

7.4

Comparing Linear and Nonlinear Functions



Learning Target: Understand differences between linear and nonlinear functions.

- Success Criteria:**
- I can identify a linear function in different representations.
 - I can explain why a representation is not a linear function.
 - I can compare linear and nonlinear functions.

Exploration 1 Comparing Functions

Work with a partner. Each equation represents the height h (in feet) of a falling object after t seconds.

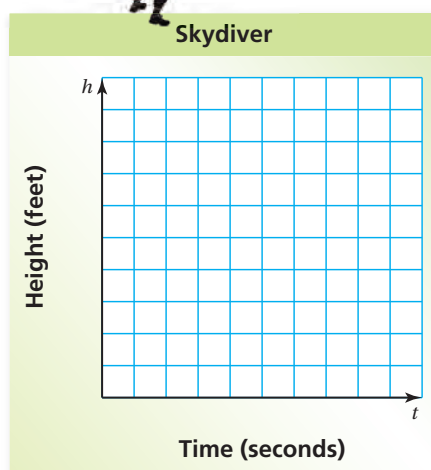
- Graph each equation. Explain your method.
- Decide whether each graph represents a *linear* or *nonlinear* function.
- Compare the falling objects.

a. Skydiver

$$h = 300 - 15t$$



Skydiver

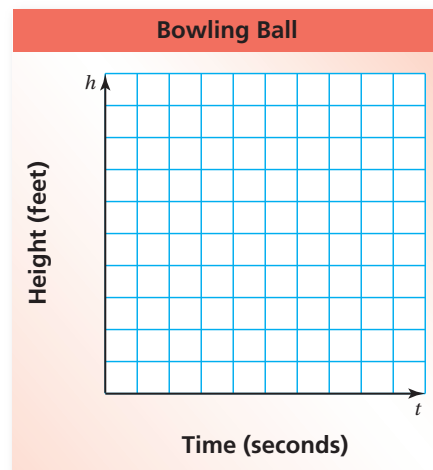


b. Bowling ball

$$h = 300 - 16t^2$$



Bowling Ball



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ANALYZE A PROBLEM

Did you use the same scale on the axes? How does the scale affect how you compare the falling objects?

Functions

MA.8.F.1.2 Given a function defined by a graph or an equation, determine whether the function is a linear function. Given an input-output table, determine whether it could represent a linear function.

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Key Vocabulary

nonlinear function, p. 374

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 each 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.

Try It

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

1.

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

2.

x	0	3	7	12
y	25	20	15	10

Example 2 B.E.S.T. Test Prep: Identifying Functions from Equations

Which equation represents a *nonlinear* function?

- Ⓐ $y = 4.7$ Ⓑ $y = -3x$ Ⓒ $y = \frac{4}{x}$ Ⓓ $y = 4(x - 1)$

The equations $y = 4.7$ and $y = -3x$ are in slope-intercept form. The equation $y = 4(x - 1)$ 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 Ⓒ.

Try It

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

3. $y = x + 5$

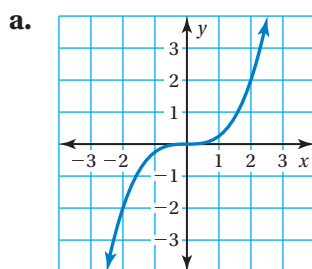
4. $y = \frac{4x}{3}$

5. $y = 1 - x^2$

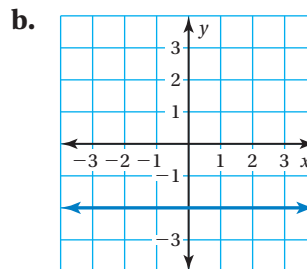


Example 3 Identifying Functions from Graphs

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



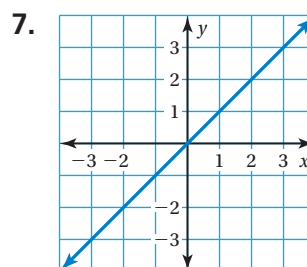
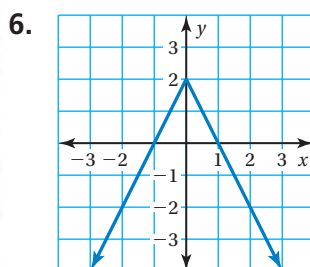
► The graph is *not* a line. So, the function is nonlinear.



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

Try It

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



In-Class Practice

1 I don't understand yet.

2 I can do it with help.

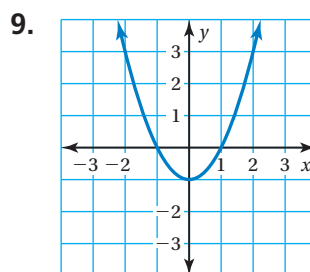
3 I can do it on my own.

4 I can teach someone else.

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

8.

x	3	-1	-5	-9
y	0	2	4	6



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

$$15y = 6x$$

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

$$10y = 4x$$

$$5xy = 2$$

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Example 4 Modeling Real Life



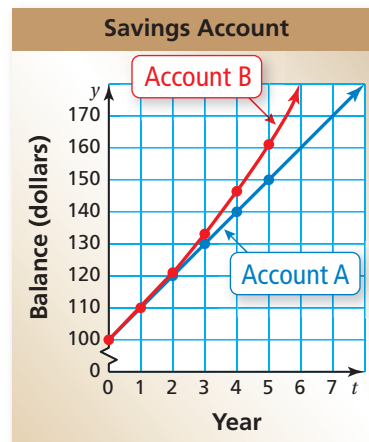
Year, t	Account A Balance	Account B Balance
0	\$100	\$100
1	\$110	\$110
2	\$120	\$121
3	\$130	\$133.10
4	\$140	\$146.41
5	\$150	\$161.05

Two accounts earn different types of interest. The table shows the balances of each account for five years. Graph the data and compare the balances of the accounts over time.

Plot the points in the table for each account.

The points for Account A lie on a line. Draw a line through the points.

The points for Account B do not lie on a line. Draw a *curve* through the points.



The graphs show that both balances are positive and increasing. The graphs also show that the balance of Account B grows faster.

The balance of Account A has a constant rate of change of \$10. The balance of Account B increases by different amounts each year. So, Account A shows linear growth, and Account B shows nonlinear growth.

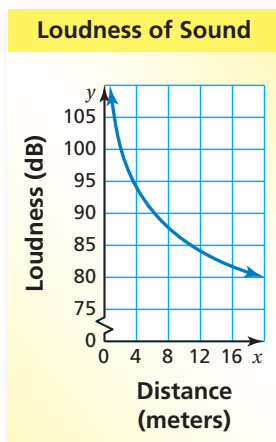
In-Class Practice

1 I don't understand yet.

2 I can do it with help.

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11. The loudness of sound is measured in *decibels* (dB). The graph shows the loudness y of a sound (in decibels) x meters from the source of the sound. Is the relationship between loudness and distance *linear* or *nonlinear*? Approximate the loudness of the sound 12 meters from the source.

12. **Dig Deeper** A *video blogger* is someone who records a video diary. A new website currently hosts 90 video bloggers and projects a gain of 10 video bloggers per month. The table below shows the actual numbers of video bloggers. How does the projection differ from the actual change?

Month	0	1	2	3	4	5
Video Bloggers	90	97	110	128	153	190

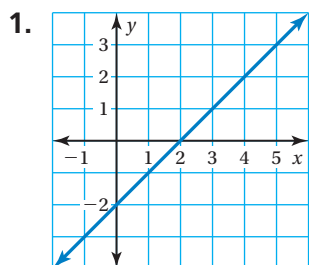


7.4

Practice WITH CalcChat® AND CalcView®

Review & Refresh

Write a linear function that relates y to x .



2.

x	0	1.5	3	4.5
y	5	4	3	2

The vertices of a figure are given. Draw the figure and its image after a dilation with the given scale factor. Identify the type of dilation.

3. $A(-3, 1), B(-1, 3), C(-1, 1); k = 3$ 4. $J(2, 4), K(6, 10), L(8, 10), M(8, 4); k = \frac{1}{4}$

Concepts, Skills, & Problem Solving

COMPARING FUNCTIONS Graph each equation. Decide whether each graph represents a *linear* or *nonlinear* function. (See Exploration 1.)

5. $h = 5 + 6t$ Equation 1

6. $y = -\frac{x}{3}$ Equation 1

$h = 5 + 6t^2$ Equation 2

$y = -\frac{3}{x}$ Equation 2

IDENTIFYING FUNCTIONS FROM TABLES Does the table represent a *linear* or *nonlinear* function? Explain. (See Example 1.)

► 7.

x	0	1	2	3
y	4	8	12	16

8.

x	6	5	4	3
y	21	15	10	6

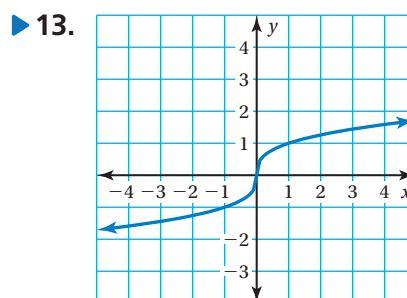
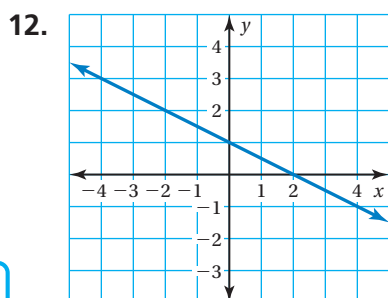
IDENTIFYING FUNCTIONS FROM EQUATIONS Does the equation represent a *linear* or *nonlinear* function? Explain. (See Example 2.)

► 9. $2x + 3y = 7$

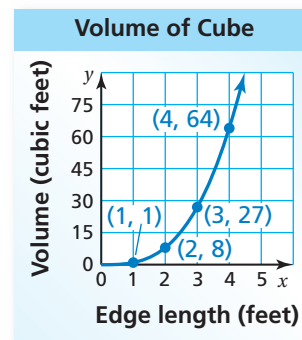
10. $y + x = 4x + 5$

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

IDENTIFYING FUNCTIONS FROM GRAPHS Does the graph represent a *linear* or *nonlinear* function? Explain. (See Example 3.)



14. **IDENTIFYING A FUNCTION** The graph shows the volume V (in cubic feet) of a cube with an edge length of x feet. Does the graph represent a *linear* or *nonlinear* function? Explain.



15. **MODELING REAL LIFE** The frequency y (in terahertz) of a light wave is a function of its wavelength x (in nanometers). Is the function relating the wavelength of light to its frequency *linear* or *nonlinear*?

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

16. **Dig Deeper** 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. Interpret the slope.
- Does the function have a maximum value? Explain your reasoning.



17. **MODELING REAL LIFE** A birch tree is 9 feet tall and grows at a rate of 2 feet per year. The table shows the height h (in feet) of a willow tree after x years. (See Example 4.)

Years, x	Height, h
0	5
1	11
4	17
9	23

- Does the table represent a *linear* or *nonlinear* function? Explain.
 - Which tree is taller after 10 years? Explain.
18. **REASONING** In their first year, Show A has 7 million viewers and Show B has 5 million viewers. Each year, Show A has 90% of the viewers it had in the previous year. Show B loses 200,000 viewers each year.
- Determine whether the function relating the year to the number of viewers is *linear* or *nonlinear* for each show.
 - Which show has more viewers in its sixth year?
19. **NUMBER SENSE** The ordered pairs represent a function.
- (0, -1), (1, 0), (2, 3), (3, 8), and (4, 15)
- Graph the ordered pairs and describe the pattern. Is the function *linear* or *nonlinear*?
 - Write an equation that represents the function.

