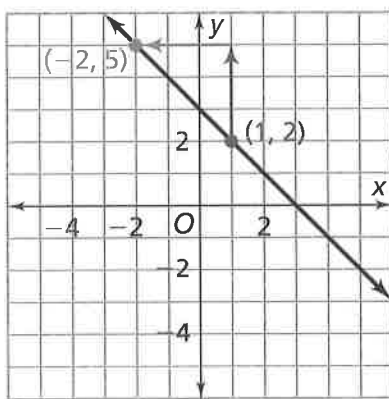




Applications

1. Plans for a set of stairs for the front of a new community center use the ratio of rise to run of 2 units to 5 units.
 - a. Recall that the carpenters' guidelines state that the ratio of rise to run should be between 0.45 and 0.60. Are these stairs within the carpenters' guidelines?
 - b. Sketch a set of stairs that meets the rise-to-run ratio of 2 units to 5 units.
 - c. Sketch the graph of a line where the y -values change by 2 units for each 5-unit change in the x -values.
 - d. Write an equation for your line in part (c).
2.
 - a. Find the horizontal distance and the vertical distance between the two labeled points on the graph below.
 - b. What is the slope of the line?



For Exercises 3–6, find the slope and the y -intercept of the line associated with the equation.

3. $y = 10 + 3x$

4. $y = 0.5x$

5. $y = -3x$

6. $y = -5x + 2$

7. Seven possible descriptions of lines are listed below.

- i. positive slope
- ii. negative slope
- iii. y -intercept equals 0
- iv. passes through the point (1, 2)
- v. slope of zero
- vi. positive y -intercept
- vii. negative y -intercept

For each equation, list *all* of the descriptions i–vii that describe the graph of that equation.

a. $y = 2x$

b. $y = 3 - 3x$

c. $y = 2x + 3$

d. $y = 5x - 3$

e. $y = 2$

In Exercises 8–12, the tables represent linear relationships. Give the slope and the y -intercept of the graph of each relationship. Then match each of the following equations with the appropriate table.

$y = 5 - 2x$

$y = 2x$

$y = -3x - 5$

$y = 2x - 1$

$y = x + 3.5$

8.

x	0	1	2	3	4
y	0	2	4	6	8

9.

x	0	1	2	3	4
y	3.5	4.5	5.5	6.5	7.5

10.

x	1	2	3	4	5
y	1	3	5	7	9

11.

x	0	1	2	3	4
y	5	3	1	-1	-3

12.

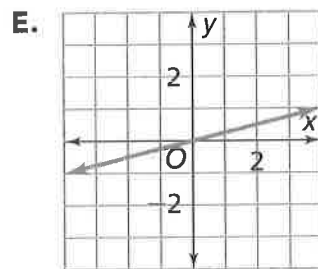
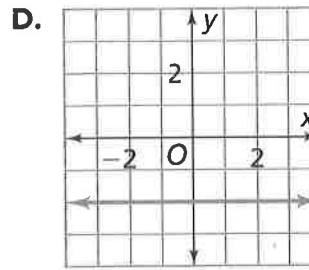
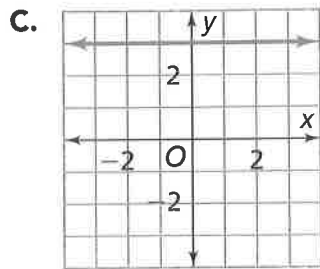
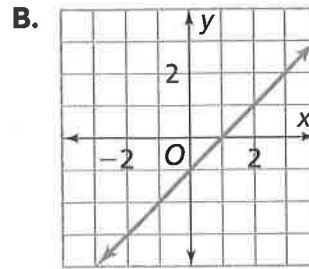
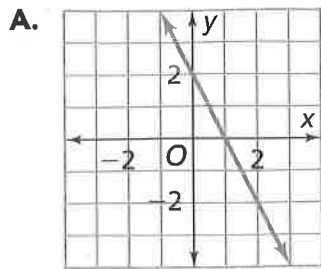
x	2	3	4	5	6
y	-11	-14	-17	-20	-23

- 13.** a. Find the slope of the line represented by the equation $y = x - 1$.
b. Make a table of x - and y -values for the equation $y = x - 1$. How is the slope related to the table entries?
- 14.** a. Find the slope of the line represented by the equation $y = -2x + 3$.
b. Make a table of x - and y -values for the equation $y = -2x + 3$. How is the slope related to the table entries?
- 15.** In parts (a) and (b), the equations represent linear relationships. Use the given information to find the value of b .
- a. The point $(1, 5)$ lies on the line representing $y = b - 3.5x$.
b. The point $(0, -2)$ lies on the line representing $y = 5x - b$.
c. What are the y -intercepts in parts (a) and (b)? What are the patterns of change in parts (a) and (b)?
d. Find the x -intercepts for the linear relationships in parts (a) and (b). (The x -intercept is the point where the graph intersects the x -axis.)

For each pair of points in Exercises 16–19, answer parts (a)–(e).

- a. Plot the points on a coordinate grid and draw a line through them.
b. Find the slope of the line.
c. Find the y -intercept of the line. Explain how you found the y -intercept.
d. Use your answers from parts (b) and (c) to write an equation for the line.
e. Find one more point that lies on the line.
- 16.** $(0, 0)$ and $(3, 3)$
- 17.** $(-1, 1)$ and $(3, -3)$
- 18.** $(0, -5)$ and $(-2, -3)$
- 19.** $(3, 6)$ and $(5, 6)$

For Exercises 20–22, determine which of the linear relationships A–K fit the description given.



F.

x	-3	-2	-1	0
y	7	5	3	1

G.

x	-4	-2	-1	0
y	2	2	2	2

H. $y = 1.5$

J. $y = -5 + 3x$

K. $y = 4 + -2x$

20. The line corresponding to this relationship has positive slope.
21. The line corresponding to this relationship has a slope of -2 .
22. The line corresponding to this relationship has a slope of 0 .
23. Decide which graph from Exercises 20–22 matches each equation.
- a. $y = x - 1$ b. $y = -2$ c. $y = \frac{1}{4}x$

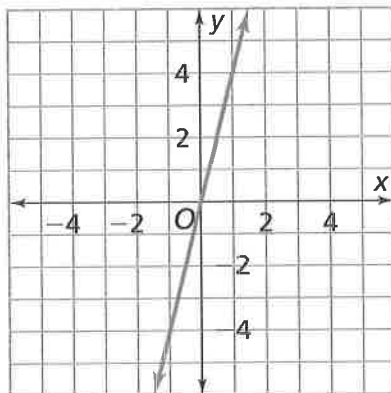
For each equation in Exercises 24–26, answer parts (a)–(d).

24. $y = x$

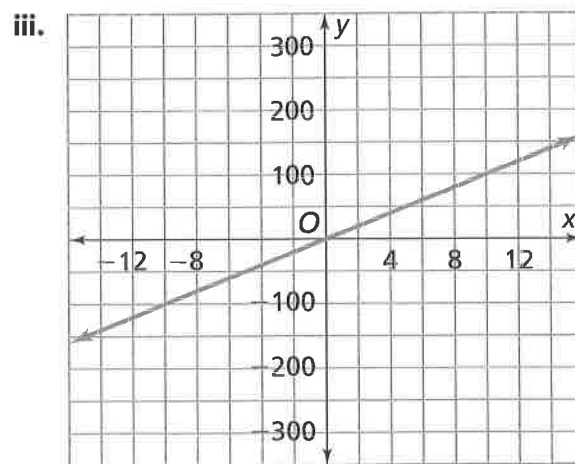
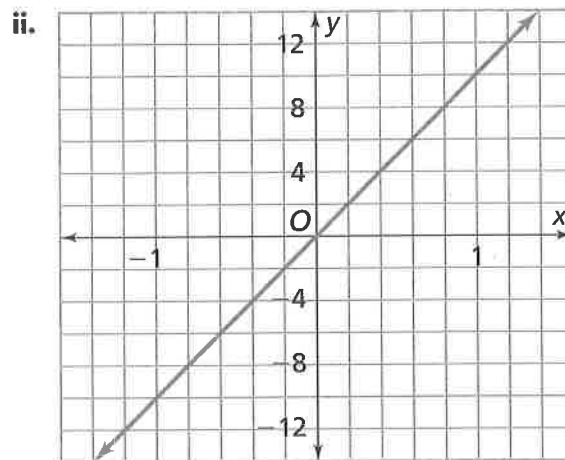
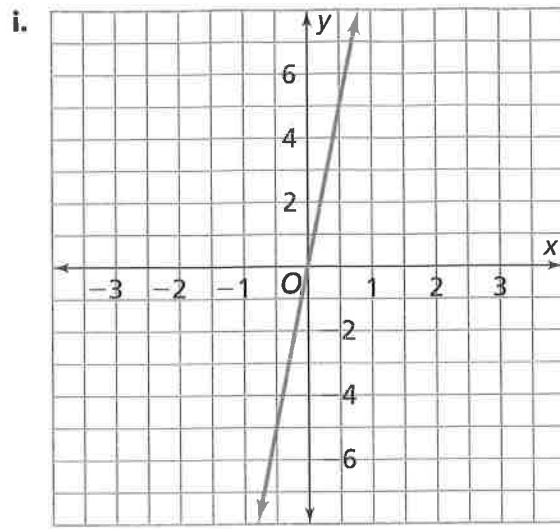
25. $y = 2x - 2$

26. $y = -0.5x + 2$

- a. Make a table of x - and y -values for the equation.
 - b. Sketch a graph of the equation.
 - c. Find the slope of the line.
 - d. Make up a problem that can be represented by each equation.
27. a. Graph a line with slope 3.
- i. Find two points on your line.
 - ii. Write an equation for the line.
- b. On the same set of axes, graph a line with slope $-\frac{1}{3}$.
- i. Find two points on your line.
 - ii. Write an equation for the line.
- c. Compare the two graphs you made in parts (a) and (b).
28. Use the line in the graph below to answer each question.
- a. Find the equation of a line that is parallel to this line.
 - b. Find the equation of a line that is perpendicular to this line.



29. a. Find the slope of each line below. Then write an equation for the line.



b. Compare the slopes of the three lines.

c. How are the three graphs similar? How are they different?

- 30.** Descriptions of three possible lines are listed below.
- a line that *does not* pass through the first quadrant
 - a line that passes through exactly two quadrants
 - a line that passes through only one quadrant
- For each, decide whether such a line exists. Explain.
 - If such a line exists, what must be true about the equation of the line that satisfies the conditions?
 - If such a line exists, sketch its graph. Then write the equation of the line next to the graph.

- 31.** Suppose the slopes of two lines are the negative reciprocal of each other. For example:

$$y = 2x \text{ and } y = -\frac{1}{2}x$$

What must be true about the two lines? Is your conjecture true if the y -intercept of either equation is not zero? Explain.

- 32.** Write equations for four lines that intersect to form the sides of a parallelogram. Explain what must be true about such lines.
- 33.** Write equations for three lines that intersect to form a right triangle. Explain what must be true about such lines.
- 34.** Describe how you can decide if two lines are parallel or perpendicular from the equations of the lines.
- 35.** Meifeng is taking a bike repair class. She pays the bike shop \$15 per week for the class. At the end of the third week, Meifeng still owes the bike shop \$75.
- How many payments does Meifeng have left?
 - How much did the class cost?
 - Write an equation that models the relationship between the time in weeks and the amount of money Meifeng owes.
 - Without graphing, describe what the graph of this relationship would look like.

- 36.** Robert is installing a patio in his backyard. At 2:00 P.M., he has 120 stones laid in the ground. At 3:30 P.M., he has 180 stones in the ground. His design for the patio says he needs 400 stones total.



- When would you predict he will be done?
 - What is a reasonable estimate for when he started?
 - If you wanted to know how many stones he would have in the ground at any time, what would be most helpful to you: an equation, a graph, or a table? Explain.
- 37.** At noon, the temperature is 30°F . For the next several hours, the temperature falls by an average of 3°F an hour.
- Write an equation for the temperature T , n hours after noon.
 - What is the y -intercept of the line the equation represents? What does the y -intercept tell you about this situation?
 - What is the slope of the line the equation represents? What does the slope tell you about this situation?
- 38.** Damon never manages to make his allowance last for a whole week, so he borrows money from his sister. Suppose Damon borrows 50 cents every week.
- Write an equation for the amount of money m Damon owes his sister after n weeks.
 - What is the slope of the graph of the equation from part (a)?

- 39.** In 2000, the small town of Cactusville was destined for obscurity. However, due to hard work by its city officials, it began adding manufacturing jobs at a fast rate. As a result, the city's population grew 239% from 2000 to 2010.



- a.** What was the population of Cactusville in 2000?
- b.** Suppose the same rate of population increase continues. What might the population be in the year 2020?
- 40.** Terrance and Katrina share a veterinary practice. They each make farm visits two days a week. They take cellular phones on these trips to keep in touch with the office. Terrance makes his farm visits on weekdays. His cellular phone rate is \$14.95 a month plus \$.50 a minute. Katrina makes her visits on Saturday and Sunday and is charged a weekend rate of \$34 a month.
- a.** Write an equation for each billing plan.
- b.** Is it possible for Terrance's cellular phone bill to be more than Katrina's? Explain how you know this.
- c.** Suppose Terrance and Katrina made the same number of calls in the month of May. Is it possible for Terrance's and Katrina's phone bills to be for the same amount? If so, how many minutes of phone calls would each person have to make for their bills to be equal?
- d.** Katrina finds another phone company that offers one rate for both weekday and weekend calls. The billing plan for this company is given by the equation $A = 25 + 0.25m$, where A is the total monthly bill and m is the number of minutes of calls. Compare this billing plan with the other two plans.

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41. Three students build the following pattern using the least number of toothpicks possible. For example, Figure 2 uses 5 toothpicks. Suppose that this pattern continues beyond Figure 3.



Figure 1

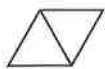


Figure 2

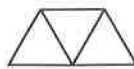


Figure 3

- a. The students are trying to figure out the perimeter of Figure 6 without building it. For each student's method, tell whether you agree or disagree. If you agree, explain why. If you disagree, describe what is incorrect about the student's reasoning.

Juan's Method

From one figure to the next, you are adding one unit of perimeter. Figure 3 has a perimeter of 5 units, so Figure 6 will have a perimeter of $5 + 1 + 1 + 1 = 8$ units.

Natalie's Method

Figure 3 has a perimeter of 5 units. 6 is twice as great as 3. So Figure 6 has twice the perimeter, or 10 units.

Steven's Method

Figure 6 will have 6 triangles, and each triangle has a perimeter of 3 units. So Figure 6 will have a perimeter of $6 \cdot 3 = 18$ units.

- b. The students want to figure out a way to calculate how many toothpicks T they would need to build any figure number F . Which students wrote correct equations? Explain.

Juan's Equation

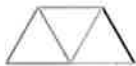
$$T = (F + 1) + F$$



There are $(F + 1)$ slanted toothpicks. There are F toothpicks on the top and bottom.

Natalie's Equation

$$T = 2F + 1$$



There are F of this shape



in each figure plus one extra toothpick at the end.

Steven's Equation

$$T = 3F - (F - 1)$$



There are F triangles, each with 3 toothpicks. But, there are $F - 1$ toothpicks double-counted.

42.



Figure 1

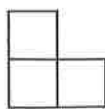


Figure 2

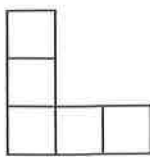


Figure 3

- Assume that this pattern continues beyond Figure 3. Write an equation that represents the number of squares S in figure n .
- Explain how you know your equation will work for any figure number.
- Write two different equations that represent the perimeter P for any given figure number n .



Connections

43. Some hills have signs indicating their steepness, or slope. Here are some examples:



On a coordinate grid, sketch hills with each of these slopes.

44. Solve each equation and check your answers.

a. $2x + 3 = 9$

b. $\frac{1}{2}x + 3 = 9$

c. $x + 3 = \frac{9}{2}$

d. $x + \frac{1}{2} = 9$

e. $\frac{x+3}{2} = 9$

45. Use properties of equality and numbers to solve each equation for x . Check your answers.

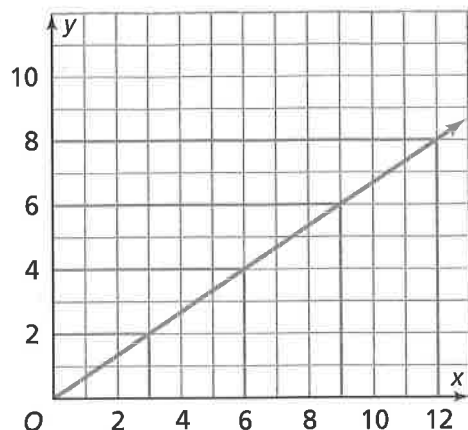
a. $3 + 6x = 4x + 9$

b. $6x + 3 = 4x + 9$

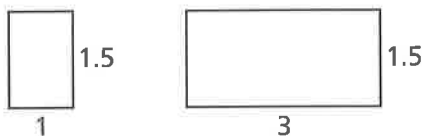
c. $6x - 3 = 4x + 9$

d. $3 - 6x = 4x + 9$

46. Use the graph below to answer each question.

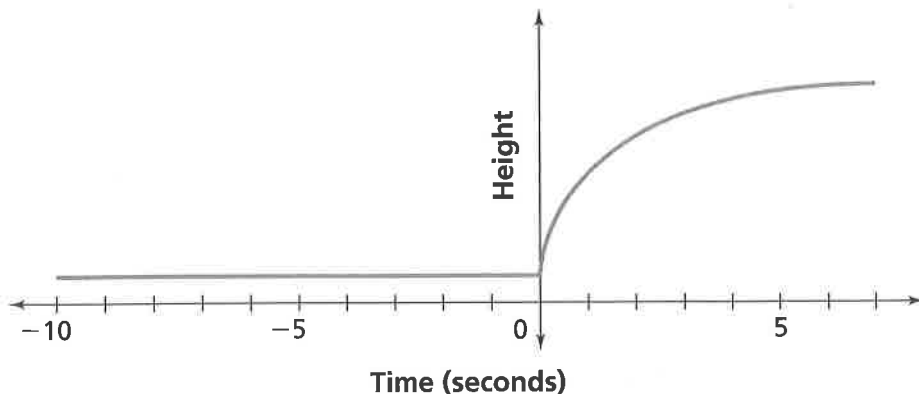


- Are any of the rectangles in the picture above similar? If so, tell which rectangles, and explain why they are similar.
- Find the slope of the diagonal line. How is it related to the similar rectangles?
- Which of these rectangles belong to the set of rectangles in the graph? Explain.



47. The graph below shows the height of a rocket from 10 seconds before liftoff through 7 seconds after liftoff.

- Describe the relationship between the height of the rocket and time.
- What is the slope for the part of the graph that is a straight line? What does this slope represent in this situation?



48. Solve each equation. Check your answers.

a. $2(x + 5) = 18$

b. $2(x + 5) = x - 8$

c. $2(x + 5) = x$

d. $2(x + 5) = -15$

49. **Multiple Choice** Which equation has a graph that contains the point $(-2, 7)$?

A. $y = 4x + 1$

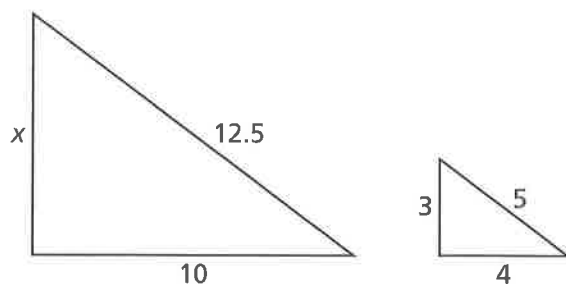
B. $y = -x + 5$

C. $y = 3x - 11$

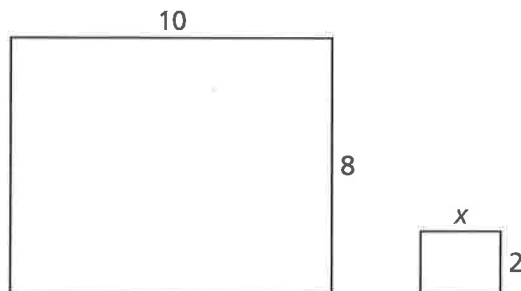
D. $y = -3x + 11$

50. Each pair of figures is similar. Find the lengths of the sides marked x .

a.



b.



51. Find a value of n that will make each statement true.

a. $\frac{n}{10} = \frac{3}{2}$

b. $\frac{5}{6} = \frac{n}{18}$

c. $-\frac{4}{6} = \frac{n}{3}$

d. $\frac{5}{18} = \frac{20}{n}$

e. Write an equation for a line whose slope is $-\frac{4}{6}$.

52. Find a value of n that will make each statement true.

a. 15% of 90 is n .

b. 20% of n is 80.

c. $n\%$ of 50 is 5.

Extensions



- 53.** On a March flight from Boston to Detroit, a monitor displayed the altitude and the outside air temperature. Two passengers that were on that flight tried to find a formula for temperature t in degrees Fahrenheit at an altitude of a feet above sea level. One passenger said the formula was $t = 46 - 0.003a$, and the other said it was $t = 46 + 0.003a$.
- Which formula makes more sense to you? Why?
 - The Detroit Metropolitan Airport is 620 feet above sea level. Use the formula you chose in part (a) to find the temperature at the airport on that day.
 - Does the temperature you found in part (b) seem reasonable? Why or why not?
- 54.** Jada's track team decides to convert their running rates from miles per hour to kilometers per hour (1 mile \approx 1.6 kilometers).
- Which method would you use to help the team do their converting: graph, table, or equation? Explain why you chose your method.
 - One of Jada's teammates said that she could write an equation for her spreadsheet program that could convert any team member's running rate from miles per hour to kilometers per hour. Write an equation that each member could use for this conversion.