

# Parallel and Perpendicular Lines

Name: \_\_\_\_\_ Date: \_\_\_\_\_ Score: \_\_\_\_\_ / 26

## Quick Review

Two lines are **parallel** if they have the *same slope* — they go in the same direction and never meet. (Different  $y$ -intercepts, though, or they'd be the same line.) Two lines are **perpendicular** if their slopes are **negative reciprocals** — they multiply to  $-1$ . If one slope is  $\frac{2}{3}$ , the perpendicular slope is  $-\frac{3}{2}$ . Flip the fraction and negate. Horizontal lines ( $y = k$ ) are perpendicular to vertical lines ( $x = h$ ) — a special case. To **write a line parallel/perpendicular to a given line through a point**: figure out the new slope (same or negative reciprocal), then use point-slope form.

## PRACTICE

Find slopes or write equations of parallel/perpendicular lines.

- |  |  |
|--|--|
| 1. What slope must a line have to be parallel to $y = 2x + 1$ ? _____  | 11. Are $y = 3x$ and $y = -\frac{1}{3}x$ perp.? _____  |
| 2. Perpendicular to $y = 2x + 1$ _____                                 | 12. What slope is perpendicular to $y = -\frac{2}{5}x$ ? _____                                 |
| 3. What slope must a line have to be parallel to $y = -3x + 4$ ? _____ | 13. Write the equation of the line through the origin that is parallel to $y = 4x - 2$ . _____ |
| 4. Perpendicular to $y = -3x + 4$ _____                                | 14. Perp. to $y = -x + 7$ _____  |
| 5. What slope is parallel to the line $y = \frac{1}{2}x$ ? _____       | 15. Are $y = \frac{2}{3}x + 1$ and $y = -\frac{3}{2}x + 1$ perp.? _____                        |
| 6. What slope is perpendicular to the line $y = \frac{1}{2}x$ ? _____  | 16. Are $y = 2x$ and $y = 2x + 5$ same? _____  |
| 7. Parallel through $(2, 5)$ to $y = 3x + 1$ _____                     | 17. Slope perp. to $2x + 3y = 6$ _____   |
| 8. Perp. through $(2, 5)$ to $y = 3x + 1$ _____                        | 18. Perp. through $(0, 0)$ to $y = 5x$ _____   |
| 9. Perp. to horizontal _____   | 19. Write the line through $(-1, 4)$ that is parallel to $y = x - 3$ . _____                   |
| 10. Are $y = 2x + 1$ and $y = 2x - 5$ parallel? _____                  | 20. Perp. through $(4, -2)$ to $y = 2x$ _____  |

## VISUAL PRACTICE

Use the graph, table, chart, or diagram to answer the question.

21. Find the slope of a line parallel to the graphed line.



Answer: \_\_\_\_\_

22. The graphed line has slope 2. What is the slope of a perpendicular line?



Answer: \_\_\_\_\_



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## ◆ Word Problems

23. A street runs along the line  $y = \frac{2}{3}x + 1$ . A perpendicular cross street passes through  $(6, 5)$ . Find its equation.

Model: \_\_\_\_\_

Answer: \_\_\_\_\_

24. Two roads are modeled by lines with slopes  $\frac{3}{4}$  and  $-\frac{4}{3}$ . Determine whether the roads are perpendicular and justify your answer.

Model: \_\_\_\_\_

Answer: \_\_\_\_\_

25. A roof beam runs along  $y = -\frac{1}{2}x + 10$ . A support beam runs perpendicular through the point  $(4, 8)$ . Write the support beam's equation.

Model: \_\_\_\_\_

Answer: \_\_\_\_\_

26. Two train tracks must be parallel for safety. Track A has equation  $y = 4x - 7$ . Track B passes through  $(0, 3)$ . Write Track B's equation.

Model: \_\_\_\_\_

Answer: \_\_\_\_\_



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## Answer Keys

- |  |  |
|--|--|
| <p>1. <math>m = 2</math></p> <p>2. <math>m = -\frac{1}{2}</math></p> <p>3. <math>m = -3</math></p> <p>4. <math>m = \frac{1}{3}</math></p> <p>5. <math>m = \frac{1}{2}</math></p> <p>6. <math>m = -2</math></p> <p>7. <math>y = 3x - 1</math></p> <p>8. <math>y = -\frac{1}{3}x + \frac{17}{3}</math></p> <p>9. vertical</p> <p>10. yes</p> <p>11. yes</p> <p>12. <math>m = \frac{5}{2}</math></p> <p>13. <math>y = 4x</math></p> | <p>14. <math>m = 1</math></p> <p>15. yes</p> <p>16. no, parallel</p> <p>17. <math>m = \frac{3}{2}</math></p> <p>18. <math>y = -\frac{1}{5}x</math></p> <p>19. <math>y = x + 5</math></p> <p>20. <math>y = -\frac{1}{2}x</math></p> <p>21. 2</p> <p>22. <math>-\frac{1}{2}</math></p> <p>23. <math>y = -\frac{3}{2}x + 14</math></p> <p>24. yes</p> <p>25. <math>y = 2x</math></p> <p>26. <math>y = 4x + 3</math></p> |
|--|--|

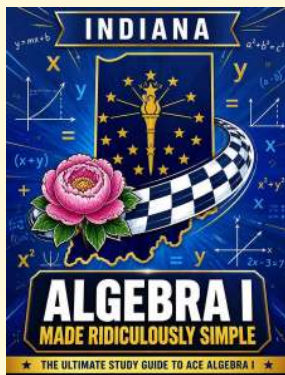
### Step-by-Step Tutor Notes

- Parallel lines have the same slope. The given line has slope 2, so the parallel line also has slope 2.
- Focus on the main idea of the problem, then simplify carefully. Negative reciprocal of 2. So the answer is  $m = -\frac{1}{2}$ .
- Read the slope from slope-intercept form:  $m = -3$ . A parallel line keeps that same slope.
- Use the clue in the question first, then let the arithmetic finish the job. Flip  $-3$  to  $-\frac{1}{3}$ , negate to  $\frac{1}{3}$ . So the answer is  $m = \frac{1}{3}$ .
- Compare the change in output to the change in input, because slope is a rate of change. Parallel lines match slopes, so the slope stays  $\frac{1}{2}$ . So the requested value is  $m = \frac{1}{2}$ .
- A perpendicular slope is the negative reciprocal. Flip  $\frac{1}{2}$  to 2 and change the sign to get  $-2$ .
- Read the table by matching the correct row and column first, then use the count or total that fits the question. Same slope 3.  $5 = 3(2) + b \Rightarrow b = -1$ . This gives  $y = 3x - 1$ .
- Use the labels on the display first; they tell you which count or total belongs in the answer. Slope  $-\frac{1}{3}$ .  $5 = -\frac{1}{3}(2) + b \Rightarrow b = \frac{17}{3}$ . This gives  $y = -\frac{1}{3}x + \frac{17}{3}$ .
- Think of slope as the amount the output changes for each 1-unit change in the input. Horizontal ( $m = 0$ ) is perpendicular to vertical (undefined slope). So the requested value is vertical.
- Think of slope as the amount the output changes for each 1-unit change in the input. Same slope, different  $y$ -intercepts. So the requested value is yes.
- This is a good place to slow down, check the notation, and simplify cleanly.  $3 \cdot (-\frac{1}{3}) = -1$ . So the answer is yes.
- The original slope is  $-\frac{2}{5}$ . Flip the fraction and change the sign, so the perpendicular slope is  $\frac{5}{2}$ .
- A parallel line has the same slope, 4. Passing through the origin means  $b = 0$ , so the equation is  $y = 4x$ .
- Compare the change in output to the change in input, because slope is a rate of change. Slope of original is  $-1$ . Negative reciprocal: 1. So the requested value is  $m = 1$ .
- Start with the definition the problem is testing, then apply it directly.  $\frac{2}{3} \cdot (-\frac{3}{2}) = -1$ . So the answer is yes.
- Compare the change in output to the change in input, because slope is a rate of change. Same slope but different intercepts — parallel but distinct. So the requested value is no, parallel.
- Line up the two changes first; that keeps the rate from getting mixed up. Convert:  $y = -\frac{2}{3}x + 2$ . Perp slope:  $\frac{3}{2}$ . So the requested value is  $m = \frac{3}{2}$ .
- Compare the change in output to the change in input, because slope is a rate of change. Slope  $-\frac{1}{5}$ , through origin. So the requested value is  $y = -\frac{1}{5}x$ .
- The given line has slope 1, so the parallel line also has slope 1. Use  $(-1, 4)$  in  $y = x + b$ :  $4 = -1 + b$ , so  $b = 5$ .
- Use the labels on the display first; they tell you which count or total belongs in the answer.  $m = -\frac{1}{2}$ .  $-2 = -\frac{1}{2}(4) + b \Rightarrow b = 0$ . This gives  $y = -\frac{1}{2}x$ .
- Compare the change in output to the change in input, because slope is a rate of change. Parallel lines have the same slope, so the parallel slope is 2. So the requested value is 2.
- Think of slope as the amount the output changes for each 1-unit change in the input. Perpendicular slopes are opposite reciprocals. The opposite reciprocal of 2 is  $-\frac{1}{2}$ . So the requested value is  $-\frac{1}{2}$ .
- Perp slope:  $-\frac{3}{2}$ . Through  $(6, 5)$ :  $5 = -\frac{3}{2}(6) + b \Rightarrow b = 14$ .
- Set up the model from the story, then calculate carefully.  $\frac{3}{4} \cdot (-\frac{4}{3}) = -1$ . They meet at a right angle.
- Read the table by matching the correct row and column first, then use the count or total that fits the question. Perp slope: 2. Through  $(4, 8)$ :  $8 = 2(4) + b \Rightarrow b = 0$ . This gives  $y = 2x$ .
- Line up the two changes first; that keeps the rate from getting mixed up. Same slope:  $m = 4$ . Through  $(0, 3)$ :  $b = 3$ . So the requested value is  $y = 4x + 3$ .



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