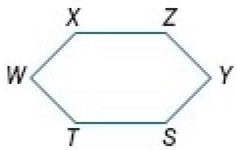
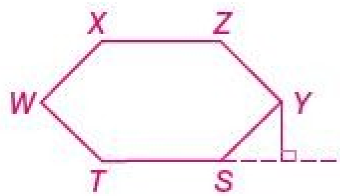
Copy each figure. Construct the segment that represents the distance indicated.

1. Y to $\overline{TS}$

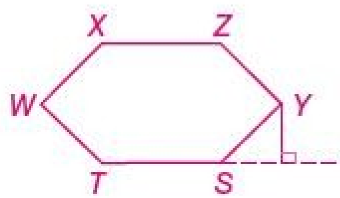


SOLUTION:

The shortest distance from point Y to line $\overline{TS}$ is the length of a segment perpendicular to $\overline{TS}$ from point Y. Draw a segment from Y to $\overline{TS}$.



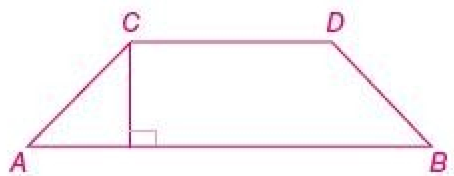
ANSWER:



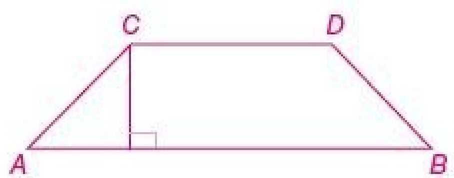
2. C to $\overleftrightarrow{AB}$

SOLUTION:

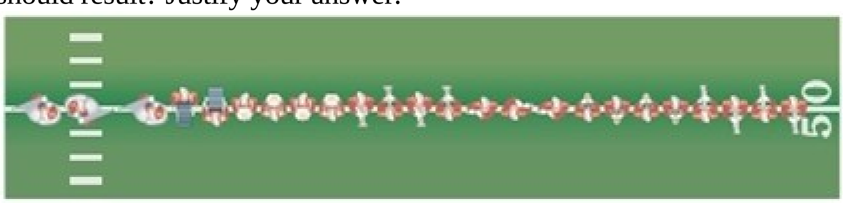
The shortest distance from point C to line $\overleftrightarrow{AB}$ is the length of a segment perpendicular to $\overleftrightarrow{AB}$ from point C. Draw a perpendicular segment from C to $\overleftrightarrow{AB}$.



ANSWER:



3. **CCSS STRUCTURE** After forming a line, every even member of a marching band turns to face the home team's end zone and marches 5 paces straight forward. At the same time, every odd member turns in the opposite direction and marches 5 paces straight forward. Assuming that each band member covers the same distance, what formation should result? Justify your answer.



SOLUTION:

The formation should be that of two parallel lines that are also parallel to the 50-yard line; the band members have formed two lines that are equidistant from the 50-yard line, so by Theorem 3.9, the two lines formed are parallel.

ANSWER:

The formation should be that of two parallel lines that are also parallel to the 50-yard line; the band members have formed two lines that are equidistant from the 50-yard line, so by Theorem 3.9, the two lines formed are parallel.

COORDINATE GEOMETRY Find the distance from *P* to ℓ.

4. Line ℓ contains points (4, 3) and (–2, 0). Point P has coordinates (3, 10).

SOLUTION:

Use the slope formula to find the slope of the line ℓ. Let $(x_1, y_1) = (4, 3)$ and $(x_2, y_2) = (–2, 0)$.

$$\begin{aligned} m &= \frac{y_2 - y_1}{x_2 - x_1} \\ &= \frac{0-3}{-2-4} \\ &= \frac{-3}{-6} \\ &= \frac{1}{2} \end{aligned}$$

Use the slope and any one of the points to write the equation of the line.

$$y - y_1 = m(x - x_1) \quad \text{Point-Slope form}$$

$$y - 0 = \frac{1}{2}(x - (-2)) \quad \text{Substitution.}$$

$$y = \frac{1}{2}x + 1 \quad \text{Equation 1}$$

The slope of an equation perpendicular to ℓ will be –2. So, write the equation of a line perpendicular to ℓ and that passes through (3, 10).

$$y - y_1 = m(x - x_1) \quad \text{Point-Slope form}$$

$$y - 10 = -2(x - 3) \quad \text{Substitution.}$$

$$y - 10 + 10 = -2x + 6 + 10$$

$$y = -2x + 16 \quad \text{Equation 2}$$

Solve the system of equations to determine the point of intersection.
The left sides of the equations are the same. So, equate the right sides and solve for *x*.

$$\frac{1}{2}x + 1 = -2x + 16 \quad \text{Equation 1 = Equation 2}$$

$$\frac{1}{2}x + 2x = 16 - 1$$

$$\frac{5}{2}x = 15$$

$$x = 6$$

Use the value of *x* to find the value of *y*.

$$\begin{aligned} y &= -2x + 16 \quad \text{Equation 2} \\ &= -2(6) + 16 \quad \text{Substitution} \\ &= 4 \end{aligned}$$

So, the point of intersection is (6, 4).

Use the Distance Formula to find the distance between the points (3, 10) and (6, 4).

$$\begin{aligned} d &= \sqrt{(x_2 - x_1)^2 + (y_2 - y_1)^2} \\ &= \sqrt{(6-3)^2 + (4-10)^2} \\ &= \sqrt{9+36} \\ &= \sqrt{45} \\ &= 3\sqrt{5} \end{aligned}$$

Therefore, the distance between the line and the point is $3\sqrt{5}$ units.

ANSWER:

$3\sqrt{5}$ units

5. Line ℓ contains points (–6, 1) and (9, –4). Point *P* has coordinates (4, 1).

SOLUTION:

Use the slope formula to find the slope of the line ℓ. Let (x_1, y_1) = (–6, 1) and (x_2, y_2) = (9, –4).

$$\begin{aligned} m &= \frac{y_2 - y_1}{x_2 - x_1} \\ &= \frac{-4-1}{9-(-6)} \\ &= \frac{-5}{15} \\ &= -\frac{1}{3} \end{aligned}$$

Use the slope and any one of the points to write the equation of the line. Let (x_1, y_1) = (–6, 1).

$$\begin{aligned} y - y_1 &= m(x - x_1) && \text{Point-Slope form} \\ y - 1 &= -\frac{1}{3}(x-(-6)) && \text{Substitution.} \\ y &= -\frac{1}{3}x - 2 + 1 \\ y &= -\frac{1}{3}x - 1 && \text{Equation 1} \end{aligned}$$

The slope of an equation perpendicular to ℓ will be 3. So, write the equation of a line perpendicular to ℓ and that passes through (4, 1).

$$\begin{aligned} y - y_1 &= m(x - x_1) && \text{Point-Slope form} \\ y - 1 &= 3(x-4) && \text{Substitution.} \\ y &= 3x - 12 + 1 \\ y &= 3x - 11 && \text{Equation 2} \end{aligned}$$

Solve the system of equations to determine the point of intersection.

The left sides of the equations are the same. So, equate the right sides and solve for *x*.

$$-\frac{1}{3}x - 1 = 3x - 11 \quad \text{Equation 1 = Equation 2}$$

$$-\frac{1}{3}x - 3x = -11 + 1$$

$$-\frac{10}{3}x = -10$$

$$x = 3 \quad x\text{-coord. of pt. of intersection.}$$

Use the value of *x* to find the value of *y*.

$$y = 3x - 11 \quad \text{Equation 2}$$

$$= 3(3) - 11 \quad \text{Substitution}$$

$$= -2 \quad y\text{-coord. of pt. of intersection}$$

So, the point of intersection is (3, –2).

Use the Distance Formula to find the distance between the points (4, 1) and (3, –2). Let (x_1, y_1) = (4, 1)and (x_2, y_2) = (3, –2).

$$d = \sqrt{(x_2 - x_1)^2 + (y_2 - y_1)^2}$$

$$= \sqrt{(3-4)^2 + (-2-1)^2}$$

$$= \sqrt{1+9}$$

$$= \sqrt{10}$$

Therefore, the distance between the line and the point is $\sqrt{10}$ units.

ANSWER:

$\sqrt{10}$ units

6. Line ℓ contains points (4, 18) and (–2, 9). Point *P* has coordinates (–9, 5).

SOLUTION:

Use the slope formula to find the slope of the line ℓ. Let (x_1, y_1) = (4, 18) and (x_2, y_2) = (–2, 9).

$$m = \frac{y_2 - y_1}{x_2 - x_1}$$

$$= \frac{9 - 18}{-2 - 4}$$

$$= \frac{-9}{-6}$$

$$= \frac{3}{2}$$

Use the slope and any one of the points to write the equation of the line. Let (x_1, y_1) = (4, 18).

$$y - y_1 = \mathrm{m}(x - x_1) \quad \text{Point-Slope form}$$
$$y - 18 = \frac{3}{2}(x - 4) \quad \text{Substitution.}$$
$$y - 18 = \frac{3}{2}x - 6$$
$$y - 18 - 18 = \frac{3}{2}x - 6 + 18$$
$$y = \frac{3}{2}x + 12 \quad \text{Equation 1}$$

The slope of an equation perpendicular to ℓ will be $-\frac{2}{3}$. So, write the equation of a line perpendicular to ℓ and that passes through (–9, 5).

$$y - y_1 = \mathrm{m}(x - x_1) \quad \text{Point-Slope form}$$
$$y - 5 = -\frac{2}{3}(x - (-9)) \quad \text{Substitution.}$$
$$y - 5 = -\frac{2}{3}x - \frac{2}{3}(9)$$
$$y - 5 = -\frac{2}{3}x - 6$$
$$y - 5 = -\frac{2}{3}x - 6 + 5$$
$$y = -\frac{2}{3}x - 1 \quad \text{Equation 2}$$

Solve the system of equations to determine the point of intersection.
The left sides of the equations are the same. So, equate the right sides and solve for *x*.

$$-\frac{2}{3}x - 1 = \frac{3}{2}x + 12 \quad \text{Equation 2} = \text{Equation 1}$$
$$-\frac{2}{3}x - \frac{3}{2}x - 1 = \frac{3}{2}x - \frac{3}{2}x + 12$$
$$-\frac{4}{6}x - \frac{9}{6}x - 1 + 1 = 12 + 1$$
$$-\frac{13}{6}x = 13$$
$$-\frac{6}{13}\left(-\frac{13}{6}x\right) = -\frac{6}{13}\left(13\right)$$
$$x = -6 \quad x\text{-coord. of the pt. of intersection}$$

Use the value of *x* to find the value of *y*.

$$y = \frac{3}{2}x + 12 \quad \text{Equation 1}$$
$$y = \frac{3}{2}(-6) + 12 \quad \text{Substitution.}$$
$$= 3 \quad y\text{-coord. of pt. of intersection}$$

So, the point of intersection is (–6, 3).

Use the Distance Formula to find the distance between the points (–9, 5) and (–6, 3). Let (x_1, y_1) = (–9, 5) and (x_2, y_2) = (–6, 3).

$$\begin{aligned} d &= \sqrt{(x_2 - x_1)^2 + (y_2 - y_1)^2} \\ &= \sqrt{(-6 - (-9))^2 + (3 - 5)^2} \\ &= \sqrt{9 + 4} \\ &= \sqrt{13} \end{aligned}$$

Therefore, the distance between the line and the point is $\sqrt{13}$ units.

ANSWER:

$\sqrt{13}$ units

Find the distance between each pair of parallel lines with the given equations.

7. $y = -2x + 4$
$y = -2x + 14$

SOLUTION:

To find the distance between the parallel lines, we need to find the length of the perpendicular segment between the two parallel lines. Pick a point on one of the equation, and write the equation of a line perpendicular through that point. Then use this perpendicular line and other equation to find the point of intersection. Find the distance between the two point using the distance formula.

Step 1: Find the equation of the line perpendicular to each of the lines.

$y = -2x + 4$ Equation 1

$y = -2x + 14$ Equation 2

The slope of a line perpendicular to both the lines will be $\frac{1}{2}$. Consider the y-intercept of any of the two lines and write the equation of the perpendicular line through it. The y-intercept of the line $y = -2x + 4$ is (0, 4). So, the equation of a line with slope $\frac{1}{2}$ and a y-intercept of 4 is $y = \frac{1}{2}x + 4$. Equation 3

Step 2: Find the intersections of the perpendicular line and each of the other lines.

To find the point of intersection of the perpendicular and the second line, solve the two equations.

$$
\begin{aligned}
-2x + 14 &= \frac{1}{2}x + 4 && \text{Equation 2 = Equation 3}\\
-2x - \frac{1}{2}x + 14 &= \frac{1}{2}x - \frac{1}{2}x + 4\\
-2x - \frac{1}{2}x + 14 &= 4\\
-\frac{4}{2}x - \frac{1}{2}x + 14 - 14 &= 4 - 14\\
-\frac{5}{2}x &= -10\\
-\frac{2}{5}\left(-\frac{5}{2}x\right) &= -\frac{2}{5}\left(-10\right)\\
x &= 4 && x\text{-coord. of pt. of intersection}
\end{aligned}
$$

Use the value of x to find the value of y.

$$
\begin{aligned}
y &= -2x + 14 && \text{Equation 2}\\
&= -2(4) + 14\\
&= 6 && y\text{-coord. of pt. of intersection}
\end{aligned}
$$

So, the point of intersection is (4, 6).

Step 3: Find the length of the perpendicular between points.

Use the Distance Formula to find the distance between the points (4, 6) and (0, 4). Let (x_1, y_1) = (4, 6) and (x_2, y_2) = (0, 4).

$$
\begin{aligned}
d &= \sqrt{(x_2 - x_1)^2 + (y_2 - y_1)^2}\\
&= \sqrt{(4-6)^2 + (4-0)^2}\\
&= \sqrt{4 + 16}\\
&= \sqrt{20}\\
&= 2\sqrt{5}
\end{aligned}
$$

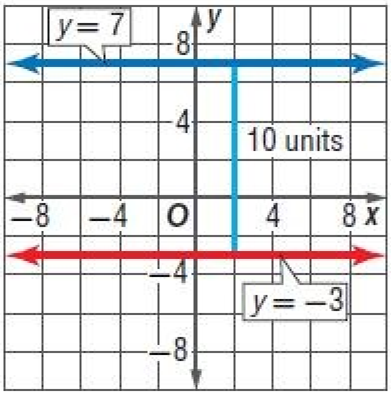
Therefore, the distance between the two lines is $2\sqrt{5}$ units.

ANSWER:

$2\sqrt{5}$ units

8. $y = 7$
$y = -3$

SOLUTION:

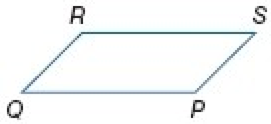


The two lines have the coefficient of *x*, zero. So, the slopes are zero. Therefore, the lines are horizontal lines passing through $y = 7$ and $y = -3$ respectively. The line perpendicular will be vertical. Thus, the distance, is the difference in the *y*-intercepts of the two lines. Then perpendicular distance between the two horizontal lines is $7 - (-3) = 10$ units.

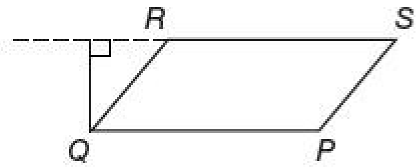
ANSWER:
10 units

Copy each figure. Construct the segment that represents the distance indicated.

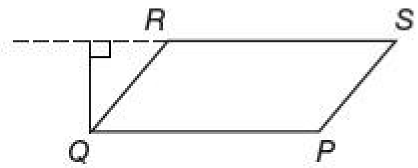
9. *Q* to $\overline{RS}$



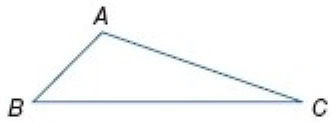
SOLUTION:
The shortest distance from point *Q* to line $\overline{RS}$ is the length of a segment perpendicular to $\overline{RS}$ from point *Q*. Draw a perpendicular segment from *Q* to $\overline{RS}$.



ANSWER:

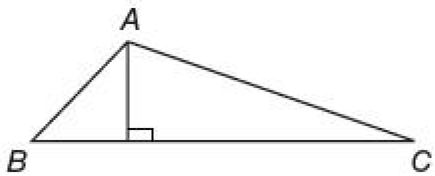


10. A to $\overline{BC}$

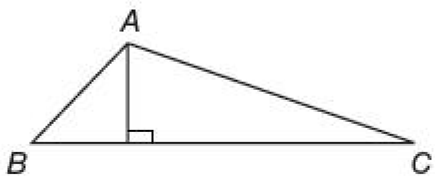


SOLUTION:

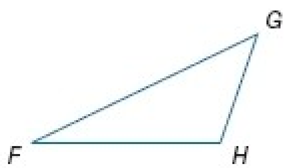
The shortest distance from point A to line $\overline{BC}$ is the length of a segment perpendicular to $\overline{BC}$ from point A. Draw a perpendicular segment from A to $\overline{BC}$.



ANSWER:

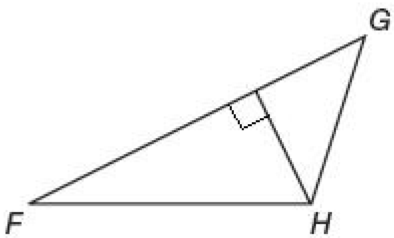


11. H to $\overline{FG}$

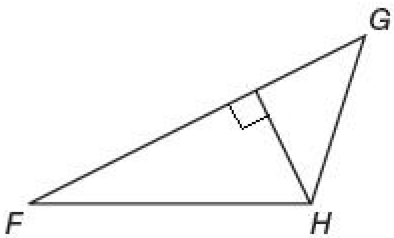


SOLUTION:

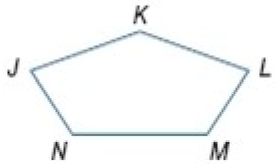
The shortest distance from point H to line $\overline{FG}$ is the length of a segment perpendicular to $\overline{FG}$ from point H. Draw a perpendicular segment from H to $\overline{FG}$.



ANSWER:

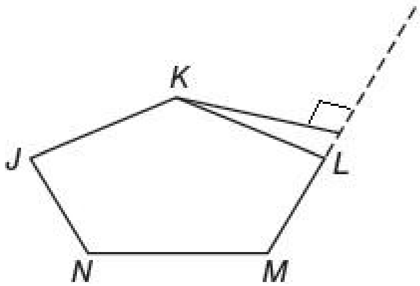


12. K to $\overline{LM}$

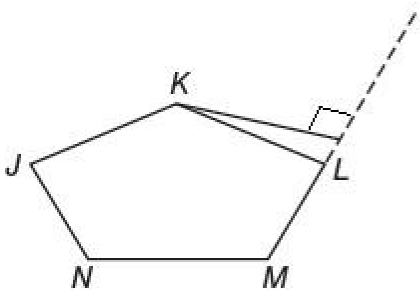


SOLUTION:

The shortest distance from point K to line $\overline{LM}$ is the length of a segment perpendicular to $\overline{LM}$ from point K. Draw a perpendicular segment from K to $\overline{LM}$.



ANSWER:



13. **DRIVEWAYS** In the diagram, is the driveway shown the shortest possible one from the house to the road? Explain why or why not.

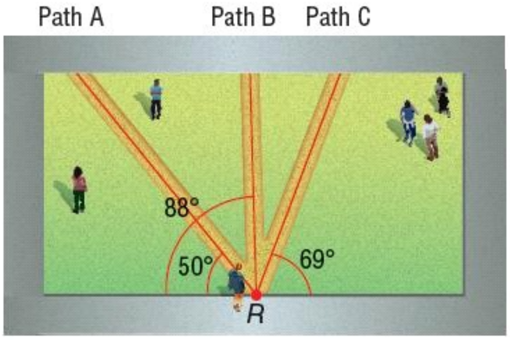
SOLUTION:

A driveway perpendicular to the road would be the shortest. The angle the driveway makes with the road is less than 90°, so it is not the shortest possible driveway.

ANSWER:

No; a driveway perpendicular to the road would be the shortest. The angle the driveway makes with the road is less than 90°, so it is not the shortest possible driveway.

14. **CCSS MODELING** Rondell is crossing the courtyard in front of his school. Three possible paths are shown in the diagram. Which of the three paths shown is the shortest? Explain your reasoning.



SOLUTION:

The shortest possible distance would be the perpendicular distance from one side of the courtyard to the other. Since Path B is the closest to 90°, it is the shortest of the three paths shown.

ANSWER:

Path B; The shortest possible distance would be the perpendicular distance from one side of the courtyard to the other. Since Path B is the closest to 90°, it is the shortest of the three paths shown.

COORDINATE GEOMETRY Find the distance from *P* to ℓ.

15. Line ℓ contains points (0, –3) and (7, 4). Point *P* has coordinates (4, 3).

SOLUTION:

Use the slope formula to find the slope of the line ℓ. Let (x_1, y_1) = (0, –3) and (x_2, y_2) = (7, 4).

$$
\begin{aligned}
m &= \frac{y_2 - y_1}{x_2 - x_1} \\
&= \frac{4 - (-3)}{7 - 0} \\
&= \frac{7}{7} \\
&= 1
\end{aligned}
$$

Use the slope and any one of the points to write the equation of the line. Let (x_1, y_1) = (0, –3).

$$
\begin{aligned}
y - y_1 &= m(x - x_1) && \text{Point-Slope form} \\
y - (-3) &= 1(x - 0) && \text{Substitution} \\
y + 3 &= x \\
y + 3 - 3 &= x - 3 \\
y &= x - 3 && \text{Equation 1}
\end{aligned}
$$

The slope of an equation perpendicular to ℓ will be –1. So, write the equation of a line perpendicular to ℓ and that passes through (4, 3).

$$
\begin{aligned}
y - y_1 &= m(x - x_1) && \text{Point-Slope form} \\
y - 3 &= -1(x - 4) && \text{Substitution.} \\
y - 3 &= -x + 4 \\
y - 3 + 3 &= -x + 4 + 3 \\
y &= -x + 7 && \text{Equation 2}
\end{aligned}
$$

Solve the system of equations to determine the point of intersection.

$$
\begin{aligned}
-x + 7 &= x - 3 && \text{Equation 2} = \text{Equation 1} \\
-x - x + 7 &= x - x - 3 \\
-2x + 7 &= -3 \\
-2x + 7 - 7 &= -3 - 7 \\
-2x &= -10 \\
\frac{-2x}{-2} &= \frac{-10}{-2} \\
x &= 5 && x\text{-coord. of the pt. of intersection}
\end{aligned}
$$

Use the value of *x* to find the value of *y*.

$$
\begin{aligned}
y &= x - 3 && \text{Equation 1} \\
&= 5 - 3 && \text{Substitution.} \\
&= 2 && y\text{-coord. of pt. of intersection}
\end{aligned}
$$

So, the point of intersection is (5, 2).

Use the Distance Formula to find the distance between the points (5, 2) and (4, 3). Let (x_1, y_1) = (5, 2) and (x_2, y_2) = (4, 3).

$$
\begin{aligned}
d &= \sqrt{(x_2 - x_1)^2 + (y_2 - y_1)^2} \\
&= \sqrt{(4 - 5)^2 + (3 - 2)^2} \\
&= \sqrt{1 + 1} \\
&= \sqrt{2}
\end{aligned}
$$

Therefore, the distance between the line and the point is $\sqrt{2}$ units.

ANSWER:

$\sqrt{2}$ units

16. Line ℓ contains points (11, –1) and (–3, –11). Point *P* has coordinates (–1, 1).

SOLUTION:

Use the slope formula to find the slope of the line ℓ. Let (x_1, y_1) = (11, –1) and (x_2, y_2) = (–3, –11).

$$
\begin{aligned}
m &= \frac{y_2 - y_1}{x_2 - x_1} \\
&= \frac{-11 - (-1)}{-3 - 11} \\
&= \frac{-10}{-14} \\
&= \frac{5}{7}
\end{aligned}
$$

Use the slope and any one of the points to write the equation of the line. Let (x_1, y_1) = (11, –1)

$$
\begin{aligned}
y - y_1 &= m(x - x_1) && \text{Point-Slope form} \\
y - (-1) &= \frac{5}{7}(x - 11) && \text{Substitution.} \\
y + 1 &= \frac{5}{7}x - \frac{55}{7} \\
y + 1 - 1 &= \frac{5}{7}x - \frac{55}{7} - 1 \\
y &= \frac{5}{7}x - \frac{62}{7} && \text{Equation 1}
\end{aligned}
$$

The slope of an equation perpendicular to ℓ will be $-\frac{7}{5}$. So, write the equation of a line perpendicular to ℓ and that passes through (–1, 1).

$$
\begin{aligned}
y - y_1 &= m(x - x_1) && \text{Point-Slope form} \\
y - 1 &= -\frac{7}{5}(x - (-1)) && \text{Substitution.} \\
y - 1 &= -\frac{7}{5}(x + 1) \\
y - 1 &= -\frac{7}{5}x - \frac{7}{5} \\
y - 1 + 1 &= -\frac{7}{5}x - \frac{7}{5} + 1 \\
y &= -\frac{7}{5}x - \frac{2}{5} && \text{Equation 2}
\end{aligned}
$$

Solve the system of equations to determine the point of intersection.

$$
\begin{aligned}
-\frac{7}{5}x-\frac{2}{5}&=\frac{5}{7}x-\frac{62}{7} && \text{Equation 2 = Equation 1}\\
-\frac{7}{5}x-\frac{5}{7}x-\frac{2}{5}&=\frac{5}{7}x-\frac{5}{7}x-\frac{62}{7}\\
-\frac{49}{35}x-\frac{25}{35}x-\frac{2}{5}+\frac{2}{5}&=-\frac{62}{7}+\frac{2}{5}\\
-\frac{74}{35}x&=-\frac{310}{35}+\frac{14}{35}\\
-\frac{74}{35}x&=-\frac{296}{35}\\
-\frac{35}{74}\left(-\frac{74}{35}x\right)&=-\frac{35}{74}\left(-\frac{296}{35}\right)\\
x&=\frac{-296}{-74}\\
x&=4 && x\text{-coord. of the pt. of intersection}
\end{aligned}
$$

Use the value of x to find the value of y.

$$
\begin{aligned}
y&=\frac{5}{7}x-\frac{62}{7} && \text{Equation 1}\\
y&=\frac{5}{7}(4)-\frac{62}{7} && \text{Substitution.}\\
&=\frac{20}{7}-\frac{62}{7}\\
&=-6 && y\text{-coord. of pt. of intersection}
\end{aligned}
$$

So, the point of intersection is (4, –6).

Use the Distance Formula to find the distance between the points (–1, 1) and (4, –6). Let (x_1, y_1) = (–1, 1) and (x_2, y_2) = (4, –6).

$$
\begin{aligned}
d&=\sqrt{(x_2-x_1)^2+(y_2-y_1)^2}\\
&=\sqrt{(4-(-1))^2+(-6-1)^2}\\
&=\sqrt{25+49}\\
&=\sqrt{74}
\end{aligned}
$$

Therefore, the distance between the line and the point is $\sqrt{74}$ units.

ANSWER:

$\sqrt{74}$ units

17. Line ℓ contains points (–2, 1) and (4, 1). Point *P* has coordinates (5, 7).

SOLUTION:

Use the slope formula to find the slope of the line ℓ. Let (x_1, y_1) = (–2, 1)and (x_2, y_2) = (4, 1).

$$m = \frac{y_2 - y_1}{x_2 - x_1}$$
$$= \frac{1 - 1}{4 - (-2)}$$
$$= \frac{0}{6}$$
$$= 0$$

Use the slope and any one of the points to write the equation of the line. Let (x_1, y_1) = (–2, 1).

$$y - y_1 = m(x - x_1) \quad \text{Point-Slope form}$$
$$y - 1 = 0(x - (-2)) \quad \text{Substitution.}$$
$$y - 1 = 0$$
$$y - 1 + 1 = +1$$
$$y = 1 \quad \text{Equation 1}$$

The slope of an equation perpendicular to ℓ will be undefined, and hence the line will be a vertical line. The equation of a vertical line through (5, 7) is $x = 5$.
The point of intersection of the two lines is (5, 1).

Use the Distance Formula to find the distance between the points (5, 1) and (5, 7). Let (x_1, y_1) = (5, 1) and (x_2, y_2) = (5, 7).

$$d = \sqrt{(x_2 - x_1)^2 + (y_2 - y_1)^2}$$
$$= \sqrt{(5 - 5)^2 + (7 - 1)^2}$$
$$= \sqrt{0 + 36}$$
$$= 6$$

Therefore, the distance between the line and the point is 6 units.

ANSWER:

6 units

3-6 Perpendiculars and Distance

18. Line ℓ contains points (4, –1) and (4, 9). Point *P* has coordinates (1, 6).

SOLUTION:

Use the slope formula to find the slope of the line ℓ. Let (x_1, y_1) = (4, –1) and (x_2, y_2) = (4, 9).

$$\begin{aligned} m &= \frac{y_2 - y_1}{x_2 - x_1} \\ &= \frac{9 - (-1)}{4 - 4} \\ &= \frac{10}{0} \end{aligned}$$

Division by zero is undefined. So, the slope of the line is undefined and the line is a vertical line through (4, –1) and (4, 9). So, the equation of the line is $x = 4$.

A line perpendicular to ℓ will be a horizontal line. Horizontal lines have zero slopes.The equation of a horizontal line through (1, 6) is $y = 6$.

The point of intersection of the two lines is (4, 6).

Use the Distance Formula to find the distance between the points (4, 6) and (1, 6).

$$\begin{aligned} d &= \sqrt{(x_2 - x_1)^2 + (y_2 - y_1)^2} \\ &= \sqrt{(1 - 4)^2 + (6 - 6)^2} \\ &= \sqrt{9 + 0} \\ &= 3 \end{aligned}$$

Therefore, the distance between the line and the point is 3 units.

ANSWER:

3 units

19. Line ℓ contains points (1, 5) and (4, –4). Point *P* has coordinates (–1, 1).

SOLUTION:

Use the slope formula to find the slope of the line ℓ. Let (x_1, y_1) = (1, 5) and (x_2, y_2) = (4, –4),

$$\begin{aligned} m &= \frac{y_2 - y_1}{x_2 - x_1} \\ &= \frac{-4 - 5}{4 - 1} \\ &= \frac{-9}{3} \\ &= -3 \end{aligned}$$

Use the slope and any one of the points to write the equation of the line. Let (x_1, y_1) = (4, –4).

$$\begin{aligned} y - y_1 &= m(x - x_1) && \text{Point-Slope form} \\ y - (-4) &= -3(x - 4) && \text{Substitution.} \\ y + 4 &= -3x + 12 \\ y + 4 - 4 &= -3x + 12 - y \\ y &= -3x + 8 && \text{Equation 1} \end{aligned}$$

The slope of an equation perpendicular to *l* will be $\frac{1}{3}$. So, write the equation of a line perpendicular to *l* and that passes through (–1, 1).

$$y - y_1 = m(x - x_1) \quad \text{Point-Slope form}$$
$$y - 1 = \frac{1}{3}(x - (-1)) \quad \text{Substitution.}$$
$$y - 1 = \frac{1}{3}x + \frac{1}{3}$$
$$y - 1 + 1 = \frac{1}{3}x + \frac{1}{3} + 1$$
$$y = \frac{1}{3}x + \frac{1}{3} + \frac{3}{3}$$
$$y = \frac{1}{3}x + \frac{4}{3} \quad \text{Equation 2}$$

Solve the system of equations to determine the point of intersection.

The left sides of the equations are the same. So, equate the right sides and solve for *x*.

$$\frac{1}{3}x + \frac{4}{3} = -3x + 8 \quad \text{Equation 2 = Equation 1.}$$
$$\frac{1}{3}x + 3x + \frac{4}{3} = -3x + 3x + 8$$
$$\frac{1}{3}x + \frac{9}{3}x + \frac{4}{3} = 8$$
$$\frac{10}{3}x + \frac{4}{3} - \frac{4}{3} = \frac{24}{3} - \frac{4}{3}$$
$$\frac{10}{3}x = \frac{20}{3}$$
$$\frac{3}{10}\left(\frac{10}{3}x\right) = \frac{3}{10}\left(\frac{20}{3}\right)$$
$$x = 2 \quad x\text{-coord. of pt. of intersection}$$

Use the value of *x* to find the value of y.

$$y = -3x + 8 \quad \text{Equation 1}$$
$$= -3(2) + 8$$
$$= 2 \quad y\text{-coord. of pt. of intersection}$$

So, the point of intersection is (2, 2).

Use the Distance Formula to find the distance between the points (2, 2) and (–1, 1).

$$\begin{aligned} d &= \sqrt{(x_2 - x_1)^2 + (y_2 - y_1)^2} \\ &= \sqrt{(-1-2)^2 + (1-2)^2} \\ &= \sqrt{9+1} \\ &= \sqrt{10} \end{aligned}$$

Therefore, the distance between the line and the point is $\sqrt{10}$ units.

ANSWER:

$\sqrt{10}$ units

20. Line ℓ contains points (–8, 1) and (3, 1). Point *P* has coordinates (–2, 4).

SOLUTION:

Use the slope formula to find the slope of the line ℓ. Let (x_1, y_1) = (–8, 1) and (x_2, y_2) = (3, 1).

$$\begin{aligned} m &= \frac{y_2 - y_1}{x_2 - x_1} \\ &= \frac{1-1}{3-(-8)} \\ &= \frac{0}{11} \\ &= 0 \end{aligned}$$

Use the slope and any one of the points to write the equation of the line. Let (x_1, y_1) = (–8, 1).

$$\begin{aligned} y - y_1 &= m(x - x_1) && \text{Point-Slope form} \\ y - 1 &= 0(x - (-8)) \\ y - 1 &= 0 \\ y - 1 &= 0 \\ y &= 1 && \text{Equation 1} \end{aligned}$$

The slope of an equation perpendicular to ℓ will be undefined, or the line will be a vertical line. The equation of a vertical line through (–2, 4) is $x = -2$.
The point of intersection of the two lines is (–2, 1).

Use the Distance Formula to find the distance between the points (–2, 1) and (–2, 4). Let (x_1, y_1) = (–2, 1) and (x_2, y_2) = (–2, 4).

$$\begin{aligned} d &= \sqrt{(x_2 - x_1)^2 + (y_2 - y_1)^2} \\ &= \sqrt{(-2-(-2))^2 + (4-1)^2} \\ &= \sqrt{0+9} \\ &= 3 \end{aligned}$$

Therefore, the distance between the line and the point is 3 units.

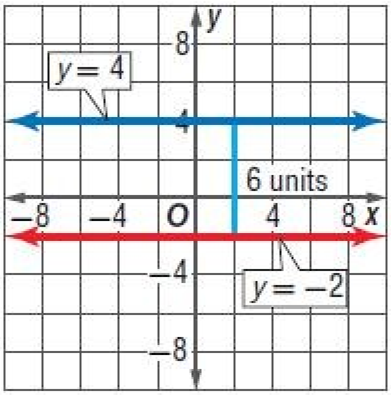
ANSWER:

3 units

Find the distance between each pair of parallel lines with the given equations.

21. $y = -2$
$y = 4$

SOLUTION:



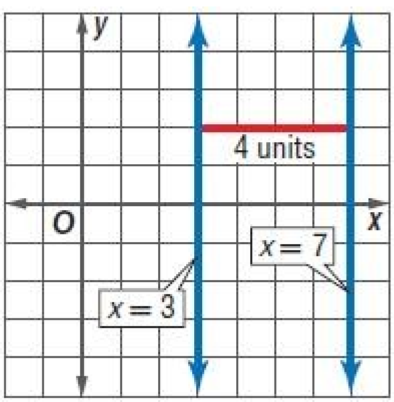
The two lines are horizontal lines and for each equation, the coefficient of x-term is zero. So, the slopes are zero. Therefore, the line perpendicular to the parallel lines will be vertical.

The distance of the vertical line between the parallel lines, will be the difference in the y-intercepts. To find the perpendicular distance between the two horizontal lines subtract –2 from 4 to get 4 – (–2) = 6 units.

ANSWER:
6 units

22. $x = 3$
$x = 7$

SOLUTION:



The two lines are vertical and of the form $x = a$. So, the slopes are undefined. Therefore, the lines are vertical lines passing through $x = 3$ and $x = 7$ respectively. The line perpendicular to each line will be horizontal. The distance will be the difference in the x-intercepts. To find the perpendicular distance between the two horizontal lines subtract 3 from 7 to get 7 – 3 = 4 units

ANSWER:
4 units

23. $y = 5x - 22$
$y = 5x + 4$

SOLUTION:

To find the distance between the parallel lines, we need to find the length of the perpendicular segment between the two parallel lines. Pick a point on one of the equation, and write the equation of a line perpendicular through that point. Then use this perpendicular line and other equation to find the point of intersection. Find the distance between the two point using the distance formula.

Step 1: Find the equation of the line perpendicular to each of the lines.

$y = 5x - 22$ Equation 1

$y = 5x + 4$ Equation 2

The slope of a line perpendicular to both the lines will be $-\frac{1}{5}$. Consider the y-intercept of any of the two lines and write the equation of the perpendicular line through it. The y-intercept of the line $y = 5x + 4$ is (0, 4). So, the equation of a line with slope $-\frac{1}{5}$ and a y-intercept of 4 is

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

Step 2: Find the intersections of the perpendicular line and each of the other lines.
To find the point of intersection of the perpendicular and the second line, solve the two equations.
The left sides of the equations are the same. So, equate the right sides and solve for x.

$$\begin{aligned}
5x - 22 &= -\frac{1}{5}x + 4 \quad \text{Equation 1} = \text{Equation 3} \\
5x + \frac{1}{5}x - 22 &= -\frac{1}{5}x + \frac{1}{5}x + 4 \\
\frac{25}{5}x + \frac{1}{5}x - 22 &= 4 \\
\frac{26}{5}x - 22 + 22 &= 4 + 22 \\
\frac{26}{5}x &= 26 \\
\frac{5}{26}\left(\frac{26}{5}x\right) &= \frac{5}{26}(26) \\
x &= 5 \quad x\text{-coord. of pt. of intersection.}
\end{aligned}$$

Use the value of x to find the value of y.

$$\begin{aligned}
y &= 5x - 22 \quad \text{Equation 1} \\
&= 5(5) - 22 \\
&= 25 - 22 \\
&= 3 \quad y\text{-coord. of pt. of intersection}
\end{aligned}$$

So, the point of intersection is (5, 3).

Step 3: Find the length of the perpendicular between points
Use the Distance Formula to find the distance between the points (5, 3) and (0, 4). Let (x_1, y_1) = (5, 3) and (x_2, y_2) = (0, 4).

$$\begin{aligned} d &= \sqrt{(x_2 - x_1)^2 + (y_2 - y_1)^2} \\ &= \sqrt{(0-5)^2 + (4-3)^2} \\ &= \sqrt{25+1} \\ &= \sqrt{26} \end{aligned}$$

Therefore, the distance between the two lines is $\sqrt{26}$ units.

ANSWER:

$\sqrt{26}$ units

24. $y = \frac{1}{3}x - 3$
$y = \frac{1}{3}x + 2$

SOLUTION:

To find the distance between the parallel lines, we need to find the length of the perpendicular segment between the two parallel lines. Pick a point on one of the equation, and write the equation of a line perpendicular through that point. Then use this perpendicular line and other equation to find the point of intersection. Find the distance between the two point using the distance formula.

Step 1: Find the equation of the line perpendicular to each of the lines.

$y = \frac{1}{3}x - 3$ Equation 1

$y = \frac{1}{3}x + 2$ Equation 2

The slope of a line perpendicular to both the lines will be –3. Consider the *y*-intercept of any of the two lines and write the equation of the perpendicular line through it. The *y*-intercept of the line $y = \frac{1}{3}x + 2$ is (0, 2). So, the equation of a line with slope –3 and a *y*-intercept of 2 is

$y = -3x + 2.$ Equation 3

Step 2: Find the intersections of the perpendicular line and each of the other lines.
To find the point of intersection of the perpendicular and the second line, solve the two equations.
The left sides of the equations are the same. So, equate the right sides and solve for *x*.

$$-3x+2=\frac{1}{3}x-3 \qquad \text{Equation 2} = \text{Equation 3}$$

$$-3x-\frac{1}{3}x+2=\frac{1}{3}x-\frac{1}{3}x-3$$

$$-\frac{9}{3}x-\frac{1}{3}x+2=-3$$

$$-\frac{10}{3}x+2-2=-3-2$$

$$\frac{-10}{3}x=-5$$

$$-\frac{3}{10}\left(-\frac{10}{3}x\right)=-\frac{3}{10}\left(-5\right)$$

$$x=\frac{3}{2}$$

$$x=1\frac{1}{2} \qquad x\text{-coord. of pt. of intersection.}$$

Use the value of x to find the value of y.

$$y=\frac{1}{3}\left(\frac{3}{2}\right)-3 \quad \text{Equation 1}$$

$$=\frac{1}{3}\left(\frac{3}{2}\right)-3$$

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

$$=-2\frac{1}{2} \qquad y\text{-coord. of pt. of intersecton}$$

So, the point of intersection is $\left(1\frac{1}{2},-2\frac{1}{2}\right)$.

Step 3: Find the length of the perpendicular between points.

Use the Distance Formula to find the distance between the points $\left(1\frac{1}{2},-2\frac{1}{2}\right)$ and (0, 2). Let $(x_1,y_1)=\left(1\frac{1}{2},-2\frac{1}{2}\right)$ and $(x_2,y_2)=(0, 2)$.

$$d=\sqrt{(x_2-x_1)^2+(y_2-y_1)^2}$$

$$=\sqrt{\left(0-\frac{3}{2}\right)^2+\left(2-\left(-\frac{5}{2}\right)\right)^2}$$

$$=\sqrt{\frac{9}{4}+\frac{81}{4}}$$

$$=\sqrt{\frac{90}{4}}$$

$$=\frac{3}{2}\sqrt{10}$$

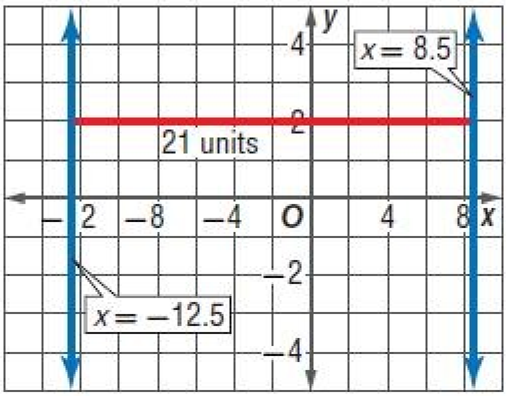
Therefore, the distance between the two lines is $1.5\sqrt{10}$ **units**.

ANSWER:

$1.5\sqrt{10}$ units

25. $x = 8.5$
$x = -12.5$

SOLUTION:



The two lines are vertical and of the form $x = a$. So, the slopes are undefined. Therefore, the lines are vertical lines passing through $x = 8.5$ and $x = –12.5$ respectively.

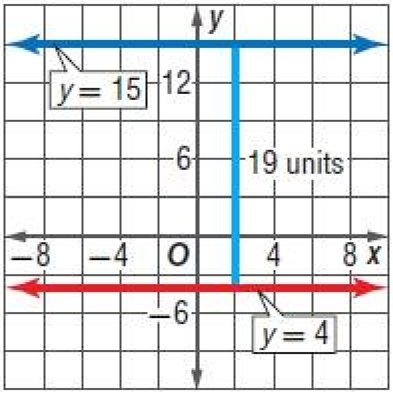
The line perpendicular to each line will be horizontal. The distance will be the difference in the x-intercepts. To find the perpendicular distance between the two horizontal lines subtract –12.5 from 8.5 to get 8.5 – (–12.5) = 21 units.

ANSWER:

21 units

26. $y = 15$
$y = -4$

SOLUTION:



The two lines are horizontal and each equation has a coefficient of zero for the *x*-term. So, the slopes are zero. Therefore, the lines are horizontal lines passing through $y = 15$ and $y = -4$ respectively. The line perpendicular to each line will be vertical. The distance will be the difference in the *y*-intercepts. To find the perpendicular distance between the two horizontal lines subtract –4 from 15 to get 15 – (–4) = 19 units.

ANSWER:
19 units

27. $y = \frac{1}{4}x + 2$
$4y - x = -60$

SOLUTION:
To find the distance between the parallel lines, we need to find the length of the perpendicular segment between the two parallel lines. Pick a point on one of the equation, and write the equation of a line perpendicular through that point. Then use this perpendicular line and other equation to find the point of intersection. Find the distance between the two point using the distance formula.

Step 1: Find the equation of the line perpendicular to each of the lines.
First, write the second equation also in the slope-intercept form.

$$4y - x = -60$$
$$4y = x - 60$$
$$y = \frac{1}{4}x - 15 \quad \text{Equation 2}$$

$$y = \frac{1}{4}x + 2 \quad \text{Equation 1}$$

The slope of a line perpendicular to both the lines will be –4. Consider the *y*-intercept of any of the two lines and write the equation of the perpendicular line through it. The *y*-intercept of the line $y = \frac{1}{4}x + 2$ is (0, 2). So, the equation of a line with slope –4 and a *y*-intercept of 2 is $y = -4x + 2$. Equation 3

Step 2: Find the intersections of the perpendicular line and each of the other lines.
To find the point of intersection of the perpendicular and the second line, solve the two equations.
The left sides of the equations are the same. So, equate the right sides and solve for *x*.

$$-4x+2=\frac{1}{4}x-15 \qquad \text{Equation 3} = \text{Equation 2}$$
$$-4x-\frac{1}{4}x+2=\frac{1}{4}x-\frac{1}{4}x-15$$
$$-\frac{16}{4}x-\frac{1}{4}x+2=-15$$
$$-\frac{17}{4}x+2-2=-15-2$$
$$-\frac{17}{4}x=-17$$
$$-\frac{4}{17}\left(-\frac{17}{4}x\right)=-\frac{4}{17}\left(-17\right)$$
$$x=4 \qquad x\text{-coord. of pt. of intersection}$$

Use the value of x to find the value of y.

$$y=\frac{1}{4}x-15 \qquad \text{Equation 2}$$
$$=\frac{1}{4}(4)-15$$
$$=-14 \qquad y\text{-coordinate of point of intersection}$$

So, the point of intersection is (4, –14).

Step 3: Find the length of the perpendicular between points.
Use the Distance Formula to find the distance between the points (4, –14) and (0, 2). Let (x_1, y_1) = (4, –14) and (x_2, y_2) = (0, 2).

$$d=\sqrt{(x_2-x_1)^2+(y_2-y_1)^2}$$
$$=\sqrt{(0-4)^2+(2-(-14))^2}$$
$$=\sqrt{16+256}$$
$$=4\sqrt{17}$$

Therefore, the distance between the two lines is $4\sqrt{17}$ units.

ANSWER:

$4\sqrt{17}$ units

28. $3x+y=3$
$y+17=-3x$

SOLUTION:

To find the distance between the parallel lines, we need to find the length of the perpendicular segment between the two parallel lines. Pick a point on one of the equation, and write the equation of a line perpendicular through that point. Then use this perpendicular line and other equation to find the point of intersection. Find the distance between the two point using the distance formula.

Step 1: Find the equation of the line perpendicular to each of the lines.
First, write the two equations in slope-intercept form.

$$3x + y = 3 \qquad\qquad y + 17 = -3x$$
$$y = -3x + 3 \quad \text{Equation 1} \qquad\qquad y = -3x - 17 \quad \text{Equation 2}$$

The slope of a line perpendicular to both the lines will be $\frac{1}{3}$. Consider the y-intercept of any of the two lines and write the equation of the perpendicular line through it. The y-intercept of the line $y = -3x + 3$ is (0, 3). So, the equation of a line with slope $\frac{1}{3}$ and a y-intercept of 3 is

$$y = \frac{1}{3}x + 3. \quad \text{Equation 3}$$

Step 2: Find the intersections of the perpendicular line and each of the other lines.
To find the point of intersection of the perpendicular and the second line, solve the two equations.
The left sides of the equations are the same. So, equate the right sides and solve for x.

$$\begin{aligned}
-3x - 17 &= \frac{1}{3}x + 3 \qquad \text{Equation 2} = \text{Equation 3}\\
-3x - \frac{1}{3}x - 17 &= \frac{1}{3}x - \frac{1}{3}x + 3\\
-\frac{9}{3}x - \frac{1}{3}x - 17 &= 3\\
-\frac{10}{3}x - 17 + 17 &= 3 + 17\\
-\frac{10}{3}x &= 20\\
-\frac{3}{10}\left(-\frac{10}{3}x\right) &= -\frac{3}{10}(20)\\
x &= -6 \qquad x\text{-coord. of pt. of intersection}
\end{aligned}$$

Use the value of x to find the value of y.

$$\begin{aligned}
y &= -3x - 17 \qquad \text{Equation 2}\\
&= -3(-6) - 17\\
&= 1 \qquad y\text{-coord. of pt. of intersection}
\end{aligned}$$

So, the point of intersection is (–6, 1).

Step 3: Find the length of the perpendicular between points.
Use the Distance Formula to find the distance between the points (–6, 1) and (0, 3). (x_1, y_1) = (–6, 1) and (x_2, y_2) = (0, 3).

$$\begin{aligned}
d &= \sqrt{(x_2 - x_1)^2 + (y_2 - y_1)^2}\\
&= \sqrt{(0 - (-6))^2 + (3 - 1)^2}\\
&= \sqrt{36 + 4}\\
&= \sqrt{40}\\
&= 2\sqrt{10}
\end{aligned}$$

Therefore, the distance between the two lines is $2\sqrt{10}$ units.

ANSWER:

$2\sqrt{10}$ units

29. $y = -\frac{5}{4}x + 3.5$
$4y + 10.6 = -5x$

SOLUTION:

To find the distance between the parallel lines, we need to find the length of the perpendicular segment between the two parallel lines. Pick a point on one of the equation, and write the equation of a line perpendicular through that point. Then use this perpendicular line and other equation to find the point of intersection. Find the distance between the two point using the distance formula.

Step 1: Find the equation of the line perpendicular to each of the lines.
First, write the second equation also in the slope-intercept form.

$$4y + 10.6 = -5x$$
$$4y = -5x - 10.6$$
$$y = -\frac{5}{4}x - 2.65 \quad \text{Equation 2}$$
$$y = -\frac{5}{4}x + 3.5 \quad \text{Equation 1}$$

The slope of a line perpendicular to both the lines will be $\frac{4}{5}$. Consider the y-intercept of any of the two lines and write the equation of the perpendicular line through it. The y-intercept of the line $y = -\frac{5}{4}x + 3.5$ is (0, 3.5). So, the equation of a line with slope $\frac{4}{5}$ and a y-intercept of 3.5 is $y = \frac{4}{5}x + 3.5$. Equation 3

Step 2: Find the intersections of the perpendicular line and each of the other lines.
To find the point of intersection of the perpendicular and the second line, solve the two equations.
The left sides of the equations are the same. So, equate the right sides and solve for *x*.

$$-\frac{5}{4}x - 2.65 = \frac{4}{5}x + 3.5 \quad \text{Equation 3} = \text{Equation 1}$$
$$-\frac{5}{4}x - \frac{4}{5}x - 2.65 = \frac{4}{5}x - \frac{4}{5}x + 3.5$$
$$-\frac{25}{20}x - \frac{16}{20}x - 2.65 = 3.5$$
$$-\frac{41}{20}x - 2.65 + 2.65 = 3.5 + 2.65$$
$$-\frac{41}{20}x = 6.15$$
$$-\frac{20}{41}\left(-\frac{41}{20}x\right) = -\frac{20}{41}(6.15)$$
$$x = -3 \quad x\text{-coord. of pt. of intersection}$$

Use the value of *x* to find the value of y.

$$
\begin{aligned}
y &= \frac{4}{5}x + 3.5 && \text{Equation 1} \\
&= \frac{4}{5}(-3) + 3.5 \\
&= 1.1 && y\text{-coord. of pt. of intersection}
\end{aligned}
$$

So, the point of intersection is (–3, 1.1).

Step 3: Find the length of the perpendicular between points.
Use the Distance Formula to find the distance between the points (–3, 1.1) and (0, 3.5). Let (x_1, y_1) = (–3, 1.1) and (x_2, y_2) = (0, 3.5).

$$
\begin{aligned}
d &= \sqrt{(x_2 - x_1)^2 + (y_2 - y_1)^2} \\
&= \sqrt{(0 - (-3))^2 + (3.5 - 1.1)^2} \\
&= \sqrt{9 + 5.76} \\
&= \sqrt{14.76}
\end{aligned}
$$

Therefore, the distance between the two lines is $\sqrt{14.76}$ units.

ANSWER:

$\sqrt{14.76}$ units

30. **PROOF** Write a two-column proof of Theorem 3.9.

SOLUTION:

Given: ℓ is equidistant to *m*, and *n* is equidistant to *m.*
Prove: $\ell \parallel n$
Proof:
Statements (Reasons)
1. ℓ is equidistant to *m*, and *n* is equidistant to *m.* (Given)
2. ℓ || *m* and *m* || *n* (Def. of equidistant)
3. slope of ℓ = slope of *m*, slope of *m* = slope of *n* (Def. of || lines)
4. slope of ℓ = slope of *n* (Substitution)
5. ℓ || *n* (Def. of || lines)

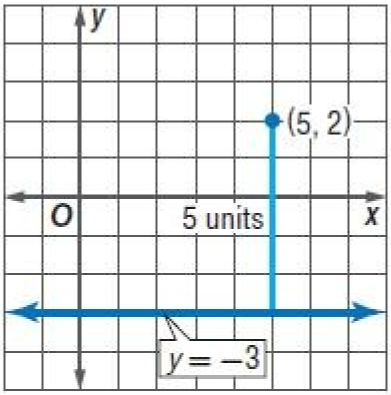
ANSWER:

Given: ℓ is equidistant to *m*, and *n* is equidistant to *m.*
Prove: $\ell \parallel n$
Proof:
Statements (Reasons)
1. ℓ is equidistant to *m*, and *n* is equidistant to *m.* (Given)
2. ℓ || *m* and *m* || *n* (Def. of equidistant)
3. slope of ℓ = slope of *m*, slope of *m* = slope of *n* (Def. of || lines)
4. slope of ℓ = slope of *n* (Substitution)
5. ℓ || *n* (Def. of || lines)

Find the distance from the line to the given point.

31. $y = –3$, (5, 2)

SOLUTION:



The slope of an equation perpendicular to $y = –3$ will be undefined, or the line will be a vertical line. The equation of a vertical line through (5, 2) is $x = 5$.

The point of intersection of the two lines is (5, –3).

Use the Distance Formula to find the distance between the points (5, 2) and (5, –3). Let (x_1, y_1) = (5, 2) and (x_2, y_2) = (5, –3).

$$\begin{aligned} d &= \sqrt{(x_2 - x_1)^2 + (y_2 - y_1)^2} \\ &= \sqrt{(5-5)^2 + (-3-2)^2} \\ &= \sqrt{0 + 25} \\ &= 5 \end{aligned}$$

Therefore, the distance between the line and the point is 5 units.

ANSWER:

5 units

32. $y = \frac{1}{6}x + 6, (-6, 5)$

SOLUTION:

The slope of an equation perpendicular to $y = \frac{1}{6}x + 6$ will be –6. A line with a slope –6 and that passes through the point (–6, 5) will have the equation,

$$\begin{aligned} y - y_1 &= m(x - x_1) && \text{Point-Slope form} \\ y - 5 &= -6(x - (-6)) \\ y - 5 &= -6x - 36 \\ y - 5 + 5 &= -6x - 36 + 5 \\ y &= -6x - 31 && \text{Equation of perpendicular line} \end{aligned}$$

Solve the two equations to find the point of intersection.

The left sides of the equations are the same. So, equate the right sides and solve for x.

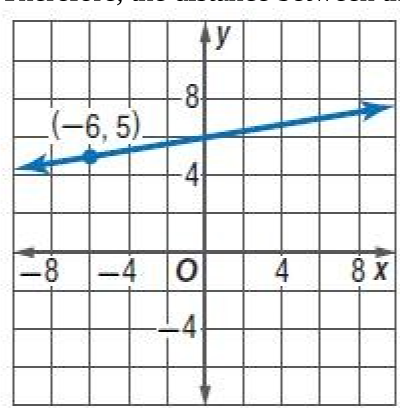
$$\frac{1}{6}x + 6 = -6x - 31$$
$$\frac{1}{6}x + 6x + 6 = -6x + 6x - 31$$
$$\frac{1}{6}x + \frac{36}{6}x + 6 = -31$$
$$\frac{37}{6}x + 6 - 6 = -31 - 6$$
$$\frac{37}{6}x = -37$$
$$\frac{6}{37}\left(\frac{37}{6}x\right) = \frac{6}{37}(-37)$$
$$x = -6 \qquad \text{x-coord. of pt. of intersection}$$

Use the value of x to find the value of y.

$$y = -6x - 31$$
$$= -6(-6) - 31$$
$$= 5 \qquad \text{y-coord. of pt. of intersection}$$

The point of intersection of the two lines is (–6, 5). That is, the point of intersection of the line and the perpendicular is same as the given point. So, the point is on the line.

Therefore, the distance between the line and the point is 0 units.



ANSWER:

0 units

33. $x = 4$, (–2, 5)

SOLUTION:

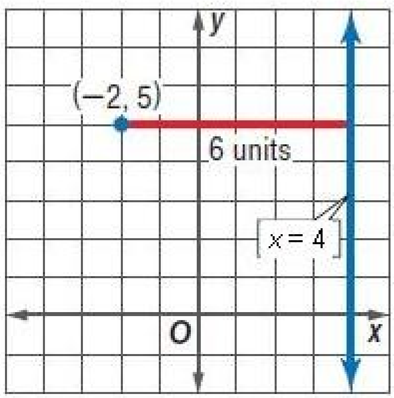
The slope of an equation perpendicular to $x = 4$ will be zero, or the line will be a horizontal line. The equation of a horizontal line through (–2, 5) is $y = 5$.

The point of intersection of the two lines is (4, 5).

Use the Distance Formula to find the distance between the points (4, 5) and (–2, 5). Let (x_1, y_1) = (4, 5) and (x_2, y_2) = (–2, 5).

$$d = \sqrt{(x_2 - x_1)^2 + (y_2 - y_1)^2}$$
$$= \sqrt{(-2 - 4)^2 + (5 - 5)^2}$$
$$= \sqrt{36 + 0}$$
$$= 6$$

Therefore, the distance between the line and the point is 6 units.



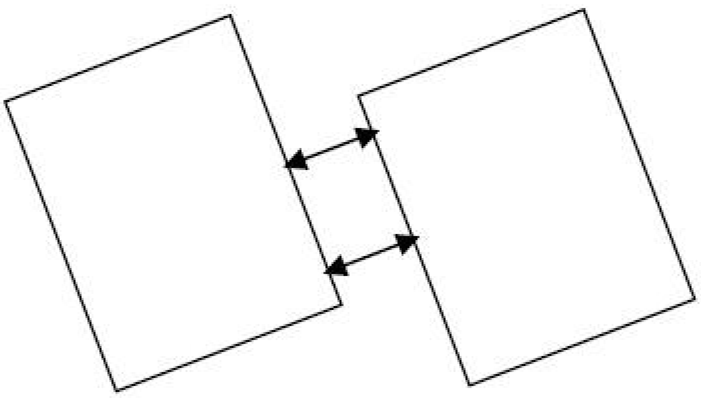
ANSWER:

6 units

34. **POSTERS** Alma is hanging two posters on the wall in her room as shown. How can Alma use perpendicular distances to confirm that the posters are parallel?

SOLUTION:

Alma can measure the perpendicular distance between the posters in two different places as shown. If these distances are equal, then the posters are parallel.



ANSWER:

Alma can measure the perpendicular distance between the posters in two different places. If these distances are equal, then the posters are parallel.

35. **SCHOOL SPIRIT** Brock is decorating a hallway bulletin board to display pictures of students demonstrating school spirit. He cuts off one length of border to match the width of the top of the board, and then uses that strip as a template to cut a second strip that is exactly the same length for the bottom.
When stapling the bottom border in place, he notices that the strip he cut is about a quarter of an inch too short. Describe what he can conclude about the bulletin board. Explain your reasoning.

SOLUTION:

He can conclude that the right and left sides of the bulletin board are not parallel, since the perpendicular distance between one line and any point on the other line must be equal be the same anywhere on the lines for the two lines to be parallel.

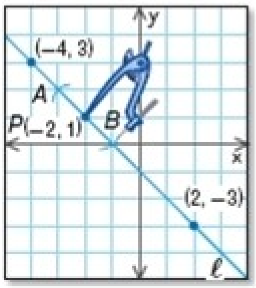
ANSWER:

He can conclude that the right and left sides of the bulletin board are not parallel, since the perpendicular distance between one line and any point on the other line must be equal be the same anywhere on the lines for the two lines to be parallel.

CONSTRUCTION Line ℓ contains points at (–4, 3) and (2, –3). Point *P* at (–2, 1) is on line ℓ. Complete the following construction.

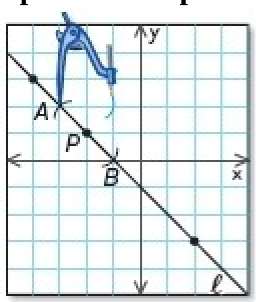
Step 1

Graph line ℓ and point *P*, and put the compass at point *P*. Using the same compass setting, draw arcs to the left and right of *P*. Label these points A and *B*.



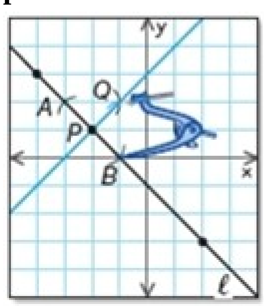
Step 2

Open the compass to a setting greater than AP. Put the compass at point A and draw an arc above line ℓ.



Step 3

Using the same compass setting, put the compass at point *B* and draw an arc above line ℓ. Label the point of intersection *Q*. Then draw $\overleftrightarrow{PQ}$.



36. What is the relationship between line ℓ and $\overleftrightarrow{PQ}$? Verify your conjecture using the slopes of the two lines.

SOLUTION:

Sample answer: The lines are perpendicular; the slope of ℓ is –1 and the slope of $\overleftrightarrow{PQ}$ is 1. Since the slopes are negative reciprocals, the lines are perpendicular.

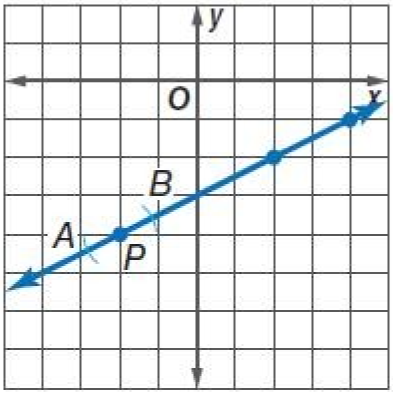
ANSWER:

Sample answer: The lines are perpendicular; the slope of ℓ is –1 and the slope of $\overleftrightarrow{PQ}$ is 1. Since the slopes are negative reciprocals, the lines are perpendicular.

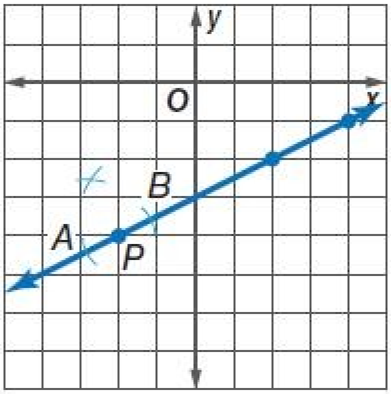
37. Repeat the construction above using a different line and point on that line.

SOLUTION:

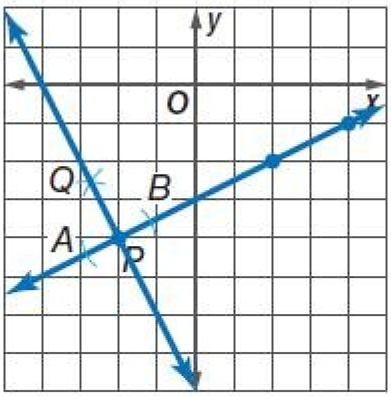
Sample answer:
Step 1:
Graph line through points (–2, –4), (2, –2), and (4, –1) with Point P at (–2, –4).Put the compass at point P. Using the same compass setting, draw arcs to the left and right of P. Label these points A and B.



Step 2:
Open the compass to a setting greater than AP. Put the compass at point A and draw an arc above the line.



Step 3:
Using the same compass setting, put the compass at point B and draw an arc above the line. Label the point of intersection Q. Then draw a line through Q and P.



ANSWER:
See students' work.

38. **CCSS SENSE-MAKING** $\overline{AB}$ has a slope of 2 and midpoint $M(3, 2)$. A segment perpendicular to $\overline{AB}$ has midpoint

$P(4, -1)$ and shares endpoint B with $\overline{AB}$.

a. Graph the segments.

b. Find the coordinates of A and B.

SOLUTION:

a. From the point $M(3, 2)$, move 2 units up and 1 unit to the right to plot the point $A(4, 4)$.
There are two methods to find the coordinates of B.

Method 1

Use the Midpoint Formula with the coordinates of A and M.

$$M = \left(\frac{x_1 + x_2}{2}, \frac{y_1 + y_2}{2}\right)$$

$$(3,2) = \left(\frac{x_1 + 2}{2}, \frac{y_1 + 0}{2}\right)$$

$$\frac{x_1 + 2}{2} = 3 \Rightarrow x_1 = 2(3) - 2 = 4$$

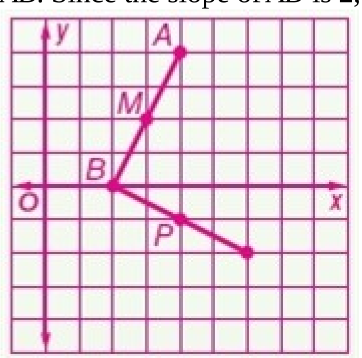
$$\frac{y_1 + 0}{2} = 2 \Rightarrow 2(2) - 0 = 4$$

Method 2

Use the slope.

To get from A to M on the graph, move down 2 units and to the left 1 unit. Since M is the midpoint, B and A are equidistant from M. From M, move down 2 units and to the left 1 unit. B has the coordinates (2, 0).

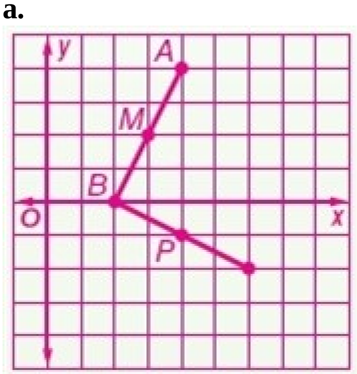
Next plot P on the graph. Since BP is perpendicular to AB, the slope of BP is the negative reciprocal of the slope of AB. Since the slope of AB is 2, the slope of BP is $-\frac{1}{2}$. Use this slope to find and plot the other endpoint.



b. From the graph in part **a,** the coordinates of A is (4, 4) and that of B is (2, 0).

ANSWER:

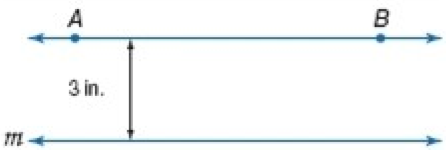
a.



b. $A(4, 4)$, $B(2, 0)$

39. **MULTIPLE REPRESENTATIONS** In this problem, you will explore the areas of triangles formed by points on parallel lines.

a. GEOMETRIC Draw two parallel lines and label them as shown.

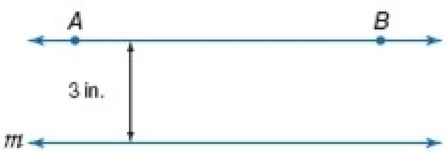


b. VERBAL Where would you place point C on line m to ensure that triangle ABC would have the largest area? Explain your reasoning.

c. ANALYTICAL If AB = 11 inches, what is the maximum area of $\triangle ABC$?

SOLUTION:

a. See students' work.



b. Place point C any place on line m. The area of the triangle is $\frac{1}{2}$ the height of the triangle times the length of the base of the triangle. Since the two lines are parallel, the distance between them will always be the same. The numbers stay constant regardless of the location of C on line m.

c. Substitute $h = 3$ and $b = 11$ in the formula to find the area.

$$A = \frac{1}{2}(3)(11)$$
$$= 16.5$$

The maximum area of the triangle will be 16.5 in^2.

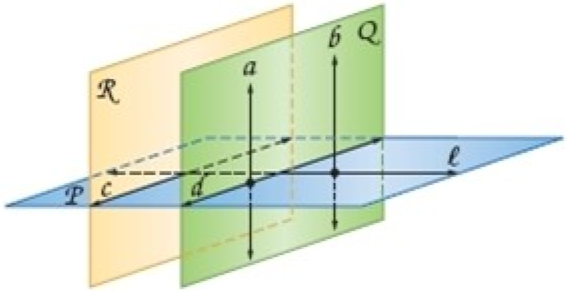
ANSWER:

a. See students' work.

b. Place point C any place on line m. The area of the triangle is $\frac{1}{2}$ the height of the triangle times the length of the base of the triangle. The numbers stay constant regardless of the location of C on line m.

c. 16.5 in^2

40. **PERPENDICULARITY AND PLANES** Make a copy of the diagram below to answer each question, marking the diagram with the given information.



a. If two lines are perpendicular to the same plane, then they are coplanar. If both line *a* and line *b* are perpendicular to plane *P*, what must also be true?
b. If a plane intersects two parallel planes, then the intersections form two parallel lines. If planes *R* and *Q* are parallel and they intersect plane *P*, what must also be true?
c. If two planes are perpendicular to the same line, then they are parallel. If both plane *Q* and plane *R* are perpendicular to line ℓ, what must also be true?

SOLUTION:

a. Since the two lines are perpendicular to the plane *P*, lines *a* and *b* are coplanar.
b. Since the planes *R* and *Q* are parallel and they intersect plane *P*, the lines formed by the intersections are parallel, $c \parallel d$.
c. Since both plane *Q* and plane *R* are perpendicular to line ℓ, $R \parallel Q$.

ANSWER:

a. Lines *a* and *b* are coplanar.
b. $c \parallel d$
c. $R \parallel Q$

41. **ERROR ANALYSIS** Han draws the segments $\overline{AB}$ and $\overline{CD}$ shown below using a straightedge. He claims that these two lines, if extended, will never intersect. Shenequa claims that they will. Is either of them correct? Justify your answer.

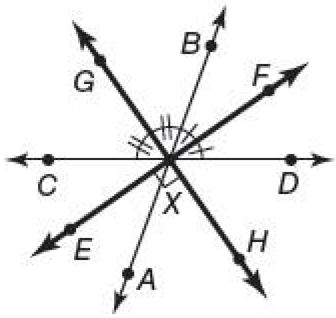
SOLUTION:
When using the student edition, the answer will be:
The distance between points *A* and *C* is 1.2 cm. The distance between points *B* and *D* is 1.35 cm. Since the lines are not equidistant everywhere, the lines will eventually intersect when extended. Therefore, Shenequa is correct.
For other forms of media, the answer will vary.

ANSWER:
When using the student edition, the answer will be:
The distance between points *A* and *C* is 1.2 cm. The distance between points *B* and *D* is 1.35 cm. Since the lines are not equidistant everywhere, the lines will eventually intersect when extended. Shenequa is correct.
For other forms of media, the answer will vary.

42. **CHALLENGE** Describe the locus of points that are equidistant from two intersecting lines, and sketch an example.

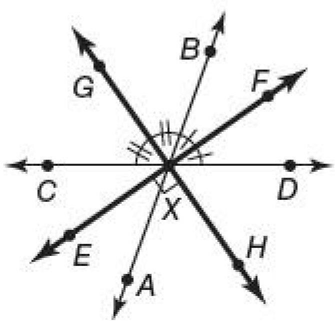
SOLUTION:

Sample answer: $\overleftrightarrow{AB}$ and $\overleftrightarrow{CD}$ intersect at X to form 2 pairs of vertical angles. The locus of points equidistant from $\overleftrightarrow{AB}$ and $\overleftrightarrow{CD}$ lie along $\overleftrightarrow{EF}$ and $\overleftrightarrow{GH}$ which bisect each pair of vertical angles. $\overleftrightarrow{EF}$ and $\overleftrightarrow{GH}$ are perpendicular.



ANSWER:

Sample answer: $\overleftrightarrow{AB}$ and $\overleftrightarrow{CD}$ intersect at X to form 2 pairs of vertical angles. The locus of points equidistant from $\overleftrightarrow{AB}$ and $\overleftrightarrow{CD}$ lie along $\overleftrightarrow{EF}$ and $\overleftrightarrow{GH}$ which bisect each pair of vertical angles. $\overleftrightarrow{EF}$ and $\overleftrightarrow{GH}$ are perpendicular.



43. **CHALLENGE** Suppose a line perpendicular to a pair of parallel lines intersects the lines at the points $(a, 4)$ and $(0, 6)$. If the distance between the parallel lines is $\sqrt{5}$, find the value of a and the equations of the parallel lines.

SOLUTION:

Substitute the coordinates of the endpoints in the Distance Formula to find the value of a.

$$D = \sqrt{(x_2 - x_1)^2 + (y_2 - y_1)^2}$$
$$\sqrt{5} = \sqrt{(0-a)^2 + (6-4)^2}$$
$$\sqrt{5} = \sqrt{a^2 + 2^2}$$
$$\left(\sqrt{5}\right)^2 = \left(\sqrt{a^2 + 2^2}\right)^2$$
$$5 = a^2 + 4$$
$$5 - 4 = a^2 + 4 - 4$$
$$1 = a^2$$
$$\sqrt{1} = \sqrt{a^2}$$
$$\pm 1 = a$$

Let a = 1. Then the slope of the line joining the points (1, 4) and (0, 6) is

$$m = \frac{y_2 - y_1}{x_2 - x_1}$$
$$= \frac{6-4}{0-1}$$
$$= -2$$

So, the slope of the line perpendicular to this line will be $\frac{1}{2}$.

Equation of a line of slope $\frac{1}{2}$ and that has a point (1, 4) on it, is

$$y - y_1 = m(x - x_1) \quad \text{Point-Slope form}$$
$$y - 4 = \frac{1}{2}(x - 1)$$
$$y - 4 = \frac{1}{2}x - \frac{1}{2}$$
$$y - 4 + 4 = \frac{1}{2}x - \frac{1}{2} + 4$$
$$y = \frac{1}{2}x + \frac{7}{2}$$

Equation of a line of slope $\frac{1}{2}$ and that has a point (0, 6) on it, is

$$y - y_1 = m(x - x_1) \quad \text{Point-Slope form}$$
$$y - 6 = \frac{1}{2}(x - 0)$$
$$y - 6 = \frac{1}{2}x$$
$$y - 6 + 6 = \frac{1}{2}x + 6$$
$$y = \frac{1}{2}x + 6$$

Let $a = -1$. Then the slope of the line joining the points (–1, 4) and (0, 6) is

$$m = \frac{y_2 - y_1}{x_2 - x_1}$$
$$= \frac{6 - 4}{0 - (-1)}$$
$$= 2$$

So, the slope of the line perpendicular to this line will be $-\frac{1}{2}$.

Equation of a line of slope $-\frac{1}{2}$ and that has a point (–1, 4) on it, is

$$y - y_1 = m(x - x_1) \quad \text{Point-Slope form}$$
$$y - 4 = -\frac{1}{2}(x - (-1))$$
$$y - 4 = -\frac{1}{2}x - \frac{1}{2}$$
$$y - 4 + 4 = -\frac{1}{2}x - \frac{1}{2} + 4$$
$$y = -\frac{1}{2}x + \frac{7}{2}$$

Equation of a line of slope $-\frac{1}{2}$ and that has a point (0, 6) on it, is

$$y - y_1 = m(x - x_1) \quad \text{Point-Slope form}$$
$$y - 6 = -\frac{1}{2}(x - 0)$$
$$y - 6 = -\frac{1}{2}x$$
$$y - 6 + 6 = -\frac{1}{2}x + 6$$
$$y = -\frac{1}{2}x + 6$$

Therefore, the equations of the parallel lines are

$$y = \frac{1}{2}x + 6 \text{ and } y = \frac{1}{2}x + \frac{7}{2}$$

or

$$y = -\frac{1}{2}x + 6 \text{ and } y = -\frac{1}{2}x + \frac{7}{2}.$$

ANSWER:

$a = \pm 1;$

$$y = \frac{1}{2}x + 6 \text{ and } y = \frac{1}{2}x + \frac{7}{2}$$

or

$$y = -\frac{1}{2}x + 6 \text{ and } y = -\frac{1}{2}x + \frac{7}{2}$$

44. **REASONING** Determine whether the following statement is *sometimes, always,* or *never* true. Explain.
The distance between a line and a plane can be found.

SOLUTION:

The distance can only be found if the line is parallel to the plane. So, the statement is *sometimes* true. If the line is not parallel to the plane, the distance from the plane to one point on the line is different than the distance to a different point on the line.

ANSWER:

Sometimes; the distance can only be found if the line is parallel to the plane.

45. **OPEN ENDED** Draw an irregular convex pentagon using a straightedge.

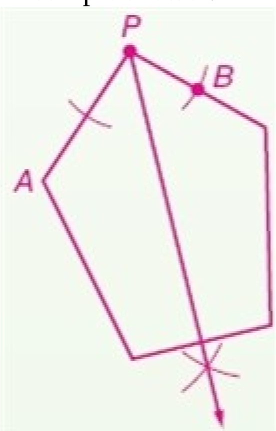
a. Use a compass and straightedge to construct a line between one vertex and a side opposite the vertex.

b. Use measurement to justify that the line constructed is perpendicular to the chosen side.

c. Use mathematics to justify this conclusion.

SOLUTION:

a. Sample answer:

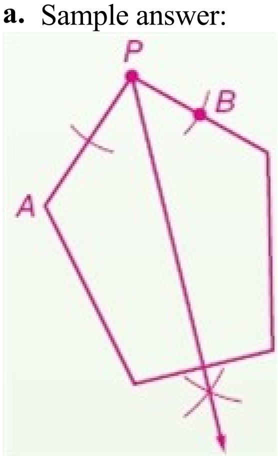


b. Sample answer: Using a protractor, the measurement of the constructed angle is equal to 90. So, the line constructed from vertex *P* is perpendicular to the nonadjacent side chosen.

c. Sample answer: The same compass setting was used to construct points *A* and *B*. Then the same compass setting was used to construct the perpendicular line to the side chosen. Since the compass setting was equidistant in both steps a perpendicular line was constructed.

ANSWER:

a. Sample answer:



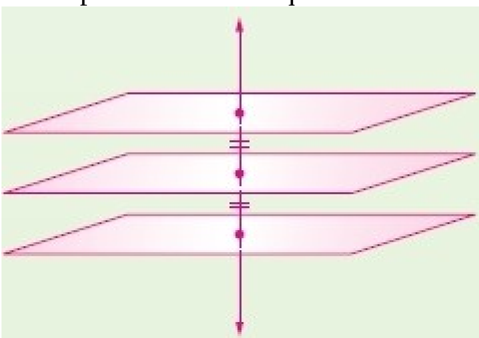
b. Sample answer: Using a protractor, the measurement of the constructed angle is equal to 90. So, the line constructed from vertex *P* is perpendicular to the nonadjacent chosen side.

c. Sample answer: The same compass setting was used to construct points *A* and *B*. Then the same compass setting was used to construct the perpendicular line to the chosen side. Since the compass setting was equidistant in both steps a perpendicular line was constructed.

46. **CCSS SENSE-MAKING** Rewrite Theorem 3.9 in terms of two planes that are equidistant from a third plane. Sketch an example.

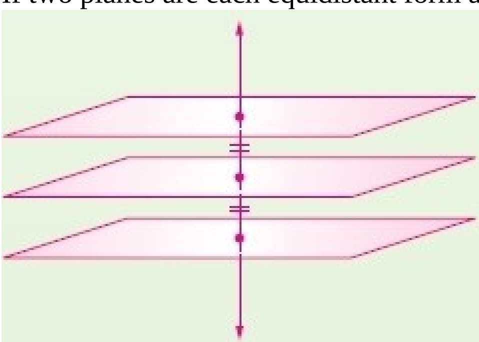
SOLUTION:

If two planes are each equidistant form a third plane, then the two planes are parallel to each other.



ANSWER:

If two planes are each equidistant form a third plane, then the two planes are parallel to each other.



47. **WRITING IN MATH** Summarize the steps necessary to find the distance between a pair of parallel lines given the equations of the two lines.

SOLUTION:

Sample answer: First, a point on one of the parallel lines is found. Then the line perpendicular to the line through the point is found. Then the point of intersection is found between the perpendicular line and the other line not used in the first step. Last, the Distance Formula is used to determine the distance between the pair of intersection points. This value is the distance between the pair of parallel lines.

ANSWER:

Sample answer: First, a point on one of the parallel lines is found. Then the line perpendicular to the line through the point is found. Then the point of intersection is found between the perpendicular line and the other line not used in the first step. Last, the Distance Formula is used to determine the distance between the pair of intersection points. This value is the distance between the pair of parallel lines.

48. **EXTENDED RESPONSE** Segment *AB* is perpendicular to segment *CD*. Segment *AB* and segment *CD* bisect each other at point *X*.

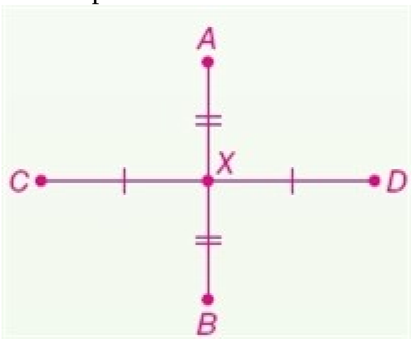
a. Draw a figure to represent the problem.

b. Find $\overline{BD}$ if $AB = 12$ and $CD = 16$.

c. Find $\overline{BD}$ if $AB = 24$ and $CD = 18$.

SOLUTION:

a. Sample answer:



b. The triangle *BXD* is a right triangle with $\overline{BD}$ as the hypotenuse.
Then by the Pythagorean Theorem:

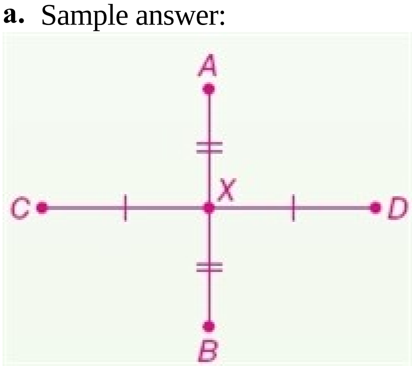
$$BD^2 = BX^2 + XD^2$$
$$BD = \sqrt{BX^2 + XD^2}$$
$$BD = \sqrt{6^2 + 8^2}$$
$$= \sqrt{36 + 64}$$
$$= \sqrt{100}$$
$$= 10$$

c. The triangle *BXD* is a right triangle with $\overline{BD}$ as the hypotenuse.
Then by the Pythagorean Theorem,

$$BD^2 = BX^2 + XD^2$$
$$BD = \sqrt{BX^2 + XD^2}$$
$$BD = \sqrt{12^2 + 9^2}$$
$$= \sqrt{144 + 81}$$
$$= \sqrt{225}$$
$$= 15$$

ANSWER:

a. Sample answer:



b. 10

c. 15

49. A city park is square and has an area of 81,000 square feet. Which of the following is the closest to the length of one side of the park?
A 100 ft
B 200 ft
C 300 ft
D 400 ft

SOLUTION:
The area of a square is the square of the length of each side. So, the length of each side is the square root of the area of the square. The area of the park is 81,000 ft^2.

$$A = s^2$$
$$81000 = s^2$$
$$\sqrt{81000} = \sqrt{s^2}$$
$$284.6 \approx s$$

So, the length of each side is closest to 300 ft. Therefore, the correct choice is C.

ANSWER:
C

50. **ALGEBRA** Pablo bought a sweater on sale for 25% off the original price and another 40% off the discounted price. If the sweater originally cost $48, what was the final price of the sweater?
F $14.40
G $21.60
H $31.20
I $36.00

SOLUTION:
To find the price after 25% off, multiply 48 by 0.25 and subtract from 48.

$48 - (0.25 \cdot 48) = 48 - 12 = 36.$
The cost after the 40% off on the discounted price is

$36 - (0.40 \cdot 36) = 36 - 14.4 = 21.6.$
So, the final price is $21.60. Therefore, the correct choice is G.

ANSWER:
G

51. **SAT/ACT** After N cookies are divided equally among 8 children, 3 remain. How many would remain if $(N + 6)$ cookies were divided equally among the 8 children?

F 0
G 1
H 2
J 4
K 6

SOLUTION:

Let n be the number of cookies each of the 8 children got. Then, $N = 8n + 3$.

To find out how many cookies would remain if there were $N + 6$ cookies, add 6 to each side of this equation.

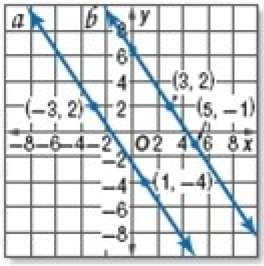
$N = 8n + 3$	Original equation
$N + 6 = 8n + 3 + 6$	Add 6 to each side.
$N + 6 = 8n + 8 + 1$	Rewrite 3 + 6 as 8 + 1.
$N + 6 = 8(n + 1) + 1$	Distributive Property

If there are $N + 6$ cookies divided equally among 8 children, 1 will remain. Therefore, the correct choice is G.

ANSWER:

G

52. Refer to the figure. Determine whether $a \parallel b$. Justify your answer.



SOLUTION:

Slope of *a*:

Let $(x_1, y_1) = (-3, 2)$ and $(x_2, y_2) = (1, -4)$.

$$m = \frac{y_2 - y_1}{x_2 - x_1} \quad \text{Slope Formula}$$

$$= \frac{-4 - 2}{1 - (-3)} \quad \text{Substitutuion.}$$

$$= \frac{-6}{4} \quad \text{Simplify.}$$

$$= -\frac{3}{2} \quad \text{Simplify.}$$

Slope of *b*:

Let $(x_1, y_1) = (3, 2)$ and $(x_2, y_2) = (5, -1)$

$$m = \frac{y_2 - y_1}{x_2 - x_1} \quad \text{Slope Formula}$$

$$= \frac{-1 - 2}{5 - 3} \quad \text{Substitutuion.}$$

$$= -\frac{3}{2} \quad \text{Simplify.}$$

Since the slopes are equal, $a \parallel b$.

ANSWER:

Slope of *a*: $m = \frac{(-4 - 2)}{(1 + 3)} = -\frac{3}{2}$;

Slope of *b*: $m = \frac{(-1 - 2)}{(5 - 3)} = -\frac{3}{2}$;

Since the slopes are equal, $a \parallel b$.

Write an equation in point-slope form of the line having the given slope that contains the given point.

53. $m: \frac{1}{4}, (3, -1)$

SOLUTION:

The point-slope form of a line is $y - y_1 = m(x - x_1)$ where m is the slope and (x_1, y_1) is a point on the line.

Here, $m = \frac{1}{4}$ and $(x_1, y_1) = (3, -1)$.

So, the equation of the line is

$$y - y_1 = m(x - x_1) \quad \text{Point-Slope form}$$
$$y - (-1) = \frac{1}{4}(x - 3)$$
$$y + 1 = \frac{1}{4}(x - 3)$$

ANSWER:

$y + 1 = \frac{1}{4}(x - 3)$

54. m: 0, (–2, 6)

SOLUTION:

The point-slope form of a line is $y - y_1 = m(x - x_1)$ where m is the slope and (x_1, y_1) is a point on the line.

Here, $m = 0$ and $(x_1, y_1) = (-2, 6)$.

So, the equation of the line is

$$y - y_1 = m(x - x_1) \quad \text{Point-Slope form}$$
$$y - 6 = 0(x - (-2))$$
$$y - 6 = 0$$

ANSWER:

$y - 6 = 0$

55. m: –1, (–2, 3)

SOLUTION:

The point-slope form of a line is $y - y_1 = m(x - x_1)$ where m is the slope and (x_1, y_1) is a point on the line.

Here, $m = -1$ and $(x_1, y_1) = (-2, 3)$.

So, the equation of the line is

$$y - y_1 = m(x - x_1) \quad \text{Point-Slope form}$$
$$y - 3 = -1(x - (-2))$$
$$y - 3 = -(x + 2)$$

ANSWER:

$y - 3 = -(x + 2)$

56. m: –2, (–6, –7)

SOLUTION:

The point-slope form of a line is $y - y_1 = m(x - x_1)$ where m is the slope and (x_1, y_1) is a point on the line.

Here, $m = -2$ and $(x_1, y_1) = (-6, -7)$.

So, the equation of the line is

$$y - y_1 = m(x - x_1) \quad \text{Point-Slope form}$$
$$y - (-7) = -2(x - (-6))$$
$$y + 7 = -2(x + 6)$$

ANSWER:

$y + 7 = -2(x + 6)$

Prove the following.

57. If $AB = BC$, then $AC = 2BC$.

SOLUTION:

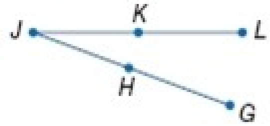
Given: $AB = BC$
Prove: $AC = 2BC$
Statements (Reasons)
1. $AB = BC$ (Given)
2. $AC = AB + BC$ (Seg. Add. Post.)
3. $AC = BC + BC$ (Substitution)
4. $AC = 2BC$ (Substitution)

ANSWER:

Given: $AB = BC$
Prove: $AC = 2BC$
Statements (Reasons)
1. $AB = BC$ (Given)
2. $AC = AB + BC$ (Seg. Add. Post.)
3. $AC = BC + BC$ (Substitution)
4. $AC = 2BC$ (Substitution)

58. **Given:** $\overline{JK} \cong \overline{KL}, \overline{HJ} \cong \overline{GH}, \overline{KL} \cong \overline{HJ}$

Prove: $\overline{GH} \cong \overline{JK}$



SOLUTION:

Given: $\overline{JK} \cong \overline{KL}, \overline{HJ} \cong \overline{GH}, \overline{KL} \cong \overline{HJ}$

Prove: $\overline{GH} \cong \overline{JK}$

Statements (Reasons)

1. $\overline{JK} \cong \overline{KL}, \overline{KL} \cong \overline{HJ}$ (Given)
2. $\overline{JK} \cong \overline{HJ}$ (Transitive Property of Congruence)
3. $\overline{HJ} \cong \overline{GH}$ (Given)
4. $\overline{JK} \cong \overline{GH}$ (Transitive Property of Congruence)
5. $\overline{GH} \cong \overline{JK}$ (Symmetric Property of Congruence)

ANSWER:

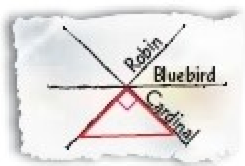
Given: $\overline{JK} \cong \overline{KL}, \overline{HJ} \cong \overline{GH}, \overline{KL} \cong \overline{HJ}$

Prove: $\overline{GH} \cong \overline{JK}$

Statements (Reasons)

1. $\overline{JK} \cong \overline{KL}$, $\overline{KL} \cong \overline{HJ}$ (Given)
2. $\overline{JK} \cong \overline{HJ}$ (Transitive Property of Congruence)
3. $\overline{HJ} \cong \overline{GH}$ (Given)
4. $\overline{JK} \cong \overline{GH}$ (Transitive Property of Congruence)
5. $\overline{GH} \cong \overline{JK}$ (Symmetric Property of Congruence)

59. **MAPS** Darnell sketched a map for his friend of the cross streets nearest to his home. Describe two different angle relationships between the streets.



SOLUTION:

The streets Robin and Cardinal are perpendicular to each other. Bluebird divides two of the angles formed by Robin and Cardinal into pairs of complementary angles.

ANSWER:

Sample answer: Robin $\perp$ Cardinal; Bluebird divides two of the angles formed by Robin and Cardinal into pairs of complementary angles.

Use the Distance Formula to find the distance between each pair of points.

60. *A*(0, 0), *B*(15, 20)

SOLUTION:

Use the Distance Formula.

$$D = \sqrt{(x_2 - x_1)^2 + (y_2 - y_1)^2}$$

Substitute. Let (x_1, y_1) = (0, 0) and (x_2, y_2) = (15, 20).

$$\begin{aligned} AB &= \sqrt{(15-0)^2 + (20-0)^2} \\ &= \sqrt{225+400} \\ &= \sqrt{625} \\ &= 25 \end{aligned}$$

The distance between *A* and *B* is 25 units.

ANSWER:

25

61. *O*(–12, 0), *P*(–8, 3)

SOLUTION:

Use the Distance Formula.

$$D = \sqrt{(x_2 - x_1)^2 + (y_2 - y_1)^2}$$

Substitute. Let (x_1, y_1) = (–12, 0) and (x_2, y_2) = (–8, 3).

$$\begin{aligned} OP &= \sqrt{(-8-(-12))^2 + (3-0)^2} \\ &= \sqrt{16+9} \\ &= \sqrt{25} \\ &= 5 \end{aligned}$$

The distance between *O* and *P* is 5 units.

ANSWER:

5

62. $C(11, –12)$, $D(6, 2)$

SOLUTION:

Use the Distance Formula.

$$D = \sqrt{(x_2 - x_1)^2 + (y_2 - y_1)^2}$$

Substitute. Let (x_1, y_1) = (11, –12) and (x_2, y_2) = (6, 2).

$$\begin{aligned} CD &= \sqrt{(6-11)^2 + (2-(-12))^2} \\ &= \sqrt{25+196} \\ &= \sqrt{221} \\ &\approx 14.9 \end{aligned}$$

The distance between C and D is $\sqrt{221}$ or about 14.9 units.

ANSWER:

$\sqrt{221} \approx 14.9$

63. $R(–2, 3)$, $S(3, 15)$

SOLUTION:

Use the Distance Formula.

$$D = \sqrt{(x_2 - x_1)^2 + (y_2 - y_1)^2}$$

Substitute. Let (x_1, y_1) = (–2, 3) and (x_2, y_2) = (3, 15).

$$\begin{aligned} RS &= \sqrt{(3-(-2))^2 + (15-3)^2} \\ &= \sqrt{25+144} \\ &= \sqrt{169} \\ &= 13 \end{aligned}$$

The distance between R and S is 13 units.

ANSWER:

13

64. $M(1, –2)$, $N(9, 13)$

SOLUTION:

Use the Distance Formula.

$$D = \sqrt{(x_2 - x_1)^2 + (y_2 - y_1)^2}$$

Substitute. Let (x_1, y_1) = (1, –2) and (x_2, y_2) = (9, 13).

$$\begin{aligned} MN &= \sqrt{(9-1)^2 + (13-(-2))^2} \\ &= \sqrt{64+225} \\ &= \sqrt{289} \\ &= 17 \end{aligned}$$

The distance between *M* and *N* is 17 units.

ANSWER:

17

65. $Q(–12, 2)$, $T(–9, 6)$

SOLUTION:

Use the Distance Formula.

$$D = \sqrt{(x_2 - x_1)^2 + (y_2 - y_1)^2}$$

Substitute. Let (x_1, y_1) = (–12, 2) and (x_2, y_2) = (–9, 6).

$$\begin{aligned} QT &= \sqrt{(-9-(-12))^2 + (6-2)^2} \\ &= \sqrt{9+16} \\ &= \sqrt{25} \\ &= 5 \end{aligned}$$

The distance between *Q* and *T* is 5 units.

ANSWER:

5