

MYSTERY PICTURE



SLOPES OF PARALLEL AND PERPENDICULAR LINES

Perpendicular or Not? Opposite Reciprocals

25 pairs of slopes · change the sign, turn it over · no calculator · a picture appears

FREE

1 n: slope $\frac{3}{2}$ m: $y = \frac{2}{3}x - 1$	2 n: slope $\frac{2}{3}$ m: $y = -\frac{3}{2}x + 1$	3 n: $y = \frac{5}{4}x + 2$ m: slope $-\frac{5}{4}$	4 n: slope $\frac{5}{3}$ m: slope $-\frac{3}{4}$	5 n: slope $-\frac{5}{3}$ m: slope $-\frac{3}{5}$
6 n: slope $-\frac{3}{4}$ m: $y = -\frac{3}{4}x + 2$	7 n: $y = -4x + 2$ m: slope $\frac{1}{4}$	8 n: slope $-\frac{2}{3}$ m: slope $\frac{2}{3}$	9 n: $y = 4x - 3$ m: slope $\frac{1}{4}$	10 n: slope 3 m: $y = -3x + 1$
11 n: slope $-\frac{2}{9}$ m: slope $-\frac{9}{2}$	12 n: slope $-\frac{1}{3}$ m: $y = 3x - 2$	13 n: $y = -\frac{1}{2}x + 4$ m: slope 3	14 n: slope $-\frac{7}{5}$ m: slope $\frac{7}{5}$	15 n: slope $\frac{7}{3}$ m: $y = \frac{3}{7}x - 2$
16 n: slope $\frac{1}{6}$ m: slope $-\frac{1}{6}$	17 n: $y = \frac{3}{4}x - 1$ m: slope $-\frac{4}{3}$	18 n: slope -6 m: $y = -\frac{1}{6}x + 3$	19 n: $y = \frac{4}{7}x + 1$ m: slope $-\frac{4}{7}$	20 n: slope $\frac{2}{5}$ m: $y = -\frac{3}{2}x + 2$
21 n: $y = \frac{5}{2}x - 3$ m: slope $\frac{5}{2}$	22 n: slope $\frac{2}{7}$ m: $y = -\frac{7}{2}x + 3$	23 n: $y = -\frac{6}{5}x + 4$ m: $y = \frac{5}{6}x - 3$	24 n: slope $-\frac{3}{8}$ m: $y = \frac{8}{3}x + 2$	25 n: $y = \frac{9}{4}x - 1$ m: slope $-\frac{4}{9}$

Mystery Picture — how to run it

25–35 minutes

1. **Give each student page 3** and a pencil. No calculator is needed.
2. **Say this once:** *“Each square gives two lines. Find the two slopes. Change the sign of one and turn it over. If you get the other slope, the lines are perpendicular: 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 top shows parallel, perpendicular and neither, and the two steps.
Answers	page 4, for you.

Each square gives two lines, n and m. A line is given by its slope, or by an equation already solved for y, like $y = 3x + 1$, so its slope is the number in front of x. Two lines are perpendicular when their slopes are opposite reciprocals: change the sign and turn the fraction over. Eight squares are filled.

The white squares are the mistakes students make. In six of them, one slope is the other turned over with the same sign: $3/2$ with $2/3$, for example. In six, the sign is changed and the fraction is not turned over: $5/4$ with $-5/4$, for example. Students who know only one of the two steps fill these squares, and the picture comes out wrong. Three more have different signs and different numbers, and two have equal slopes.

If part of a student’s picture looks wrong, the mistake is in that square. Ask: *“Did the sign change? Did the fraction turn over? Both must happen.”* Guessing does not work. Every simple guessing rule, such as filling every square where the signs differ, gets at least six 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 — perpendicular or not?

Perpendicular slopes

Name _____

Period _____

Date _____

Each square gives two lines, n and m . Find the two slopes. In an equation like $y = 3x + 1$, the slope is the number in front of x : here it is 3. **Are the lines perpendicular? If yes, fill the square with slanted lines. If no, leave it white.** A picture appears. If part of it is missing, check that square again.

Parallel
slopes $\frac{2}{3}$ and $\frac{2}{3}$

Perpendicular
slopes $\frac{2}{3}$ and $-\frac{3}{2}$

Neither
slopes $\frac{2}{3}$ and $-\frac{2}{3}$

Perpendicular slope, in two steps: change the sign, then turn the fraction over. $-\frac{2}{3} \rightarrow \frac{2}{3} \rightarrow \frac{3}{2}$.

Perpendicular lines meet at a right angle. Their slopes are opposite reciprocals.

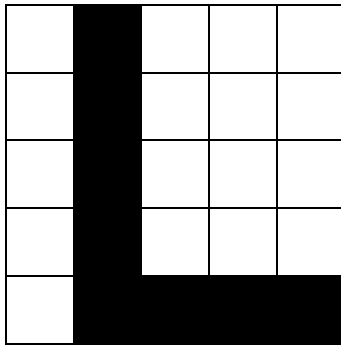
1 n : slope $\frac{3}{2}$ m : $y = \frac{2}{3}x - 1$	2 n : slope $\frac{2}{3}$ m : $y = -\frac{3}{2}x + 1$	3 n : $y = \frac{5}{4}x + 2$ m : slope $-\frac{5}{4}$	4 n : slope $\frac{5}{3}$ m : slope $-\frac{3}{4}$	5 n : slope $-\frac{5}{3}$ m : slope $-\frac{3}{5}$
6 n : slope $-\frac{3}{4}$ m : $y = -\frac{3}{4}x + 2$	7 n : $y = -4x + 2$ m : slope $\frac{1}{4}$	8 n : slope $-\frac{2}{3}$ m : slope $\frac{2}{3}$	9 n : $y = 4x - 3$ m : slope $\frac{1}{4}$	10 n : slope 3 m : $y = -3x + 1$
11 n : slope $-\frac{2}{9}$ m : slope $-\frac{9}{2}$	12 n : slope $-\frac{1}{3}$ m : $y = 3x - 2$	13 n : $y = -\frac{1}{2}x + 4$ m : slope 3	14 n : slope $-\frac{7}{5}$ m : slope $\frac{7}{5}$	15 n : slope $\frac{7}{3}$ m : $y = \frac{3}{7}x - 2$
16 n : slope $\frac{1}{6}$ m : slope $-\frac{1}{6}$	17 n : $y = \frac{3}{4}x - 1$ m : slope $-\frac{4}{3}$	18 n : slope -6 m : $y = -\frac{1}{6}x + 3$	19 n : $y = \frac{4}{7}x + 1$ m : slope $-\frac{4}{7}$	20 n : slope $\frac{2}{5}$ m : $y = -\frac{3}{2}x + 2$
21 n : $y = \frac{5}{2}x - 3$ m : slope $\frac{5}{2}$	22 n : slope $\frac{2}{7}$ m : $y = -\frac{7}{2}x + 3$	23 n : $y = -\frac{6}{5}x + 4$ m : $y = \frac{5}{6}x - 3$	24 n : slope $-\frac{3}{8}$ m : $y = \frac{8}{3}x + 2$	25 n : $y = \frac{9}{4}x - 1$ m : slope $-\frac{4}{9}$



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Mystery Picture — answers

For the teacher



The finished picture is **the letter L**. Eight squares are filled.

To check a square, find the two slopes. In an equation solved for y , the slope is the number in front of x . Change the sign of the first and turn it over. The square is filled only when that gives the second slope. This sheet writes every slope as a whole number or a fraction in lowest terms. Some textbooks use other definitions, so tell the class which ones this sheet uses.

	The square	Answer	Why
1	n : slope $3/2$. m : $y = (2/3)x - 1$.	white	The slope of n is $3/2$, and the slope of m is $2/3$. The fraction is turned over, but the sign is kept. The perpendicular slope is $-2/3$.
2	n : slope $2/3$. m : $y = -(3/2)x + 1$.	fill	The slope of n is $2/3$, and the slope of m is $-3/2$. Change the sign of $2/3$ and turn it over: that gives $-3/2$. Perpendicular.
3	n : $y = (5/4)x + 2$. m : slope $-5/4$.	white	The slope of n is $5/4$, and the slope of m is $-5/4$. The sign is changed, but the fraction is not turned over. The perpendicular slope is $-4/5$.
4	n : slope $5/3$. m : slope $-3/4$.	white	The slope of n is $5/3$, and the slope of m is $-3/4$. The signs differ, but the fraction is not turned over. The perpendicular slope is $-3/5$.
5	n : slope $-5/3$. m : slope $-3/5$.	white	The slope of n is $-5/3$, and the slope of m is $-3/5$. The fraction is turned over, but the sign is kept. The perpendicular slope is $3/5$.
6	n : slope $-3/4$. m : $y = -(3/4)x + 2$.	white	Both slopes are $-3/4$. Equal slopes are never perpendicular.
7	n : $y = -4x + 2$. m : slope $1/4$.	fill	The slope of n is -4 , and the slope of m is $1/4$. Change the sign of -4 and turn it over: that gives $1/4$. Perpendicular.
8	n : slope $-2/3$. m : slope $2/3$.	white	The slope of n is $-2/3$, and the slope of m is $2/3$. The sign is changed, but the fraction is not turned over. The perpendicular slope is $3/2$.
9	n : $y = 4x - 3$. m : slope $1/4$.	white	The slope of n is 4 , and the slope of m is $1/4$. The fraction is turned over, but the sign is kept. The perpendicular slope is $-1/4$.
10	n : slope 3 . m : $y = -3x + 1$.	white	The slope of n is 3 , and the slope of m is -3 . The sign is changed, but the fraction is not turned over. The perpendicular slope is $-1/3$.
11	n : slope $-2/9$. m : slope $-9/2$.	white	The slope of n is $-2/9$, and the slope of m is $-9/2$. The fraction is turned over, but the sign is kept. The perpendicular slope is $9/2$.
12	n : slope $-1/3$. m : $y = 3x - 2$.	fill	The slope of n is $-1/3$, and the slope of m is 3 . Change the sign of $-1/3$ and turn it over: that gives 3 . Perpendicular.
13	n : $y = -(1/2)x + 4$. m : slope 3 .	white	The slope of n is $-1/2$, and the slope of m is 3 . The signs differ, but the fraction is not turned over. The perpendicular slope is 2 .
14	n : slope $-7/5$. m : slope $7/5$.	white	The slope of n is $-7/5$, and the slope of m is $7/5$. The sign is changed, but the fraction is not turned over. The perpendicular slope is $5/7$.
15	n : slope $7/3$. m : $y = (3/7)x - 2$.	white	The slope of n is $7/3$, and the slope of m is $3/7$. The fraction is turned over, but the sign is kept. The perpendicular slope is $-3/7$.
16	n : slope $1/6$. m : slope $-1/6$.	white	The slope of n is $1/6$, and the slope of m is $-1/6$. The sign is changed, but the fraction is not turned over. The perpendicular slope is -6 .
17	n : $y = (3/4)x - 1$. m : slope $-4/3$.	fill	The slope of n is $3/4$, and the slope of m is $-4/3$. Change the sign of $3/4$ and turn it over: that gives $-4/3$. Perpendicular.
18	n : slope -6 . m : $y = -(1/6)x + 3$.	white	The slope of n is -6 , and the slope of m is $-1/6$. The fraction is turned over, but the sign is kept. The perpendicular slope is $1/6$.
19	n : $y = (4/7)x + 1$. m : slope $-4/7$.	white	The slope of n is $4/7$, and the slope of m is $-4/7$. The sign is changed, but the fraction is not turned over. The perpendicular slope is $-7/4$.
20	n : slope $2/5$. m : $y = -(3/2)x + 2$.	white	The slope of n is $2/5$, and the slope of m is $-3/2$. The signs differ, but the fraction is not turned over. The perpendicular slope is $-5/2$.
21	n : $y = (5/2)x - 3$. m : slope $5/2$.	white	Both slopes are $5/2$. Equal slopes are never perpendicular.
22	n : slope $2/7$. m : $y = -(7/2)x + 3$.	fill	The slope of n is $2/7$, and the slope of m is $-7/2$. Change the sign of $2/7$ and turn it over: that gives $-7/2$. Perpendicular.
23	n : $y = -(6/5)x + 4$. m : $y = (5/6)x - 3$.	fill	The slope of n is $-6/5$, and the slope of m is $5/6$. Change the sign of $-6/5$ and turn it over: that gives $5/6$. Perpendicular.
24	n : slope $-3/8$. m : $y = (8/3)x + 2$.	fill	The slope of n is $-3/8$, and the slope of m is $8/3$. Change the sign of $-3/8$ and turn it over: that gives $8/3$. Perpendicular.
25	n : $y = (9/4)x - 1$. m : slope $-4/9$.	fill	The slope of n is $9/4$, and the slope of m is $-4/9$. Change the sign of $9/4$ and turn it over: that gives $-4/9$. Perpendicular.