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.

x

$2x$

a. Perimeters of Similar Rectangles

x	1	2	3	4	5
P					

b. Areas of Similar Rectangles

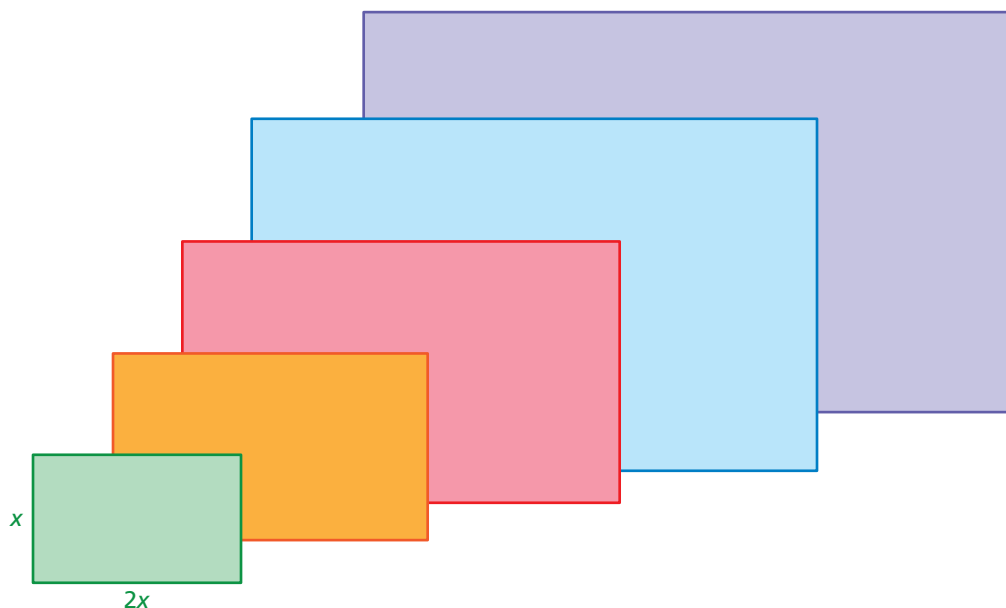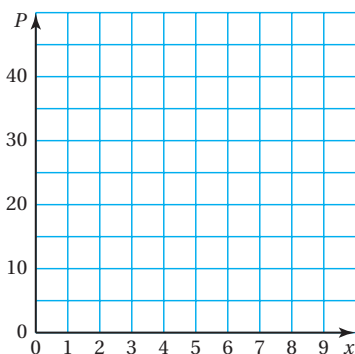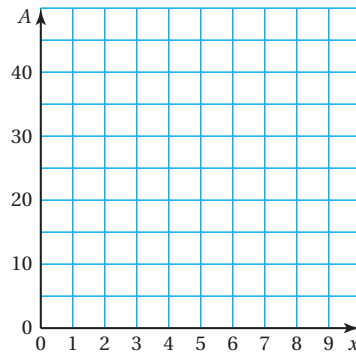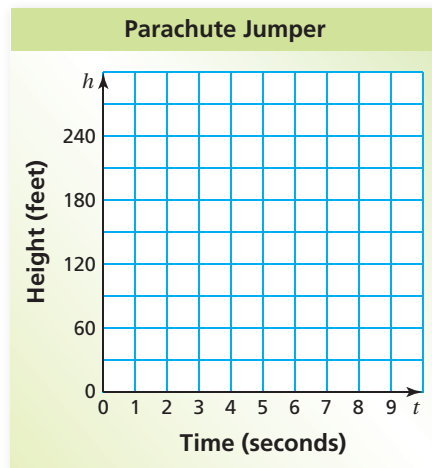| x	1	2	3	4	5
A					

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.**
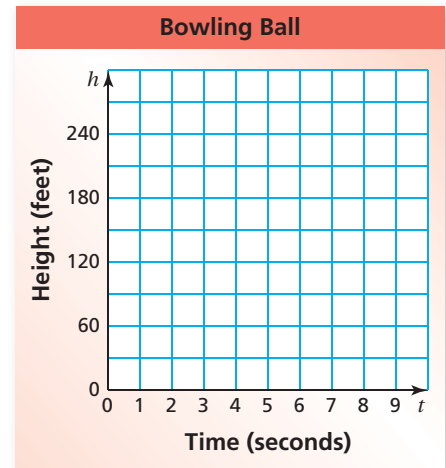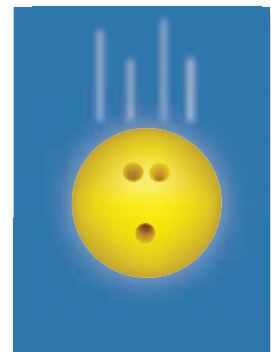- **Compare the two falling objects. Which one has an increasing speed?**

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

Parachute Jumper

Bowling Ball

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.
+3 +3 +3

x	3	6	9	12
y	40	32	24	16

−8 −8 −8

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

b.
+2 +2 +2

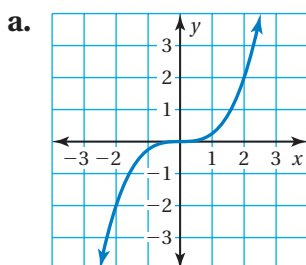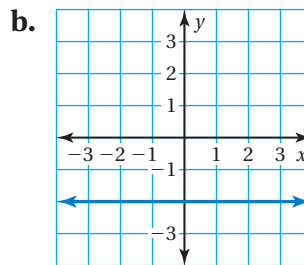| x	1	3	5	7
y	2	11	33	88

+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.

a.

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

b.

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

On Your Own

Now You're Ready
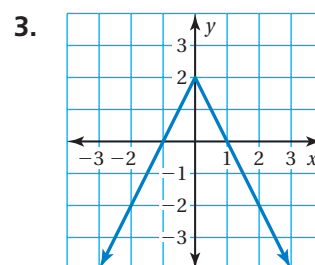Exercises 3–11

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

3.

EXAMPLE **3**   **Standardized Test Practice**

Which equation represents a *nonlinear* function?

Ⓐ $y = 4.7$ Ⓑ $y = \pi x$

Ⓒ $y = \dfrac{4}{x}$ Ⓓ $y = 4(x - 1)$

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 $y = \dfrac{4}{x}$ cannot be rewritten in slope-intercept form.

So, it is a nonlinear function.

⋮   The correct answer is Ⓒ.

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

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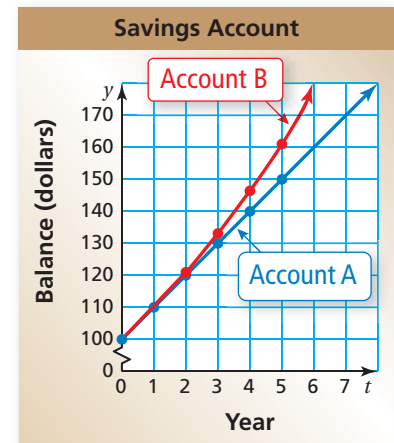
The balance of Account A has a constant rate of change of $10. So, the function representing the balance of Account A is linear.

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.** $y = \dfrac{4x}{3}$ **6.** $y = 1 - x^2$

✓ Vocabulary and Concept Check

1. **VOCABULARY** Describe the difference between a linear function and a nonlinear function.

2. **WHICH ONE DOESN'T BELONG?** Which equation does *not* belong with the other three? Explain your reasoning.

$$5y = 2x \qquad y = \frac{2}{5}x \qquad 10y = 4x \qquad 5xy = 2$$

Practice and Problem Solving

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

① **3.**

x	0	1	2	3
y	4	8	12	16

4.

x	1	2	3	4
y	1	2	6	24

5.

x	6	5	4	3
y	21	15	10	6

6.

x	−1	0	1	2
y	−7	−3	1	5

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

② **7.**

8.
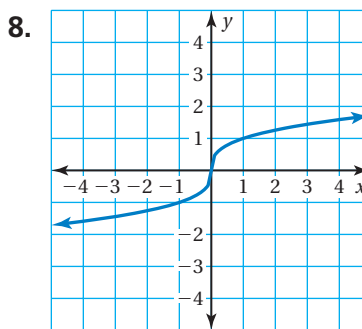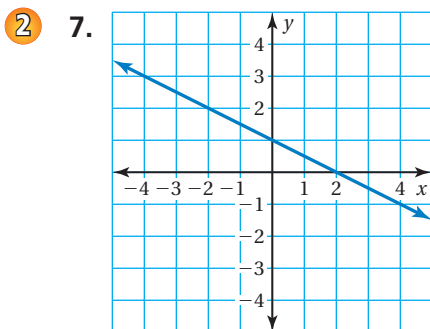
9.

x	5	11	17	23
y	7	11	15	19

10.

x	−3	−1	1	3
y	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.

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

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

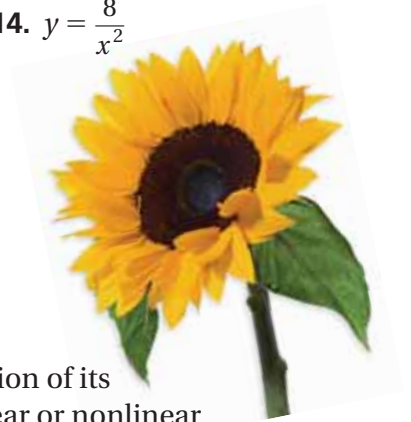**3** **12.** $2x + 3y = 7$

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

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

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

   a. What is the missing y-value that makes the table represent a linear function?

   b. 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.*

20.

21.

22.

23.

24. MULTIPLE CHOICE What is the value of x?

   Ⓐ 30   Ⓑ 60   Ⓒ 90   Ⓓ 180

30°

$x°$