

## Applications

- Hoshi walks 10 meters in 3 seconds.
  - What is her walking rate?
  - At this rate, how long does it take her to walk 100 meters?
  - Suppose she walks this same rate for 50 seconds. How far does she walk?
  - Write an equation that represents the distance  $d$  that Hoshi walks in  $t$  seconds.
- Milo walks 40 meters in 15 seconds and Mira walks 30 meters in 10 seconds. Whose walking rate is faster?

**In Exercises 3–5, Jose, Mario, Melanie, Mike, and Alicia are on a weeklong cycling trip. Cycling times include only biking time, not time to eat, rest, and so on.**

- The table below gives the distance Jose, Mario, and Melanie travel for the first 3 hours. Assume that each person cycles at a constant rate.

**Cycling Distance**

Cycling Time (hours)	Distance (miles)		
	Jose	Mario	Melanie
0	0	0	0
1	5	7	9
2	10	14	18
3	15	21	27

- Find the average rate at which each person travels during the first 3 hours. Explain.
- Find the distance each person travels in 7 hours.
- Graph the time and distance data for all three riders on the same coordinate axes.
- Use the graphs to find the distance each person travels in  $6\frac{1}{2}$  hours.
- Use the graphs to find the time it takes each person to travel 70 miles.

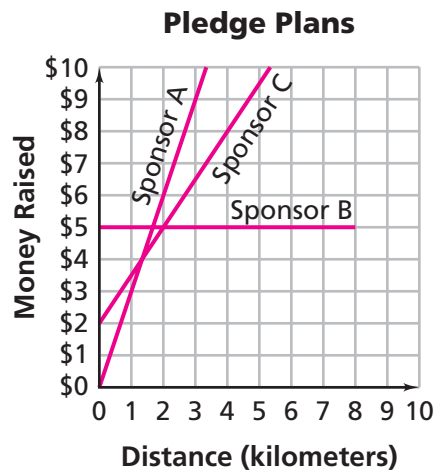
- f. How does the rate at which each person rides affect each graph?
- g. For each rider, write an equation that can be used to calculate the distance traveled after a given number of hours.
- h. Use your equations from part (g) to calculate the distance each person travels in  $6\frac{1}{2}$  hours.
- i. How does a person's biking rate show up in his or her equation?
4. Mike makes the following table of the distances he travels during the first day of the trip.
- Suppose Mike continues riding at this rate. Write an equation for the distance Mike travels after  $t$  hours.
  - Sketch a graph of the equation. How did you choose the range of values for the time axis? For the distance axis?
  - How can you find the distances Mike travels in 7 hours and in  $9\frac{1}{2}$  hours, using the table? Using the graph? Using the equation?
  - How can you find the numbers of hours it takes Mike to travel 100 miles and 237 miles, using the table? Using the graph? Using the equation?
  - For parts (c) and (d), what are the advantages and disadvantages of using each form of representation—a table, a graph, and an equation—to find the answers?
  - Compare the rate at which Mike rides with the rates at which Jose, Mario, and Melanie ride. Who rides the fastest? How can you determine this from the tables? From the graphs? From the equations?

Cycling Distance

Time (hours)	Distance (miles)
0	0
1	6.5
2	13
3	19.5
4	26
5	32.5
6	39



5. The distance Alicia travels in  $t$  hours is represented by the equation  $d = 7.5t$ .
- At what rate does Alicia travel?
  - Suppose the graph of Alicia's distance and time is put on the same set of axes as Mike's, Jose's, Mario's, and Melanie's graphs. Where would it be located in relationship to each of the graphs? Describe the location without actually making the graph.
6. The graph below represents the walkathon pledge plans from three sponsors.



- Describe each sponsor's pledge plan.
  - What is the number of dollars per kilometer each sponsor pledges?
  - What does the point where the line crosses the y-axis mean for each sponsor?
  - Write the coordinates of two points on each line. What information does each point represent for the sponsor's pledge plan?
7. The students in Ms. Chang's class decide to order water bottles that advertise the walkathon. Maliik obtains two different quotes for the costs of the bottles.
- Fill It Up charges \$4 per bottle.
- Bottles by Bob charges \$25 plus \$3 per bottle.
- For each company, write an equation Maliik could use to calculate the cost for any number of bottles.



- b.** On the same set of axes, graph both equations from part (a). Which variable is the independent variable? Which is the dependent variable?
- c.** Which company do you think the class should buy water bottles from? What factors influenced your decision?
- d.** For what number of water bottles is the cost the same for both companies?
- 8. Multiple Choice** The equation  $C = 5n$  represents the cost  $C$  in dollars for  $n$  caps that advertise the walkathon. Which of the following pairs of numbers could represent a number of caps and the cost for that number of caps,  $(n, C)$ ?
- A.** (0, 5)      **B.** (3, 15)      **C.** (15, 60)      **D.** (5, 1)
- 9.** The equation  $d = 3.5t + 50$  represents the distance  $d$  in meters that a cyclist is from his home after  $t$  seconds.
- a.** Which of the following pairs of numbers represent the coordinates of a point on the graph of this equation? Explain your answer.
- i.** (10, 85)      **ii.** (0, 0)      **iii.** (3, 60.5)
- b.** What information do the coordinates represent about the cyclist?
- 10.** Examine the patterns in each table.

**Table 1**

$x$	$y$
-2	3
-1	3
0	3
1	3
2	3

**Table 2**

$x$	$y$
-3	9
-2	4
-1	1
0	0
1	1

**Table 3**

$x$	$y$
0	10
3	19
5	25
10	40
12	46

**Table 4**

$x$	$y$
0	-3
2	-6
4	-9
6	-12
8	-15

- a.** Describe the similarities and differences in Tables 1–4.
- b.** Explain how you can use the tables to decide if the data represent a linear relationship.
- c.** Sketch a graph of the data in each table.
- d.** Write an equation for each linear relationship. Explain what information the numbers and variables represent in the relationship.

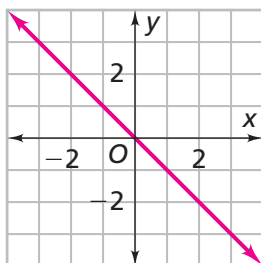
- 11.** The temperature at the North Pole is  $30^{\circ}\text{F}$  and is expected to drop  $5^{\circ}\text{F}$  per hour for the next several hours. Write an equation that represents the relationship between temperature and time. Explain what information your numbers and variables mean. Is this a linear relationship?
- 12.** Jamal's parents give him money to spend at camp. Jamal spends the same amount of money on snacks each day. The table below shows the amount of money, in dollars, he has left at the end of each day.

**Snack Money**

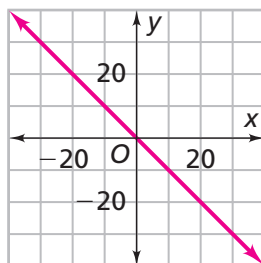
Days	Money Left
0	\$20
1	\$18
2	\$16
3	\$14
4	\$12
5	\$10
6	\$8

- a.** How much money does Jamal have at the start of camp? Explain.
- b.** How much money is spent each day? Explain.
- c.** Assume that Jamal's spending pattern continues. Is the relationship between the number of days and the amount of money left in Jamal's wallet a linear relationship? Explain.
- d.** Check your answer to part (c) by sketching a graph of this relationship.
- e.** Write an equation that represents the relationship. Explain what information the numbers and variables represent.
- 13.** Write an equation for each graph.

**Graph 1**



**Graph 2**



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- 14. a.** Give an example of a linear situation with a rate of change that is
- positive.
  - zero (no change).
  - negative.
- b.** Write an equation that represents each situation in part (a).

## Connections

- 15.** Jelani is in a walking race at his school. In the first 20 seconds, he walks 60 meters. In the next 30 seconds, he walks 60 meters. In the next 10 seconds, he walks 35 meters. In the last 40 seconds, he walks 80 meters.
- Describe how Jelani's walking rate changes during the race.
  - What would a graph of Jelani's walking race look like?
- 16.** Insert parentheses where needed in each expression to show how to get each result.
- $2 + -3 \times 4 = -10$
  - $4 + -3 \times -4 = -4$
  - $-12 \div 2 + -4 = 6$
  - $8 \div -2 + -2 = -6$
- 17.** Which of the following number sentences are true? In each case, explain how you could answer without any calculation. Check your answers by doing the indicated calculations.
- $20 \times 410 = (20 \times 400) + (20 \times 10)$
  - $20 \times 308 = (20 \times 340) - (20 \times 32)$
  - $-20 \times -800 = (-20 \times -1,000) + (-20 \times 200)$
  - $-20 + (300 \times 32) = (-20 + 300) \times (-20 + 32)$
- 18.** Fill in the missing numbers to make each sentence true.
- $15 \times (6 + 4) = (15 \times \blacksquare) + (15 \times 4)$
  - $2 \times (x + 6) = (2 \times \blacksquare) + (\blacksquare \times 6)$
  - $(x \times 2) + (x \times 6) = \blacksquare \times (2 + 6)$
- 19. a.** Draw a rectangle whose area can be represented by the expression  $5 \times (12 + 6)$ .
- b.** Write another expression to represent the area of the rectangle in part (a).

- 20.** Find the unit rate and use it to write an equation relating the two quantities.
- a.** 50 dollars for 150 T-shirts
  - b.** 8 dollars to rent 14 video games
  - c.** 24 tablespoons of sugar in 3 glasses of Bolda Cola

- 21.** The longest human-powered sporting event is the Tour de France cycling race. The record average speed for this race is 25.88 miles per hour, which was attained by Lance Armstrong in 2005.



- a.** The race was 2,242 miles long. How long did it take Armstrong to complete the race in 2005?
- b.** Suppose Lance had reduced his average cycling rate by 0.1 mile per hour. By how much would his time have changed?

- 22. a.** In 2002, Gillian O’Sullivan set the record of the 5,000 m race-walking event. She finished the race in 20 minutes 2.60 seconds. What was O’Sullivan’s average walking speed, in meters per second?
- b.** In 1990, Nadezhda Ryashkina set the record for the 10,000 m race-walking event. She finished this race in 41 minutes 56.23 seconds. What was Ryashkina’s average walking rate, in meters per second?
- 23.** A recipe for orange juice calls for 2 cups of orange juice concentrate and 3 cups of water. The table below shows the amount of concentrate and water needed to make a given number of batches of juice.

**Orange Juice Mixture Amounts**

Batches of Juice ( $b$ )	Concentrate ( $c$ )	Water ( $w$ )	Juice ( $j$ )
1	2 cups	3 cups	5 cups
2	4 cups	6 cups	10 cups
3	6 cups	9 cups	15 cups
4	8 cups	12 cups	20 cups

The relationship between the number of batches  $b$  of juice and the number of cups  $c$  of concentrate is linear. The equation for this relationship is  $c = 2b$ . Are there other linear relationships in this table? Sketch graphs or write equations for the linear relationships you find.

24. The table below gives information about a pineapple punch recipe. The table shows the number of cups of orange juice, pineapple juice, and soda water needed for different quantities of punch.

**Recipe**

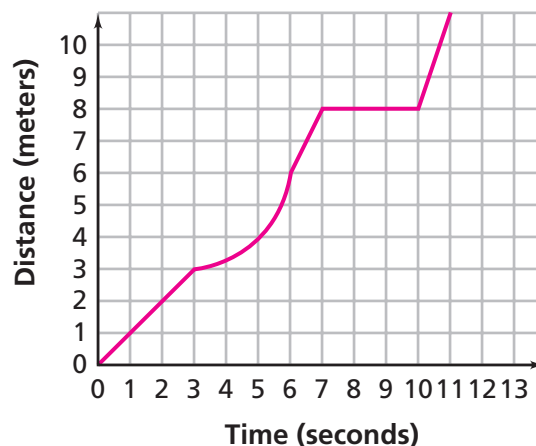
<i>J</i> (orange juice, cups)	<i>P</i> (pineapple juice, cups)	<i>S</i> (soda water, cups)
1	■	■
2	■	■
3	■	■
4	12	6
5	■	■
6	■	■
7	■	■
8	24	12



The relationship between cups of orange juice and cups of pineapple juice is linear, and the relationship between cups of orange juice and cups of soda water is linear.

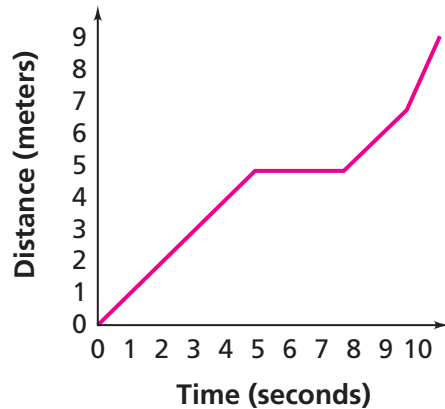
- Zahara makes the recipe using 6 cups of orange juice. How many cups of soda water does she use? Explain your reasoning.
  - Patrick makes the recipe using 6 cups of pineapple juice. How many cups of orange juice and how many cups of soda water does he use? Explain.
25. The graph below represents the distance John runs in a race. Use the graph to describe John's progress during the course of the race. Does he run at a constant rate during the trip? Explain.

**Running Distance**





26. a. Does the graph represent a linear relationship? Explain.



b. Could this graph represent a walking pattern? Explain.

**In Exercises 27–29, students conduct an experiment to investigate the rate at which a leaking faucet loses water. They fill a paper cup with water, make a small hole in the bottom, and collect the dripping water in a measuring container, measuring the amount of water in the container at the end of each 10-second interval.**

27. Students conducting the leaking-faucet experiment produce the table below. The measuring container they use holds only 100 milliliters.

a. Suppose the students continue their experiment. After how many seconds will the measuring container overflow?

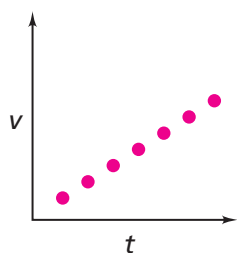
**Leaking Faucet**

<b>Time (seconds)</b>	10	20	30	40	50	60	70
<b>Water Loss (milliliters)</b>	2	5	8.5	11.5	14	16.5	19.5

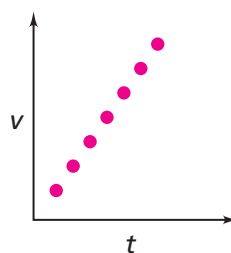
b. Is this relationship linear? Explain.

28. Denise and Takashi work together on the leaking-faucet experiment. Each of them makes a graph of the data they collect. What might have caused their graphs to look so different?

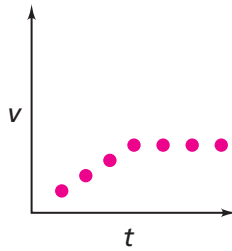
**Denise's Graph**



**Takashi's Graph**



29. What information might the graph below represent in the leaking-faucet experiment?



## Extensions

30. a. The table below shows the population of four cities for the past eight years. Describe how the population of each city changed over the eight years.

**Populations of Four Cities**

Year	Population			
	Deep Valley	Nowhere	Swampville	Mount Silicon
0 (start)	1,000	1,000	1,000	1,000
1	1,500	900	1,500	2,000
2	2,000	800	2,500	4,000
3	2,500	750	3,000	8,000
4	3,000	700	5,000	16,000
5	3,500	725	3,000	32,000
6	4,000	900	2,500	64,000
7	4,500	1,500	1,500	128,000
8	5,000	1,700	1,000	256,000

- b. Use the table to decide which relationships are linear.
- c. Graph the data for each city. Describe how you selected ranges of values for the horizontal and vertical axes.
- d. What are the advantages of using a table or a graph to represent the data?

- 31.** In the walkathon, Jose decides to charge his patrons \$10 for the first 5 kilometers he walks and \$1 per kilometer after 5 kilometers.
- Sketch a graph that represents the relationship between money collected and kilometers walked.
  - Compare this graph to the graphs of the other pledge plans in Problem 1.3.
- 32.** The cost  $C$  to make T-shirts for the walkathon is represented by the equation  $C = 20 + 5N$ , where  $N$  is the number of T-shirts.
- Find the coordinates of a point that lies on the graph of this equation. Explain what the coordinates mean in this context.
  - Find the coordinates of a point above the line. Explain what the coordinates mean in this context.
  - Find the coordinates of a point below the line. Explain what the coordinates mean in this context.
- 33.** Frankie is looking forward to walking in a walkathon. She writes some equations to use to answer some questions she has. For each part below, tell what you think the equation might represent and write one question she could use it to answer.
- $y = 3x + 20$
  - $y = 0.25x$
  - $y = 4x$

