SOLUTION

a) The function f is defined using two different equations. To find $f(4)$, we must first determine whether to use the equation $f(x) = 2x$ or the equation $f(x) = x + 1$. To do this, we focus first on the two parts of the domain.

$$f(x) = \begin{cases} 2x, & \text{if } x < 0, \\ x + 1, & \text{if } x \geq 0. \end{cases}$$

4 is in the second part of the domain.

Since $4 \geq 0$, we use the equation $f(x) = x + 1$. Thus, $f(4) = 4 + 1 = 5$.

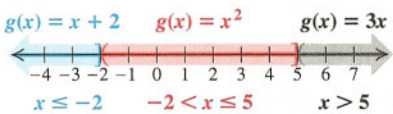
b) To find $f(-10)$, we first note that $-10 < 0$, so we must use the equation $f(x) = 2x$. Thus, $f(-10) = 2(-10) = -20$.

Try Exercise 113.

EXAMPLE 13 Find each function value for the function g given by

$$g(x) = \begin{cases} x + 2, & \text{if } x \leq -2, \\ x^2, & \text{if } -2 < x \leq 5, \\ 3x, & \text{if } x > 5. \end{cases}$$

a) $g(-2)$ **b)** $g(3)$ **c)** $g(7)$



SOLUTION It may help to visualize the domain on the number line.

a) To find $g(-2)$, we note that -2 is in the part of the domain that is shaded blue. Since $-2 \leq -2$, we use the first equation, $g(x) = x + 2$:

$$g(-2) = -2 + 2 = 0.$$

b) We note that 3 is in the part of the domain that is shaded red. Since $-2 < 3 \leq 5$, we use the second equation, $g(x) = x^2$:

$$g(3) = 3^2 = 9.$$

c) We note that 7 is in the part of the domain that is shaded gray. Since $7 > 5$, we use the last equation, $g(x) = 3x$:

$$g(7) = 3 \cdot 7 = 21.$$

Try Exercise 115.

2.1 Exercise Set

FOR EXTRA HELP MyMathLab MathXL PRACTICE WATCH DOWNLOAD READ REVIEW

Concept Reinforcement *Complete each of the following sentences.*

1. A function is a special kind of correspondence between two sets.
2. In any function, each member of the domain is paired with exactly one member of the range.
3. For any function, the set of all inputs, or first values, is called the domain.
4. For any function, the set of all outputs, or second values, is called the range.
5. When a function is graphed, members of the domain are located on the horizontal axis.
6. When a function is graphed, members of the range are located on the vertical axis.
7. The notation $f(3)$ is read "f of 3," "f at 3," or "the value of f at 3."
8. The vertical line test can be used to determine whether or not a graph represents a function.

Determine whether each correspondence is a function.

9.

2	a
4	b
6	c
8	d
10	

Yes

10.

3	9
6	8
9	7
12	6

No

11.

Girl's age (in months)	*Average daily weight gain (in grams)*
2	21.8
9	11.7
16	8.5
23	7.0

Yes

Source: *American Family Physician*, December 1993, p. 1435

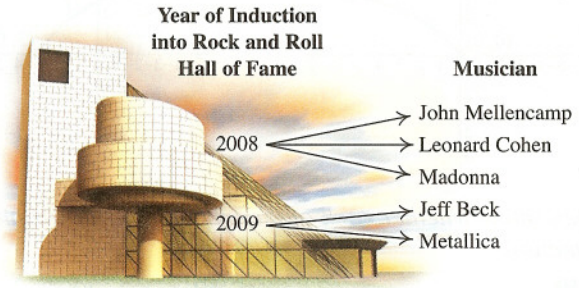
12.

Boy's age (in months)	*Average daily weight gain (in grams)*
2	24.8
9	11.7
16	8.2
23	7.0

Yes

Source: *American Family Physician*, December 1993, p. 1435

13.



Source: The Rock and Roll Hall of Fame and Museum, Inc. No

14.

Sources: www.leannesbirthdays.com/; and www.kidsparties.com Yes

15.

Predator	*Prey*
cat	dog
fish	worm
dog	cat
tiger	fish
bat	mosquito

Yes

16.

State	*Neighboring state*
Texas	Oklahoma
	New Mexico
Colorado	Arkansas
	Louisiana

No

⊡ Answers to Exercises 27–32 are on p. IA-3.

Determine whether each of the following is a function. Identify any relations that are not functions.

17. The correspondence matching a USB flash drive with its storage capacity Function

18. The correspondence matching a member of a rock band with the instrument the person can play Relation but not a function

19. The correspondence matching a player on a team with that player's uniform number Function

20. The correspondence matching a triangle with its area Function

For each correspondence, **(a)** *write the domain,* **(b)** *write the range, and* **(c)** *determine whether the correspondence is a function.*

21. $\{(-3, 3), (-2, 5), (0, 9), (4, -10)\}$
(a) $\{-3, -2, 0, 4\}$; **(b)** $\{-10, 3, 5, 9\}$; **(c)** yes

22. $\{(0, -1), (1, 3), (2, -1), (5, 3)\}$
(a) $\{0, 1, 2, 5\}$; **(b)** $\{-1, 3\}$; **(c)** yes

23. $\{(1, 1), (2, 1), (3, 1), (4, 1), (5, 1)\}$
(a) $\{1, 2, 3, 4, 5\}$; **(b)** $\{1\}$; **(c)** yes

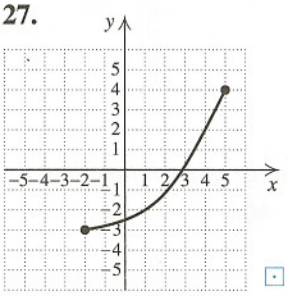
24. $\{(1, 1), (1, 2), (1, 3), (1, 4), (1, 5)\}$
(a) $\{1\}$; **(b)** $\{1, 2, 3, 4, 5\}$; **(c)** no

25. $\{(4, -2), (-2, 4), (3, -8), (4, 5)\}$
(a) $\{-2, 3, 4\}$; **(b)** $\{-8, -2, 4, 5\}$; **(c)** no

26. $\{(0, 7), (4, 8), (7, 0), (8, 4)\}$
(a) $\{0, 4, 7, 8\}$; **(b)** $\{0, 4, 7, 8\}$; **(c)** yes

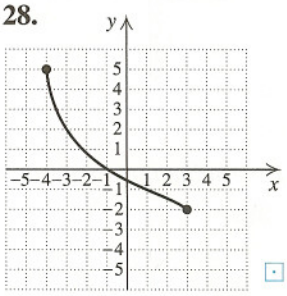
For each graph of a function, determine **(a)** $f(1)$; **(b)** *the domain;* **(c)** *any x-values for which* $f(x) = 2$; *and* **(d)** *the range.*

27.



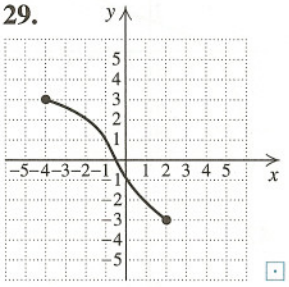
⊡

28.



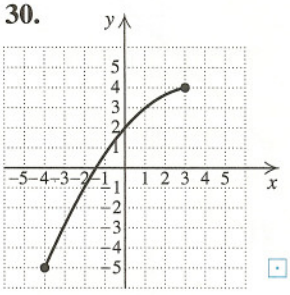
⊡

29.



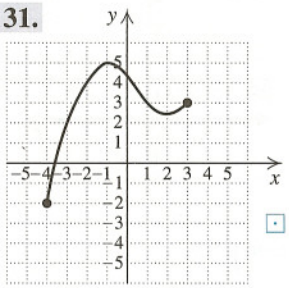
⊡

30.



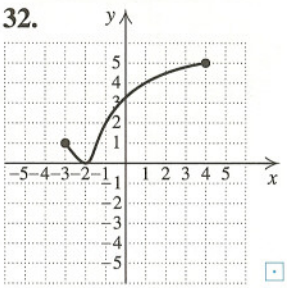
⊡

31.



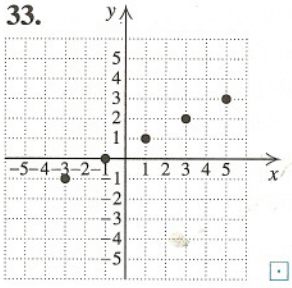
⊡

32.

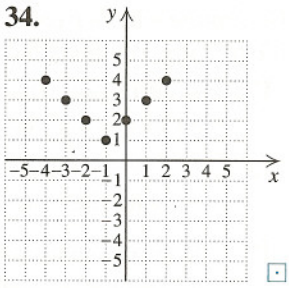


⊡

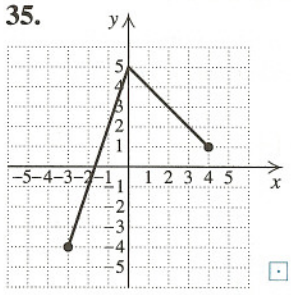
33.



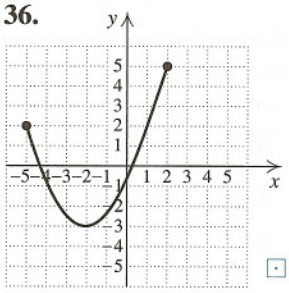
34.



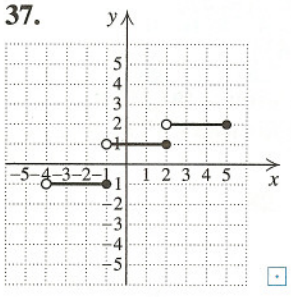
35.



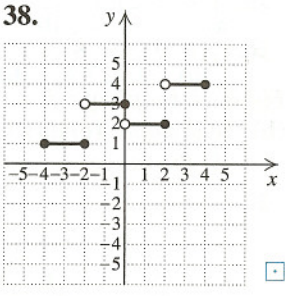
36.



37.

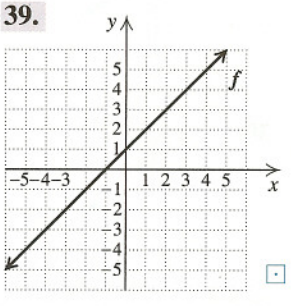


38.

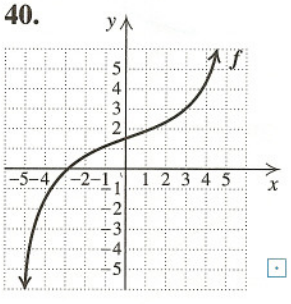


Determine the domain and the range of each function.

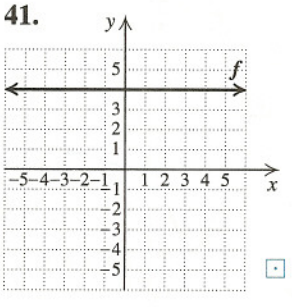
39.



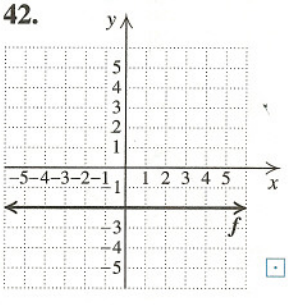
40.



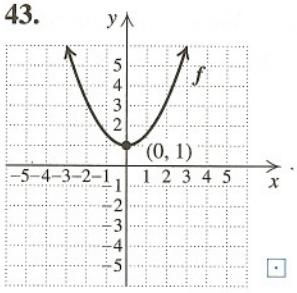
41.



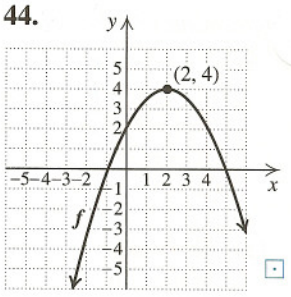
42.



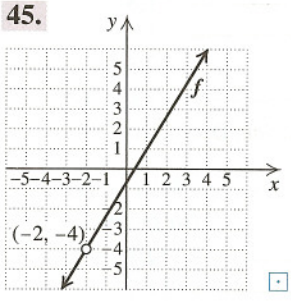
43.



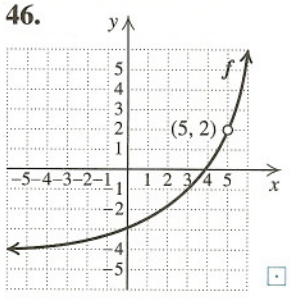
44.



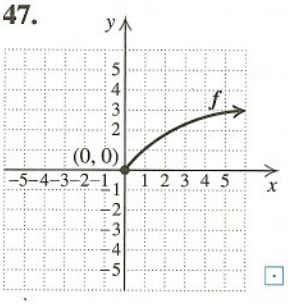
45.



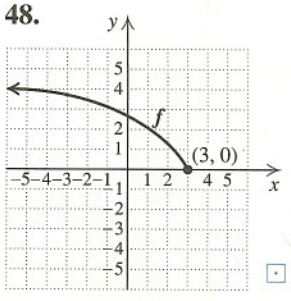
46.



47.

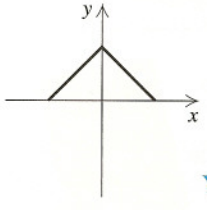


48.



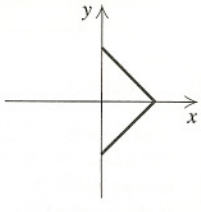
Determine whether each of the following is the graph of a function.

49.



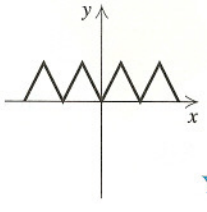
Yes

50.



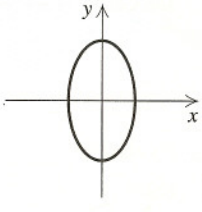
No

51.



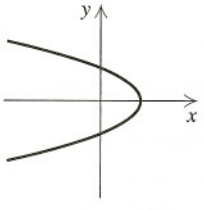
Yes

52.



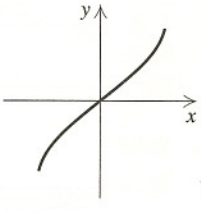
No

53.



No

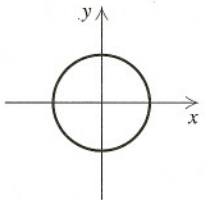
54.



Yes

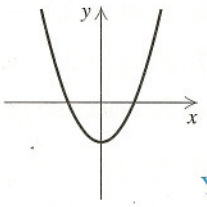
Answers to Exercises 33–48 are on p. IA-3.

55.



No

56.



Yes

Find the function values.

57. $g(x) = 2x + 3$

a) $g(0)$ 3 **b)** $g(-4)$ -5 **c)** $g(-7)$ -11
d) $g(8)$ 19 **e)** $g(a + 2)$ $2a + 7$ **f)** $g(a) + 2$ $2a + 5$

58. $h(x) = 3x - 2$

a) $h(4)$ 10 **b)** $h(8)$ 22 **c)** $h(-3)$ -11
d) $h(-4)$ -14 **e)** $h(a - 1)$ $3a - 5$ **f)** $h(a) - 1$ $3a - 3$

59. $f(n) = 5n^2 + 4n$

a) $f(0)$ 0 **b)** $f(-1)$ 1 **c)** $f(3)$ 57
d) $f(t)$ $5t^2 + 4t$ **e)** $f(2a)$ $20a^2 + 8a$ **f)** $2 \cdot f(a)$ $10a^2 + 8a$

Aha!

60. $g(n) = 3n^2 - 2n$

a) $g(0)$ 0 **b)** $g(-1)$ 5 **c)** $g(3)$ 21
d) $g(t)$ $3t^2 - 2t$ **e)** $g(2a)$ $12a^2 - 4a$ **f)** $2 \cdot g(a)$ $6a^2 - 4a$

61. $f(x) = \dfrac{x - 3}{2x - 5}$

a) $f(0)$ $\frac{3}{5}$ **b)** $f(4)$ $\frac{1}{3}$ **c)** $f(-1)$ $\frac{4}{7}$
d) $f(3)$ 0 **e)** $f(x + 2)$ $\dfrac{x - 1}{2x - 1}$

62. $s(x) = \dfrac{3x - 4}{2x + 5}$

a) $s(10)$ $\frac{26}{25}$ **b)** $s(2)$ $\frac{2}{9}$ **c)** $s\left(\frac{1}{2}\right)$ $-\frac{5}{12}$
d) $s(-1)$ $-\frac{7}{3}$ **e)** $s(x + 3)$ $\dfrac{3x + 5}{2x + 11}$

Use a graphing calculator to find the function values.

63. $f(a) = a^2 + a - 1$

a) $f(-6)$ 29 **b)** $f(1.7)$ 3.59

64. $g(t) = 3t^2 - 8$

a) $g(29)$ 2515 **b)** $g(-0.1)$ -7.97

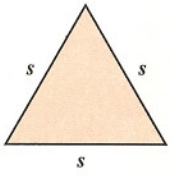
65. $h(n) = 8 - n - \dfrac{1}{n}$

a) $h(0.2)$ 2.8 **b)** $h\left(-\frac{1}{4}\right)$ 12.25

66. $p(a) = \dfrac{2}{a} - a^2$

a) $p\left(\frac{1}{8}\right)$ 15.984375 **b)** $p(-0.5)$ -4.25

The function A described by $A(s) = s^2\dfrac{\sqrt{3}}{4}$ *gives the area of an equilateral triangle with side s.*



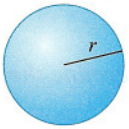
67. Find the area when a side measures 4 cm.

$4\sqrt{3}\ \text{cm}^2 \approx 6.93\ \text{cm}^2$

68. Find the area when a side measures 6 in.

$9\sqrt{3}\ \text{in}^2 \approx 15.59\ \text{in}^2$

The function V described by $V(r) = 4\pi r^2$ *gives the surface area of a sphere with radius r.*



69. Find the surface area when the radius is 3 in.

$36\pi\ \text{in}^2 \approx 113.10\ \text{in}^2$

70. Find the surface area when the radius is 5 cm.

$100\pi\ \text{cm}^2 \approx 314.16\ \text{cm}^2$

71. *Pressure at Sea Depth.* The function $P(d) = 1 + (d/33)$ gives the pressure, in *atmospheres* (atm), at a depth of d feet in the sea. Note that $P(0) = 1$ atm, $P(33) = 2$ atm, and so on. Find the pressure at 20 ft, at 30 ft, and at 100 ft.

$1\frac{20}{33}$ atm; $1\frac{10}{11}$ atm; $4\frac{1}{33}$ atm

72. *Melting Snow.* The function $W(d) = 0.112d$ approximates the amount, in centimeters, of water that results from d centimeters of snow melting. Find the amount of water that results from snow melting from depths of 16 cm, 25 cm, and 100 cm. 1.792 cm; 2.8 cm; 11.2 cm

Fill in the missing values in each table.

	$f(x) = 2x - 5$	
	x	$f(x)$
73.	8	11
74.	9	13
75.	0	-5
76.	-4	-13

$f(x) = \frac{1}{3}x + 4$	
x	$f(x)$
77. $-\frac{21}{2}$	$\frac{1}{2}$
78. -13	$-\frac{1}{3}$
79. $\frac{1}{2}$	$\frac{25}{6}$
80. $-\frac{1}{3}$	$\frac{35}{9}$

81. If $f(x) = 4 - x$, for what input is the output 7? -3

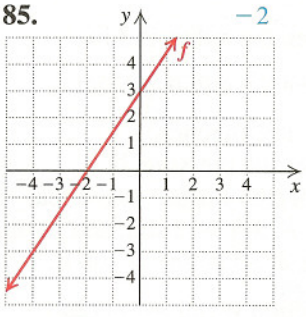
82. If $f(x) = 5x + 1$, for what input is the output $\frac{1}{2}$? $-\frac{1}{10}$

83. If $f(x) = 0.1x - 0.5$, for what input is the output -3? -25

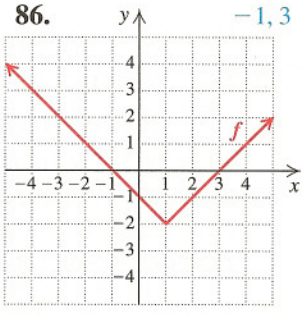
84. If $f(x) = 2.3 - 1.5x$, for what input is the output 10? $-\frac{77}{15}$, or $-5.1\overline{3}$

In Exercises 85–98, determine the zeros, if any, of each function.

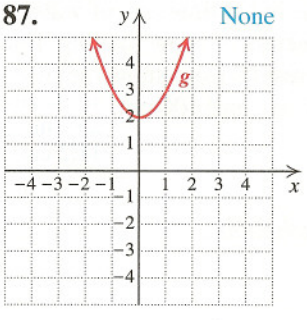
85. -2



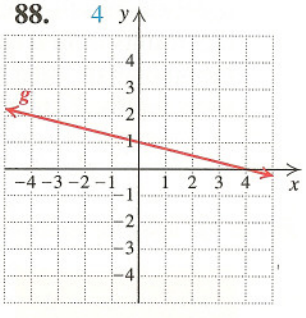
86. $-1, 3$



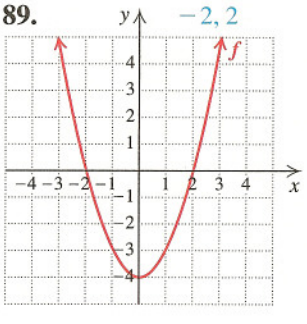
87. None



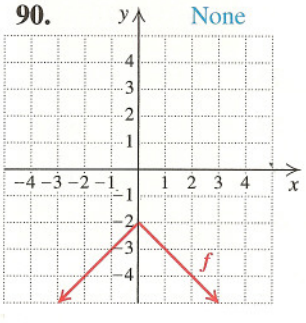
88. 4



89. $-2, 2$



90. None



91. $f(x) = x - 5$ 5

92. $f(x) = x + 3$ -3

93. $f(x) = \frac{1}{2}x + 10$ -20

94. $f(x) = \frac{2}{3}x - 6$ 9

⊡ Answers to Exercises 100, 102, and 108 are on p. IA-3.

95. $f(x) = 2.7 - x$ 2.7

96. $f(x) = 0.5 - x$ [illegible]

97. $f(x) = 3x + 7$ $-\frac{7}{3}$

98. $f(x) = 5x - 8$ $\frac{8}{5}$

Find the domain of f.

99. $f(x) = \frac{5}{x - 3}$ $\{x | x \text{ is a real number and } x \neq 3\}$

100. $f(x) = \frac{7}{6 - x}$ ⊡

101. $f(x) = \frac{x}{2x - 1}$ $\{x | x \text{ is a real number and } x \neq \frac{1}{2}\}$

102. $f(x) = \frac{2x}{4x + 3}$ ⊡

103. $f(x) = 2x + 1$ $\mathbb{R}$

104. $f(x) = x^2 + 3$ $\mathbb{R}$

105. $f(x) = |5 - x|$ $\mathbb{R}$

106. $f(x) = |3x - 4|$ $\mathbb{R}$

107. $f(x) = \frac{5}{x - 9}$ $\{x | x \text{ is a real number and } x \neq 9\}$

108. $f(x) = \frac{3}{x + 1}$ ⊡

109. $f(x) = x^2 - 9$ $\mathbb{R}$

110. $f(x) = x^2 - 2x + 1$ $\mathbb{R}$

111. $f(x) = \frac{2x - 7}{5}$ $\mathbb{R}$

112. $f(x) = \frac{x + 5}{8}$ $\mathbb{R}$

Find the indicated function values for each function.

113. $f(x) = \begin{cases} x, & \text{if } x < 0, \\ 2x + 1, & \text{if } x \geq 0 \end{cases}$

a) $f(-5)$ -5 **b)** $f(0)$ 1 **c)** $f(10)$ 21

114. $g(x) = \begin{cases} x - 5, & \text{if } x \leq 5, \\ 3x, & \text{if } x > 5 \end{cases}$

a) $g(0)$ -5 **b)** $g(5)$ 0 **c)** $g(6)$ 18

115. $G(x) = \begin{cases} x - 5, & \text{if } x < -1, \\ x, & \text{if } -1 \leq x \leq 2, \\ x + 2, & \text{if } x > 2 \end{cases}$

a) $G(0)$ 0 **b)** $G(2)$ 2 **c)** $G(5)$ 7

116. $F(x) = \begin{cases} 2x, & \text{if } x \leq 0, \\ x, & \text{if } 0 < x \leq 3, \\ -5x, & \text{if } x > 3 \end{cases}$

a) $F(-1)$ -2 **b)** $F(3)$ 3 **c)** $F(10)$ -50

117. $f(x) = \begin{cases} x^2 - 10, & \text{if } x < -10, \\ x^2, & \text{if } -10 \leq x \leq 10, \\ x^2 + 10, & \text{if } x > 10 \end{cases}$

a) $f(-10)$ 100 **b)** $f(10)$ 100 **c)** $f(11)$ 131

118. $f(x) = \begin{cases} 2x^2 - 3, & \text{if } x \leq 2, \\ x^2, & \text{if } 2 < x < 4, \\ 5x - 7, & \text{if } x \geq 4 \end{cases}$

a) $f(0)$ -3 **b)** $f(3)$ 9 **c)** $f(6)$ 23

TW **119.** Explain why the domain of the function given by $f(x) = \frac{x + 3}{2}$ is $\mathbb{R}$, but the domain of the function given by $g(x) = \frac{2}{x + 3}$ is not $\mathbb{R}$.

20. For the function given by $n(z) = ab + wz$, what is the independent variable? How can you tell?

SKILL REVIEW

To prepare for Section 2.2, review simplifying expressions and solving for a variable (Sections 1.2 and 1.6).

Simplify. [1.2]

121. $\dfrac{6-3}{-2-7}$ $-\frac{1}{3}$

122. $\dfrac{-2-(-4)}{5-8}$ $-\frac{2}{3}$

123. $\dfrac{-5-(-5)}{3-(-10)}$ 0

124. $\dfrac{2-(-3)}{-3-2}$ -1

Solve for y. [1.6]

125. $2x - y = 8$ $y = 2x - 8$

126. $5x + 5y = 10$ $y = -x + 2$

127. $2x + 3y = 6$ $y = -\frac{2}{3}x + 2$

128. $5x - 4y = 8$ $y = \frac{5}{4}x - 2$

SYNTHESIS

TW **129.** Jaylan is asked to write a function relating the number of fish in an aquarium to the amount of food needed for the fish. Which quantity should he choose as the independent variable? Why?

TW **130.** Explain the difference between finding $f(0)$ and finding the zeros of f.

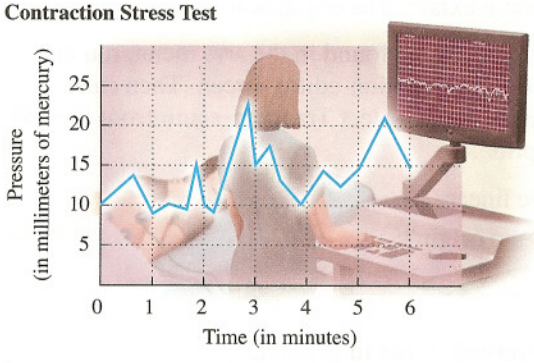
For Exercises 131 and 132, let $f(x) = 3x^2 - 1$ *and* $g(x) = 2x + 5$.

131. Find $f(g(-4))$ and $g(f(-4))$. 26; 99

132. Find $f(g(-1))$ and $g(f(-1))$. 26; 9

133. If f represents the function in Exercise 15, find $f(f(f(f(tiger))))$. Worm

Pregnancy. For Exercises 134–137, use the following graph of a woman's "stress test." This graph shows the size of a pregnant woman's contractions as a function of time.



134. How large is the largest contraction that occurred during the test? About 22 mm

135. At what time during the test did the largest contraction occur? About 2 min 50 sec

TW **136.** On the basis of the information provided, how large a contraction would you expect 60 sec after the end of the test? Why?

137. What is the frequency of the largest contraction? 1 every 3 min

138. The *greatest integer function* $f(x) = [\![x]\!]$ is defined as follows: $[\![x]\!]$ is the greatest integer that is less than or equal to x. For example, if $x = 3.74$, then $[\![x]\!] = 3$; and if $x = -0.98$, then $[\![x]\!] = -1$. Graph the greatest integer function for $-5 \le x \le 5$. (The notation $f(x) = \text{int}(x)$, used in many graphing calculators, is often found in the MATH NUM submenu.)

139. Suppose that a function g is such that $g(-1) = -7$ and $g(3) = 8$. Find a formula for g if $g(x)$ is of the form $g(x) = mx + b$, where m and b are constants. $g(x) = \frac{15}{4}x - \frac{13}{4}$

Try Exercise Answers: Section 2.1

9. Yes **17.** Function **21.** (a) $\{-3, -2, 0, 4\}$; (b) $\{-10, 3, 5, 9\}$; (c) yes **31.** (a) 3; (b) $\{x \mid -4 \le x \le 3\}$; (c) -3; (d) $\{y \mid -2 \le y \le 5\}$ **39.** Domain: $\mathbb{R}$; range: $\mathbb{R}$ **45.** Domain: $\{x \mid x \text{ is a real number } and\ x \ne -2\}$; range: $\{y \mid y \text{ is a real number } and\ y \ne -4\}$ **57.** (a) 3; (b) -5; (c) -11; (d) 19; (e) $2a + 7$; (f) $2a + 5$ **63.** (a) 29; (b) 3.59 **83.** -25 **91.** 5 **99.** $\{x \mid x \text{ is a real number } and\ x \ne 3\}$ **113.** (a) -5; (b) 1; (c) 21 **115.** (a) 0; (b) 2; (c) 7

138.