Applications

1. Hoshi walks 10 meters in 3 seconds.
   a. What is her walking rate?
   b. At this rate, how long does it take her to walk 100 meters?
   c. She walks at this same rate for 50 seconds. How far does she walk?
   d. Write an equation that represents the distance d that Hoshi walks in t seconds.

2. Milo walks 40 meters in 15 seconds. Mira walks 30 meters in 10 seconds. Whose walking rate is greater?

For Exercises 3–5, Jose, Mario, Melanie, Mike, and Alicia are on a weeklong cycling trip. The table below gives the distance Jose, Mario, and Melanie each travel for the first 3 hours. Cycling times include only biking time, not time to eat, rest, and so on.

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

3. a. Assume that each person cycles at a constant rate. Find the rate at which each person travels during the first 3 hours. Explain.
   b. Find the distance each person travels in 7 hours.
   c. Graph the time and distance data for all three riders on the same coordinate axes.
   d. Use the graphs to find the distance each person travels in $6\frac{1}{2}$ hours.
   e. 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 cycling rate show up in his or her equation?

j. Are any of these proportional relationships? If so, what is the constant of proportionality?

4. Mike makes the following table of the distances he travels during the first day of the trip.

Cycling Distance

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

a. Suppose Mike continues riding at this rate. Write an equation for the distance Mike travels after t hours.

b. Sketch a graph of the equation. How did you choose the range of values for the time axis? For the distance axis?

c. 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?

d. 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?

e. For parts (c) and (d), what are the advantages and disadvantages of using each model—a table, a graph, and an equation—to find the answers?

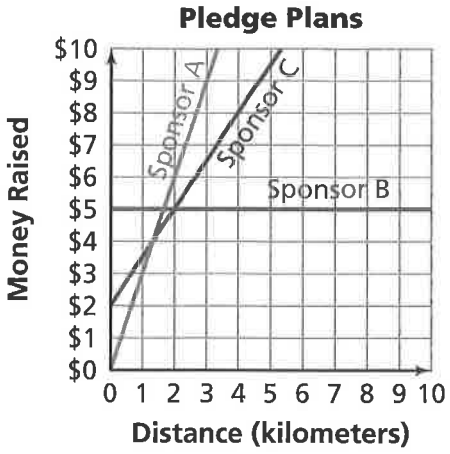
f. Compare the rate at which Mike rides with the rates at which Jose, Mario, and Melanie ride. Who rides the fastest? How can you determine this from the tables? From the graphs? From the equations?

5. The distance in miles Alicia travels in t hours is represented by the equation $d = 7.5t$.

a. At what rate does Alicia travel? Explain.

b. 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 for three sponsors.



a. Describe each sponsor's pledge plan.

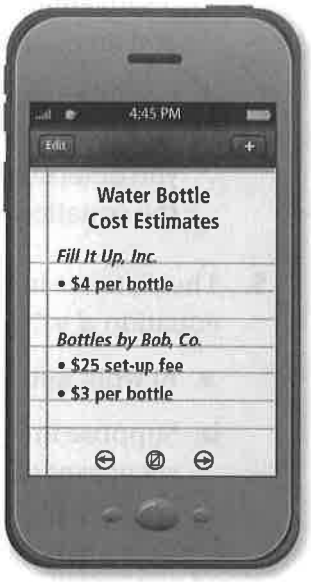
b. What is the number of dollars per kilometer each sponsor pledges?

c. What does the point where the line crosses the y-axis mean for each sponsor?

d. Write the coordinates of two points on each line. What information does each point represent for the sponsor's pledge plan?

e. Does each relationship represent a proportional relationship?

7. The students in Ms. Chang's class decide to order water bottles that advertise the walkathon. Hyun obtains two different quotes for the costs of the bottles.



a. For each company, write an equation Hyun 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. From which company do you think the class should buy water bottles? What factors influenced your decision?

d. For what number of water bottles is the cost the same for both companies? Explain.

8. Multiple Choice The equation $C = 5n$ represents the cost C in dollars for n caps that advertise the walkathon. Which of the following ordered pairs 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 $d = 3.5t + 50$ gives the distance d in meters that a cyclist is from his home after t seconds.

a. Which of the following ordered pairs represents 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 tell you about the cyclist?

10. Examine the pattern 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 each table to decide whether the data indicate a linear relationship between the two quantities.

c. Sketch a graph of the data in each table.

d. Write an equation that represents the relationship between the independent and dependent variables for each linear relationship. Explain what information the numbers and variables tell you about the relationship.

11. a. The temperature at the North Pole is 30°F and is expected to drop 5°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 represent.

b. Is this a linear relationship? Explain your reasoning.

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

a. How much money does Jamal have at the start of camp? Explain.

b. How much money does he spend each day? Explain.

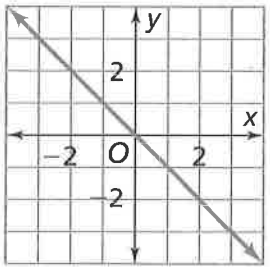
c. Is the relationship between the number of days and the amount of money left in Jamal's wallet a linear relationship? Explain.

d. Assume that Jamal's spending pattern continues. Check your answer to part (c) by sketching a graph of this relationship.

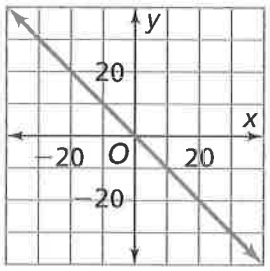
e. Write an equation that represents the relationship. Explain what information the numbers and variables represent.

13. Write an equation for each graph.

Graph 1



Graph 2



14. a. Describe a situation that involves a linear relationship between an independent variable and a dependent variable for which the rate of change is:

i. positive. **ii.** zero (no change). **iii.** negative.

b. Write an equation that models 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.

a. Describe how Jelani's walking rate changes during the race.

b. What would a graph of Jelani's walking race look like?

16. Insert parentheses in the expression on the left side of each equation to make each number sentence true.

a. $2 + -3 \times 4 = -10$

b. $4 + -3 \times -4 = -4$

c. $-12 \div 2 + -4 = 6$

d. $8 \div -2 + -2 = -6$

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.

a. $20 \times 410 = (20 \times 400) + (20 \times 10)$

b. $20 \times 308 = (20 \times 340) - (20 \times 32)$

c. $-20 \times -800 = (-20 \times -1{,}000) + (-20 \times 200)$

d. $-20 + (300 \times 32) = (-20 + 300) \times (-20 + 32)$

18. Fill in the missing parts to make each number sentence true.

a. $15 \times (6 + 4) = (15 \times \square) + (15 \times 4)$

b. $2 \times (x + 6) = (2 \times \square) + (\square \times 6)$

c. $(x \times 2) + (x \times 6) = \square \times (2 + 6)$

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. 150 dollars for 50 T-shirts

b. 62 dollars to rent 14 video games

c. 18 tablespoons of sugar in 3 glasses of Bolda Cola

21. The longest human-powered sporting event is the Tour de France cycling race. In a particular year, the average speed for the winner of this race was 23.66 miles per hour.

a. In that same year, the race was 2,292 miles long. How long did it take the winner to complete the race?

b. Suppose the winner had reduced his average cycling rate by 0.1 mile per hour. By how much would his time have changed?

22. **a.** 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?

b. In 2001, Olimpiada Ivanova set the record for the 20,000 m race-walking event. She finished the race in 86 minutes 52.3 seconds. What was Ivanova's average walking speed, 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 of juice b and the number of cups of concentrate c is linear. The equation that represents this linear relationship is $c = 2b$. Are there other relationships in this table that are linear? Sketch graphs or write equations for any you find.

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

Pineapple Punch Recipe

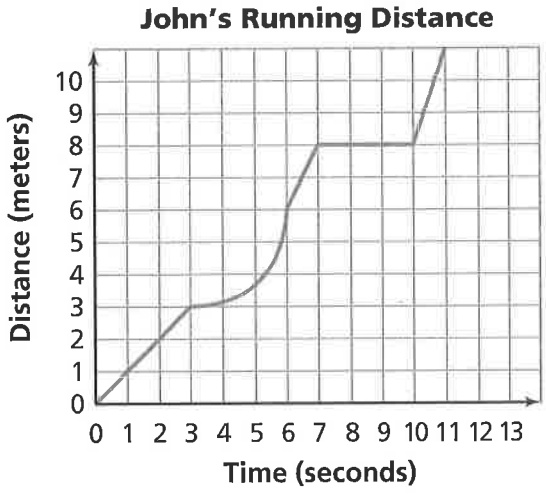
J (orange juice, cups)	*P* (pineapple juice, cups)	*S* (soda water, cups)
1		
2		
3		
4	12	6
5		
6		
7		
8	24	12

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

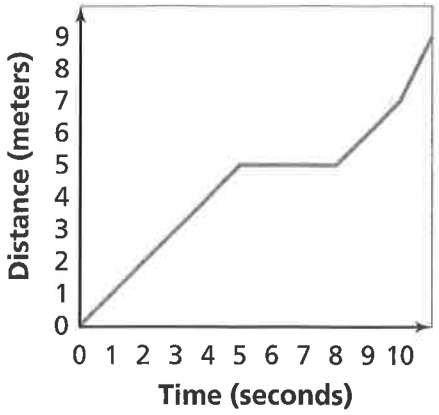
a. Zahara makes the recipe using 6 cups of orange juice. How many cups of soda water does she use? Explain your reasoning.

b. Patrick makes the recipe using 6 cups of pineapple juice. How many cups of orange juice and cups of soda water does he use? Explain.

25. The graph at the right 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 race? Explain.



26. **a.** Does this graph represent a linear relationship? Explain.



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

For 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 has a capacity of 100 milliliters.

Leaking Faucet Experiment

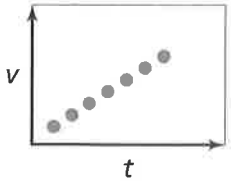
Time (seconds)	10	20	30	40	50	60	70
Water Loss (milliliters)	2	5	8.5	11.5	14	16.5	19.5

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

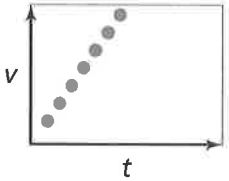
b. Is this a linear relationship? Explain.

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 different?

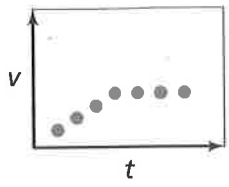
Denise's Graph



Takashi's Graph



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



Extensions

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

City Populations

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 determine which relationships are linear.

c. Graph the data for each city. Describe how you selected ranges of values for the variables on 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, José asks his sponsors to donate \$10 for the first 5 kilometers he walks and \$1 per kilometer after 5 kilometers.

a. Sketch a graph that represents the relationship between the money collected from each sponsor and the number of kilometers walked.

b. 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 given by the equation $C = 20 + 5n$, where n is the number of T-shirts.

a. Find the coordinates of a point that lies on the graph of this equation. Explain what information the coordinates represent in this context.

b. Find the coordinates of a point above the line. Explain what information the coordinates represent in this context.

c. Find the coordinates of a point below the line. Explain what information the coordinates represent in this context.

33. Reggie is looking forward to walking in a walkathon. He writes some equations to use to answer some questions he has about the walkathon. For each of parts (a)–(c), do the following two things:

- Tell what information you think he was trying to find with the equation.
- Write one question he could use the equation to answer.

a. $y = 3x + 20$

b. $y = 0.25x$

c. $y = 4x$