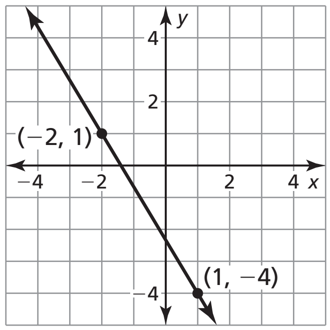
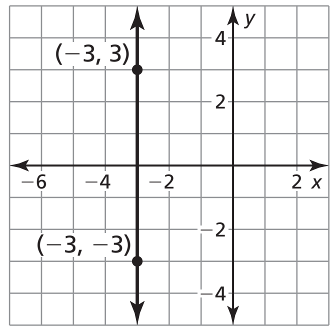
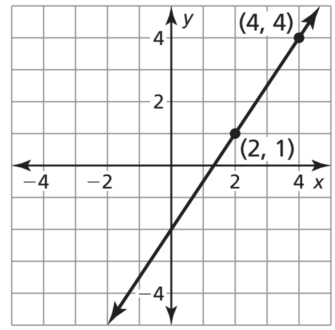
Name ____ Date _________

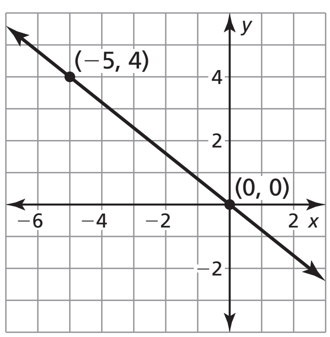
Chapter 3 Maintaining Mathematical Proficiency

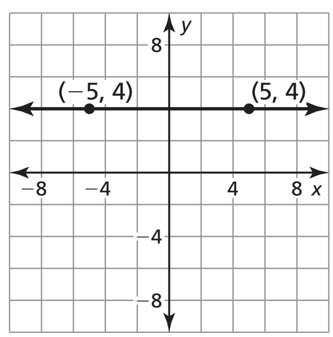
Find the slope of the line.

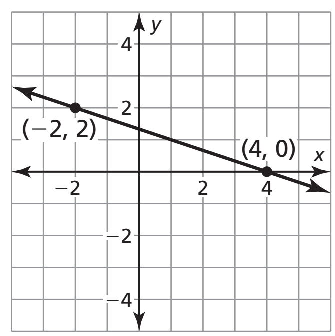
1. 

2. 

3. 

4. 

5. 

6. 

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

7. $(0, -8);\ m = \dfrac{3}{5}$

8. $(-4, 3);\ m = \dfrac{1}{3}$

9. $(2, -1);\ m = 5$

Name____ Date__________

3.1 Pairs of Lines and Angles

For use with Exploration 3.1

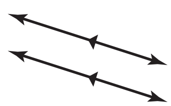
Essential Question What does it mean when two lines are parallel, intersecting, coincident, or skew?

1 EXPLORATION: Points of Intersection

Work with a partner. Write the number of points of intersection of each pair of coplanar lines.

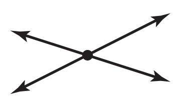
a. parallel lines

____



b. intersecting lines

____

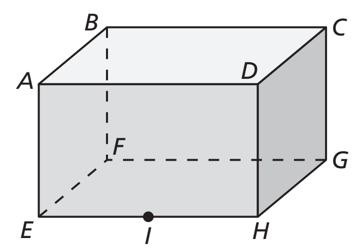


c. coincident lines

____

2 EXPLORATION: Classifying Pairs of Lines

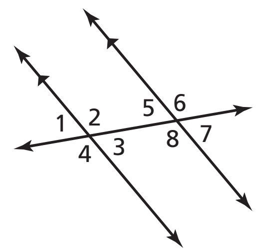
Work with a partner. The figure shows a *right rectangular prism.* All its angles are right angles. Classify each of the following pairs of lines as *parallel*, *intersecting*, *coincident*, or *skew*. Justify your answers. (Two lines are **skew lines** when they do not intersect and are not coplanar.)



Pair of Lines	Classification	Reason
a. $\overleftrightarrow{AB}$ and $\overleftrightarrow{BC}$		
b. $\overleftrightarrow{AD}$ and $\overleftrightarrow{BC}$		
c. $\overleftrightarrow{EI}$ and $\overleftrightarrow{IH}$		
d. $\overleftrightarrow{BF}$ and $\overleftrightarrow{EH}$		
e. $\overleftrightarrow{EF}$ and $\overleftrightarrow{CG}$		
f. $\overleftrightarrow{AB}$ and $\overleftrightarrow{GH}$		

3 EXPLORATION: Identifying Pairs of Angles

Work with a partner. In the figure, two parallel lines are intersected by a third line called a *transversal*.



a. Identify all the pairs of vertical angles. Explain your reasoning.

b. Identify all the linear pairs of angles. Explain your reasoning.

Communicate Your Answer

4. What does it mean when two lines are parallel, intersecting, coincident, or skew?

5. In Exploration 2, find three more pairs of lines that are different from those given. Classify the pairs of lines as *parallel*, *intersecting*, *coincident*, or *skew*. Justify your answers.

Name____ Date __________

3.1 Notetaking with Vocabulary
For use after Lesson 3.1

In your own words, write the meaning of each vocabulary term.

parallel lines

skew lines

parallel planes

transversal

corresponding angles

alternate interior angles

alternate exterior angles

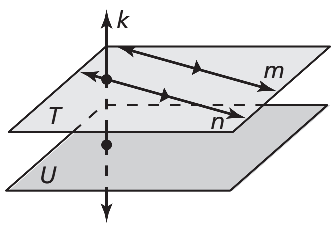
consecutive interior angles

Notes:

Core Concepts

Parallel Lines, Skew Lines, and Parallel Planes

Two lines that do not intersect are either *parallel lines* or *skew lines*. Two lines are **parallel lines** when they do not intersect and are coplanar. Two lines are **skew lines** when they do not intersect and are not coplanar. Also, two planes that do not intersect are **parallel planes**.



Lines m and n are parallel lines $(m \parallel n)$.

Lines m and k are skew lines.

Planes T and U are parallel planes $(T \parallel U)$.

Lines k and n are intersecting lines, and there is a plane (not shown) containing them.

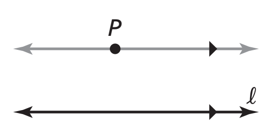
Small directed arrows, as shown on lines m and n above, are used to show that lines are parallel. The symbol $\parallel$ means "is parallel to," as in $m \parallel n$.

Segments and rays are parallel when they lie in parallel lines. A line is parallel to a plane when the line is in a plane parallel to the given plane. In the diagram above, line n is parallel to plane U.

Notes:

Postulate 3.1 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.



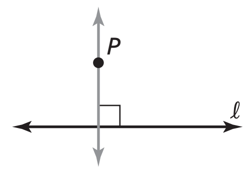
There is exactly one line through P parallel to ℓ.

Notes:

Postulate 3.2 Perpendicular Postulate

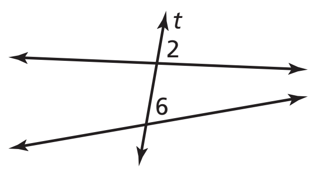
If there is a line and a point not on the line, then there is exactly one line through the point perpendicular to the given line.

There is exactly one line through P perpendicular to ℓ.

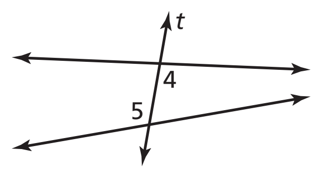


Notes:

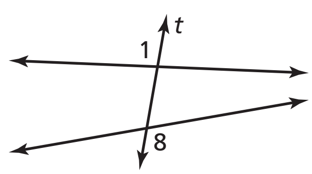
Angles Formed by Transversals



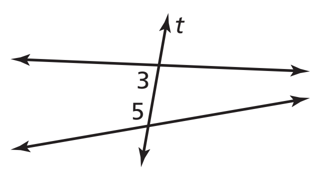
Two angles are **corresponding angles** when they have corresponding positions. For example, $\angle 2$ and $\angle 6$ are above the lines and to the right of the transversal t.



Two angles are **alternate interior angles** when they lie between the two lines and on opposite sides of the transversal t.



Two angles are **alternate exterior angles** when they lie outside the two lines and on opposite sides of the transversal t.



Two angles are **consecutive interior angles** when they lie between the two lines and on the same side of the transversal t.

Notes:

Extra Practice

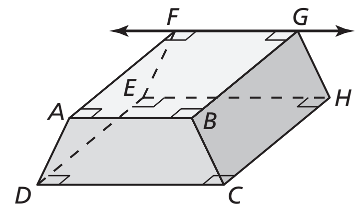
In Exercises 1–4, think of each segment in the diagram as part of a line. Which line(s) or plane(s) contain point *B* and appear to fit the description?

1. line(s) skew to $\overleftrightarrow{FG}$.

2. line(s) perpendicular to $\overleftrightarrow{FG}$.

3. line(s) parallel to $\overleftrightarrow{FG}$.

4. plane(s) parallel to plane *FGH*.



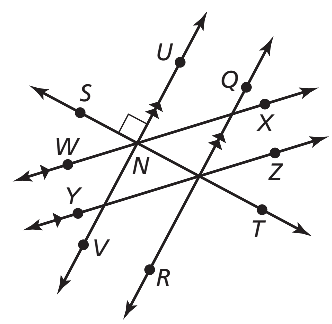
In Exercises 5–8, use the diagram.

5. Name a pair of parallel lines.

6. Name a pair of perpendicular lines.

7. Is $\overleftrightarrow{WX} \parallel \overleftrightarrow{QR}$? Explain.

8. Is $\overleftrightarrow{ST} \perp \overleftrightarrow{NV}$? Explain.



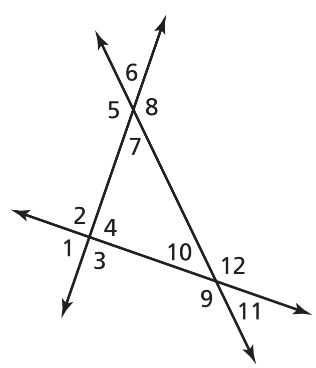
In Exercises 9–12, identify all pairs of angles of the given type.

9. corresponding

10. alternate interior

11. alternate exterior

12. consecutive interior



Name______________________________ Date__________

3.2 Parallel Lines and Transversals

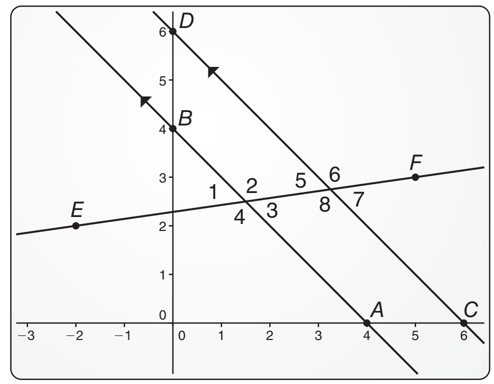
For use with Exploration 3.2

Essential Question When two parallel lines are cut by a transversal, which of the resulting pairs of angles are congruent?

1 EXPLORATION: Exploring Parallel Lines

Go to *BigIdeasMath.com* for an interactive tool to investigate this exploration.

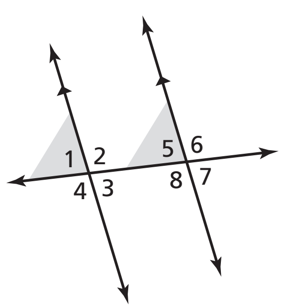
Work with a partner.
Use dynamic geometry software to draw two parallel lines. Draw a third line that intersects both parallel lines. Find the measures of the eight angles that are formed. What can you conclude?



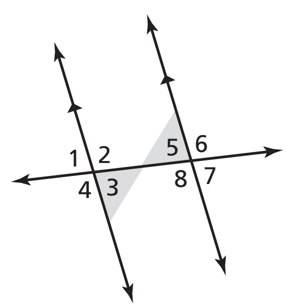
2 EXPLORATION: Writing Conjectures

Work with a partner. Use the results of Exploration 1 to write conjectures about the following pairs of angles formed by two parallel lines and a transversal.

a. corresponding angles

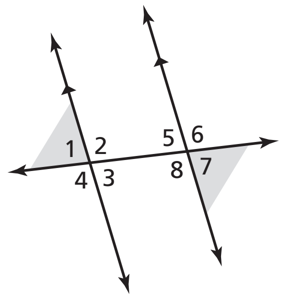


b. alternate interior angles

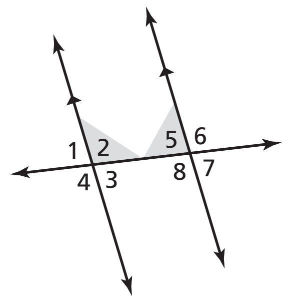


2 **EXPLORATION:** Writing Conjectures (continued)

c. alternate exterior angles



d. consecutive interior angles



Communicate Your Answer

3. When two parallel lines are cut by a transversal, which of the resulting pairs of angles are congruent?

4. In Exploration 2, $m\angle 1 = 80°$. Find the other angle measures.

Name____ Date__________

3.2 Notetaking with Vocabulary

For use after Lesson 3.2

In your own words, write the meaning of each vocabulary term.

corresponding angles

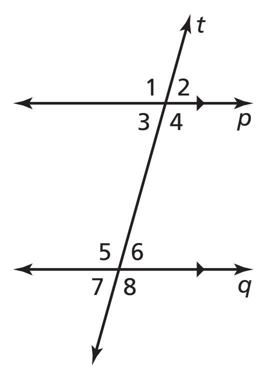
parallel lines

supplementary angles

vertical angles

Theorems

Theorem 3.1 Corresponding Angles Theorem



If two parallel lines are cut by a transversal, then the pairs of corresponding angles are congruent.

Examples In the diagram, $\angle 2 \cong \angle 6$ and $\angle 3 \cong \angle 7$.

Theorem 3.2 Alternate Interior Angles Theorem

If two parallel lines are cut by a transversal, then the pairs of alternate interior angles are congruent.

Examples In the diagram, $\angle 3 \cong \angle 6$ and $\angle 4 \cong \angle 5$.

Theorem 3.3 Alternate Exterior Angles Theorem

If two parallel lines are cut by a transversal, then the pairs of alternate exterior angles are congruent.

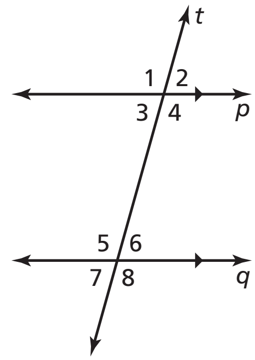
Examples In the diagram, $\angle 1 \cong \angle 8$ and $\angle 2 \cong \angle 7$.

Name ____ Date __________

3.2 **Notetaking with Vocabulary (continued)**

Theorem 3.4 Consecutive Interior Angles Theorem

If two parallel lines are cut by a transversal, then the pairs of consecutive interior angles are supplementary.



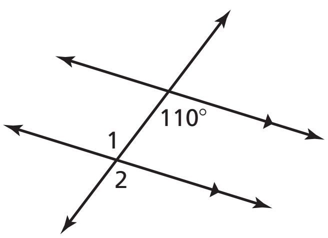
Examples In the diagram, $\angle 3$ and $\angle 5$ are supplementary, and $\angle 4$ and $\angle 6$ are supplementary.

Notes:

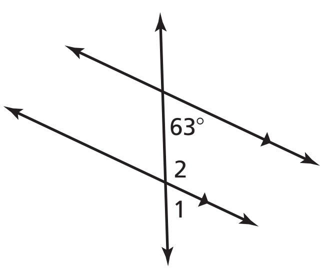
Extra Practice

In Exercises 1–4, find $m\angle 1$ and $m\angle 2$. Tell which theorem you use in each case.

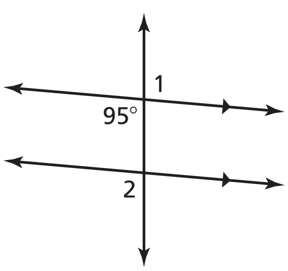
1.



2.

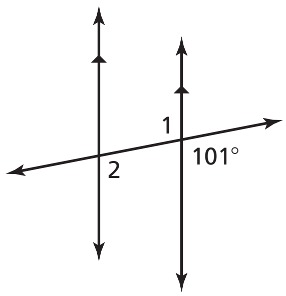


3.



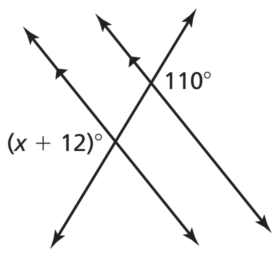
3.2 Notetaking with Vocabulary (continued)

4.

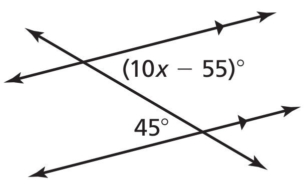


In Exercises 5–8, find the value of *x*. Show your steps.

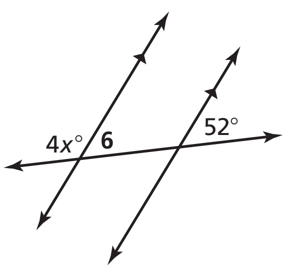
5.



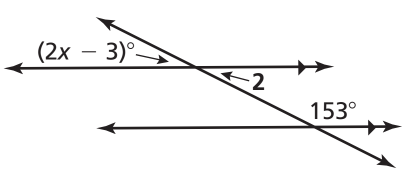
6.



7.



8.



Name ____ Date __________

3.3 Proofs with Parallel Lines

For use with Exploration 3.3

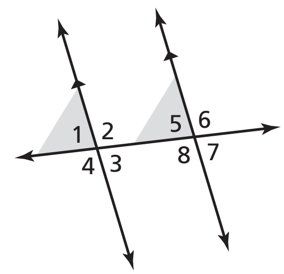
Essential Question For which of the theorems involving parallel lines and transversals is the converse true?

1 EXPLORATION: Exploring Converses

Work with a partner. Write the converse of each conditional statement. Draw a diagram to represent the converse. Determine whether the converse is true. Justify your conclusion.

a. Corresponding Angles Theorem (Theorem 3.1)

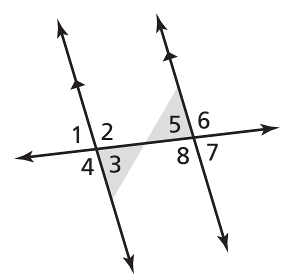
If two parallel lines are cut by a transversal, then the pairs of corresponding angles are congruent.



Converse

b. Alternate Interior Angles Theorem (Theorem 3.2)

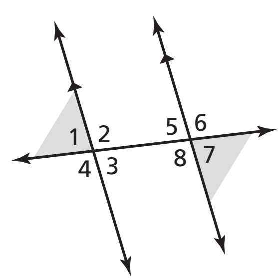
If two parallel lines are cut by a transversal, then the pairs of alternate interior angles are congruent.



Converse

c. Alternate Exterior Angles Theorem (Theorem 3.3)

If two parallel lines are cut by a transversal, then the pairs of alternate exterior angles are congruent.

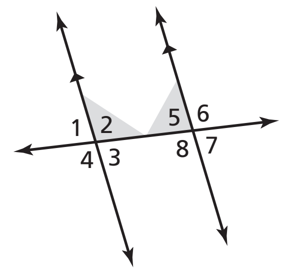


Converse

1 EXPLORATION: Exploring Converses (continued)

d. Consecutive Interior Angles Theorem (Theorem 3.4)

If two parallel lines are cut by a transversal, then the pairs of consecutive interior angles are supplementary.



Converse

Communicate Your Answer

2. For which of the theorems involving parallel lines and transversals is the converse true?

3. In Exploration 1, explain how you would prove any of the theorems that you found to be true.

Name ____ Date __________

3.3 Notetaking with Vocabulary
For use after Lesson 3.3

In your own words, write the meaning of each vocabulary term.

converse

parallel lines

transversal

corresponding angles

congruent

alternate interior angles

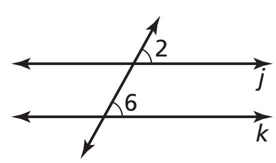
alternate exterior angles

consecutive interior angles

Theorems

Theorem 3.5 Corresponding Angles Converse

If two lines are cut by a transversal so the corresponding angles are congruent, then the lines are parallel.

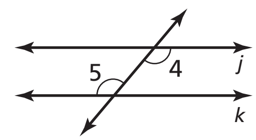


$j \parallel k$

Notes:

Theorem 3.6 Alternate Interior Angles Converse

If two lines are cut by a transversal so the alternate interior angles are congruent, then the lines are parallel.

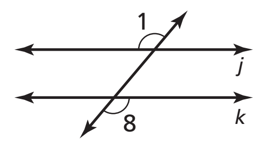


$j \parallel k$

Notes:

Theorem 3.7 Alternate Exterior Angles Converse

If two lines are cut by a transversal so the alternate exterior angles are congruent, then the lines are parallel.

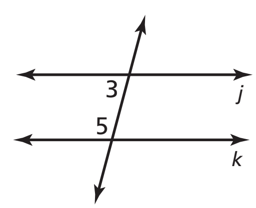


$j \parallel k$

Notes:

Theorem 3.8 Consecutive Interior Angles Converse

If two lines are cut by a transversal so the consecutive interior angles are supplementary, then the lines are parallel.

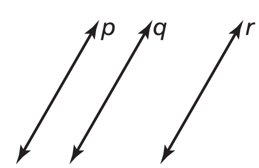


If $\angle 3$ and $\angle 5$ are supplementary, then $j \parallel k$.

Notes:

Theorem 3.9 Transitive Property of Parallel Lines

If two lines are parallel to the same line, then they are parallel to each other.



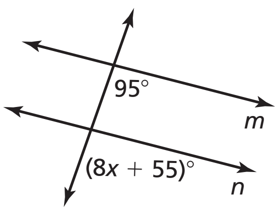
If $p \parallel q$ and $q \parallel r$, then $p \parallel r$.

Notes:

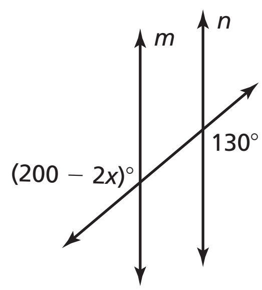
Extra Practice

In Exercises 1 and 2, find the value of *x* that makes $m \parallel n$. Explain your reasoning.

1.

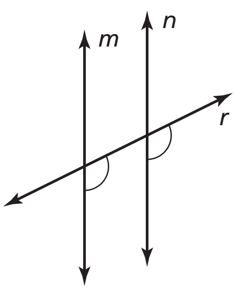


2.

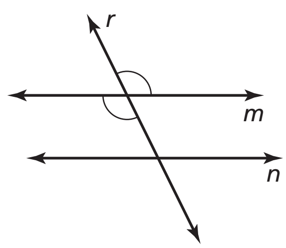


In Exercises 3–6, decide whether there is enough information to prove that $m \parallel n$. If so, state the theorem you would use.

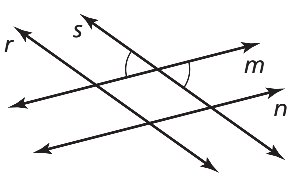
3.



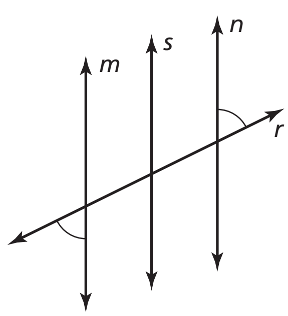
4.



5.



6.



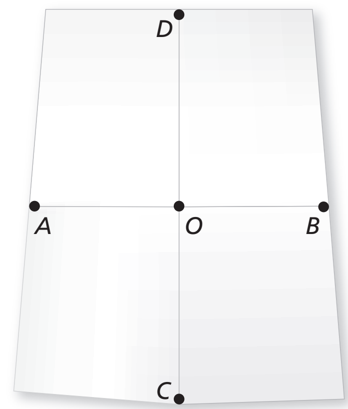
Name____ Date__________

3.4 Proofs with Perpendicular Lines
For use with Exploration 3.4

Essential Question What conjectures can you make about perpendicular lines?

1 EXPLORATION: Writing Conjectures

Work with a partner. Fold a piece of paper in half twice. Label points on the two creases, as shown.

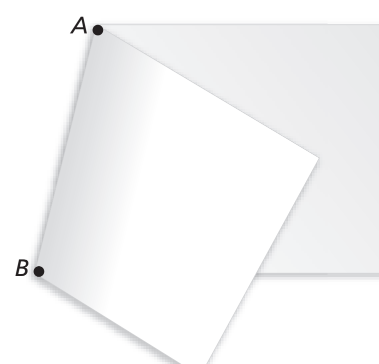


a. Write a conjecture about $\overline{AB}$ and $\overline{CD}$. Justify your conjecture.

b. Write a conjecture about $\overline{AO}$ and $\overline{OB}$. Justify your conjecture.

2 EXPLORATION: Exploring a Segment Bisector

Work with a partner. Fold and crease a piece of paper, as shown. Label the ends of the crease as *A* and *B*.



a. Fold the paper again so that point *A* coincides with point *B*. Crease the paper on that fold.

b. Unfold the paper and examine the four angles formed by the two creases. What can you conclude about the four angles?

Name ____ Date __________

3 EXPLORATION: Writing a Conjecture

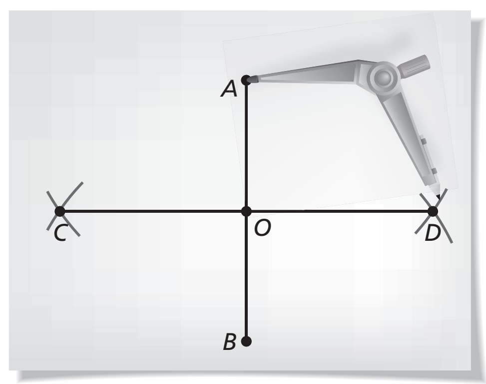
Go to *BigIdeasMath.com* for an interactive tool to investigate this exploration.

Work with a partner.

a. Draw $\overline{AB}$, as shown.

b. Draw an arc with center A on each side of $\overline{AB}$. Using the same compass setting, draw an arc with center B on each side of $\overline{AB}$. Label the intersections of the arcs C and D.

c. Draw $\overline{CD}$. Label its intersection with $\overline{AB}$ as O. Write a conjecture about the resulting diagram. Justify your conjecture.



Communicate Your Answer

4. What conjectures can you make about perpendicular lines?

5. In Exploration 3, find AO and OB when $AB = 4$ units.

Name____ Date__________

3.4 Notetaking with Vocabulary
For use after Lesson 3.4

In your own words, write the meaning of each vocabulary term.

distance from a point to a line

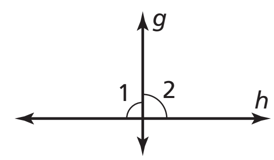
perpendicular bisector

Theorems

Theorem 3.10 Linear Pair Perpendicular Theorem

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

If $\angle 1 \cong \angle 2$, then $g \perp h$.

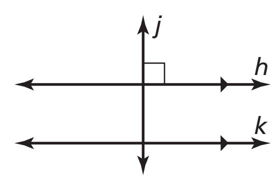


Notes:

Theorem 3.11 Perpendicular Transversal Theorem

In a plane, if a transversal is perpendicular to one of two parallel lines, then it is perpendicular to the other line.

If $h \parallel k$ and $j \perp h$, then $j \perp k$.

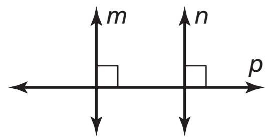


Notes:

Name ____ Date _________

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.



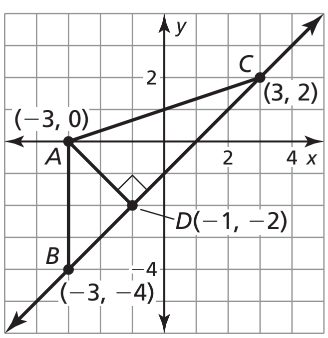
If $m \perp p$ and $n \perp p$, then $m \parallel n$.

Notes:

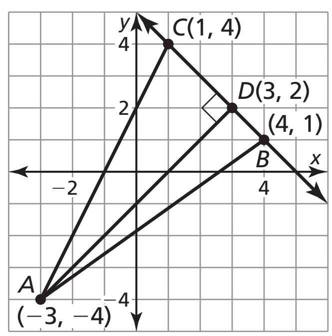
Extra Practice

In Exercises 1–4, find the distance from point A to $\overleftrightarrow{BC}$.

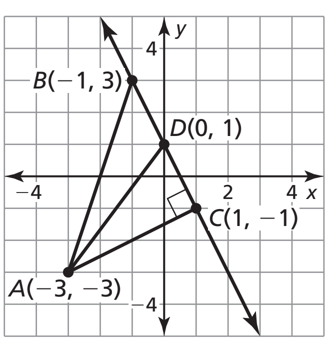
1.



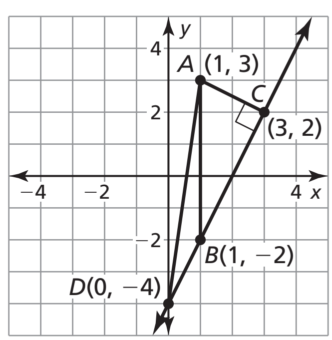
2.



3.



4.

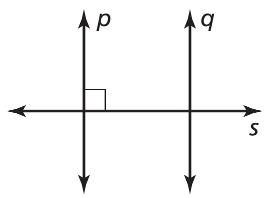


Name______________________________ Date__________

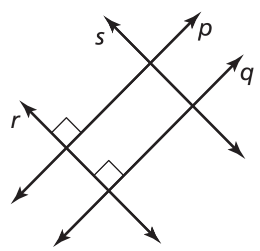
3.4 Notetaking with Vocabulary (continued)

In Exercises 5–8, determine which lines, if any, must be parallel. Explain your reasoning.

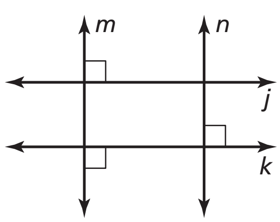
5.



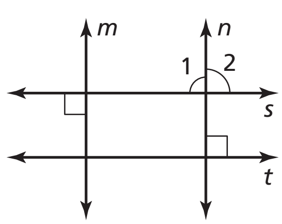
6.



7.



8.



Name ____ Date __________

3.5 Equations of Parallel and Perpendicular Lines

For use with Exploration 3.5

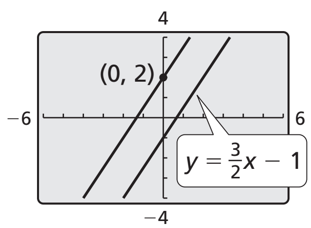
Essential Question How can you write an equation of a line that is parallel or perpendicular to a given line and passes through a given point?

1 EXPLORATION: Writing Equations of Parallel and Perpendicular Lines

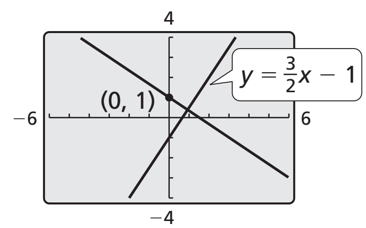
Go to *BigIdeasMath.com* for an interactive tool to investigate this exploration.

Work with a partner. Write an equation of the line that is parallel or perpendicular to the given line and passes through the given point. Use a graphing calculator to verify your answer. What is the relationship between the slopes?

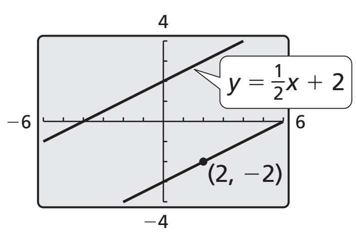
a.



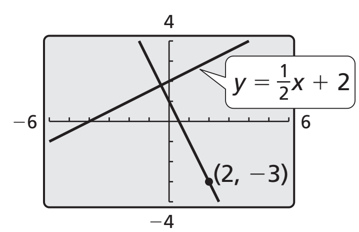
b.



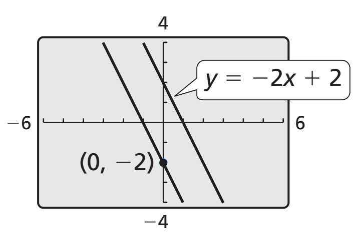
c.



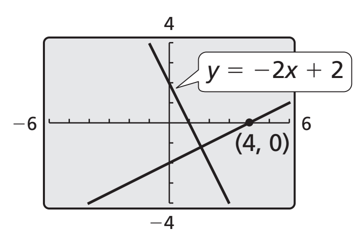
d.



e.



f.



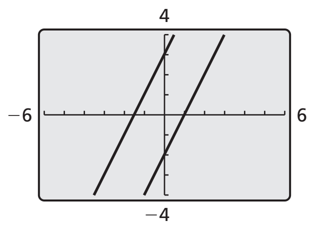
Name____________________ Date__________

2 EXPLORATION: Writing Equations of Parallel and Perpendicular Lines

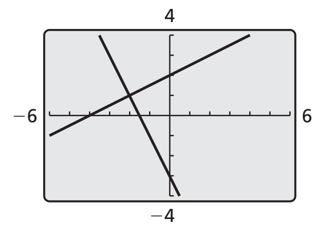
Go to *BigIdeasMath.com* for an interactive tool to investigate this exploration.

Work with a partner. Write the equations of the parallel or perpendicular lines. Use a graphing calculator to verify your answers.

a.



b.



Communicate Your Answer

3. How can you write an equation of a line that is parallel or perpendicular to a given line and passes through a given point?

4. Write an equation of the line that is (a) parallel and (b) perpendicular to the line $y = 3x + 2$ and passes through the point $(1, -2)$.

Name ______________________________ Date __________

3.5 Notetaking with Vocabulary

For use after Lesson 3.5

In your own words, write the meaning of each vocabulary term.

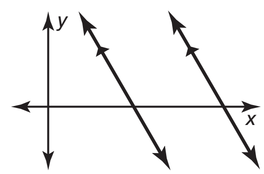
directed line segment

Theorems

Theorem 3.13 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.



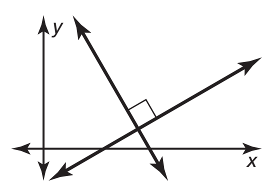
$m_1 = m_2$

Notes:

Theorem 3.14 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.



$m_1 \bullet m_2 = -1$

Notes:

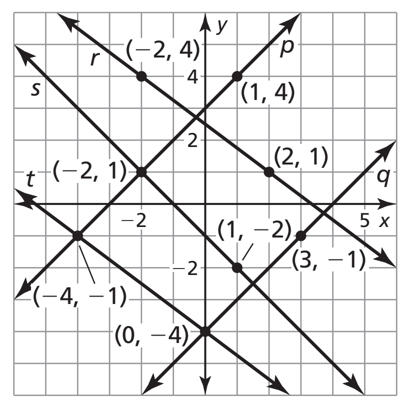
Extra Practice

In Exercises 1 and 2, find the coordinates of point *P* along the directed line segment *AB* so that *AP* to *PB* is the given ratio.

1. $A(-2, 7), B(-4, 1)$; 3 to 1

2. $A(3, 1), B(8, -2)$; 2 to 3

3. Determine which of the lines are parallel and which of the lines are perpendicular.



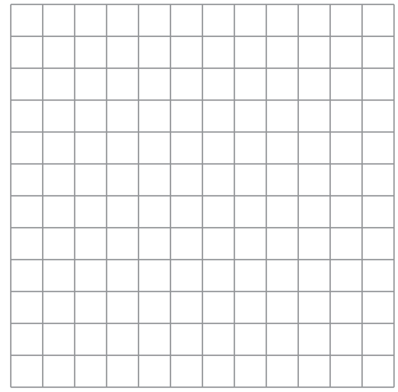
4. Tell whether the lines through the given points are *parallel*, *perpendicular*, or *neither*. Justify your answer.

Line 1: $(2, 0), (-2, 2)$

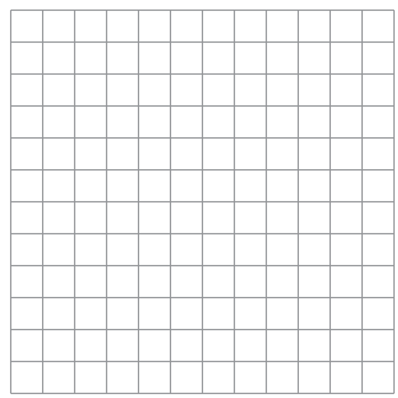
Line 2: $(1, -2), (4, 4)$

3.5 Notetaking with Vocabulary (continued)

5. Write an equation of the line passing through point $P(3, -2)$ that is parallel to $y = \frac{2}{3}x - 1$. Graph the equations of the lines to check that they are parallel.



6. Write an equation of the line passing through point $P(-2, 2)$ that is perpendicular to $y = 2x + 3$. Graph the equations of the lines to check that they are perpendicular.



7. Find the distance from point $A(0, 5)$ to $y = -3x - 5$.