Mini-Lesson 3.1

Lines and Angles

Learning Objectives:

1. Identify relationships between lines and planes that do not intersect.
2. Learn the names of angles formed by lines and a transversal.
3. Key vocabulary: *parallel lines, skew lines, parallel planes, parallel segments, transversal, interior angles, exterior angles, alternate interior angles, same-side interior angles, consecutive interior angles, corresponding angles, alternate exterior angles*

Key Examples:

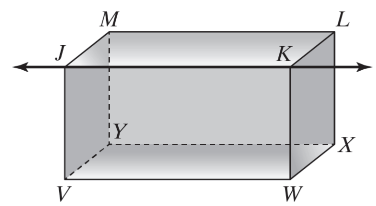
1. Recall that each segment in the figure shown is part of a line, as shown for $\overleftrightarrow{JK}$. Answer the questions based on the appearance of the figure.

   a) Which line(s) are parallel to $\overleftrightarrow{JK}$?

   b) Which line(s) are skew to $\overleftrightarrow{JK}$ and also pass through point Y?

   c) Name any line(s) perpendicular to $\overleftrightarrow{JK}$.

   d) Name any plane(s) parallel to plane *JKLM*.



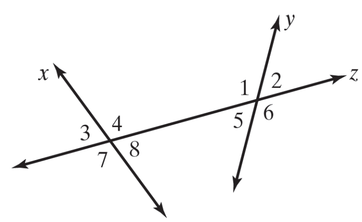
2. List all angle pairs in the figure.

   a) alternate interior

   b) corresponding

   c) alternate exterior

   d) same-side interior



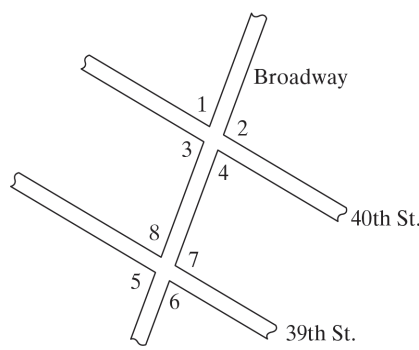
3. In Manhattan, Broadway intersects both 39th and 40th Streets, as shown. 39th Street is parallel to 40th Street. Broadway follows a straight line between these streets.
   Fill in the blanks.

   a) ∠1 and ∠6 are ______________ angles.

   b) ∠2 and ∠7 are ______________ angles.

   c) ∠3 and ∠8 are ______________ angles.

   d) ∠4 and ∠8 are ______________ angles.



Answers: 1a) $\overleftrightarrow{LM}$, $\overleftrightarrow{XY}$, and $\overleftrightarrow{VW}$ 1b) $\overleftrightarrow{MY}$ and $\overleftrightarrow{VY}$ 1c) $\overleftrightarrow{JM}$, $\overleftrightarrow{JV}$, $\overleftrightarrow{KL}$, and $\overleftrightarrow{KW}$ 1d) plane *VWXY* 2a) ∠4 and ∠5, ∠1 and ∠8 2b) ∠3 and ∠1, ∠7 and ∠5, ∠4 and ∠2, ∠8 and ∠6 2c) ∠3 and ∠6, ∠2 and ∠7 2d) ∠4 and ∠1, ∠8 and ∠5 3a) alternate exterior 3b) corresponding 3c) same-side interior 3d) alternate interior

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Mini-Lesson 3.1

Lines and Angles

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Interactive Lecture Video
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Video Organizer
Section 3.1 (MML)

PowerPoints, Section 3.1

Teaching Notes:

- Bring in a right rectangular prism, such as a shoe box or cereal box, to demonstrate the concepts introduced at the beginning of the section. Students will understand these concepts, especially *skew lines,* much better if they see them on a 3-D model.
- Students often think that the term *transversal* only applies to a line that intersects two or more *parallel* lines. Draw figures like those in the textbook to emphasize that any line that intersects two or more other lines is a transversal.

ERROR PREVENTION

- Students are more likely to make errors in identifying the types of angle pairs when the two lines are not (more-or-less) horizontal and the transversal is not (more-or-less) vertical. Use figures like that in Example 2 in the textbook to make sure that students can correctly identify the angle pairs by name regardless of how the lines are oriented.

Closure Questions:

- True or false: Any two lines either intersect or are parallel. Explain.

  This statement is true only if you are considering geometry in a plane. In space, two lines may be neither parallel not intersecting; such lines are called skew lines.

- What are the names for the four kinds of angle pairs that are formed when two lines are intersected by a transversal?

  alternate interior angles, same-side interior angles (or consecutive interior angles), corresponding angles, alternate exterior angles

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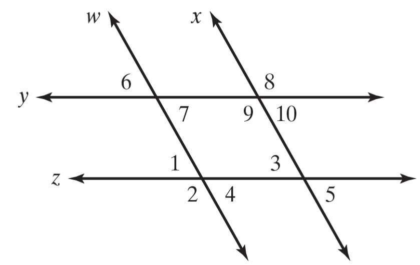
Mini-Lesson 3.2
Proving Lines Are Parallel

Learning Objectives:

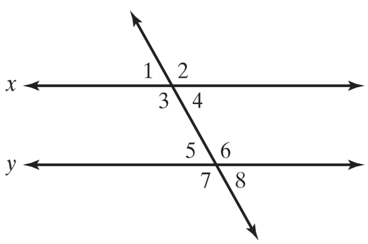
1. Use theorems to prove that two lines are parallel.
2. Use algebra to find the measures of angles needed so that lines are parallel.
3. Key vocabulary: *flow proof*

Key Examples:

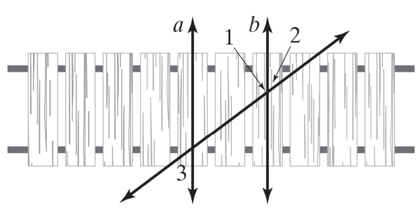
1. Which lines are parallel if $\angle 6 \cong \angle 4$? Justify your answer.



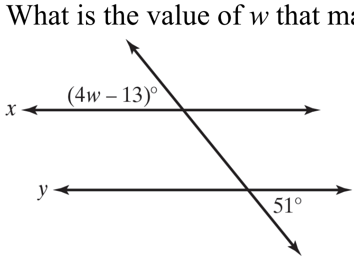
2. Use the figure to prove that $\angle 3 \cong \angle 6$ given that $x \parallel y$. Write the proof as a flow proof, using any of the three angle theorems.



3. The footbridge shown in the figure consists of wooden planks laid across two beams. Suppose $\angle 2 \cong \angle 3$. Are lines *a* and *b* parallel? Explain.



4. What is the value of *w* that makes $x \parallel y$?



Answers: 1) $y \parallel z$; $\angle 6$ and $\angle 4$ are alternate exterior angles formed by lines *y* and *z* with transversal *w*. 2) *See Additional Answers at end of Mini-Lessons*. 3) Yes, $a \parallel b$. $\angle 2$ and $\angle 3$ are alternate exterior angles. If two lines and a transversal form congruent alternate exterior angles, then the lines are parallel by the Alternate Exterior Angles Theorem. 4) $w = 16$

Mini-Lesson 3.2

Proving Lines Are Parallel

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eText, Section 3.2 (MML)

Interactive Lecture Video Section 3.2

Interactive Lecture Video Objective 1

Interactive Lecture Video Objective 2

Video Organizer Section 3.2 (print)

Video Organizer Section 3.2 (MML)

PowerPoints, Section 3.2

Teaching Notes:

- Provide students with some basic information on the history of the Parallel Postulate and why this is the most important geometry postulate.

ERROR PREVENTION

- When two parallel lines are intersected by a transversal, if the measure of one of the 8 angles formed is given, you can easily determine the measures of the other 7 angles. To avoid errors, remind students that this is true only if the two lines are *parallel.*

Closure Questions:

- Complete this sentence in three different ways:

  If two lines and a transversal form _______________ angles that are congruent, then the lines are parallel.

  alternate interior; corresponding; alternate exterior

- Complete this sentence:

  If two lines and a transversal form _______________ angles that are supplementary, then the lines are parallel.

  same-side interior

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Mini-Lesson 3.3

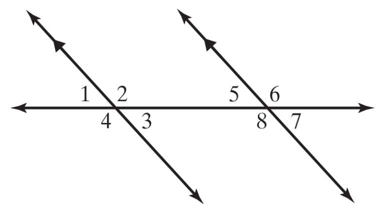
Parallel Lines and Angles Formed by Transversals

Learning Objectives:

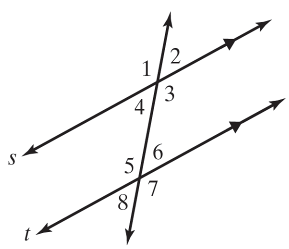
1. Prove and use theorems about parallel lines cut by a transversal
2. Use algebra to find measures of angles formed by parallel lines cut by a transversal.

Key Examples:

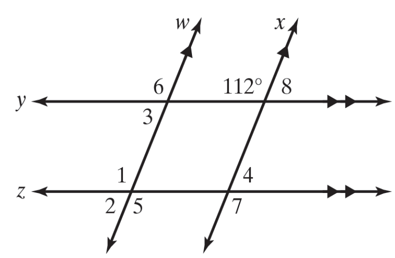
1. Given that $m\angle 6 = 133°$, find the measure of each angle. Tell what theorem or postulate you used.
   a) $m\angle 2$
   b) $m\angle 4$
   c) $m\angle 5$
   d) $m\angle 7$



2. Given $m\angle 7 = 128°$, find the measures of the other angles.



3. Use the figure to find the measure of each angle. Justify each answer by listing the appropriate theorem.
   a) $m\angle 6$
   b) $m\angle 3$
   c) $m\angle 7$
   d) $m\angle 4$
   e) $m\angle 5$
   f) $m\angle 2$



Answers: 1a) 133° (Corresponding Angles Converse) 1b) 133° (Alternate Exterior Angles Converse) 1c) 47° (Linear Pair Theorem) 1d) 47° (Linear Pair Theorem) 2) $m\angle 1 = m\angle 3 = m\angle 5 = 128°$; $m\angle 2 = m\angle 4 = m\angle 6 = m\angle 8 = 52°$ 3a) 112°; Corresponding Angles Converse 3b) 68°; Linear Pair Theorem 3c) 112°; Alternate Exterior Angles Converse 3d) 68°; Linear Pair Theorem 3e) 112°; Alternate Exterior Angles Converse 3f) 112°; Alternate Exterior Angles Converse 4) $y = 70$

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Mini-Lesson 3.3

Parallel Lines and Angles Formed by Transversals

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Interactive Lecture Video Objective 1

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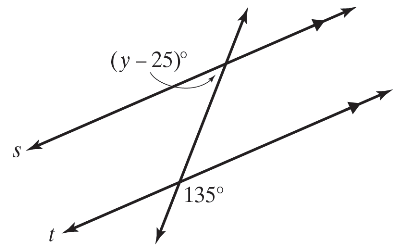
PowerPoints, Section 3.3

4. Given $s \parallel t$, find the value of y.



Teaching Notes:

- Review the relationship between a conditional and its converse. Remind students that if a conditional is true, its converse may be true or false.
- Remind students that when two lines are cut by a transversal, 2 pairs of alternate interior angles, 2 pairs of same-side interior angles, 2 pairs of alternate exterior angles, and 4 pairs of corresponding angles are formed.

ERROR PREVENTION

- Because the angles in the other types of pairs formed when parallel lines are cut by a transversal are congruent, students may think that same-side interior angles are also congruent. Remind them these angles are supplementary, and will only be congruent if they are right angles.

Closure Questions:

- If two lines are cut by a transversal and corresponding angles are not congruent, what can you conclude?

  The lines are not parallel.

- How can you combine the Alternate Interior Angles Theorem (Theorem 3.2-4) and its Converse (Theorem 3.3-1) into a single biconditional statement?

  If two lines are cut by a transversal, alternate interior angles are congruent if and only if the two lines are parallel.

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Mini-Lesson 3.4

Proving Theorems About Parallel and Perpendicular Lines

Learning Objectives:

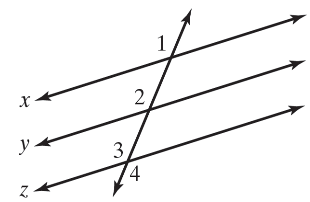
1. Use and prove statements about parallel and perpendicular lines.
2. Use algebra to find measures of angles related to perpendicular lines.

Key Examples:

1. Fill in the blanks to complete the following proof.

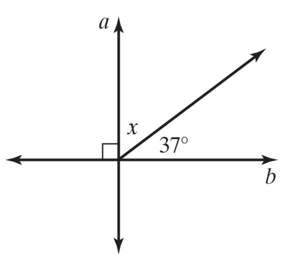
   Given: $x \parallel y$ and $y \parallel z$

   Prove: $\angle 1 \cong \angle 4$



Statements	Reasons
1. $x \parallel y$	1. Given
2. $\angle 1 \cong \angle 2$	2. __________
3. $y \parallel z$	3. __________
4. __________	4. Corresponding Angles Converse
5. $\angle 1 \cong \angle 3$	5. __________
6. __________	6. Vertical angles are ≅

2. Use the figure to find the value of x.



Answers: 1) Step2: Corresponding Angles Converse; Step 3: $\angle 2 \cong \angle 3$; Step 4: Given; Step 5: Substitution or Transitive Property; Step 6: $\angle 1 \cong \angle 4$ 2) 53°

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Mini-Lesson 3.4

Proving Theorems About Parallel and Perpendicular Lines

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Video Organizer Section 3.4 (MML)

PowerPoints, Section 3.4

Teaching Notes:

- Ask students to draw a figure in which none of the lines are horizontal or vertical to illustrate each of the postulates and theorems in this section.

ERROR PREVENTION

- Students may have trouble visualizing situations involving combinations of parallel or perpendicular lines. Give them practice with situations like those in Exercises 19–24, starting with three lines and then moving on to four or more lines.

Closure Questions:

- Complete the following sentence in two different ways:

  Through a point not on a line, there is one and only one line ____________________ to the given line.

  Then name the postulates that you have stated.

  parallel; perpendicular

  Parallel Postulate; Perpendicular Postulate

- Theorem 3.4-2 states that "Whenever two lines are parallel to a third line, they are parallel to each other." Which property of equality does this mean is also a property of parallel lines?

  the Transitive Property

- Which theorem in this section is only true if we include the restriction "in a plane"?

  the Perpendicular Transversal Theorem

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Mini-Lesson 3.5

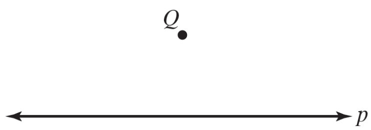
Constructions—Parallel and Perpendicular Lines

<u>Learning Objectives:</u>

1. Construct parallel and perpendicular lines.

<u>Key Examples:</u>

1. Given line p and point Q not on line p. Construct line t through Q so that $t \parallel p$.



2. Draw a segment. Label its length c. Construct quadrilateral $GHJK$ with $\overleftrightarrow{GH} \parallel \overleftrightarrow{JK}$ so that $GH = c$ and $JK = 3c$.

3. Use a straight edge to draw $\overleftrightarrow{MN}$. Construct $\overleftrightarrow{NP}$ so that $\overleftrightarrow{NP} \perp \overleftrightarrow{MN}$ at point P.

4. Draw $\overleftrightarrow{GH}$ and a point K not on $\overleftrightarrow{GH}$. Construct $\overleftrightarrow{KL}$ so that $\overleftrightarrow{KL} \perp \overleftrightarrow{GH}$.

Answers: 1)–4) *See Additional Answers at end of Mini-Lessons.*

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Mini-Lesson 3.5

Constructions—Parallel and Perpendicular Lines

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PowerPoints, Section 3.5

Teaching Notes:

- Remind students that the only tools permitted for constructions are a straight edge and compass. They are not allowed to measure lengths with a ruler or angles with a protractor.
- Review three basic constructions from Section 1.8 that are used in the new constructions in this section:

  Construct a segment congruent to a given segment.
  Construct an angle congruent to a given angle.
  Construct the perpendicular bisector of a segment.

ERROR PREVENTION

- Students are less likely to have trouble with the Key Examples and the Exercise Set if they first copy each of the four constructions illustrated in the textbook examples, following the instructions step-by-step.

Closure Questions:

- Which postulates are necessary for the constructions in this section to work?

  the Parallel Postulate and the Perpendicular Postulate

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Mini-Lesson 3.6

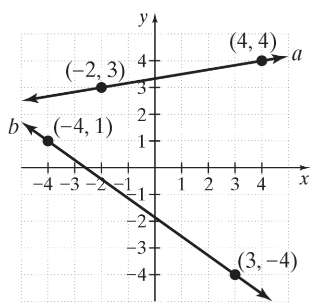
Coordinate Geometry—The Slope of a Line

Learning Objectives:

1. Use the slope of a line.
2. Interpret the slope-intercept form in an application.
3. Compare the slope of parallel and perpendicular lines.
4. Key vocabulary: *slope, vertical change, horizontal change, rate of change, y-intercept point, y-intercept, slope-intercept form, perpendicular lines*

Key Examples:

1. a) Find the slope of line a.
   b) Find the slope of line b.



2. Find the slope and the y-intercept point of the line $4y - 3x = 16$.

3. Use the equation $y = 3.2x + 48$ to predict the price of a one-day adult pass for Disney World for the year 2045, where x represents the last two digits of the year and y represents the price in dollars.

4. Are the following pairs of lines parallel, perpendicular, or neither?
   a) $4x + 3y = 11$
   $6x + 4y = 8$
   b) $5x - 7y = 8$
   $21x + 15y = -4$

Answers: 1a) $\frac{1}{6}$ 1b) $-\frac{5}{7}$ 2) slope: $\frac{3}{4}$; y-intercept point (0, 4) 3) \$192 4a) neither 4b) perpendicular

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Mini-Lesson 3.6

Coordinate Geometry—The Slope of a Line

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Video Organizer Section 3.6 (MML)

PowerPoints, Section 3.6

Teaching Notes:

- Introducing the concept of slope as the ratio $\frac{\text{rise}}{\text{run}}$ at the beginning of this section may help many students. Start with examples such as a ramp and a road, as shown at the beginning of the section, so that students understand that slope is not limited to lines drawn on a coordinate system.
- Explain the four cases of slope in terms of driving on a road: If you are driving uphill, the slope of the road is positive. If you are driving downhill, the slope of the road is negative. If you are driving on a perfectly flat road, the slope of the road is 0. It is impossible to drive straight up in the air, so the slope of a vertical line is undefined.

ERROR PREVENTION

- A common error in calculating the slope of a line occurs when a student does not use the same order for the coordinates of the two points in the numerator and denominator. Remind them that either point may be used first, but that the points must be used in a consistent order.

Closure Questions:

- Does it matter which two points on a line you use to calculate its slope?

  No; although the coordinates of the chosen points will differ, the slope will be the same no matter which two points are used.

- How would you find the slope of the line with equation $5x - 2y = 10$?

  Write the equation in slope-intercept form by solving for y. In this form, the coefficient of x will be the slope of the line.

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Mini-Lesson 3.7

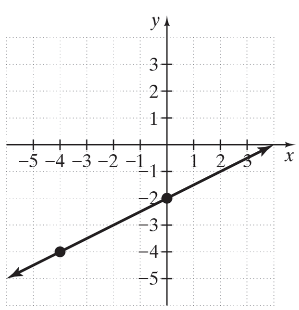
Coordinate Geometry—Equations of Lines

Learning Objectives:

1. Use the slope-intercept form.
2. Use the point-slope form.
3. Write equations of vertical and horizontal lines.
4. Find equations of parallel and perpendicular lines.
5. Key vocabulary: *point-slope form, standard form, vertical lines, horizontal line*

Key Examples:

1. Write the equation of the line with y-intercept point (0, –7) and slope of $\frac{2}{5}$.
2. Graph $y = \frac{3}{5}x - 5$.
3. Graph $3y + 4x = 9$.
4. Find an equation of the line with slope –5 containing the point (3, 2). Write the equation in slope-intercept form, $y = mx + b$.
5. Find an equation of the line through points (5, –3) and (9, 5). Write the equation in slope-intercept form, $y = mx + b$.
6. Find an equation of the line graphed. Write the equation in standard form.



7. Sales of cars from the New Studebaker Company increase from 6500 in 2015 to 13,000 in 2020. Use these figures to predict the number of cars expected to be sold in 2035.
8. Find the equation of the horizontal line containing the point (4, 7).
9. Find the equation of the horizontal line containing the point (–3, 5).

Answers: 1) $y = \frac{2}{5}x - 7$ 2) and 3) *See Additional Answers at end of Mini-Lessons*. 4) $y = -5x + 17$ 5) $y = 2x - 13$ 6) $x - 2y = 4$ 7) 32,500 cars 8) $y = 7$ 9) $x = -3$ 10) $6x + 5y = 62$ 11) $y = -\frac{2}{9}x + 5$

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Mini-Lesson 3.7

Coordinate Geometry—Equations of Lines

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PowerPoints, Section 3.7

10. Find an equation of the line containing the point (7, 4) and parallel to the line $6x + 5y = 7$. Write the equation in standard form.

11. Write an equation that describes the line containing the point (–18, 9) and is perpendicular to the line $9x - 2y = 11$. Write the equation in slope-intercept form.

<u>Teaching Notes</u>:

- Work through an example of finding the point-slope form of the equation of a line given two points first using one of the points as (x_1, y_1) and then the other. Then ask students to rewrite each of the two equations in both slope-intercept form and standard form to show that they are equivalent.

ERROR PREVENTION

- When graphing a line using its slope and *y*-intercept, students sometimes make errors when the slope is negative. Tell them to always write the slope as a fraction with a positive denominator so that they will always move to the *right* from the *y*-intercept, moving up or down depending on whether the numerator is positive or negative.

<u>Closure Questions:</u>

- For what type of line is it impossible to write an equation in slope-intercept form or point-slope form? Explain.

  A vertical line; the slope of a vertical line is undefined.

- How can you write the equation of the line $y = 5$ in slope-intercept form? What are the slope and *y*-intercept of this line?

  $y = 0x + 5$*; the slope is 0 and the y-intercept is 5.*

- Which form the equation of a line can be used to write an equation of *any* line in the coordinate plane?

  The general form, $Ax + By = 0$*, where A and B are not both 0.*

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