulates and deductive reasoning to prove the theorems you are studying in this book.

Non-Euclidean geometries start by assuming different postulates, so they result in different theorems.

You have learned that the shortest distance between two points is the length of the straight line segment between them. This is true in the *Euclidean* geometry that you are studying. But think about what happens when you are in a city and want to get from point *A* to point *B*. You cannot walk through the buildings, so you have to go along the streets.

Taxicab geometry is the non-Euclidean geometry that a taxicab or a pedestrian must obey.

In taxicab geometry, you can travel either horizontally or vertically parallel to the axes. In this geometry, the distance between two points is the shortest number of *blocks* between them.



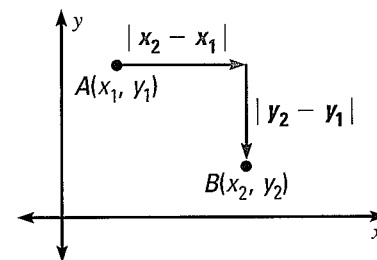
KEY CONCEPT

For Your Notebook

Taxicab Distance

The distance between two points is the sum of the differences in their coordinates.

$$AB = |x_2 - x_1| + |y_2 - y_1|$$



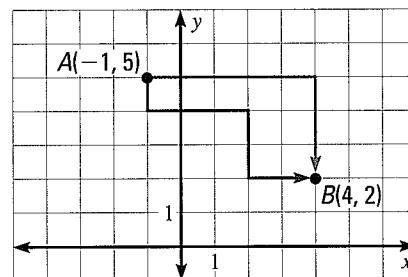
EXAMPLE 1 Find a taxicab distance

Find the taxicab distance from $A(-1, 5)$ to $B(4, 2)$. Draw two different shortest paths from A to B .

Solution

$$\begin{aligned} AB &= |x_2 - x_1| + |y_2 - y_1| \\ &= |4 - (-1)| + |2 - 5| \\ &= |5| + |-3| \\ &= 8 \end{aligned}$$

- The shortest path is 8 blocks.
Two possible paths are shown.



REVIEW

ABSOLUTE VALUE

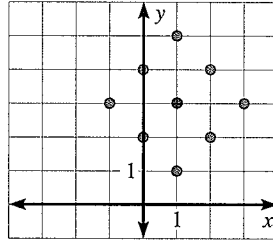
For help with absolute value, see p. 870.

CIRCLES In Euclidean geometry, a *circle* is all points that are the same distance from a fixed point, called the *center*. That distance is the *radius*. Taxicab geometry uses the same definition for a circle, but taxicab circles are not round.

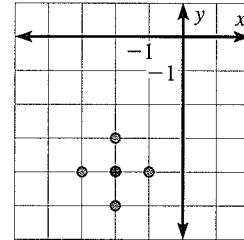
EXAMPLE 2 Draw a taxicab circle

Draw the taxicab circle with the given radius r and center C .

a. $r = 2, C(1, 3)$



b. $r = 1, C(-2, -4)$



PRACTICE

EXAMPLE 1

on p. 198
for Exs. 1–6

FINDING DISTANCE Find the taxicab distance between the points.

- | | | |
|------------------------|-----------------------|------------------------|
| 1. $(4, 2), (0, 0)$ | 2. $(3, 5), (6, 2)$ | 3. $(-6, 3), (8, 5)$ |
| 4. $(-1, -3), (5, -2)$ | 5. $(-3, 5), (-1, 5)$ | 6. $(-7, 3), (-7, -4)$ |

EXAMPLE 2

on p. 199
for Exs. 7–9

DRAWING CIRCLES Draw the taxicab circle with radius r and center C .

- | | | |
|---------------------|---------------------|----------------------|
| 7. $r = 2, C(3, 4)$ | 8. $r = 4, C(0, 0)$ | 9. $r = 5, C(-1, 3)$ |
|---------------------|---------------------|----------------------|

FINDING MIDPOINTS A *midpoint* in taxicab geometry is a point where the distances to the endpoints are equal. Find all the midpoints of \overline{AB} .

- | | | |
|--------------------------|-------------------------|-------------------------|
| 10. $A(2, 4), B(-2, -2)$ | 11. $A(1, -3), B(1, 3)$ | 12. $A(2, 2), B(-3, 0)$ |
|--------------------------|-------------------------|-------------------------|

13. TRAVEL PLANNING A hotel's website claims that the hotel is an easy walk to a number of sites of interest. What are the coordinates of the hotel?

www.hotel-arca.com

Getting Around Town by Foot

- Subway stop: 2 blocks
- Aquarium: 8 blocks
- Shopping mall: 5 blocks

14. REASONING The taxicab distance between two points is always greater than or equal to the Euclidean distance between the two points. *Explain* what must be true about the points for both distances to be equal.

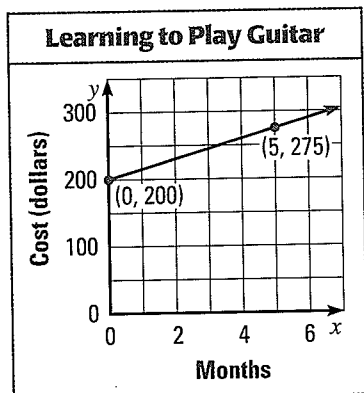


Lessons 3.4–3.6

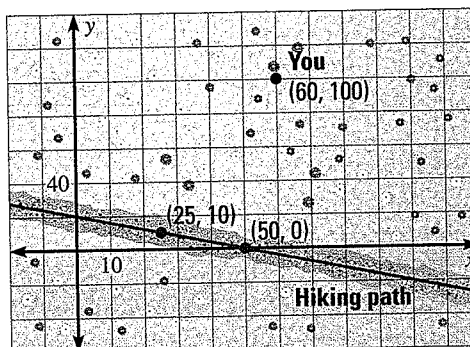
- 1. MULTI-STEP PROBLEM** You are planning a party. You would like to have the party at a roller skating rink or bowling alley. The table shows the total cost to rent the facilities by number of hours.

Hours	Roller skating rink cost (\$)	Bowling alley cost (\$)
1	35	20
2	70	40
3	105	60
4	140	80
5	175	100

- Use the data in the table. Write and graph two equations to represent the total cost y to rent the facilities, where x is the number of hours you rent the facility.
 - Are the lines from part (a) parallel? *Explain* why or why not.
 - What is the meaning of the slope in each equation from part (a)?
 - Suppose the bowling alley charges an extra \$25 set-up fee. Write and graph an equation to represent this situation. Is this line parallel to either of the lines from part (a)? *Explain* why or why not.
- 2. GRIDDED ANSWER** The graph models the accumulated cost of buying a used guitar and taking lessons over the first several months. Find the slope of the line.



- 3. OPEN-ENDED** Write an equation of a line parallel to $2x + 3y = 6$. Then write an equation of a line perpendicular to your line.
- 4. SHORT RESPONSE** You are walking across a field to get to a hiking path. Use the graph below to find the shortest distance you can walk to reach the path. *Explain* how you know you have the shortest distance.



- 5. EXTENDED RESPONSE** The Johnstown Inclined Plane in Johnstown, Pennsylvania, is a cable car that transports people up and down the side of a hill. During the cable car's climb, you move about 17 feet upward for every 25 feet you move forward. At the top of the incline, the horizontal distance from where you started is about 500 feet.



- How high is the car at the top of its climb compared to its starting height?
- Find the slope of the climb.
- Another cable car incline in Pennsylvania, the Monongahela Incline, climbs at a slope of about 0.7 for a horizontal distance of about 517 feet. *Compare* this climb to that of the Johnstown Inclined Plane. Which is steeper? *Justify* your answer.

CHAPTER SUMMARY

BIG IDEAS

For Your Notebook

Big Idea 1

Using Properties of Parallel and Perpendicular Lines

When parallel lines are cut by a transversal, angle pairs are formed. Perpendicular lines form congruent right angles.

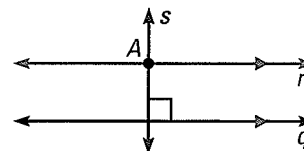
	<p>$\angle 2$ and $\angle 6$ are corresponding angles, and they are congruent.</p> <p>$\angle 3$ and $\angle 6$ are alternate interior angles, and they are congruent.</p> <p>$\angle 1$ and $\angle 8$ are alternate exterior angles, and they are congruent.</p> <p>$\angle 3$ and $\angle 5$ are consecutive interior angles, and they are supplementary.</p>
	<p>If $a \perp b$, then $\angle 1$, $\angle 2$, $\angle 3$, and $\angle 4$ are all right angles.</p>

Big Idea 2

Proving Relationships Using Angle Measures

You can use the angle pairs formed by lines and a transversal to show that the lines are parallel. Also, if lines intersect to form a right angle, you know that the lines are perpendicular.

Through point A not on line q , there is only one line r parallel to q and one line s perpendicular to q .

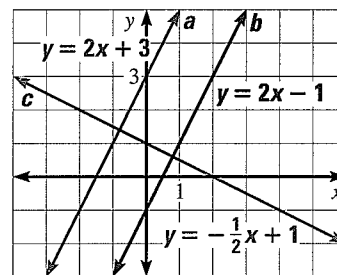


Big Idea 3

Making Connections to Lines in Algebra

In Algebra I, you studied slope as a rate of change and linear equations as a way of modeling situations.

Slope and equations of lines are also a useful way to represent the lines and segments that you study in Geometry. For example, the slopes of parallel lines are the same ($a \parallel b$), and the product of the slopes of perpendicular lines is -1 ($a \perp c$, and $b \perp c$).



REVIEW KEY VOCABULARY

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

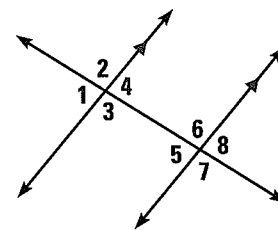
- parallel lines, p. 147
- skew lines, p. 147
- parallel planes, p. 147
- transversal, p. 149
- corresponding angles, p. 149
- alternate interior angles, p. 149
- alternate exterior angles, p. 149
- consecutive interior angles, p. 149
- paragraph proof, p. 163
- slope, p. 171
- slope-intercept form, p. 180
- standard form, p. 182
- distance from a point to a line, p. 192

VOCABULARY EXERCISES

- Copy and complete: Two lines that do not intersect and are not coplanar are called ? .
- WRITING** Compare alternate interior angle pairs and consecutive interior angle pairs.

Copy and complete the statement using the figure at the right.

- $\angle 1$ and ? are corresponding angles.
- $\angle 3$ and ? are alternate interior angles.
- $\angle 4$ and ? are consecutive interior angles.
- $\angle 7$ and ? are alternate exterior angles.



Identify the form of the equation as *slope-intercept form* or *standard form*.

7. $14x - 2y = 26$

8. $y = 7x - 13$

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 3.

3.1

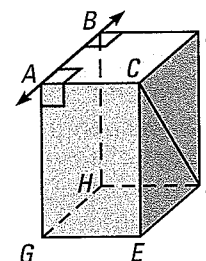
Identify Pairs of Lines and Angles

pp. 147–152

EXAMPLE

Think of each segment in the rectangular box at the right as part of a line.

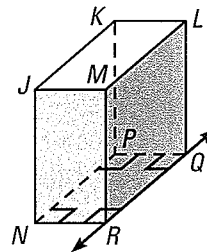
- \overleftrightarrow{BD} , \overleftrightarrow{AC} , \overleftrightarrow{BH} , and \overleftrightarrow{AG} appear perpendicular to \overleftrightarrow{AB} .
- \overleftrightarrow{CD} , \overleftrightarrow{GH} , and \overleftrightarrow{EF} appear parallel to \overleftrightarrow{AB} .
- \overleftrightarrow{CF} and \overleftrightarrow{EG} appear skew to \overleftrightarrow{AB} .
- Plane EFG appears parallel to plane ABC .



EXAMPLE 1
on p. 147
for Exs. 9–12

EXERCISES

Think of each segment in the diagram of a rectangular box as part of a line. Which line(s) or plane(s) contain point N and appear to fit the description?



9. Line(s) perpendicular to \overleftrightarrow{QR}
10. Line(s) parallel to \overleftrightarrow{QR}
11. Line(s) skew to \overleftrightarrow{QR}
12. Plane(s) parallel to plane LMQ

3.2 Use Parallel Lines and Transversals

pp. 154–160

EXAMPLE

Use properties of parallel lines to find the value of x .

By the Vertical Angles Congruence Theorem,
 $m\angle 6 = 50^\circ$.

$$(x - 5)^\circ + m\angle 6 = 180^\circ$$

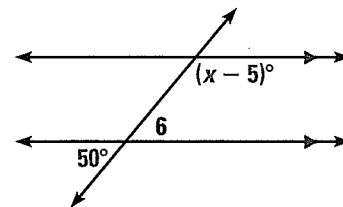
Consecutive Interior Angles Theorem

$$(x - 5)^\circ + 50^\circ = 180^\circ$$

Substitute 50° for $m\angle 6$.

$$x = 135$$

Solve for x .

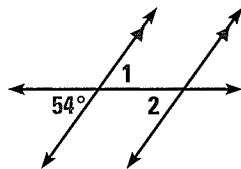


EXERCISES

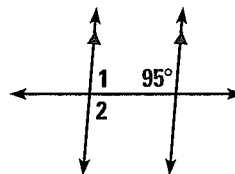
Find $m\angle 1$ and $m\angle 2$. Explain your reasoning.

EXAMPLES 1 and 2
on pp. 154–155
for Exs. 13–19

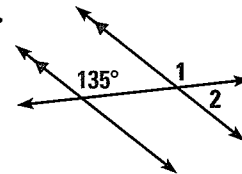
13.



14.

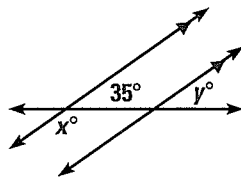


15.

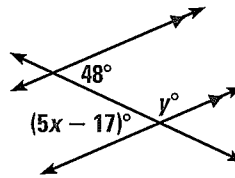


Find the values of x and y .

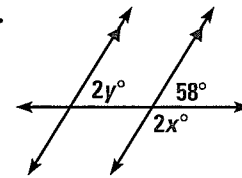
16.



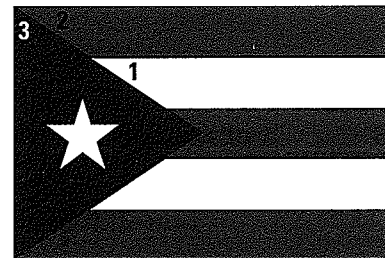
17.



18.



19. **FLAG OF PUERTO RICO** Sketch the rectangular flag of Puerto Rico as shown at the right. Find the measure of $\angle 1$ if $m\angle 3 = 55^\circ$. Justify each step in your argument.



3

CHAPTER REVIEW

3.3 Prove Lines are Parallel

pp. 161–169

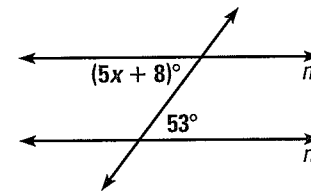
EXAMPLE

Find the value of x that makes $m \parallel n$.

Lines m and n are parallel when the marked corresponding angles are congruent.

$$\begin{aligned}(5x + 8)^\circ &= 53^\circ \\ 5x &= 45 \\ x &= 9\end{aligned}$$

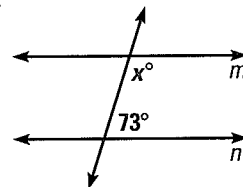
► The lines m and n are parallel when $x = 9$.



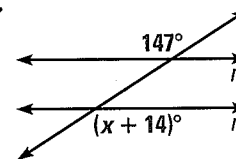
EXERCISES

Find the value of x that makes $m \parallel n$.

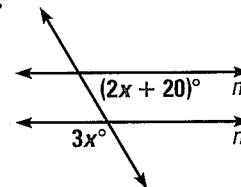
20.



21.



22.



EXAMPLE 1

on p. 161
for Exs. 20–22

3.4 Find and Use Slopes of Lines

pp. 171–178

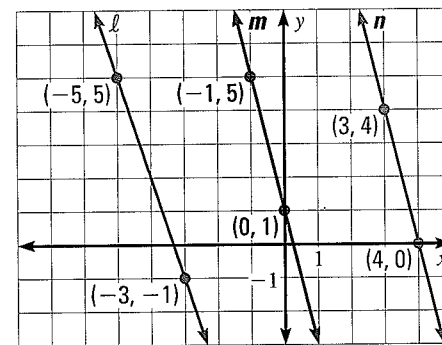
EXAMPLE

Find the slope of each line. Which lines are parallel?

$$\text{Slope of } \ell = \frac{-1 - 5}{-3 - (-5)} = \frac{-6}{2} = -3$$

$$\text{Slope of } m = \frac{1 - 5}{0 - (-1)} = \frac{-4}{1} = -4$$

$$\text{Slope of } n = \frac{0 - 4}{4 - 3} = \frac{-4}{1} = -4$$



► Because m and n have the same slope, they are parallel. The slope of ℓ is different, so ℓ is not parallel to the other lines.

EXERCISES

Tell whether the lines through the given points are *parallel*, *perpendicular*, or *neither*.

23. Line 1: $(8, 12), (7, -5)$
Line 2: $(-9, 3), (8, 2)$

24. Line 1: $(3, -4), (-1, 4)$
Line 2: $(2, 7), (5, 1)$

EXAMPLES

2 and 3

on pp. 172–173
for Exs. 23–24

3.5 Write and Graph Equations of Lines

pp. 180–187

EXAMPLE

Write an equation of the line k passing through the point $(-4, 1)$ that is perpendicular to the line n with the equation $y = 2x - 3$.

First, find the slope of line k .
Line n has a slope of 2.

$$2 \cdot m = -1$$

$$m = -\frac{1}{2}$$

Then, use the given point and the slope in the slope-intercept form to find the y -intercept.

$$y = mx + b$$

$$1 = -\frac{1}{2}(-4) + b$$

$$-1 = b$$

► An equation of line k is $y = -\frac{1}{2}x - 1$.

EXERCISES

Write equations of the lines that pass through point P and are (a) parallel and (b) perpendicular to the line with the given equation.

25. $P(3, -1)$, $y = 6x - 4$

26. $P(-6, 5)$, $7y + 4x = 2$

EXAMPLES
2 and 3
on pp. 180–181
for Exs. 25–26

3.6 Prove Theorems About Perpendicular Lines

pp. 190–197

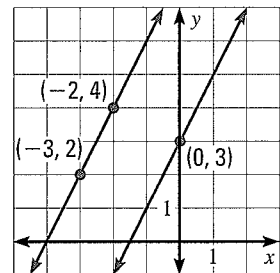
EXAMPLE

Find the distance between $y = 2x + 3$ and $y = 2x + 8$.

Find the length of a perpendicular segment from one line to the other. Both lines have a slope of 2, so the slope of a perpendicular segment to each line is $-\frac{1}{2}$.

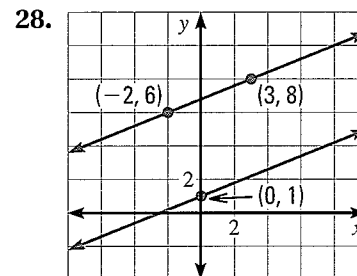
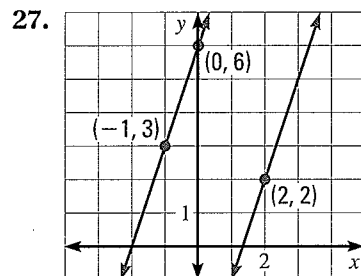
The segment from $(0, 3)$ to $(-2, 4)$ has a slope of $\frac{4-3}{-2-0} = -\frac{1}{2}$. So, the distance between the lines is

$$d = \sqrt{(-2 - 0)^2 + (4 - 3)^2} = \sqrt{5} \approx 2.2 \text{ units.}$$



EXERCISES

Use the Distance Formula to find the distance between the two parallel lines. Round to the nearest tenth, if necessary.



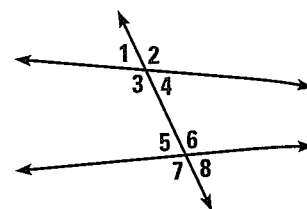
EXAMPLE 4
on p. 193
for Exs. 27–28

3

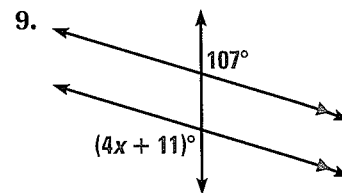
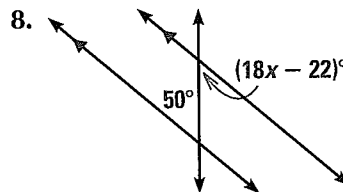
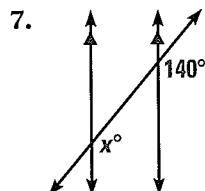
CHAPTER TEST

Classify the pairs of angles as *corresponding*, *alternate interior*, *alternate exterior*, or *consecutive interior*.

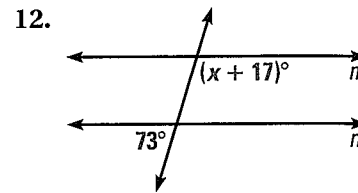
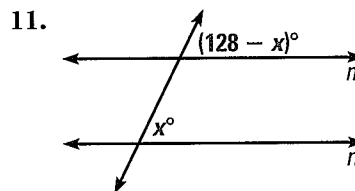
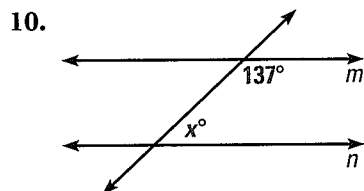
1. $\angle 1$ and $\angle 8$
2. $\angle 2$ and $\angle 6$
3. $\angle 3$ and $\angle 5$
4. $\angle 4$ and $\angle 5$
5. $\angle 3$ and $\angle 7$
6. $\angle 3$ and $\angle 6$



Find the value of x .



Find the value of x that makes $m \parallel n$.



Find the slope of the line that passes through the points.

13. $(3, -1), (3, 4)$

14. $(2, 7), (-1, -3)$

15. $(0, 5), (-6, 12)$

Write an equation of the line that passes through the given point P and has the given slope m .

16. $P(-2, 4), m = 3$

17. $P(7, 12), m = -0.2$

18. $P(3, 5), m = -8$

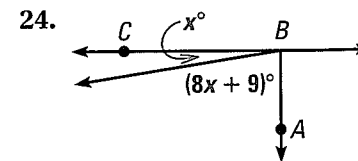
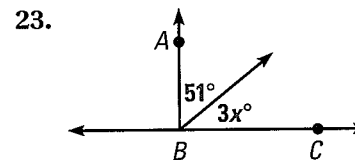
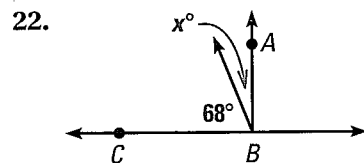
Write an equation of the line that passes through point P and is perpendicular to the line with the given equation.

19. $P(1, 3), y = 2x - 1$

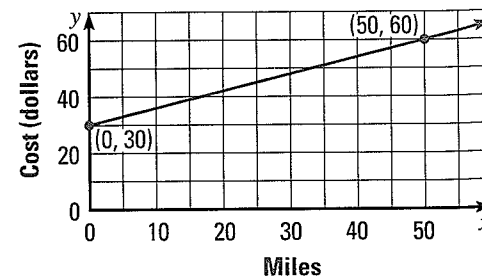
20. $P(0, 2), y = -x + 3$

21. $P(2, -3), x - y = 4$

In Exercises 22–24, $\overline{AB} \perp \overline{BC}$. Find the value of x .



25. **RENTAL COSTS** The graph at the right models the cost of renting a moving van. Write an equation of the line. Then find the cost of renting the van for a 100 mile trip.



GRAPH AND SOLVE LINEAR INEQUALITIES

xy EXAMPLE 1 Graph a linear inequality in two variables

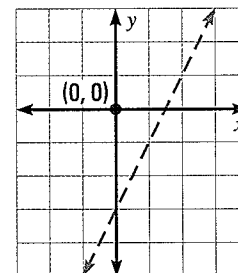
Graph the inequality $0 > 2x - 3 - y$.

Solution

Rewrite the inequality in slope-intercept form, $y > 2x - 3$.

The boundary line $y = 2x - 3$ is not part of the solution, so use a dashed line.

To decide where to shade, use a point not on the line, such as $(0, 0)$, as a test point. Because $0 > 2 \cdot 0 - 3$, $(0, 0)$ is a solution. Shade the half-plane that includes $(0, 0)$.



xy EXAMPLE 2 Use an inequality to solve a real-world problem

SAVINGS Lily has saved \$49. She plans to save \$12 per week to buy a camera that costs \$124. In how many weeks will she be able to buy the camera?

Solution

Let w represent the number of weeks needed.

$$49 + 12w \geq 124 \quad \text{Write an algebraic model.}$$

$$12w \geq 75 \quad \text{Subtract 49 from each side.}$$

$$w \geq 6.25 \quad \text{Divide each side by 12.}$$

► She must save for 7 weeks to be able to buy the camera.

EXERCISES

EXAMPLE 1
for Exs. 1–8

Graph the linear inequality.

- | | | | |
|------------------|----------------------|-------------------------|---------------------|
| 1. $y > -2x + 3$ | 2. $y \leq 0.5x - 4$ | 3. $-2.5x + y \geq 1.5$ | 4. $x < 3$ |
| 5. $y < -2$ | 6. $5x - y > -5$ | 7. $2x + 3y \geq -18$ | 8. $3x - 4y \leq 6$ |

EXAMPLE 2
for Exs. 9–11

Solve.

- LOANS** Eric borrowed \$46 from his mother. He will pay her back at least \$8 each month. At most, how many months will it take him?
- GRADES** Manuel's quiz scores in history are 76, 81, and 77. What score must he get on his fourth quiz to have an average of at least 80?
- PHONE CALLS** Company A charges a monthly fee of \$5 and \$.07 per minute for phone calls. Company B charges no monthly fee, but charges \$.12 per minute. After how many minutes of calls is the cost of using Company A less than the cost of using Company B?