2.4 Exercise Set

FOR EXTRA HELP MyMathLab MathXL PRACTICE WATCH DOWNLOAD READ REVIEW

Concept Reinforcement *Classify each of the following statements as either true or false.*

1. The equation $y - 5 = -3(x - 7)$ is written in point–slope form. True
2. The equation $y = -2x + 6$ is written in point–slope form. False
3. Knowing the coordinates of just one point on a line is enough to write an equation of the line. False
4. Knowing the coordinates of just two points on a line is enough to write an equation of the line. True
5. The point–slope form gives enough information to graph the line. True
6. The equations $y = 3x - 5$ and $3x - y = 5$ describe the same line. True
7. Point–slope form can be used with either point that is used to calculate the slope of that line. True
8. There are situations for which point–slope form is more convenient to use than slope–intercept form. True
9. We use interpolation to predict a value that extends beyond known values. False
10. Linear regression is used to fit an equation to data. True

Find an equation in point–slope form of the line having the specified slope and containing the point indicated. Then graph the line.

11. $m = 3$, $(5, 2)$ ⊡
12. $m = 2$, $(3, 4)$ ⊡
13. $m = -4$, $(1, 2)$ ⊡
14. $m = -5$, $(1, 4)$ ⊡
15. $m = \frac{1}{2}$, $(-2, -4)$ ⊡
16. $m = 1$, $(-5, -7)$ ⊡
17. $m = -1$, $(8, 0)$ ⊡
18. $m = -3$, $(-2, 0)$ ⊡

For each point–slope equation listed, state the slope and a point on the graph.

19. $y - 3 = \frac{1}{4}(x - 5)$ ⊡
20. $y - 5 = 6(x - 1)$ ⊡
21. $y + 1 = -7(x - 2)$ ⊡
22. $y - 4 = -\frac{2}{3}(x + 8)$ ⊡
23. $y - 6 = -\frac{10}{3}(x + 4)$ ⊡
24. $y + 1 = -9(x - 7)$ ⊡
25. Aha! $y = 5x$ 5; $(0, 0)$
26. $y = \frac{4}{5}x$ $\frac{4}{5}$; $(0, 0)$

⊡ Answers to Exercises 11–24, 27–36, and 45 are on pp. IA-5 and IA-6.

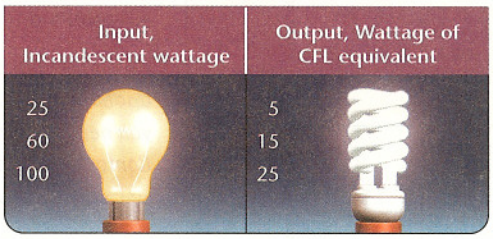
Find an equation of the line having the specified slope and containing the indicated point. Write your final answer as a linear function in slope–intercept form. Then graph the line.

27. $m = 2$, $(1, -4)$ ⊡
28. $m = -4$, $(-1, 5)$ ⊡
29. $m = -\frac{3}{5}$, $(-4, 8)$ ⊡
30. $m = -\frac{1}{5}$, $(-2, 1)$ ⊡
31. $m = -0.6$, $(-3, -4)$ ⊡
32. $m = 2.3$, $(4, -5)$ ⊡
33. Aha! $m = \frac{2}{7}$, $(0, -6)$ ⊡
34. $m = \frac{1}{4}$, $(0, 3)$ ⊡
35. $m = \frac{3}{5}$, $(-4, 6)$ ⊡
36. $m = -\frac{2}{7}$, $(6, -5)$ ⊡

Find an equation of the line containing each pair of points. Write your final answer as a linear function in slope–intercept form.

37. $(2, 3)$ and $(3, 7)$ $f(x) = 4x - 5$
38. $(3, 8)$ and $(1, 4)$ $f(x) = 2x + 2$
39. $(1.2, -4)$ and $(3.2, 5)$ $f(x) = 4.5x - 9.4$
40. $(-1, -2.5)$ and $(4, 8.5)$ $f(x) = 2.2x - 0.3$
41. Aha! $(2, -5)$ and $(0, -1)$ $f(x) = -2x - 1$
42. $(-2, 0)$ and $(0, -7)$ $f(x) = -\frac{7}{2}x - 7$
43. $(-6, -10)$ and $(-3, -5)$ $f(x) = \frac{5}{3}x$
44. $(-1, -3)$ and $(-4, -9)$ $f(x) = 2x - 1$

Energy-Saving Lightbulbs. *An energy bill signed into law in 2007 requires the United States to phase out standard incandescent lightbulbs. A more efficient replacement is the compact fluorescent (CFL) bulb. The table below lists incandescent wattage and the CFL wattage required to create the same amount of light.*
Source: U.S. Department of Energy



45. Use the data in the figure above to draw a graph. Estimate the wattage of a CFL bulb that creates light equivalent to that of a 75-watt incandescent bulb. Then predict the wattage of a CFL bulb that creates light equivalent to a 120-watt incandescent bulb. ⊡

46. Use the graph from Exercise 45 to estimate the wattage of a CFL bulb that creates light equivalent to that of a 40-watt incandescent bulb. Then predict the wattage of a CFL bulb that creates light equivalent to that of a 150-watt incandescent bulb. 9 watts; 38 watts

Blood Alcohol Level. *The data in the table below can be used to predict the number of drinks required for a person of a specified weight to be considered legally intoxicated (blood alcohol level of 0.08 or above). One 12-oz glass of beer, a 5-oz glass of wine, or a cocktail containing 1 oz of a distilled liquor all count as one drink. Assume that all drinks are consumed within one hour.*

12 oz 5 oz 1 oz

Input, Body Weight (in pounds)	Output, Number of Drinks
100	2.5
160	4
180	4.5
200	5

47. Use the data in the table above to draw a graph and to estimate the number of drinks that a 140-lb person would have to drink to be considered intoxicated. Then predict the number of drinks it would take for a 230-lb person to be considered intoxicated. ⊡

48. Use the graph from Exercise 47 to estimate the number of drinks that a 120-lb person would have to drink to be considered intoxicated. Then predict the number of drinks it would take for a 250-lb person to be considered intoxicated. 3 drinks; 6.5 drinks

In Exercises 49–60, assume that a constant rate of change exists for each model formed.

49. *Automobile Production.* The world's auto manufacturers had a production capacity of 84 million vehicles in 2008. This figure is projected to grow to 97 million vehicles in 2015. Let $a(t)$ represent world production capacity t years after 2000.
Source: PricewaterhouseCoopers

a) Find a linear function that fits the data. ⊡

b) Use the function from part (a) to predict the production capacity in 2013. ⊡

c) In what year will the world production capacity be 100 million vehicles? About 2017

50. *Convention Attendees.* In recent years, Las Vegas has become a popular location for conventions. The number of convention attendees in Las Vegas rose from 4.6 million in 2002 to 6.1 million in 2006. Let $v(t)$ represent the number of convention attendees in Las Vegas t years after 2000.
Source: Las Vegas Convention and Visitors Authority

a) Find a linear function that fits the data. ⊡

b) Use the function from part (a) to predict the number of convention attendees in Las Vegas in 2011. 7.975 million attendees

c) In what year will there be 8 million convention attendees in Las Vegas? About 2011

51. *Life Expectancy of Females in the United States.* In 1994, the life expectancy at birth of females was 79.0 years. In 2006, it was 80.2 years. Let $E(t)$ represent life expectancy and t the number of years since 1990.
Source: *Statistical Abstract of the United States,* 2010

a) Find a linear function that fits the data. ⊡

b) Use the function of part (a) to predict the life expectancy at birth of females in 2012. 80.8 yr

52. *Life Expectancy of Males in the United States.* In 1994, the life expectancy at birth of males was 72.4 years. In 2006, it was 75.1 years. Let $E(t)$ represent life expectancy and t the number of years since 1990.
Source: *Statistical Abstract of the United States,* 2010

a) Find a linear function that fits the data. ⊡

b) Use the function of part (a) to predict the life expectancy at birth of males in 2012. 76.45 yr

53. *Recycling.* In 2000, Americans recycled 53 million tons of solid waste. By 2008, the figure had grown to 61 million tons. Let $N(t)$ represent the number of tons recycled, in millions, and t the number of years since 2000.
Source: U.S. EPA $N(t) = t + 53$

a) Find a linear function that fits the data.

b) Use the function of part (a) to predict the amount recycled in 2012. 65 million tons

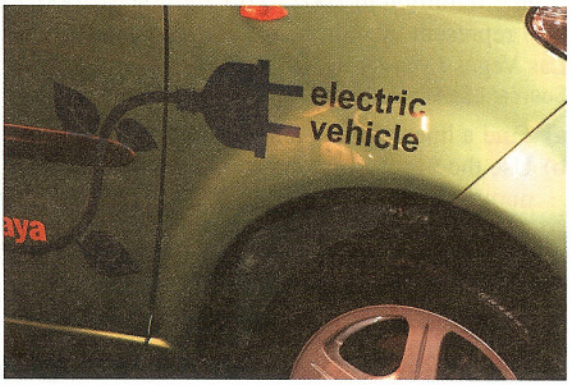
54. *PAC contributions.* In 2002, Political Action Committees (PACs) contributed $282 million to federal candidates. By 2008, the figure had risen to $412.8 million. Let $A(t)$ represent the amount of PAC contributions, in millions, and t the number of years since 2000.
Source: Federal Election Commission

a) Find a linear function that fits the data. ⊡

b) Use the function of part (a) to predict the amount of PAC contributions in 2012. $500 million

⊡ Answers to Exercises 47, 49(a), 49(b), 50(a), 51(a), 52(a), and 54(a) are on p. IA-6.

55. *Environmental Awareness.* The percentage of Americans who are familiar with the term "carbon footprint" grew from 38 percent in 2007 to 57 percent in July 2009. Let $C(t)$ represent the percentage of Americans who are familiar with the term "carbon footprint" and t the number of years since 2006.
Source: National Marketing Institute



a) Find a linear function that fits the data. ⊡
b) Predict the percentage of Americans who will be familiar with the term "carbon footprint" in 2012. ⊡
c) When will all Americans be familiar with the term "carbon footprint"? By 2014

56. *Medical Care.* In 2002, Medicaid long-term care expenses totaled $92 billion. This figure had risen to $109 billion by 2006. Let $M(t)$ represent Medicaid long-term care expenses, in billions of dollars, and t the number of years since 2000.
Source: Kaiser Commission on Medicaid and the Uninsured, Analysis of 2008 National Health Interview Survey data

a) Find a linear function that fits the data. ⊡
b) Predict the amount of Medicaid long-term care expenses in 2010. $126 billion
c) In what year will Medicaid long-term care expenses reach $150 billion? During 2015

57. *Online Banking.* In 2009, about 54 million American households conducted at least some of their banking online. That number is expected to rise to 66 million by 2014. Let $N(t)$ represent the number of American households using online banking, in millions, t years after 2000.
Source: Forrester Research $N(t) = 2.4t + 32.4$

a) Find a linear function that fits the data.
Aha! **b)** Use the function of part (a) to predict the number of American households that will use online banking in 2019. 78 million households
c) In what year will 100 million American households use online banking? 2028

58. *National Park Land.* In 1994, the National Park system consisted of about 74.9 million acres. By 2010, the figure had grown to 84 million acres. Let $A(t)$ represent the amount of land in the National Park systen in millions of acres, t years after 1990.
Source: U.S. National Park Service

a) Find a linear function that fits the data. ⊡
b) Use the function of part (a) to predict the amount of land in the National Park system in 2014. ⊡

59. *Records in the 100-Meter Run.* In 1999, the record for the 100-m run was 9.79 sec. In 2009, it was 9.58 sec. Let $R(t)$ represent the record in the 100-m run and t the number of years since 1999.
Sources: International Association of Athletics Federation; *Guinness World Records*

a) Find a linear function that fits the data. ⊡
b) Use the function of part (a) to predict the record in 2015 and in 2030. 9.454 sec; 9.139 sec
c) When will the record be 9.5 sec? 2013

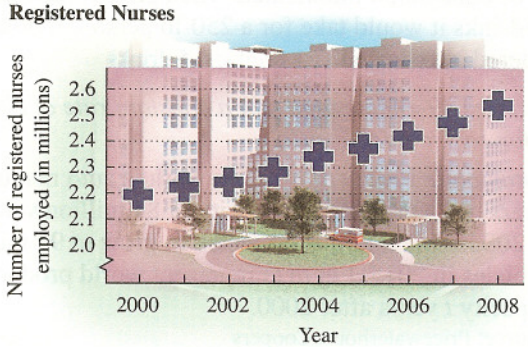
60. *Pressure at Sea Depth.* The pressure 100 ft beneath the ocean's surface is approximately 4 atm (atmospheres), whereas at a depth of 200 ft, the pressure is about 7 atm.

a) Find a linear function that expresses pressure as a function of depth. $P(d) = 0.03d + 1$
b) Use the function of part (a) to determine the pressure at a depth of 690 ft. 21.7 atm

Determine whether the data in each graph appear to be linear.

Linear

61. **Registered Nurses**



Source: Bureau of Labor Statistics, U.S. Department of Labor

⊡ Answers to Exercises 55(a), 55(b), 56(a), 58(a), 58(b), and 59(a) are on p. IA-6.

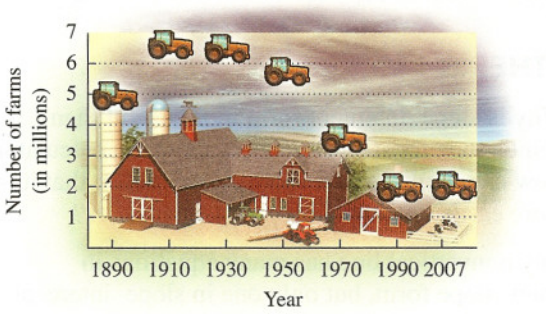
62. Holiday Shopping Linear

Source: comScore

63. Holiday Shopping Not linear

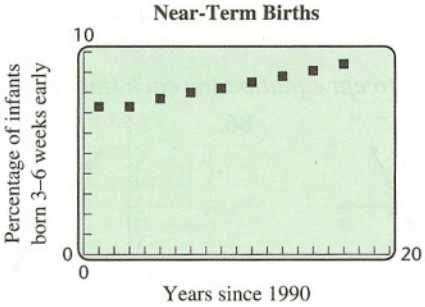
Source: Based on data from National Retail Federation

64. U.S. Farming Not linear



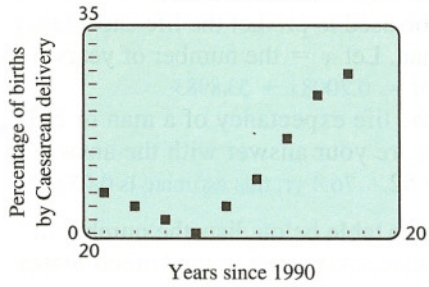
Source: U.S. Department of Agriculture

65. Linear



Source: U.S. Centers for Disease Control

66. Not linear



Source: U.S. Centers for Disease Control

67. *Life Expectancy of Females in the United States.* The table below lists the life expectancy at birth of women who were born in the United States in selected years.

Life expectancy of women

Year	Life Expectancy (in years)
1960	73.1
1970	74.4
1980	77.5
1990	78.8
2000	79.7
2006	80.2

Source: National Vital Statistics Reports

a) Use linear regression to find a linear equation that can be used to predict the life expectancy W of a woman. Let x = the number of years since 1900. $W = 0.1611x + 63.6983$

b) Predict the life expectancy of a woman in 2012 and compare your answer with the answer to Exercise 51. 81.7 yr; this estimate is 0.9 yr higher

68. *Life Expectancy of Males in the United States.* The table below lists the life expectancy of males born in the United States in selected years.

Life expectancy of men

Year	Life Expectancy (in years)
1960	66.6
1970	67.1
1980	70.0
1990	71.8
2000	74.4
2006	75.1

Source: National Vital Statistics Reports

a) Use linear regression to find a linear function that can be used to predict the life expectancy M of a man. Let x = the number of years since 1900. $M = 0.2008x + 53.8983$

b) Predict the life expectancy of a man in 2012 and compare your answer with the answer to Exercise 52. 76.4 yr; this estimate is 0.05 yr lower

69. *Nursing.* The table below lists the number of registered nurses employed in the United States for various years.

Year	Number of Registered Nurses Employed (in millions)
2000	2.19
2001	2.22
2002	2.24
2003	2.28
2004	2.34
2005	2.37
2006	2.42
2007	2.47
2008	2.54

Source: Bureau of Labor Statistics, U.S. Department of Labor

$N = 0.0433t + 2.1678$

a) Use linear regression to find a linear equation that can be used to predict the number N of registered nurses, in millions, employed t years after 2000.

b) Estimate the number of registered nurses employed in 2012. 2.69 million registered nurses

70. *Holiday Shopping.* The amount of money spent by online shoppers on "Cyber Monday," the Monday following Thanksgiving Day, is shown in the table below.

Year	Amount Spent on Cyber Monday (in millions)
2005	$486
2006	610
2007	730
2008	834
2009	887

Source: comScore

a) Use linear regression to find a linear equation that can be used to predict the amount spent A, in millions of dollars, on Cyber Monday x years after 2005. $A = 102.6x + 504.2$

b) Estimate the amount spent on Cyber Monday in 2011. $1119.8 million, or $1.1198 billion

TW **71.** Suppose that you are given the coordinates of two points on a line, and one of those points is the y-intercept. What method would you use to find an equation for the line? Explain the reasoning behind your choice.

TW **72.** On the basis of your answers to Exercises 51 and 52, would you predict that at some point in the future the life expectancy of males will exceed that of females? Why or why not?

SKILL REVIEW

To prepare for Section 2.5, review simplifying expressions and finding the domain of a function (Sections 1.3 and 2.1).

Simplify. [1.3]

73. $(2x^2 - x) + (3x - 5)$ $2x^2 + 2x - 5$

74. $(4t + 3) - (6t + 7)$ $-2t - 4$

75. $(2t - 1) - (t - 3)$ $t + 2$

76. $(5x^2 - 4) - (9x^2 - 7x)$ $-4x^2 + 7x - 4$

Find the domain of each function. [2.1]

77. $f(x) = \dfrac{x}{x - 3}$ ⊡

78. $g(x) = x^2 - 1$ $\mathbb{R}$

79. $g(x) = |6x + 11|$ $\mathbb{R}$

80. $f(x) = \dfrac{x - 7}{2x}$ ⊡

SYNTHESIS

TW **81.** Why is slope–intercept form more useful than point–slope form when using a graphing calculator? How can point–slope form be modified so that it is more easily used with graphing calculators?

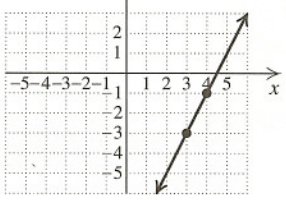
TW **82.** Any nonvertical line has many equations in point–slope form, but only one in slope–intercept form. Why is this?

Graph.

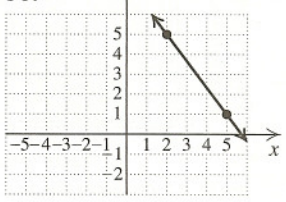
Aha! **83.** $y - 3 = 0(x - 52)$ ⊡ **84.** $y + 4 = 0(x + 93)$ ⊡

Write the slope–intercept equation for each line shown.

85. $y = 2x - 9$



86. $y = -\frac{4}{3}x + \frac{23}{3}$



⊡ Answers to Exercises 77, 80, 83, and 84 are on p. IA-6.

Write an equation of the line containing the specified point and parallel to the indicated line.

87. $(3, 7)$, $x + 2y = 6$ $y = -\frac{1}{2}x + \frac{17}{2}$

88. $(-1, 4)$, $3x - y = 7$ $y = 3x + 7$

Write an equation of the line containing the specified point and perpendicular to the indicated line.

89. $(2, 5)$, $2x + y = -3$ $y = \frac{1}{2}x + 4$

90. $(4, 0)$, $x - 3y = 0$ $y = -3x + 12$

91. For a linear function g, $g(3) = -5$ and $g(7) = -1$.

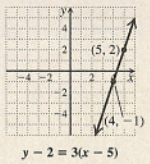
a) Find an equation for g. $g(x) = x - 8$

b) Find $g(-2)$. -10

c) Find a such that $g(a) = 75$. 83

Try Exercise Answers: Section 2.4

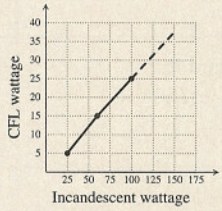
11.



$y - 2 = 3(x - 5)$

37. $f(x) = 4x - 5$

45. 19 watts; 30 watts

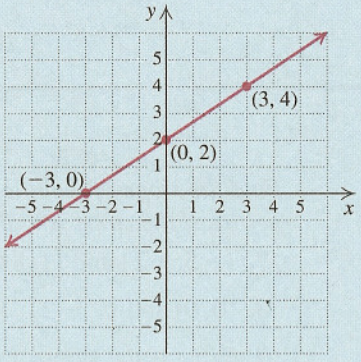


49. **(a)** $a(t) = \frac{13}{7}t + \frac{484}{7}$; **(b)** $93\frac{2}{7}$ million vehicles, or approximately 93.3 million vehicles; **(c)** about 2017

61. Linear **67.** **(a)** $W = 0.1611x + 63.6983$; **(b)** 81.7 yr; this estimate is 0.9 yr higher

Mid-Chapter Review

Any line can be described by a number of equivalent equations. For example, all four of the equations below describe the given line.



$y = \frac{2}{3}x + 2$,

$2x - 3y = -6$,

$y - 4 = \frac{2}{3}(x - 3)$,

$2x + 6 = 3y$

Form of a Linear Equation	Example	Uses
Slope–intercept form: $y = mx + b$ or $f(x) = mx + b$	$f(x) = \frac{1}{2}x + 6$	Finding slope and y-intercept Graphing using slope and y-intercept Writing an equation given slope and y-intercept Writing linear functions
Standard form: $Ax + By = C$	$5x - 3y = 7$	Finding x- and y-intercepts Graphing using intercepts Solving systems of equations (see Chapter 3)
Point–slope form: $y - y_1 = m(x - x_1)$	$y - 2 = \frac{4}{5}(x - 1)$	Finding slope and a point on the line Graphing using slope and a point on the line Writing an equation given slope and a point on the line or given two points on the line Working with curves and tangents in calculus

GUIDED SOLUTIONS

1. Find the y-intercept and the x-intercept of the graph of $y - 3x = 6$. [2.3]

Solution

y-intercept: $y - 3 \cdot \square = 6$

$y = \square$

The y-intercept is $(\square, \square)$.

x-intercept: $\square - 3x = 6$

$-3x = 6$

$x = \square$

The x-intercept is $(\square, \square)$.

y-intercept: $y - 3 \cdot 0 = 6$

$y = 6$

The y-intercept is $(0, 6)$.

x-intercept: $0 - 3x = 6$

$-3x = 6$

$x = -2$

The x-intercept is $(-2, 0)$.

2. Find the slope of the line containing the points $(1, 5)$ and $(3, -1)$. [2.2]

Solution

$$m = \frac{y_2 - y_1}{x_2 - x_1} = \frac{-1 - \square}{3 - \square} = \frac{\square}{2} = \square$$

$$m = \frac{y_2 - y_1}{x_2 - x_1} = \frac{-1 - 5}{3 - 1} = \frac{-6}{2} = -3$$

MIXED REVIEW

State whether each equation is in slope–intercept form, standard form, point–slope form, or none of these.

1. $2x + 5y = 8$ [2.3] Standard form

2. $y = \frac{2}{3}x - \frac{11}{3}$ [2.2] Slope–intercept form

3. $x - 13 = 5y$ [2.2], [2.3], [2.4] None of these

4. $y - 2 = \frac{1}{3}(x - 6)$ [2.4] Point–slope form

5. $x - y = 1$ [2.3] Standard form

6. $y = -18x + 3.6$ [2.2] Slope–intercept form

Find the slope of the line containing the given pair of points. If the slope is undefined, state this. [2.2]

7. $(-5, -2)$ and $(1, 8)$ $\frac{5}{3}$

8. $(0, 0)$ and $(0, -2)$ Undefined

9. What is the slope of the line $y = 4$? [2.3] 0

10. What is the slope of the line $x = -7$? [2.3] Undefined

11. Determine the slope and the y-intercept of the line given by $x - 3y = 1$. [2.2] ⊡

12. Find a linear function whose graph has slope -3 and y-intercept 7. [2.2] $f(x) = -3x + 7$

13. Find an equation in point–slope form of the line with slope 5 that contains the point $(-3, 7)$. [2.4] $y - 7 = 5(x - (-3))$

14. Find an equation in slope–intercept form of the line containing the points $(4, -1)$ and $(-2, -5)$. [2.4] $y = \frac{2}{3}x - \frac{11}{3}$

Graph.

15. $y = 2x - 1$ [2.2] ⊡

16. $3x + y = 6$ [2.3] ⊡

17. $y - 2 = \frac{1}{2}(x - 1)$ [2.4] ⊡

18. $f(x) = 4$ [2.3] ⊡

19. $f(x) = -\frac{3}{4}x + 5$ [2.2] ⊡

20. $3x = 12$ [2.3] ⊡

⊡ Answers to Exercises 11 and 15–20 are on p. IA-6.

2.5 The Algebra of Functions

- The Sum, Difference, Product, or Quotient of Two Functions
- Domains and Graphs

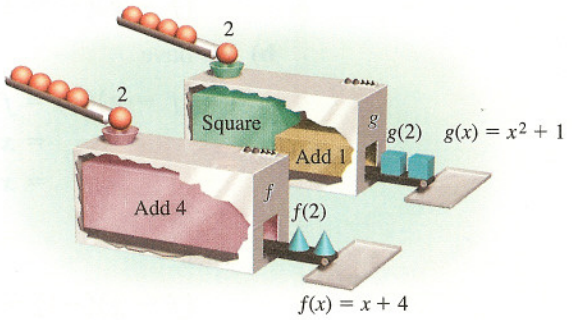
We now examine four ways in which functions can be combined.

THE SUM, DIFFERENCE, PRODUCT, OR QUOTIENT OF TWO FUNCTIONS

Suppose that a is in the domain of two functions, f and g. The input a is paired with $f(a)$ by f and with $g(a)$ by g. The outputs can then be added to get $f(a) + g(a)$.

EXAMPLE 1 Let $f(x) = x + 4$ and $g(x) = x^2 + 1$. Find $f(2) + g(2)$.

SOLUTION We visualize two function machines. Because 2 is in the domain of each function, we can compute $f(2)$ and $g(2)$.



Since

$$f(2) = 2 + 4 = 6 \quad \text{and} \quad g(2) = 2^2 + 1 = 5,$$

we have

$$f(2) + g(2) = 6 + 5 = 11.$$

Try Exercise 7.

STUDY TIP

Test Preparation

The best way to prepare for taking tests is by working consistently throughout the course. That said, here are some extra suggestions.

- Make up your own practice test.
- Ask your instructor or former students for old exams to practice on.
- Review your notes and all homework that gave you difficulty.
- Make use of the Study Summary, Review Exercises, and Test at the end of each chapter.