CHAPTER 9

Algebra: Linear Functions

BIG Idea

- **Standard 7AF3.0** Graph and interpret linear and some nonlinear functions.

Key Vocabulary

constant of variation (p. 483)
line of fit (p. 505)
linear function (p. 472)
slope (p. 477)

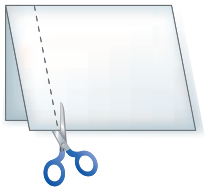
Real-World Link

Roller Coasters If you ride the *Boomerang* roller coaster, located in Buena Park, California, you will travel 935 feet in 108 seconds. You can use the linear function $935 = 108r$ to model the average speed of this coaster.

FOLDABLES Study Organizer

Algebra: Linear Functions Make this Foldable to help you organize your notes. Begin with seven sheets of $8\frac{1}{2}'' \times 11''$ paper.

1. **Fold** a sheet of paper in half lengthwise. Cut a 1″ tab along the left edge through one thickness.



2. **Glue** the 1″ tab down. Write the title of the lesson on the front tab.

3. **Repeat** Steps 1–2 for the remaining sheets of paper. Staple together to form a booklet.

Eric Gieszl/Ultimate Rollercoaster

GET READY for Chapter 9

Diagnose Readiness You have two options for checking Prerequisite Skills.

Option 2

MathOnline Take the Online Readiness Quiz at ca.gr7math.com.

Option 1

Take the Quick Check below. Refer to the Quick Review for help.

QUICK Check

Graph each point on the same coordinate grid. (Prior Grade)

1. $A(-3, -4)$
2. $B(2, -1)$
3. $C(0, -2)$
4. $D(-4, 3)$

5. **WALKING** From his cabin, Derek walked 4 miles south and 2 miles west, where he rested. If the origin represents the cabin, graph the point representing Derek's resting point. (Prior Grade)

Evaluate each expression if $x = 6$. (Lesson 1-2)

6. $3x$
7. $4x - 9$
8. $2x + 8$
9. $5 + x$

10. **PROFIT** The weekly profit of a certain company is $48x - 875$, where x represents the number of units sold. Find the weekly profit, if the company sells 37 units. (Lesson 1-2)

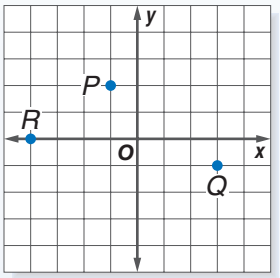
Solve each equation. (Lesson 1-9)

11. $14 = n + 9$
12. $z - 3 = 8$
13. $-17 = b - 21$
14. $23 + r = 15$

QUICK Review

Example 1

Graph $P(-1, 2)$, $Q(3, -1)$, and $R(-4, 0)$ on a coordinate grid.



Start at the origin. The first number in each ordered pair is the x-coordinate. The second number in each ordered pair is the y-coordinate.

Example 2

Evaluate $6x - 1$ if $x = 4$.

$6x - 1 = 6(4) - 1$ Replace x with 4.
$= 24 - 1$ Multiply 6 by 4.
$= 23$ Subtract.

Example 3

Solve $18 + m = 7$.

$18 + m = 7$ Write the equation.
$-18 \quad = -18$ Subtract 18 from each side.
$m = -11$

Explore 9-1

Algebra Lab
Functions

Main IDEA

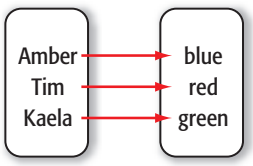
Model functions using real-world situations.

Preparation for Standard 7AF3.3 Graph linear functions, noting that the vertical change (change in *y*-value) per unit of horizontal change (change in *x*-value) is always the same and know that the ratio ("rise over run") is called the slope of a graph.

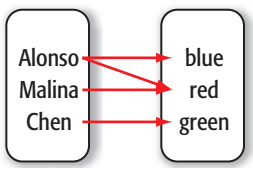
Standard 7MR2.5 **Use a variety of methods,** such as words, numbers, **symbols,** charts, graphs, tables, **diagrams,** and models, to explain mathematical reasoning.

A *relation* expresses how objects in one group called *inputs* are assigned or related to objects in another group called *outputs*. Suppose three students select a favorite color from the colors blue, red, or green. The relation diagrams below show two of several possible results.

Relation 1

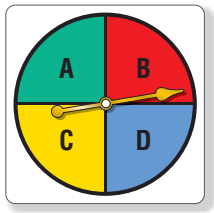


Relation 2



A *function* is a relation in which exactly one output is assigned to each input. In the example above, the first relation is a function, since each person chose one favorite color. The second relation is not a function, since Alonso chose two colors as his favorite.

ACTIVITY



STEP 1 Create a spinner like the one shown. Each of the four people in your group should spin the spinner once to simulate selecting TV show A, B, C, or D as their favorite. Each person should keep spinning until they get a result different from anyone else. Record the results as Relation 1.

STEP 2 Next, have each person spin again, this time spinning until one or more persons are assigned the same letter. Record the results as Relation 2.

STEP 3 Finally, have each person spin again, and allow one person to spin twice. Record the five results as Relation 3.

Analyze the Results

1. Make a diagram like the one shown above for each relation.
2. Determine whether each relation is a function. Explain your reasoning in the context of selecting a favorite TV show.
3. **MAKE A CONJECTURE** Draw a diagram of each of the relations described below. Then determine if the relation is a function. Explain.
   a. one person spins four times, each time spinning a different letter
   b. each of four people spins the same letter

9-1 Functions

Main IDEA

Complete function tables.

Preparation for Standard 7AF3.3 Graph linear functions, noting that the vertical change (change in *y*-value) per unit of horizontal change (change in *x*-value) is always the same and know that the ratio ("rise over run") is called the slope of a graph. **Standard 7MR2.5 Use a variety of methods,** such as words, numbers, **symbols,** charts, graphs, **tables, diagrams,** and models, **to explain mathematical reasoning.**

NEW Vocabulary

function
domain
range
function table

READING in the Content Area

For strategies in reading this lesson, visit ca.gr7math.com.

GET READY for the Lesson

ENTERTAINMENT Suppose you can buy DVDs for $15 each.

1. Copy and complete the table at the right.
2. If 6 DVDs are purchased, what is the total cost?
3. Explain how to find the total cost of 9 DVDs.

DVDs	Cost ($)
1	15
2	30
3	
4	
5	

The total cost depends on, or is a function of, the number of DVDs purchased. A relationship that assigns exactly one output value for each input value is called a **function**. Functions are often written as equations.

The *input x* is any real number.

$$f(x) = 7x$$

$f(x)$ is read *the function of x,* or more simply, *f of x.* It is the *output.*

The operations performed in the function are sometimes called the *rule.*

To find the value of a function for a certain number, substitute the number into the function value.

EXAMPLES Find a Function Value

Find each function value.

1 **$f(9)$ if $f(x) = x - 5$**

$f(x) = x - 5$ Write the function.

$f(9) = 9 - 5$ or 4 Substitute 9 for x into the function rule.

So, $f(9) = 4$.

2 **$f(-3)$ if $f(x) = 2x + 1$**

$f(x) = 2x + 1$ Write the function.

$f(-3) = 2(-3) + 1$ Substitute -3 for x into the function rule.

$f(-3) = -6 + 1$ or -5 Simplify.

So, $f(-3) = -5$.

CHECK Your Progress **Find each function value.**

a. $f(2)$ if $f(x) = x - 4$

b. $f(6)$ if $f(x) = 2x - 8$

STUDY TIP

Input and Output
The variable for the input is called the *independent variable* because it can be any number. The variable for the output is called the *dependent variable* because it *depends* on the input value.

The set of input values in a function is called the **domain**. The set of output values is called the **range**. You can organize the input, rule, and output into a **function table**.

EXAMPLE 3 Make a Function Table

Complete the function table for $f(x) = x + 5$. Then state the domain and range of the function.

Input	Rule	Output
x	$f(x) = x + 5$	$f(x)$
-2		
-1		
0		
1		

Substitute each value of x, or input, into the function rule. Then simplify to find the output.

Input	Rule	Output
x	$f(x) = x + 5$	$f(x)$
-2	$-2 + 5$	$f(-2) = 3$
-1	$-1 + 5$	$f(-1) = 4$
0	$0 + 5$	$f(0) = 5$
1	$1 + 5$	$f(1) = 6$

The domain is $\{-2, -1, 0, 1\}$.

The range is $\{3, 4, 5, 6\}$.

CHECK Your Progress

Copy and complete each function table. Then state the domain and range of the function.

c. $f(x) = x - 7$

x	$x - 7$	$f(x)$
-3		
-2		
-1		
0		

d. $f(x) = 4x$

x	$4x$	$f(x)$
-5		
-3		
2		
5		

e. $f(x) = 2x + 3$

x	$2x + 3$	$f(x)$
-1		
2		
3		
5		

Real-World Career
How Does a Zookeeper Use Math?
A zookeeper must order the appropriate amount of various foods that will keep each animal healthy.

MathOnline
For more information, go to ca.gr7math.com.

Sometimes functions are written using two variables. One variable, usually x, represents the input and the other, usually y, represents the output. The function in Example 3 can also be written as $y = x + 5$.

EXAMPLE 4 Functions with Two Variables

ZOOKEEPER **The zoo needs 1.5 tons of specially mixed elephant chow to feed its elephants each week. Write a function to represent the amount of elephant chow c needed for w weeks. Then determine how much elephant chow the zoo will need to feed its elephants for 12 weeks.**

Words	Amount of chow	equals	1.5 times	the number of weeks.
Function	c	$=$	$1.5 \cdot$	w

The function $c = 1.5w$ represents the situation.

To find the amount of chow needed for 12 weeks, substitute 12 for w.

$c = 1.5w$ Write the function.

$c = 1.5(12)$ or 18 Substitute 12 for w.

The zoo needs 18 tons of elephant chow.

CHECK Your Progress

f. HOME REPAIR An air conditioner repair service charges \$60 for a service call plus \$30 per hour for labor. Write a function to represent the charge c for a service call with h hours of labor. How much would the charge be if there are 3 hours of labor?

Personal Tutor

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CHECK Your Understanding

Examples 1, 2 (p. 465)

Find each function value.

1. $f(4)$ if $f(x) = x - 6$
2. $f(-2)$ if $f(x) = 4x + 1$

Example 3 (p. 466)

Copy and complete each function table. Then state the domain and range of the function.

3. $f(x) = 8 - x$

x	$8 - x$	$f(x)$
−3		
−1		
2		
4		

4. $f(x) = 5x + 1$

x	$5x + 1$	$f(x)$
−2		
0		
1		
3		

5. $f(x) = 3x - 2$

x	$3x - 2$	$f(x)$
−5		
−2		
2		
5		

Example 4 (p. 466)

6. **MEASUREMENT** The perimeter of a square is 4 times the length of a side. Write a function to represent the perimeter p of a square with sides measuring s units. What is the perimeter of a square with a 14-inch side?

Exercises

HOMEWORK HELP

For Exercises	See Examples
7–12	1, 2
13–18	3
19–20	4

Find each function value.

7. $f(7)$ if $f(x) = 5x$
8. $f(9)$ if $f(x) = x + 13$
9. $f(4)$ if $f(x) = 3x - 1$
10. $f(5)$ if $f(x) = 2x + 5$
11. $f(-5)$ if $f(x) = 4x - 1$
12. $f(-12)$ if $f(x) = 2x + 15$

Copy and complete each function table. Then state the domain and range of the function.

13. $f(x) = 6x - 4$

x	$6x - 4$	$f(x)$
−5		
−1		
2		
7		

14. $f(x) = 5 - 2x$

x	$5 - 2x$	$f(x)$
−2		
0		
3		
5		

15. $f(x) = 7 + 3x$

x	$7 + 3x$	$f(x)$
−3		
−2		
1		
6		

Copy and complete each function table. Then state the domain and range of the function.

16. $f(x) = x - 9$

x	$x - 9$	$f(x)$
−2		
−1		
7		
12		

17. $f(x) = 7x$

x	$7x$	$f(x)$
−5		
−3		
2		
6		

18. $f(x) = 4x + 3$

x	$4x + 3$	$f(x)$
−4		
−2		
3		
5		

19. **SPORTS** Tyree's bowling score is handicapped by 30 points, meaning that he receives an additional 30 points on his final score. Write a function that can be used to represent Tyree's final score s given his base score b. What is his adjusted score if he bowled 185?

20. **PARTY PLANNING** Sherry is having a birthday party at the Swim Center. The cost of renting the pool is $45 plus $3.50 for each person. Write a function to represent the total cost c for p people. What is the total cost if 20 people attend the party?

Find each function value.

21. $f\left(\frac{5}{6}\right)$ if $f(x) = 2x + \frac{1}{3}$

22. $f\left(\frac{5}{8}\right)$ if $f(x) = 4x - \frac{1}{4}$

23. **BIKING** After 1 hour, a cyclist had ridden 12 miles. If she then continued riding at an average rate of 8 miles per hour, how long did it take her to ride 60 miles?

EXTRA PRACTICE
See pages 699, 716.
MathOnline
Self-Check Quiz at ca.gr7math.com

24. **SCUBA DIVING** The table shows the water pressure encountered by a diver. Write a function to represent the pressure p encountered at a depth of d feet. What would the pressure be at a depth of 175 feet? Round to the nearest tenth.

Depth (ft)	Pressure (lb/in^2)
0	14.7
33	29.4
66	44.1
99	58.8
132	73.5

H.O.T. Problems

25. **OPEN ENDED** If $f(x) = 2x - 4$, find a value of x that will make the function value a negative number.

26. **CHALLENGE** Write the function rule for each function table.

a.

x	$f(x)$
−3	−30
−1	−10
2	20
6	60

b.

x	$f(x)$
−5	−9
−1	−5
3	−1
7	3

c.

x	y
−2	−3
1	3
3	7
5	11

d.

x	y
−2	−5
1	1
3	5
5	9

27. **WRITING IN MATH** For the function $y = x + 4$, find the input value when the output value is −5. Write a rule that can be used to find the input value when the output value is known.

STANDARDS PRACTICE

28. The equation $c = 6.50t$ represents c, the total cost of t tickets for a movie. Which table contains values that satisfy this equation?

A

Cost of Movie Tickets				
t	1	2	3	4
c	\$6.50	\$13.00	\$19.50	\$26.00

B

Cost of Movie Tickets				
t	1	2	3	4
c	\$6.50	\$12.00	\$18.00	\$24.50

C

Cost of Movie Tickets				
t	1	2	3	4
c	\$13.00	\$19.50	\$26.00	\$32.50

D

Cost of Movie Tickets				
t	1	2	3	4
c	\$6.50	\$8.50	\$9.50	\$10.50

29. Stephanie received a \$25 gift certificate to an online music store. If the cost of purchasing a song is \$0.95, which table best describes b, the balance remaining after she buys s songs?

F

s	b
1	24.10
2	23.20
4	21.40
6	19.60
8	17.80

H

s	b
2	23.10
4	21.20
5	20.25
8	17.40
10	15.50

G

s	b
0	25.00
3	22.00
6	19.00
9	16.00
12	13.00

J

s	b
5	20.05
10	15.10
15	10.15
20	5.20
25	0.25

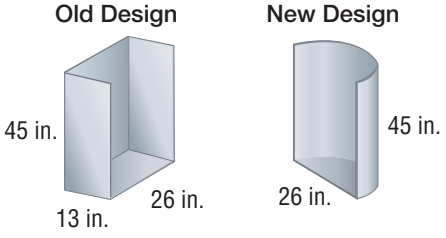
Spiral Review

30. **MEASUREMENT** The length of a rectangle is 6 inches. Its area is greater than 30 square inches. Write an inequality for the situation. Solve the inequality. Interpret the solution. (Lesson 8-7)

Solve each inequality. (Lesson 8-6)

31. $b + 15 > 32$ **32.** $y - 24 \leq 12$ **33.** $9 \leq 16 + t$ **34.** $18 \geq a - 6$

35. **UTILITIES** An airport has changed the booths used for public telephones. The old booths consisted of four sides of a rectangular prism. The new booths are half of a cylinder with an open top. How much less material is needed to construct a new booth than an old booth? (Lesson 7-7)



36. **MEASUREMENT** A block of cheese in the shape of a rectangular prism has a volume of 305 cubic centimeters. After several slices are cut from the block, it measures 10.25 centimeters by 6.5 centimeters by 2 centimeters. How much cheese was used? (Lesson 7-5)

37. Find the distance between the points $(-1, 1)$ and $(3, -2)$. (Lesson 3-7)

GET READY for the Next Lesson

PREREQUISITE SKILL **Graph each point on the same coordinate plane.**

38. $A(-4, 2)$ **39.** $B(3, -1)$ **40.** $C(0, -3)$ **41.** $D(1, 4)$

Explore 9-2

Algebra Lab
Graphing Relationships

Main IDEA

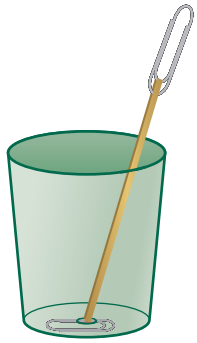
Graph relationships.

Standard 7AF1.5 Represent quantitative relationships graphically and interpret the meaning of a specific part of a graph in the situation represented by the graph.

In this lab, you will investigate a relationship between the number of pennies in a cup and how far the cup will stretch a rubber band.

ACTIVITY

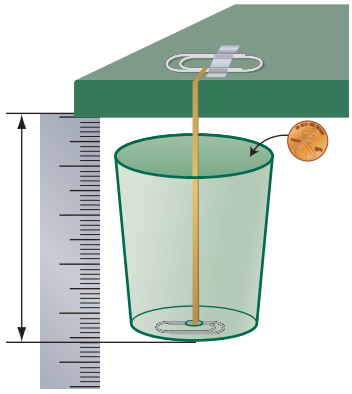
STEP 1 Using a pencil, punch a small hole in the bottom of a paper cup. Place a paper clip onto a rubber band. Push the other end of the rubber band through the hole in the cup. Attach a second paper clip to the other end of the rubber band. Place it horizontally across the bottom of the cup to keep it from coming through the hole.



STEP 2 Copy the table at the right.

Number of Pennies x	Distance y

STEP 3 Tape the top paper clip to the edge of a desk. Measure and record the distance from the bottom of the desk to the bottom of the cup. Drop one penny into the cup. Measure and record the new distance from the bottom of the desk to the bottom of the cup.



STEP 4 Continue adding one penny at a time. Measure and record the distance after each addition up to 10 pennies.

Analyze the Results

1. **MAKE A CONJECTURE** Examine the data. Do you think the number of pennies affects the distance? Explain.
2. Graph the ordered pairs formed by your data. Do the points resemble a straight line?
3. **MAKE A PREDICTION** What will the distance of the bottom of the cup from the bottom of the desk be if 15 pennies are placed in the cup?
4. Find the ratio of each distance to the number of pennies. What do you notice about these ratios?

9-2 Representing Linear Functions

Main IDEA

Represent linear functions using function tables and graphs.

Standard 7AF1.5 **Represent quantitative relationships graphically and interpret the meaning of a specific part of a graph in the situation represented by the graph.**

NEW Vocabulary

linear function

GET READY for the Lesson

ROLLER COASTERS The *Millennium Force* has a maximum speed of 1.5 miles per minute. If x represents the minutes traveled at this speed, the function rule for the distance traveled is $y = 1.5x$.

1. Copy and complete the function table.
2. Graph the ordered pairs (x, y) on a coordinate plane. What do you notice?

Input	Rule	Output	(Input, Output)
x	$1.5x$	y	(x, y)
1	1.5(1)	1.5	(1, 1.5)
2	1.5(2)		
3			
4			

Functions can be represented in words, in a table, with a graph, and as ordered pairs.

Real-World EXAMPLE 1 Graph a Function

SCHOOL SUPPLIES **The school store sells book covers for \$2 each and notebooks for \$1. Toni wants to buy some of each. The cost of x books covers and y notebooks is $2x + y$. Toni has \$5 to spend, so $2x + y = 5$. Graph $2x + y = 5$ to find how many covers and notebooks Toni can buy.**

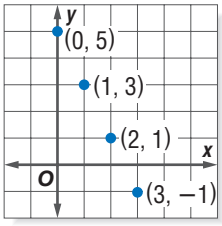
$2x + y = 5$ Write the equation.

$2x - 2x + y = 5 - 2x$ Subtract $2x$ from each side to solve for y.

$y = 5 - 2x$ Simplify.

The equation $y = 5 - 2x$ represents a function. Choose values for x and substitute them to find y. Then graph the ordered pairs (x, y).

x	$5 - 2x$	y	(x, y)
0	$5 - 2(0)$	5	(0, 5)
1	$5 - 2(1)$	3	(1, 3)
2	$5 - 2(2)$	1	(2, 1)
3	$5 - 2(3)$	-1	(3, -1)



She cannot buy negative amounts, so she can buy 0 covers and 5 notebooks, 1 cover and 3 notebooks, or 2 covers and 1 notebook.

STUDY TIP

Check for Reasonableness Check solutions in the context of the original problem to be sure they make sense.

CHECK Your Progress

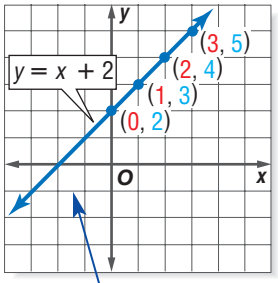
a. **DECORATING** A repeating pattern is made using 6 triangular tiles x and 1 hexagonal tile y. Graph the function $6x + y = 35$ to find the number of each tile needed if 35 tiles are used.

EXAMPLE 2 Graph a Function

Graph $y = x + 2$.

- Select any four values for the input x. Substitute these values for x to find the output y.
- Graph each ordered pair. Draw a line that passes through each point.

x	$x + 2$	y	(x, y)
0	0 + 2	2	(0, 2)
1	1 + 2	3	(1, 3)
2	2 + 2	4	(2, 4)
3	3 + 2	5	(3, 5)



The line is the complete graph of the function. The ordered pair corresponding to any point on the line is a solution of the equation $y = x + 2$.

The point where the line crosses the x-axis is the solution to the equation $0 = x + 2$.

Check It appears that $(-2, 0)$ is also a solution. Check this by substitution.

$y = x + 2$ Write the function.

$0 \stackrel{?}{=} -2 + 2$ Replace x with -2 and y with 0.

$0 = 0$ ✓ Simplify.

STUDY TIP

Solutions The solutions of a function are ordered pairs that make an equation representing the function true.

CHECK Your Progress

Graph each function.

b. $y = x - 5$ c. $y = -2x$ d. $y = 2x + 1$

Personal Tutor

Online Personal Tutor at ca.gr7math.com

REVIEW Vocabulary

linear relationship relationships that have straight-line graphs (Lesson 4-10)

A function in which the graph of the solutions forms a line is called a **linear function**. Therefore, $y = x + 2$ is a *linear equation*.

CONCEPT Summary Representing Functions

Words The value of y is one less than the corresponding value of x.

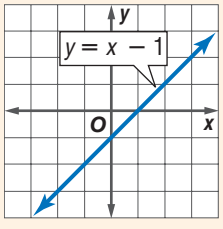
Equation $y = x - 1$

Ordered Pairs (0, −1), (1, 0), (2, 1), (3, 2)

Table

x	y
0	−1
1	0
2	1
3	2

Graph

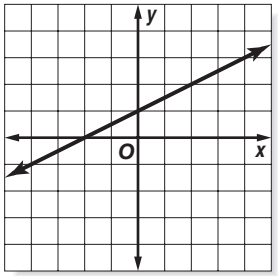


STANDARDS EXAMPLE

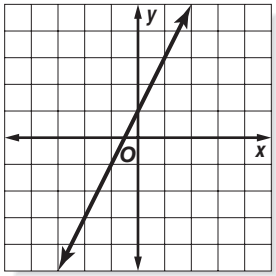
3 **Which line graphed below best represents the table of values for the ordered pairs (x, y)?**

x	−2	−1	0	1
y	−3	−1	1	3

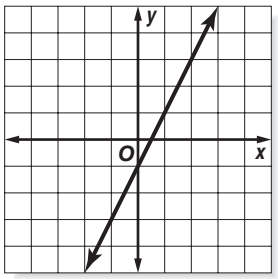
A



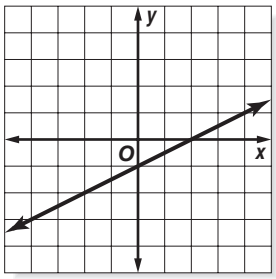
C



B



D



Read the Item

You need to decide which of the four graphs represents the data.

Solve the Item

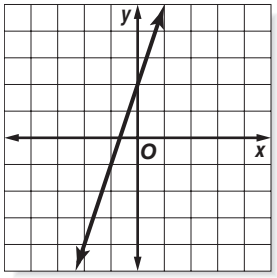
The values in the table represent the ordered pairs (−2, −3), (−1, −1), (0, 1), and (1, 3). Test the ordered pairs. Graph C is the only graph that contains all these ordered pairs. The answer is C.

Test-Taking Tip

Eliminate the Possibilities By testing the ordered pair (0, 1) first, choices B and D can be eliminated.

CHECK Your Progress

e. The graph of the line $y = 3x + 2$ is drawn on the coordinate grid. Which table of ordered pairs contains only points on this line?



F

x	−1	0	2	3
y	−5	−2	4	7

H

x	−6	−3	0	3
y	0	−1	2	3

G

x	−1	5	7	8
y	−1	1	−3	2

J

x	−3	−1	1	2
y	−7	−1	5	8

CHECK Your Understanding

Example 1 (p. 471)

1. **GARDENING** Marigolds x come in containers with 4 flowers and daisies y come individually. Graph the function $4x + y = 15$ to find the number of containers of marigolds and daisies you can get if you want 15 flowers.

Example 2 (p. 472)

Graph each function.

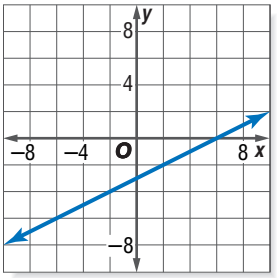
2. $y = x + 5$
3. $y = 3x - 2$
4. $y = -2x + 1$

Example 3 (p. 473)

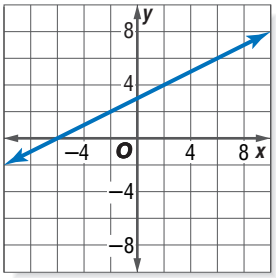
5. **STANDARDS PRACTICE** Which line graphed best represents the table of values for the ordered pairs (x, y)?

x	−7	−2	2	9
y	−6.5	−4	−2	1.5

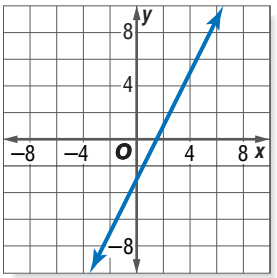
A



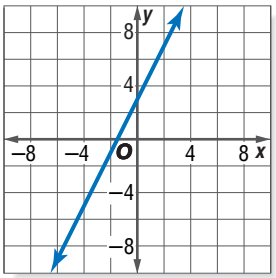
C



B



D



Exercises

HOMEWORK HELP

For Exercises	See Examples
6, 7	1
8–15	2
27, 28	3

6. **PETS** Fancy goldfish x cost \$3 each and common goldfish y cost \$1 each. Graph the function $3x + y = 20$ to determine how many of each type of goldfish Tasha can buy for \$20.

7. **CLOTHES** A store sells T-shirts x in packs of 5 and regular shirts y individually. Graph the function $5x + y = 10$ to determine the number of each type of shirt Bethany can have if she buys 10 shirts.

Graph each function.

8. $y = 4x$
9. $y = -3x$
10. $y = x - 3$
11. $y = x + 1$
12. $y = 3x - 7$
13. $y = 2x + 3$
14. $y = \frac{1}{3}x + 1$
15. $y = \frac{1}{2}x - 3$

16. **MEASUREMENT** The equation $s = 180(n - 2)$ relates the sum of the measures of angles s formed by the sides of a polygon to the number of sides n. Find four ordered pairs (n, s) that are solutions of the equation. Then graph the equation.

MEASUREMENT For Exercises 17–19, use the following information.
The equation $y = 1.09x$ describes the approximate number of meters y in x yards.

17. Would negative values of x have any meaning in this situation? Explain.
18. Graph the function.
19. About how many meters is a 40-yard race?

MOUNTAIN CLIMBING For Exercises 20 and 21, use the following information and the table at the right.
If the temperature is 80°F at sea level, the function $t = 80 - 3.6h$ describes the temperature t at a height of h thousand feet above sea level.

Various California Mountains	
Mountain	**Elevation (ft)**
Mount Whitney	14,494
Pyramid Peak	9,984
Adams Peak	8,197
Mount Palomar	6,138

20. Graph the temperature function.
21. What is the temperature at each peak on a day that is 80°F at sea level?

EXTRA PRACTICE
See pages 699, 716.
MathOnline
Self-Check Quiz at ca.gr7math.com

22. **MONEY** Drake is saving money to buy a new computer for $1,200. He already has $450 and plans to save $30 a week. The function $f(x) = 30x + 450$ represents the amount Drake has saved after x weeks. Graph the function to determine the number of weeks it will take Drake to save enough money to buy the computer.

H.O.T. Problems

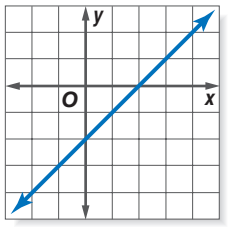
23. **OPEN ENDED** Draw a graph of a linear function. Name three solutions of the function.

24. **Which One Doesn't Belong?** Identify the ordered pair that is not a solution of $y = 2x - 3$. Explain your reasoning.

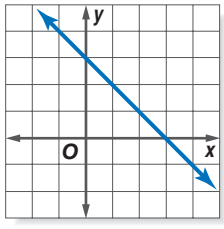
(1, –1)	(2, 1)	(0, 3)	(–2, –7)

25. **CHALLENGE** Name the coordinates of four points that satisfy each function. Then give the function rule.

a.



b.



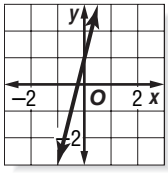
26. **WRITING IN MATH** Explain how a function table can be used to graph a function.

STANDARDS PRACTICE

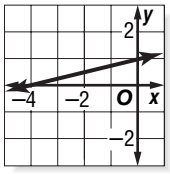
27. Which line graphed below best represents the table of values for the ordered pairs (x, y)?

x	−4	0	4	8
y	−2	−1	0	1

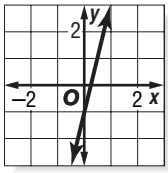
A



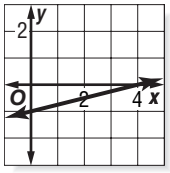
C



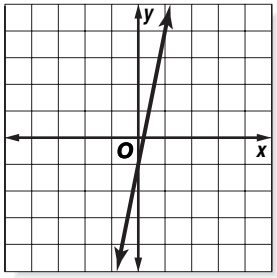
B



D



28. The graph shows the line $y = 5x - 1$.



Which table of ordered pairs contains only points on this line?

F

x	−2	−1	0	1
y	−9	−4	1	6

G

x	−3	−2	−1	0
y	−8	−7	−6	−5

H

x	0	1	2	3
y	−1	0	1	2

J

x	−1	0	1	2
y	−6	−1	4	9

Spiral Review

Find each function value. (Lesson 9-1)

29. $f(6)$ if $f(x) = 7x - 3$

30. $f(-5)$ if $f(x) = 3x + 15$

31. $f(3)$ if $f(x) = 2x - 7$

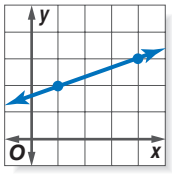
32. BAND The school band makes $0.50 for every flower they sell. They want to make at least $500 on the flower sale. Write and solve an inequality to find how many flowers they can sell and meet their goal. (Lesson 8-7)

33. MEASUREMENT Find the volume of a cylinder with a diameter of 7 inches and a height of 9 inches. Round to the nearest tenth if necessary. (Lesson 7-5)

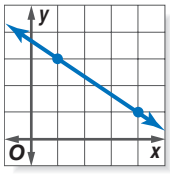
GET READY for the Next Lesson

PREREQUISITE SKILL **Find the constant rate of change for each graph.** (Lesson 4-9)

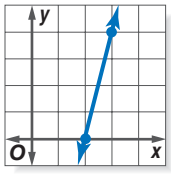
34.



35.



36.



9-3 Slope

Main IDEA

Find the slope of a line.

Standard 7AF3.3 **Graph linear functions, noting that the vertical change (change in *y*-value) per unit of horizontal change (change in *x*-value) is always the same and know that the ratio ("rise over run") is called the slope of a graph.**

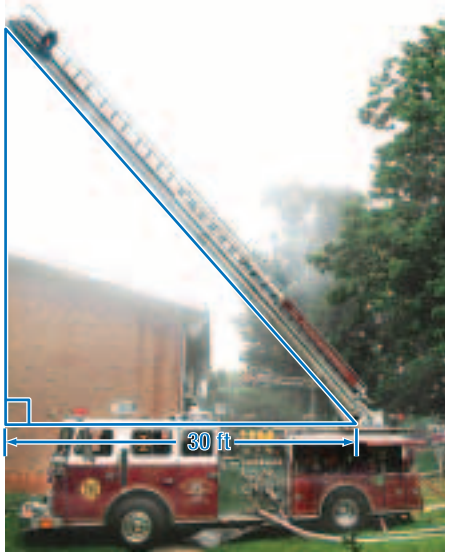
NEW Vocabulary

slope
rise
run

GET READY for the Lesson

SAFETY A ladder truck uses a moveable ladder to reach upper levels of houses and buildings.

1. The rate of change of the ladder compares the height it is raised to the distance of its base from the building. Write this rate as a fraction in simplest form.
2. Find the rate of change of a ladder that has been raised 100 feet and whose base is 50 feet from the building.

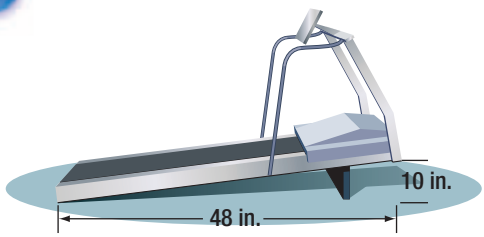


The term slope is used to describe the *steepness* of a straight line. **Slope** is the ratio of the **rise**, or vertical change, to the **run**, or horizontal change. In linear functions, no matter which two points you choose, the slope of the line is always constant.

$$\text{slope} = \frac{\text{rise}}{\text{run}}$$ ← vertical change between any two points ← horizontal change between the same two points

Real-World EXAMPLE

1 **EXERCISE** **Find the slope of the treadmill at the right.**



$$\text{slope} = \frac{\text{rise}}{\text{run}}$$ Definition of slope

$$= \frac{10 \text{ in.}}{48 \text{ in.}}$$ rise = 10 in., run = 48 in.

$$= \frac{5}{24}$$ Simplify.

The slope of the treadmill is $\frac{5}{24}$.

STUDY TIP

Slope Slope provides a way of describing how steep a line is *numerically*.

CHECK Your Progress

a. **HIKING** A hiking trail rises 6 feet for every horizontal change of 100 feet. What is the slope of the hiking trail?

Since slope is a rate of change, it can be positive (slanting upward) or negative (slanting downward).

EXAMPLE Find Slope Using a Graph

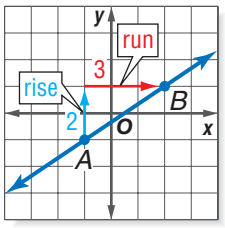
STUDY TIP

Translating Rise and Run

up → positive
down → negative
right → positive
left → negative

2 **Find the slope of the line.**

Choose two points on the line. The vertical change is 2 units while the horizontal change is 3 units.



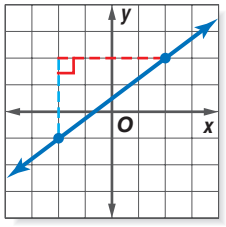
$$\text{slope} = \frac{\text{rise}}{\text{run}} \quad \text{Definition of slope}$$

$$= \frac{2}{3} \quad \text{rise} = 2, \text{run} = 3$$

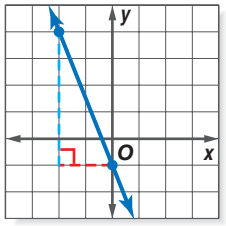
The slope of the line is $\frac{2}{3}$.

CHECK Your Progress

b.



c.



Slope can be found by finding the ratio of the change in y-values (rise) to the change in x-values (run) for any two points on a line.

EXAMPLE Find Slope Using a Table

3 **The points given in the table lie on a line. Find the slope of the line. Then graph the line.**

Choose two points from the table to find the changes in the x- and y-values.

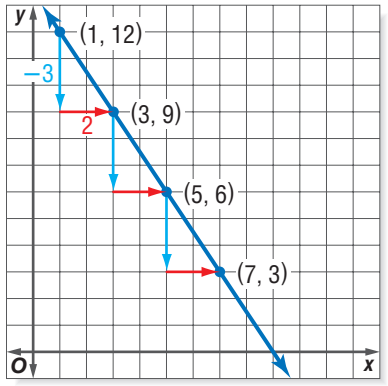
		+2	+2	+2
x	1	3	5	7
y	12	9	6	3
		−3	−3	−3

$$\text{slope} = \frac{\text{change in } y}{\text{change in } x}$$

$$= \frac{9 - 12}{3 - 1}$$

$$= \frac{-3}{2} \text{ or } -\frac{3}{2}$$

The slope is $-\frac{3}{2}$.



STUDY TIP

Slope You can choose any two points to calculate slope. Whichever y-value you use first, be sure to use the corresponding x-value first.

CHECK Your Progress

d.

x	−6	−2	2	6
y	−2	−1	0	1

e.

x	−4	0	4	8
y	−1	−2	−3	−4

Personal Tutor

Online **Personal Tutor at** ca.gr7math.com

READING Math

Subscripts x_1 is read *x sub one* and x_2 is read *x sub two*. They are used to indicate two different *x*-coordinates.

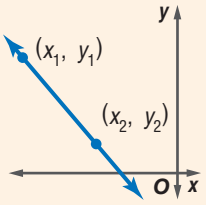
You have found slope by using $\frac{\text{rise}}{\text{run}}$ and $\frac{\text{change in } y}{\text{change in } x}$. You can also find the slope of a line by using the coordinates of any two points on the line. One point can be represented by (x_1, y_1) and the other by (x_2, y_2). The small numbers slightly below x and y are called *subscripts*.

KEY CONCEPT — Slope Formula

Words The slope m of a line passing through points (x_1, y_1) and (x_2, y_2) is the ratio of the difference in the *y*-coordinates to the corresponding difference in the *x*-coordinates.

Symbols $m = \frac{y_2 - y_1}{x_2 - x_1}$, where $x_2 \neq x_1$

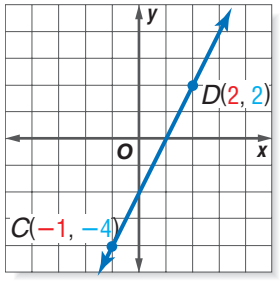
Model



EXAMPLES Find Slope Using Coordinates

Find the slope of the line that passes through each pair of points.

4 $C(-1, -4)$, $D(2, 2)$



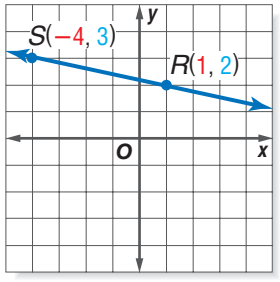
$m = \frac{y_2 - y_1}{x_2 - x_1}$ Slope formula

$m = \frac{2 - (-4)}{2 - (-1)}$ $(x_1, y_1) = (-1, -4)$, $(x_2, y_2) = (2, 2)$

$m = \frac{6}{3}$ or 2 Simplify.

Check When going from left to right, the graph of the line slants upward. This is correct for positive slope.

5 $R(1, 2)$, $S(-4, 3)$



$m = \frac{y_2 - y_1}{x_2 - x_1}$ Slope formula

$m = \frac{3 - 2}{-4 - 1}$ $(x_1, y_1) = (1, 2)$, $(x_2, y_2) = (-4, 3)$

$m = \frac{1}{-5}$ or $-\frac{1}{5}$ Simplify.

Check When going from left to right, the graph of the line slants downward. This is correct for negative slope.

STUDY TIP

Using the Slope Formula

- It does not matter which point you define as (x_1, y_1) and (x_2, y_2).
- However, the coordinates of both points must be used in the same order.

To check Example 5, let $(x_1, y_1) = (-4, 3)$ and $(x_2, y_2) = (1, 2)$. Then find the slope.

CHECK Your Progress

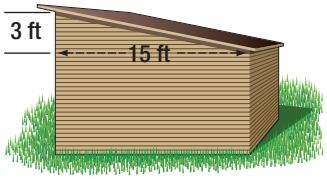
Find the slope of the line that passes through each pair of points.

f. $A(2, 2)$, $B(5, 3)$ **g.** $C(-2, 1)$, $D(0, -3)$ **h.** $J(-7, -4)$, $K(-3, -2)$

CHECK Your Understanding

Example 1 (p. 477)

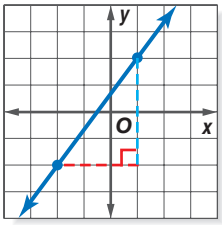
1. **BUILDINGS** Find the slope of the roof of the storage shed.



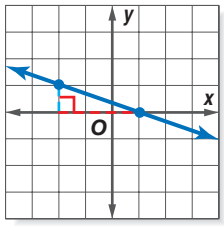
Example 2 (p. 478)

Find the slope of each line.

2.



3.



Example 3 (p. 478)

4. The points given in the table lie on a line. Find the slope of the line. Then graph the line.

x	0	1	2	3
y	1	3	5	7

Examples 4, 5 (p. 479)

Find the slope of the line that passes through each pair of points.

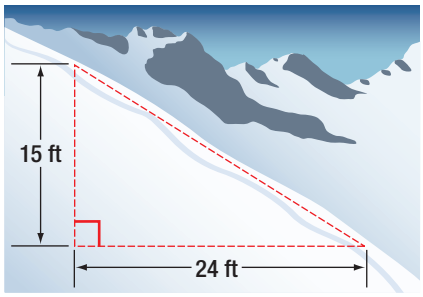
5. $A(-3, -2)$, $B(5, 4)$
6. $C(-4, 2)$, $D(1, 5)$
7. $E(-6, 5)$, $F(3, -3)$
8. $G(1, 5)$, $H(4, -3)$

Exercises

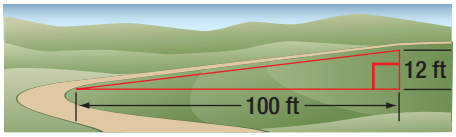
HOMEWORK HELP

For Exercises	See Examples
9, 10	1
11–14	2
15, 16	3
17–22	4, 5

9. **SKIING** Find the slope of a ski run that descends 15 feet for every horizontal change of 24 feet.

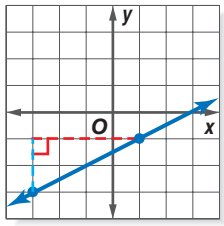


10. **ROADS** Find the slope of a road that rises 12 feet for every horizontal change of 100 feet.



Find the slope of each line.

11.



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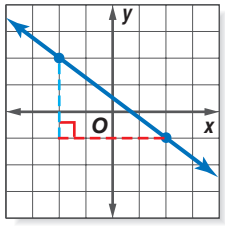

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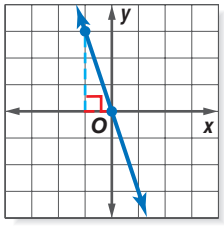

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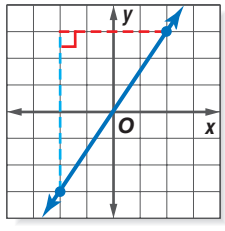


The points given in each table lie on a line. Find the slope of the line. Then graph the line.

15.

x	0	2	4	6
y	9	4	−1	−6

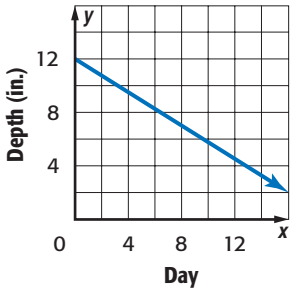
16.

x	−3	3	9	15
y	−3	1	5	9

Find the slope of the line that passes through each pair of points.

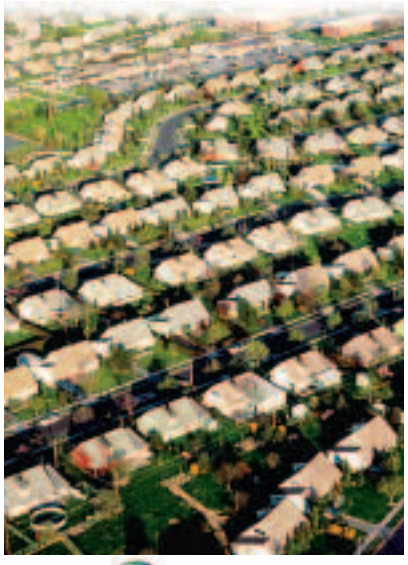
17. $A(0, 1), B(2, 7)$
18. $C(2, 5), D(3, 1)$
19. $E(1, 2), F(4, 7)$
20. $G(-6, -1), H(4, 1)$
21. $J(-9, 3), K(2, 1)$
22. $M(-2, 3), N(7, -4)$

23. **AQUARIUMS** The graph shows the depth of water in an aquarium over several days. Find the slope of the line and explain its meaning as a rate of change.



TRAVEL For Exercises 24–26, use the following information.
After 2 hours, Kendra had traveled 110 miles. After 3 hours, she had traveled 165 miles. After 5 hours, she had traveled 275 miles.

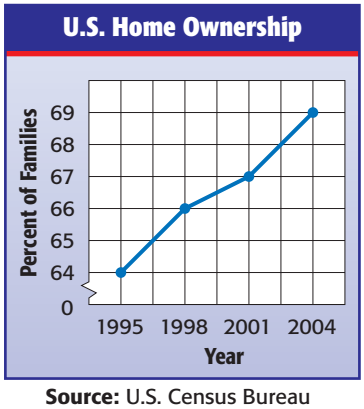
24. Graph the information with the hours on the horizontal axis and miles traveled on the vertical axis. Draw a line through the points.
25. What is the slope of the graph?
26. What does the slope of the graph represent?



Real-World Link
After World War II, the rate of home ownership in the U.S. rose steadily for three decades, from 44% in the late 1940s to 65.6% in 1980.
Source: www.census.gov

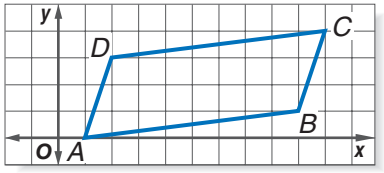
HOUSING For Exercises 27–29, use the graph at the right.

27. Find the slope of the line representing the change between each three-year period.
28. Does the graph show a constant rate of change? Explain.
29. If the graph is extended in each direction, could you expect the slope to remain constant throughout the graph? Explain.



Source: U.S. Census Bureau

30. **GEOMETRY** Two lines that are parallel have the same slope. Determine whether quadrilateral $ABCD$ is a parallelogram. Justify your reasoning.



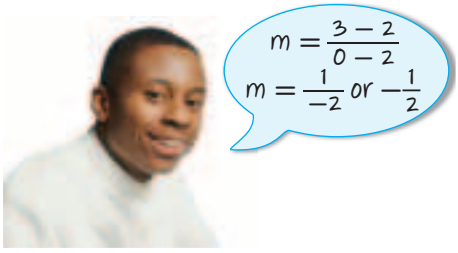
EXTRA PRACTICE
See pages 700, 716.
Math Online
Self-Check Quiz at ca.gr7math.com

31. **DISABILITIES** Wheelchair ramps for access to public buildings are allowed a maximum of one inch of vertical increase for every one foot of horizontal distance. Would a ramp that is 10 feet long and 8 inches tall meet this guideline? Explain your reasoning.

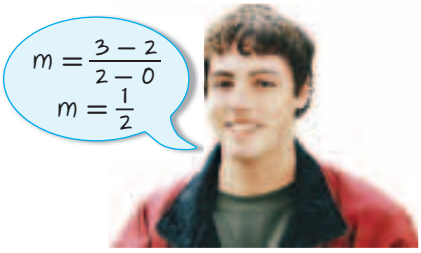
H.O.T. Problems

32. **OPEN ENDED** Write the coordinates of two points. Show that you can define either point as (x_1, y_1) and the slope of the line containing the points will be the same.

33. **FIND THE ERROR** Martin and Dylan are finding the slope of the line that passes through $X(0, 2)$ and $Y(2, 3)$. Who is correct? Explain.



Martin



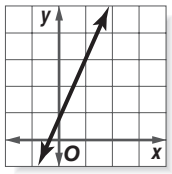
Dylan

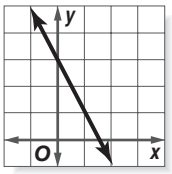
34. **CHALLENGE** Find the slope of the straight line that is the graph of the function expressing the circumference of a circle as a function of the radius.

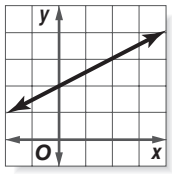
35. **WRITING IN MATH** For the slope of a linear function, explain why the vertical change (rise) and the horizontal change (run) is always the same.

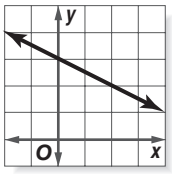
STANDARDS PRACTICE

36. Which line graphed below has a slope of -2?

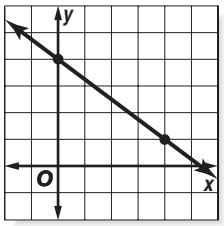
A 

C 

B 

D 

37. What is the slope of the linear function shown in the graph?



F $-\frac{4}{3}$

G $-\frac{3}{4}$

H $\frac{3}{4}$

J $\frac{4}{3}$

Spiral Review

Graph each function. (Lesson 9-2)

38. $y = 5x$

39. $y = x - 2$

40. $y = 2x - 1$

41. $y = 3x + 2$

42. **TEMPERATURE** The function used to change a Celsius temperature C to a Fahrenheit temperature F is $F = \frac{9}{5}C + 32$. Change 25° Celsius to Fahrenheit. (Lesson 9-1)

GET READY for the Next Lesson

PREREQUISITE SKILL **Solve each equation.** (Lesson 1-10)

43. $42 = -14x$

44. $144 = 18a$

45. $\frac{n}{3} = 7$

46. $-6 = \frac{t}{9}$

9-4 Direct Variation

Main IDEA

Use direct variation to solve problems.

Standard 7AF3.4 **Plot the values of quantities whose ratios are always the same (e.g., cost to the number of an item, feet to inches, circumference to diameter of a circle). Fit a line to the plot and understand that the slope of the line equals the quantities.**

Standard 7AF4.2 **Solve multistep problems involving** rate, average speed, distance, and time or a **direct variation.**

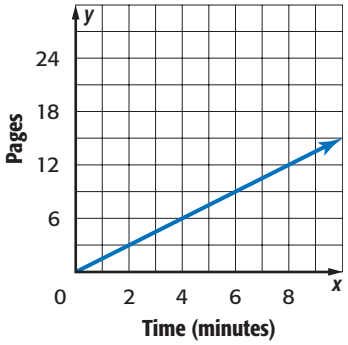
NEW Vocabulary

direct variation
constant of variation

GET READY for the Lesson

COMPUTERS Use the graph at the right that shows the output of a color printer.

1. What is the constant rate of change, or slope, of the line?
2. Is the total number of pages printed always proportional to the printing time? If so, what is the constant ratio?
3. Compare the constant rate of change to the constant ratio.

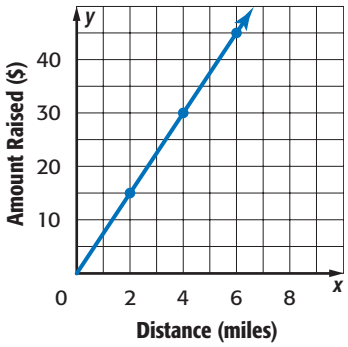


In the example above, the number of minutes and the number of pages printed both vary, while the ratio of pages printed to minutes, 1.5 pages per minute, remains constant.

When the ratio of two variable quantities is constant, their relationship is called a **direct variation**. The constant ratio is called the **constant of variation**.

Real-World EXAMPLE 1 Find a Constant Ratio

FUND-RAISER **The amount of money Robin has raised for a bike-a-thon is shown in the graph at the right. Determine the amount that Robin raises for each mile she rides.**



Since the graph of the data forms a line, the rate of change is constant. Use the graph to find the constant ratio.

$$\frac{\text{amount raised}}{\text{distance}} \rightarrow \frac{15}{2} \text{ or } \frac{7.5}{1} \quad \frac{30}{4} \text{ or } \frac{7.5}{1} \quad \frac{45}{6} \text{ or } \frac{7.5}{1} \quad \frac{60}{8} \text{ or } \frac{7.5}{1}$$

Robin raises $7.50 for each mile she rides.

CHECK Your Progress

a. **SKYDIVING** Two minutes after a skydiver opens his parachute, he has descended 1,900 feet. After 5 minutes, he has descended 4,750 feet. If the distance varies directly as the time, at what rate is the skydiver descending?

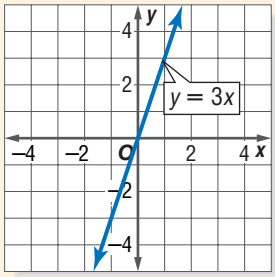
KEY CONCEPT — Direct Variation

Words A direct variation is a relationship in which the ratio of y to x is a constant, k. We say y varies directly with x.

Symbols $k = \frac{y}{x}$ or $y = kx$, where $k \neq 0$

Example $y = 3x$

Model



Real-World EXAMPLE 2 Solve a Direct Variation

Real-World Link
Most pets age at a different rate than their human companions. For example, a 3-year-old dog is often considered to be 21 in human years.

PETS Refer to the information at the left. Assume that the age of a dog varies directly as its equivalent age in human years. What is the human-year age of a dog that is 6 years old?

METHOD 1 Use an equation.

Write an equation of direct variation. Let x represent the dog's actual age and let y represent the human-equivalent age.

$y = kx$ Direct variation
$21 = k(3)$ $y = 21, x = 3$
$7 = k$ Simplify.
$y = 7x$ Substitute for $k = 7$.

Use the equation to find y when $x = 6$.

$y = 7x$
$y = 7(6)$ $x = 6$
$y = 42$ Multiply.

METHOD 2 Use a proportion.

human equivalent age → $\frac{21}{3} = \frac{x}{6}$ ← human equivalent age
actual age → ← actual age

$21 \cdot 6 = 3 \cdot x$ Find the cross products.
$126 = 3x$ Multiply.
$\frac{126}{3} = \frac{3x}{3}$ Divide each side by 3.
$42 = x$ Simplify.

A dog that is 6 years old is 42 years old in human-equivalent years.

CHOOSE Your Method

b. **SHOPPING** A grocery store sells 6 oranges for $2. How much would it cost to buy 10 oranges? Round to the nearest cent if necessary.

Personal Tutor

Online Personal Tutor at ca.gr7math.com

STUDY TIP

Look Back
To review **proportional relationships**, see Lessons 4-2 and 4-3.

Not all relationships with a constant rate of change are proportional. Likewise, not all linear functions are direct variations.

EXAMPLES Identify Direct Variation

Determine whether each linear function is a direct variation. If so, state the constant of variation.

3

Miles, x	25	50	75	100
Gallons, y	1	2	3	4

Compare the ratios to check for a common ratio.

$\frac{\text{gallons}}{\text{miles}} \rightarrow \frac{1}{25} \quad \frac{2}{50} \text{ or } \frac{1}{25} \quad \frac{3}{75} \text{ or } \frac{1}{25} \quad \frac{4}{100} \text{ or } \frac{1}{25}$

Since the ratios are the same, the function is a direct variation. The constant of variation is $\frac{1}{25}$.

4

Hours, x	2	4	6	8
Earnings, y	36	52	68	84

$\frac{\text{earnings}}{\text{hours}} \rightarrow \frac{36}{2} \text{ or } \frac{18}{1} \quad \frac{52}{4} \text{ or } \frac{13}{1} \quad \frac{68}{6} \text{ or } \frac{11.33}{1} \quad \frac{84}{8} \text{ or } \frac{10.50}{1}$

The ratios are not the same, so the function is not a direct variation.

CHECK Your Progress

c.

Days, x	5	10	15	20
Height, y	12.5	25	37.5	50

d.

Time, x	4	6	8	10
Distance, y	12	16	20	24

STUDY TIP

Direct Variations
Notice that the graph of a direct variation, which is a proportional linear relationship, is a line that passes through the origin.

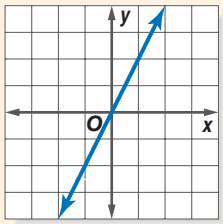
CONCEPT Summary

Proportional Linear Function

Table

x	−2	−1	1	2
y	−4	−2	2	4
$\frac{y}{x}$	2	2	2	2

Graph



Equation

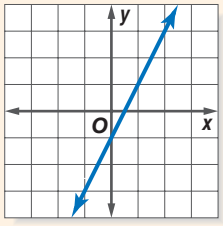
$y = 2x$

Nonproportional Linear Function

Table

x	−2	−1	1	2
y	−5	−3	1	3
$\frac{x}{y}$	$\frac{5}{2}$	3	1	$\frac{3}{2}$

Graph



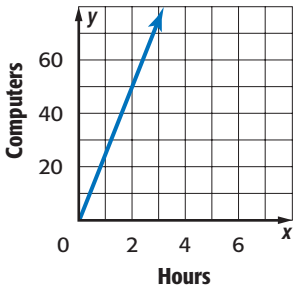
Equation

$y = 2x - 1$

CHECK Your Understanding

Example 1 (p. 483)

1. **MANUFACTURING** The number of computers built varies directly as the number of hours the production line operates. What is the ratio of computers built to hours of production?



Example 2 (p. 484)

2. **TRANSPORTATION** A charter bus travels 210 miles in $3\frac{1}{2}$ hours. Assuming that the distance traveled is directly proportional to the time traveled, how far will the bus travel in 6 hours?

Examples 3, 4 (p. 485)

3. Determine whether the linear function is a direct variation. If so, state the constant of variation.

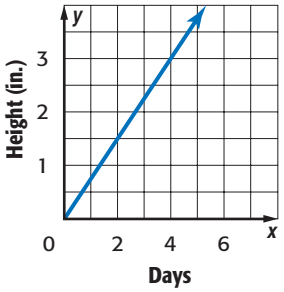
Hours, x	2	3	4	5
Miles, y	116	174	232	290

Exercises

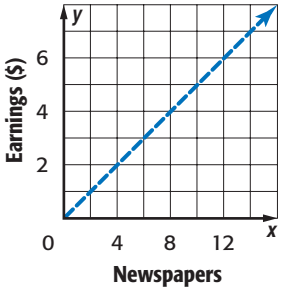
HOMEWORK HELP

For Exercises	See Examples
4–5	1
6–11	2
12–15	3, 4

4. **GARDENING** Janelle planted ornamental grass seeds. After the grass breaks the soil surface, its height varies directly with the number of days. What is the rate of growth?



5. **JOBS** The amount Dusty earns is directly proportional to the number of newspapers he delivers. How much does Dusty earn for each newspaper delivery?



6. **SUBMARINES** Ten minutes after a submarine is launched from a research ship, it is 25 meters below the surface. After 30 minutes, the submarine has descended 75 meters. At what rate is the submarine diving?

7. **MOVIES** The Stratton family rented 3 DVDs for $10.47. The next weekend, they rented 5 DVDs for $17.45. What is the rental fee for a DVD?

8. **MEASUREMENT** Morgan used 3 gallons of paint to cover 1,050 square feet and 5 gallons to paint an additional 1,750 square feet. How many gallons of paint would she need to cover 2,800 square feet?

9. **MEASUREMENT** The weight of an object on Mars varies directly with its weight on Earth. An object that weighs 70 pounds on Mars weighs 210 pounds on Earth. If an object weighs 160 pounds on Earth, how much would it weigh on Mars?

Real-World Link
The aspect ratio of a television screen describes the ratio of the width of the screen to the height. Standard screens have an aspect ratio of 4:3 while widescreen televisions have an aspect ratio of 16:9.
Source: infoplease.com

10. **ELECTRONICS** The height of a wide-screen television screen is directly proportional to its width. A manufacturer makes a television screen that is 60 centimeters wide and 33.75 centimeters high. Find the height of a television screen that is 90 centimeters wide.

11. **BAKING** A cake recipe requires $2\frac{3}{4}$ cups of flour for 12 servings. How much flour is required to make a cake that serves 30?

Determine whether each linear function is a direct variation. If so, state the constant of variation.

12.

Pictures, x	5	6	7	8
Profit, y	20	24	28	32

13.

Minutes, x	200	400	600	800
Cost, y	65	115	165	215

14.

Age, x	10	11	12	13
Grade, y	5	6	7	8

15.

Price, x	10	15	20	25
Tax, y	0.70	1.05	1.40	1.75

ALGEBRA **If y varies directly with x, write an equation for the direct variation. Then find each value.**

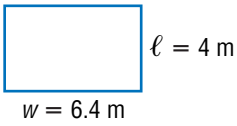
16. If $y = -12$ when $x = 9$, find y when $x = -4$.
17. Find y when $x = 10$ if $y = 8$ when $x = 20$.
18. If $y = -6$ when $x = -14$, what is the value of x when $y = -4$?
19. Find x when $y = 25$, if $y = 7$ when $x = 8$.
20. Find y when $x = 5$, if $y = 12.6$ when $x = 14$.

21. **MEASUREMENT** The number of centimeters in a measure varies directly as the number of inches. Find the measure of an object in centimeters if it is 50 inches long.

Inches, x	6	9	12	15
Centimeters, y	15.24	22.86	30.48	38.10

EXTRA PRACTICE
See pages 700, 716.
Math Online
Self-Check Quiz at ca.gr7math.com

22. **MEASUREMENT** The length of the rectangle shown varies directly as its width. What is the perimeter of a rectangle that is 10 meters long?



H.O.T. Problems

23. **OPEN ENDED** Identify values for x and y in a direct variation relationship where $y = 9$ when $x = 16$.

24. **CHALLENGE** The amount of stain needed to cover a wood surface is directly proportional to the area of the surface. If 3 pints are required to cover a square deck with a side of 7 feet, how many pints of stain are needed to paint a square deck with a side of 10 feet 6 inches?

25. **WRITING IN MATH** Write a real-world problem involving a direct variation. Then solve your problem.

STANDARDS PRACTICE

26. Students in a science class recorded lengths of a stretched spring, as shown in the table below.

Length of Stretched Spring	
Distance Stretched, x (centimeters)	Mass, y (grams)
0	0
2	12
5	30
9	54
12	72

Which equation best represents the relationship between the distance stretched x and the mass of an object on the spring y?

A $y = -6x$ **C** $y = -\frac{x}{6}$

B $y = 6x$ **D** $y = \frac{x}{6}$

27. Nicole read 24 pages during a 30-minute independent reading period. How many pages would she read in 45 minutes?

F 30 **H** 42

G 36 **J** 48

28. To make fruit punch, Kelli must add 8 ounces of pineapple juice for every 12 ounces of orange juice. If she uses 32 ounces of orange juice, which proportion can she use to find p, the number of ounces of pineapple juice she should add to make the punch?

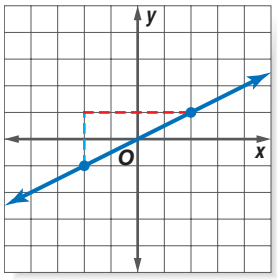
A $\frac{8}{12} = \frac{32}{x}$ **C** $\frac{8}{12} = \frac{x}{32}$

B $\frac{8}{x} = \frac{32}{12}$ **D** $\frac{x}{12} = \frac{8}{32}$

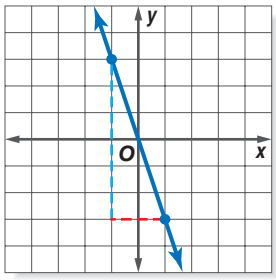
Spiral Review

Find the slope of each line. (Lesson 9-3)

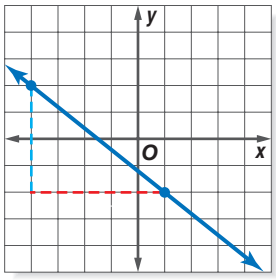
29.



30.



31.



32. **JOBS** The function $p = 7.5h$ describes the relationship between the number of hours h Callie works and the amount she is paid p. Graph the function. Then use your graph to determine how much Callie can expect to earn if she works 20 hours. (Lesson 9-2)

33. **HEALTH** Many health authorities recommend that a healthy diet contains no more than 30% of its Calories from fat. If Jennie consumes 1,500 Calories each day, what is the maximum number of Calories she should consume from fat? (Lesson 5-3)

GET READY for the Next Lesson

PREREQUISITE SKILL **Solve each equation.** (Lesson 1-9)

34. $7 + a = 15$ **35.** $23 = d + 44$ **36.** $28 = n - 14$ **37.** $t - 22 = -31$

CHAPTER 9

Mid-Chapter Quiz

Lessons 9-1 through 9-4

Find each function value. (Lesson 9-1)

1. $f(9)$ if $f(x) = 12x$
2. $f(6)$ if $f(x) = x + 7$
3. $f(8)$ if $f(x) = 2x - 8$
4. $f(2)$ if $f(x) = 6x + 1$

5. **SCIENCE** Sonar units locate objects using the time it takes to reflect sound waves back from an object. The function $f(x) = 727x$, where $f(x)$ is the distance to the object in meters and x is the time in seconds, can be used to locate objects under water. Find the distance to a wrecked ship if it takes 5.24 seconds for sound to reflect back. (Lesson 9-1)

6. **STANDARDS PRACTICE** Which equation describes the function represented by the table? (Lesson 9-1)

x	y
−2	−7
0	−3
2	1
4	5

A $y = 2x - 3$
C $y = x + 4$
B $y = x - 3$
D $y = 2x + 3$

7. **PICNICS** Shelby is hosting a picnic. The cost to rent the shelter is $25 plus $2 per person. Write a function using two variables to represent the situation. Find the total cost if 150 people attend. (Lesson 9-1)

Graph each function. (Lesson 9-2)

8. $y = x + 6$
9. $y = 2x - 5$

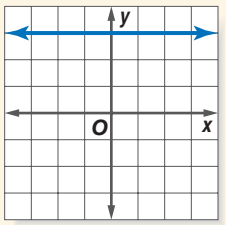
10. **WATER** A store sells bottles of water x in packs of 6 and individual bottles of water y. Graph the function $6x + y = 17$ to determine the number of each type of bottled water Sophia can have if she buys 17 bottles of water. (Lesson 9-2)

Find the slope of the line that passes through each pair of points. (Lesson 9-3)

11. $A(2, 5)$, $B(3, 1)$
12. $C(-1, 2)$, $D(-5, 2)$
13. $E(5, 2)$, $F(2, -3)$

14. **STANDARDS PRACTICE** Which graph has a negative slope? (Lesson 9-3)

F



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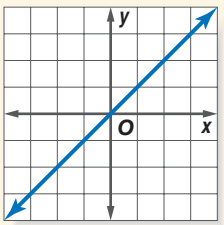

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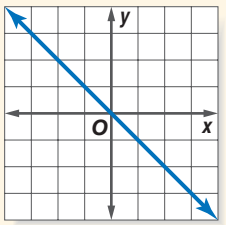

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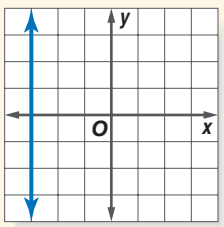
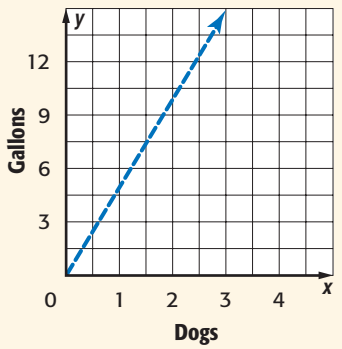


15. **BAKING** Ernesto baked 3 cakes in $2\frac{1}{2}$ hours. Assuming that the number of cakes baked is directly proportional to the number of hours, how many cakes can he bake in $7\frac{1}{2}$ hours? (Lesson 9-4)

16. **JOBS** The number of gallons of water Fina uses is directly proportional to the number of dogs she washes. How many gallons of water does she use for each dog she washes? (Lesson 9-4)



Explore 9-5

Algebra Lab
Proportional and Nonproportional Functions

Main IDEA

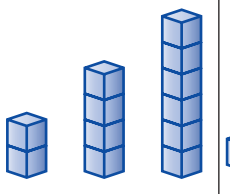
Compare and contrast proportional and nonproportional linear functions.

Standard 7AF1.5 **Represent quantitative relationships graphically and interpret the meaning of a specific part of a graph in the situation represented by the graph.**
Standard 7MR2.5 **Use a variety of methods,** such as words, numbers, **symbols,** charts, **graphs, tables,** diagrams, and **models, to explain mathematical reasoning.**

In this lab, you will use models to develop two different functions.

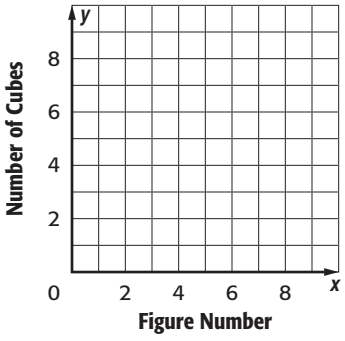
ACTIVITY

STEP 1 Using centimeter cubes, build the two tower patterns shown.

Pattern	A				B			
Figures								
Figure Number	0	1	2	3	0	1	2	3

STEP 2 Let x represent the figure number and y represent the number of cubes in each tower. Copy and complete the table below for each pattern. Then graph and label each set of tower data on separate coordinate planes.

x	Process	y
0		
1		
2		
3		
4		
5		
x		



Analyze the Results

1. Compare and contrast the models of patterns A and B.
2. Compare and contrast the processes for patterns A and B.
3. Compare and contrast the graphs of patterns A and B.
4. Which pattern represents a proportional relationship or direct variation, and which represents a nonproportional relationship? Explain. How can you tell this from the process shown in the table? from the graph?

9-5 Slope-Intercept Form

In Motion | In Motion for MAC

Concepts in MOtion
BrainPOP® ca.gr7math.com

Main IDEA

Graph linear equations using the slope and *y*-intercept.

Standard 7AF3.3 Graph linear functions, noting that the vertical change (change in *y*-value) per unit of horizontal change (change in *x*-value) is always the same and know that the ratio ("rise over run") is called the slope of a graph.

NEW Vocabulary

slope-intercept form
y-intercept

MINI Lab

Graph each equation listed in the table at the right.

1. Use the graphs to find the slope and *y*-intercept of each line. Copy and complete the table.
2. Compare each equation with the value of its slope. What do you notice?

Equation	Slope	*y*-intercept
$y = 3x + 2$		
$y = \frac{1}{4}x + (-1)$		
$y = -2x + 3$		

Proportional linear functions can be written in the form $y = kx$, where k is the constant of variation, or slope of the line. Nonproportional linear functions can be written in the form $y = mx + b$. This is called the **slope-intercept form**. When an equation is written in this form, m is the slope and b is the *y*-intercept. The ***y*-intercept** of a line is the *y*-value of the point where the line crosses the *y*-axis.

EXAMPLES Find Slopes and *y*-intercepts of Graphs

State the slope and the *y*-intercept of the graph of each equation.

1 $y = \frac{2}{3}x - 4$

$y = \frac{2}{3}x + (-4)$ Write the equation in the form $y = mx + b$.

$y = mx + b$ $m = \frac{2}{3}$, $b = -4$

The slope of the graph is $\frac{2}{3}$, and the *y*-intercept is -4.

2 $x + y = 6$

$x + y = 6$ Write the original equation.

$x - x + y = 6 - x$ Subtract x from each side.

$y = 6 - x$ Simplify.

$y = -1x + 6$ Write the equation in the form $y = mx + b$. Recall that $-x$ means $-1x$.

$y = mx + b$ $m = -1$, $b = 6$

The slope of the graph is -1, and the *y*-intercept is 6.

CHECK Your Progress

a. $y = -5x + 3$ b. $y = \frac{1}{4}x - 6$ c. $y - x = 5$

EXAMPLE Graph Using Slope-Intercept Form

3 **Graph $y = -\frac{3}{2}x - 1$ using the slope and y-intercept.**

Step 1 Find the slope and y-intercept.

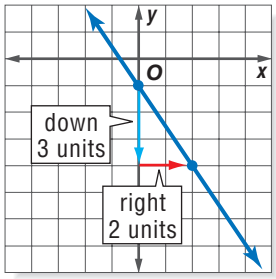
$y = -\frac{3}{2}x - 1$ slope $= -\frac{3}{2}$, y-intercept $= -1$

Step 2 Graph the y-intercept -1.

Step 3 Write the slope $-\frac{3}{2}$ as $\frac{-3}{2}$. Use it to locate a second point on the line.

$m = \frac{-3}{2}$ ← change in y: down 3 units ← change in x: right 2 units

Step 4 Draw a line through the two points.



STUDY TIP

Check for Accuracy
To check your graph, substitute the x- and y-values of another point on your graph into the equation. For Example 3, test the point $(2, -4)$.

$y = -\frac{3}{2}x - 1$

$-4 = -\frac{3}{2}(2) - 1$

$-4 = -3 - 1$

$-4 = -4$ ✓

Personal Tutor

CHECK Your Progress **Graph each equation.**

d. $y = x + 3$ e. $y = \frac{1}{2}x - 1$ f. $y = -\frac{4}{3}x + 2$

Personal Tutor at ca.gr7math.com

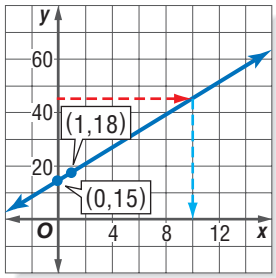
EXAMPLES Graph an Equation to Solve Problems

ADVERTISING **It costs \$15 to design a poster and \$3 to print each poster. The cost y to print x posters is given by $y = 3x + 15$.**

4 **Graph the equation to find the number of posters that can be printed for \$45.**

$y = 3x + 15$ slope $= 3$, y-intercept $= 15$

Plot the point $(0, 15)$. Locate another point up 3 and right 1. Draw the line. The x-coordinate is 10 when the y-coordinate is 45, so the number of posters is 10.



5 **Describe what the slope and y-intercept represent.**

The slope 3 represents the cost in dollars per poster, and the y-intercept 15 is the one-time charge in dollars for preparing the design.

6 **Is the total cost proportional to the number of posters? Explain.**

Compare the ratio of total cost to number of posters for two points.

$\frac{18}{1} = \$18$ per poster $\frac{45}{10} = \$4.50$ per poster The ratios are different.

So, the total cost is not proportional to the number of posters.

Real-World Link
In the year 2000, over \$236 billion was spent on advertising in the United States.
Source: McCann-Erickson, Inc.

CHECK Your Progress

TRANSPORTATION **A taxi fare y can be determined by the equation $y = 0.50x + 3.50$, where x is the number of miles traveled.**

g. Graph the equation to find the cost of traveling 8 miles.

h. What do the slope and y-intercept represent?

i. Is the total fare proportional to the number of miles? Explain.

Juan Silva/Getty Images

CHECK Your Understanding

Examples 1, 2 (p. 491)

State the slope and the y-intercept for the graph of each equation.

1. $y = x + 2$
2. $y = -\frac{1}{6}x - \frac{1}{2}$
3. $2x + y = 3$

Example 3 (p. 492)

Graph each equation using the slope and the y-intercept.

4. $y = \frac{1}{3}x - 2$
5. $y = -\frac{5}{2}x + 1$
6. $y = -2x + 5$

Examples 4–6 (p. 492)

MONEY MATTERS **For Exercises 7–9, use the following information.**
Lydia borrowed \$90 from her mother and plans to pay her mother \$10 per week. The equation for the amount of money y Lydia owes her mother is $y = 90 - 10x$, where x is the number of weeks after the loan.

7. Graph the equation to find the amount Lydia owes her mother after 4 weeks.
8. What do the slope and x-intercept represent?
9. Is the amount owed proportional to the number of weeks? Explain.

Exercises

HOMEWORK HELP

For Exercises	See Examples
10–15	1, 2
16–21	3
22–27	4–6

State the slope and the y-intercept for the graph of each equation.

10. $y = 3x + 4$
11. $y = -5x + 2$
12. $y = \frac{1}{2}x - 6$
13. $y = -\frac{3}{7}x - \frac{1}{7}$
14. $y - 2x = 8$
15. $3x + y = -4$

Graph each equation using the slope and the y-intercept.

16. $y = \frac{1}{3}x - 5$
17. $y = -x + \frac{3}{2}$
18. $y = -\frac{4}{3}x + 1$
19. $y = \frac{3}{2}x - 4$
20. $y + 2x = -3.5$
21. $1.5 = y - 3x$

BOATING **For Exercises 22–24, use the following information.**
The Lakeside Marina charges a \$35 rental fee for a boat, in addition to charging \$15 an hour for usage. The total cost y of renting a boat for x hours can be represented by the equation $y = 15x + 35$.

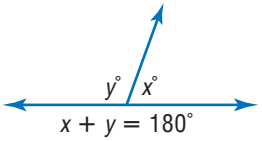
22. Graph the equation to find the total cost for a 3-hour rental.
23. What do the slope and the y-intercept represent?
24. Is the total cost proportional to the number of hours? Explain.

SPACE SCIENCE **For Exercises 25–27, use the following information.**
From 4,074 meters above Earth, a space shuttle glides to the runway. Let $y = 4{,}074 - 47x$ represent the altitude of the shuttle after x seconds.

25. Graph the equation to find the shuttle's altitude after 50 seconds.
26. What do the slope and y-intercept represent?
27. Is the altitude propotional to the number of seconds? Explain.

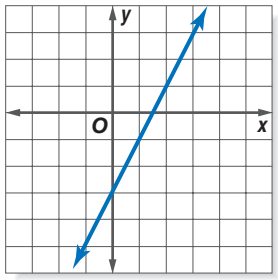
28. **INSECTS** The equation $y = 15x + 37$ can be used to approximate the temperature y in degrees Fahrenheit based on the number of chirps x a cricket makes in 15 seconds. Graph the equation to estimate the number of chirps a cricket will make in 15 seconds if the temperature is 80°F.

GEOMETRY For Exercises 29–31, use the supplementary angles at the right.



29. Write the equation in slope-intercept form.
30. Graph the equation.
31. Is the relationship between supplementary angles proportional? Explain.

For Exercises 32–34, use the graph at the right.



32. What is the slope of the line?
33. Identify the y-intercept of the graph.
34. What is an equation of the line in slope-intercept form?

WEATHER For Exercises 35–37, use the following information.

The equation $y = 1.5x + 2$ can be used to find the total rainfall in y inches x hours after 12:00 P.M. during a tropical storm.

35. Graph the equation.
36. State the slope and y-intercept and describe what they represent.
37. Name the x-intercept and describe what it represents.

EXTRA PRACTICE
See pages 700, 716.
MathOnline
Self-Check Quiz at ca.gr7math.com

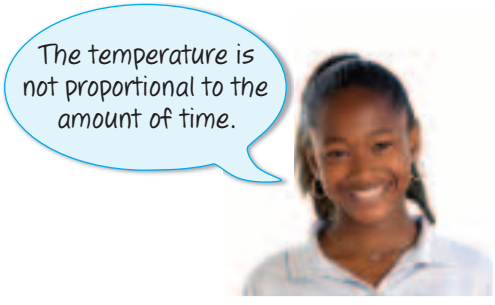
H.O.T. Problems

38. **OPEN ENDED** Draw the graph of a line that has a y-intercept but no x-intercept. What is the slope of the line?

39. **FIND THE ERROR** The table shows the results of a science experiment in which water is heated until it is boiling then removed from the heat source. Whose conclusion is correct? Explain.

Time (s)	Temperature (°C)
0	100°
15	99°
30	98°
45	97°

Aurelio



Chantel

40. **CHALLENGE** A triangle's original vertices are located at (3, 0), (4, −3), and (1, −4). The triangle is translated 1 unit to the right and 3 units up. It is then reflected across the graph of $y = x + 1$. Determine the new vertices of the triangle.

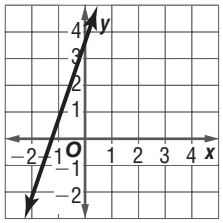
41. **REASONING** What is the slope and y-intercept of a vertical line?

42. **WRITING IN MATH** Write a real-world problem that involves a linear equation in slope-intercept form. Graph the equation. Explain the meaning of the slope and y-intercept.

STANDARDS PRACTICE

43. Which *best* represents the graph of $y = 3x + 4$?

A



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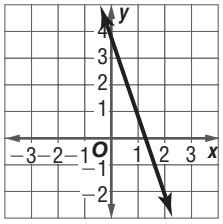

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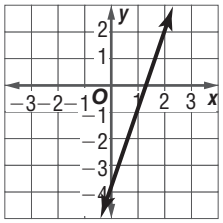

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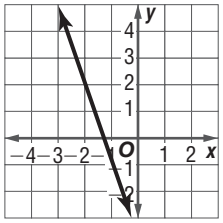
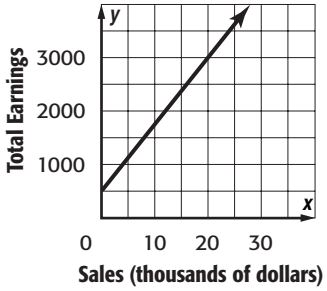


44. Which statement could be true for the graph below?



F Mr. Blackwell will earn $1,750 if his sales are $10,000.

G Ms. Chu will not earn any money if she has no sales.

H Mr. Montoya earns $250 for every $1,000 he sells.

J Ms. James earns $2,500 if she sells $2,500 worth of merchandise.

Spiral Review

45. **BICYCLING** Angel rides her bike 25 miles in $2\frac{1}{2}$ hours. How long will it take her to ride 60 miles? (Lesson 9-4)

Find the slope of the line that passes through each pair of points. (Lesson 9-3)

46. $M(4, 3), N(-2, 1)$

47. $S(-5, 4), T(-7, 1)$

48. $X(-9, 5), Y(-2, 5)$

49. **MEASUREMENT** The function $y = 0.39x$ approximates the number of centimeters y in x inches. Make a function table. Then graph the function. (Lesson 9-2)

50. **MEASUREMENT** When filled to capacity, a cylindrical silo can hold 8,042 cubic feet of grain. The circumference C of the silo is approximately 50.3 feet. Find the height h of the silo to the nearest foot. (Lesson 7-5)

GET READY for the Next Lesson

PREREQUISITE SKILL **Solve each equation. Check your solution.** (Lesson 8-2)

51. $3a - 12 = -3$

52. $-2 = -n + 4$

53. $-\frac{1}{3}p - 7 = -3$

54. $4 - \frac{1}{5}x = 20$

Extend 9-5

Graphing Calculator Lab
Modeling Linear Behavior

Main IDEA

Use technology to investigate situations to determine if they display linear behavior.

Standard 7AF1.5 **Represent quantitative relationships graphically and interpret the meaning of a specific part of a graph in the situation represented by the graph.**
Standard 7MR3.3 Develop generalizations of the results obtained and the strategies used and apply them to new problem situations.

Many situations in the real world exhibit *linear behavior* or behavior in which equal changes in one quantity produce approximately equal changes in another quantity. In this activity, you will examine a situation using a data collection device and a graphing calculator to determine if this situation displays linear behavior.

ACTIVITY

1

STEP 1 Connect a motion detector to your calculator. Start the data collection program by pressing APPS (CBL/CBR) ENTER, and then select RANGER, Applications, Meters, Dist Match.

STEP 2 Place the detector on a desk or table so that it can read the motion of a walker.

STEP 3 Mark the floor at a distance of 1 and 6 meters from the detector. Have a partner stand at the 1-meter mark.

STEP 4 When you press the button to begin collecting data, have your partner begin to walk away from the detector at a slow but steady pace.

STEP 5 Stop collecting data when your partner passes the 6-meter mark.

STEP 6 Press ENTER to display a graph of the data. The x-values represent equal intervals of time in seconds. The y-values represent the distances from the detector in meters.

Analyze the Results

1. Describe the DISTANCE graph of the collected data. Does the relationship between time and distance appear to be linear? Explain.
2. Use the TRACE feature on your calculator to find the y-intercept on the graph. Interpret its meaning.

MathOnline **Other Calculator Keystrokes at** ca.gr7math.com

3. Press STAT 1 and record the time data from L1 and the distance data from L2 in a table like the one shown. Then use these data to calculate the rate of change $\frac{\text{distance}}{\text{time}}$ for several pairs of points. What do you notice?

List L1	List L2

4. Does your answer to Exercise 3 support your conclusion about the graph in Exercise 1? Explain.

5. **MAKE A PREDICTION** Predict how your graph and answers to Exercise 3 would change if the person in the activity were to
   a. move at a steady but *quick* pace away from the detector.
   b. move at a steady but slow pace *toward* the detector.

6. **COLLECT THE DATA** Repeat the activity and answer Questions 1 through 3 again for each of the situations described in Exercise 5.

7. **MAKE A CONJECTURE** How could you change the situation to be one that does not display linear behavior?

8. **COLLECT THE DATA** Repeat the activity and answer Questions 1 through 3 again for the situation you described in Exercise 7.

Families of graphs are graphs that are related in some manner. In this activity, you will study families of linear graphs.

STUDY TIP

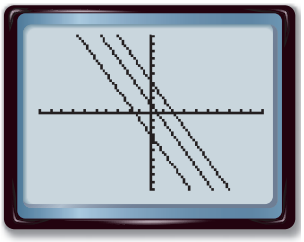
Window

Pressing ZOOM 6 changes the viewing window for a graph to be [−10, 10] scl:1 by [−10, 10] scl:1

ACTIVITY

2

STEP 1 Clear any existing equations from the Y= list by pressing Y= CLEAR.



STEP 2 Enter each of the following equations: $y = -2x + 4$, $y = -2x + 1$, and $y = -2x - 3$.

STEP 3 Press ZOOM 6 to graph the equations.

Analyze the Results

9. Compare the three equations and their graphs.

10. **MAKE A CONJECTURE** Consider equations of the form $y = ax + b$, where the value of a is constant but the value of b varies. What do you think is true for the graphs of these equations?

11. Use your calculator to graph $y = 2x + 3$, $y = -x + 3$, and $y = -3x + 3$. Compare the three equations and their graphs.

12. **MAKE A CONJECTURE** Consider equations of the form $y = ax + b$, where the value of a varies but the value of b remains constant. What do you think is true for the graphs of these equations?

9-6 Writing Systems of Equations and Inequalities

Main IDEA

Write systems of equations and inequalities.

Standard 7AF1.1 **Use variables and appropriate operations to write** an expression, an equation, an inequality, **or a system of equations or inequalities that represents a verbal description** (e.g. three less than a number, half as large as area *A*).

NEW Vocabulary

system of equations
system of inequalities

GET READY for the Lesson

Two Internet sites sell the same product for the same price, but their shipping charges differ as shown in the table.

Internet Site	Base Charge	Charge per Pound
A	\$3.00	\$1.00
B	\$1.00	\$2.00

The shipping charges can be represented by the following equations and tables where x represents the number of pounds, and y represents the shipping charge.

Internet Site A

$y = x + 3$

x	$y = x + 3$	y	(x, y)
0	$0 + 3$	3	(0, 3)
1	$1 + 3$	4	(1, 4)
2	$2 + 3$	5	(2, 5)
3	$3 + 3$	6	(3, 6)

Internet Site B

$y = 2x + 1$

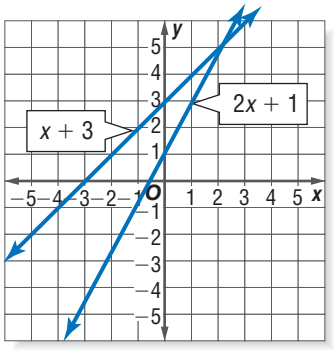
x	$y = 2x + 1$	y	(x, y)
0	$2(0) + 1$	1	(0, 1)
1	$2(1) + 1$	3	(1, 3)
2	$2(2) + 1$	5	(2, 5)
3	$2(3) + 1$	7	(3, 7)

For Questions 1–3, refer to the tables above.

1. For what number of pounds are the shipping charges the same?
2. For what number of pounds are the shipping charges for Internet Site A less than the ones for Internet Site B?
3. For what number of pounds are the shipping charges for Internet Site A greater than Internet Site B?

For Questions 4 and 5, refer to the graphs of the equations at the right.

4. At what point do the two lines intersect?
5. What does this ordered pair represent?



Together, the equations $y = x + 3$ and $y = 2x + 1$ are called a **system of equations**. There are two equations and two different unknowns, x and y. The solution of a system of equations is an ordered pair that satisfies each equation.

STUDY TIP

System of Equations
When writing the system, it is important to keep like variables lined up in relation to each other.

EXAMPLE Writing Systems of Equations

1 **MOVIES** **Seven adults and children went to the movies. The number of adults was one more than the number of children. Write a system of equations that represents the number of adults and children.**

Let a = the number of adults, and let c = the number of children.

number of adults		plus		number of children		equals		total number of people.
a		$+$		c		$=$		7

number of adults		equals		number of children		plus		one.
a		$=$		c		$+$		1

So, the system of equations is $a + c = 7$ and $a = c + 1$.

CHECK Your Progress

a. **MONEY** Jerry has a total of five nickels and dimes in his pocket. The value of the coins is 35 cents. Write a system of equations that represents the number of coins Jerry has.

A **system of inequalities** is similar to a system of equations except that it contains the symbol $<$, $\leq$, $>$, or $\geq$.

EXAMPLE Writing Systems of Inequalities

2 **ADVERTISING** **Jeremy wants to advertise in the classified section of two newspapers. He wants to spend less than $35 per newspaper. Newspaper A charges a fee of $5 per day, plus $2.25 per line. Newspaper B charges a fee of $4 per day plus $3.50 per line. Write a system of inequalities to represent what Jeremy will spend for advertising.**

Let x = the number of lines used, and let y = the number of days the ad runs.

Cost per line times number of lines		plus		cost per day times number of days		is less than		$35.
$2.25x$		$+$		$5y$		$<$		35
$3.50x$		$+$		$4y$		$<$		35

So, the system of inequalities is.
$2.25x + 5y < 35$
$3.50x + 4y < 35$.

CHECK Your Progress

b. The number of dimes and quarters is more than 15, but the value of the coins when added together is less than $5. Write a system of inequalities that represents the number of coins. (*Hint:* Remember that the value of a dime is $0.10 and the value of a quarter is $0.25.)

CHECK Your Understanding

Example 1 (p. 499)

1. **AGE** The sum of Sally's age plus twice Jerry's age is 48. The difference of Sally's age minus Jerry's age is 3. Write a system of equations that represents their ages.

2. **BASKETBALL** In 2006, Vince Carter and Jason Kidd cost the New Jersey Nets a total of approximately $33 million. If Jason Kidd makes $3 million dollars more than Vince Carter, write a system of equations that represents their salaries.

Example 2 (p. 499)

3. **CELL PHONES** Shantel is considering two rate plans that a cell phone company offers. Plan A offers a standard basic charge plus $0.15 per minute used. Plan B offers the same basic charge plus $15 with unlimited minutes. She needs to spend less than $39 per month. Write a system of inequalities to represent the plans.

4. **LANDSCAPING** A homeowner is going to seed a new lawn and cover it with straw. The lawn is 3,500 square feet. He can only fit a total of 4 bags of seed or bales of straw in his vehicle at a time. Write a system of inequalities to represent the situation.

	Units	Coverage (sq. ft)
Seed (S)	1 bag	2,000
Straw (R)	1 bale	436

Exercises

HOMEWORK HELP

For Exercises	See Examples
5–7	1
8–10	2

Write a system of equations that represents each situation.

5. **PETS** A pet store currently has a total of 45 cats and dogs. There are 7 more cats than dogs.

6. **PARKS** The city park has ordered a total of 22 maple and oak trees to be planted. The total cost for the trees is $620, with maples costing $25 each and oaks costing $32 each.

7. **TRACK** There are 63 athletes on the high school track teams. There are 7 more girls than boys on the team.

Write a system of inequalities that represents each situation.

8. **ELECTRONICS** A store is ordering two types of stereos. They want to make a total profit of more than $4,800. Model A stereo sells for a profit of $35, and Model B stereo sells for a profit of $75. The store plans on selling at least 110 stereos.

9. **SCHOOL SUPPLIES** The teacher tries to keep at least 50 pens and pencils in the classroom for students. He likes there to be at least ten more pencils than pens.

10. **APPLIANCES** A delivery truck can fit no more than 20 washers and dryers at a time. Washers weigh 175 pounds and dryers weigh 155 pounds. The truck's maximum capacity is 3,300 pounds.

EXTRA PRACTICE

See page 701, 716.

Math Online

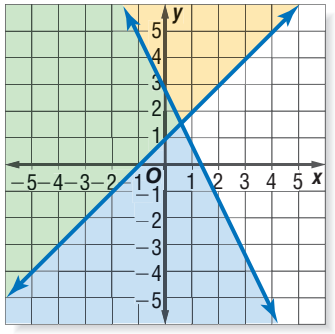
Self-Check Quiz at ca.gr7math.com

H.O.T. Problems

11. **CHALLENGE** The solution of a *system of inequalities* is the set of all ordered pairs that satisfies *both* inequalities.

    a. Write a system of inequalities for the graph at the right.

    b. List three solutions of the system.



12. **WRITING IN MATH** Write a real-world problem that could be represented by a system of equations or inequalities. Explain how the system would be helpful in the situation.

STANDARDS PRACTICE

13. Claire baked 36 cookies. There are 8 more chocolate chip cookies than peanut butter. Which system can be used to find the number of each type of cookie?

    A $c + p = 36$, $p = c + 8$

    B $c + p = 36$, $c = p + 8$

    C $c + p = 8$, $p = c + 36$

    D $c + p = 8$, $c = p + 36$

14. Which inequality represents the statement "A number n decreased by 11 is greater than or less than 53"?

    F $11 - n \leq 53$

    G $11 - n \geq 53$

    H $n - 11 \geq 53$

    J $n - 11 \leq 53$

Spiral Review

READING For Exercises 15–17, use the following information. (Lesson 9-5)

Eric has read 30 pages of a novel. He plans to read 50 pages every evening until he is finished. The equation $y = 30 + 50x$ can be used to represent the number of pages y Eric has read after x days.

15. Graph the equation.

16. Use the graph to find the number of pages Eric will have read after 6 days.

17. What do the slope and y-intercept represent?

18. **TRAVEL** One and a half hours after leaving its main station, a commuter train has traveled 202.5 miles. At this rate, how far will the train travel after 5 hours? (Lesson 9-4)

For the given value, state whether each inequality is *true* or *false*. (Lesson 8-6)

19. $18 - n > 4, n = 11$ 20. $13 + x < 21, x = 8$ 21. $34 \leq 5p, p = 7$ 22. $\frac{a}{-4} \geq 3, a = -12$

GET READY for the Next Lesson

23. **PREREQUISITE SKILL** A display of video game boxes is stacked in the shape of a pyramid. There are 5 boxes in the top row, 7 boxes in the second row, 9 boxes in the third row, and so on. The display contains 10 rows of boxes. How many boxes are in the display? Use the *look for a pattern* strategy. (Lesson 2-8)

9-7 Problem-Solving Investigation

MAIN IDEA: Solve problems by using a graph.

Standard 7MR2.5 Use a variety of methods, such as words, numbers, symbols, charts, graphs, tables, diagrams, and models, **to explain mathematical reasoning. Standard 7SDAP1.2 Represent two numerical variables on a scatterplot and informally describe how the data points are distributed and any apparent relationship that exists between the two variables (e.g., between time spent on homework and grade level).**

P.S.I. TEAM +

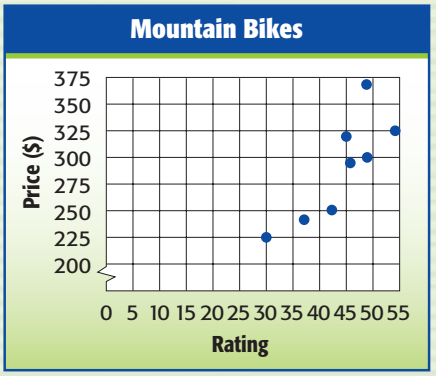
e-MAIL: USE A GRAPH

YOUR MISSION: Use a graph to solve the problem.

THE PROBLEM: Are the highest-rated bikes the most expensive?

JULIA: I am planning to buy a mountain bike. I found a graph with the ratings and the prices of 8 different bikes.

EXPLORE	You want to know whether the highest-rated bikes are the most expensive.
PLAN	Study the graph.
SOLVE	The graph shows that the highest-rated bike is *not* the most expensive bike. Also, the prices of the two bikes with the second-highest rating vary considerably.
CHECK	Look at the graph. The dot farthest to the right is *not* the highest on the graph.



Analyze The Strategy

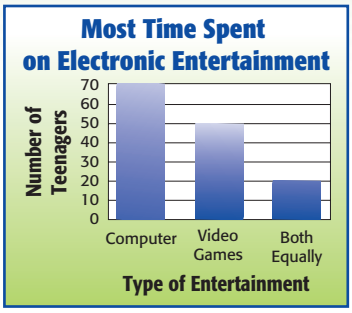
1. Explain why the bike represented by (48, 300) might be the best bike to buy.
2. Find a graph in a newspaper or magazine, or on the Internet. Write a sentence explaining the information contained in the graph.

Laura Sifferlin

Mixed Problem Solving

For Exercises 3 and 4, solve by using a graph.

3. **STATISTICS** Teenagers were asked which they spent more time using: their computer, their video game system, or both equally. The graph shows the results of the survey. How many teenagers were surveyed?



4. **STATISTICS** A zoologist studied extinction times in years of birds on an island. Make a graph of the data. Does the bird with the greatest average number of nests have the greatest extinction time?

Bird	Average Number of Nests	Extinction Time (yr)
Cuckoo	1.4	2.5
Magpie	4.5	10.0
Swallow	3.8	2.6
Robin	3.3	4.0
Stonechat	3.6	2.4
Blackbird	4.7	3.3
Tree Sparrow	2.2	1.9

Use any strategy to solve Exercises 5–8. Some strategies are shown below.

PROBLEM-SOLVING STRATEGIES
- Use the four-step plan.
- Look for a pattern.
- Use a graph.

5. **MONEY** Ming is towing a boat on the back of his minivan. Normally he gets 26 miles per gallon, but pulling the boat decreases his fuel consumption by 10 miles per gallon. If gasoline costs $2.75 per gallon, about how much more does a 520-mile trip cost to pull the boat?

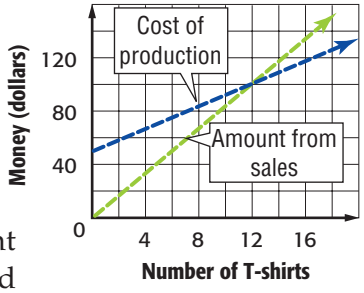
EDUCATION **For Exercises 6 and 7, use the table below.**

Students per Computer in U.S. Public Schools			
Year	Students	Year	Students
1991	20	1996	10
1992	18	1997	7.8
1993	16	1998	6.1
1994	14	1999	5.7
1995	10.5	2000	5.4

Source: National Center for Education Statistics

6. Make a graph of the data.
7. Describe how the number of students per computer changed from 1991 to 2000.

8. **ALGEBRA** The blue line shows the cost of producing T-shirts. The green line shows the amount of money received from the sale of the T-shirts. How many shirts must be sold to make a profit?



Select the Operation

For Exercises 9 and 10, select the appropriate operation(s) to solve the problem. Justify your selection(s) and solve the problem.

9. **COLLEGE** Caton's big brother has a full scholarship for tuition, books, and room and board for four years of college. The total scholarship is $87,500. Room and board cost $9,500 per year. His books cost about $750 per year. What is the cost of his yearly tuition?

10. **STATISTICS** The results of a survey showed that 34% of eighth graders wanted to take an extra language class. The school's policy says that there must be at least 32 students interested in the class. If 105 eighth graders were surveyed, is this enough students for an extra language class?

9-8 Scatter Plots

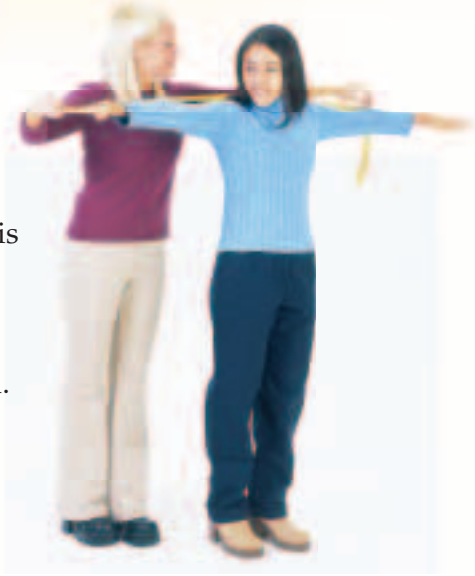
Main IDEA

Construct and interpret scatter plots.

Standard 7SDAP1.2 **Represent two numerical variables on a scatterplot and informally describe how the data points are distributed and any apparent relationship that exists between the two variables (e.g., between time spent on homework and grade level).**

MINI Lab

Measure a partner's height in inches. Then ask your partner to stand with his or her arms extended parallel to the floor. Measure the distance from the end of the longest finger on one hand to the longest finger on the other hand. Write these measures as the ordered pair (height, arm span) on the board.



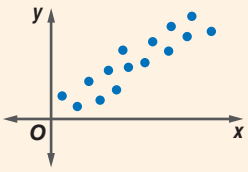
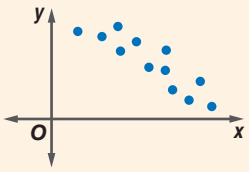
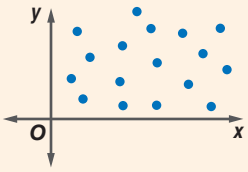
1. Graph each of the ordered pairs listed on the board.
2. Examine the graph. Do you think there is a relationship between height and arm span? Explain.

NEW Vocabulary

scatter plot
line of fit

A **scatter plot** is a graph that shows the relationship between two sets of data. In this type of graph, two sets of data are graphed as ordered pairs on a coordinate plane. Scatter plots often show a pattern, trend, or relationship between the variables.

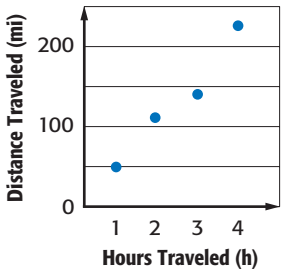
CONCEPT Summary — Types of Relationships

Positive Relationship	Negative Relationship	No Relationship
		
As x increases, y increases.	As x increases, y decreases.	No obvious pattern

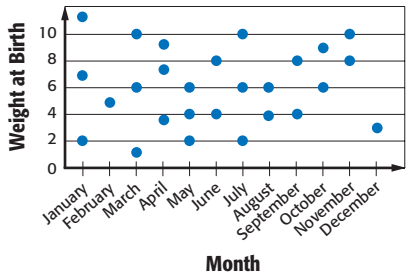
EXAMPLES Identify a Relationship

1 **Explain whether the scatter plot of the data for the hours traveled in a car and the distance traveled shows a *positive*, *negative*, or *no* relationship.**

As the number of hours you travel increases, the distance traveled increases. Therefore, the scatter plot shows a positive relationship.



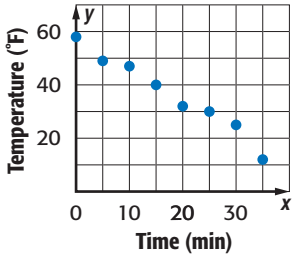
2 **Explain whether the scatter plot of the data for the month of birth and birth weight show a *positive*, *negative*, or *no* relationship.**



Birth weight does not depend on the month of birth. Therefore, the scatter plot shows no relationship.

CHECK Your Progress

a. Explain whether the scatter plot of the data for time and temperature shows a *positive*, *negative*, or *no* relationship.



Real-World Link
The Great Lakes (Superior, Michigan, Huron, Erie, and Ontario) and their connecting waterways form the largest inland water transportation system in the world.
Source: *The World Book*

A **line of fit** is a line that is very close to most of the data points.

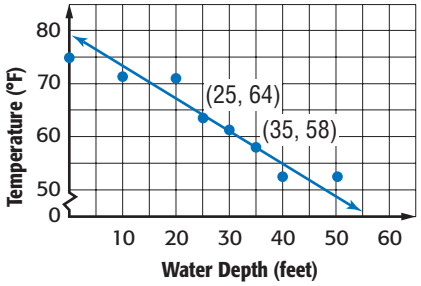
EXAMPLES Line of Fit

LAKES **The water temperatures at various depths in a lake are given.**

Water Depth	0	10	20	25	30	35	40	50
Temperature (°F)	75	72	71	64	61	58	53	53

3 **Make a scatter plot using the data. Then draw a line that best seems to represent the data.**

Graph each of the data points. Draw a line that fits the data.



STUDY TIP

Estimation Drawing a line of fit using the method in this lesson is an estimation. Therefore, it is possible to draw different lines to approximate the same data.

4 **Write an equation for this line of fit.**

The line passes through points at (25, 64) and (35, 58). Use these points to find the slope, or rate of change, of the line.

$m = \frac{y_2 - y_1}{x_2 - x_1}$ Definition of slope

$m = \frac{58 - 64}{35 - 25}$ $(x_1, y_1) = (25, 64)$, $(x_2, y_2) = (35, 58)$

$m = \frac{-6}{10}$ or $-\frac{3}{5}$ The slope is $-\frac{3}{5}$, and the y-intercept is 79.

The y-intercept is 79 because the line of fit crosses the y-axis at about the point (0, 79).

$y = mx + b$ Slope-intercept form

$y = -\frac{3}{5}x + 79$

The equation for the line of fit is $y = -\frac{3}{5}x + 79$.

5 **Use the equation to predict the temperature at a depth of 55 feet.**

$y = -\frac{3}{5}x + 79$ Equation for the line of fit

$y = -\frac{3}{5}(55) + 79$ or 46 The temperature will be about 46°F.

CHECK Your Progress

EDUCATION **The approximate numbers of high school graduates in Texas over a 10-year period are shown in the table.**

Graduating Class	Number of Graduates	Graduating Class	Number of Graduates
1994	163,000	1999	203,000
1995	169,000	2000	213,000
1996	172,000	2001	215,000
1997	182,000	2002	225,000
1998	197,000	2003	238,000

Source: Texas Education Agency

b. Make a scatter plot of the data. Then draw a line that represents the data.

c. Write an equation for a line of fit.

d. Use the equation to predict the number of graduates for the graduating class of 2015.

Personal Tutor

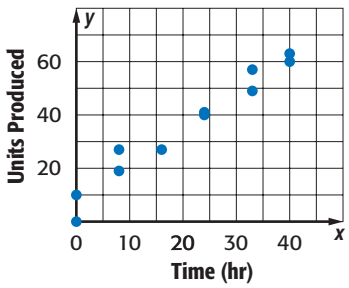
Personal Tutor at ca.gr7math.com

CHECK Your Understanding

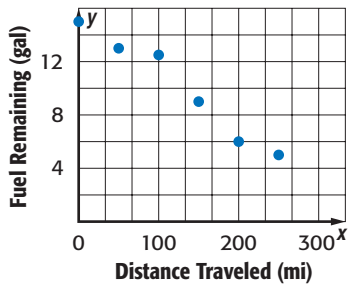
Examples 1, 2 (pp. 504–505)

Explain whether the scatter plot of the data for each of the following shows a *positive*, *negative*, or *no* relationship.

1.



2.



Examples 3–5 (pp. 505–506)

EDUCATION **For Exercises 3–5, use the table.**

Enrollment in U.S. Public and Private Schools (millions)					
Year	Students	Year	Students	Year	Students
1900	15.5	1940	25.4	1980	41.7
1910	17.8	1950	25.1	1990	40.5
1920	21.6	1960	35.2	2000	46.9
1930	25.7	1970	45.6		

3. Draw a scatter plot for the data and draw a line of fit.

4. Write an equation for the line of fit.

5. Estimate the enrollment in public and private schools in 2010.

Extra Examples at ca.gr7math.com

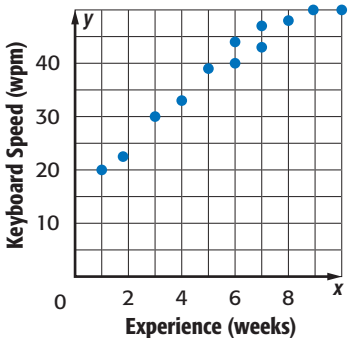
Exercises

HOMEWORK HELP

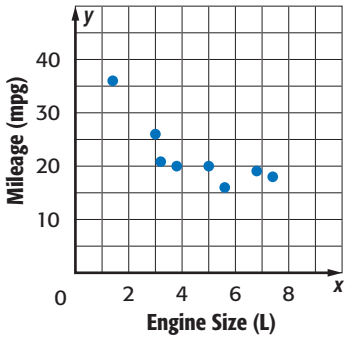
For Exercises	See Examples
6–9	1, 2
10–15	3–5

Explain whether the scatter plot of the data for each of the following shows a *positive*, *negative*, or *no* relationship.

6.



7.



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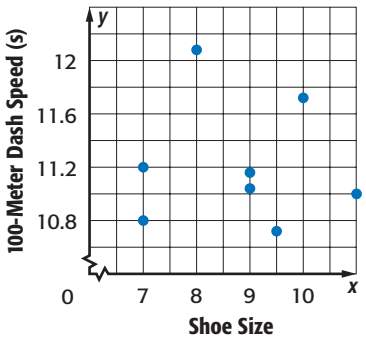
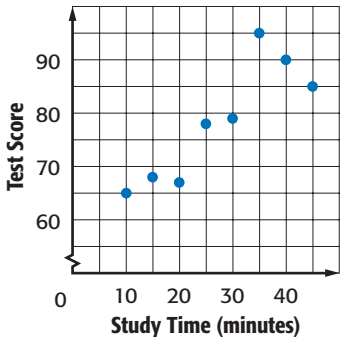


9.



FOOD **For Exercises 10–12, use the table at the right.**

10. Draw a scatter plot for the data. Then draw a line of fit.
11. Write an equation for the line of fit.
12. Use your equation to estimate the number of fat grams in a muffin with 350 Calories.

Nutritional Information of Commercial Muffins

Muffin (brand)	Fat (grams)	Calories
A	2	250
B	3	300
C	4	260
D	14	410
E	15	390
F	10	300
G	18	430
H	23	480
I	20	490

LIFE EXPECTANCY **For Exercises 13–15, use the following table.**

Year Born	1900	1910	1920	1930	1940	1950	1960	1970	1980	1990	1999	2000
Life Expectancy	47.3	50.0	54.1	59.7	62.9	68.2	69.7	70.8	73.7	75.4	76.7	77.1

Source: U.S. Census Bureau

13. Draw a scatter plot for the data. Then draw a line that seems to best fit the data.
14. Write an equation for your line of fit.
15. Use the equation to predict the life expectancy for a person born in 2020.

Explain whether a scatter plot of the data for each of the following would show a *positive*, *negative*, or *no* relationship.

16. length of a side of a square and perimeter of the square
17. grade in school and number of pets
18. length of time for a shower and amount of water used
19. outside temperature and amount of heating bill

BASEBALL For Exercises 20–22, use the table at the right.

20. Make a scatter plot of the data to show the relationship between home runs and runs batted in.
21. Explain whether you can draw a line of fit to approximate the data.
22. Could you predict the number of runs batted in for a player if you are given the number of home runs hit by that player? Explain.

Player	Home Runs	Runs Batted In
A. Jones	51	128
A. Rodriguez	48	130
D. Ortiz	47	148
D. Lee	46	107
M. Ramirez	45	144
M. Teixeira	43	144
A. Pujols	41	117
A. Dunn	40	101
P. Konerko	40	100
R. Sexton	39	121

Source: mlb.com

23. **SCHOOL** Determine the relationship a scatter plot of the data might show. Explain.

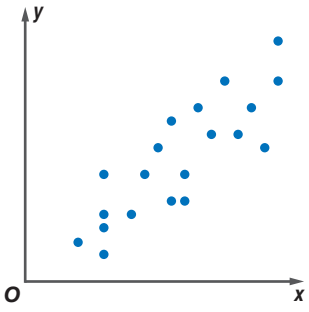
Week	1	2	3	4	5	6	7	8	9
Quiz Score	91	91	84	85	90	87	86	97	97

EXTRA PRACTICE
See pages 701, 716.
Math Online
Self-Check Quiz at ca.gr7math.com

24. **FIND THE DATA** Refer to the California Data File on pages 16–19. Choose some data and make a scatter plot with a line of fit. Use your graph to make predictions about unlisted data.

H.O.T. Problems

25. **OPEN ENDED** Give an example of data that could be represented by the scatter plot at the right.



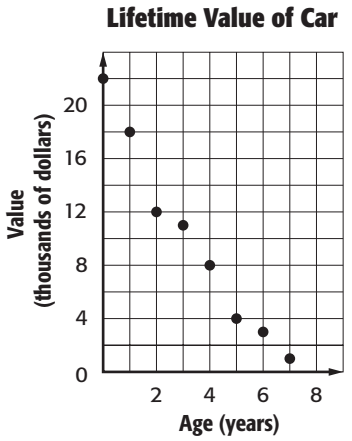
26. **NUMBER SENSE** Suppose a scatter plot shows that as the values of x decrease, the values of y decrease. Does the scatter plot show a *positive*, *negative*, or *no* relationship?
27. **CHALLENGE** Determine whether the following statement is *always*, *sometimes*, or *never* true. Justify your answer.

A scatter plot that shows a positive relationship suggests that the relationship is proportional.

28. **WRITING IN MATH** Explain why a scatter plot of skateboard sales and swimsuit sales for each month of the year might show a positive relationship. Does this mean that one factor caused the other? Explain.

STANDARDS PRACTICE

29. A car owner tracked the value of a car using a scatter plot.



Which description best represents the relationship of the car's value?

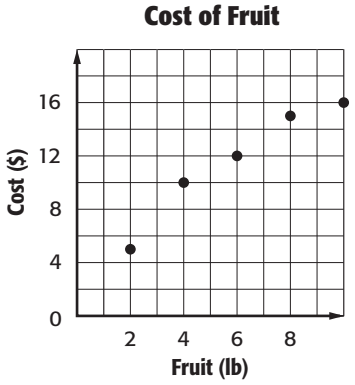
A negative trend

B no trend

C positive trend

D cannot be determined

30. The scatter plot shows the cost of fruit Franco bought from a produce stand in relation to the weight of the fruit.



Based on the information in the graph, which statement is a valid conclusion?

F As Franco bought more pieces of fruit, the cost of the fruit increased.

G As Franco bought fewer pieces of fruit, the cost of the fruit decreased.

H As Franco bought fewer pounds of fruit, the number of pieces of fruit decreased.

J As Franco bought more pounds of fruit, the cost of the fruit increased.

Spiral Review

CITIES **For Exercises 31–33, use the table.** (Lesson 9-7)

31. Make a graph of the data.

32. Describe how the population of Detroit, Michigan, changed from 1950 to 2000.

33. Which city had the greatest percent increase from 1950 to 2000?

34. **SPORTS** There are a total of 36 baseballs and softballs in a bin. There are 5 more softballs than baseballs. Write a system of equations that represents the situation. (Lesson 9-6)

Largest U.S. Cities		
City	2000	1950
New York, NY	8,010,000	7,890,000
Los Angeles, CA	3,690,000	1,970,000
Chicago, IL	2,900,000	3,620,000
Houston, TX	1,950,000	600,000
Philadelphia, PA	1,520,000	2,070,000
Phoenix, AZ	1,320,000	110,000
San Diego, CA	1,220,000	330,000
Dallas, TX	1,190,000	430,000
San Antonio, TX	1,150,000	410,000
Detroit, MI	950,000	1,850,000

Source: U.S. Census Bureau

Solve each equation. Check your solution. (Lesson 8-5)

35. $2x + 16 = 6x$

36. $4a - 9 = 7a + 6$

37. $5y - 1 = 3y + 11$

38. $n + 0.8 = -n + 1$

Extend 9-8

Graphing Calculator Lab
Scatter Plots

Main IDEA

Create scatter plots and calculate lines of fit using technology.

Standard 7SDAP1.2 **Represent two numerical variables on a scatter plot and informally describe how the data points are distributed and any apparent relationship that exists between the two variables (e.g., between time spent on homework and grade level).** **Standard 7MR2.5** **Use a variety of methods, such as** words, numbers, symbols, charts, **graphs,** tables, diagrams, and models, **to explain mathematical reasoning.**

A graphing calculator is useful for creating and analyzing scatter plots of large sets of data.

ACTIVITY

1 **LEISURE** **The tables give the weekly number of hours spent watching television and weekly number of hours spent exercising for each person in a survey. Make a scatter plot of the data.**

Weekly Television (h)	17	20	11	10	15	38	5	25
Weekly Exercise (h)	5	4.5	7.5	8	6.5	1	7.5	3

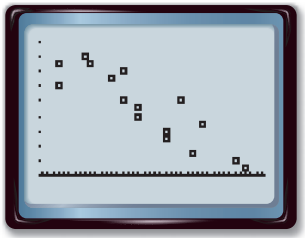
Weekly Television (h)	25	32	5	17	40	28	20	30
Weekly Exercise (h)	2.5	3.5	6	7	0.5	5	4	1.5

STEP 1 Clear the existing data by pressing STAT ENTER ▲ CLEAR ENTER.

STEP 2 Next enter the data. Input the number of weekly hours spent watching television in L1 and press ENTER. Then enter the weekly hours spent exercising in L2.

STEP 3 Turn on the statistical plot by pressing 2nd [STAT PLOT] ENTER ENTER Select the scatter plot and confirm L1 as the Xlist, L2 as the Ylist, and the square as the mark.

STEP 4 Graph the data by pressing ZOOM 9. Use the Trace feature and the left and right arrow keys to move from one point to another.



Analyze the Results

1. Describe how the data are related. Explain your reasoning.

MathOnline **Other Calculator Keystrokes at** ca.gr7math.com

2. **WEATHER** Use a graphing calculator to make a scatter plot of the following weather data. Store the data in L3 and L4 and use Plot 2 to create the graph. Then determine whether the data have a *positive*, *negative*, or *no relationship*. Explain your reasoning.

Average Monthly Temperature (°F)	77	42	45	55	57	63	76	65
Average Monthly Rainfall (in.)	6.0	4.8	7	3.2	6.8	4.8	5.7	7.2

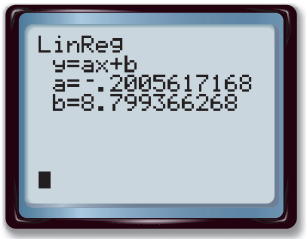
Average Monthly Temperature (°F)	67	73	51	81	84	86	64	43
Average Monthly Rainfall (in.)	2.6	5.5	5.9	6.3	7.9	4.2	6.3	4.5

ACTIVITY

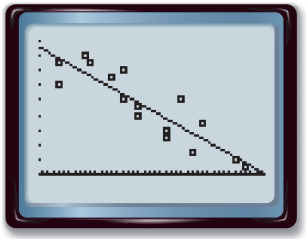
2 LEISURE **Find and graph a line of fit for the data in Activity 1.**

STEP 1 Access the CALC menu by pressing STAT ▶.

STEP 2 Select 4 to find a line of fit in the form $y = ax + b$. Press 2nd [L1] , 2nd [L2] ENTER to find a line of fit for the data in lists L1 and L2.



STEP 3 Graph the line of fit in Y1 by pressing Y= and then VARS 5 to access the **Statistics**… menu. Use the ▶ and ENTER keys to select **EQ** and then press 1 to select **RegEQ**, the line of fit equation. Finally, press GRAPH.



Analyze the Results

3. **MAKE A PREDICTION** Use the TRACE feature to predict the average number of hours of exercise someone who watches 35 hours of television would get.

4. **COLLECT THE DATA** Collect a set of data that can be represented in a scatter plot. Enter the data in a graphing calculator. Determine whether the data have a *positive*, *negative*, or *no relationship*. Then use the calculator to find a line of fit and to make a prediction.

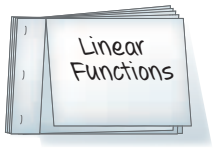
CHAPTER 9

Study Guide and Review

Download Vocabulary Review from ca.gr7math.com

FOLDABLES Study Organizer — GET READY to Study

Be sure the following Key Concepts are noted in your Foldable.



Key Concepts

Functions (Lessons 9-1 and 9-2)

- A function is a relationship in which one value is dependent upon another.
- Functions can be represented by words, equations, tables, ordered pairs, and graphs.

Slope (Lesson 9-3)

- The slope m of a line passing through points (x_1, y_1) and (x_2, y_2) is the ratio of the difference in the y-coordinates to the corresponding difference in the x-coordinates.

Direct Variation (Lesson 9-4)

- A direct variation is a relationship in which the ratio of y to x is a constant, k.

Slope-Intercept Form (Lesson 9-5)

- An equation written in slope-intercept form is written as $y = mx + b$.
- When an equation is written in slope-intercept form, m is the slope and b is the y-intercept.

Systems of Equations (Lesson 9-6)

- Two equations together are called a system of equations.

Scatter Plots (Lesson 9-8)

- In a positive relationship, x increases and y increases.
- In a negative relationship, x increases and y decreases.
- In a no relationship, no obvious pattern exists between x and y.

Key Vocabulary

- constant of variation (p. 483)
- direct variation (p. 483)
- domain (p. 466)
- function (p. 465)
- function table (p. 466)
- linear function (p. 472)
- line of fit (p. 505)
- range (p. 466)
- rise (p. 477)
- run (p. 477)
- scatter plot (p. 504)
- slope (p. 477)
- slope-intercept form (p. 491)
- system of equations (p. 498)
- y-intercept (p. 491)

Vocabulary Check

Choose the correct term or number to complete each sentence.

1. The (domain, range) is the set of input values of a function.
2. The range is the set of (input, output) values of a function.
3. A relationship where one thing depends on another is called a (function, slope).
4. A (scatter plot, function table) is a graph that shows the relationship between two sets of data.
5. The (x-intercept, y-intercept) has the coordinates $(0, b)$.
6. The slope formula is $\left(\frac{y_2 - y_1}{x_2 - x_1}, \frac{x_2 - x_1}{y_2 - y_1}\right)$.
7. A line that is very close to most of the data points in a scatter plot is called a (line of fit, y-intercept).
8. The (rise, run) is the vertical change between two points on a line.
9. A(n) (dependent, independent) variable is the variable for the output of a function.

MathOnline Vocabulary Review at ca.gr7math.com

Lesson-by-Lesson Review

9-1 Functions (pp. 465–469)

Find each function value.

10. $f(3)$ if $f(x) = 3x + 1$
11. $f(-11)$ if $f(x) = -2x$
12. $f(2)$ if $f(x) = \frac{1}{2}x - 4$
13. **FITNESS** Wilson's Fitness Club charges \$20 for a membership fee plus \$28 a month. Write a function to represent the cost c for n months. How much would it cost if you belonged to the club for 9 months?
14. Complete the function table for $f(x) = 3x + 2$. Then state the domain and the range of the function.

x	$3x + 2$	y
−2		
0		
1		
5		

Example 1 Complete the function table for $f(x) = 2x - 1$. Then state the domain and range of the function.

x	$2x - 1$	$f(x)$
−2	$2(-2) - 1$	−5
0	$2(0) - 1$	−1
1	$2(1) - 1$	1
5	$2(5) - 1$	9

Domain: {−2, 0, 1, 5}
Range: {−5, −1, 1, 9}

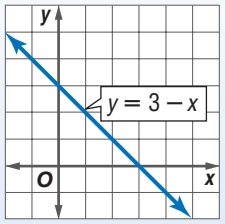
9-2 Representing Linear Functions (pp. 471–476)

Graph each function.

15. $y = -2x + 1$
16. $y = \frac{1}{2}x - 2$
17. **MEASUREMENT** The function $y = 4x$ represents the perimeter y of a square with sides x units long. Graph the function.
18. **CANDY** A regular fruit smoothie x costs \$1.50, and a large fruit smoothie y costs \$3. Graph the function $1.5x + 3y = 12$ to determine how many of each type of fruit smoothie Lisa can buy with \$12.

Example 2 Graph $y = 3 - x$.

x	$3 - x$	y	(x, y)
−1	$3 - (-1)$	4	(−1, 4)
0	$3 - 0$	3	(0, 3)
2	$3 - 2$	1	(2, 1)
3	$3 - 3$	0	(3, 0)



CHAPTER 9

Study Guide and Review

9-3 Slope (pp. 477–482)

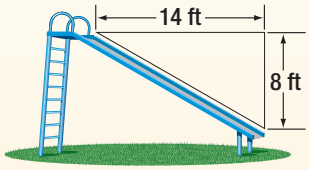
Find the slope of each line that passes through each pair of points.

19. $A(-2, 3)$, $B(-1, 5)$

20. $G(6, 2)$, $H(1, 5)$

21. $Q(2, 1)$, $R(3, -5)$

22. **SLIDES** Find the slope of a slide that descends 8 feet for every horizontal change of 14 feet.



23. **ANIMALS** A lizard is crawling up a hill that rises 5 feet for every horizontal change of 30 feet. Find the slope of the hill.

Example 3 **Find the slope of the line that passes through $A(-3, 2)$ and $B(5, -1)$.**

$m = \frac{y_2 - y_1}{x_2 - x_1}$ Definition of slope

$m = \frac{-1 - 2}{5 - (-3)}$ $(x_1, y_1) = (-3, 2)$, $(x_2, y_2) = (5, -1)$

$m = \frac{-3}{8}$ or $-\frac{3}{8}$ Simplify.

9-4 Direct Variation (pp. 483–488)

24. **TIME** It takes Gabriella 4 hours to knit 6 scarves. Assuming that the number of scarves made varies directly as the time spent knitting, how many scarves will she make in 6 hours?

25. **MONEY** Josiah spent $15.60 on 3 comic books. The next time, he spent $10.40 on 2 comic books. What is the cost for each comic book?

26. **FRUIT** The cost of peaches varies directly with the number of pounds bought. If 3 pounds of peaches cost $4.50, find the cost of 5.5 pounds.

Example 4 **Mrs. Dimas paid $6.48 for 8 apples. The next weekend, she paid $9.72 for 12 apples. What is the cost of each apple?**

$\frac{\$6.48}{8 \text{ apples}}$ or $\frac{\$0.81}{1 \text{ apple}}$ $\frac{\$9.72}{12 \text{ apples}}$ or $\frac{\$0.81}{1 \text{ apple}}$

So, each apple costs $0.81.

Mixed Problem Solving
For mixed problem-solving practice, see page 716.

9-5 Slope-Intercept Form (pp. 491–495)

State the slope and y-intercept for the graph of each equation.

27. $y = 2x + 5$
28. $y = -\frac{1}{5}x + 6$
29. $y - 4x = 7$
30. $3x + y = -2$

31. **MONEY** Malik had \$100 in his savings account. He plans to add \$25 each week. The equation for the amount of money y Malik has in his savings account is $y = 100 + 25x$, where x is the number of weeks. Graph the equation.

32. **BIRDS** The altitude in feet y of an albatross that is slowly landing can be given by $y = 400 - 100x$, where x represents the time in minutes. State the slope and y-intercept of the graph of the equation and describe what they represent.

Example 5 **State the slope and y-intercept of the graph of $y = -\frac{1}{2}x + 3$.**

$y = -\frac{1}{2}x + 3$ Write the equation.

$y = mx + b$

The slope of the graph is $-\frac{1}{2}$, and the y-intercept is 3.

9-6 Writing Systems of Equations and Inequalities (pp. 498–501)

33. **FOOD** Twenty-five teenagers were surveyed. There were six more who preferred pizza than preferred steak. Write a system of equations that represents this situation.

34. **CELL PHONES** Sheryl is considering two different cell phone plans. The first plan costs \$19 per month plus \$0.10 per minute. The second plan costs \$0.15 per minute with no monthly base fee. Write a system of equations that represents the total cost of these two plans.

35. **RATES** A video rental store offers two plans. Plan 1 charges a basic fee plus \$1.25 per day. Plan 2 charges twice the basic fee and \$0.50 per day. If a customer wants to spend less than \$7.50, write a system of inequalities representing each situation.

Example 6 **There are seven more red fruit pops in a bag than orange ones. There are 53 fruit pops in the bag. Write a system of equations to represent the number of fruit pops.**

Let r = red fruit pops and g = orange fruit pops.

$r + g = 53$ There is a total of 53 fruit pops.

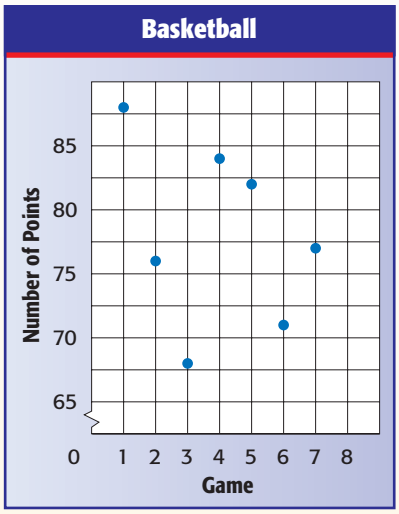
$r = g + 7$ There are 7 more red fruit pops than orange.

CHAPTER 9

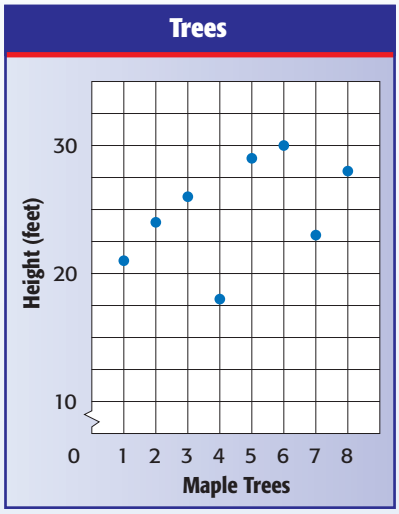
Study Guide and Review

9-7 PSI: Use a Graph (pp. 502–503)

36. **BASKETBALL** The graph shows the number of points scored in the first seven basketball games. What is the average number of points scored so far this season?



Example 7 **The graph shows the heights of maple trees. Find the average height of the trees. Round to the nearest tenth.**



Add the heights: 21 + 24 + 26 + 18 + 29 + 30 + 23 + 28 or 199

Divide: $\frac{199}{8}$ or 24.9

So, the average height is 24.9 feet.

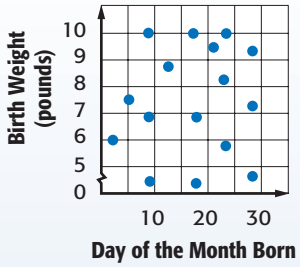
9-8 Scatter Plots (pp. 504–509)

Determine whether a scatter plot of the data for the following might show a *positive*, *negative*, or *no* relationship.

37. day of the week and temperature
38. child's age and grade level in school
39. temperature outside and amount of clothing
40. **ATTENDANCE** Use the table to draw a scatter plot and a line of fit for the data.

Volleyball Game	1	2	3	4	5	6	7
Number of Students	28	30	37	35	36	39	40

Example 8 **Determine whether the graph at the right shows a *positive*, *negative*, or *no* relationship.**



Since there is no obvious pattern, there is no relationship.

CHAPTER 9

Practice Test

Find each function value.

1. $f(3)$ if $f(x) = -2x + 6$
2. $f(0)$ if $f(x) = 3x - 1$
3. $f(-2)$ if $f(x) = \frac{x}{2} + 5$
4. **JOBS** The amount Jerri earns working is directly proportional to the time she works. If she earns \$187.50 after working 25 hours, how much will she earn working 30 hours?
5. **RAIN** By 6 P.M., 3 inches of rain had fallen. For the next 3 hours, 0.5 inch of rain fell per hour. How many inches fell by 9 P.M.?

Graph each function.

6. $y = -2x + 5$
7. $y = \frac{1}{3}x - 1$

Find the slope of the line that passes through each pair of points.

8. $A(-2, 5), B(-2, 1)$
9. $E(2, -1), F(5, -3)$
10. **STANDARDS PRACTICE** Rico planted 18 flowers in 30 minutes. At the same rate, how many flowers would he plant in 55 minutes?

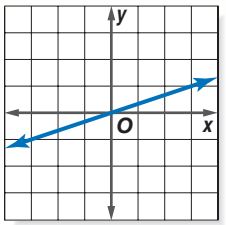
    A 30 **B** 33 **C** 36 **D** 38

CHILD CARE For Exercises 11–13, use the following information.

The cost per child at a day care center is \$35 a day plus a registration fee of \$50. The cost c for d days of child care is $c = 35d + 50$.

11. Graph the equation to find the cost for 5 days.
12. What do the slope and y-intercept represent?
13. Is the cost proportional to the number of days? Explain.
14. **MONEY** Robert has 26 coins that are all nickels and dimes. The value of the coins is \$1.85. Write a system of equations that represents this situation.
15. **STANDARDS PRACTICE** Which is the graph of $y = -3x$?

F



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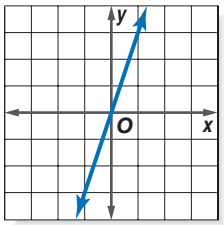

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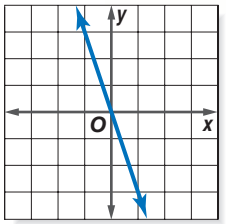
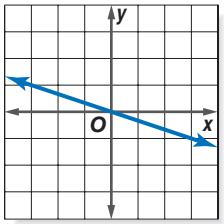


J



SALES For Exercises 16 and 17, use the table.

New Customers			
Month	Customers	Month	Customers
Jan	542	Jul	631
Feb	601	Aug	620
Mar	589	Sep	723
Apr	610	Oct	754
May	648	Nov	885
June	670	Dec	1,027

16. Make a graph of the data.
17. Describe how the number of new customers changed from January to December.

TRAVEL For Exercises 18–20, use the table.

Distance (mi)	50	100	150	200	250
Gas (gal)	2	6	8	15	18

18. Draw a scatter plot for the data and draw a line of fit.
19. Write an equation for the line of fit.
20. Use your equation to estimate the amount of gas needed to travel 375 miles.

CHAPTER 9

California Standards Practice

Cumulative, Chapters 1–9

Read each question. Then fill in the correct answer on the answer document provided by your teacher or on a sheet of paper.

1 A pattern of equations is shown below. Which statement best describes this pattern of equations?

80% of 62.5 is 50
40% of 125 is 50
20% of 250 is 50
10% of 500 is 50

A When the percent is halved and the other number is doubled, the answer is 50.

B When the percent is halved and the other number is halved, the answer is 50.

C When the percent is increased by 2 and the other number remains the same, the answer is 50.

D When the percent remains the same and the other number is increased by 2, the answer is 50.

2 The area of a square is 20 square inches. Which best represents the length of a side of the square?

F 4.5 inches

G 5 inches

H 10 inches

J 11 inches

3 Beth's monthly charge for Internet access c can be found using the equation $c = 12 + 2.50h$, where h represents the number of hours of usage during a month. What is the total charge for a month in which Beth used the Internet for 9 hours?

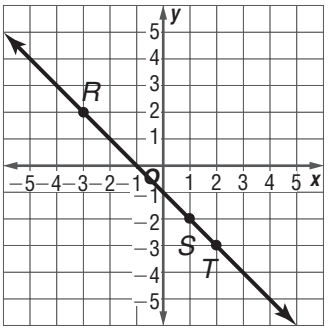
A \$39.95

B \$34.50

C \$27.00

D \$22.50

4 Which statement is true about the slope of line $\overleftrightarrow{RT}$?



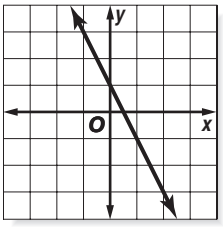
F The slope is the same between any two points.

G The slope between point R and point S is greater than the slope between point S and point T.

H The slope between point R and point T is greater than the slope between point S and point T.

J The slope is positive.

5 The graph of the line $y = -2x + 1$ is shown below. Which table of ordered pairs contains only points on this line?



A

x	−2	−1	0
y	5	3	−1

B

x	−2	−1	0
y	3	1	−1

C

x	−1	0	1
y	−3	−1	1

D

x	−1	0	1
y	3	1	−1

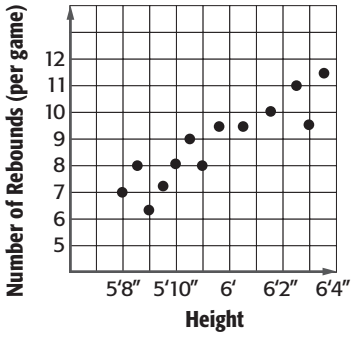
6 A truck used 6.3 gallons of gasoline to travel 107 miles. How many gallons of gasoline would it need to travel an additional 250 miles?

F 8.4 gal
G 14.7 gal
H 18.9 gal
J 21.0 gal

TEST-TAKING TIP

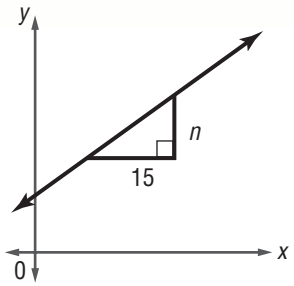
Question 6 When working with units of measurement, remember to write the units to ensure that the numbers are compared correctly.

7 Which of the following conclusions about the number of rebounds per game and the height of a player is best supported by the scatter plot below?



A The number of rebounds increases as the player's height decreases.
B The number of rebounds is unchanged as the player's height increases.
C The number of rebounds increases as the player's height increases.
D There is no relationship between the number of rebounds and the player's height.

8 The slope of the line shown below is $\frac{4}{5}$.



What is the value of n?

F 4
G 8
H 12
J 16

Pre-AP

Record your answers on a sheet of paper. Show your work.

9 Study the data in the table.

Date	Number of Customers	Scoops Sold
June 1	75	100
June 2	125	230
June 3	350	460
June 4	275	370
June 5	175	300
June 6	225	345
June 7	210	325

a. What type of display would be most appropriate for this data?
b. Graph the data.
c. Describe the relationship of the data.

NEED EXTRA HELP?									
If You Missed Question...	1	2	3	4	5	6	7	8	9
Go to Lesson...	2-8	3-2	9-1	9-3	9-5	9-8	4-3	9-3	9-8
For Help with Standard...	MR1.1	NS2.4	MR2.5	AF3.3	AF3.3	AF4.2	SDAP1.2	AF3.3	SDAP1.2