

CUT & GLUE SORT

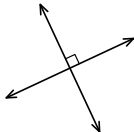


SLOPES OF PARALLEL AND PERPENDICULAR LINES

Perpendicular or Not? Slopes, Equations, Graphs

Twelve pairs of lines · perpendicular or not · three rows

FREE

1 Line n has slope $\frac{2}{5}$. Line m has slope $-\frac{2}{5}$.	2 	3 Line n has slope $\frac{3}{4}$. Line m passes through the point $(0, 0)$.
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Row 1. Perpendicular. The two lines meet at a right angle.

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Row 2. Not perpendicular. The two lines do not meet at a right angle.

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Row 3. Cannot tell. The piece does not give enough to decide.

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Cut & Glue Sort — how to run it

25 minutes, including the cutting

1. **Hand out pages 3 and 4**, one of each per student, with scissors and glue. No calculator is needed.
2. **Say this once:** *“Are the two lines perpendicular? Use the slopes, the equations, the dots on the grid, or a right-angle mark. Do not measure. If the piece does not give enough, put it in row 3.”*
3. **Check a sheet in ten seconds:** every row gets four pieces.

Student sheets pages 3 and 4, one of each per student. Page 3 has the three rows. Page 4 has the pieces and a box that shows parallel, perpendicular and neither.

Answers page 5.

Two lines are perpendicular when their slopes are opposite reciprocals: change the sign and turn the fraction over. On square paper, the student counts squares between two dots on each line to find its slope. A vertical line has no slope, but a vertical line and a horizontal line are still perpendicular. That piece belongs in row 1, not row 3: the slope rule cannot decide it, but the lines are perpendicular.

Row 2 holds the pieces that tempt students most. One pair has the sign changed but not turned over. One has the fraction turned over but the sign kept. One pair on square paper looks perpendicular, but counting gives slopes $3/4$ and $-5/4$, so it is not. The last gives two horizontal lines, $y = 4$ and $y = -1$. They are parallel, not perpendicular.

Row 3 holds pieces that do not give enough to decide. Two are drawings on plain paper with no grid, no numbers and no mark: the lines look perpendicular, but a drawing alone cannot show an exact right angle. Two give one line by a single point, and many lines with different slopes pass through one point. A plain drawing *with* a right-angle mark is in row 1. Guessing does not work: a simple guessing rule, such as sorting by how the lines look, places at most six pieces correctly.



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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Cut & Glue Sort — perpendicular or not?

Slopes of perpendicular lines

Name _____

Period _____

Date _____

Each piece on the next page shows two lines. **Are the two lines perpendicular? Glue the piece in its row.** Use only what the piece gives: slopes, equations, points, dots on square paper, or a small square that marks a right angle. Do not measure with a protractor.

Row 1. Perpendicular. The two lines meet at a right angle.

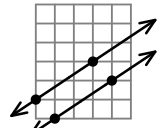
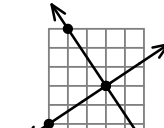
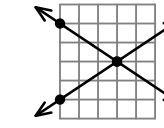
Row 2. Not perpendicular. The two lines do not meet at a right angle.

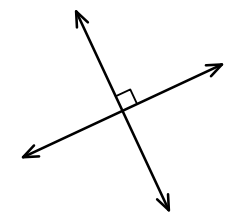
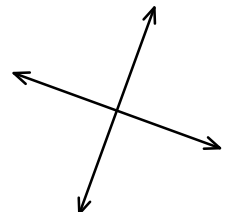
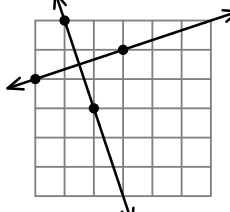
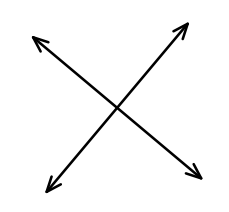
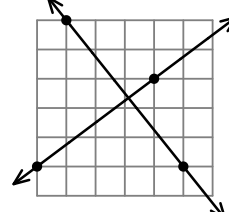
Row 3. Cannot tell. The piece does not give enough to decide.

Cut & Glue Sort — the pieces

Cut along the dashed lines

Cut out the twelve pieces. Glue each one in its row on the other sheet. On square paper, count the squares between the dots.

 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. $-\frac{2}{3} \rightarrow \frac{2}{3} \rightarrow \frac{3}{2}$. A vertical line, like $x = 3$, has no slope. A vertical line and a horizontal line, like $y = -1$, are perpendicular.
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1 Line n has slope $\frac{2}{5}$. Line m has slope $-\frac{2}{5}$.	2 	3 Line n has slope $\frac{3}{4}$. Line m passes through the point $(0, 0)$.	4 
5 Line $n: y = 3x + 2$ Line $m: y = \frac{1}{3}x - 1$	6 	7 Line $n: x = 3$ Line $m: y = -1$	8 
9 	10 Line $n: y = 4$ Line $m: y = -1$	11 Line $n: y = -4x + 1$ Line $m: y = \frac{1}{4}x - 2$	12 Line $n: y = -2x + 1$ Line m passes through the point $(0, 1)$.



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Each row holds four pieces. Every piece is described again here, with the reason. This sheet calls two lines perpendicular when they meet at a right angle, and says a vertical line has no slope. Some textbooks use other definitions, so tell the class which ones this sheet uses.

1 Perpendicular. The two lines meet at a right angle.

- 2.** Two lines on plain paper, with a right-angle mark where they cross. *Why:* A small square marks the right angle where the two lines cross.
- 6.** Two lines on square paper, each through two dots. *Why:* Count squares between the dots. One line goes 3 across and 1 up: slope $1/3$. The other goes 1 across and 3 down: slope -3 . Change the sign of $1/3$ and turn it over: -3 . These are opposite reciprocals.
- 7.** Line n: $x = 3$. Line m: $y = -1$. *Why:* $x = 3$ is a vertical line and $y = -1$ is a horizontal line. A vertical line and a horizontal line are perpendicular. The vertical line has no slope, so the slope rule does not decide this pair, but the lines are still perpendicular.
- 11.** Line n: $y = -4x + 1$. Line m: $y = (1/4)x - 2$. *Why:* The slopes are -4 and $1/4$. Change the sign of -4 and turn it over: $1/4$. These are opposite reciprocals.

2 Not perpendicular. The two lines do not meet at a right angle.

- 1.** Line n: slope $2/5$. Line m: slope $-2/5$. *Why:* The slopes are $2/5$ and $-2/5$. The sign is changed, but the fraction is not turned over. The perpendicular slope would be $-5/2$.
- 5.** Line n: $y = 3x + 2$. Line m: $y = (1/3)x - 1$. *Why:* The slopes are 3 and $1/3$. The fraction is turned over, but the sign is kept. The perpendicular slope would be $-1/3$.
- 9.** Two lines on square paper, each through two dots. *Why:* Count squares between the dots. One line goes 4 across and 3 up: slope $3/4$. The other goes 4 across and 5 down: slope $-5/4$. The opposite reciprocal of $3/4$ is $-4/3$, so they are not perpendicular, even though they look it.
- 10.** Line n: $y = 4$. Line m: $y = -1$. *Why:* $y = 4$ and $y = -1$ are both horizontal lines with slope 0. They are parallel, not perpendicular.

3 Cannot tell. The piece does not give enough to decide.

- 3.** Line n: slope $3/4$. Line m passes through $(0, 0)$. *Why:* Line m is given by one point only, $(0, 0)$. Many lines with different slopes pass through that point, so nothing fixes how m runs.
- 4.** Two lines on plain paper, with no mark, no grid and no numbers. *Why:* The lines look perpendicular, but there is no grid, no number and no right-angle mark. A drawing alone cannot show an exact right angle.
- 8.** Two lines on plain paper, with no mark, no grid and no numbers. *Why:* The lines look perpendicular, but there is no grid, no number and no right-angle mark. A drawing alone cannot show an exact right angle.
- 12.** Line n: $y = -2x + 1$. Line m passes through $(0, 1)$. *Why:* Line m is given by one point only, $(0, 1)$. Many lines with different slopes pass through that point, so nothing fixes how m runs.

To check a piece with a student, ask: “What is the slope of each line? Change the sign of one and turn it over. Do you get the other? And if a line has no slope, is it vertical, or is it not given?”