

MYSTERY PICTURE



EQUATIONS OF PARALLEL AND PERPENDICULAR LINES

Parallel and Perpendicular Lines: Is the First Line Right?

25 squares · the new slope and the point · nothing to solve · a picture appears

FREE

1 Perpendicular to $y = 2x - 4$ through (2, 4) $4 = -\frac{1}{2}(2) + b$	2 Perpendicular to $y = \frac{1}{2}x + 3$ through (-4, 3) $3 = -2(4) + b$	3 Perpendicular to $y - 4 = -3(x + 1)$ through (3, 2) $2 = -3(3) + b$	4 Parallel to $y = -2x + 6$ through (3, -1) $-1 = -2(3) + b$	5 Perpendicular to $y = 3x + 2$ through (3, -2) $-2 = -3(3) + b$
6 Perpendicular to $y = -\frac{2}{3}x + 1$ through (4, 3) $3 = \frac{3}{2}(4) + b$	7 Perpendicular to $y = \frac{1}{3}x - 1$ through (2, -5) $2 = -3(-5) + b$	8 Parallel to $y = 3x + 1$ through (-1, 5) $5 = 3(-1) + b$	9 Perpendicular to $y = -4x + 1$ through (-4, 2) $2 = -\frac{1}{4}(-4) + b$	10 Perpendicular to $y - 5 = 2(x - 1)$ through (4, -3) $5 = -\frac{1}{2}(1) + b$
11 Perpendicular to $y = 4x - 2$ through (4, 1) $1 = -\frac{1}{4}(4) + b$	12 Perpendicular to $y - 2 = \frac{1}{3}(x - 3)$ through (1, -4) $-4 = -3(1) + b$	13 Parallel to $y = \frac{3}{4}x - 1$ through (4, -2) $2 = \frac{3}{4}(4) + b$	14 Parallel to $y = \frac{2}{3}x + 2$ through (3, -1) $-1 = -\frac{2}{2}(3) + b$	15 Perpendicular to $y + 1 = -\frac{1}{3}(x - 3)$ through (-2, 5) $-2 = 3(5) + b$
16 Parallel to $y - 3 = -\frac{1}{2}(x - 2)$ through (-4, -1) $-1 = -\frac{1}{2}(-4) + b$	17 Perpendicular to $y = \frac{1}{2}x - 5$ through (2, -3) $-3 = -\frac{1}{2}(2) + b$	18 Parallel to $y = 2x + 5$ through (-3, 1) $1 = 2(-3) + b$	19 Parallel to $y - 2 = 4(x - 1)$ through (-2, 3) $2 = 4(1) + b$	20 Perpendicular to $y = -\frac{3}{4}x + 2$ through (4, 3) $3 = -\frac{3}{4}(4) + b$
21 Perpendicular to $y = -\frac{1}{2}x + 4$ through (-2, -3) $-3 = 2(-2) + b$	22 Perpendicular to $y = -\frac{3}{2}x + 1$ through (3, 4) $4 = -\frac{2}{3}(3) + b$	23 Parallel to $y = \frac{1}{4}x - 3$ through (-4, 2) $2 = -4(-4) + b$	24 Perpendicular to $y = 5x - 1$ through (5, 2) $2 = -\frac{1}{5}(5) + b$	25 Perpendicular to $y = -2x + 1$ through (-4, 3) $3 = \frac{1}{2}(4) + b$

1. **Give each student page 3** and a pencil. No calculator is needed.
2. **Say this once:** *“Each square starts finding b . Do not solve it. Is the first line right? It must use the slope of the NEW line, and the x and y of the point the NEW line goes through (the point after ‘through’), each in its place. If it is right, fill the square with slanted lines. If not, leave it white.”*
3. **Let them work.** The picture shows when they are right. Nothing else is needed.

Student sheet page 3, one per student. A box at the bottom shows the steps.
Answers pages 4–5, for you.

Each square names a new line and shows the first line of the work for its b , such as $4 = -\frac{1}{2}(2) + b$. To write the line as $y = mx + b$, a student first finds the new slope (the same for a parallel line, the opposite reciprocal for a perpendicular one). Then the student puts that slope and the point into $y = mx + b$ and solves for b . Nobody solves anything here. The only question is whether that first line is set up right. Ten squares are filled.

The white squares are the common mistakes. In eight of them the slope is wrong: the given slope is used for a perpendicular line, the sign is changed but the fraction is not turned over (or the other way round), or the opposite reciprocal is used for a parallel line. Using the old slope is the most common mistake in this lesson. In the other seven the slope is right but the point is not: its x and y are swapped, a negative sign is lost, or a point of the given line is used in place of the point.

If part of a student’s picture looks wrong, the mistake is in that square. Ask: *“Which slope is in this line? Is it the new slope? Which number is x , and which is y ?”* Guessing does not work. Every simple rule, such as checking only the slope, gets at least seven squares wrong.



This is the free lesson this activity came from. The worksheet, the full answers and the lesson plan are on it, at three levels of difficulty.
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Mystery Picture — is the first line right?

Parallel and perpendicular lines

Name _____

Period _____

Date _____

Each square names a new line and shows the first line of the work to find its b . Do not solve it. Is the first line right? It must use the slope of the NEW line, and the x and y of the point the NEW line goes through (the point after “through”), each in its place. **If it is right, fill the square with slanted lines. If not, leave it white.** A picture appears. If part of it is missing, check that square again.

1 Perpendicular to $y = 2x - 4$ through (2, 4) $4 = -\frac{1}{2}(2) + b$	2 Perpendicular to $y = \frac{1}{2}x + 3$ through (-4, 3) $3 = -2(4) + b$	3 Perpendicular to $y - 4 = -3(x + 1)$ through (3, 2) $2 = -3(3) + b$	4 Parallel to $y = -2x + 6$ through (3, -1) $-1 = -2(3) + b$	5 Perpendicular to $y = 3x + 2$ through (3, -2) $-2 = -3(3) + b$
6 Perpendicular to $y = -\frac{2}{3}x + 1$ through (4, 3) $3 = \frac{3}{2}(4) + b$	7 Perpendicular to $y = \frac{1}{3}x - 1$ through (2, -5) $2 = -3(-5) + b$	8 Parallel to $y = 3x + 1$ through (-1, 5) $5 = 3(-1) + b$	9 Perpendicular to $y = -4x + 1$ through (-4, 2) $2 = -\frac{1}{4}(-4) + b$	10 Perpendicular to $y - 5 = 2(x - 1)$ through (4, -3) $5 = -\frac{1}{2}(1) + b$
11 Perpendicular to $y = 4x - 2$ through (4, 1) $1 = -\frac{1}{4}(4) + b$	12 Perpendicular to $y - 2 = \frac{1}{3}(x - 3)$ through (1, -4) $-4 = -3(1) + b$	13 Parallel to $y = \frac{3}{4}x - 1$ through (4, -2) $2 = \frac{3}{4}(4) + b$	14 Parallel to $y = \frac{2}{3}x + 2$ through (3, -1) $-1 = -\frac{3}{2}(3) + b$	15 Perpendicular to $y + 1 = -\frac{1}{3}(x - 3)$ through (-2, 5) $-2 = 3(5) + b$
16 Parallel to $y - 3 = -\frac{1}{2}(x - 2)$ through (-4, -1) $-1 = -\frac{1}{2}(-4) + b$	17 Perpendicular to $y = \frac{1}{2}x - 5$ through (2, -3) $-3 = -\frac{1}{2}(2) + b$	18 Parallel to $y = 2x + 5$ through (-3, 1) $1 = 2(-3) + b$	19 Parallel to $y - 2 = 4(x - 1)$ through (-2, 3) $2 = 4(1) + b$	20 Perpendicular to $y = -\frac{3}{4}x + 2$ through (4, 3) $3 = -\frac{3}{4}(4) + b$
21 Perpendicular to $y = -\frac{1}{2}x + 4$ through (-2, -3) $-3 = 2(-2) + b$	22 Perpendicular to $y = -\frac{3}{2}x + 1$ through (3, 4) $4 = -\frac{2}{3}(3) + b$	23 Parallel to $y = \frac{1}{4}x - 3$ through (-4, 2) $2 = -4(-4) + b$	24 Perpendicular to $y = 5x - 1$ through (5, 2) $2 = -\frac{1}{5}(5) + b$	25 Perpendicular to $y = -2x + 1$ through (-4, 3) $3 = \frac{1}{2}(4) + b$

Step 1. Find the slope of the given line. If its equation is not solved for y , solve it for y first.

Step 2. Write the slope of the new line on its own. **Parallel:** the same slope.

Perpendicular: the opposite reciprocal. Turn the fraction over *and* change its sign.

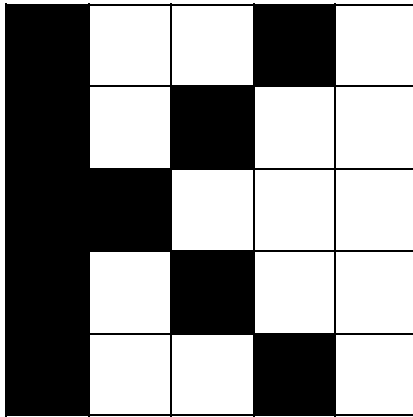
Step 3. Put the NEW slope, and the x and y of the point the NEW line goes through, into $y = mx + b$. Not a point of the given line. That is the first line of the work for b .



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Mystery Picture — answers

For the teacher



The finished picture is **the letter K**. Ten squares are filled.

To check a square, find the new slope: the same as the given line's for a parallel line, the opposite reciprocal for a perpendicular one. The first line is right when it uses that slope and puts the x and y of the point the new line goes through in their places. The table gives the reason for every square. It goes on over the page.

	The square	Answer	Why
1	Perpendicular to $y = 2x - 4$, through $(2, 4)$. First line: $4 = -\frac{1}{2}(2) + b$	fill	The given slope is 2, so the perpendicular slope is $-\frac{1}{2}$, and the point $(2, 4)$ goes in as $x = 2, y = 4$. It leads to $y = -\frac{1}{2}x + 5$.
2	Perpendicular to $y = \frac{1}{2}x + 3$, through $(-4, 3)$. First line: $3 = -2(4) + b$	white	The slope -2 is right, but a coordinate's sign lost: it puts in $x = 4, y = 3$, and the new line goes through $(-4, 3)$. The line is $y = -2x - 5$.
3	Perpendicular to $y - 4 = -3(x + 1)$, through $(3, 2)$. First line: $2 = -3(3) + b$	white	It uses the slope -3 : the given slope put in for a perpendicular. The perpendicular slope is $\frac{1}{3}$. The line is $y = \frac{1}{3}x + 1$.
4	Parallel to $y = -2x + 6$, through $(3, -1)$. First line: $-1 = -2(3) + b$	fill	The given slope is -2 , so the parallel slope is -2 , and the point $(3, -1)$ goes in as $x = 3, y = -1$. It leads to $y = -2x + 5$.
5	Perpendicular to $y = 3x + 2$, through $(3, -2)$. First line: $-2 = -3(3) + b$	white	It uses the slope -3 : the sign changed, the fraction not turned over. The perpendicular slope is $-\frac{1}{3}$. The line is $y = -\frac{1}{3}x - 1$.
6	Perpendicular to $y = -\frac{2}{3}x + 1$, through $(4, 3)$. First line: $3 = \frac{3}{2}(4) + b$	fill	The given slope is $-\frac{2}{3}$, so the perpendicular slope is $\frac{3}{2}$, and the point $(4, 3)$ goes in as $x = 4, y = 3$. It leads to $y = \frac{3}{2}x - 3$.
7	Perpendicular to $y = \frac{1}{3}x - 1$, through $(2, -5)$. First line: $2 = -3(-5) + b$	white	The slope -3 is right, but the x and y of the point swapped: it puts in $x = -5, y = 2$, and the new line goes through $(2, -5)$. The line is $y = -3x + 1$.
8	Parallel to $y = 3x + 1$, through $(-1, 5)$. First line: $5 = 3(-1) + b$	fill	The given slope is 3, so the parallel slope is 3, and the point $(-1, 5)$ goes in as $x = -1, y = 5$. It leads to $y = 3x + 8$.
9	Perpendicular to $y = -4x + 1$, through $(-4, 2)$. First line: $2 = -\frac{1}{4}(-4) + b$	white	It uses the slope $-\frac{1}{4}$: the fraction turned over, the sign not changed. The perpendicular slope is $\frac{1}{4}$. The line is $y = \frac{1}{4}x + 3$.
10	Perpendicular to $y - 5 = 2(x - 1)$, through $(4, -3)$. First line: $5 = -\frac{1}{2}(1) + b$	white	The slope $-\frac{1}{2}$ is right, but a point of the given line put in place of the point: it puts in $x = 1, y = 5$, and the new line goes through $(4, -3)$. The line is $y = -\frac{1}{2}x - 1$.
11	Perpendicular to $y = 4x - 2$, through $(4, 1)$. First line: $1 = -\frac{1}{4}(4) + b$	fill	The given slope is 4, so the perpendicular slope is $-\frac{1}{4}$, and the point $(4, 1)$ goes in as $x = 4, y = 1$. It leads to $y = -\frac{1}{4}x + 2$.
12	Perpendicular to $y - 2 = \frac{1}{3}(x - 3)$, through $(1, -4)$. First line: $-4 = -3(1) + b$	fill	The given slope is $\frac{1}{3}$, so the perpendicular slope is -3 , and the point $(1, -4)$ goes in as $x = 1, y = -4$. It leads to $y = -3x - 1$.

Mystery Picture — answers, squares 13 to 25

For the teacher

	The square	Answer	Why
13	Parallel to $y = \frac{3}{4}x - 1$, through $(4, -2)$. First line: $2 = \frac{3}{4}(4) + b$	white	The slope $\frac{3}{4}$ is right, but a coordinate's sign lost: it puts in $x = 4, y = 2$, and the new line goes through $(4, -2)$. The line is $y = \frac{3}{4}x - 5$.
14	Parallel to $y = \frac{2}{3}x + 2$, through $(3, -1)$. First line: $-1 = -\frac{3}{2}(3) + b$	white	It uses the slope $-\frac{3}{2}$: the opposite reciprocal put in for a parallel. The parallel slope is $\frac{2}{3}$. The line is $y = \frac{2}{3}x - 3$.
15	Perpendicular to $y + 1 = -\frac{1}{3}(x - 3)$, through $(-2, 5)$. First line: $-2 = 3(5) + b$	white	The slope 3 is right, but the x and y of the point swapped: it puts in $x = 5, y = -2$, and the new line goes through $(-2, 5)$. The line is $y = 3x + 11$.
16	Parallel to $y - 3 = -\frac{1}{2}(x - 2)$, through $(-4, -1)$. First line: $-1 = -\frac{1}{2}(-4) + b$	fill	The given slope is $-\frac{1}{2}$, so the parallel slope is $-\frac{1}{2}$, and the point $(-4, -1)$ goes in as $x = -4, y = -1$. It leads to $y = -\frac{1}{2}x - 3$.
17	Perpendicular to $y = \frac{1}{2}x - 5$, through $(2, -3)$. First line: $-3 = -\frac{1}{2}(2) + b$	white	It uses the slope $-\frac{1}{2}$: the sign changed, the fraction not turned over. The perpendicular slope is -2 . The line is $y = -2x + 1$.
18	Parallel to $y = 2x + 5$, through $(-3, 1)$. First line: $1 = 2(-3) + b$	fill	The given slope is 2, so the parallel slope is 2, and the point $(-3, 1)$ goes in as $x = -3, y = 1$. It leads to $y = 2x + 7$.
19	Parallel to $y - 2 = 4(x - 1)$, through $(-2, 3)$. First line: $2 = 4(1) + b$	white	The slope 4 is right, but a point of the given line put in place of the point: it puts in $x = 1, y = 2$, and the new line goes through $(-2, 3)$. The line is $y = 4x + 11$.
20	Perpendicular to $y = -\frac{3}{4}x + 2$, through $(4, 3)$. First line: $3 = -\frac{3}{4}(4) + b$	white	It uses the slope $-\frac{3}{4}$: the given slope put in for a perpendicular. The perpendicular slope is $\frac{4}{3}$. The line is $y = \frac{4}{3}x - \frac{7}{3}$.
21	Perpendicular to $y = -\frac{1}{2}x + 4$, through $(-2, -3)$. First line: $-3 = 2(-2) + b$	fill	The given slope is $-\frac{1}{2}$, so the perpendicular slope is 2, and the point $(-2, -3)$ goes in as $x = -2, y = -3$. It leads to $y = 2x + 1$.
22	Perpendicular to $y = -\frac{3}{2}x + 1$, through $(3, 4)$. First line: $4 = -\frac{2}{3}(3) + b$	white	It uses the slope $-\frac{2}{3}$: the fraction turned over, the sign not changed. The perpendicular slope is $\frac{2}{3}$. The line is $y = \frac{2}{3}x + 2$.
23	Parallel to $y = \frac{1}{4}x - 3$, through $(-4, 2)$. First line: $2 = -4(-4) + b$	white	It uses the slope -4 : the opposite reciprocal put in for a parallel. The parallel slope is $\frac{1}{4}$. The line is $y = \frac{1}{4}x + 3$.
24	Perpendicular to $y = 5x - 1$, through $(5, 2)$. First line: $2 = -\frac{1}{5}(5) + b$	fill	The given slope is 5, so the perpendicular slope is $-\frac{1}{5}$, and the point $(5, 2)$ goes in as $x = 5, y = 2$. It leads to $y = -\frac{1}{5}x + 3$.
25	Perpendicular to $y = -2x + 1$, through $(-4, 3)$. First line: $3 = \frac{1}{2}(4) + b$	white	The slope $\frac{1}{2}$ is right, but a coordinate's sign lost: it puts in $x = 4, y = 3$, and the new line goes through $(-4, 3)$. The line is $y = \frac{1}{2}x + 5$.