

Graphing and Writing Linear Equations

- **13.1** Graphing Linear Equations
- **13.2** Slope of a Line
- **13.3** Graphing Proportional Relationships
- **13.4** Graphing Linear Equations in Slope-Intercept Form
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Chapter Learning Target:

Understand graphing linear equations.

Chapter Success Criteria:

- I can identify key features of a graph.
- I can explain the meaning of different forms of linear equations.
- I can interpret the slope and intercepts of a line.
- I can create graphs of linear equations.
- **13.6** Writing Equations in Slope-Intercept Form
- **13.7** Writing Equations in Point-Slope Form



STEAM Video



Wind Speed



Performance Task



Hurricane!

A hurricane is a storm with violent winds. How can you prepare your home for a hurricane?

Watch the STEAM Video "Hurricane!" Then answer the following questions.

- 1. Robert says that the closer you are to the eye of a hurricane, the stronger the winds become. The wind speed on an island is 50 miles per hour when the eye of a hurricane is 140 miles away.
 - **a.** Describe the wind speed on the island when the eye of the hurricane is 100 miles away.
 - **b.** Describe the distance of the island from the eye of the hurricane when the wind speed on the island is 25 miles per hour.
 - **c.** Sketch a line that could represent the wind speed *y* (in miles per hour) on the island when the eye of the hurricane is *x* miles away from the island.
- **2.** A storm dissipates as it travels over land. What does this mean?

Anatomy of a Hurricane

After completing this chapter, you will be able to use the concepts you learned to answer the questions in the *STEAM Video Performance Task*. You will be given information about the atmospheric pressure inside a hurricane.

Time, <i>x</i> (hours)	Atmospheric Pressure, <i>y</i> (millibars)
18	1008
36	999
84	975

You will be asked to use a model to find the strength of a hurricane after *x* hours of monitoring. Why is it helpful to predict how strong the winds of a hurricane will become?

Getting Ready for Chapter



Chapter Exploration

1. Work with a partner.

- **a.** Use the equation $y = \frac{1}{2}x + 1$ to complete the table. (Choose any two *x*-values and find the *y*-values.)
- **b.** Write the two ordered pairs given by the table. These are called *solutions* of the equation.
- **c. PRECISION** Plot the two solutions. Draw a line *exactly* through the points.
- **d.** Find a different point on the line. Check that this point is a solution
 - of the equation $y = \frac{1}{2}x + 1$.
- e. **LOGIC** Do you think it is true that *any* point on the line is a solution of the equation $y = \frac{1}{2}x + 1$? Explain.





f. Choose five additional *x*-values for the table below. (Choose both positive and negative *x*-values.) Plot the five corresponding solutions. Does each point lie on the line?

	Solutions					
x						
$y = \frac{1}{2}x + 1$						

- **g.** LOGIC Do you think it is true that any solution of the equation $y = \frac{1}{2}x + 1$ is a point on the line? Explain.
- **h.** Why do you think y = ax + b is called a *linear equation*?

Vocabulary

The following vocabulary terms are defined in this chapter. Think about what each term might mean and record your thoughts.

linear equationslopey-interceptsolution of a linear equationx-intercept

131 Graphing Linear Equations

Learning Target: Graph linear equations. Success Criteria:

- I can create a table of values and write ordered pairs given a linear equation.
- I can plot ordered pairs to create a graph of a linear equation.
- I can use a graph of a linear equation to solve a real-life problem.

EXPLORATION 1 **Creating Graphs**

Work with a partner. It starts snowing at midnight in Town A and Town B. The snow falls at a rate of 1.5 inches per hour.

a. In Town A, there is no snow on the ground at midnight. How deep is the snow at each hour between midnight and 6 A.M.? Make a graph that represents this situation.



- **b.** Repeat part (a) for Town B, which has 4 inches of snow on the ground at midnight.
- **c.** The equations below represent the depth *y* (in inches) of snow *x* hours after midnight in Town C and Town D. Graph each equation.

Town C Town D y = 2x + 3y = 8

d. Use your graphs to compare the snowfall in each town.



Math Practice

Use a Graph

How can you use each graph to find the rate of snowfall? the depth of the snow when it begins to fall?

13.1 Lesson

Key Vocabulary

linear equation, *p. 556* solution of a linear equation, *p. 556*





Linear Equations

A **linear equation** is an equation whose graph is a line. The points on the line are **solutions** of the equation.

You can use a graph to show the solutions of a linear equation. The graph below represents the equation y = x + 1.

x	У	(x, y)
-1	0	(-1, <mark>0</mark>)
0	1	(<mark>0</mark> , 1)
2	3	(2, <mark>3</mark>)



EXAMPLE 1

Graphing a Linear Equation

Graph y = -2x + 1.

Step 1: Make a table of values.

x	y = -2x + 1	У	(x, y)
-1	y = -2(-1) + 1	3	(-1,3)
0	y = -2(0) + 1	1	(0, 1)
2	y = -2(2) + 1	-3	(2, -3)

Step 2: Plot the ordered pairs.



Step 3: Draw a line through the points. Try It Graph the linear equation. y = -2x + 1 y = -2x

1. y = 3x **2.** y = -2x - 1

Every point that is a solution of y = b has a y-coordinate of b. These points lie on a horizontal line through (0, b). You can use similar reasoning to understand why the graph of x = a is a vertical line through (a, 0).



Graphing Horizontal and Vertical Lines

The graph of y = b is a horizontal line passing through (0, b).



The graph of x = a is a vertical line passing through (a, 0).



EXAMPLE 2 **Graphing a Horizontal Line and a Vertical Line**

a. Graph y = -3.

The graph of y = -3 is a horizontal line passing through (0, -3). Draw a horizontal line through this point.





The graph of x = 2 is a vertical line passing through (2, 0). Draw a vertical line through this point.



Try It Graph the linear equation.

4. y = 3





Self-Assessment for Concepts & Skills-

Solve each exercise. Then rate your understanding of the success criteria in your journal.

GRAPHING A LINEAR EQUATION Graph the linear equation.

- 9. y = 0.8x 28. y = -x + 1**11.** $y = \frac{2}{2}$ **10.** x = 2.5
- **12. WHICH ONE DOESN'T BELONG?** Which equation does *not* belong with the other three? Explain your reasoning.

 $y = x^2 + 6$ x + 5 = y $y = x - 2 \qquad 4x + 3 = y$

EXAMPLE 3 Modeling Real Life



A tropical storm becomes a hurricane when wind speeds are at least 74 miles per hour.

The wind speed y (in miles per hour) of a tropical storm is y = 2x + 66, where x is the number of hours after the storm enters the Gulf of Mexico. When does the storm become a hurricane?

Use a graph to find the time it takes for the storm to become a hurricane. Make a table of values. Plot the ordered pairs and draw a line through the points.

x	y = 2x + 66	У	(x, y)
0	y = 2(0) + 66	66	(0, 66)
1	y = 2(1) + 66	68	(1, 68)
2	y = 2(2) + 66	70	(2, 70)
3	y = 2(3) + 66	72	(3, 72)



Another Method Use

the equation y = 2x + 66 to find *x* when y = 74.



From the graph, you can see that y = 74 when x = 4.

So, the storm becomes a hurricane 4 hours after it enters the Gulf of Mexico.



Self-Assessment for Problem Solving

Solve each exercise. Then rate your understanding of the success criteria in your journal.

- **13.** A game show contestant earns *y* dollars for completing a puzzle in *x* minutes. This situation is represented by the equation y = -250x + 5000. How long did a contestant who earned \$500 take to complete the puzzle? Justify your answer.
- **14.** The total cost *y* (in dollars) to join a cheerleading team and attend *x* competitions is represented by the equation y = 10x + 50.
 - **a.** Graph the linear equation.
 - b. You have \$75 to spend. How many competitions can you attend?
- **15.** The seating capacity *y* for a banquet hall is represented by y = 8x + 56, where *x* is the number of extra tables you need. How many extra tables do you need to double the original seating capacity?



13.1 Practice





Tell whether the triangles are similar. Explain.





Describe the translation of the point to its image.



⊳ Concepts, Skills, & Problem Solving

CREATING GRAPHS Make a graph of the situation. (See Exploration 1, p. 555.)

- **6.** The equation y = -2x + 8 represents the amount *y* (in fluid ounces) of dish detergent in a bottle after *x* days of use.
- **7.** The equation y = 15x + 20 represents the cost *y* (in dollars) of a gym membership after *x* months.

PRECISION Copy and complete the table with two solutions. Plot the ordered pairs and draw the graph of the linear equation. Use the graph to find a third solution of the equation.



GRAPHING A LINEAR EQUATION Graph the linear equation.

10. $y = -5x$	11. $y = 9x$	12. $y = 5$	13. $x = -6$
14. $y = x - 3$	15. $y = -7x - 1$	16. $y = -\frac{x}{3} + 4$	17. $y = 0.75x - 0.5$
18. $y = -\frac{2}{3}$	19. <i>y</i> = 6.75	20. $x = -0.5$	21. $x = \frac{1}{4}$

- **22. YOU BE THE TEACHER** Your friend graphs the equation y = 4. Is your friend correct? Explain your reasoning.
- **23. MODELING REAL LIFE** The equation *y* = 20 represents the cost *y* (in dollars) for sending *x* text messages in a month. Graph the linear equation. What does the graph tell you about your texting plan?





- **24. MODELING REAL LIFE** The equation y = 2x + 3 represents the cost *y* (in dollars) of mailing a package that weighs *x* pounds.
 - **a.** Use a graph to estimate how much it costs to mail the package.
 - **b.** Use the equation to find exactly how much it costs to mail the package.

SOLVING A LINEAR EQUATION Solve for *y*. Then graph the linear equation.

- **25.** y 3x = 1
- **27.** $-\frac{1}{3}y + 4x = 3$

- **26.** 5x + 2y = 4
- **28.** x + 0.5y = 1.5
- **29. MODELING REAL LIFE** The depth *y* (in inches) of a lake after *x* years is represented by the equation y = 0.2x + 42. How much does the depth of the lake increase in four years? Use a graph to justify your answer.



- **30. MODELING REAL LIFE** The amount *y* (in dollars) of money in your savings account after *x* months is represented by the equation y = 12.5x + 100.
 - **a.** Graph the linear equation.
 - **b.** How many months will it take you to save a total of \$237.50?



- **31. (MP) PROBLEM SOLVING** The radius *y* (in millimeters) of a chemical spill after *x* days is represented by the equation y = 6x + 50.
 - **a.** Graph the linear equation.
 - **b.** The leak is noticed after two weeks. What is the area of the leak when it is noticed? Justify your answer.
- **32. GEOMETRY** The sum *S* of the interior angle measures of a polygon with *n* sides is $S = (n 2) \cdot 180^{\circ}$.
 - **a.** Plot four points (*n*, *S*) that satisfy the equation. Is the equation a linear equation? Explain your reasoning.
 - **b.** Does the value n = 3.5 make sense in the context of the problem? Explain your reasoning.
- **33. DIG DEEPER!** One second of video on your cell phone uses the same amount of memory as two pictures. Your cell phone can store 2500 pictures.
 - **a.** Create a graph that represents the number *y* of pictures your cell phone can store when you take *x* seconds of video.
 - **b.** How many pictures can your cell phone store in addition to a video that is one minute and thirty seconds long?

13.2 Slope of a Line

Learning Target: Find and interpret the slope of a line.

- Success Criteria:
- I can explain the meaning of slope.
- I can find the slope of a line.
- I can interpret the slope of a line in a real-life problem.

EXPLORATION 1 Measuring the Steepness of a Line

Work with a partner. Draw any nonvertical line in a coordinate plane.

- a. Develop a way to measure the *steepness* of the line. Compare your method with other pairs.
- **b.** Draw a line that is parallel to your line. What can you determine about the steepness of each line? Explain your reasoning.

EXPLORATION 2

Using Right Triangles

Work with a partner. Use the figure shown.



- **a.** $\triangle ABC$ is a right triangle formed by drawing a horizontal line segment from point A and a vertical line segment from point B. Use this method to draw another right triangle, $\triangle DEF$, with its longest side on the line.
- **b.** What can you conclude about the two triangles in part (a)? Justify your conclusion. Compare your results with other pairs.
- c. Based on your conclusions in part (b), what is true about $\frac{BC}{AC}$ and the corresponding measure in $\triangle DEF$? Explain your reasoning. What do these values tell you about the line?

Math Practice

Construct Arguments

Do your answers to parts (b) and (c) change when you draw $\triangle DEF$ in a different location in part (a)? Explain.

13.2 Lesson

Key Vocabulary

slope, *p. 562* rise, *p. 562* run, *p. 562*



in the slope formula, x_1 is read as "x sub one," and y_2 is read as "y sub two." The numbers 1 and 2 in x_1 and y_2 are called subscripts.

📌 Key Idea

Slope

The **slope** *m* of a line is the value of the ratio of the change in y (the **rise**) to the change in x (the **run**) between any two points, (x_1, y_1) and (x_2, y_2) , on the line. The slope of a line is a measure of the steepness of the line.



Lines with positive slopes rise from left to right.

Lines with negative slopes fall from left to right.

EXAMPLE 1

Finding Slopes of Lines

a. a. b. b. c. b. c. c.

> The line rises from left to right. So, the slope is positive. Use the graph to find the rise and the run of the line.





The line falls from left to right. So, the slope is negative. Use the coordinates $(x_1, y_1) = (-1, 1)$ and $(x_2, y_2) = (1, -2)$ to find the slope.

$$m = \frac{y_2 - y_1}{x_2 - x_1}$$
$$= \frac{-2 - 1}{1 - (-1)}$$
$$= \frac{-3}{2}, \text{ or } -\frac{3}{2}$$

The methods in parts (a) and (b) show that you can find the slope of a line by using the graph or by using a formula.

Try It Find the slope of the line.



from left to right.

horizontal.

from left to right.

vertical.



Parallel Lines and Slope

Lines in the same plane that do not intersect are parallel lines. Nonvertical parallel lines have the same slope.

All vertical lines are parallel.



EXAMPLE 3 Identifying Parallel Lines

Which lines are parallel? How do you know?

Find the slope of each line.



The slopes of the blue and green lines are 4. The slope of the red line is 5.

The blue and green lines have the same slope, so they are parallel.

Try It

5. WHAT IF? The blue line passes through (-4, -3) and (-3, 2). Are any of the lines parallel? Explain.



Self-Assessment for Concepts & Skills

Solve each exercise. Then rate your understanding of the success criteria in your journal.

6. **VOCABULARY** What does it mean for a line to have a slope of 4?

FINDING THE SLOPE OF A LINE Find the slope of the line through the given points.

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7. (1, -1), (6, 2)
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8. (2, -3), (5, -3)

9. FINDING SLOPE Are the lines parallel? Explain your reasoning.



EXAMPLE 4

Modeling Real Life



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The table shows the distance y (in miles) of a space probe from a comet x minutes after it begins its approach. The points in the table lie on a line. Find and interpret the slope of the line.

x	1	4	7	10
у	8	6	4	2

Choose any two points from the table and use the slope formula.

Use the points $(x_1, y_1) = (1, 8)$ and $(x_2, y_2) = (4, 6)$.



The slope is $-\frac{2}{3}$. So, the distance between the probe and the comet decreases 2 miles every 3 minutes, or $\frac{2}{3}$ mile every minute.





Self-Assessment for Problem Solving



Solve each exercise. Then rate your understanding of the success criteria in your journal.

10. The table shows the lengths *y* (in inches) of your hair *x* months after your last haircut. The points in the table lie on a line. Find and interpret the slope of the line. After how many months is your hair 4 inches long?



- **11.** A customer pays an initial fee and a daily fee to rent a snowmobile. The total payment for 3 days is 92 dollars. The total payment for 5 days is 120 dollars. What is the daily fee? Justify your answer.
- **12.** You in-line skate from an elevation of 720 feet to an elevation of 750 feet in 30 minutes. Your friend in-line skates from an elevation of 600 feet to an elevation of 690 feet in one hour. Compare your rates of change in elevation.



Graph the linear equation.

1.
$$y = 4x - 3$$
 2. $x = -3$

 3. $y = 2$
 4. $y = \frac{3}{2}x - \frac{1}{2}$

Find the missing values in the ratio table.

5.	Yards	1		5	7	
	Feet	3	10			

Miles	0.6		1.8	
Hours	1	2		4

🃂 Concepts, Skills, & Problem Solving

USING RIGHT TRIANGLES Use the figure shown. (See Exploration 2, p. 561.)

6.



- **7.** Find the slope of the line.
- **8.** Let point *D* be at (-4, 1). Use the sides of $\triangle BDA$ to find the slope of the line.

FINDING THE SLOPE OF A LINE Find the slope of the line.



FINDING THE SLOPE OF A LINE Find the slope of the line through the given points.

- **15.** (4, -1), (-2, -1)
- **18.** (-3, 1), (-1, 5)
- **16.** (5, -3), (5, 8)**17.** (-7, 0), (-7, -6)**19.** (10, 4), (4, 15)**20.** (-3, 6), (2, 6)



- **21. (WP) REASONING** Draw a line through each point using a slope of $m = \frac{1}{4}$. Do the lines intersect? Explain.
- **22. YOU BE THE TEACHER** Your friend finds the slope of the line shown. Is your friend correct? Explain your reasoning.



IDENTIFYING PARALLEL LINES Which lines are parallel? How do you know?



IDENTIFYING PARALLEL LINES Are the given lines parallel? Explain your reasoning.

25. y = -5, y = 3 **26.** y = 0, x = 0 **27.** x = -4, x = 1

FINDING SLOPE The points in the table lie on a line. Find the slope of the line.

28.	x	1	3	5	7
	у	2	10	18	26



29.	x	-3	2	7	12
	У	0	2	4	6

30. MODELING REAL LIFE Carpenters refer to the slope of a roof as the *pitch* of the roof. Find the pitch of the roof.

- **31. PROJECT** The guidelines for a wheelchair ramp suggest that the ratio of the rise to the run be no greater than 1 : 12.
 - **a. (MP) CHOOSE TOOLS** Find a wheelchair ramp in your school or neighborhood. Measure its slope. Does the ramp follow the guidelines?
 - **b.** Design a wheelchair ramp that provides access to a building with a front door that is 2.5 feet above the sidewalk. Illustrate your design.

USING AN EQUATION Use an equation to find the value of k so that the line that passes through the given points has the given slope.

- **32.** (1, 3), (5, k); m = 2 **33.** (-2, k), (2, 0); m = -1
- **34.** $(-4, k), (6, -7); m = -\frac{1}{5}$ **35.** $(4, -4), (k, -1); m = \frac{3}{4}$
- **36. MODELING REAL LIFE** The graph shows the numbers of prescriptions filled over time by a pharmacy.
 - **a.** Find the slope of the line.
 - **b.** Explain the meaning of the slope as a rate of change.





- **37. CRITICAL THINKING** Which is steeper: the boat ramp, or a road with a 12% grade? Explain. (*Note:* Road grade is the vertical increase divided by the horizontal distance.)
- **38.** WP **REASONING** Do the points A(-2, -1), B(1, 5), and C(4, 11) lie on the same line? Without using a graph, how do you know?
- **39. WPROBLEM SOLVING** A small business earns a profit of \$6500 in January and \$17,500 in May. What is the rate of change in profit for this time period? Justify your answer.
- **40. (MP) STRUCTURE** Choose two points in the coordinate plane. Use the slope formula to find the slope of the line that passes through the two points.

Then find the slope using the formula $\frac{y_1 - y_2}{x_1 - x_2}$. Compare your results.

- **41. DIG DEEPER!** The top and the bottom of the slide are level with the ground, which has a slope of 0.
 - **a.** What is the slope of the main portion of the slide?
 - **b.** Describe the change in the slope when the bottom of the slide is only 12 inches above the ground. Explain your reasoning.





13.3 Graphing Proportional Relationships

Learning Target:

Success Criteria:

Graph proportional relationships.

- I can graph an equation that represents a proportional relationship.
- I can write an equation that represents a proportional relationship.
- I can use graphs to compare proportional relationships.

EXPLORATION 1 Using a Ratio Table to Find Slope

Work with a partner. The graph shows amounts of vinegar and water that can be used to make a cleaning product.

- Use the graph to make a ratio table relating the quantities.
 Explain how the slope of the line is represented in the table.
- b. Make a ratio table that represents a different ratio of vinegar to water. Use the table to describe the slope of the graph of the new relationship.



EXPLORATION 2

Deriving an Equation

Work with a partner. Let (x, y) represent any point on the graph of a proportional relationship.



Math Practice

Use a Graph How can you find the side lengths of the triangles in the graph?

- **a.** Describe the relationship between the corresponding side lengths of the triangles shown in the graph. Explain your reasoning.
- **b.** Use the relationship in part (a) to write an equation relating *y*, *m*, and *x*. Then solve the equation for *y*.
- **c.** What does your equation in part (b) describe? What does *m* represent? Explain your reasoning.

13.3 Lesson



Proportional Relationships

In the equation y = mx, m represents the constant of proportionality, the slope, and the unit rate. **Words** When two quantities *x* and *y* are proportional, the relationship can be represented by the equation y = mx, where *m* is the constant of proportionality.

Graph The graph of y = mx is a line with a slope of *m* that passes through the origin.



EXAMPLE 1

Graphing a Proportional Relationship

The cost y (in dollars) for x ounces of frozen yogurt is represented by y = 0.5x. Graph the equation and interpret the slope.

x	y = 0.5x	У	(x, y)
0	y = 0.5(0)	0	(0, 0)
1	y = 0.5(1)	0.5	(1, 0.5)
2	y = 0.5(2)	1	(2, 1)
3	y = 0.5(3)	1.5	(3, 1.5)

Method 2: Use the slope.

The equation shows that the slope m is 0.5. So, the graph passes through (0, 0) and (1, 0.5).

Plot the ordered pairs and draw a line through the points. Because negative values of *x* do not make sense in this context, graph in the first quadrant only.

The slope indicates that the unit cost is \$0.50 per ounce.



Try It

1. WHAT IF? The cost of frozen yogurt is represented by y = 0.75x. Graph the equation and interpret the slope.

EXAMPLE 2 Writing and Using an Equation

The weight y of an object on Titan, one of Saturn's moons, is proportional to the weight x of the object on Earth. An object that weighs 105 pounds on Earth would weigh 15 pounds on Titan.

a. Write an equation that represents the situation.

Use the point (105, 15) to find the slope of the line.

y = mx	Equation of a proportional relationship
15 = m(105)	Substitute 15 for <i>y</i> and 105 for <i>x</i> .
$\frac{1}{7} = m$	Simplify.

So, an equation that represents the situation is $y = \frac{1}{7}x$.

b. How much would a chunk of ice that weighs 3.5 pounds on Titan weigh on Earth?

$3.5 = \frac{1}{7}x$	Substitute 3.5 for <i>y</i> .
24.5 = x	Multiply each side by 7.

So, the chunk of ice would weigh 24.5 pounds on Earth.

Try It

2. How much would a spacecraft that weighs 3500 kilograms on Earth weigh on Titan?



Solve each exercise. Then rate your understanding of the success criteria in your journal.

GRAPHING A PROPORTIONAL RELATIONSHIP Graph the equation.

- **3.** y = 4x**4.** v = -3x**5.** v = 8x
- 6. WRITING AND USING AN EQUATION The number y of objects a machine produces is proportional to the time *x* (in minutes) that the machine runs. The machine produces five objects in four minutes.

a. Write an equation that represents the situation.

- **b.** Graph the equation in part (a) and interpret the slope.
- c. How many objects does the machine produce in one hour?

The slope indicates that the weight of an object on Titan is one-seventh its weight on Earth.

EXAMPLE 3

Modeling Real Life



The distance y (in meters) that a four-person ski lift travels in x seconds is represented by the equation y = 2.5x. The graph shows the distance that a two-person ski lift travels.

a. Which ski lift is faster?

Identify the slope of the graph for each lift. Then interpret each slope as a unit rate.



slope = $\frac{\text{change in } y}{\text{change in } x}$ = $\frac{8}{4} = 2$

The four-person lift travels 2.5 meters per second.

The two-person lift travels 2 meters per second.

Two-Person Lift

So, the four-person lift is faster than the two-person lift.

- b. Graph the equation that represents the four-person lift in the same coordinate plane as the two-person lift. Compare and interpret the steepness of each graph.
 - The graph that represents the four-person lift is steeper than the graph that represents the two-person lift. So, the four-person lift is faster.





Solve each exercise. Then rate your understanding of the success criteria in your journal.

Artificial Waterfall 1 16,000 (5, 15, 000)14,000 Water (liters) 12,000 10,000 8000 6000 4000 (1, 3000)2000 2 3 4 5 1 1 Time (seconds)

- 7. The amount y (in liters) of water that flows over a natural waterfall in x seconds is represented by the equation y = 500x. The graph shows the number of liters of water that flow over an artificial waterfall. Which waterfall has a greater flow? Justify your answer.
- **8.** The speed of sound in air is 343 meters per second. You see lightning and hear thunder 12 seconds later.
 - **a.** Is there a proportional relationship between the amount of time that passes and your distance from a lightning strike? Explain.
 - **b.** Estimate your distance from the lightning strike.





Find the slope of the line.



Solve the equation. Check your solution.

5. $x + \frac{1}{6} = 4 - 2x$ **6.** 2(1-x) = 11**4.** 2x + 3x = 10



📂 Concepts, Skills, & Problem Solving

USING EQUIVALENT RATIOS The graph shows amounts of water and flour that can be used to make dough. (See Exploration 1, p. 569.)

- 7. Use the graph to make a ratio table relating the quantities. Explain how the slope of the line is represented in the table.
- **8.** Make a ratio table that represents a different ratio of flour to water. Use the table to describe the slope of the graph of the new relationship.
- **9. GRAPHING AN EQUATION** The amount *y* (in dollars) that you raise by selling *x* fundraiser tickets is represented by the equation y = 5x. Graph the equation and interpret the slope.



IDENTIFYING PROPORTIONAL RELATIONSHIPS Tell whether x and y are in a proportional relationship. Explain your reasoning. If so, write an equation that represents the relationship.





- 14. MODELING REAL LIFE The cost *y* (in dollars) to rent a kayak is proportional to the number *x* of hours that you rent the kayak. It costs \$27 to rent the kayak for 3 hours.
 - **a.** Write an equation that represents the situation.
 - **b.** Interpret the slope of the graph of the equation.
 - **c.** How much does it cost to rent the kayak for 5 hours? Justify your answer.





- **15. MODELING REAL LIFE** The distance y (in miles) that a truck travels on x gallons of gasoline is represented by the equation y = 18x. The graph shows the distance that a car travels.
 - **a.** Which vehicle gets better gas mileage? Explain how you found your answer.
 - **b.** How much farther can the vehicle you chose in part (a) travel on 8 gallons of gasoline?
- **16. WP PROBLEM SOLVING** Toenails grow about 13 millimeters per year. The table shows fingernail growth.

Weeks	1	2	3	4
Fingernail Growth (millimeters)	0.7	1.4	2.1	2.8

- a. Do fingernails or toenails grow faster? Explain.
- **b.** In the same coordinate plane, graph equations that represent the growth rates of toenails and fingernails. Compare and interpret the steepness of each graph.
- **17. (WP) REASONING** The quantities *x* and *y* are in a proportional relationship. What do you know about the ratio of *y* to *x* for any point (*x*, *y*) on the graph of *x* and *y*?
- **18. DIG DEEPER**. The graph relates the temperature change y (in degrees Fahrenheit) to the altitude change x (in thousands of feet).
 - **a.** Is the relationship proportional? Explain.
 - **b.** Write an equation of the line. Interpret the slope.
 - **c.** You are at the bottom of a mountain where the temperature is 74°F. The top of the mountain is 5500 feet above you. What is the temperature at the top of the mountain? Justify your answer.



19. CRITICAL THINKING Consider the distance equation *d* = *rt*, where *d* is the distance (in feet), *r* is the rate (in feet per second), and *t* is the time (in seconds). You run for 50 seconds. Are the distance you run and the rate you run at proportional? Use a graph to justify your answer.

13.4 Graphing Linear Equations in Slope-Intercept Form

Learning Target: Success Criteria:

Learning Target: Graph linear equations in slope-intercept form.

- I can identify the slope and *y*-intercept of a line given an equation.
- I can rewrite a linear equation in slope-intercept form.
- I can use the slope and y-intercept to graph linear equations.

EXPLORATION 1

Deriving an Equation

Work with a partner. In the previous section, you learned that the graph of a proportional relationship can be represented by the equation y = mx, where *m* is the constant of proportionality.



Math Practice

Understand Quantities

How does the meaning of the equation y = mx help you make a conjecture in part (a)?

a. You translate the graph of a proportional relationship 3 units up as shown below. Let (x, y) represent any point on the graph. Make a conjecture about the equation of the line. Explain your reasoning.



- **b.** Describe the relationship between the corresponding side lengths of the triangles. Explain your reasoning.
- **c.** Use the relationship in part (b) to write an equation relating *y*, *m*, and *x*. Does your equation support your conjecture in part (a)? Explain.
- **d.** You translate the graph of a proportional relationship *b* units up. Write an equation relating *y*, *m*, *x*, and *b*. Justify your answer.

13.4 Lesson

Key Vocabulary

x-intercept, p. 576 y-intercept, p. 576 slope-intercept form, p. 576

> Linear equations can, but do not always, pass through the origin. So, proportional relationships are a special type of linear equation in which b = 0.



Intercepts

The *x*-intercept of a line is the *x*-coordinate of the point where the line crosses the *x*-axis. It occurs when y = 0.

The **y-intercept** of a line is the y-coordinate of the point where the line crosses the y-axis. It occurs when x = 0.





Words A linear equation written in the form y = mx + b is in **slope-intercept form**. The slope of the line is *m*, and the *y*-intercept of the line is *b*.

Algebra

y = mx	+b
slope	y-intercept

EXAMPLE 1

Identifying Slopes and y-Intercepts

Find the slope and the *y*-intercept of the graph of each linear equation.

a. y = -4x - 2 y = -4x + (-2) Write in slope-intercept form. The slope is -4, and the *y*-intercept is -2. b. $y - 5 = \frac{3}{2}x$ $y = \frac{3}{2}x + 5$ Add 5 to each side. The slope is $\frac{3}{2}$, and the *y*-intercept is 5.

Try It Find the slope and the *y*-intercept of the graph of the linear equation.

1.
$$y = 3x - 7$$
 2. $y - 1 = -\frac{2}{3}x$



Graphing a Linear Equation in Slope-Intercept Form

Graph y = -3x + 3. Identify the *x*-intercept.

Step 1: Find the slope and the *y*-intercept.



- **Step 2:** The *y*-intercept is 3. So, plot (0, 3).
- **Step 3:** Use the slope to find another point and draw the line.

$$m = \frac{\text{rise}}{\text{run}} = \frac{-3}{1}$$

Plot the point that is 1 unit right and 3 units down from (0, 3). Draw a line through the two points.



1

The line crosses the *x*-axis at (1, 0). So, the *x*-intercept is 1.

Try It Graph the linear equation. Identify the x-intercept.

3.
$$y = x - 4$$
 4. $y = -\frac{1}{2}x +$



Solve each exercise. Then rate your understanding of the success criteria in your journal.

- 5. IN YOUR OWN WORDS Consider the graph of the equation
 - y = mx + b.

6.

- **a.** How does changing the value of *m* affect the graph of the equation?
- **b.** How does changing the value of *b* affect the graph of the equation?

IDENTIFYING SLOPE AND *y***-INTERCEPT** Find the slope and the *y*-intercept of the graph of the linear equation.

$$y = -x + 0.25$$
 7. $y - 2 = -\frac{3}{4}x$

GRAPHING A LINEAR EQUATION Graph the linear equation. Identify the *x*-intercept.

8. y = x - 7 **9.** y = 2x + 8

EXAMPLE 3

Modeling Real Life

The cost y (in dollars) of taking a taxi x miles is represented by the equation y = 2.5x + 2. Graph the equation. Interpret the *y*-intercept and the slope.

Understand the problem.

You are given an equation that represents the cost of taking a taxi. You are asked to graph the equation and interpret the *y*-intercept and the slope.





Use the equation to identify the slope and the *y*-intercept. Then graph the equation and interpret the *y*-intercept and the slope.

The equation is already written in the form y = mx + b. So, the slope is $2.5 = \frac{5}{2}$ and the *y*-intercept is 2. Use the slope and the *y*-intercept to graph the equation.



Use the slope to plot another point, (2, 7). Draw a line through the points.



Self-Assessment for Problem Solving

Solve each exercise. Then rate your understanding of the success criteria in your journal.



- **10.** The height γ (in feet) of a movable bridge after rising for x seconds is represented by the equation y = 3x + 16. Graph the equation. Interpret the y-intercept and slope. How many seconds does it take the bridge to reach a height of 76 feet? Justify your answer.
- **11.** The number *y* of perfume bottles in storage after *x* months is represented by the equation y = -20x + 460. Graph the equation. Interpret the y-intercept and the slope. In how many months will there be no perfume bottles left in storage? Justify your answer.



13.4 Practice



Review & Refresh

Tell whether x and y are in a proportional relationship. Explain your reasoning. If so, write an equation that represents the relationship.

2

1.	x	1	2	3	4
	у	6	8	10	12

•	x	-8	-4	4	8
	у	4	2	-2	-4

Solve the equation for *y*.

4. 3y = -6x + 1 **5.** $1 + y = -\frac{4}{5}x - 2$ **3.** x = 4y - 2**6.** 2.5y = 5x - 5 **7.** 1.3y + 5.2 = -3.9x **8.** $y - \frac{2}{3}x = -6$



▶ Concepts, Skills, & Problem Solving

GRAPHING A LINEAR EQUATION Graph the equation. (See Exploration 1, p. 575.)

- **9.** The graph of y = 3.5x is translated up 2 units.
- **10.** The graph of y = -5x is translated down 3 units.

MATCHING EQUATIONS AND GRAPHS Match the equation with its graph. Identify the slope and the y-intercept.



IDENTIFYING SLOPES AND *y***-INTERCEPTS** Find the slope and the y-intercept of the graph of the linear equation.

- **16.** $y = -\frac{4}{5}x 2$ **14.** y = 4x - 5**15.** y = -7x + 12**19.** $y - 6 = \frac{3}{8}x$ **17.** y = 2.25x + 3 **18.** $y + 1 = \frac{4}{3}x$ **21.** $y = -5 - \frac{1}{2}x$ **20.** y - 3.5 = -2x**22.** y = 11 + 1.5x
- **23. YOU BE THE TEACHER** Your friend finds the slope and *y*-intercept of the graph of the equation y = 4x - 3. Is your friend correct? Explain your reasoning.

y = 4x - 3; The slope is 4 and the y-intercept is 3.

- **24. MODELING REAL LIFE** The number *y* of seasonal allergy shots available at a facility *x* days after receiving a shipment is represented by y = -15x + 375.
 - **a.** Graph the linear equation.
 - **b.** Interpret the slope and the *y*-intercept.

GRAPHING AN EQUATION Graph the linear equation. Identify the *x*-intercept.

- **25.** y = x + 3**26.** y = 4x 8**27.** y = -3x + 9**28.** y = -5x 5**29.** y + 14 = -7x**30.** y = 8 2x
- **31. WP PRECISION** You go to a harvest festival and pick apples.
 - **a.** Which equation represents the cost (in dollars) of going to the festival and picking *x* pounds of apples? Explain.

$$y = 5x + 0.75$$
 $y = 0.75x + 5$

- **b.** Graph the equation you chose in part (a).
- **32.** We **REASONING** Without graphing, identify the equations of the lines that are parallel. Explain your reasoning.



$$y = 2x + 4$$
 $y = \frac{1}{2}x + 1$ $y = 2x - 3$ $y = 2x + 1$ $y = \frac{1}{2}x + 2$



13.5 Graphing Linear Equations in Standard Form

Learning Target: Graph li

Success Criteria:

Graph linear equations in standard form.

- I can rewrite the standard form of a linear equation in slope-intercept form.
- I can find intercepts of linear equations written in standard form.
- I can use intercepts to graph linear equations.

EXPLORATION 1

Using Intercepts

Work with a partner. You spend \$150 on fruit trays and vegetable trays for a party.



a. You buy *x* fruit trays and *y* vegetable trays. Complete the verbal model. Then use the verbal model to write an equation that relates *x* and *y*.



- **b.** What is the greatest number of fruit trays that you can buy? vegetable trays? Can you use these numbers to graph your equation from part (a) in the coordinate plane? Explain.
- c. Use a graph to determine the different combinations of fruit trays and vegetable trays that you can buy. Justify your answers algebraically.



d. You are given an extra \$50 to spend. How does this affect the intercepts of your graph in part (c)? Explain your reasoning.

Math Practice

Make Sense of Quantities What does the slope of the line represent in this context?

13.5 Lesson





Standard Form of a Linear Equation The **standard form** of a linear equation is

Ax + By = C

where A and B are not both zero.



Graphing a Linear Equation in Standard Form

Graph -2x + 3y = -6.

Step 1: Write the equation in slope-intercept form.

-2x + 3y = -6	Write the equation.
3y = 2x - 6	Add 2 <i>x</i> to each side.
$y = \frac{2}{3}x - 2$	Divide each side by 3.

Step 2: Use the slope and the *y*-intercept to graph the equation.



4. 2x + y = 5

3. $-\frac{2}{3}x + y = 0$

Multi-Language Glossary at BigldeasMath.com

EXAMPLE 2 Graphing a Linear Equation in Standard Form

Graph x + 3y = -3 using intercepts.

Step 1: To find the <i>x</i> -intercept, substitute 0 for <i>y</i> .	To find the <i>y</i> -intercept, substitute 0 for <i>x</i> .
x + 3y = -3	x + 3y = -3
x+3(0)=-3	0 + 3y = -3
x = -3	y = -1

Step 2: Graph the equation.



Try It Graph the linear equation using intercepts.

5. 2x - y = 8 **6.** x + 3y = 6



Solve each exercise. Then rate your understanding of the success criteria in your journal.

WP STRUCTURE Determine whether the equation is in standard form. If not, rewrite the equation in standard form.

7. y = x - 6 **8.** $y - \frac{1}{6}x + 5 = 0$ **9.** 4x + y = 5

10. WRITING Describe two ways to graph the equation 4x + 2y = 6.

GRAPHING A LINEAR EQUATION Graph the linear equation.

11.	4x + y = 5	12.	$\frac{1}{3}x + 2y = 8$
13.	5x - y = 10	14.	x - 3y = 9

EXAMPLE 3 Modeling Real Life



You have \$6 to spend on apples and bananas. The equation 1.5x + 0.6y = 6 represents this situation, where x is the number of pounds of apples and y is the number of pounds of bananas. Graph the equation. Interpret the intercepts.

Find the intercepts. Then use the intercepts to graph the equation and interpret the intercepts.



x-intercept





y-intercept

The *x*-intercept shows that you can buy 4 pounds of apples when you do not buy any bananas. The *y*-intercept shows that you can buy 10 pounds of bananas when you do not buy any apples.

Self-Assessment for Problem Solving

Solve each exercise. Then rate your understanding of the success criteria in your journal.

15. You have \$30 to spend on paint and clay. The equation 2x + 6y = 30 represents this situation, where *x* is the number of paint bottles and *y* is the number of tubs of clay. Graph the equation. Interpret the intercepts. How many bottles of paint can you buy if you buy 3 tubs of clay? Justify your answer.



- **16.** You complete two projects for a class in 60 minutes. The equation x + y = 60 represents this situation, where *x* is the time (in minutes) you spend assembling a birdhouse and *y* is the time (in minutes) you spend writing a paper.
 - **a.** Graph the equation. Interpret the intercepts.
 - **b.** You spend twice as much time assembling the birdhouse as you do writing the paper. How much time do you spend writing the paper? Justify your answer.

13.5 Practice



🕨 Review & Refresh

Find the slope and the *y*-intercept of the graph of the linear equation.

1.
$$y = x - 1$$
 2. $y = -2x + 1$ **3.** $y = \frac{8}{9}x - 8$

Tell whether the blue figure is a reflection of the red figure.



📂 Concepts, Skills, & Problem Solving

USING INTERCEPTS Define two variables for the verbal model. Write an equation in slope-intercept form that relates the variables. Graph the equation using intercepts. (See Exploration 1, p. 581.)



REWRITING AN EQUATION Write the linear equation in slope-intercept form.

9. 2x + y = 17 **10.** $5x - y = \frac{1}{4}$ **11.** $-\frac{1}{2}x + y = 10$

GRAPHING AN EQUATION Graph the linear equation.

12. -18x + 9y = 72 **13.** 16x - 4y = 2

14.
$$\frac{1}{4}x + \frac{3}{4}y = 1$$

MATCHING Match the equation with its graph.

15. 15x - 12y = 60

16. 5x + 4y = 20







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- **18. YOU BE THE TEACHER** Your friend finds the *x*-intercept of -2x + 3y = 12. Is your friend correct? Explain your reasoning.
- **19. MODELING REAL LIFE** A charm bracelet costs \$65, plus \$25 for each charm. The equation -25x + y = 65represents the cost y (in dollars) of the bracelet, where *x* is the number of charms.
 - **a.** Graph the equation.
 - **b.** How much does a bracelet with three charms cost?

USING INTERCEPTS TO GRAPH Graph the linear equation using intercepts.

- **21.** 2x + y = 8**20.** 3x - 4y = -12
- 23. MODELING REAL LIFE Your cousin has \$90 to spend on video games and movies. The equation 30x + 15y = 90 represents this situation, where *x* is the number of video games purchased and *y* is the number of movies purchased. Graph the equation. Interpret the intercepts.
 - **24. (MD) PROBLEM SOLVING** A group of friends go scuba diving. They rent a boat for x days and scuba gear for y people, represented by the equation 250x + 50y = 1000.
 - **a.** Graph the equation and interpret the intercepts.
 - **b.** How many friends can go scuba diving if they rent the boat for 1 day? 2 days?
 - **c.** How much money is spent in total?
- **25. DIG DEEPER!** You work at a restaurant as a host and a server. You earn \$9.45 for each hour you work as a host and \$3.78 for each hour you work as a server.
 - **a.** Write an equation in standard form that models your earnings.
 - **b.** Graph the equation.
 - **26.** WP LOGIC Does the graph of every linear equation have an *x*-intercept? Justify your reasoning.
 - 27. CRITICAL THINKING For a house call, a veterinarian charges \$70, plus \$40 per hour.
 - Write an equation that represents the total fee *y* (in dollars) a. the veterinarian charges for a visit lasting *x* hours.
 - **b.** Find the *x*-intercept. Does this value make sense in this context? Explain your reasoning.
 - Graph the equation.



22. $\frac{1}{3}x - \frac{1}{6}y = -\frac{2}{3}$





13.6 Writing Equations in Slope-Intercept Form

Learning Target: Write equations of lines in slope-intercept form.

- Success Criteria:
- I can find the slope and the y-intercept of a line.
 - I can use the slope and the y-intercept to write an equation of a line.
 - I can write equations in slope-intercept form to solve real-life problems.

EXPLORATION 1

Writing Equations of Lines

Work with a partner. For each part, answer the following questions.

- What are the slopes and the y-intercepts of the lines?
- What are equations that represent the lines?
- What do the lines have in common?

Math Practice

Analyze Givens Why are the slope and *y*-intercept enough information to write an equation for a line?





EXPLORATION 2

Interpreting the Slope and the y-Intercept

Work with a partner. The graph represents the distance y (in miles) of a car from Phoenix after t hours of a trip.

- Find the slope and the *y*-intercept of a. the line. What do they represent in this situation?
- **b.** Write an equation that represents the graph.
- How can you determine the distance c. of the car from Phoenix after 11 hours?



13.6 Lesson

EXAMPLE 1 Writing Equations in Slope-Intercept Form

Write an equation in slope-intercept form of the line that passes through the given points.

Because the line crosses the *y*-axis at (0, 5), the *y*-intercept is 5.



y

-3

2

7

12

Find the slope and the *y*-intercept.



After writing an equation, check that the given points are solutions of the equation.



b.

X

0

3

6

9

So, an equation is
$$y = -\frac{3}{2}x + 5$$
.

Find the slope and the *y*-intercept. Use the points (0, -3) and (3, 2).

$$m = \frac{y_2 - y_1}{x_2 - x_1}$$
$$= \frac{-3 - 2}{0 - 3}$$
$$= \frac{-5}{-3}, \text{ or } \frac{5}{3}$$

Because y = -3 when x = 0, the *y*-intercept is -3.

So, an equation is
$$y = \frac{5}{3}x + (-3)$$
, or $y = \frac{5}{3}x - 3$

Try It Write an equation in slope-intercept form of the line that passes through the given points.





Writing an Equation

Which equation is shown in the graph?

A.
$$y = -4$$
B. $y = -3$ C. $y = 0$ D. $y = -3x$

Find the slope and the *y*-intercept. The line is horizontal, so the change in *y* is 0.

 $m = \frac{\text{change in } y}{\text{change in } x} = \frac{0}{3} = 0$

Because the line crosses the *y*-axis at (0, -4), the *y*-intercept is -4.

So, the equation is y = 0x + (-4), or y = -4.

The correct answer is **A**.

Try It Write an equation of the line that passes through the given points.

3.	x	-4	0	4
	У	5	5	5





Solve each exercise. Then rate your understanding of the success criteria in your journal.

WRITING EQUATIONS IN SLOPE-INTERCEPT FORM Write an equation in slope-intercept form of the line that passes through the given points.

6.

5.	x	у
	-2	-4
	-1	-1
	0	2
	1	5

- **7.** WRITING AN EQUATION Write an equation of the line that passes through (0, -5) and (2, -5).



Remember The graph of y = a is a horizontal line that passes through (0, a).

EXAMPLE 3 Modeling Real Life



Engineers used tunnel boring machines like the ones shown above to dig an extension of the Metro Gold Line in Los Angeles. The tunnels are 1.7 miles long and 21 feet wide. Engineers are digging a 3500-foot long tunnel at a constant rate. After 4 months, the engineers still need to dig 1500 feet to finish the project. How much time does it take to complete the tunnel from start to finish?

Write an equation of the line that represents the distance y (in feet) remaining after x months.

When the project starts, the engineers still need to dig 3500 feet, represented by (0, 3500). So, the *y*-intercept is 3500.

After 4 months, the engineers still need to dig 1500 feet, represented by (4, 1500). Use the points (0, 3500) and (4, 1500) to find the slope.

 $m = \frac{\text{change in } y}{\text{change in } x} = \frac{-2000}{4} = -500$

So, an equation is y = -500x + 3500.

The tunnel is complete when the distance remaining is 0 feet. So, find the value of *x* when y = 0.

y = -500x + 3500	Write the equation.
0 = -500x + 3500	Substitute 0 for <i>y</i> .
-3500 = -500x	Subtract 3500 from each side.
7 = x	Divide each side by -500 .

It takes 7 months to complete the tunnel from start to finish.



Self-Assessment for Problem Solving

Solve each exercise. Then rate your understanding of the success criteria in your journal.

8. You load boxes onto an empty truck at a constant rate. After 3 hours, there are 100 boxes on the truck. How much longer do you work if you load a total of 120 boxes? Justify your answer.

x	0	6	12
У	15	12	9

- **9.** The table shows the amounts *y* (in tons) of waste left in a landfill after *x* months of waste relocation. Interpret the slope and the *y*-intercept of the line that passes through the given points. How many months does it take to empty the landfill? Justify your answer.
- **10. DIG DEEPER!** A lifetime subscription to a website costs \$250. A monthly subscription to the website costs \$10 to join and \$15 per month. Write equations to represent the costs of each plan. If you want to be a member for one year, which plan is less expensive? Explain.





Write the linear equation in slope-intercept form.

1.
$$4x + y = 1$$
 2. $x - y =$

Plot the ordered pair in a coordinate plane.

4. (1, 4) **5.** (-1, -2) **6.** (0, 1) **7.** (2, 7)

1

5



📂 Concepts, Skills, & Problem Solving

INTERPRETING THE SLOPE AND THE *y***-INTERCEPT** The graph represents the cost *y* (in dollars) to open an online gaming account and buy *x* games. (See Exploration 2, p. 587.)

- **8.** Find the slope and the *y*-intercept of the line. What do they represent in this situation?
- 9. Write an equation that represents the graph.
- **10.** How can you determine the total cost of opening an account and buying 6 games?



WRITING EQUATIONS IN SLOPE-INTERCEPT FORM Write an equation in slope-intercept form of the line that passes through the given points.



 WRITING EQUATIONS Write an equation of the line that passes through the given points.

 17. (-1, 4), (0, 2) 18. (-1, 0), (0, 0) 19. (0, 4), (0, -3)

20. YOU BE THE TEACHER Your friend writes an equation of the line shown. Is your friend correct? Explain your reasoning.



- **21. MODELING REAL LIFE** A boa constrictor is 18 inches long at birth and grows 8 inches per year. Write an equation in slope-intercept form that represents the length *y* (in feet) of a boa constrictor that is *x* years old.
- **22. MODELING REAL LIFE** The table shows the speeds *y* (in miles per hour) of a car after *x* seconds of braking. Write an equation of the line that passes through the points in the table. Interpret the slope and the *y*-intercept of the line.
- **23. MODELING REAL LIFE** A dentist charges a flat fee for an office visit, plus an additional fee for every tooth removed. The graph shows the total cost *y* (in dollars) for a patient when the dentist removes *x* teeth. Interpret the slope and the *y*-intercept.
- **24. MODELING REAL LIFE** One of your friends gives you \$10 for a charity walkathon. Another friend gives you an amount per mile. After 5 miles, you have raised \$13.50 total. Write an equation that represents the amount *y* of money you have raised after *x* miles.

x	0	1	2	3
у	70	60	50	40



- **25. WP PROBLEM SOLVING** You have 500 sheets of notebook paper. After 1 week, you have 72% of the sheets left. You use the same number of sheets each week. Write an equation that represents the number *y* of sheets remaining after *x* weeks.
- **26. DIG DEEPER** The palm tree on the left is 10 years old. The palm tree on the right is 8 years old. The trees grow at the same rate.
 - **a.** Estimate the height *y* (in feet) of each tree.
 - **b.** Plot the two points (*x*, *y*), where *x* is the age of each tree and *y* is the height of each tree.
 - **c.** What is the rate of growth of the trees?
 - **d.** Write an equation that represents the height of a palm tree in terms of its age.



22. MODELING REAL LIFE The ta

13.7 Writing Equations in Point-Slope Form

Learning Target: Write equations of lines in point-slope form.

Success Criteria:

- I can use a point on a line and the slope to write an equation of the line.
- I can use any two points to write an equation of a line.
- I can write equations in point-slope form to solve real-life problems.

exploration 1

Deriving an Equation

Work with a partner. Let (x_1, y_1) represent a specific point on a line. Let (x, y) represent any other point on the line.



Math Practice

Recognize Usefulness of Tools How does the graph help you derive an equation?

EXPLORATION 2

- **a.** Write an equation that represents the slope *m* of the line. Explain your reasoning.
- **b.** Multiply each side of your equation in part (a) by the expression in the denominator. What does the resulting equation represent? Explain your reasoning.

Writing an Equation

Work with a partner.

For 4 months, you saved \$25 a month. You now have \$175 in your savings account.

- **a.** Draw a graph that shows the balance in your account after t months.
- **b.** Use your result from Exploration 1 to write an equation that represents the balance A after t months.



13.7 Lesson

Key Vocabulary point-slope form, p. 594



Point-Slope Form

Words A linear equation written in the form $y - y_1 = m(x - x_1)$ is in **point-slope form**. The line passes through the point (x_1, y_1) , and the slope of the line is *m*.



EXAMPLE 1 Writing an Equation Using a Slope and a Point

Write an equation in point-slope form of the line that passes through the point (-6, 1) with slope $\frac{2}{3}$.

 $y - y_1 = m(x - x_1)$ Write the point-slope form. $y - 1 = \frac{2}{3}[x - (-6)]$ Substitute $\frac{2}{3}$ for m, -6 for x_1 , and 1 for y_1 . $y - 1 = \frac{2}{3}(x + 6)$ Simplify.

So, an equation is $y - 1 = \frac{2}{3}(x + 6)$.

Check Check that (-6, 1) is a solution of the equation.

 $y - 1 = \frac{2}{3}(x + 6)$ Write the equation. $1 - 1 \stackrel{?}{=} \frac{2}{3}(-6 + 6)$ Substitute. 0 = 0Simplify.

Try It Write an equation in point-slope form of the line that passes through the given point and has the given slope.

1. (1, 2); m = -4 **2.** (7, 0); m = 1 **3.** (-8, -5); $m = -\frac{3}{4}$

EXAMPLE 2 Writing an Equation Using Two Points

Write an equation in slope-intercept form of the line that passes through the given points.

Find the slope. Use the points (2, 4) and (5, -2).

x	у
-1	10
2	4
5	-2

m -	$y_2 - y_1$	-2 - 4	6 _	_2
<i>m</i> -	$\overline{x_2 - x_1}$	5 - 2	3	4

Another Method

You can use any of the given points to write an equation of the line.

Use
$$m = -2$$
 and $(5, -2)$.
 $y - (-2) = -2(x - 5)$
 $y + 2 = -2x + 10$
 $y = -2x + 8$

Then use the slope m = -2 and the point (2, 4) to write an equation of the line.

$y - y_1 = m(x - x_1)$	Write the point-slope form.
y-4=-2(x-2)	Substitute -2 for m , 2 for x_1 , and 4 for y_1 .
y-4 = -2x+4	Distributive Property
y = -2x + 8	Write in slope-intercept form.

Try It Write an equation in slope-intercept form of the line that passes through the given points.

4. (-2, 1), (3, -4)

5.	x	-5	-3	-1
	у	5	3	1

Self-Assessment for Concepts & Skills -

Solve each exercise. Then rate your understanding of the success criteria in your journal.

WRITING AN EQUATION Write an equation in point-slope form of the line that passes through the given point and has the given slope.

6.	(2, 0); $m = 1$	7.	$(-3, -1); m = -\frac{1}{3}$	8.	(5, 4); m = 3
----	-----------------	----	------------------------------	----	---------------

x	3	5	7
у	1	-2	-5

- **9.** WRITING AN EQUATION Write an equation of the line that passes through the points given in the table.
- **10. DIFFERENT WORDS, SAME QUESTION** Which is different? Sketch "both" graphs.

What is the graph of the equation y = 4x + 3?

Graph the line that passes through the points (4, 5) and (5, 9).

Graph y = 4x + 3. Graph the linear equation y - 7 = 4(x - 1).

EXAMPLE 3



You finish parasailing and are being pulled back to the boat. After 2 seconds, you are 25 feet above the boat. At what height were you parasailing?

Modeling Real Life

You are 25 feet above the boat after 2 seconds, which can be represented by the point (2, 25). You are being pulled down at a rate of 10 feet per second. So, the slope is -10.

Because you know a point and the slope, use point-slope form to write an equation that represents your height y (in feet) above the boat after x seconds.

$y - y_1 = m(x - x_1)$	Write the point-slope form.
y - 25 = -10(x - 2)	Substitute for $m, x_1, and y_1$.
y - 25 = -10x + 20	Distributive Property
y = -10x + 45	Write in slope-intercept form.

The height at which you were parasailing is represented by the *y*-intercept.

So, you were parasailing at a height of 45 feet.



Solve each exercise. Then rate your understanding of the success criteria in your journal.

- **11.** A writer finishes a project that a coworker started at a rate of 3 pages per hour. After 3 hours, 25% of the project is complete.
 - **a.** The project is 200 pages long. Write and graph an equation for the total number *y* of pages that have been finished after the writer works for *x* hours.
 - **b.** The writer has a total of 45 hours to finish the project. Will the writer meet the deadline? Explain your reasoning.
- **12. DIG DEEPER** You and your friend begin to run along a path at different constant speeds. After 1 minute, your friend is 45 meters ahead of you. After 3 minutes, your friend is 105 meters ahead of you.
 - **a.** Write and graph an equation for the distance *y* (in meters) your friend is ahead of you after *x* minutes. Justify your answer.
 - **b.** Did you and your friend start running from the same spot? Explain your reasoning.



🕨 Review & Refresh

Write an equation in slope-intercept form of the line that passes through the given points.





Solve the equation. Check your solution, if possible.

3. 2x + 3 = 2x **4.** 6x - 7 = 1 - 3x **5.** 0.1x - 1 = 1.2x - 5.4

🃂 Concepts, Skills, & Problem Solving

WRITING AN EQUATION The value of a new car decreases \$4000 each year. After 3 years, the car is worth \$18,000. (See Exploration 2, p. 593.)

- 6. Draw a graph that shows the value of the car after *t* years.
- 7. Write an equation that represents the value V of the car after t years.

WRITING AN EQUATION Write an equation in point-slope form of the line that passes through the given point and has the given slope.

8. (3,0); $m = -\frac{2}{3}$ 9. (4,8); $m = \frac{3}{4}$ 10. (1,-3); m = 411. (7,-5); $m = -\frac{1}{7}$ 12. (3,3); $m = \frac{5}{3}$ 13. (-1,-4); m = -2

WRITING AN EQUATION Write an equation in slope-intercept form of the line that passes through the given points.

- **14.** (-1, -1), (1, 5)**15.** (2, 4), (3, 6)**16.** (-2, 3), (2, 7)**17.** (4, 1), (8, 2)**18.** (-9, 5), (-3, 3)**19.** (1, 2), (-2, -1)
- **20. MODELING REAL LIFE** At 0°C, the volume of a gas is 22 liters. For each degree the temperature *T* (in degrees Celsius) increases, the volume *V* (in liters) of the gas increases by $\frac{2}{25}$. Write an equation that represents the volume of the gas in terms of the temperature.

WRITING AN EQUATION Write an equation of the line that passes through the given points in any form. Explain your choice of form.



3

27. (WP) REASONING Write an equation of the line that passes through the point (8, 2) and is parallel to the graph of the equation y = 4x - 3.

3

- **28. MODELING REAL LIFE** The table shows the amount *y* (in fluid ounces) of carpet cleaner in a tank after *x* minutes of cleaning.
 - **a.** Write an equation that represents the amount of cleaner in the tank after *x* minutes.

x	У
5	108
10	88
15	68

- **b.** How much cleaner is in the tank when the cleaning begins?
- c. After how many minutes is the tank empty? Justify your answer.



3

-4.5

- **29. DIG DEEPER!** According to Dolbear's law, you can predict the temperature *T* (in degrees Fahrenheit) by counting the number *x* of chirps made by a snowy tree cricket in 1 minute. When the temperature is 50° F, a cricket chirps 40 times in 1 minute. For each rise in temperature of 0.25° F, the cricket makes an additional chirp each minute.
 - a. You count 100 chirps in 1 minute. What is the temperature?

1

2

- **b.** The temperature is 96°F. How many chirps do you expect the cricket to make? Justify your answer.
- **30. (D) PROBLEM SOLVING** The Leaning Tower of Pisa in Italy was built between 1173 and 1350.
 - **a.** Write an equation that represents the yellow line.
 - **b.** The tower is 56 meters tall. How far from the center is the top of the tower? Justify your answer.

Connecting Concepts

Using the Problem-Solving Plan

1. Every item in a retail store is on sale for 40% off. Write and graph an equation that represents the sale price *y* of an item that has an original price of *x* dollars.



You know the percent discount of items in a retail store. You are asked to write and graph an equation that represents the sale price of an item that has an original price of *x* dollars.



Make a plan.

Selling an item for 40% off is the same as selling an item for 60% of its original price. Use this information to write and graph an equation that represents the situation.



Use the plan to solve the problem. Then check your solution.

- **2.** Two supplementary angles have angle measures of x° and y° . Write and graph an equation that represents the relationship between the measures of the angles.
- **3.** A mechanic charges a diagnostic fee plus an hourly rate. The table shows the numbers of hours worked and the total costs for three customers. A fourth customer pays \$285. Find the number of hours that the mechanic worked for the fourth customer.

Hours, <i>x</i>	1	3	5
Cost, y (dollars)	90	210	330

Performance Task



Anatomy of a Hurricane

At the beginning of this chapter, you watched a STEAM Video called "Hurricane!" You are now ready to complete the performance task related to this video, available at *BigIdeasMath.com*. Be sure to use the problem-solving plan as you work through the performance task.





Review Vocabulary

Write the definition and give an example of each vocabulary term.

linear equation, *p. 556* solution of a linear equation, *p. 556* slope, *p. 562* rise, p. 562 run, p. 562 x-intercept, p. 576 y-intercept, p. 576 slope-intercept form, *p. 576* standard form, *p. 582* point-slope form, *p. 594*

Graphic Organizers

You can use a **Definition and Example Chart** to organize information about a concept. Here is an example of a Definition and Example Chart for the vocabulary term *linear equation*.



Choose and complete a graphic organizer to help you study the concept.

- 1. slope
- **2.** slope of parallel lines
- 3. proportional relationship
- 4. slope-intercept form
- 5. standard form
- 6. point-slope form



"Here is my Definition and Example Chart. Wednesday, Thursday, and Friday (Freya's day) are all named after mythical beings."

Chapter Self-Assessment

As you complete the exercises, use the scale below to rate your understanding of the success criteria in your journal.



Graph the linear equation.

1. $y = \frac{3}{5}x$ **2.** y = -2**3.** y = 9 - x

4.
$$y = -0.25x + 4$$

- **5.** $y = \frac{2}{3}x + 2$ 7. The equation y = 0.5x + 3 represents the
 - **a.** Use a graph to estimate how much it costs to ride 5.25 miles in a taxi.

cost *y* (in dollars) of riding in a taxi *x* miles.

6. x = -5

- **b.** Use the equation to find exactly how much it costs to ride 5.25 miles in a taxi.
- **8.** The equation y = 9.5x represents the earnings y (in dollars) of an aquarium gift shop employee that works *x* hours.
 - **a.** Graph the linear equation.
 - **b.** How much does the employee earn for working 40 hours?
- **9.** Is $y = x^2$ a linear equation? Explain your reasoning.
- **10.** The sum *S* of the exterior angle measures of a polygon with *n* sides is $S = 360^{\circ}$.
 - **a.** Plot four points (*n*, *S*) that satisfy the equation. Is the equation a linear equation? Explain your reasoning.
 - **b.** Does the value n = 2 make sense in the context of the problem? Explain your reasoning.







Describe the slope of the line. Then find the slope of the line.





Find the slope of the line through the given points.

13. (-5, 4), (8, 4)

14. (-3, 5), (-3, 1)

The points in the table lie on a line. Find the slope of the line.

15.	x	0	1	2	3	16.	x	-2	0	2	4
	У	-1	0	1	2		у	3	4	5	6

- **17.** How do you know when two lines are parallel? Use an example to justify your answer.
- **18.** Draw a line through the point (-1, 2) that is parallel to the graph of the line in Exercise 11.



13.3 Graphing Proportional Relationships (pp. 569–574)

Learning Target: Graph proportional relationships.

Tell whether x and y are in a proportional relationship. Explain your reasoning. If so, write an equation that represents the relationship.



- **21.** The cost *y* (in dollars) to provide food for guests at a dinner party is proportional to the number *x* of guests attending the party. It costs \$30 to provide food for 4 guests.
 - **a.** Write an equation that represents the situation.
 - **b.** Interpret the slope of the graph of the equation.
 - **c.** How much does it cost to provide food for 10 guests? Justify your answer.
- **22.** The distance y (in miles) you run after x weeks is represented by the equation y = 8x. Graph the equation and interpret the slope.
- **23.** You research that hair grows 15 centimeters per year on average. The table shows your friend's hair growth.

Months	1	2	3	4
Hair Growth (centimeters)	1.5	3	4.5	6

- a. Does your friend's hair grow faster than average? Explain.
- **b.** In the same coordinate plane, graph the average hair growth and the hair growth of your friend. Compare and interpret the steepness of each of the graphs.



13.4 Graphing Linear Equations in Slope-Intercept Form (pp. 575–580)

29. y = -x - 8

Learning Target: Graph linear equations in slope-intercept form.

Find the slope and the *y*-intercept of the graph of the linear equation.

24.
$$y = -4x + 1$$
 25. $y = \frac{2}{3}x - 12$ **26.** $y - 7 = 0.5x$

Graph the linear equation. Identify the *x*-intercept.

27. y = 2x - 6 **28.** y = -4x + 8

- **30.** The cost *y* (in dollars) of one person buying admission to a fair and going on *x* rides is y = x + 12.
 - **a.** Graph the equation.
 - **b.** Interpret the *y*-intercept and the slope.
- **31.** Graph the linear equation with slope -5 and *y*-intercept 0.



Learning Target: Graph linear equations in standard form.

Write the linear equation in slope-intercept form.

32.
$$4x + 2y = -12$$
 33. $x - y =$

Graph the linear equation.

34.	$\frac{1}{4}x + y = 3$	35. $-4x + 2y = 8$
36.	x + 5y = 10	37. $-\frac{1}{2}x + \frac{1}{8}y = \frac{3}{4}$

38. A dog kennel charges \$30 per night to board your dog and \$6 for each hour of playtime. The amount of money you spend is given by 30x + 6y = 180, where x is the number of nights and y is the number of hours of playtime. Graph the equation and interpret the intercepts.



Write an equation in slope-intercept form of the line that passes through the given points.

39.



У

4

1

-5



4



1 $\overline{4}$



43. Write an equation of the line that passes through (0, 8) and (6, 8).

44. Write an equation of the line that passes through (0, -5) and (-5, -5).

45. A construction crew is extending a highway sound barrier that is

13 miles long. The crew builds $\frac{1}{2}$ of a mile per week. Write an equation in slope-intercept form that represents the length *y* (in miles) of the barrier after *x* weeks.



Write an equation in point-slope form of the line that passes through the given point and has the given slope.

46. (4, 4);
$$m = 3$$
 47. (2, -8); $m = -\frac{2}{3}$

Write an equation in slope-intercept form of the line that passes through the given points.

49.	x	1	2	3
	у	-3	1	5

50. The table shows your elevation *y* (in feet) on a ski slope after *x* minutes.

x	1	2	3
у	800	600	400

- **a.** Write an equation that represents your elevation after *x* minutes.
- **b.** What is your starting elevation?
- **c.** After how many minutes do you reach the bottom of the ski slope? Justify your answer.
- **51.** A company offers cable television at \$29.95 per month plus a one-time installation fee. The total cost for the first six months of service is \$214.70.
 - **a.** Write an equation in point-slope form that represents the total cost you pay for cable television after *x* months.
 - **b.** How much is the installation fee? Justify your answer.
- **52.** When might it be better to represent an equation in point-slope form rather than slope-intercept form? Use an example to justify your answer.

Find the slope and the y-intercept of the graph of the linear equation.

1.
$$y = 6x - 5$$
 2. $y - 1 = 3x + 8.4$ **3.** $-\frac{1}{2}x + 2y = 7$

Graph the linear equation.

4.
$$y = -\frac{1}{2}x - 5$$
 5. $-3x + 6y = 12$ **6.** $y = \frac{2}{3}x$

7. Which lines are parallel? Explain.



8. The points in the table lie on a line. Find the slope of the line.

x	У
-1	-4
0	-1
1	2
2	5

Write an equation in slope-intercept form of the line that passes through the given points.



- **11.** Write an equation in point-slope form of the line that passes through (-4, 1) and (4, 3).
- **12.** The number *y* of new vocabulary words that you learn after *x* weeks is represented by the equation y = 15x.
 - **a.** Graph the equation and interpret the slope.
 - b. How many new vocabulary words do you learn after 5 weeks?
 - **c.** How many more vocabulary words do you learn after 6 weeks than after 4 weeks?
- **13.** You used \$90 worth of paint for a school float. The amount of money you spend is given by 18x + 15y = 90, where *x* is the number of gallons of blue paint and *y* is the number of gallons of white paint. Graph the equation and interpret the intercepts.

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- **Cumulative Practice**
- **1.** Which equation matches the line shown in the graph?



- **A.** y = 2x 2
- **B.** y = 2x + 1
- **C.** y = x 2
- **D.** y = x + 1



2. Which point lies on the graph of 6x - 5y = 14?

F. (-4, -1)	G. (-2, 4)
H. (-1, -4)	Ⅰ. (4, −2)

3. You reflect the triangle in the *x*-axis. What are the coordinates of the image?



A. X'(4, 1), Y'(2, 3), Z'(-2, 1)

- **C.** X'(-4, -1), Y'(-2, -3), Z'(2, -1)
- **B.** X'(4, -1), Y'(2, -3), Z'(-2, -1)

D. X'(1, 4), Y'(3, 2), Z'(1, -2)

4. Which of the following is the equation of a line parallel to the line shown in the graph?



5. What is the value of *x*?



- **6.** An emergency plumber charges \$49.00 plus \$70.00 per hour of the repair. A bill to repair your sink is \$241.50. This can be modeled by 70.00h + 49.00 = 241.50, where *h* represents the number of hours for the repair. How many hours did it take to repair your sink?
 - **A.** 2.75 hours
 - **C.** 4.15 hours

- **B.** 3.45 hours
- **D.** 13,475 hours
- 7. It costs \$40 to rent a car for one day.
 Think In addition, the rental agency charges you for each mile driven, as shown in the graph.
 - *Part A* Determine the slope of the line joining the points on the graph.

Part B Explain what the slope represents.



8. What value of *x* makes the equation true?



7 + 2x = 4x - 5

9. Trapezoid *KLMN* is graphed in the coordinate plane shown.



Rotate Trapezoid *KLMN* 90° clockwise about the origin. What are the coordinates of point M', the image of point M after the rotation?

- F. (-3, -2)
 G. (-2, -3)

 H. (-2, 3)
 I. (3, 2)
- **10.** Solve the formula K = 3M 7 for M.
 - **A.** M = K + 7 **B.** $M = \frac{K + 7}{3}$ **C.** $M = \frac{K}{3} + 7$ **D.** $M = \frac{K - 7}{3}$
- **11.** What is the distance *d* across the canyon?

