EXAMPLE 1 Parallel Line Through a Given Point

Write the slope-intercept form of an equation for the line that passes through (4, –2) and is parallel to the graph of $y = \frac{1}{2}x - 7$.

The line parallel to $y = \frac{1}{2}x - 7$ has the same slope, $\frac{1}{2}$.

Replace m with $\frac{1}{2}$, and (x_1, y_1) with $(4, -2)$ in the point-slope form.

EXAMPLE 1 Parallel Line Through a Given Point

$$y = \frac{1}{2}x - 4$$

Write the equation in slope-intercept form.

EXAMPLE 1 Check Your Progress

Write the slope-intercept form of an equation for the line that passes through (2, 3) and is parallel to the graph of $y = \frac{1}{2}x - 1$.

A. $y = -2x + 3$

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

C. $y = \frac{1}{2}x + 2$

D. $y = -2x - 1$

EXAMPLE 1 Check Your Progress

Write the slope-intercept form of an equation for the line that passes through (2, 3) and is parallel to the graph of $y = \frac{1}{2}x - 1$.

A. $y = -2x + 3$

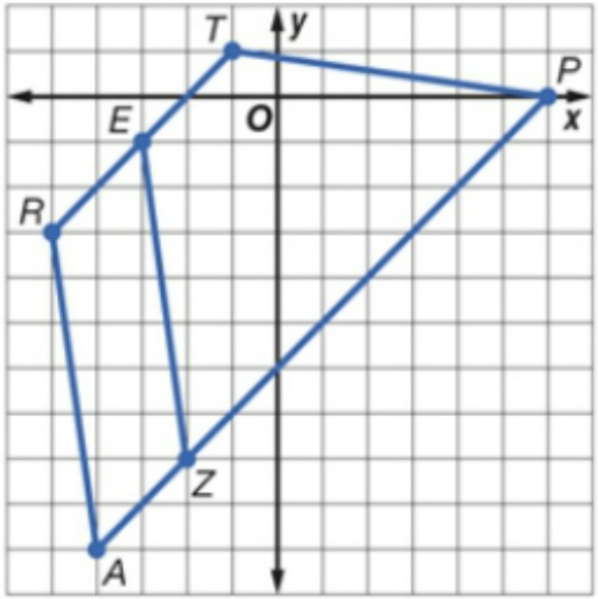
B. $y = \frac{1}{2}x + 3$

C. $y = \frac{1}{2}x + 2$

D. $y = -2x - 1$

Real-World Example 2 Slopes of Perpendicular Lines

A. GEOMETRY The height of a trapezoid is the length of a segment that is perpendicular to both bases. In trapezoid *ARTP*, $\overline{RT}$ and $\overline{AP}$ are bases. Can $\overline{EZ}$ be used to measure the height of the trapezoid? Explain.



Real-World Example 2 Slopes of Perpendicular Lines

Find the slope of each segment.

Slope of $\overline{RT}$: $m = \frac{1-(-3)}{-1-(-5)}$ or 1

Slope of $\overline{AP}$: $m = \frac{0-(-10)}{6-(-4)}$ or 1

Slope of $\overline{EZ}$: $m = \frac{-8-(-1)}{-2-(-3)}$ or -7

Real-World Example 2 Slopes of Perpendicular Lines

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Slope of $\overline{EZ}$: $m = \frac{-8-(-1)}{-2-(-3)}$ or -7

Answer: The slope of $\overline{RT}$ and $\overline{AP}$ is 1 and the slope of $\overline{EZ}$ is –7. Since $1(-7) \neq -1$, $\overline{EZ}$ is not perpendicular to $\overline{RT}$ and $\overline{AP}$. So, it cannot be used to measure the height of $ARTP$.

Real-World Example 2 Slopes of Perpendicular Lines

B. GEOMETRY The height of a trapezoid is the length of a segment that is perpendicular to both bases. In trapezoid *ARTP*, $\overline{RT}$ and $\overline{AP}$ are bases. Are the bases parallel?

Slope of $\overline{RT}$: $m = \dfrac{1-(-3)}{-1-(-5)}$ or 1

Slope of $\overline{AP}$: $m = \dfrac{0-(-10)}{6-(-4)}$ or 1

Real-World Example 2 Slopes of Perpendicular Lines

B. GEOMETRY **The height of a trapezoid is the length of a segment that is perpendicular to both bases. In trapezoid *ARTP*, $\overline{RT}$ and $\overline{AP}$ are bases. Are the bases parallel?**

Slope of $\overline{RT}$: $m = \dfrac{1-(-3)}{-1-(-5)}$ or 1

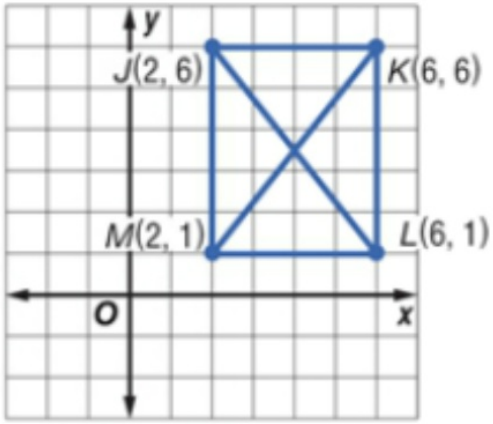
Slope of $\overline{AP}$: $m = \dfrac{0-(-10)}{6-(-4)}$ or 1

Answer: Yes, both $\overline{RT}$ and $\overline{AP}$ have a slope of 1.

Real-World Example 2

Check Your Progress

The graph shows the diagonals of a rectangle. Determine whether $\overline{JL}$ is perpendicular to $\overline{KM}$.



A. $\overline{JL}$ is not perpendicular to $\overline{KM}$.

B. $\overline{JL}$ is perpendicular to $\overline{KM}$.

C. cannot be determined

Real-World Example 2

Check Your Progress

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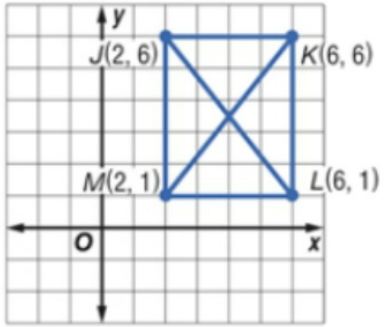

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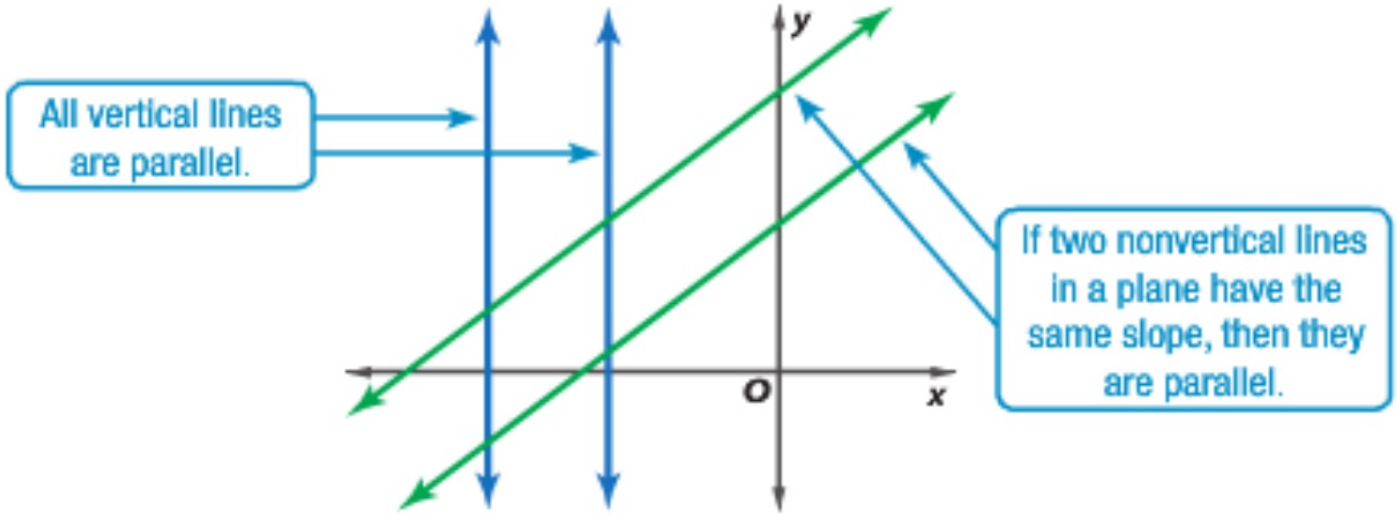
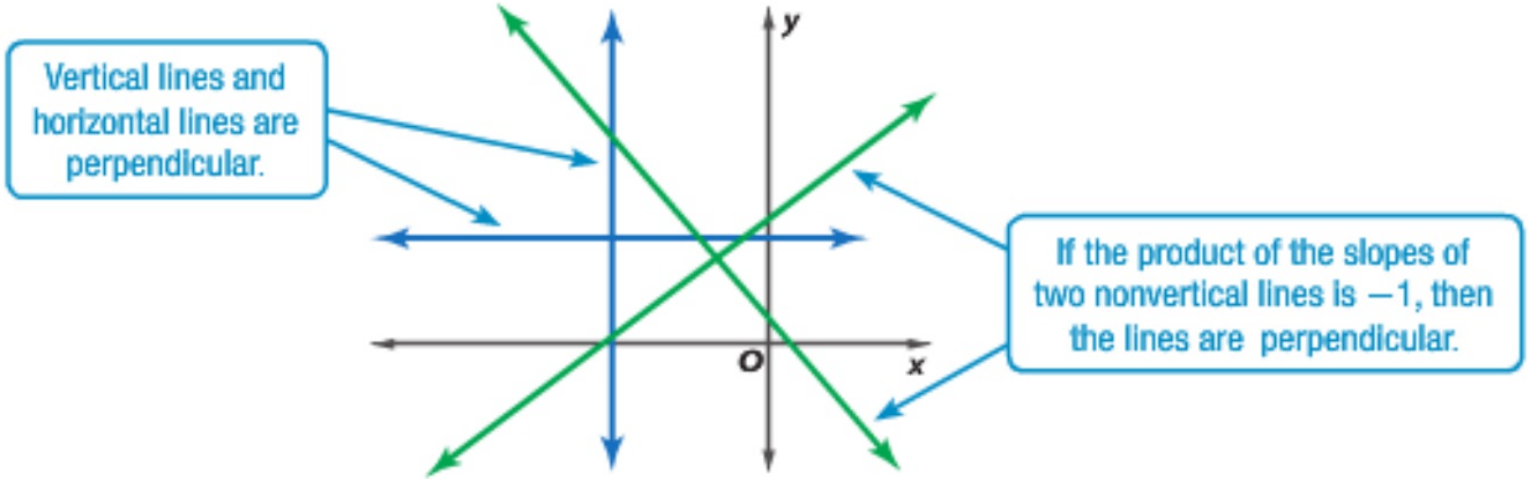
C. cannot be determined

Parallel Lines:



Perpendicular Lines:

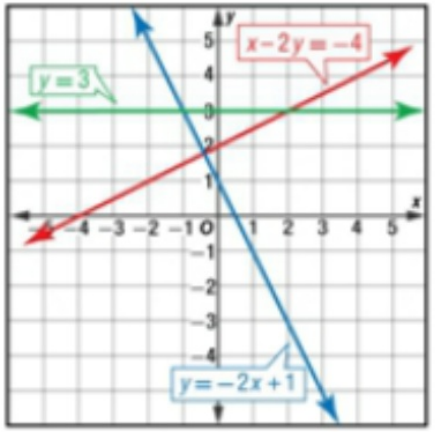


EXAMPLE 3 Parallel or Perpendicular Lines

Determine whether the graphs of $3x + y = 12$, $y = \frac{1}{3}x + 2$, and $2x - 6y = -5$ are *parallel* or *perpendicular*. Explain.

EXAMPLE 3 Check Your Progress

Determine whether the graphs of $y = -2x + 1$, $x - 2y = -4$, and $y = 3$ are *parallel* or *perpendicular*.



A. $y = -2x + 1$ and $x - 2y = -4$ are perpendicular. None of the lines are parallel.

B. $y = -2x + 1$ and $y = 3$ are perpendicular. None of the lines are parallel.

C. $y = -2x + 1$ and $x - 2y = -4$ are parallel. None of the lines are perpendicular.

D. None of the lines are parallel or perpendicular.

EXAMPLE 3 Check Your Progress

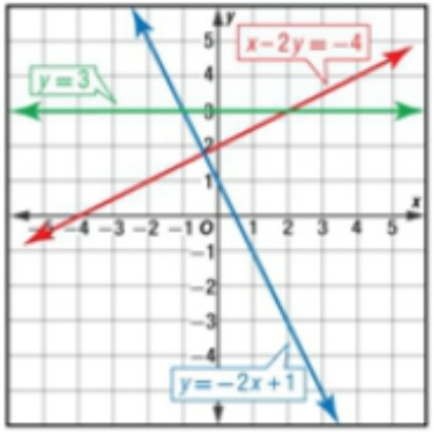
Determine whether the graphs of $y = -2x + 1$, $x - 2y = -4$, and $y = 3$ are *parallel* or *perpendicular*.

A. $y = -2x + 1$ and $x - 2y = -4$ are perpendicular. None of the lines are parallel.

B. $y = -2x + 1$ and $y = 3$ are perpendicular. None of the lines are parallel.

C. $y = -2x + 1$ and $x - 2y = -4$ are parallel. None of the lines are perpendicular.

D. None of the lines are parallel or perpendicular.



Check Your Understanding

= Step-by-Step Solutions begin on page R13.

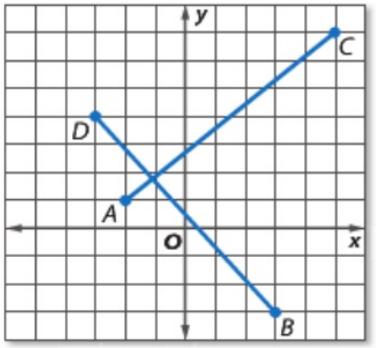
Example 1 **Write an equation in slope-intercept form for the line that passes through the given point and is parallel to the graph of the given equation.**

1. $(-1, 2), y = \frac{1}{2}x - 3$ $y = \frac{1}{2}x + 2\frac{1}{2}$

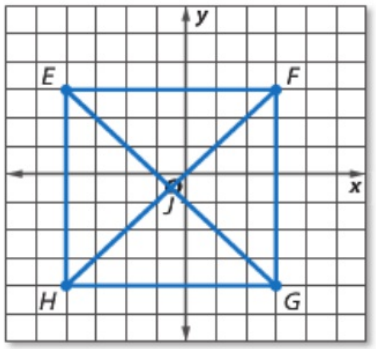
2. $(0, 4), y = -4x + 5$ $y = -4x + 4$

Example 2

3. GARDENS A garden is in the shape of a quadrilateral with vertices $A(-2, 1)$, $B(3, -3)$, $C(5, 7)$, and $D(-3, 4)$. Two paths represented by $\overline{AC}$ and $\overline{BD}$ cut across the garden. Are the paths perpendicular? Explain.



4. CCSS PRECISION A square is a quadrilateral that has opposite sides parallel, consecutive sides that are perpendicular, and diagonals that are perpendicular. Determine whether the quadrilateral is a square. Explain. **See margin.**



Example 3 **Determine whether the graphs of the following equations are *parallel* or *perpendicular*. Explain.**

5 $y = -2x, 2y = x, 4y = 2x + 4$

6. $y = \frac{1}{2}x, 3y = x, y = -\frac{1}{2}x$

6. None are parallel or perpendicular; none of the slopes are equal or opposite reciprocals.

Additional Answer

4. Since $\overline{EH}$ and $\overline{FG}$ are parallel to the y-axis, they are parallel. Since $\overline{EF}$ and $\overline{HG}$ are parallel to the x-axis they are parallel and $\overline{EH}$ is perpendicular to $\overline{EF}$ and $\overline{HG}$. Likewise, $\overline{FG}$ is perpendicular to $\overline{EF}$ and $\overline{HG}$. The slope of $\overline{EG}$ is -1 and the slope of $\overline{FH}$ is 1. Since the slopes are opposite reciprocals, $\overline{EG} \perp \overline{FH}$. The quadrilateral is a square.

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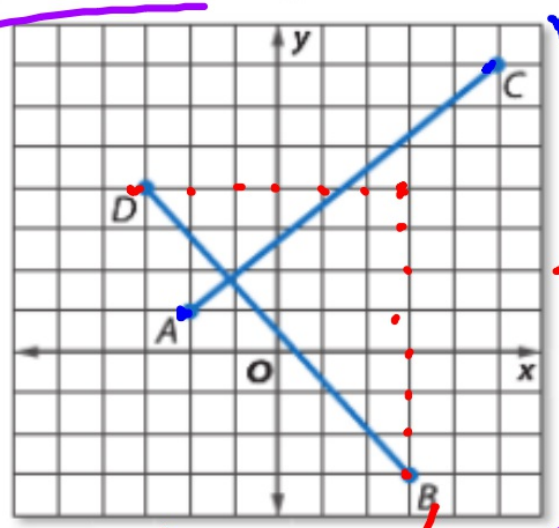
3. GARDENS A garden is in the shape of a quadrilateral with vertices $A(-2, 1)$, $B(3, -3)$, $C(5, 7)$, and $D(-3, 4)$. Two paths represented by $\overline{AC}$ and $\overline{BD}$ cut across the garden. Are the paths perpendicular? Explain.



yes

$m = \frac{y_2 - y_1}{x_2 - x_1} = \frac{1-7}{-2-5}$

$= \frac{-6}{-7}$

$m = \frac{6}{7}$

-7

6

$m = -\frac{7}{6}$

Example 1 Write an equation in slope-intercept form for the line that passes through the given point and is parallel to the graph of the given equation.

1. $(-1, 2), y = \frac{1}{2}x - 3$ $y = \frac{1}{2}x + 2\frac{1}{2}$

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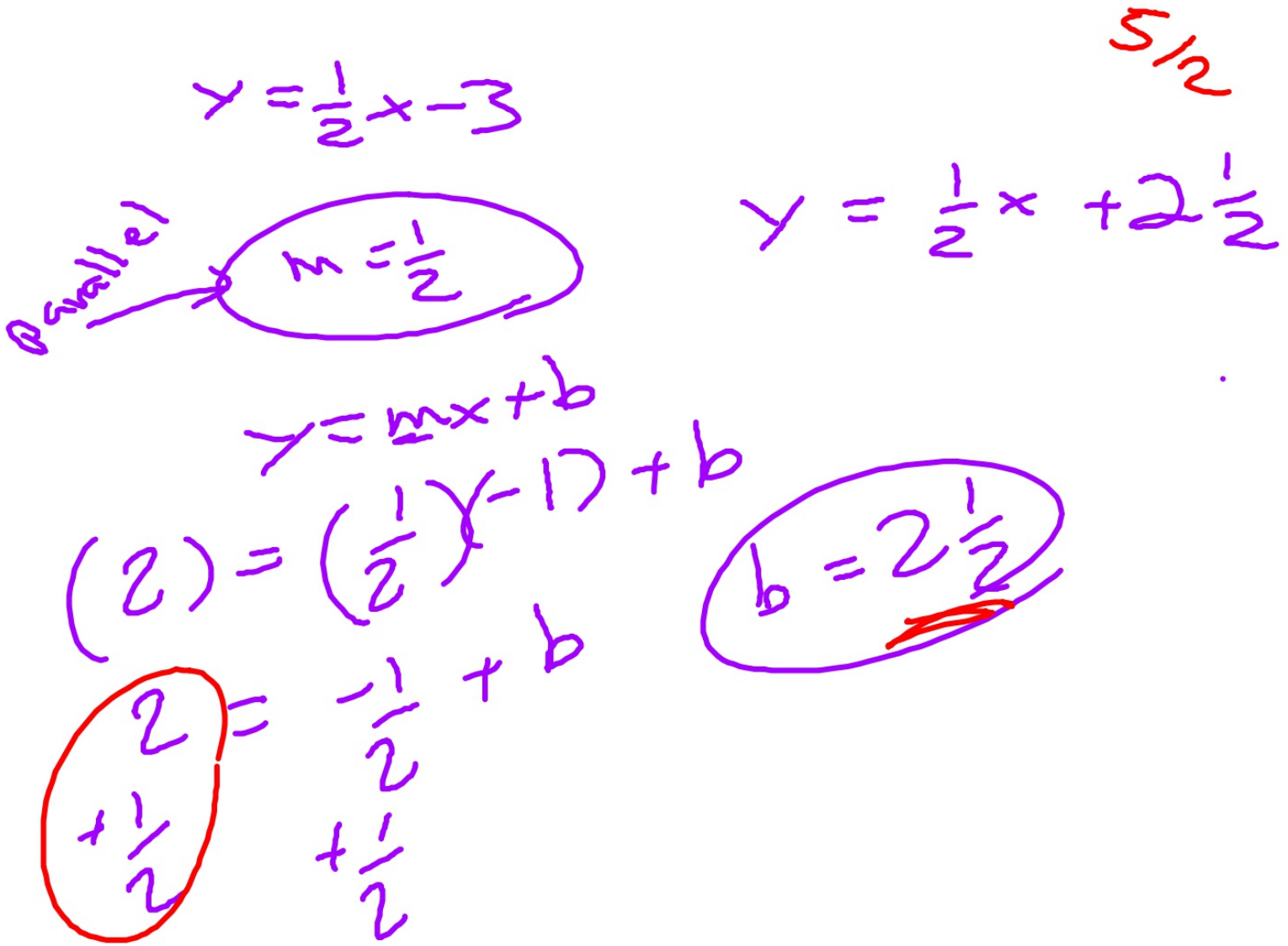

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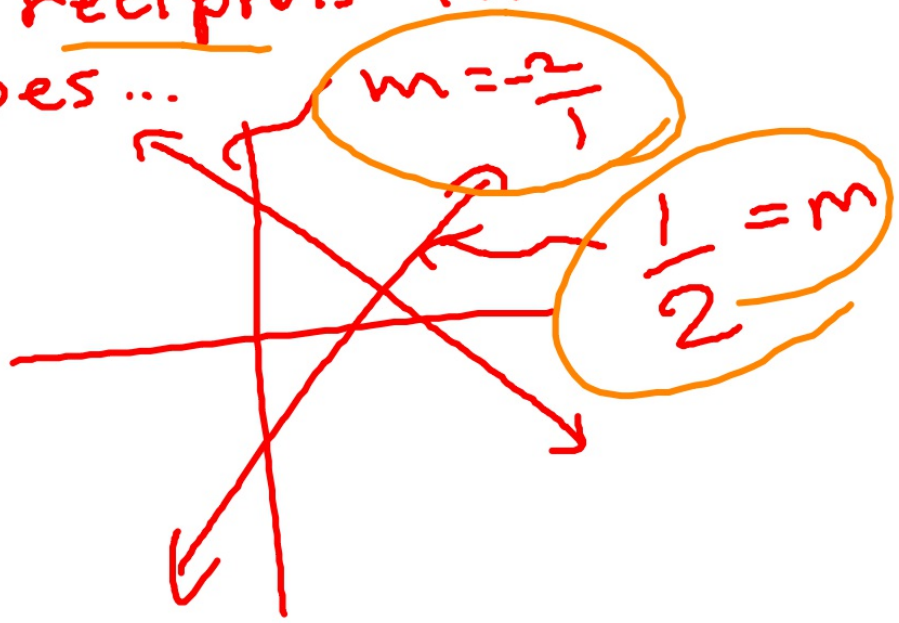
perpendicular lines have negative reciprols for their slopes...



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a square.

1) $y = -2x$

$m = \frac{-2}{1}$

2) $\frac{2y}{2} = \frac{1x}{2}$

$y = \frac{1}{2}x$

$m = \frac{1}{2}$

3) $\frac{4y}{4} = \frac{2x}{4} + \frac{4}{4}$

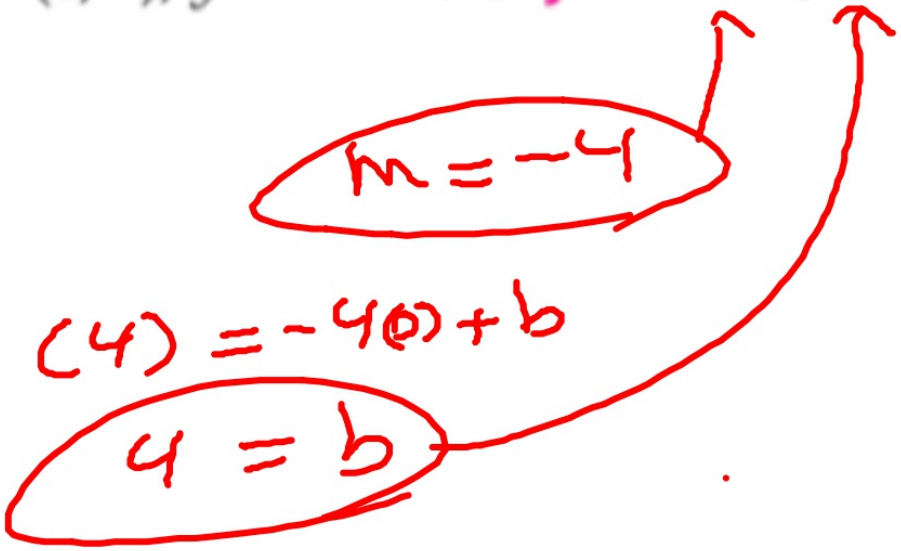
$y = \frac{1}{2}x + 1$

$m = \frac{1}{2}$

1 is perpendicular to 2 and 3

2 and 3 are parallel

2. $(0, 4), y = -4x + 5$ $y = -4x + 4$



Practice and Problem Solving

Extra Practice is on page [illegible].

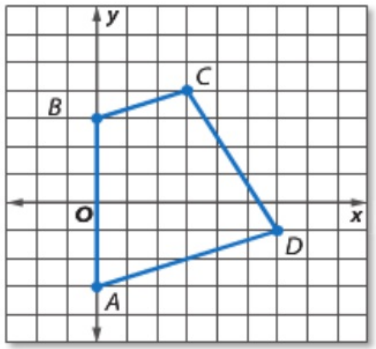
Example 1 Write an equation in slope-intercept form for the line that passes through the given point and is parallel to the graph of the given equation.

11. $(3, -2)$, $y = x + 4$ **12.** $(4, -3)$, $y = 3x - 5$ **13.** $(0, 2)$, $y = -5x + 8$

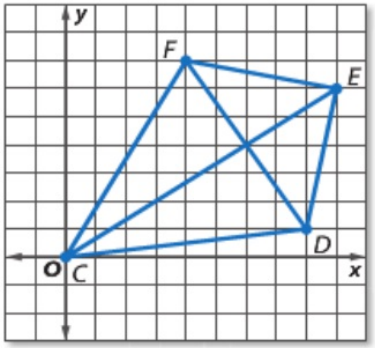
14. $(-4, 2)$, $y = -\frac{1}{2}x + 6$ **15.** $(-2, 3)$, $y = -\frac{3}{4}x + 4$ **16.** $(9, 12)$, $y = 13x - 4$

Example 2

17. GEOMETRY A trapezoid is a quadrilateral that has exactly one pair of parallel opposite sides. Is $ABCD$ a trapezoid? Explain your reasoning. **See margin.**



18. GEOMETRY $CDEF$ is a kite. Are the diagonals of the kite perpendicular? Explain your reasoning.



19. Determine whether the graphs of $y = -6x + 4$ and $y = \frac{1}{6}x$ are perpendicular. Explain. **Yes; the slopes are -6 and $\frac{1}{6}$.**

20. MAPS On a map, Elmwood Drive passes through $R(4, -11)$ and $S(0, -9)$, and Taylor Road passes through $J(6, -2)$ and $K(4, -5)$. If they are straight lines, are the two streets perpendicular? Explain. **No; the slopes are $-\frac{1}{2}$ and $\frac{3}{2}$.**

Ev [illegible] her the graphs of the following equations are

11. $y = x - 5$
12. $y = 3x - 15$
13. $y = -5x + 2$
14. $y = -\frac{1}{2}x$
15. $y = -\frac{3}{4}x + 1\frac{1}{2}$
16. $y = 13x - 105$
18. The slope of $\overline{CE}$ is $\frac{2}{3}$ and the slope of $\overline{DF}$ is $-\frac{3}{2}$. The diagonals are perpendicular because the slopes are opposite reciprocals.

Additional Answers

17. Yes; the line containing $\overline{AD}$ and the line containing $\overline{BC}$ have the same slope, $\frac{1}{3}$. Therefore, one pair of sides is parallel. The slope of $\overline{AB}$ is undefined and the slope of $\overline{CD}$ [illegible]

Example 3 CCSS **PERSEVERANCE** Determine whether the graphs of the following equations are *parallel* or *perpendicular*. Explain.

21. $2x - 8y = -24, 4x + y = -2, x - 4y = 4$

22. $3x - 9y = 9, 3y = x + 12, 2x - 6y = 12$

21. $2x - 8y = -24$ and $4x + y = -2$ are perpendicular; $2x - 8y = -24$ and $x - 4y = 4$ are parallel.

22. All of the lines are parallel.

Example 4 Write an equation in slope-intercept form for the line that passes through the given point and is perpendicular to the graph of the equation. **23–28.** See margin.

23. $(-3, -2), y = -2x + 4$

24. $(-5, 2), y = \frac{1}{2}x - 3$

25. $(-4, 5), y = \frac{1}{3}x + 6$

26. $(2, 6), y = -\frac{1}{4}x + 3$

27. $(3, 8), y = 5x - 3$

28. $(4, -2), y = 3x + 5$

23. $y = \frac{1}{2}x - \frac{1}{2}$

24. $y = -2x - 8$

25. $y = -3x - 7$

26. $y = 4x - 2$

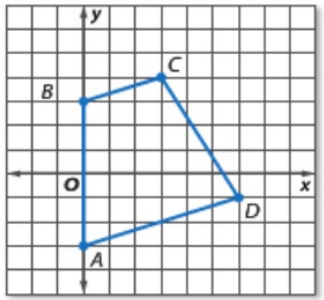
27. $y = -\frac{1}{5}x + 8\frac{3}{5}$

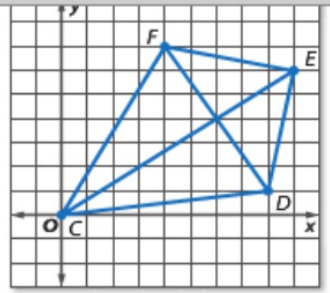
28. $y = -\frac{1}{3}x - \frac{2}{3}$

29. $y = 2x + 16$

30. $y = -\frac{3}{2}x + \frac{27}{2}$

31. $y = -\frac{1}{5}x - \frac{3}{25}$





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

16. $y = 13x - 105$

18. The slope of $\overline{CE}$ is $\frac{2}{3}$ and the slope of $\overline{DF}$ is $-\frac{3}{2}$. The diagonals are perpendicular because the slopes are opposite reciprocals.

19. Determine whether the graphs of $y = -6x + 4$ and $y = \frac{1}{6}x$ are perpendicular. Explain. **Yes; the slopes are -6 and $\frac{1}{6}$.**

20. **MAPS** On a map, Elmwood Drive passes through $R(4, -11)$ and $S(0, -9)$, and Taylor Road passes through $J(6, -2)$ and $K(4, -5)$. If they are straight lines, are the two streets perpendicular? Explain.

No; the slopes are $-\frac{1}{2}$ and $\frac{3}{2}$.

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25. $(-4, 5), y = \frac{1}{3}x + 6$

26. $(2, 6), y = -\frac{1}{4}x + 3$

27. [illegible]

28. $(4, -2), y = 3x + 5$

R Write an equation i[illegible]icular to the graph of