**Geometry**

**Section 3.1 Notes: Parallel Lines and Transversals**

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**Key Concepts Parallel and Skew**

- **Parallel lines** are coplanar lines that do not intersect.  
  Example: \( JK \parallel LM \)

- **Skew lines** are lines that do not intersect and are not coplanar.  
  Example: Lines \( \ell \) and \( m \) are skew.

- **Parallel planes** are planes that do not intersect.  
  Example: Planes \( A \) and \( B \) are parallel.

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\( JK \parallel LM \) is read as *line \( JK \) is parallel to line \( LM \).*

If segments or rays are contained within lines that are parallel or skew, then the segments or rays are parallel or skew.

**Example 1:** Use the figure to the right.

a) Name all segments parallel to \( BC \).

b) Name a segment skew to \( EH \).

c) Name a plane parallel to plane \( ABG \).

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A line that intersects two or more coplanar lines at two different points is called a **transversal**. In the diagram on the next page, line \( t \) is a transversal of lines \( q \) and \( r \). Notice that line \( t \) forms a total of eight angles with lines \( q \) and \( r \). These angles, and specific pairings of these angles, are given special names.
**Key Concept: Transversal Angle Pair Relationships**

<table>
<thead>
<tr>
<th><strong>Four interior angles</strong> lie in the region between lines ( q ) and ( r ).</th>
<th>( \angle 3, \angle 4, \angle 5, \angle 6 )</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Four exterior angles</strong> lie in the two regions that are not between lines ( q ) and ( r ).</td>
<td>( \angle 1, \angle 2, \angle 7, \angle 8 )</td>
</tr>
<tr>
<td><strong>Consecutive interior angles</strong> are interior angles that lie on the same side of transversal ( t ).</td>
<td>( \angle 4 ) and ( \angle 5 ), ( \angle 3 ) and ( \angle 6 )</td>
</tr>
<tr>
<td><strong>Alternate interior angles</strong> are nonadjacent interior angles that lie on opposite sides of transversal ( t ).</td>
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</tr>
<tr>
<td><strong>Corresponding angles</strong> lie on the same side of transversal ( t ) and on the same side of lines ( q ) and ( r ).</td>
<td>( \angle 1 ) and ( \angle 5 ), ( \angle 2 ) and ( \angle 6 ) ( \angle 3 ) and ( \angle 7 ), ( \angle 4 ) and ( \angle 8 )</td>
</tr>
</tbody>
</table>

**Example 2:** Classify the relationship between the given angles as *alternate interior*, *alternate exterior*, *corresponding*, or *consecutive interior* angles.

a) \( \angle 2 \) and \( \angle 6 \)

b) \( \angle 1 \) and \( \angle 7 \)

c) \( \angle 3 \) and \( \angle 8 \)

d) \( \angle 3 \) and \( \angle 5 \)

**Example 3:** Classify the relationship between the given angles as *alternate interior*, *alternate exterior*, *corresponding*, or *consecutive interior* angles.

a) \( \angle 4 \) and \( \angle 5 \)

b) \( \angle 7 \) and \( \angle 9 \)

c) \( \angle 4 \) and \( \angle 7 \)

d) \( \angle 2 \) and \( \angle 11 \)
Example 4: BUS STATION  The driveways at a bus station are shown. Identify the transversal connecting the given angles. Then classify the relationship between the pair of angles.

a) $\angle 1$ and $\angle 2$

b) $\angle 2$ and $\angle 3$

c) $\angle 4$ and $\angle 5$
For numbers 1 – 4, refer to the figure at the right to identify each of the following.

1. all planes that intersect plane \(STX\)
2. all segments that intersect \(QU\)
3. all segments that are parallel to \(XY\).
4. all segments that are skew to \(VW\).

For numbers 5 – 10, classify the relationship between each pair of angles as alternate interior, alternate exterior, corresponding, or consecutive interior angles.

5. \(\angle 2\) and \(\angle 10\)
6. \(\angle 7\) and \(\angle 13\)
7. \(\angle 9\) and \(\angle 13\)
8. \(\angle 6\) and \(\angle 16\)
9. \(\angle 3\) and \(\angle 10\)
10. \(\angle 8\) and \(\angle 14\)

For numbers 11 – 14, name the transversal that forms each pair of angles. Then identify the special name for the angle pair.

11. \(\angle 2\) and \(\angle 12\)
12. \(\angle 6\) and \(\angle 18\)
13. \(\angle 13\) and \(\angle 19\)
14. \(\angle 11\) and \(\angle 7\)

For numbers 15 and 16, refer to the drawing of the end table.

15. Find an example of parallel planes.
16. Find an example of parallel lines.

17. **FIGHTERS** Two fighter aircraft fly at the same speed and in the same direction leaving a trail behind them. Describe the relationship between these two trails.
18. **ESCALATORS** An escalator at a shopping mall runs up several levels. The escalator railing can be modeled by a straight line running past horizontal lines that represent the floors. Describe the relationships of these lines.

![Diagram of escalators]

19. **DESIGN** Carol designed the picture frame shown below. How many pairs of parallel segments are there among various edges of the frame?

![Diagram of picture frame]

20. **NEIGHBORHOODS** John, Georgia, and Phillip live nearby each other as shown in the map. Describe how their corner angles relate to each other in terms of alternate interior, alternate exterior, corresponding, consecutive interior, or vertical angles.

![Map of neighborhoods]

21. **MAPPING** Use the figure to the right.

   a) Connor lives at the angle that forms an alternate interior angle with Georgia’s residence. Add Connor to the map.

   ![Map with Connor added]

   b) Quincy lives at the angle that forms a consecutive interior angle with Connors’ residence. Add Quincy to the map.

   ![Map with Quincy added]
Geometry  
Section 3.2 Notes: Angles and Parallel Lines

In the photo, line $t$ is a transversal of lines $a$ and $b$, and $\angle 1$ and $\angle 2$ are corresponding angles. Since lines $a$ and $b$ are parallel, there is a special relationship between corresponding angle pairs.

**Postulate 3.1  Corresponding Angles Postulate**

If two parallel lines are cut by a transversal, then each pair of corresponding angles is congruent.

**Examples** $\angle 1 \cong \angle 3$, $\angle 2 \cong \angle 4$, $\angle 5 \cong \angle 7$, $\angle 6 \cong \angle 8$

**Example 1:** Use the diagram below to find the missing angle measure. Tell which postulates (or theorems) you used.

a) If $m\angle 11 = 51^\circ$, find $m\angle 15$.

$\angle 11 \cong \angle \underline{\text{________}}$ because….

$m\angle 11 = m\angle \underline{\text{________}}$ because….

$m\angle 15 = \underline{\text{________}}$ because…..

b) If $m\angle 11 = 51^\circ$, find $m\angle 16$.

**Theorems  Parallel Lines and Angle Pairs**

3.1 **Alternate Interior Angles Theorem** If two parallel lines are cut by a transversal, then each pair of alternate interior angles is congruent.

**Examples** $\angle 1 \cong \angle 3$ and $\angle 2 \cong \angle 4$

3.2 **Consecutive Interior Angles Theorem** If two parallel lines are cut by a transversal, then each pair of consecutive interior angles is supplementary.

**Examples** $\angle 1$ and $\angle 2$ are supplementary.  
$\angle 3$ and $\angle 4$ are supplementary.

3.3 **Alternate Exterior Angles Theorem** If two parallel lines are cut by a transversal, then each pair of alternate exterior angles is congruent.

**Examples** $\angle 5 \cong \angle 7$ and $\angle 6 \cong \angle 8$
Example 2: The diagram represents the floor tiles in Michelle’s house.

a) If $m\angle 2 = 125^\circ$, find $m\angle 3$.

b) If $m\angle 2 = 125^\circ$, find $m\angle 4$.

Example 3: Use the diagram below to determine the value of the variable.

a) $m\angle 5 = (2x - 10)^\circ$ and $m\angle 7 = (x + 15)^\circ$

b) $m\angle 4 = (4(y - 25))^\circ$ and $m\angle 8 = (4y)^\circ$

**Theorem 3.4 Perpendicular Transversal Theorem**

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

**Examples** If line $a \parallel$ line $b$ and line $a \perp$ line $t$, then line $b \perp$ line $t.$
Geometry
Section 3.2 Worksheet

For numbers 1 – 6, use the figure with \( m \angle 2 = 92^\circ \) and \( m \angle 12 = 74^\circ \). Find the measure of each angle. Tell which postulate(s) or theorem(s) you used.

1. \( m \angle 10 = \) 
2. \( m \angle 8 = \) 
3. \( m \angle 9 = \) 
4. \( m \angle 5 = \) 
5. \( m \angle 11 = \) 
6. \( m \angle 13 = \)

For numbers 7 and 8, find the value of the variable(s) in each figure. Explain your reasoning.

7. 
8. 

For numbers 9 and 10, solve for \( x \). (Hint: Draw an auxiliary line.)

9. 
10. 

11. **PROOF** Write a paragraph proof of Theorem 3.3.

   Given: \( \ell \parallel m, m \parallel n \)

   Prove: \( \angle 1 \cong \angle 12 \)
12. **FENCING** A diagonal brace strengthens the wire fence and prevents it from sagging. The brace makes a 50° angle with the wire as shown. Find the value of the variable.

![Fence Diagram]

13. **RAMPS** A parking garage ramp rises to connect two horizontal levels of a parking lot. The ramp makes a 10° angle with the horizontal. What is the measure of angle 1 in the figure?

![Ramp Diagram]

14. **BRIDGES** A double decker bridge has two parallel levels connected by a network of diagonal girders. One of the girders makes a 52° angle with the lower level as shown in the figure. What is the measure of angle 1?

![Bridge Diagram]

15. **CITY ENGINEERING** Seventh Avenue runs perpendicular to both 1st and 2nd Streets, which are parallel. However, Maple Avenue makes a 115° angle with 2nd Street. What is the measure of angle 1?

![City Engineering Diagram]

16. **PODIUMS** A carpenter is building a podium. The side panel of the podium is cut from a rectangular piece of wood. The rectangle must be sawed along the dashed line in the figure. What is the measure of angle 1?

![Podium Diagram]

17. **SECURITY** An important bridge crosses a river at a key location. Because it is so important, robotic security cameras are placed at the locations of the dots in the figure. Each robot can scan x degrees. On the lower bank, it takes 4 robots to cover the full angle from the edge of the river to the bridge. On the upper bank, it takes 5 robots to cover the full angle from the edge of the river to the bridge.

a) How are the angles that are covered by the robots at the lower and upper banks related? Derive an equation that x satisfies based on this relationship.

b) How wide is the scanning angle for each robot? What are the angles that the bridge makes with the upper and lower banks?
The steepness or slope of a hill is described by the ratio of the hill’s vertical rise to its horizontal run. In algebra, you learned that the slope of a line in the coordinate plane can be calculated using any two points on the line.

**Key Concept: Slope of a Line**

In a coordinate plane, the slope of a line is the ratio of the change along the y-axis to the change along the x-axis between any two points on the line. The slope $m$ of a line containing two points with coordinates $(x_1, y_1)$ and $(x_2, y_2)$ is given by the formula

$$m = \frac{y_2 - y_1}{x_2 - x_1}, \text{ where } x_1 \neq x_2.$$

![Diagram of slope concept]

**Example 1:** Find the slope of the given lines.

a) ![Graph with points S, O, and T]

b) ![Graph with points P, O, and Q]

c) ![Graph with points F and G]

d) ![Graph with horizontal and vertical axes]
Example 1 illustrates the four different types of slopes.

**Example 2:** Find the slope of the lines that contain the given points:

a) $(-3, 4), (2, 1)$  

b) $(-1, -3), (6, -3)$

c) $(2, -4), (5, 2)$  

d) $(3, 5), (3, 2)$

Slope can be interpreted as a **rate of change**, describing how a quantity $y$ changes in relation to quantity $x$. The slope of a line can also be used to identify the coordinates of any point on the line.

**Example 3:** In 2000, the annual sales for one manufacturer of camping equipment were $48.9$ million. In 2005, the annual sales were $85.9$ million. If sales increase at the same rate, what will be the total sales in 2015?
Example 4: Between 1994 and 2000, the number of cellular telephone subscribers increased by an average rate of 14.2 million per year. In 2000, the total subscribers were 109.5 million. If the number of subscribers increases at the same rate, how many subscribers will there be in 2010?

You can use the slopes of two lines to determine whether the lines are parallel or perpendicular. Lines with the same slope are parallel.

**Postulates Parallel and Perpendicular Lines**

3.2 Slopes of Parallel Lines Two nonvertical lines have the same slope if and only if they are parallel. All vertical lines are parallel.

Example Parallel lines \( \ell \) and \( m \) have the same slope, 4.

3.3 Slopes of Perpendicular Lines Two nonvertical lines are perpendicular if and only if the product of their slopes is \(-1\). Vertical and horizontal lines are perpendicular.

Example line \( m \perp \) line \( p \)

\[
\text{product of slopes} = 4 \cdot -\frac{1}{4} \text{ or } -1
\]

Example 5: Determine whether \( \overline{FG} \) and \( \overline{HJ} \) are parallel, perpendicular, or neither for \( F(1, -3), G(-2, -1), H(5, 0), \) and \( J(6, 3) \). Graph each line to verify your answer.

Example 6: Determine whether \( \overline{AB} \) and \( \overline{CD} \) are parallel, perpendicular, or neither for \( A(-2, -1), B(4, 5), C(6, 1), \) and \( D(9, -2) \).
Example 7: Graph the line that contains $Q(5, 1)$ and is parallel to $\overline{MN}$ with $M(-2, 4)$ and $N(2, 1)$.

Example 8: Determine which graph represents the line that contains $R(2, -1)$ and is parallel to $\overline{OP}$ with $O(1, 6)$ and $P(-3, 1)$.

a)     b)     c)     d) None of these
Geometry
Section 3.3 Worksheet

For numbers 1 and 2, determine the slope of the line that contains the given points.

1. $B(-4, 4), R(0, 2)$

2. $I(-2, -9), P(2, 4)$

For numbers 3 – 6, find the slope of each line.

3. $LM$

4. $GR$

5. a line parallel to $GR$

6. a line perpendicular to $PS$

For numbers 7 – 10, determine whether $KM$ and $ST$ are parallel, perpendicular, or neither.

7. $K(-1, -8), M(1, 6), S(-2, -6), T(2, 10)$

8. $K(-5, -2), M(5, 4), S(-3, 6), T(3, -4)$

9. $K(-4, 10), M(2, -8), S(1, 2), T(4, -7)$

10. $K(-3, -7), M(3, -3), S(0, 4), T(6, -5)$
For numbers 11 – 14, graph the line that satisfies each condition.

11. slope = \(-\frac{1}{2}\), contains \(U(2, -2)\)  
12. slope = \(\frac{4}{3}\), contains \(P(-3, -3)\)  
13. Contains \(B(-4, 2)\), parallel to \(FG\) with \(F(0, -3)\) and \(G(4, -2)\)  
14. Contains \(Z(-3, 0)\), perpendicular to \(EK\) with \(E(-2, 4)\) and \(K(2, -2)\)

15. **PROFITS** After Take Two began renting DVDs at their video store, business soared. Between 2005 and 2010, profits increased at an average rate of $9000 per year. Total profits in 2010 were $45,000. If profits continue to increase at the same rate, what will the total profit be in 2014?

16. **HIGHWAYS** A highway on-ramp rises 15 feet for every 100 horizontal feet traveled. What is the slope of the ramp?

17. **DESCENT** An airplane descends at a rate of 300 feet for every 5000 horizontal feet that the plane travels. What is the slope of the path of descent?

18. **ROAD TRIP** Jenna is driving 400 miles to visit her grandmother. She manages to travel the first 100 miles of her trip in two hours. If she continues at this rate, how long will it take her to drive the remaining distance?
19. **WATER LEVEL** Before the rain began, the water in a lake was 268 inches deep. The rain began and after four hours of rain, the lake was 274 inches deep. The rain continued for one more hour at the same intensity. What was the depth of the lake when the rain stopped?

20. **CITY BLOCKS** The figure shows a map of part of a city consisting of two pairs of parallel roads. If a coordinate grid is applied to this map, Ford Street would have a slope of –3.

   a) The intersection of B Street and Ford Street is 150 yards east of the intersection of Ford Street and Clover Street. How many yards south is it?

   b) What is the slope of 6th Street? Explain.

   c) What are the slopes of Clover and B Streets? Explain.

   d) The intersection of B Street and 6th Street is 600 yards east of the intersection of B Street and Ford Street. How many yards north is it?
Geometry
3.4 Notes: Equations of Lines

You may remember from algebra that an equation of a nonvertical line can be written in different but equivalent forms.

![Key Concept Nonvertical Line Equations](image)

When given the slope and either the y-intercept or a point on a line, you can use these forms to write the equation of the line.

**Example 1:**

a) Write an equation in slope-intercept form of the line with slope of 6 and y-intercept of −3. Then graph the line.

b) Write an equation in slope-intercept form of the line with slope of −1 and y-intercept of 4.

**Example 2:**

a) Write an equation in point-slope form of the line whose slope is $\frac{-3}{5}$ that contains (−10, 8). Then graph the line.

b) Write an equation in point-slope form of the line whose slope is $\frac{1}{3}$ that contains (6, −3).
When the slope of a line is not given, use two points on the line to calculate the slope. Then use point-slope or slope-intercept form to write an equation of the line.

**Example 3:**

a) Write an equation in slope-intercept form for a line containing \((4, 9)\) and \((-2, 0)\).

b) Write an equation in slope-intercept form for a line containing \((-3, -7)\) and \((-1, 3)\).

**Example 4:** Write an equation of the line through \((5, -2)\) and \((0, -2)\) in slope-intercept form.

The equations of horizontal and vertical lines involve only one variable.

<table>
<thead>
<tr>
<th>Key Concepts</th>
<th>Horizontal and Vertical Line Equations</th>
</tr>
</thead>
<tbody>
<tr>
<td>The equation of a horizontal line is (y = b), where (b) is the y-intercept of the line.</td>
<td></td>
</tr>
<tr>
<td><strong>Example</strong></td>
<td>(y = -3)</td>
</tr>
<tr>
<td>The equation of a vertical line is (x = a), where (a) is the x-intercept of the line.</td>
<td></td>
</tr>
<tr>
<td><strong>Example</strong></td>
<td>(x = -2)</td>
</tr>
</tbody>
</table>

Parallel lines that are not vertical have equal slopes. Two nonvertical lines are perpendicular if the product of their slopes is \(-1\). Vertical and horizontal lines are always perpendicular to one another.

**Example 5:**

a) Write an equation in slope-intercept form for a line perpendicular to the line \(y = \frac{1}{5}x + 2\) through \((2, 0)\).
b) Write an equation in slope-intercept form for a line perpendicular to the line $y = \frac{1}{3}x + 2$ through (0, 8).

Many real-world situations can be modeled using a linear equation.

**Example 6:** An apartment complex charges $525 per month plus a $750 annual maintenance fee.

a) Write an equation to represent the total first year’s cost, $A$, for $r$ months of rent.

b) Compare this rental cost to a complex which charges a $200 annual maintenance fee but $600 per month to rent. If a person expects to stay in an apartment for one year, which complex offers the better rate?

**Example 7:** A car rental company charges $25 per day plus a $100 deposit.

a) Write an equation to represent the total cost, $C$, for $d$ days of use.

b) Compare this rental cost to a company which charges a $50 deposit but $35 per day for use. If a person expects to rent a car for 9 days, which company offers the better rate?
For numbers 1 – 3, write an equation in slope-intercept form of the line having the given slope and y-intercept or given points. Then graph the line.

1. \( m = \frac{2}{3} \), \( b = -10 \)  
2. \( m = -\frac{7}{9} \), \( \left( 0, -\frac{1}{2} \right) \)  
3. \( m = 4.5 \), \( (0, 0.25) \)

For numbers 4 – 7, write equations in point-slope form of the line having the given slope that contains the given point. Then graph the line.

4. \( m = \frac{3}{2} \), \( (4, 6) \)  
5. \( m = -\frac{6}{5} \), \( (-5, -2) \)  
6. \( m = 0.5 \), \( (7, -3) \)  
7. \( m = -1.3 \), \( (-4, 4) \)

For numbers 8 – 17, write an equation in slope-intercept form for each line shown or described.

8. \( b \)  
9. \( c \)

10. parallel to line \( b \), contains \((3, -2)\)

11. perpendicular to line \( c \), contains \((-2, -4)\)
12. \( m = -\frac{4}{9}, b = 2 \) 13. \( m = 3, \) contains \((2, -3)\)

14. \( x\)-intercept is \(-6,\) \(y\)-intercept is \(2\) 15. \( x\)-intercept is \(2,\) \(y\)-intercept is \(-5\)

16. passes through \((2, -4)\) and \((5, 8)\) 17. contains \((-4, 2)\) and \((8, -1)\)

18. **COMMUNITY EDUCATION** A local community center offers self-defense classes for teens. A $25 enrollment fee covers supplies and materials and open classes cost $10 each. Write an equation to represent the total cost of \(x\) self-defense classes at the community center.

19. **GROWTH** At the same time each month over a one year period, John recorded the height of a tree he had planted. He then calculated the average growth rate of the tree. The height \(h\) in inches of the tree during this period was given by the formula \(h = 1.7t + 28,\) where \(t\) is the number of months. What are the slope and \(y\)-intercept of this line and what do they signify?
20. **DRIVING** Ellen is driving to a friend’s house. The graph shows the distance (in miles) that Ellen was from home \( t \) minutes after she left her house. Write an equation that relates \( m \) and \( t \).

21. **COST** Carla has a business that tests the air quality in artist’s studios. She had to purchase $750 worth of testing equipment to start her business. She charges $50 to perform the test. Let \( n \) be the number of jobs she gets and let \( P \) be her net profit. Write an equation that relates \( P \) and \( n \). How many jobs does she need to make $750?

22. **PAINT TESTING** A paint company decided to test the durability of its white paint. They painted a square all white with their paint and measured the reflectivity of the square each year. Seven years after being painted, the reflectivity was 85%. Ten years after being painted, the reflectivity dropped to 82.9%. Assuming that the reflectivity decreases steadily with time, write an equation that gives the reflectivity \( R \) (as a percentage) as a function of time \( t \) in years. What is the reflectivity of a fresh coat of their white paint?

23. **ARTISTRY** Gail is an oil painter. She paints on canvases made from Belgian linen. Before she paints on the linen, she has to prime the surface so that it does not absorb the oil from the paint she uses. She can buy linen that has already been primed for $21 per yard, or she can buy unprimed linen for $15 per yard, but then she would also have to buy a jar of primer for $30.

   a) Let \( P \) be the cost of \( Y \) yards of primed Belgian linen. Write an equation that relates \( P \) and \( Y \).

   b) Let \( U \) be the cost of buying \( Y \) yards of unprimed linen and a jar of primer. Write an equation that relates \( U \) and \( Y \).

   c) For how many yards would it be less expensive for Gail to buy the primed linen?
Parallel lines that are cut by a transversal create several pairs of congruent angles. These special angle pairs can also be used to prove that a pair of lines are parallel.

**Theorems** Proving Lines Parallel

**3.5 Alternate Exterior Angles Converse**
If two lines in a plane are cut by a transversal so that a pair of alternate exterior angles is congruent, then the two lines are parallel.

**3.6 Consecutive Interior Angles Converse**
If two lines in a plane are cut by a transversal so that a pair of consecutive interior angles is supplementary, then the lines are parallel.

**3.7 Alternate Interior Angles Converse**
If two lines in a plane are cut by a transversal so that a pair of alternate interior angles is congruent, then the lines are parallel.

**3.8 Perpendicular Transversal Converse**
In a plane, if two lines are perpendicular to the same line, then they are parallel.
Example 1: Use the diagram to the right.

a) Given $\angle 1 \cong \angle 3$, is it possible to prove that any of the lines shown are parallel? If so, state the postulate or theorem that justifies your answer.

b) Given $m\angle 1 = 103^\circ$ and $m\angle 4 = 100^\circ$, is it possible to prove that any of the lines shown are parallel? If so, state the postulate or theorem that justifies your answer.

Example 2: Given $\angle 1 \cong \angle 5$, is it possible to prove that any of the lines shown are parallel?

Angle relationships can be used to solve problems involving unknown values.

Example 3:

a) Find $m\angle ZYN$ so that $\overline{PQ} \parallel \overline{MN}$. Show your work.

b) Find $x$ so that $\overline{GH} \parallel \overline{RS}$.

The angle pair relationship formed by a transversal can be used to prove that two lines are parallel.
**Example 4:** In the window shown, the diamond grid pattern is constructed by hand. Is it possible to ensure that the wood pieces that run the same direction are parallel? If so, explain how. If not, explain why not.

**Example 5:** In the game Tic-Tac-Toe, four lines intersect to form a square with four right angles in the middle of the grid. Is it possible to prove any of the lines parallel or perpendicular? Choose the best answer.

a) The two horizontal lines are parallel.
b) The two vertical lines are parallel.
c) The vertical lines are perpendicular to the horizontal lines.
d) All of these statements are true.
For numbers 1 – 4, use the given the following information to determine which lines, if any, are parallel. State the postulate or theorem that justifies your answer.

1. \( m\angle BCG + m\angle FGC = 180^\circ \)

2. \( \angle CBF \cong \angle GFH \)

3. \( \angle EFB \cong \angle FBC \)

4. \( \angle ACD \cong \angle KBF \)

For numbers 5 – 7, solve for \( x \) so that \( l \parallel m \). Identify the postulate or theorem you used.

5. \( 4x - 6 = 3x + 6 \)

6. \( 7x - 24 = 5x + 18 \)

7. \( (2x + 12)^\circ = (5x - 15)^\circ \)

8. PROOF Write a two-column proof.
   Given: \( \angle 2 \) and \( \angle 3 \) are supplementary.
   Prove: \( AB \parallel CD \)

9. LANDSCAPING The head gardener at a botanical garden wants to plant rosebushes in parallel rows on either side of an existing footpath. How can the gardener ensure that the rows are parallel?
10. **RECTANGLES** Jim made a frame for a painting. He wants to check to make sure that opposite sides are parallel by measuring the angles at the corners and seeing if they are right angles. How many corners must he check in order to be sure that the opposite sides are parallel?

11. **BOOKS** The two gray books on the bookshelf each make a $70^\circ$ angle with the base of the shelf. What more can you say about these two gray books?

![Image of gray books](image1)

12. **PATTERNS** A rectangle is cut along the slanted, dashed line shown in the figure. The two pieces are rearranged to form another figure. Describe as precisely as you can the shape of the new figure. Explain.

![Image of rectangles](image2)

13. **FIREWORKS** A fireworks display is being readied for a celebration. The designers want to have four fireworks shoot out along parallel trajectories. They decide to place two launchers on a dock and the other two on the roof of a building. To pull off this display, what should the measure of angle 1 be?

![Image of fireworks](image3)

14. **SIGNS** Harold is making a giant letter “A” to put on the rooftop of the “A is for Apple” Orchard Store. The figure shows a sketch of the design.

a) What should the measures of angles 1 and 2 be so that the horizontal part of the “A” is truly horizontal?

b) When building the “A,” Harold makes sure that angle 1 is correct, but when he measures angle 2, it is not correct. What does this imply about the “A”?

![Image of giant letter A](image4)
Geometry
3.6 Notes: Perpendiculars and Distance

The construction of a line perpendicular to an existing line through a point not on the existing line in Extend Lesson 1-5 establishes that there is at least one line through a point, $P$, that is perpendicular to a line, $AB$. The following postulate states that this line is the only line through $P$ perpendicular to $AB$.

**Postulate 3.6 Perpendicular Postulate**

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

Example 1:

a) A certain roof truss is designed so that the center post extends from the peak of the roof (point $A$) to the main beam. Construct and name the segment whose length represents the shortest length of wood that will be needed to connect the peak of the roof to the main beam.

b) Which segment represents the shortest distance from point $A$ to $DB$. 

For numbers 1 – 3, construct the segment that represents the distance indicated.

1. $O$ to $\overline{MN}$
2. $A$ to $\overline{DC}$
3. $T$ to $\overline{VU}$

4. **DISTANCE** Paul is standing in the schoolyard. The figure shows his distance from various classroom doors lined up along the same wall. How far is Paul from the wall itself?