

3-4

Linear Functions

Check Skills You'll Need

1. **Vocabulary Review**
What is the *output variable* in the function $b = 4a - 12$?

Use the function $m = 4n$ to complete the input-output table.

	n	m
2.	1	■
3.	2	■
4.	3	■
5.	4	■

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Lesson 3-2

What You'll Learn

To recognize linear functions and use tables and equations to graph them

New Vocabulary linear function, discrete data, continuous data

Why Learn This?

When you turn on a faucet or hose, the rate that the water comes out can be modeled with a linear function.

People fill things with liquid every day like gas tanks, watering cans, and swimming pools. If the liquid enters the container at a constant rate, then there is a linear function that relates time and the amount of liquid in the container.



A **linear function** is a function whose points lie on a straight line when the function is graphed. There are many ways to determine if a function is linear. One way is to use a table. If the ratios between the changes in variables in a table are the same, then the function is linear.

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8.F.3

EXAMPLE Linear Functions in Tables

1 Determine which function represented by a table is linear.

Function 1

		+1	+1	+1
x	1	2	3	4
y	6	8	10	14
		+2	+2	+4

The ratios between the changes in variables are $\frac{1}{2}$, $\frac{1}{2}$, and $\frac{1}{4}$. The ratios are *not* the same so the function is *not* linear.

Function 2

		-1	-2	-3
x	2	1	-1	-4
y	-6	-3	3	12
		+3	+6	+9

The ratios between the changes in variables are all $-\frac{1}{3}$, $-\frac{2}{6}$, and $-\frac{3}{9}$ which all simplify to $-\frac{1}{3}$. The ratios are the same so the function is linear.

Function 2 is linear since the ratios between the changes in variables are the same.

x	5	9	17	21
y	-12	-13	-15	-16

Quick Check

1. Determine if the function represented in the table is linear. Explain.

Discrete data are data that involve a count of items, such as numbers of people or cars. For discrete data, plot the data points and connect them with a dashed line. **Continuous data** are data where numbers between any two data values have meaning. Use a solid line to indicate continuous data.

EXAMPLE Graphing Discrete Data

Vocabulary Tip

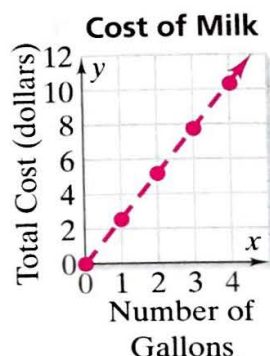
A dashed line in a graph means that not every point on the graph satisfies the conditions of the problem.

- 2 **Groceries** A gallon of milk costs \$2.59. The total cost of g gallons of milk is a function of the price of one gallon. Make a table and graph the function.

Step 1 Determine whether the data are discrete or continuous. You cannot buy part of a gallon container, so the data are discrete.

Step 2 Make a table. Connect the points with a dashed line.

Number of Gallons	Total Cost (dollars)
1	\$2.59
2	\$5.18
3	\$7.77
4	\$10.36



Quick Check

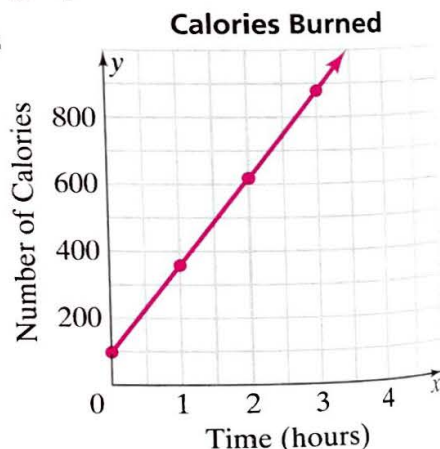
2. **Tickets** The function $c = 15t$ represents the cost (in dollars) of t adult tickets to a museum. Make a table and graph the function.

EXAMPLE Graphing Continuous Data

- 3 **Fitness** Xin lifted weights and burned 100 calories. Then she walked and burned 257 calories per hour. The function $c = 257h + 100$ gives the total calories Xin burned where c represents calories and h represents hours walking. Use the equation to make a table and graph the function.

Xin can walk for part of an hour, so the data is continuous. Plot the data and connect the data points with a solid line.

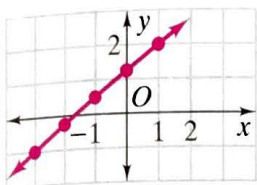
Time (hours)	Number of Calories
0	100
1	357
2	614
3	871



Quick Check

3. **Flying** The function $a = 4,000 - 600m$ gives the altitude a of a plane in feet after m minutes. Make a table and graph the function.

Check Your Understanding



- Vocabulary** Explain how you can use a table that represents a function to determine if the function is linear.
- Does the graph at the left show discrete or continuous data?
- Make a table for the function $d = 3t$ which gives the distance traveled at the rate of 3 mi per hr. Then graph the function.

Homework Exercises

For more exercises, see **Extra Skills and Word Problems**.

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For Exercises	See Examples
4–7	1
8–10	2–3

Determine if the function represented by the table is linear. Explain.

4.

x	-10	-14	-18	-24
y	6	10	16	24

5.

x	-12	-2	6	18
y	-3	-8	-11	-17

Determine whether the data for each function are *discrete* or *continuous*. Then make a table and graph for the function.

- The function $d = 40 - 15x$ represents the amount of money d (in dollars) you have left after buying x CDs.
- Scuba Diving** The deeper a scuba diver descends, the more pressure the diver feels. The function $p = 1 + 0.03x$ represents the approximate pressure p (in atmospheres) at x feet below sea level.
- The function $y = 1.8x + 32$ represents the equivalent temperature y in degrees Fahrenheit for a temperature of x degrees Celsius.
- Guided Problem Solving** A woman rents a table at a jewelry show. The function $m = 20.25n - 10$ represents the money m in dollars a woman makes for the number of necklaces n she sells. Graph the function. What is the cost of renting the table?
 - What is the input variable? What is the output variable?
 - Choose input values, find the outputs, and graph the function.
- Writing in Math** Describe a relation in your daily life that is a function. Explain why it is a function and define the input and the output.
- Science** The height of a burning candle depends on how long the candle has been burning. For one type of candle, the function $h = 8 - \frac{1}{2}t$ gives the candle's height h (in centimeters) as a function of the time t the candle has burned (in hours).
 - Graph the function.
 - What was the original height of the candle?
 - What is the greatest amount of time the candle can burn?

GPS



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12. Graph the functions $y = 2x + 1$ and $y = 2x - 1$ on the same coordinate grid. What do you notice about the two lines?
13. **Challenge** Plaza Pizza charges \$8 for a small pizza plus \$2 per topping. Royal Pizza charges \$12 for a small pizza and \$1 per topping. Write functions for both pizza places using c for cost and t for toppings. Graph the functions on the same axes. For how many toppings will the small pizzas cost the same?

Test Prep and Mixed Review

Practice

Multiple Choice

14. Which of the following tables is best represented by discrete data?

(A)

Temperature	
Time	Temp ($^{\circ}$ F)
8:00 a.m.	61
9:00 a.m.	62
10:00 a.m.	64
11:00 a.m.	67

(C)

Points Scored	
Game	Points
1	20
2	32
3	14
4	8

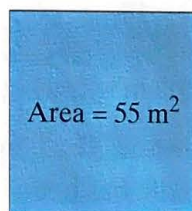
(B)

Brian's Weight	
Date	Weight (lb)
May 1	98
June 1	102
July 1	101
August 1	100

(D)

Altitude of Hiker	
Time (min)	Altitude (ft)
30	672
60	783
90	815
120	899

15. The function $d = 45t$ gives the distance d Juan traveled in miles after t hours. The function $d = 30t$ gives the distance d Kelly traveled in miles after t hours. If Juan and Kelly start at the same point and travel in opposite directions, how far apart will they be after 5 hr?
- (F) 375 mi (G) 225 mi (H) 150 mi (J) 75 mi
16. Which is the best estimate of the perimeter of the square?



- (A) 7.4 m (B) 29.6 m (C) 31.6 m (D) 52 m

Solve for x .

17. $2x + 7 = 3x - 3$ 18. $5x - 8 = 2x + 10$ 19. $12x + 8 = 8x - 24$

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For Exercises

See Lesson

17-19

2-4