

3.4 Find and Use Slopes of Lines



- Before** You used properties of parallel lines to find angle measures.
- Now** You will find and compare slopes of lines.
- Why** So you can compare rates of speed, as in Example 4.

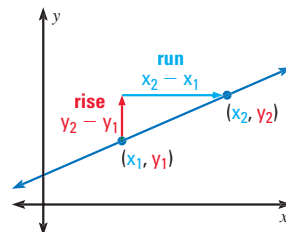
Key Vocabulary

- **slope**, p. 879
- **rise**, p. 879
- **run**, p. 879

The **slope** of a nonvertical line is the ratio of vertical change (*rise*) to horizontal change (*run*) between any two points on the line.

If a line in the coordinate plane passes through points (x_1, y_1) and (x_2, y_2) then the slope m is

$$m = \frac{\text{rise}}{\text{run}} = \frac{\text{change in } y}{\text{change in } x} = \frac{y_2 - y_1}{x_2 - x_1}$$

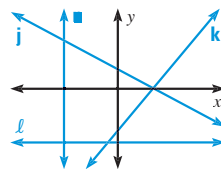


KEY CONCEPT

For Your Notebook

Slope of Lines in the Coordinate Plane

- Negative slope:** falls from left to right, as in line j
- Positive slope:** rises from left to right, as in line k
- Zero slope (slope of 0):** horizontal, as in line ℓ
- Undefined slope:** vertical, as in line n



EXAMPLE 1 Find slopes of lines in a coordinate plane

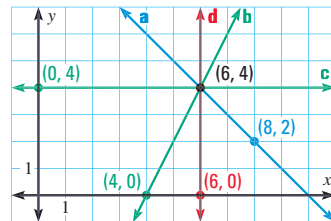
Find the slope of line a and line d .

Solution

$$\text{Slope of line } a: m = \frac{y_2 - y_1}{x_2 - x_1} = \frac{4 - 2}{6 - 8} = \frac{2}{-2} = -1$$

$$\text{Slope of line } d: m = \frac{y_2 - y_1}{x_2 - x_1} = \frac{4 - 0}{6 - 6} = \frac{4}{0},$$

which is undefined.



REVIEW SLOPE

For more help with slope, see p. 879.



GUIDED PRACTICE for Example 1

Use the graph in Example 1. Find the slope of the line.

1. Line b **2**
2. Line c **0**

COMPARING SLOPES When two lines intersect in a coordinate plane, the steeper line has the slope with greater absolute value. You can also compare slopes to tell whether two lines are parallel or perpendicular.

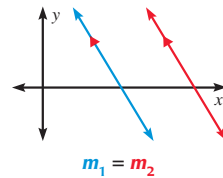
POSTULATES

For Your Notebook

POSTULATE 17 Slopes of Parallel Lines

In a coordinate plane, two nonvertical lines are parallel if and only if they have the same slope.

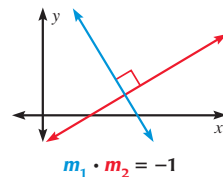
Any two vertical lines are parallel.



POSTULATE 18 Slopes of Perpendicular Lines

In a coordinate plane, two nonvertical lines are perpendicular if and only if the product of their slopes is -1 .

Horizontal lines are perpendicular to vertical lines.



READ VOCABULARY

If the product of two numbers is -1 , then the numbers are called *negative reciprocals*.

EXAMPLE 2 Identify parallel lines

Find the slope of each line. Which lines are parallel?

Solution

Find the slope of k_1 through $(-2, 4)$ and $(-3, 0)$.

$$m_1 = \frac{0 - 4}{-3 - (-2)} = \frac{-4}{-1} = 4$$

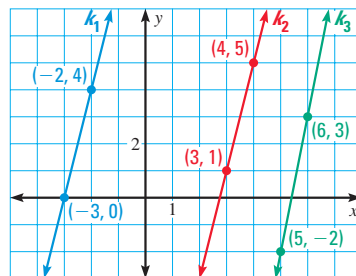
Find the slope of k_2 through $(4, 5)$ and $(3, 1)$.

$$m_2 = \frac{1 - 5}{3 - 4} = \frac{-4}{-1} = 4$$

Find the slope of k_3 through $(6, 3)$ and $(5, -2)$.

$$m_3 = \frac{-2 - 3}{5 - 6} = \frac{-5}{-1} = 5$$

► Compare the slopes. Because k_1 and k_2 have the same slope, they are parallel. The slope of k_3 is different, so k_3 is not parallel to the other lines.



GUIDED PRACTICE for Example 2

3. Line m passes through $(-1, 3)$ and $(4, 1)$. Line t passes through $(-2, -1)$ and $(3, -3)$. Are the two lines parallel? *Explain* how you know.

Yes; they have the same slope.

EXAMPLE 3 Draw a perpendicular line

Line h passes through $(3, 0)$ and $(7, 6)$. Graph the line perpendicular to h that passes through the point $(2, 5)$.

Solution

STEP 1 Find the slope m_1 of line h through $(3, 0)$ and $(7, 6)$.

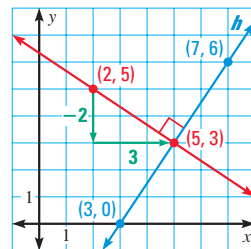
$$m_1 = \frac{6 - 0}{7 - 3} = \frac{6}{4} = \frac{3}{2}$$

STEP 2 Find the slope m_2 of a line perpendicular to h . Use the fact that the product of the slopes of two perpendicular lines is -1 .

$$\frac{3}{2} \cdot m_2 = -1 \quad \text{Slopes of perpendicular lines}$$

$$m_2 = \frac{-2}{3} \quad \text{Multiply each side by } \frac{2}{3}$$

STEP 3 Use the rise and run to graph the line.



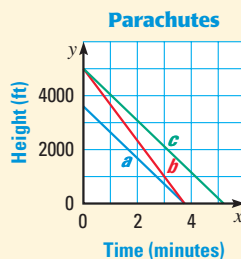
REVIEW GRAPHING

Given a point on a line and the line's slope, you can use the rise and run to find a second point and draw the line.



EXAMPLE 4 Standardized Test Practice

A skydiver made jumps with three parachutes. The graph shows the height of the skydiver from the time the parachute opened to the time of the landing for each jump. Which statement is true?



- (A) The parachute opened at the same height in jumps a and b .
- (B) The parachute was open for the same amount of time in jumps b and c .
- (C) The skydiver descended at the same rate in jumps a and b .
- (D) The skydiver descended at the same rate in jumps a and c .

ELIMINATE CHOICES

The y -intercept represents the height when the parachute opened, so the heights in jumps a and b were not the same. So you can eliminate choice A.

Solution

The rate at which the skydiver descended is represented by the slope of the segments. The segments that have the same slope are a and c .

► The correct answer is D. (A) (B) (C) (D)



GUIDED PRACTICE for Examples 3 and 4

5. Parachute c . *Sample answer:* It was in the air approximately 1.25 minutes longer than either a or b .

4. Line n passes through $(0, 2)$ and $(6, 5)$. Line m passes through $(2, 4)$ and $(4, 0)$. Is $n \perp m$? *Explain.* **Yes; the product of their slopes is -1 .**
5. In Example 4, which parachute is in the air for the longest time? *Explain.*
6. In Example 4, what do the x -intercepts represent in the situation? How can you use this to eliminate one of the choices? **Time of the landing.**
Sample answer: b and c are in the air different amounts of time.