

# 4.4 Comparing Linear and Nonlinear Functions

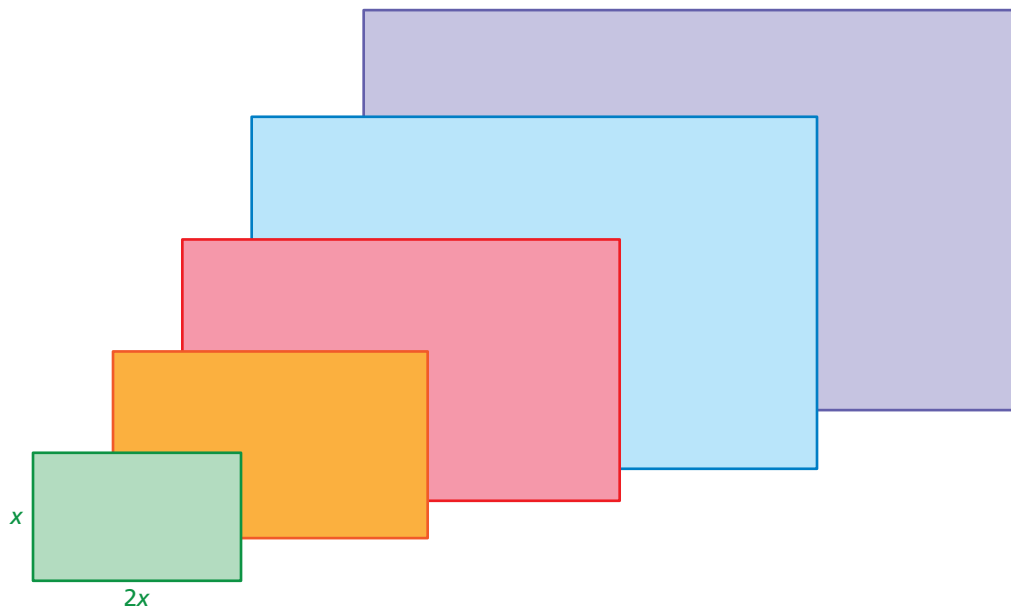


STATE STANDARDS  
MA.8.A.1.6

**Essential Question** How can you recognize when a pattern in real life is linear or nonlinear?

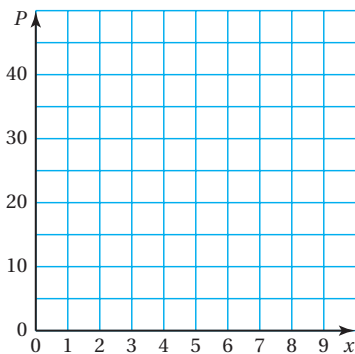
## 1 ACTIVITY: Finding Patterns for Similar Figures

Work with a partner. Copy and complete each table for the sequence of similar rectangles. Graph the data in each table. Decide whether each pattern is linear or nonlinear.



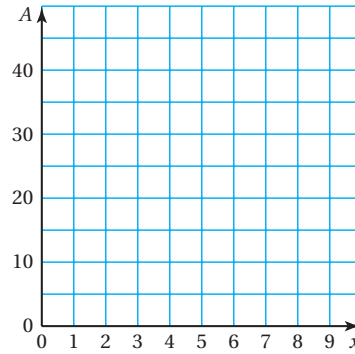
a. Perimeters of Similar Rectangles

<b>x</b>	1	2	3	4	5
<b>P</b>					



b. Areas of Similar Rectangles

<b>x</b>	1	2	3	4	5
<b>A</b>					



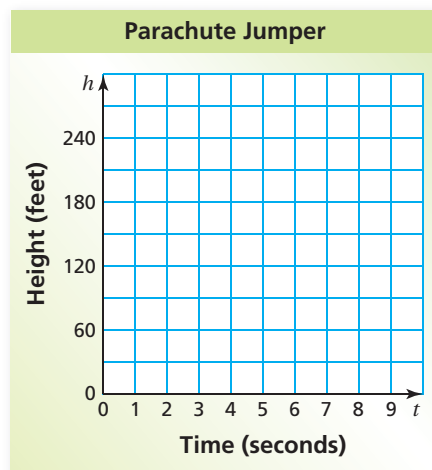
## 2 ACTIVITY: Comparing Linear and Nonlinear Functions

Work with a partner. The table shows the height  $h$  (in feet) of a falling object at  $t$  seconds.

- Graph the data in the table.
- Decide whether the graph is linear or nonlinear.
- Compare the two falling objects. Which one has an increasing speed?

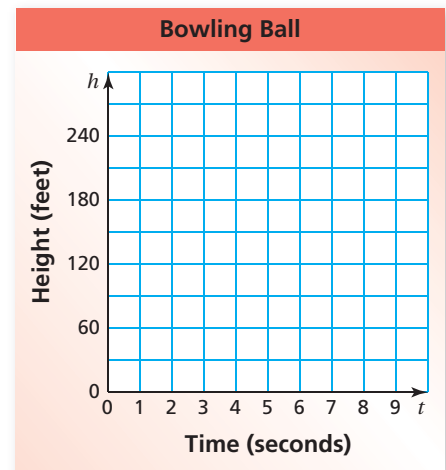
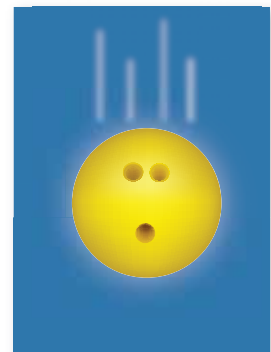
a. Falling parachute jumper

$t$	0	1	2	3	4
$h$	300	285	270	255	240



b. Falling bowling ball

$t$	0	1	2	3	4
$h$	300	284	236	156	44




### What Is Your Answer?

3. **IN YOUR OWN WORDS** How can you recognize when a pattern in real life is linear or nonlinear? Describe two real-life patterns: one that is linear and one that is nonlinear. Use patterns that are different from those described in Activities 1 and 2.

### Practice

Use what you learned about comparing linear and nonlinear functions to complete Exercises 3–6 on page 172.

**Key Vocabulary**   
nonlinear function,  
p. 170

The graph of a linear function shows a constant rate of change. A **nonlinear function** does not have a constant rate of change. So, its graph is *not* a line.

## EXAMPLE 1 Identifying Functions from Tables

Does the table represent a *linear* or *nonlinear* function? Explain.

a.

$x$	3	6	9	12
$y$	40	32	24	16

$+3$   $+3$   $+3$   
 $-8$   $-8$   $-8$

As  $x$  increases by 3,  $y$  decreases by 8. The rate of change is constant. So, the function is linear.

b.

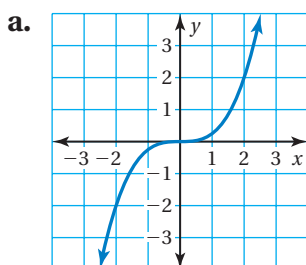
$x$	1	3	5	7
$y$	2	11	33	88

$+2$   $+2$   $+2$   
 $+9$   $+22$   $+55$

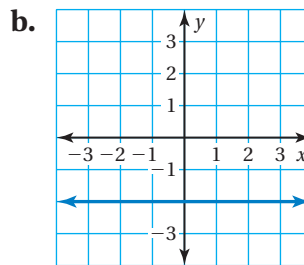
As  $x$  increases by 2,  $y$  increases by different amounts. The rate of change is *not* constant. So, the function is nonlinear.

## EXAMPLE 2 Identifying Functions from Graphs

Does the graph represent a *linear* or *nonlinear* function? Explain.



The graph is *not* a line. So, the function is nonlinear.



The graph is a line. So, the function is linear.

### On Your Own

Now You're Ready  
Exercises 3–11

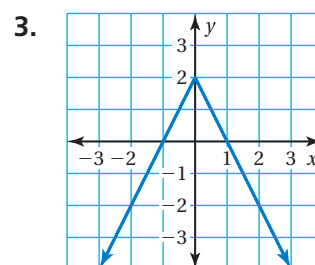
Does the table or graph represent a *linear* or *nonlinear* function? Explain.

1.

$x$	$y$
0	25
7	20
14	15
21	10

2.

$x$	$y$
2	8
4	4
6	0
8	-4



### EXAMPLE 3 Standardized Test Practice

Which equation represents a *nonlinear* function?

- (A)  $y = 4.7$       (B)  $y = \pi x$   
 (C)  $y = \frac{4}{x}$       (D)  $y = 4(x - 1)$

The equations  $y = 4.7$ ,  $y = \pi x$ , and  $y = 4(x - 1)$  can be rewritten in slope-intercept form. So, they are linear functions.

The equation  $y = \frac{4}{x}$  cannot be rewritten in slope-intercept form. So, it is a nonlinear function.

❖ The correct answer is (C).

### EXAMPLE 4 Real-Life Application

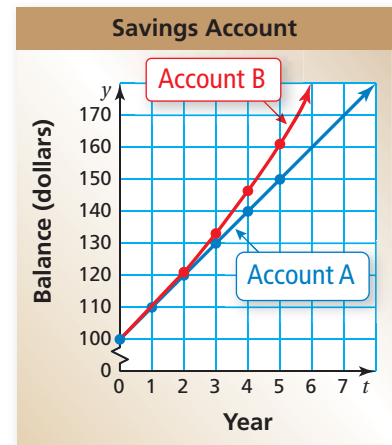
Account A earns simple interest. Account B earns compound interest. The table shows the balances for 5 years. Graph the data and compare the graphs.

#### Remember

The simple interest formula is given by  $I = Prt$ .

- $I$  is the simple interest
- $P$  is the principal
- $r$  is the annual interest rate
- $t$  is the time in years

Year, $t$	Account A Balance	Account B Balance
0	\$100	\$100
1	\$110	\$110
2	\$120	\$121
3	\$130	\$133.10
4	\$140	\$146.41
5	\$150	\$161.05



The balance of Account A has a constant rate of change of \$10. So, the function representing the balance of Account A is linear.

The balance of Account B increases by different amounts each year. Because the rate of change is not constant, the function representing the balance of Account B is nonlinear.

#### On Your Own

Now You're Ready  
Exercises 12–14

Does the equation represent a *linear* or *nonlinear* function? Explain.

4.  $y = x + 5$

5.  $y = \frac{4x}{3}$

6.  $y = 1 - x^2$

# 4.4 Exercises

## Vocabulary and Concept Check

- VOCABULARY** Describe the difference between a linear function and a nonlinear function.
- WHICH ONE DOESN'T BELONG?** Which equation does *not* belong with the other three? Explain your reasoning.

$$5y = 2x$$

$$y = \frac{2}{5}x$$

$$10y = 4x$$

$$5xy = 2$$

## Practice and Problem Solving

Graph the data in the table. Decide whether the function is *linear* or *nonlinear*.

1 3.

<b>x</b>	0	1	2	3
<b>y</b>	4	8	12	16

4.

<b>x</b>	1	2	3	4
<b>y</b>	1	2	6	24

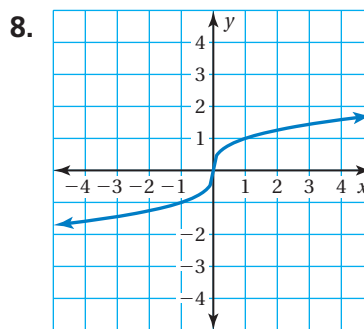
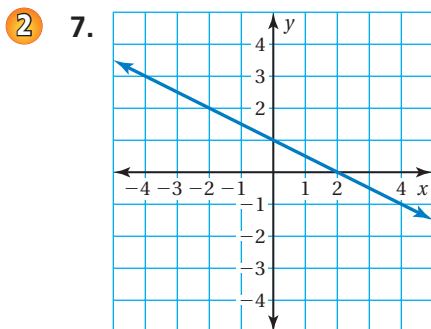
5.

<b>x</b>	6	5	4	3
<b>y</b>	21	15	10	6

6.

<b>x</b>	-1	0	1	2
<b>y</b>	-7	-3	1	5

Does the table or graph represent a *linear* or *nonlinear* function? Explain.



9.

<b>x</b>	5	11	17	23
<b>y</b>	7	11	15	19

10.

<b>x</b>	-3	-1	1	3
<b>y</b>	9	1	1	9

11. **VOLUME** The table shows the volume  $V$  (in cubic feet) of a cube with a side length of  $x$  feet. Does the table represent a linear or nonlinear function? Explain.

<b>Side Length, <math>x</math></b>	1	2	3	4	5	6	7	8
<b>Volume, <math>V</math></b>	1	8	27	64	125	216	343	512

Does the equation represent a *linear* or *nonlinear* function? Explain.

12.  $2x + 3y = 7$

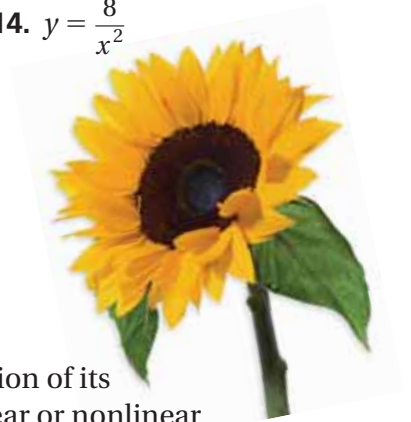
13.  $y + x = 4x + 5$

14.  $y = \frac{8}{x^2}$

15. **SUNFLOWER SEEDS** The table shows the cost  $y$  (in dollars) of  $x$  pounds of sunflower seeds.

Pounds, $x$	Cost, $y$
2	2.80
3	?
4	5.60

- What is the missing  $y$ -value that makes the table represent a linear function?
- Write a linear function that represents the cost  $y$  of  $x$  pounds of seeds.



16. **LIGHT** The frequency  $y$  (in terahertz) of a light wave is a function of its wavelength  $x$  (in nanometers). Does the table represent a linear or nonlinear function? Explain.

Color	Red	Yellow	Green	Blue	Violet
Wavelength, $x$	660	595	530	465	400
Frequency, $y$	454	504	566	645	749

17. **LIGHTHOUSES** The table shows the heights  $x$  (in feet) of four Florida lighthouses and the number  $y$  of steps in each. Does the table represent a linear or nonlinear function? Explain.

Lighthouse	Height, $x$	Steps, $y$
Ponce de Leon Inlet	175	213
St. Augustine	167	219
Cape Canaveral	145	179
Key West	86	98



18. **PROJECT** The wooden bars of a xylophone produce different musical notes when struck. The pitch of a note is determined by the length of the bar. Use the Internet or some other reference to decide whether the pitch of a note is a linear function of the length of the bar.

19. **Geometry** The radius of the base of a cylinder is 3 feet. Is the volume of the cylinder a linear or nonlinear function of the height of the cylinder?



### Fair Game Review What you learned in previous grades & lessons

Classify the angle as *acute*, *obtuse*, *right*, or *straight*.



24. **MULTIPLE CHOICE** What is the value of  $x$ ?

- (A) 30      (B) 60      (C) 90      (D) 180

