Name ______________________ Date ______________

LESSON 3.1

# Study Guide

*For use with pages 146–152*

**GOAL** **Identify angle pairs formed by three intersecting lines.**

### Vocabulary

Two lines are **parallel lines** if they do not intersect and are coplanar.

Two lines are **skew lines** if they do not intersect and are not coplanar.

Two planes that do not intersect are **parallel planes.**

A **transversal** is a line that intersects two or more coplanar lines at different points.

When two lines are cut by a transversal, two angles are **corresponding angles** if they have corresponding positions.

When two lines are cut by a transversal, two angles are **alternate interior angles** if they lie between the two lines and on opposite sides of the transversal.

When two lines are cut by a transversal, two angles are **alternate exterior angles** if they lie outside the two lines and on opposite sides of the transversal.

When two lines are cut by a transversal, two angles are **consecutive interior angles** if they lie between the two lines and on the same side of the transversal.

**Postulate 13 Parallel Postulate:** If there is a line and a point not on the line, then there is exactly one line through the point parallel to the given line.

**Postulate 14 Perpendicular Postulate:** If there is a line and a point not on the line, then there is exactly one line through the point perpendicular to the given line.

LESSON 3.1

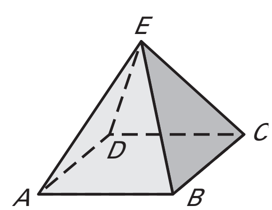
## EXAMPLE 1 Identify relationships in space

**Think of each segment in the diagram as part of a line. Which line(s) in the diagram appear to fit the description?**

**a.** Parallel to $\overleftrightarrow{AB}$

**b.** Skew to $\overleftrightarrow{AB}$

**c.** Parallel to $\overleftrightarrow{BC}$




**Solution**

**a.** Only $\overleftrightarrow{CD}$ is parallel to $\overleftrightarrow{AB}$.

**b.** $\overleftrightarrow{ED}$ and $\overleftrightarrow{EC}$ are skew to $\overleftrightarrow{AB}$.

**c.** Only $\overleftrightarrow{AD}$ is parallel to $\overleftrightarrow{BC}$.

Name ______________________ Date ____________

LESSON 3.1

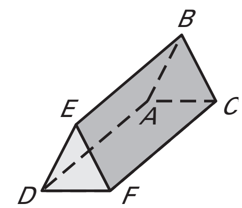
# Study Guide *continued*

*For use with pages 146–152*

## Exercises for Example 1

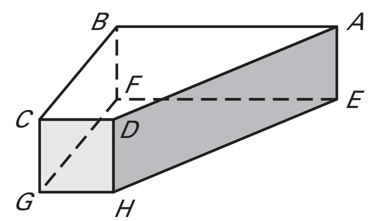
**Think of each segment in the diagram as part of a line. Fill in the blank with *parallel*, *skew*, or *perpendicular*.**

1. $\overleftrightarrow{DE}$ and $\overleftrightarrow{CF}$ are __?__.
2. $\overleftrightarrow{AD}$, $\overleftrightarrow{BE}$, and $\overleftrightarrow{CF}$ are __?__.
3. Plane $ABC$ and plane $DEF$ are __?__.
4. $\overleftrightarrow{BE}$ and $\overleftrightarrow{AB}$ are __?__.




**Think of each segment in the diagram as part of a line. There may be more than one right answer.**

5. Name a line perpendicular to $\overleftrightarrow{HD}$.
6. Name a plane parallel to plane $DCH$.
7. Name a line parallel to $\overleftrightarrow{BC}$.
8. Name a line skew to $\overleftrightarrow{FG}$.




**EXAMPLE 2** 

## Identify angle relationships

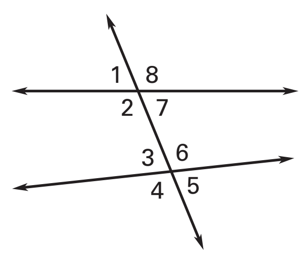
**Identify all pairs of angles of the given type.**

**a.** Corresponding

**b.** Alternate interior

**c.** Alternate exterior

**d.** Consecutive interior




**Solution**

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

**b.** $\angle 2$ and $\angle 6$
$\angle 7$ and $\angle 3$

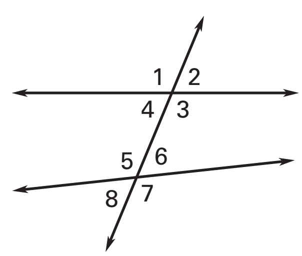
**c.** $\angle 1$ and $\angle 5$
$\angle 8$ and $\angle 4$

**d.** $\angle 2$ and $\angle 3$
$\angle 7$ and $\angle 6$

## Exercises for Example 2

**Complete the statement with *corresponding*, *alternate interior*, *alternate exterior*, or *consecutive interior*.**

9. $\angle 3$ and $\angle 5$ are __?__ angles.
10. $\angle 2$ and $\angle 6$ are __?__ angles.
11. $\angle 1$ and $\angle 7$ are __?__ angles.
12. $\angle 4$ and $\angle 5$ are __?__ angles.




LESSON 3.1

# *Answer Key*

## Lesson 3.1

### Study Guide

**1.** skew **2.** parallel **3.** parallel
**4.** perpendicular **5.** $\overleftrightarrow{AD}$, $\overleftrightarrow{EH}$, $\overleftrightarrow{DC}$, $\overleftrightarrow{HG}$
**6.** plane *ABE* **7.** $\overleftrightarrow{FG}$ **8.** $\overleftrightarrow{AE}$, $\overleftrightarrow{DH}$, $\overleftrightarrow{AD}$, $\overleftrightarrow{DC}$
**9.** alternate interior **10.** corresponding
**11.** alternate exterior **12.** consecutive interior

Name ______________________________ Date ______________

LESSON 3.2

# Study Guide

*For use with pages 153–160*

**GOAL** **Use angles formed by parallel lines and transversals.**

## Vocabulary

**Postulate 15 Corresponding Angles Postulate:** If two parallel lines are cut by a transversal, then the pairs of corresponding angles are congruent.

**Theorem 3.1 Alternate Interior Angles Theorem:** If two parallel lines are cut by a transversal, then the pairs of alternate interior angles are congruent.

**Theorem 3.2 Alternate Exterior Angles Theorem:** If two parallel lines are cut by a transversal, then the pairs of alternate exterior angles are congruent.

**Theorem 3.3 Consecutive Interior Angles Theorem:** If two parallel lines are cut by a transversal, then the pairs of consecutive interior angles are supplementary.

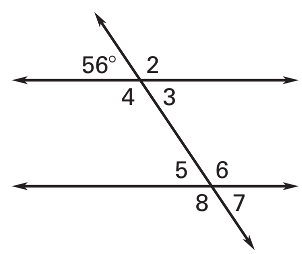
**EXAMPLE 1**

## Identify congruent angles

**The measure of three of the numbered angles is 56°. Identify the angles. *Explain* your reasoning.**

**Solution**

Using the Vertical Angles Congruence Theorem, *m*≥ 3 = 56°. By the Corresponding Angles Postulate, *m*≥ 5 = 56°. Because ≥ 3 and ≥ 7 are corresponding angles, by the Corresponding Angles Postulate, you know that *m*≥ 7= 56°.

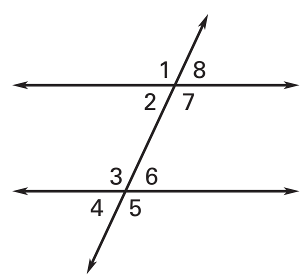



## Exercises for Example 1

**Use the diagram at the right.**

1. If *m*≥ 2 = 65°, find three other angles that have a measure of 65°. *Explain* your reasoning.

2. If *m*≥ 5 = 115°, find three other angles that have a measure of 115°. *Explain* your reasoning.



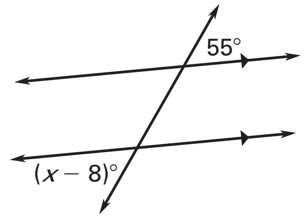

LESSON 3.2

Name ______________________ Date ______________

LESSON 3.2
# Study Guide *continued*
*For use with pages 153–160*

**EXAMPLE 2** 
## Use properties of parallel lines

**Find the value of *x*.**




**Solution**

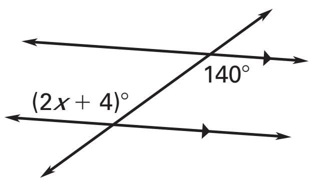
$x - 8 = 55$ Alternate Exterior Angles Theorem

$x = 63$ Add 8 to each side.

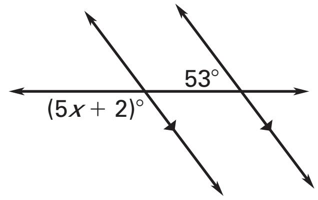
## Exercises for Example 2

**Find the value of x.**

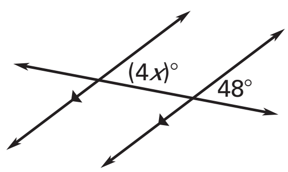
**3.**



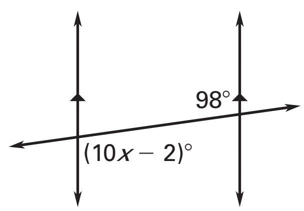

**4.**



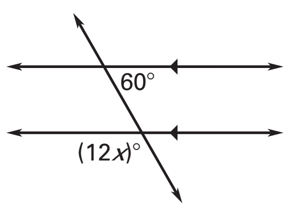

**5.**



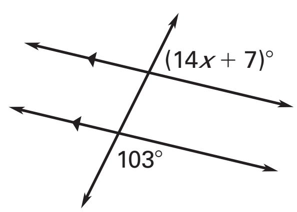

**6.**



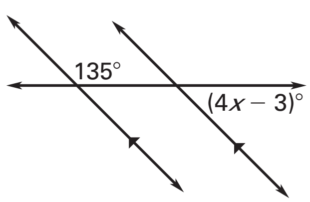

**7.**



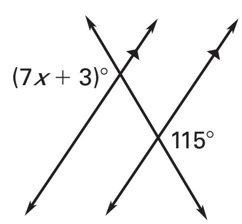

**8.**




**9.**




**10.**



## Lesson 3.2

### Study Guide

**1.** Using the Vertical Angles Congruence Theorem, $m\angle 8 = 65°$. By the Corresponding Angles Postulate, $m\angle 4 = 65°$. Because $\angle 8$ and $\angle 6$ are corresponding angles, by the Corresponding Angles Postulate, you know that $m\angle 6 = 65°$.

**2.** Using the Vertical Angles Congruence Theorem, $m\angle 3 = 115°$. By the Corresponding Angles Postulate, $m\angle 7 = 115°$. Because $\angle 3$ and $\angle 1$ are corresponding angles, by the Corresponding Angles Postulate, you know that $m\angle 1 = 115°$.

**3.** 68 **4.** 25 **5.** 12 **6.** 10

**7.** 10 **8.** 5 **9.** 12 **10.** 16

Name ______________________ Date ____________

LESSON 3.3

# Study Guide

*For use with pages 161–169*

**GOAL** **Use angle relationships to prove that lines are parallel.**

### Vocabulary

A proof can be written in paragraph form, called a **paragraph proof.**

**Postulate 16 Corresponding Angles Converse:** If two lines are cut by a transversal so the corresponding angles are congruent, then the lines are parallel.

**Theorem 3.4 Alternate Interior Angles Converse:** If two lines are cut by a transversal so the alternate interior angles are congruent, then the lines are parallel.

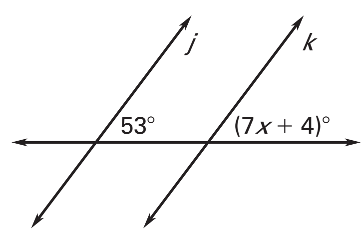
**Theorem 3.5 Alternate Exterior Angles Converse:** If two lines are cut by a transversal so the alternate exterior angles are congruent, then the lines are parallel.

**Theorem 3.6 Consecutive Interior Angles Converse:** If two lines are cut by a transversal so the consecutive interior angles are supplementary, then the lines are parallel.

**Theorem 3.7 Transitive Property of Parallel Lines:** If two lines are parallel to the same line, then they are parallel to each other.

## EXAMPLE 1 Apply the Corresponding Angles Converse

**Find the value of $x$ that makes $j \parallel k$.**




**Solution**

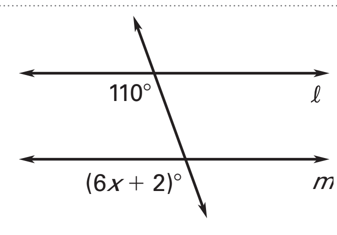
Lines $j$ and $k$ are parallel if the marked corresponding angles are congruent.

| | |
|---|---|
| $(7x + 4)^\circ = 53^\circ$ | Use Postulate 16 to write an equation. |
| $7x = 49$ | Subtract 4 from each side. |
| $x = 7$ | Divide each side by 7. |

The lines $j$ and $k$ are parallel when $x = 7$.

## Exercises for Example 1

**1.** Find the value of $x$ that makes $\ell \parallel m$.




LESSON 3.3

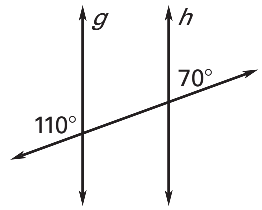
Name ______________________________ Date ______________

LESSON 3.3

# Study Guide *continued*

*For use with pages 161–169*

**2.** Is there enough information in the diagram to conclude that $g \parallel h$? *Explain.*

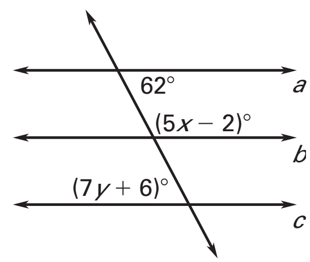



## EXAMPLE 2 Show lines are parallel

**Use the diagram at the right.**

**a.** Find the value of $x$ that makes $a \parallel b$.

**b.** Find the value of $y$ that makes $a \parallel c$.




**Solution**

**a.** Lines $a$ and $b$ are parallel if the marked consecutive interior angles are supplementary.

| | |
|---|---|
| $(5x - 2)^\circ + 62^\circ = 180^\circ$ | Use Theorem 3.6 to write an equation. |
| $5x + 60 = 180$ | Combine like terms. |
| $5x = 120$ | Subtract 60 from each side. |
| $x = 24$ | Divide each side by 5. |

The lines $a$ and $b$ are parallel when $x = 24$.

**b.** Lines $a$ and $c$ are parallel if the marked alternate interior angles are congruent.

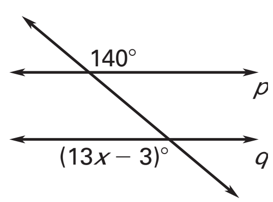
| | |
|---|---|
| $(7y + 6)^\circ = 62^\circ$ | Use Theorem 3.4 to write an equation. |
| $7y = 56$ | Subtract 6 from each side. |
| $y = 8$ | Divide each side by 7. |

The lines $a$ and $c$ are parallel when $y = 8$.

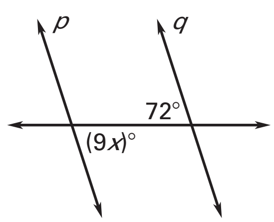
## Exercises for Example 2

**Find the value of $x$ that makes $p \parallel q$.**

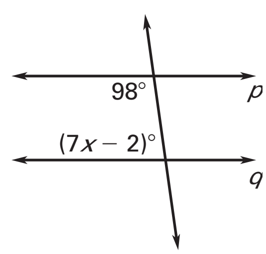
**3.**




**4.**




**5.**




LESSON 3.3

# Answer Key

## Lesson 3.3

### Study Guide

**1.** 18

**2.** Yes; the angle that corresponds with 70° has a measure of 70° because it is a linear pair with the angle that measures 110°.

**3.** 11 **4.** 8 **5.** 12

Name ____________________ Date ____________

LESSON 3.4

# Study Guide

*For use with pages 171–179*

LESSON 3.4

**GOAL** **Find and compare slopes of lines.**

### Vocabulary

The **slope** ($m$) of a nonvertical line is the ratio of vertical change (*rise*) to horizontal change (*run*) between any two points on the line.

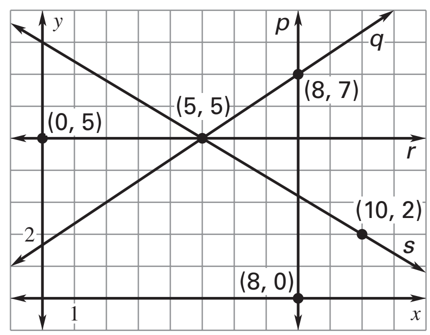
$$m = \frac{\text{rise}}{\text{run}} = \frac{\text{change in } y}{\text{change in } x} = \frac{y_2 - y_1}{x_2 - x_1}$$

**Postulate 17 Slopes of Parallel Lines:** In a coordinate plane, two nonvertical lines are parallel if and only if they have the same slope. Any two vertical lines are parallel.

**Postulate 18 Slopes of Perpendicular Lines:** In a coordinate plane, two nonvertical lines are perpendicular if and only if the product of their slopes is $-1$. Horizontal lines are perpendicular to vertical lines.

## EXAMPLE 1 Find slopes of lines in a coordinate plane

**Find the slope of line *q* and line *r*.**




**Solution**

Slope of line $q$: $m = \frac{y_2 - y_1}{x_2 - x_1} = \frac{7 - 5}{8 - 5} = \frac{2}{3}$

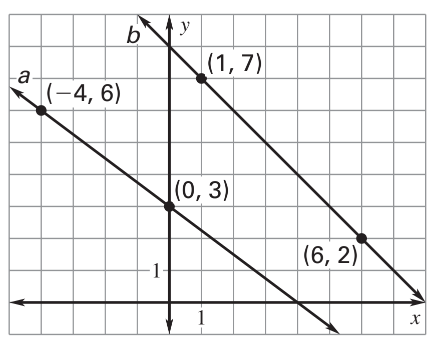
Slope of line $r$: $m = \frac{y_2 - y_1}{x_2 - x_1} = \frac{5 - 5}{5 - 0} = 0$

### Exercise for Example 1

**1.** In Example 1, find the slope of line $p$ and line $s$.

## EXAMPLE 2 Identify parallel lines

**Find the slope of each line. Is $a \parallel b$?**




**Solution**

Find the slope of $a$ through $(-4, 6)$ and $(0, 3)$.

$$m_a = \frac{3 - 6}{0 - (-4)} = -\frac{3}{4}$$

Find the slope of $b$ through $(1, 7)$ and $(6, 2)$.

$$m_b = \frac{2 - 7}{6 - 1} = -1$$

Compare the slopes. Because $a$ and $b$ have different slope, they are not parallel.

LESSON 3.4

# Study Guide *continued*

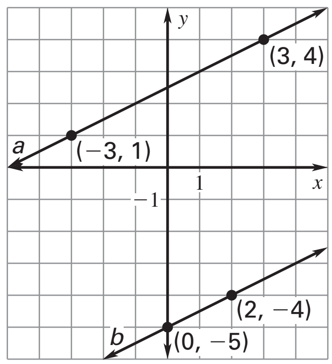
*For use with pages 171–179*



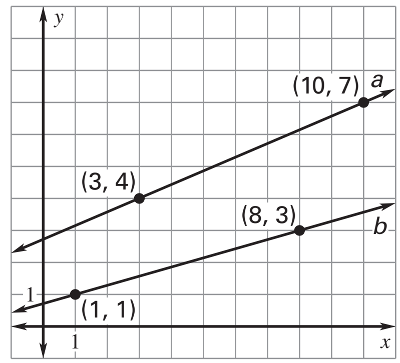
## Exercises for Example 2

**Find the slope of each line. Is $a \parallel b$?**

**2.**




**3.**




**EXAMPLE 3**

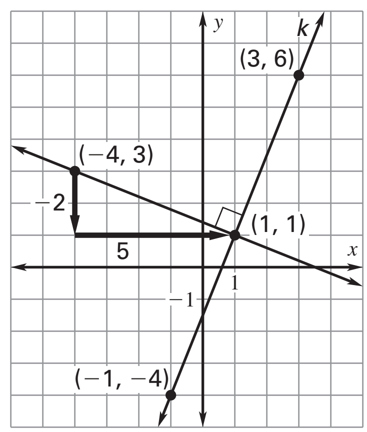
## Draw a perpendicular line

**Line *k* passes through (−1, −4) and (3, 6). Graph the line perpendicular to *k* that passes through the point (−4, 3).**

**Solution**

**STEP 1** **Find** the slope $m_1$ of line $k$ through $(-1, -4)$ and $(3, 6)$.

$$m_1 = \frac{6 - (-4)}{3 - (-1)} = \frac{10}{4} = \frac{5}{2}$$




**STEP 2** **Find** the slope $m_2$ of a line perpendicular to $k$. Use the fact that the product of the slopes of two perpendicular lines is $-1$.

$$\frac{5}{2} \cdot m_2 = -1$$

$$m_2 = -\frac{2}{5}$$

**STEP 3** **Use** the rise and run to graph the line.

## Exercises for Example 3

**4.** Line $j$ passes through $(-4, 2)$ and $(6, 0)$. Graph the line perpendicular to $j$ that passes through the point $(0, -4)$.

**5.** Line $n$ passes through $(-2, 3)$ and $(5, -1)$. Graph the line perpendicular to $n$ that passes through the point $(-6, -1)$.

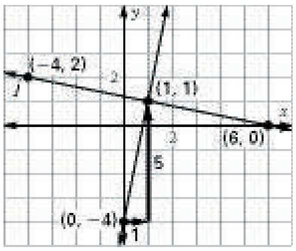
## *Lesson 3.4*

### Study Guide

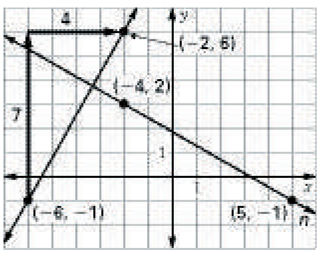
**1.** undefined, $-\frac{3}{5}$ **2.** $m_a = \frac{1}{2}$, $m_b = \frac{1}{2}$; parallel

**3.** $m_a = \frac{3}{7}$, $m_b = \frac{2}{7}$; not parallel

**4.**




**5.**



Name ______________________ Date ______________

LESSON 3.5

# Study Guide

*For use with pages 180–187*

**GOAL** **Find equations of lines.**

### Vocabulary

The general form of a linear equation in **slope-intercept form** is $y = mx + b$, where $m$ is the slope and $b$ is the $y$-intercept.

A linear equation written as $Ax + By = C$, where $A$ and $B$ are not both zero, is written in **standard form.**



## EXAMPLE 1 Write an equation of a parallel line

**Write an equation of the line passing through the point (3, 4) that is parallel to the line with the equation $y = -4x + 5$.**

**STEP 1** **Find** the slope $m$. The slope of a line parallel to $y = -4x + 5$ is the same as the given line, so the slope is $-4$.

**STEP 2** **Find** the $y$-intercept $b$ by using $m = -4$ and $(x, y) = (3, 4)$.

| | |
|---|---|
| $y = mx + b$ | Use slope-intercept form. |
| $4 = -4(3) + b$ | Substitute for $x$, $y$, and $m$. |
| $16 = b$ | Solve for $b$. |

Because $m = -4$ and $b = 16$, an equation of the line is $y = -4x + 16$.



## EXAMPLE 2 Write an equation of a perpendicular line

**Write an equation of the line $p$ passing through the point (6, −3) that is perpendicular to the line $q$ with the equation $y = 4x - 7$.**

**STEP 1** **Find** the slope $m$ of line $p$. Line $q$ has a slope of 4.

| | |
|---|---|
| $4 \cdot m = -1$ | The product of the slopes of ⊥ lines is $-1$. |
| $m = -\frac{1}{4}$ | Divide each side by $-2$. |

**STEP 2** **Find** the $y$-intercept $b$ by using $m = -\frac{1}{4}$ and $(x, y) = (8, -3)$.

| | |
|---|---|
| $y = mx + b$ | Use slope-intercept form. |
| $-3 = -\frac{1}{4}(8) + b$ | Substitute for $x$, $y$, and $m$. |
| $-1 = b$ | Solve for $b$. |

Because $m = -\frac{1}{4}$ and $b = -1$, an equation of line $p$ is $y = -\frac{1}{4}x - 1$.

Name ______________________________ Date ______________

LESSON 3.5 **Study Guide** *continued*
*For use with pages 180–187*

## Exercises for Examples 1 and 2

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

**1.** $P(10, 3), y = x - 12$ **2.** $P(-5, 2), y = -x - 9$ **3.** $P(-1, 2), y = \frac{2}{3}x - 2$

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

**4.** $P(8, 7), y = -x + 3$ **5.** $P(-4, 5), y = 2x - 6$ **6.** $P(2, -3), y = \frac{4}{7}x + 2$

**EXAMPLE 3**

## Graph a line with equation in standard form

**Graph $2x + 3y = 18$.**

**Solution**

**STEP 1** **Find** the intercepts.

To find the *x*-intercept, let $y = 0$.

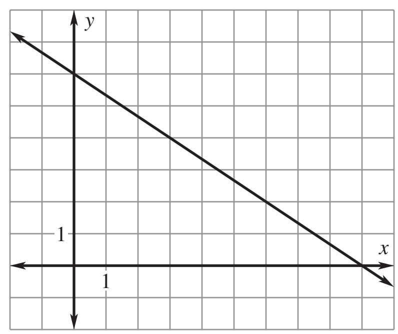
$$2x + 3y = 18$$
$$2x + 3(0) = 18$$
$$x = 9$$

To find the *y*-intercept, let $x = 0$.

$$2x + 3y = 18$$
$$2(0) + 3y = 18$$
$$y = 6$$

**STEP 2** **Graph** the line.

The line intercepts the axes at (9, 0) and (0, 6). Graph these points, then draw a line through the points.




## Exercises for Example 3

**Graph the equation.**

**7.** $5x + 2y = 20$ **8.** $x - 6y = 12$ **9.** $7x + 5y = -14$

LESSON 3.5

## *Lesson 3.5*

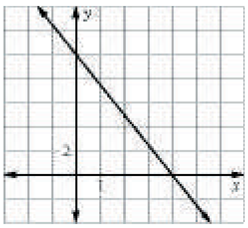
### Study Guide

**1.** $y = x - 7$ **2.** $y = -x - 3$ **3.** $y = \frac{2}{3}x + \frac{8}{3}$

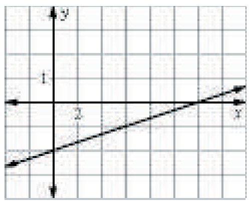
**4.** $y = x - 1$ **5.** $y = -\frac{1}{2}x + 3$

**6.** $y = -\frac{7}{4}x + \frac{1}{2}$

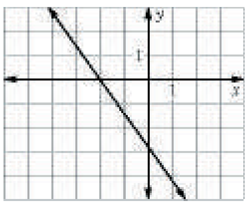
**7.**



**8.**



**9.**



Name ______________________ Date ____________

LESSON 3.6

# Study Guide

*For use with pages 190–197*

**GOAL** **Find the distance between a point and a line.**

## Vocabulary

The **distance from a point to a line** is the length of the perpendicular segment from the point to the line.

**Theorem 3.8:** If two lines intersect to form a linear pair of congruent angles, then the lines are perpendicular.

**Theorem 3.9:** If two lines are perpendicular, then they intersect to form four right angles.

**Theorem 3.10:** If two sides of two adjacent acute angles are perpendicular, then the angles are complementary.

**Theorem 3.11 Perpendicular Transversal Theorem:** If a transversal is perpendicular to one of two parallel lines, then it is perpendicular to the other.

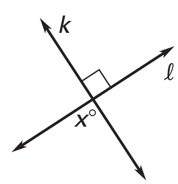
**Theorem 3.12 Lines Perpendicular to a Transversal Theorem:** In a plane, if two lines are perpendicular to the same line, then they are parallel to each other.

**EXAMPLE 1**

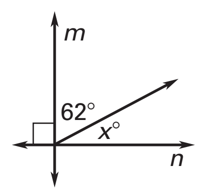
## Application of the Theorems

**Find the value of *x*.**

**a.**




**b.**




**Solution**

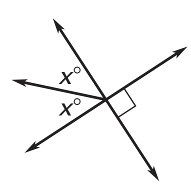
**a.** $x = 90$, by Theorem 3.9, because $k$ and $\ell$ are perpendicular, all four angles formed are right angles. By definition of a right angle, $x$ is 90.

**b.** By Theorem 3.9, because $m$ and $n$ are perpendicular, all four angles formed are right angles. By Theorem 3.2, the 62° angle and the $x°$ angle are complementary. Thus $x + 62 = 90$, so $x = 28$.

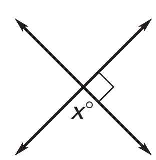
## Exercises for Example 1

**Find the value of *x*.**

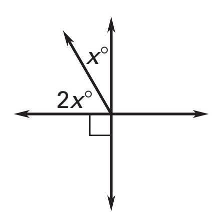
**1.**




**2.**




**3.**



Name ______________________ Date ______________

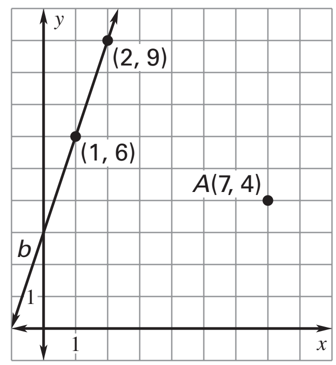
LESSON 3.6

# Study Guide *continued*

*For use with pages 190–197*

## EXAMPLE 2 Find the distance between a point and a line

**What is the distance from point *A* to line *b*?**




**Solution**

You need to find the slope of line *b*. Using the points (1, 6) and (2, 9), the slope of the line is

$$m = \frac{9 - 6}{2 - 1} = 3.$$

The distance from point *A* to line *b* is the perpendicular segment from the point to the line. The slope of a perpendicular segment from point *A* to line *b* is $-\frac{1}{3}$. The segment from (1, 6) to (7, 4) has a slope of $-\frac{1}{3}$.

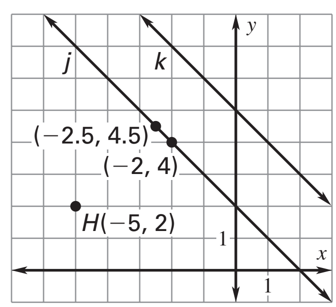
Find the distance between these points.

$$d = \sqrt{(1 - 7)^2 + (6 - 4)^2} \approx 6.3$$

The distance from point *A* to line *b* is about 6.3 units.

## Exercises for Example 2

**Use the graph at the right.**




**4.** What is the distance from point *H* to line *j*?

**5.** What is the distance from line *j* to line *k*?

LESSON 3.6

# *Answer Key*

## *Lesson 3.6*

**Study Guide**

**1.** 45 **2.** 90 **3.** 30 **4.** about 3.5 units
**5.** about 2.1 units