Chapter 2

Graphs, Functions, and Applications

Exercise Set 2.1

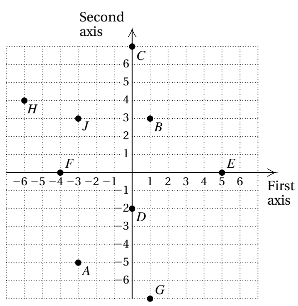
RC2.
$$\begin{aligned} 4y - 3x &= 0 \\ 4y &= 3x \\ y &= \frac{3}{4}x \end{aligned}$$

The answer is (b).

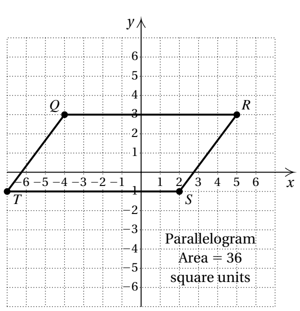
RC4.
$$\begin{aligned} 3y + 4x &= -12 \\ 3y &= -4x - 12 \\ y &= -\frac{4}{3}x - 4 \end{aligned}$$

The answer is (c).

2.



4.



Parallelogram

$A = bh = 9 \cdot 4 = 36$ square units

6.
$$\begin{array}{c|l} \multicolumn{2}{c}{t = 4 - 3s} \\ \hline 4 \ ? & 4 - 3 \cdot 3 \\ & 4 - 9 \\ & -5 \qquad \text{FALSE} \end{array}$$

Since $4 = -5$ is false, $(3, 4)$ is not a solution of $t = 4 - 3s$.

8.
$$\begin{array}{r|l} \multicolumn{2}{c}{4r + 3s = 5} \\ \hline 4 \cdot 2 + 3 \cdot (-1) \ ? & 5 \\ 8 - 3 & \\ 5 & \end{array}$$

Substituting 2 for r and -1 for s (alphabetical order of variables)

Since $5 = 5$ is true, $(2, -1)$ is a solution of $4r + 3s = 5$.

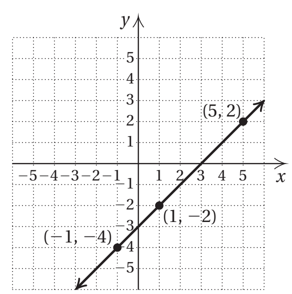
10.
$$\begin{array}{r|l} \multicolumn{2}{c}{2p - 3q = -13} \\ \hline 2(-5) - 3 \cdot 1 \ ? & -13 \\ -10 - 3 & \\ -13 & \end{array}$$

Substituting -5 for p and 1 for q

Since $-13 = -13$ is true, $(-5, 1)$ is a solution of $2p - 3q = -13$.

12.
$$\begin{array}{c|l} \multicolumn{2}{c}{y = x - 3} \\ \hline 2 \ ? & 5 - 3 \\ & 2 \qquad \text{TRUE} \end{array} \qquad \begin{array}{c|l} \multicolumn{2}{c}{y = x - 3} \\ \hline -4 \ ? & -1 - 3 \\ & -4 \qquad \text{TRUE} \end{array}$$

Plot the points $(5, 2)$ and $(-1, -4)$ and draw the line through them.



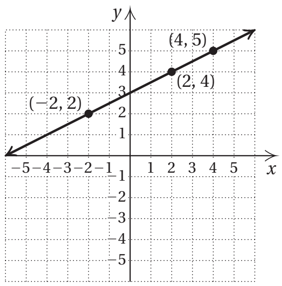
The line appears to pass through $(0, -3)$ as well. We check to see if $(0, -3)$ is a solution of $y = x - 3$.

$$\begin{array}{c|l} \multicolumn{2}{c}{y = x - 3} \\ \hline -3 \ ? & 0 - 3 \\ & -3 \qquad \text{TRUE} \end{array}$$

$(0, -3)$ is a solution. Other correct answers include $(-3, -6)$, $(-2, -5)$, $(1, -2)$, $(2, -1)$, $(3, 0)$, and $(4, 1)$.

14.
$$\begin{array}{c|l} \multicolumn{2}{c}{y = \frac{1}{2}x + 3} \\ \hline 5 \ ? & \frac{1}{2} \cdot 4 + 3 \\ & 2 + 3 \\ & 5 \qquad \text{TRUE} \end{array} \qquad \begin{array}{c|l} \multicolumn{2}{c}{y = \frac{1}{2}x + 3} \\ \hline 2 \ ? & \frac{1}{2}(-2) + 3 \\ & -1 + 3 \\ & 2 \qquad \text{TRUE} \end{array}$$

Plot the points $(4, 5)$ and $(-2, 2)$ and draw the line through them.



The line appears to pass through $(2, 4)$ as well. We check to see if $(2, 4)$ is a solution of $y = \frac{1}{2}x + 3$.

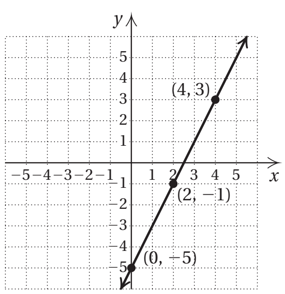
$$\begin{array}{c|l} y & = \frac{1}{2}x + 3 \\ \hline 4 & ?\ \frac{1}{2} \cdot 2 + 3 \\ & 1 + 3 \\ & 4 \qquad \text{TRUE} \end{array}$$

$(2, 4)$ is a solution. Other correct answers include $(-6, 0)$, $(-4, 1)$, $(0, 3)$, and $(6, 6)$.

16.

$$\begin{array}{r|l} 4x - 2y & = 10 \\ \hline 4 \cdot 0 - 2(-5) & ?\ 10 \\ 0 + 10 & \\ 10 & \quad \text{TRUE} \end{array} \qquad \begin{array}{r|l} 4x - 2y & = 10 \\ \hline 4 \cdot 4 - 2 \cdot 3 & ?\ 10 \\ 16 - 6 & \\ 10 & \quad \text{TRUE} \end{array}$$

Plot the points $(0, -5)$ and $(4, 3)$ and draw the line through them.



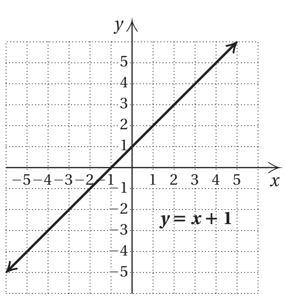
The line appears to pass through $(5, 5)$ as well. We check to see if $(5, 5)$ is a solution of $4x - 2y = 10$.

$$\begin{array}{r|l} 4x - 2y & = 10 \\ \hline 4 \cdot 5 - 2 \cdot 5 & ?\ 10 \\ 20 - 10 & \\ 10 & \quad \text{TRUE} \end{array}$$

$(5, 5)$ is a solution. Other correct answers include $(1, -3)$, $(2, -1)$, and $(3, 1)$.

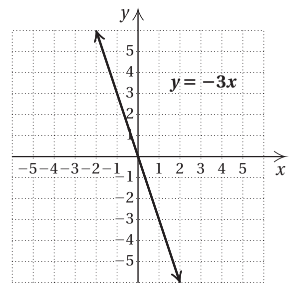
18.

x	y
-2	-1
-1	0
0	1
1	2
2	3
3	4



20.

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



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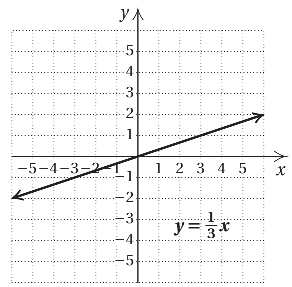

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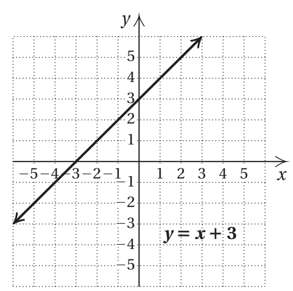

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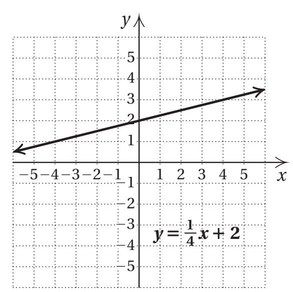

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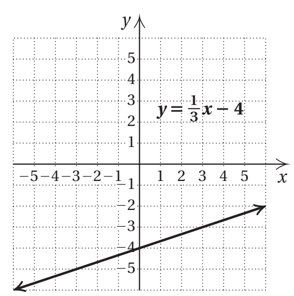

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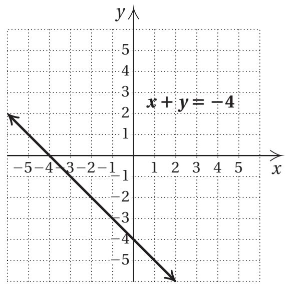

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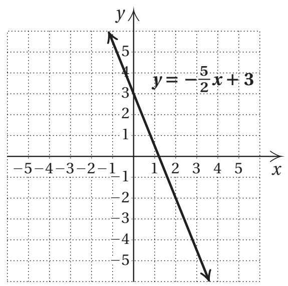

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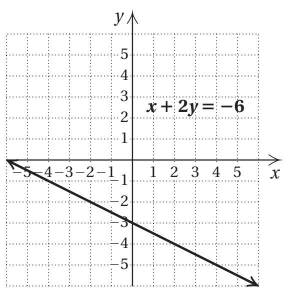

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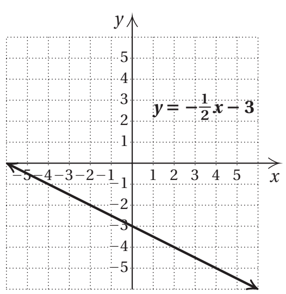

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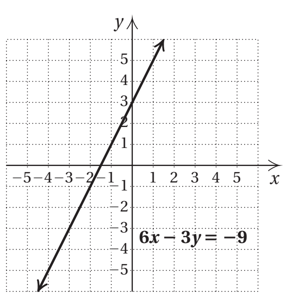

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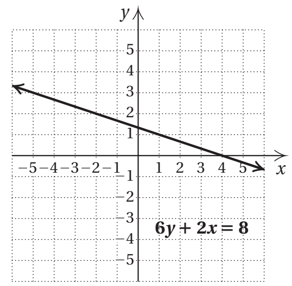
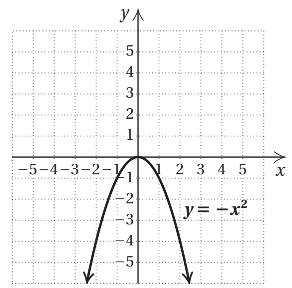


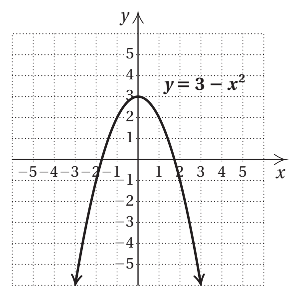
42.

x	y
-2	-4
-1	-1
0	0
1	-1
2	-4



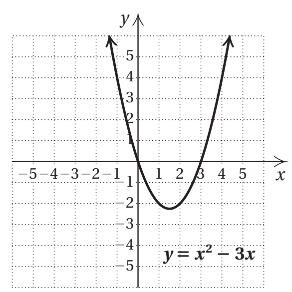
44.

x	y
-3	-6
-2	-1
-1	2
0	3
1	2
2	-1



46.

x	y
-1	4
0	0
1	-2
2	-2
3	0
4	4



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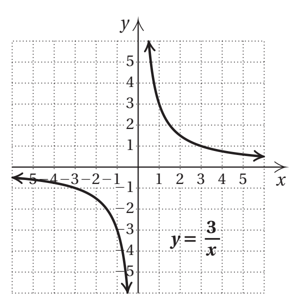

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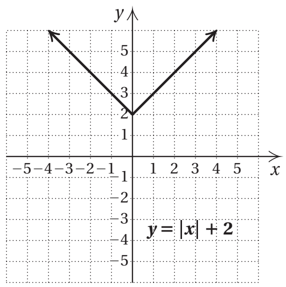

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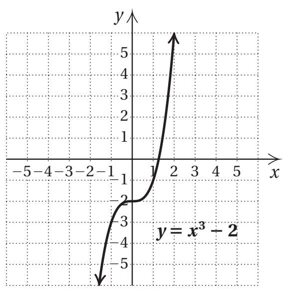


54. $2x - 5 \geq -10$ *or* $-4x - 2 < 10$

$2x \geq -5$ *or* $-4x < 12$

$x \geq -\dfrac{5}{2}$ *or* $x > -3$

The solution set is $\{x|x > -3\}$, or $(-3, \infty)$.

56. $-13 < 3x + 5 < 23$

$-18 < 3x < 18$

$-6 < x < 6$

The solution set is $\{x| -6 < x < 6\}$, or $(-6, 6)$.

58. Let h = the height of the triangle, in feet.

Solve: $\dfrac{1}{2} \cdot 16 \cdot h = 200$

$h = 25$ ft

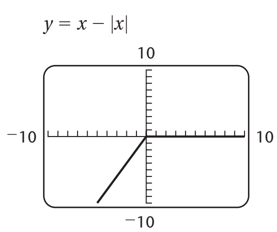
60. Let x = the selling price of the house. Then $x - 100,000$ = the amount that exceeds \$100,000.

Solve:

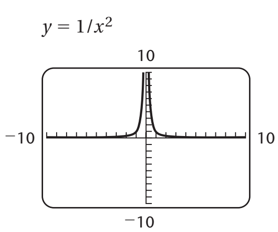
$$0.07(100,000) + 0.04(x - 100,000) = 16,200$$

$$x = \$330,000$$

62.



64.



66. Each y-coordinate is 3 times the corresponding x-coordinate, so the equation is $y = 3x$.

68. Each y-coordinate is 5 less the square of the corresponding x-coordinate, so the equation is $y = 5 - x^2$.

Exercise Set 2.2

RC2. $f(0) = 3$

RC4. $f(3) = 0$

2. Yes; each member of the domain is matched to only one member of the range.

4. No; a member of the domain (6) is matched to more than one member of the range.

6. Yes; each member of the domain is matched to only one member of the range.

8. Yes; each member of the domain is matched to only one member of the range.

10. This correspondence is a function, since each person in a family has only one height, in inches.

12. This correspondence is not a function, since each state has two senators.

14. a) $g(0) = 0 - 6 = -6$

b) $g(6) = 6 - 6 = 0$

c) $g(13) = 13 - 6 = 7$

d) $g(-1) = -1 - 6 = -7$

e) $g(-1.08) = -1.08 - 6 = -7.08$

f) $g\left(\dfrac{7}{8}\right) = \dfrac{7}{8} - 6 = -5\dfrac{1}{8}$

16. a) $f(6) = -4 \cdot 6 = -24$

b) $f\left(-\dfrac{1}{2}\right) = -4\left(-\dfrac{1}{2}\right) = 2$

c) $f(0) = -4 \cdot 0 = 0$

d) $f(-1) = -4(-1) = 4$

e) $f(3a) = -4 \cdot 3a = -12a$

f) $f(a - 1) = -4(a - 1) = -4a + 4$

18. a) $h(4) = 19$

b) $h(-6) = 19$

c) $h(12) = 19$

d) $h(0) = 19$

e) $h\left(\dfrac{2}{3}\right) = 19$

f) $h(a + 3) = 19$

20. a) $f(0) = 3 \cdot 0^2 - 2 \cdot 0 + 1 = 1$

b) $f(1) = 3 \cdot 1^2 - 2 \cdot 1 + 1 = 3 - 2 + 1 = 2$

c) $f(-1) = 3(-1)^2 - 2(-1) + 1 = 3 + 2 + 1 = 6$

d) $f(10) = 3 \cdot 10^2 - 2 \cdot 10 + 1 = 300 - 20 + 1 = 281$

e) $f(-3) = 3(-3)^2 - 2(-3) + 1 = 27 + 6 + 1 = 34$

f) $f(2a) = 3(2a)^2 - 2(2a) + 1 = 3 \cdot 4a^2 - 4a + 1 =$
$12a^2 - 4a + 1$

22. a) $g(4) = |4 - 1| = |3| = 3$

b) $g(-2) = |-2 - 1| = |-3| = 3$

c) $g(-1) = |-1 - 1| = |-2| = 2$

d) $g(100) = |100 - 1| = |99| = 99$

e) $g(5a) = |5a - 1|$

f) $g(a + 1) = |a + 1 - 1| = |a|$

24. a) $f(1) = 1^4 - 3 = 1 - 3 = -2$

b) $f(-1) = (-1)^4 - 3 = 1 - 3 = -2$

c) $f(0) = 0^4 - 3 = 0 - 3 = -3$

d) $f(2) = 2^4 - 3 = 16 - 3 = 13$

e) $f(-2) = (-2)^4 - 3 = 16 - 3 = 13$

f) $f(-a) = (-a)^4 - 3 = a^4 - 3$

26. In 1980, $h = 1980 - 1945 = 35$.

$A(35) = 0.059(35) + 53 \approx 55.1$ years

In 2013, $h = 2013 - 1945 = 68$

$A(68) = 0.059(68) + 53 \approx 57.0$ years

28. $T(5) = 10 \cdot 5 + 20 = 50 + 20 = 70°\text{C}$

$T(20) = 10 \cdot 20 + 20 = 200 + 20 = 220°\text{C}$

$T(1000) = 10 \cdot 1000 + 20 = 10,000 + 20 = 10,020°\text{C}$

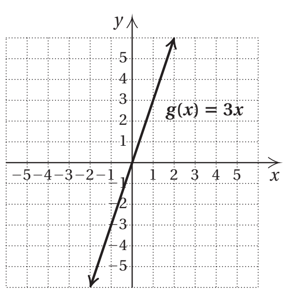
30. $C(62) = \frac{5}{9}(62 - 32) = \frac{5}{9} \cdot 30 = \frac{50}{3} = 16\frac{2}{3}°\text{C}$

$C(77) = \frac{5}{9}(77 - 32) = \frac{5}{9} \cdot 45 = 25°\text{C}$

$C(23) = \frac{5}{9}(23 - 32) = \frac{5}{9}(-9) = -5°\text{C}$

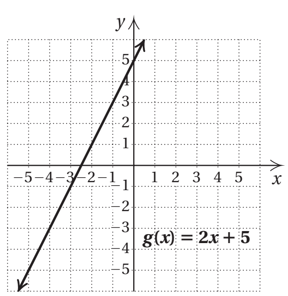
32.

x	$g(x)$
-1	-3
0	0
1	3
2	6



34.

x	$g(x)$
-3	-1
-2	1
-1	3
0	5



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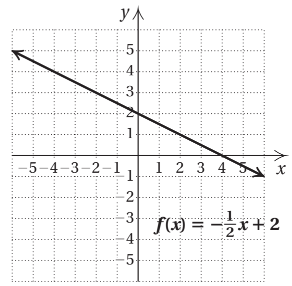

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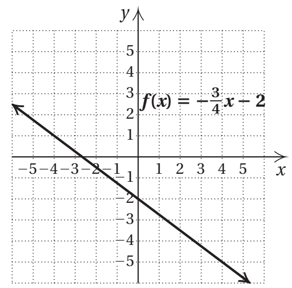
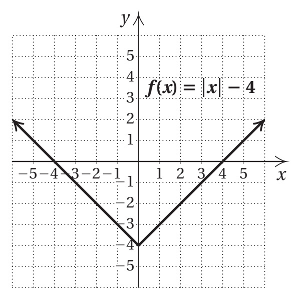


40.

x	$f(x)$
-3	-1
-2	-2
-1	-3
0	-4
1	-3
2	-2
3	-1



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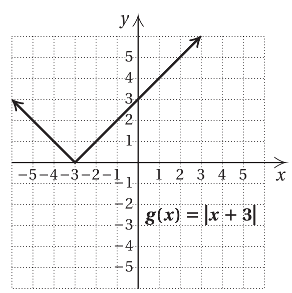
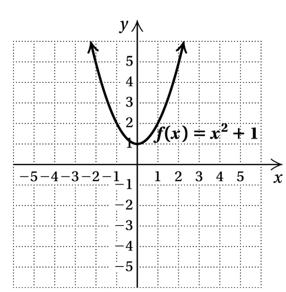


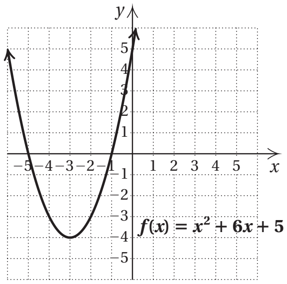
44.

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



46.

x	y
-5	0
-4	-3
-3	-4
-2	-3
-1	0
0	5
1	12



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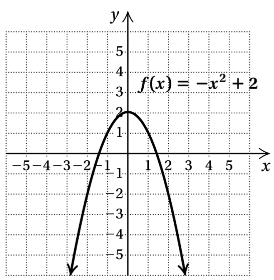
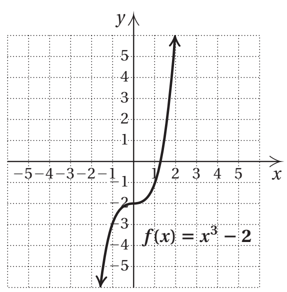


50.

x	$f(x)$
-2	-10
-1	-3
0	-2
1	-1
2	6



52. No; it fails the vertical line test.

54. Yes; it passes the vertical line test.

56. Yes; it passes the vertical line test.

58. No; it fails the vertical line test.

60. About 1.3 million children

62. About 280,000 pharmacists

64.
$$\begin{aligned} 6x - 31 &= 11 + 6(x-7) \\ 6x - 31 &= 11 + 6x - 42 \\ 6x - 31 &= 6x - 31 \\ -31 &= -31 \end{aligned}$$

We get a true equation, so all real numbers are solutions.

66.
$$\begin{aligned} \frac{2}{3}(4x-2) &> 60 \\ 4x - 2 &> 90 \\ 4x &> 92 \\ x &> 23 \end{aligned}$$

$\{x|x > 23\}$, or $(23, \infty)$

68.
$$\begin{aligned} 4(x-5) &= 3(x+2) \\ 4x - 20 &= 3x + 6 \\ x &= 26 \end{aligned}$$

70.
$$\begin{aligned} \frac{1}{2}x + 10 &< 8x - 5 \\ 15 &< \frac{15}{2}x \\ 2 &< x \end{aligned}$$

$\{x|x > 2\}$, or $(2, \infty)$

72.
$$\begin{aligned} \frac{1}{16}x + 4 &= \frac{5}{8}x - 1 \\ 5 &= \frac{9}{16}x \\ \frac{80}{9} &= x \end{aligned}$$

74. $x + 5 = 3$ when $x = -2$. Find $h(-2)$.
$h(-2) = (-2)^2 - 4 = 4 - 4 = 0$

76. $g(-1) = 2(-1) + 5 = 3$, so $f(g(-1)) = f(3) = 3 \cdot 3^2 - 1 = 26$.
$f(-1) = 3(-1)^2 - 1 = 2$, so $g(f(-1)) = g(2) = 2 \cdot 2 + 5 = 9$.

Exercise Set 2.3

RC2. $5 - x = 0$ for $x = 5$, so the domain is $\{x|x \text{ is a real number } \textit{and } x \neq 5\}$. The answer is (b).

RC4. $|x - 5| = 0$ for $x = 5$, so the domain is $\{x|x \text{ is a real number } \textit{and } x \neq 5\}$. The answer is (b).

RC6. $x + 5 = 0$ for $x = -5$, so the domain is $\{x|x \text{ is a real number } \textit{and } x = -5\}$. The answer is (d).

2. a) $f(1) = 1$

b) The set of all x-values in the graph is $\{-3, -1, 1, 3, 5\}$.

c) The only point whose second coordinate is 2 is $(3, 2)$, so the x-value for which $f(x) = 2$ is 3.

d) The set of all y-values in the graph is $\{-1, 0, 1, 2, 3\}$.

4. a) $f(1) = -2$

b) The set of all x-values in the graph is $\{x| -4 \leq x \leq 2\}$, or $[-4, 2]$.

c) The only point whose second coordinate is 2 is about $(-2, 2)$, so the x-value for which $f(x) = 2$ is about -2.

d) The set of all y-values in the graph is $\{y| -3 \leq y \leq 3\}$, or $[-3, 3]$.

6. a) $f(1) = -1$

b) No endpoints are indicated and we see that the graph extends indefinitely both horizontally and vertically, so the domain is the set of all real numbers.

c) The only point whose second coordinate is 2 is $(-2, 2)$, so the x-value for which $f(x) = 2$ is -2.

d) The range is the set of all real numbers. (See part (b) above.)

8. a) $f(1) = 3$

b) No endpoints are indicated and we see that the graph extends indefinitely horizontally, so the domain is the set of all real numbers.

c) There are two points for which the second coordinate is 2. They are about $(-1.4, 2)$ and $(1.4, 2)$, so the x-values for which $f(x) = 2$ are about -1.4 and 1.4.

d) The largest y-value is 4. No endpoints are indicated and we see that the graph extends downward indefinitely from $(0, 4)$, so the range is $\{y|y \le 4\}$, or $(-\infty, 4]$.

10. $f(x) = \dfrac{7}{5-x}$

Solve: $5 - x = 0$

$x = 5$

The domain is $\{x|x \text{ is a real number } \textit{and } x \ne 5\}$, or $(-\infty, 5) \cup (5, \infty)$.

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

We can calculate $4 - 5x$ for any value of x, so the domain is the set of all real numbers.

14. $f(x) = x^2 - 2x + 3$

We can calculate $x^2 - 2x + 3$ for any value of x, so the domain is the set of all real numbers.

16. $f(x) = \dfrac{x-2}{3x+4}$

Solve: $3x + 4 = 0$

$x = -\dfrac{4}{3}$

The domain is $\left\{x|x \text{ is a real number } \textit{and } x \ne -\dfrac{4}{3}\right\}$, or $\left(-\infty, -\dfrac{4}{3}\right) \cup \left(-\dfrac{4}{3}, \infty\right)$.

18. $f(x) = |x - 4|$

We can calculate $|x - 4|$ for any value of x, so the domain is the set of all real numbers.

20. $f(x) = \dfrac{4}{|2x-3|}$

Solve: $|2x - 3| = 0$

$x = \dfrac{3}{2}$

The domain is $\left\{x|x \text{ is a real number } \textit{and } x \ne \dfrac{3}{2}\right\}$, or $\left(-\infty, \dfrac{3}{2}\right) \cup \left(\dfrac{3}{2}, \infty\right)$.

22. $g(x) = \dfrac{-11}{4+x}$

Solve: $4 + x = 0$

$x = -4$

The domain is $\{x|x \text{ is a real number } \textit{and } x \ne -4\}$, or $(-\infty, -4) \cup (-4, \infty)$.

24. $g(x) = 8 - x^2$

We can calculate $8 - x^2$ for any value of x, so the domain is the set of all real numbers.

26. $g(x) = 4x^3 + 5x^2 - 2x$

We can calculate $4x^3 + 5x^2 - 2x$ for any value of x, so the domain is the set of all real numbers.

28. $g(x) = \dfrac{2x-3}{6x-12}$

Solve: $6x - 12 = 0$

$x = 2$

The domain is $\{x|x \text{ is a real number } \textit{and } x \ne 2\}$, or $(-\infty, 2) \cup (2, \infty)$.

30. $g(x) = |x| + 1$

We can calculate $|x| + 1$ for any value of x, so the domain is the set of all real numbers.

32. $g(x) = \dfrac{x^2+2x}{|10x-20|}$

Solve: $|10x - 20| = 0$

$x = 2$

The domain is $\{x|x \text{ is a real number } \textit{and } x \ne 2\}$, or $(-\infty, 2) \cup (2, \infty)$.

34. $\{x|x \text{ is an integer}\}$

36. $|x| = -8$

Since absolute value must be nonnegative, the solution set is $\{\ \}$ or $\emptyset$.

38. $|2x + 3| = 13$

$2x + 3 = -13$ *or* $2x + 3 = 13$

$2x = -16$ *or* $2x = 10$

$x = -8$ *or* $x = 5$

The solution set is $\{-8, 5\}$.

40. $|5x - 6| = |3 - 8x|$

$5x - 6 = 3 - 8x$ *or* $5x - 6 = -(3 - 8x)$

$13x = 9$ *or* $5x - 6 = -3 + 8x$

$x = \dfrac{9}{13}$ *or* $-3x = 3$

$x = \dfrac{9}{13}$ *or* $x = -1$

The solution set is $\left\{-1, \dfrac{9}{13}\right\}$.

42. $|3x - 8| = 0$

$$\begin{aligned} 3x - 8 &= 0 \\ 3x &= 8 \\ x &= \frac{8}{3} \end{aligned}$$

The solution set is $\left\{\frac{8}{3}\right\}$.

44. Graph each function on a graphing calculator, and determine the range from the graph.

For the function in Exercise 22, the range is $\{x|x \text{ is a real number } \textit{and } x \neq 0\}$, or $(-\infty, 0) \cup (0, \infty)$.

For the function in Exercise 23, the range is $\{x|x \geq 0\}$, or $[0, \infty)$.

For the function in Exercise 24, the range is $\{x|x \leq 8\}$, or $(-\infty, 8]$.

For the function in Exercise 30, the range is $\{x|x \geq 1\}$, or $[1, \infty)$.

46. We must have $2 - x \geq 0$, or $2 \geq x$. Thus, the domain is $\{x|x \leq 2\}$, or $(-\infty, 2]$.

Exercise Set 2.4

RC2.
$$\begin{aligned} (f-g)(x) &= f(x) - g(x) \\ &= x^2 - 1 - (x+3) \\ &= x^2 - 1 - x - 3 \\ &= x^2 - x - 4 \end{aligned}$$

Answer (c) is correct.

RC4.
$$\begin{aligned} (g-f)(x) &= g(x) - f(x) \\ &= x + 3 - (x^2 - 1) \\ &= x + 3 - x^2 + 1 \\ &= -x^2 + x + 4 \end{aligned}$$

Answer (e) is correct.

2. Since $f(4) = -2 \cdot 4 + 3 = -8 + 3 = -5$ and $g(4) = 4^2 - 5 = 16 - 5 = 11$, we have

$$f(4) + g(4) = -5 + 11 = 6.$$

4. Since $f(2) = -2 \cdot 2 + 3 = -4 + 3 = -1$ and $g(2) = 2^2 - 5 = 4 - 5 = -1$, we have

$$f(2) - g(2) = -1 - (-1) = -1 + 1 = 0.$$

6. Since $f(-1) = -2(-1) + 3 = 2 + 3 = 5$ and $g(-1) = (-1)^2 - 5 = 1 - 5 = -4$, we have

$$f(-1) \cdot g(-1) = 5(-4) = -20.$$

8. Since $f(3) = -2 \cdot 3 + 3 = -6 + 3 = -3$ and $g(3) = 3^2 - 5 = 9 - 5 = 4$, we have

$$f(3)/g(3) = \frac{-3}{4} = -\frac{3}{4}.$$

10. Since $g(-3) = (-3)^2 - 5 = 9 - 5 = 4$ and $f(-3) = -2(-3) + 3 = 6 + 3 = 9$, we have

$$g(-3)/f(-3) = \frac{4}{9}.$$

12.
$$\begin{aligned} (f-g)(x) &= f(x) - g(x) \\ &= -2x + 3 - (x^2 - 5) \\ &= -2x + 3 - x^2 + 5 \\ &= -x^2 - 2x + 8 \end{aligned}$$

14.
$$\begin{aligned} (g/f)(x) &= g(x)/f(x) \\ &= \frac{x^2 - 5}{-2x + 3} \end{aligned}$$

16. Since $F(a) = a^2 - 2$ and $G(a) = 5 - a$, we have

$$\begin{aligned} (F+G)(a) &= F(a) + G(a) \\ &= a^2 - 2 + 5 - a \\ &= a^2 - a + 3. \end{aligned}$$

$$\begin{aligned} \text{Or } (F+G)(x) &= F(x) + G(x) \\ &= x^2 - 2 + 5 - x \\ &= x^2 - x + 3, \end{aligned}$$

so $(F+G)(a) = a^2 - a + 3$.

18. Since $F(2) = 2^2 - 2 = 4 - 2 = 2$ and $G(2) = 5 - 2 = 3$, we have

$$\begin{aligned} (F-G)(2) &= F(2) - G(2) \\ &= 2 - 3 = -1. \end{aligned}$$

$$\begin{aligned} \text{Or } (F-G)(x) &= F(x) - G(x) \\ &= x^2 - 2 - (5 - x) \\ &= x^2 - 2 - 5 + x \\ &= x^2 + x - 7, \end{aligned}$$

so $(F-G)(2) = 2^2 + 2 - 7 = 4 + 2 - 7 = -1$.

20.
$$\begin{aligned} (G \cdot F)(x) &= G(x) \cdot F(x) \\ &= (5 - x)(x^2 - 2) \\ &= 5x^2 - 10 - x^3 + 2x, \text{ or} \\ &\quad -x^3 + 5x^2 + 2x - 10 \end{aligned}$$

22.
$$\begin{aligned} (G-F)(x) &= G(x) - F(x) \\ &= 5 - x - (x^2 - 2) \\ &= 5 - x - x^2 + 2 \\ &= -x^2 - x + 7 \end{aligned}$$

24. Since $F(-1) = (-1)^2 - 2 = -1$ and $G(-1) = 5 - (-1) = 6$,

we have $(F/G)(-1) = F(-1)/G(-1) = \frac{-1}{6} = -\frac{1}{6}$.

Alternatively, we could first find $(F/G)(x)$.

$$(F/G)(x) = F(x)/G(x) = \frac{x^2 - 2}{5 - x}$$

Then $(F/G)(-1) = \frac{(-1)^2 - 2}{5 - (-1)} = \frac{-1}{6} = -\frac{1}{6}$.

26. Since $G(6) = 5 - 6 = -1$, we have

$$(G \cdot G)(6) = G(6) \cdot G(16) = -1(-1) = 1.$$

Alternatively, we could first find $(G \cdot G)(x)$.

$$\begin{aligned}(G \cdot G)(x) &= G(x) \cdot G(x)\\ &= (5 - x)(5 - x)\\ &= 25 - 10x + x^2\end{aligned}$$

Then $(G \cdot G)(6) = 25 - 10 \cdot 6 + 6^2 = 25 - 60 + 36 = 1$.

28. $$\begin{aligned}(r/t)(x) &= r(x)/t(x)\\ &= \frac{\frac{5}{x^2}}{\frac{3}{2x}} = \frac{5}{x^2} \cdot \frac{2x}{3}\\ &= \frac{5 \cdot 2 \cdot \not{x}}{\not{x} \cdot x \cdot 3} = \frac{10}{3x}\end{aligned}$$

30. $$\begin{aligned}(r + t)(x) &= r(x) + t(x)\\ &= \frac{5}{x^2} + \frac{3}{2x} = \frac{10}{2x^2} + \frac{3x}{2x^2}\\ &= \frac{10 + 3x}{2x^2}\end{aligned}$$

32. $$\begin{aligned}(t - r)(x) &= t(x) - r(x)\\ &= \frac{3}{2x} - \frac{5}{x^2} = \frac{3x}{2x^2} - \frac{10}{2x^2}\\ &= \frac{3x - 10}{2x^2}\end{aligned}$$

34. $0.8 + 2.9 = 3.7$ million

36. $21 - 11 = 10$

38. $f(x) = 5x - 1$, $g(x) = 2x^2$

Domain of f = Domain of $g = \{x|x \text{ is a real number}\}$, so Domain of $f + g$ = Domain of $f - g$ = Domain of $f \cdot g = \{x|x \text{ is a real number}\}$.

40. $f(x) = 3x^2$, $g(x) = \dfrac{1}{x - 9}$

Domain of $f = \{x|x \text{ is a real number}\}$

Domain of $g = \{x|x \text{ is a real number } \textit{and } x \neq 9\}$

Domain of $f + g$ = Domain of $f - g$ = Domain of $f \cdot g = \{x|x \text{ is a real number } \textit{and } x \neq 9\}$

42. $f(x) = x^3 + 1$, $g(x) = \dfrac{5}{x}$

Domain of $f = \{x|x \text{ is a real number}\}$

Domain of $g = \{x|x \text{ is a real number } \textit{and } x \neq 0\}$

Domain of $f + g$ = Domain of $f - g$ = Domain of $f \cdot g = \{x|x \text{ is a real number } \textit{and } x \neq 0\}$

44. $f(x) = 9 - x^2$, $g(x) = \dfrac{3}{x + 6}$

Domain of $f = \{x|x \text{ is a real number}\}$

Domain of $g = \{x|x \text{ is a real number } \textit{and } x \neq -6\}$

Domain of $f + g$ = Domain of $f - g$ = Domain of $f \cdot g = \{x|x \text{ is a real number } \textit{and } x \neq -6\}$

46. $f(x) = \dfrac{5}{3 - x}$, $g(x) = \dfrac{1}{4x - 1}$

Domain of $f = \{x|x \text{ is a real number } \textit{and } x \neq 3\}$

Domain of $g = \left\{x|x \text{ is a real number } \textit{and } x \neq \dfrac{1}{4}\right\}$

Domain of $f + g$ = Domain of $f - g$ = Domain of $f \cdot g = \left\{x|x \text{ is a real number } \textit{and } x \neq 3 \textit{ and } x \neq \dfrac{1}{4}\right\}$

48. $f(x) = 2x^3$, $g(x) = 5 - x$

Domain of f = Domain of $g = \{x|x \text{ is a real number}\}$ and $g(5) = 0$, so Domain of $f/g =$ $\{x|x \text{ is a real number } \textit{and } x \neq 5\}$.

50. $f(x) = 5 + x$, $g(x) = 6 - 2x$

Domain of f = Domain of $g = \{x|x \text{ is a real number}\}$ and $g(3) = 0$, so Domain of $f/g =$ $\{x|x \text{ is a real number } \textit{and } x \neq 3\}$.

52. $f(x) = \dfrac{1}{2 - x}$, $g(x) = 7 + x$

Domain of $f = \{x|x \text{ is a real number } \textit{and } x \neq 2\}$

Domain of $g = \{x|x \text{ is a real number }\}$ and we have $g(-7) = 0$.

Domain of $f/g = \{x|x \text{ is a real number } \textit{and } x \neq 2$ $\textit{and } x \neq -7\}$

54. $f(x) = \dfrac{7x}{x - 2}$, $g(x) = 3x + 7$

Domain of $f = \{x|x \text{ is a real number } \textit{and } x \neq 2\}$

Domain of $g = \{x|x \text{ is a real number}\}$ and $g\left(-\dfrac{7}{3}\right) = 0$

Domain of $f/g = \left\{x|x \text{ is a real number } \textit{and } x \neq 2\right.$

$\left.\textit{and } x \neq -\dfrac{7}{3}\right\}$

56. $(F \cdot G)(6) = F(6) \cdot G(6) = 0(3.5) = 0$

$(F \cdot G)(9) = F(9) \cdot G(9) = 1 \cdot 2 = 2$

58. $(F/G)(3) = F(3)/G(3) = \dfrac{2}{1} = 2$

$(F/G)(7) = F(7)/G(7) = \dfrac{-1}{4} = -\dfrac{1}{4}$

60. Domain of $F = \{x|0 \leq x \leq 9\}$; $F(6) = 0$ and $F(8) = 0$

Domain of $G = \{x|3 \leq x \leq 10\}$

Domain of $F - G$ = Domain of $F \cdot G = \{x|3 \leq x \leq 9\}$

Domain of $G/F = \{x|3 \leq x \leq 9 \textit{ and } x \neq 6 \textit{ and } x \neq 8\}$

62. Let p = the number of points Isaiah scored. Then $p - 5$ = the number of points Terrence scored.

Solve: $p + p - 5 = 27$

$p = 16$, so Terrence scored $p - 5 = 16 - 5 = 11$ points.

64. $7x + 16 = 5x - 20$
$2x = -36$
$x = -18$

66. $fx) = \dfrac{3x}{2x+5}$, $g(x) = \dfrac{x^4 - 1}{3x + 9}$

Domain of $f = \left\{x | x \text{ is a real number } and\ x \neq -\frac{5}{2}\right\}$

Domain of $g = \{x | x \text{ is a real number } and\ x \neq -3\}$

$g(x) = 0$ when $x^4 - 1 = 0$ or when $x = 1$ *or* $x = -1$

Domain of $f/g = \Big\{x | x$ is a real number *and*

$x \neq -\frac{5}{2}$ *and* $x \neq -3$ *and* $x \neq 1$ *and* $x \neq -1\Big\}$

68. The inputs that are in the domains of both f and g are -2, -1, 0, and 1, so Domain of $f+g$ = Domain of $f-g$ = Domain of $f \cdot g = \{-2, -1, 0, 1\}$.

$g(-1) = 0$, so Domain of $f/g = \{-2, 0, 1\}$.

Chapter 2 Mid-Chapter Review

1. True; a function is a special type of relation in which each member of the domain is paired with exactly one member of the range.

2. False; see the definition of a function on page 85 of the text.

3. True; for a function $f(x) = c$, where c is a constant, all the inputs have the output c.

4. True; see the vertical-line test on page 90 of the text.

5. False; for example, see Exercise 3 above.

6. We substitute -2 for x and -1 for y (alphabetical order of variables.)

$5y + 6$	$= 4x$	
$5(-1) + 6$	? $4(-2)$	
$-5 + 6$	-8	
1		FALSE

Thus, $(-2, -1)$ is not a solution of the equation.

7. We substitute $\frac{1}{2}$ for a and 0 for b (alphabetical order of variables.)

$8a$	$= 4 - b$	
$8 \cdot \frac{1}{2}$	? $4 - 0$	
4	4	TRUE

Thus, $\left(\frac{1}{2}, 0\right)$ is a solution of the equation.

8. Yes; each member of the domain is matched to only one member of the range.

9. No; the number 15 in the domain is matched to 2 numbers of the range, 25 and 30.

10. The set of all x-values on the graph extends from -3 through 3, so the domain is $\{x| -3 \leq x \leq 3\}$, or $[-3, 3]$.

The set of all y-values on the graph extends from -2 through 1, so the range is $\{y| -2 \leq y \leq 1\}$, or $[-2, 1]$.

11. $g(x) = 2 + x$
$g(-5) = 2 + (-5) = -3$

12. $f(x) = x - 7$
$f(0) = 0 - 7 = -7$

13. $h(x) = 8$
$h\left(\frac{1}{2}\right) = 8$

14. $f(x) = 3x^2 - x + 5$
$f(-1) = 3(-1)^2 - (-1) + 5 = 3 \cdot 1 + 1 + 5 = 3 + 1 + 5 = 9$

15. $g(p) = p^4 - p^3$
$g(10) = 10^4 - 10^3 = 10,000 - 1000 = 9000$

16. $f(t) = \frac{1}{2}t + 3$
$f(-6) = \frac{1}{2}(-6) + 3 = -3 + 3 = 0$

17. No vertical line will intersect the graph more than once. Thus, the graph is the graph of a function.

18. It is possible for a vertical line to intersect the graph more than once. Thus, the graph is not the graph of a function.

19. No vertical line will intersect the graph more than once. Thus, the graph is the graph of a function.

20. $g(x) = \dfrac{3}{12 - 3x}$

Since $\dfrac{3}{12 - 3x}$ cannot be calculated when the denominator is 0, we find the x-value that causes $12 - 3x$ to be 0:

$12 - 3x = 0$
$12 = 3x$
$4 = x$

Thus, the domain of g is $\{x | x \text{ is a real number } and\ x \neq 4\}$, or $(-\infty, 4) \cup (4, \infty)$.

21. $f(x) = x^2 - 10x + 3$

Since we can calculate $x^2 - 10x + 3$ for any real number x, the domain is the set of all real numbers.

22. $h(x) = \dfrac{x - 2}{x + 2}$

Since $\dfrac{x-2}{x+2}$ cannot be calculated when the denominator is 0, we find the x-value that causes $x + 2$ to be 0:

$x + 2 = 0$
$x = -2$

Thus, the domain of g is $\{x | x \text{ is a real number } and\ x \neq -2\}$, or $(-\infty, -2) \cup (-2, \infty)$.

23. $f(x) = |x - 4|$

Since we can calculate $|x - 4|$ for any real number x, the domain is the set of all real numbers.

24. $y = -\frac{2}{3}x - 2$

We find some ordered pairs that are solutions.

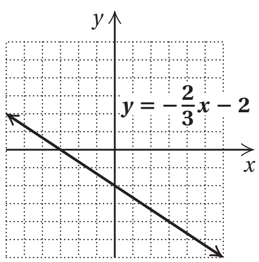
When $x = -3$, $y = -\frac{2}{3}(-3) - 2 = 2 - 2 = 0$.

When $x = 0$, $y = -\frac{2}{3} \cdot 0 - 2 = 0 - 2 = -2$.

When $x = 3$, $y = -\frac{2}{3} \cdot 3 - 2 = -2 - 2 = -4$.

x	y
-3	0
0	-2
3	-4

Plot these points, draw the line they determine, and label it $y = -\frac{2}{3}x - 2$.



25. $f(x) = x - 1$

We find some ordered pairs that are solutions.

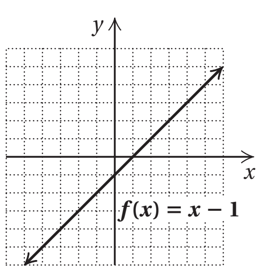
$f(-3) = -3 - 1 = -4$.

$f(0) = 0 - 1 = -1$.

$f(4) = 4 - 1 = 3$.

x	$f(x)$
-3	-4
0	-1
4	3

Plot these points, draw the line they determine, and label it $f(x) = x - 1$.



26. $h(x) = 2x + \frac{1}{2}$

We find some ordered pairs that are solutions.

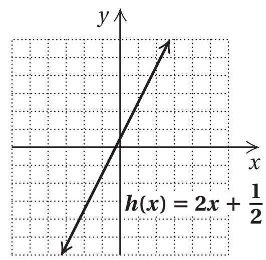
When $x = -2$, $y = 2(-2) + \frac{1}{2} = -4 + \frac{1}{2} = -3\frac{1}{2}$.

When $x = 0$, $y = 2 \cdot 0 + \frac{1}{2} = 0 + \frac{1}{2} = \frac{1}{2}$.

When $x = 2$, $y = 2 \cdot 2 + \frac{1}{2} = 4 + \frac{1}{2} = 4\frac{1}{2}$.

x	$h(x)$
-2	$-3\frac{1}{2}$
0	$\frac{1}{2}$
2	$4\frac{1}{2}$

Plot these points, draw the line they determine, and label it $h(x) = 2x + \frac{1}{2}$.



27. $g(x) = |x| - 3$

We find some ordered pairs that are solutions.

$g(-4) = |-4| - 3 = 4 - 3 = 1$

$g(-1) = |-1| - 3 = 1 - 3 = -2$

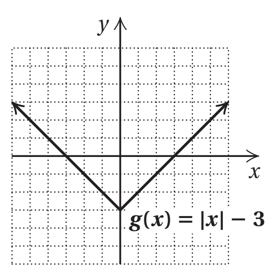
$g(0) = |0| - 3 = 0 - 3 = -3$

$g(2) = |2| - 3 = 2 - 3 = -1$

$g(3) = |3| - 3 = 3 - 3 = 0$

x	$g(x)$
-4	1
-1	-2
0	-3
2	-1
3	0

Plot these points, draw the line they determine, and label it $g(x) = |x| - 3$.



28. $y = 1 + x^2$

We find some ordered pairs that are solutions.

When $x = -2$, $y = 1 + (-2)^2 = 1 + 4 = 5$.

When $x = -1$, $y = 1 + (-1)^2 = 1 + 1 = 2$.

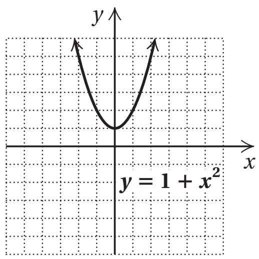
When $x = 0$, $y = 1 + 0^2 = 1 + 0 = 1$.

When $x = 1$, $y = 1 + 1^2 = 1 + 1 = 2$.

When $x = 2$, $y = 1 + 2^2 = 1 + 4 = 5$.

x	y
-2	5
-1	2
0	1
1	2
2	5

Plot these points, draw the line they determine, and label it $y = 1 + x^2$.



29. $f(x) = -\frac{1}{4}x$

We find some ordered pairs that are solutions.

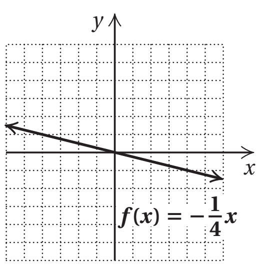
$f(-4) = -\frac{1}{4}(-4) = 1$

$f(0) = -\frac{1}{4} \cdot 0 = 0$

$f(4) = -\frac{1}{4} \cdot 4 = -1$

x	$f(x)$
-4	1
0	0
4	-1

Plot these points, draw the line they determine, and label it $f(x) = -\frac{1}{4}x$.



30.
$$\begin{aligned}(f-g)(x) &= f(x) - g(x)\\ &= 3x - 1 - (x^2 + 2)\\ &= 3x - 1 - x^2 - 2\\ &= -x^2 + 3x - 3\end{aligned}$$

31. $f(-2) = 3(-2) - 1 = -6 - 1 = -7$

$g(-2) = (-2)^2 + 2 = 4 + 2 = 6$

$f(-2) \cdot g(-2) = -7 \cdot 6 = -42$

32. $(g/f)(a) = g(a)/f(a) = \dfrac{a^2+2}{3a-1}$

33. $f(x) = 5x^2$, $g(x) = x + 4$

Domain of f = Domain of $g = \{x|x \text{ is a real number}\}$

Domain of $f + g$ = Domain of $f - g$ = Domain of $f \cdot g = \{x|x \text{ is a real number}\}$

Since $g(x) = 0$ when $x = -4$, we have Domain of $f/g = \{x|x \text{ is a real number } \textit{and } x \neq -4\}$.

34. $f(x) = \dfrac{7}{x-9}$, $g(x) = 6 - x$

Domain of $f = \{x|x \text{ is a real number } \textit{and } x \neq 9\}$

Domain of $g = \{x|x \text{ is a real number}\}$

Domain of $f + g$ = Domain of $f - g$ = Domain of $f \cdot g = \{x|x \text{ is a real number } \textit{and } x \neq 9\}$

Since $g(x) = 0$ when $x = 6$, we have Domain of $f/g = \{x|x \text{ is a real number } \textit{and } x \neq 9 \textit{ and } x \neq 6\}$.

35. No; since each input has exactly one output, the number of outputs cannot exceed the number of inputs.

36. When $x < 0$, then $y < 0$ and the graph contains points in quadrant III. When $0 < x < 30$, then $y < 0$ and the graph contains points in quadrant IV. When $x > 30$, then $y > 0$ and the graph contains points in quadrant I. Thus, the graph passes through three quadrants.

37. The output -3 corresponds to the input 2. The number -3 in the range is paired with the number 2 in the domain. The point $(2, -3)$ is on the graph of the function.

38. The domain of a function is the set of all inputs, and the range is the set of all outputs.

Exercise Set 2.5

RC2. $m = \dfrac{-3-0}{-3-(-2)} = \dfrac{-3}{-1} = 3$

The answer is (b).

RC4. This is a horizontal line, so the slope is 0. The answer is (c).

RC6. $m = \dfrac{1-(-2)}{-1-3} = \dfrac{3}{-4} = -\dfrac{3}{4}$

The answer is (a).

2. Slope is -5; y-intercept is $(0, 10)$.

4. Slope is -5; y-intercept is $(0, 7)$.

6. Slope is $\frac{15}{7}$; y-intercept is $\left(0, \frac{16}{5}\right)$.

8. Slope is -3.1; y-intercept is $(0, 5)$.

10.
$$\begin{aligned}-8x - 7y &= 24\\ -7y &= 8x + 24\\ y &= -\frac{8}{7}x - \frac{24}{7}\end{aligned}$$

Slope is $-\frac{8}{7}$; y-intercept is $\left(0, -\frac{24}{7}\right)$.

12. $$\begin{aligned} 9y + 36 - 4x &= 0 \\ 9y &= 4x - 36 \\ y &= \frac{4}{9}x - 4 \end{aligned}$$

Slope is $\frac{4}{9}$; y-intercept is $(0, -4)$.

14. $$\begin{aligned} 5x &= \frac{2}{3}y - 10 \\ 5x + 10 &= \frac{2}{3}y \\ \frac{15}{2}x + 15 &= y \end{aligned}$$

Slope is $\frac{15}{2}$; y-intercept is $(0, 15)$.

16. $$\begin{aligned} 3y - 2x &= 5 + 9y - 2x \\ -6y &= 5 \\ y &= -\frac{5}{6}, \text{ or } 0x - \frac{5}{6} \end{aligned}$$

Slope is 0; y-intercept is $\left(0, -\frac{5}{6}\right)$.

18. We can use any two points on the line, such as $(-3, -4)$ and $(0, -3)$.

$$\begin{aligned} m &= \frac{\text{change in } y}{\text{change in } x} \\ &= \frac{-3 - (-4)}{0 - (-3)} = \frac{1}{3} \end{aligned}$$

20. We can use any two points on the line, such as $(2, 4)$ and $(4, 0)$.

$$\begin{aligned} m &= \frac{\text{change in } y}{\text{change in } x} \\ &= \frac{0 - 4}{4 - 2} = \frac{-4}{2} = -2 \end{aligned}$$

22. Slope $= \dfrac{-1 - 7}{2 - 8} = \dfrac{-8}{-6} = \dfrac{4}{3}$

24. Slope $= \dfrac{-15 - (-12)}{-9 - 17} = \dfrac{-3}{-26} = \dfrac{3}{26}$

26. Slope $= \dfrac{-17.6 - (-7.8)}{-12.5 - 14.4} = \dfrac{-9.8}{-26.9} = \dfrac{98}{269}$

28. $m = \dfrac{43.33}{1238} = \dfrac{7}{200}$, or about 3.5%

30. $m = \dfrac{7}{11} = 0.\overline{63} = 63.\overline{63}\%$

32. Rate of change $= \dfrac{16 - 5.4}{2050 - 2011} = \dfrac{10.6}{39} \approx 0.27$

The rate of change is about 0.27 million, or 270,000 people per year.

34. We can use the coordinates of any two points on the line. We'll use $(0, 100)$ and $(9, 40)$.

Slope $= \dfrac{\text{change in } y}{\text{change in } x} = \dfrac{40 - 100}{9 - 0} = \dfrac{-60}{9} = -\dfrac{20}{3}$,

or $-6\frac{2}{3}$m per second

36. Rate of change $= \dfrac{41 - 33}{2012 - 2002} = \dfrac{8}{10} = 0.8$

The rate of change is 0.8 million, or 800,000 people per year.

38. $$\begin{aligned} & 9\{2x - 3[5x + 2(-3x + y^0 - 2)]\} \\ &= 9\{2x - 3[5x + 2(-3x + 1 - 2)]\} \quad (y^0 = 1) \\ &= 9\{2x - 3[5x + 2(-3x - 1)]\} \\ &= 9\{2x - 3[5x - 6x - 2]\} \\ &= 9\{2x - 3[-x - 2]\} \\ &= 9\{2x + 3x + 6\} \\ &= 9\{5x + 6\} \\ &= 45x + 54 \end{aligned}$$

40. $$\begin{aligned} & 5^4 \div 625 \div 5^2 \cdot 5^7 \div 5^3 \\ &= 1 \div 5^2 \cdot 5^7 \div 5^3 \\ &= 5^{-2} \cdot 5^7 \div 5^3 \\ &= 5^5 \div 5^3 \\ &= 5^2, \text{ or } 25 \end{aligned}$$

42. $|5x - 8| \geq 32$

$$\begin{aligned} 5x - 8 &\leq -32 \quad \textit{or} \quad 5x - 8 \geq 32 \\ 5x &\leq -24 \quad \textit{or} \quad 5x \geq 40 \\ x &\leq -\frac{24}{5} \quad \textit{or} \quad x \geq 8 \end{aligned}$$

The solution set is $\left\{x \middle| x \leq -\frac{24}{5} \textit{ or } x \geq 8\right\}$, or

$\left(-\infty, -\frac{24}{5}\right] \cup [8, \infty)$.

44. $|5x - 8| = 32$

$$\begin{aligned} 5x - 8 &= -32 \quad \textit{or} \quad 5x - 8 = 32 \\ 5x &= -24 \quad \textit{or} \quad 5x = 40 \\ x &= -\frac{24}{5} \quad \textit{or} \quad x = 8 \end{aligned}$$

The solution set is $\left\{-\frac{24}{5}, 8\right\}$.

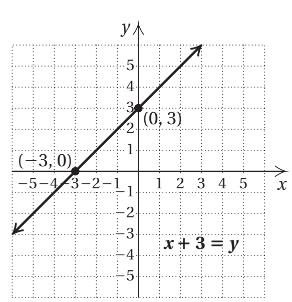
Exercise Set 2.6

RC2. False; the y-intercept of $y = -2x + 7$ is $(0, 7)$.

RC4. True

RC6. False; see page 209 in the text.

2.



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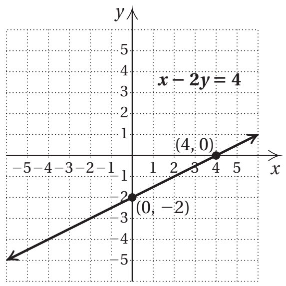

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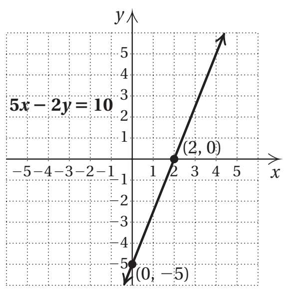

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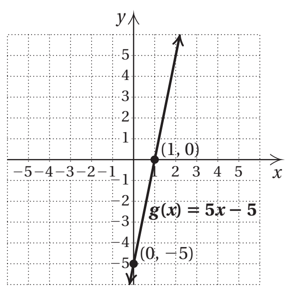

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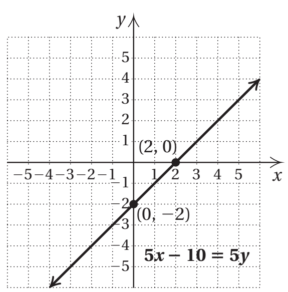
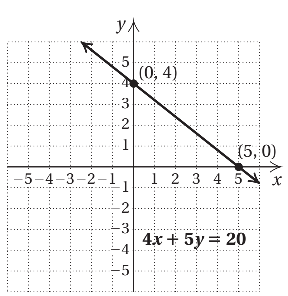
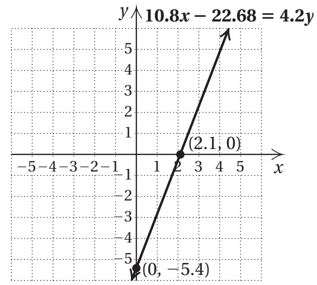


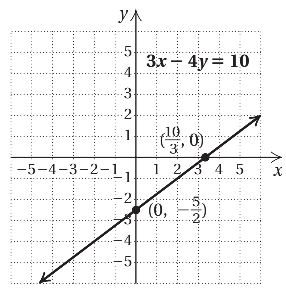
12.



14.



16.

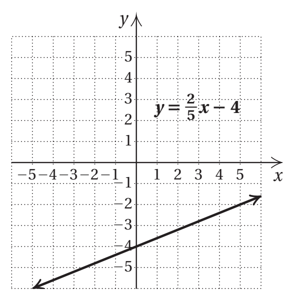


18. $y = \frac{2}{5}x - 4$

Slope: $\frac{2}{5}$; y-intercept: $(0, -4)$

Starting at $(0, -4)$, find another point by moving 2 units up and 5 units to the right to $(5, -2)$.

Starting at $(0, -4)$ again, move 2 units down and 5 units to the left to $(-5, -6)$.

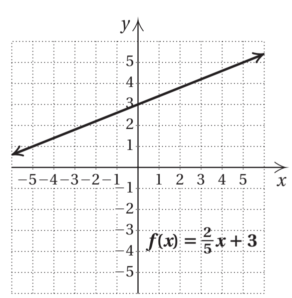


20. $y = \frac{2}{5}x + 3$

Slope: $\frac{2}{5}$; y-intercept: $(0, 3)$

Starting at $(0, 3)$, find another point by moving 2 units up and 5 units to the right to $(5, 5)$.

Starting at $(0, 3)$ again, move 2 units down and 5 units to the left to $(-5, 1)$.



22. $x - 3y = 6$

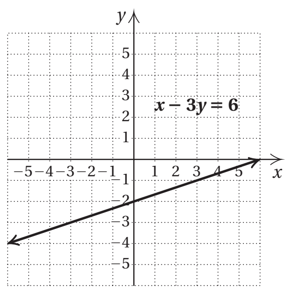
$$-3y = -x + 6$$

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

Slope: $\frac{1}{3}$; y-intercept: $(0, -2)$

Starting at $(0, -2)$, find another point by moving 1 unit up and 3 units to the right to $(3, -1)$.

From $(3, -1)$, move 1 unit up and 3 units to the left again to $(6, 0)$.



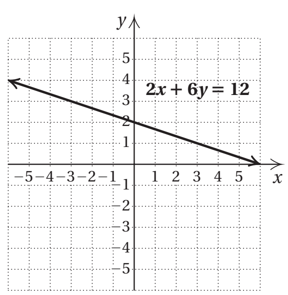
24. $2x + 6y = 12$

$$6y = -2x + 12$$

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

Slope: $-\frac{1}{3}$; y-intercept: $(0, 2)$

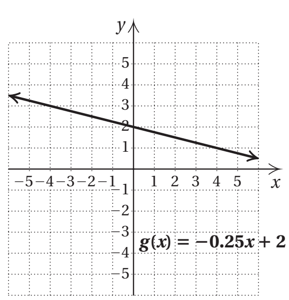
Starting at $(0, 2)$, find another point by moving 1 unit up and 3 units to the left to $(-3, 3)$. Starting at $(0, 2)$ again, move 1 unit down and 3 units to the right to $(3, 1)$.



26. $g(x) = -0.25x + 2$

Slope: -0.25, or $-\frac{1}{4}$; y-intercept: $(0, 2)$

Starting at $(0, 2)$, find another point by moving 1 unit up and 4 units to the left to $(-4, 3)$. Starting at $(0, 2)$ again, move 1 unit down and 4 units to the right to $(4, 1)$.

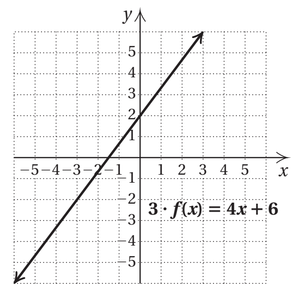


28. $3 \cdot f(x) = 4x + 6$

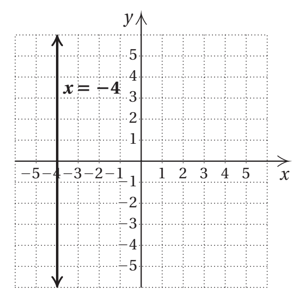
$$f(x) = \frac{4}{3}x + 2$$

Slope: $\frac{4}{3}$; y-intercept: $(0, 2)$

Starting at $(0, 2)$, find another point by moving 4 units up and 3 units to the right to $(3, 6)$. Starting at $(0, 2)$ again, move 4 units down and 3 units to the left to $(-3, -2)$.

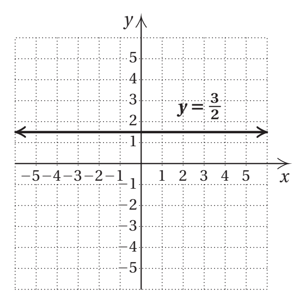


30.



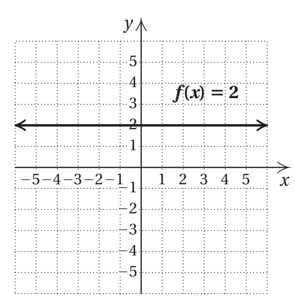
The slope is not defined.

32.



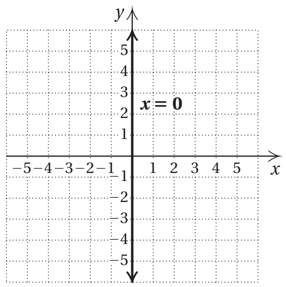
The slope is 0.

34.



The slope is 0.

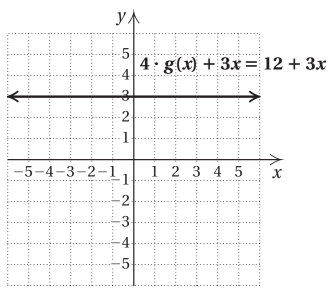
36.



The slope is not defined.

38. $4 \cdot g(x) + 3x = 12 + 3x$

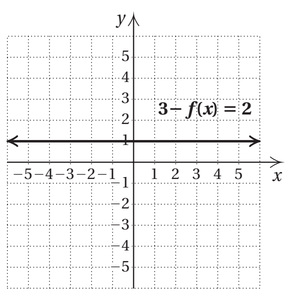
$$4 \cdot g(x) = 12$$
$$g(x) = 3$$



The slope is 0.

40. $3 - f(x) = 2$

$$1 = f(x)$$



The slope is 0.

42. Write both equations in slope-intercept form.

$y = 2x - 7 \quad (m = 2)$

$y = 2x + 8 \quad (m = 2)$

The slopes are the same and the y-intercepts are different, so the lines are parallel.

44. Write both equations in slope-intercept form.

$y = -6x - 8 \quad (m = -6)$

$y = 2x + 5 \quad (m = 2)$

The slopes are not the same, so the lines are not parallel.

46. Write both equations in slope-intercept form.

$y = -7x - 9 \quad (m = -7)$

$y = -7x - \dfrac{7}{3} \quad (m = -7)$

The slopes are the same and the y-intercepts are different, so the lines are parallel.

48. The graph of $5y = -2$, or $y = -\dfrac{2}{5}$, is a horizontal line; the graph of $\dfrac{3}{4}x = 16$, or $x = \dfrac{64}{3}$, is a vertical line. Thus, the graphs are not parallel.

50. Write both equations in slope-intercept form.

$y = \dfrac{2}{5}x + \dfrac{3}{5} \quad \left(m = \dfrac{2}{5}\right)$

$y = -\dfrac{2}{5}x + \dfrac{4}{5} \quad \left(m = -\dfrac{2}{5}\right)$

$\dfrac{2}{5}\left(-\dfrac{2}{5}\right) = -\dfrac{4}{25} \neq -1$, so the lines are not perpendicular.

52. $y = -x + 7 \quad (m = -1)$

$y = x + 3 \quad (m = 1)$

$-1 \cdot 1 = -1$, so the lines are perpendicular.

54. $y = x \quad (m = 1)$

$y = -x \quad (m = -1)$

$1(-1) = -1$, so the lines are perpendicular.

56. Since the graphs of $-5y = 10$, or $y = -2$, and $y = -\dfrac{4}{9}$ are both horizontal lines, they are not perpendicular.

58. Move the decimal point 5 places to the right. The number is small, so the exponent is negative.

$0.000047 = 4.7 \times 10^{-5}$

60. Move the decimal point 7 places to the left. The number is large, so the exponent is positive.

$99,902,000 = 9.9902 \times 10^7$

62. The exponent is positive, so the number is large. Move the decimal point 8 places to the right.

$9.01 \times 10^8 = 901,000,000$

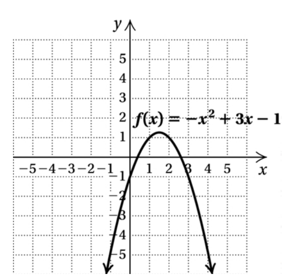
64. The exponent is negative, so the number is small. Move the decimal point 2 places to the left.

$8.5677 \times 10^{-2} = 0.085677$

66. $12a + 21ab = 3a(4 + 7b)$

68. $64x - 128y + 256 = 64(x - 2y + 4)$

70.



72. $x + 7y = 70$

$y = -\dfrac{1}{7}x + 10 \quad \left(m = -\dfrac{1}{7}\right)$

$y + 3 = kx$

$y = kx - 3 \quad (m = k)$

In order for the graphs to be perpendicular, the product of the slopes must be -1.

$$-\frac{1}{7}\cdot k = -1$$
$$k = 7$$

74. The x-coordinate must be -4, and the y-coordinate must be 5. The point is $(-4, 5)$.

76. All points on the y-axis are pairs of the form $(0, y)$. Thus any number for y will do and x must be 0. The equation is $x = 0$. The graph fails the vertical-line test, so the equation is not a function.

78.
$$\begin{aligned} 2y &= -7x + 3b \\ 2(-13) &= -7\cdot 0 + 3b \\ -26 &= 3b \\ -\frac{26}{3} &= b \end{aligned}$$

Exercise Set 2.7

RC2. $y = -5$ is a horizontal line, so its slope is 0.

a) 0

b) not defined

RC4. $y = -\frac{5}{6}x + \frac{4}{3}$

a) $-\frac{5}{6}$

b) $\frac{6}{5}$

RC6.
$$\begin{aligned} 10x + 5y &= 14 \\ 5y &= -10x + 14 \\ y &= -2x + \frac{14}{5} \end{aligned}$$

a) -2

b) $\frac{1}{2}$

2. $y = 5x - 3$

4. $y = -9.1x + 2$

6. $f(x) = \frac{4}{5}x + 28$

8. $f(x) = -\frac{7}{8}x - \frac{7}{11}$

10. Using the point-slope equation:
$$\begin{aligned} y - y_1 &= m(x - x_1) \\ y - 2 &= 4(x - 5) \\ y - 2 &= 4x - 20 \\ y &= 4x - 18 \end{aligned}$$
Using the slope-intercept equation:
$$\begin{aligned} y &= mx + b \\ 2 &= 4\cdot 5 + b \\ -18 &= b \end{aligned}$$
$$y = 4x - 18$$

12. Using the point-slope equation:
$$\begin{aligned} y - y_1 &= m(x - x_1) \\ y - 8 &= -2(x - 2) \\ y - 8 &= -2x + 4 \\ y &= -2x + 12 \end{aligned}$$
Using the slope-intercept equation:
$$\begin{aligned} y &= mx + b \\ 8 &= -2\cdot 2 + b \\ 12 &= b \end{aligned}$$
$$y = -2x + 12$$

14. Using the point-slope equation:
$$\begin{aligned} y - y_1 &= m(x - x_1) \\ y - (-2) &= 3(x - (-2)) \\ y + 2 &= 3(x + 2) \\ y + 2 &= 3x + 6 \\ y &= 3x + 4 \end{aligned}$$
Using the slope-intercept equation:
$$\begin{aligned} y &= mx + b \\ -2 &= 3(-2) + b \\ 4 &= b \end{aligned}$$
$$y = 3x + 4$$

16. Using the point-slope equation:
$$\begin{aligned} y - y_1 &= m(x - x_1) \\ y - 0 &= -3(x - (-2)) \\ y &= -3(x + 2) \\ y &= -3x - 6 \end{aligned}$$
Using the slope-intercept equation:
$$\begin{aligned} y &= mx + b \\ 0 &= -3(-2) + b \\ -6 &= b \end{aligned}$$
$$y = -3x - 6$$

18. Using the point-slope equation:
$$\begin{aligned} y - y_1 &= m(x - x_1) \\ y - 4 &= 0(x - 0) \\ y - 4 &= 0 \\ y &= 4 \end{aligned}$$
Using the slope-intercept equation:
$$\begin{aligned} y &= mx + b \\ 4 &= 0\cdot 0 + b \\ 4 &= b \end{aligned}$$
$$y = 0x + 4, \text{ or } y = 4$$

20. Using the point-slope equation:

$$y - y_1 = m(x - x_1)$$
$$y - 3 = -\frac{4}{5}(x - 2)$$
$$y - 3 = -\frac{4}{5}x + \frac{8}{5}$$
$$y = -\frac{4}{5}x + \frac{23}{5}$$

Using the slope-intercept equation:

$$y = mx + b$$
$$3 = -\frac{4}{5} \cdot 2 + b$$
$$\frac{23}{5} = b$$

$$y = -\frac{4}{5}x + \frac{23}{5}$$

22. $m = \dfrac{7-5}{4-2} = \dfrac{2}{2} = 1$

Using the point-slope equation:

$$y - y_1 = m(x - x_1)$$
$$y - 5 = 1(x - 2)$$
$$y - 5 = x - 2$$
$$y = x + 3$$

Using the slope-intercept equation:

$$y = mx + b$$
$$5 = 1 \cdot 2 + b$$
$$3 = b$$

$y = 1 \cdot x + 3$, or $y = x + 3$

24. $m = \dfrac{9-(-1)}{9-(-1)} = \dfrac{10}{10} = 1$

Using the point-slope equation:

$$y - y_1 = m(x - x_1)$$
$$y - 9 = 1(x - 9)$$
$$y - 9 = x - 9$$
$$y = x$$

Using the slope-intercept equation:

$$y = mx + b$$
$$9 = 1 \cdot 9 + b$$
$$0 = b$$

$y = 1 \cdot x + 0$, or $y = x$

26. $m = \dfrac{0-(-5)}{3-0} = \dfrac{5}{3}$

Using the point-slope equation:

$$y - y_1 = m(x - x_1)$$
$$y - 0 = \frac{5}{3}(x - 3)$$
$$y = \frac{5}{3}x - 5$$

Using the slope-intercept equation:

$$y = mx + b$$
$$-5 = \frac{5}{3} \cdot 0 + b$$
$$-5 = b$$

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

28. $m = \dfrac{-1-(-7)}{-2-(-4)} = \dfrac{6}{2} = 3$

Using the point-slope equation:

$$y - y_1 = m(x - x_1)$$
$$y - (-7) = 3(x - (-4))$$
$$y + 7 = 3(x + 4)$$
$$y + 7 = 3x + 12$$
$$y = 3x + 5$$

Using the slope-intercept equation:

$$y = mx + b$$
$$-7 = 3(-4) + b$$
$$5 = b$$

$$y = 3x + 5$$

30. $m = \dfrac{7-0}{-4-0} = -\dfrac{7}{4}$

Using the point-slope equation:

$$y - y_1 = m(x - x_1)$$
$$y - 0 = -\frac{7}{4}(x - 0)$$
$$y = -\frac{7}{4}x$$

Using the slope-intercept equation:

$$y = mx + b$$
$$0 = -\frac{7}{4} \cdot 0 + b$$
$$0 = b$$

$y = -\frac{7}{4}x + 0$, or $y = -\frac{7}{4}x$

32. $m = \dfrac{\frac{5}{6} - \frac{3}{2}}{-3 - \frac{2}{3}} = \dfrac{-\frac{4}{6}}{-\frac{11}{3}} = \dfrac{2}{11}$

Using the point-slope equation:

$$y - y_1 = m(x - x_1)$$
$$y - \frac{5}{6} = \frac{2}{11}(x - (-3))$$
$$y - \frac{5}{6} = \frac{2}{11}(x + 3)$$
$$y - \frac{5}{6} = \frac{2}{11}x + \frac{6}{11}$$
$$y = \frac{2}{11}x + \frac{91}{66}$$

Using the slope-intercept equation:

$$y = mx + b$$
$$\frac{5}{6} = \frac{2}{11}(-3) + b$$
$$\frac{91}{66} = b$$
$$y = \frac{2}{11}x + \frac{91}{66}$$

34. $2x - y = 7$ Given line

$$y = 2x - 7 \qquad m = 2$$

Using the slope, 2, and the y-intercept $(0, 3)$, we write the equation of the line: $y = 2x + 3$.

36. $2x + y = -3$ Given line

$$y = -2x - 3 \qquad m = -2$$

Using the point-slope equation:

$$y - y_1 = m(x - x_1)$$
$$y - (-5) = -2(x - (-4))$$
$$y + 5 = -2(x + 4)$$
$$y + 5 = -2x - 8$$
$$y = -2x - 13$$

Using the slope-intercept equation:

$$y = mx + b$$
$$-5 = -2(-4) + b$$
$$-13 = b$$
$$y = -2x - 13$$

38. $5x + 2y = 6$ Given line

$$y = -\frac{5}{2} + 3 \qquad m = -\frac{5}{2}$$

Using the point-slope equation:

$$y - y_1 = m(x - x_1)$$
$$y - 0 = -\frac{5}{2}(x - (-7))$$
$$y = -\frac{5}{2}(x + 7)$$
$$y = -\frac{5}{2}x - \frac{35}{2}$$

Using the slope-intercept equation:

$$y = mx + b$$
$$0 = -\frac{5}{2}(-7) + b$$
$$-\frac{35}{2} = b$$
$$y = -\frac{5}{2}x - \frac{35}{2}$$

40. $x - 3y = 9$ Given line

$$y = \frac{1}{3}x - 3 \qquad m = \frac{1}{3}$$

Using the point-slope equation:

$$y - y_1 = m(x - x_1)$$
$$y - 1 = -3(x - 4)$$
$$y - 1 = -3x + 12$$
$$y = -3x + 13$$

Using the slope-intercept equation:

$$y = mx + b$$
$$1 = -3 \cdot 4 + b$$
$$13 = b$$
$$y = -3x + 13$$

42. $5x - 2y = 4$ Given line

$$y = \frac{5}{2}x - 2 \qquad m = \frac{5}{2}$$

Using the point-slope equation:

$$y - y_1 = m(x - x_1)$$
$$y - (-5) = -\frac{2}{5}(x - (-3))$$
$$y + 5 = -\frac{2}{5}(x + 3)$$
$$y + 5 = -\frac{2}{5}x - \frac{6}{5}$$
$$y = -\frac{2}{5}x - \frac{31}{5}$$

Using the slope-intercept equation:

$$y = mx + b$$
$$-5 = -\frac{2}{5}(-3) + b$$
$$-\frac{31}{5} = b$$
$$y = -\frac{2}{5}x - \frac{31}{5}$$

44. $-3x + 6y = 2$ Given line

$$y = \frac{1}{2}x + \frac{1}{3} \qquad m = \frac{1}{2}$$

Using the point-slope equation:

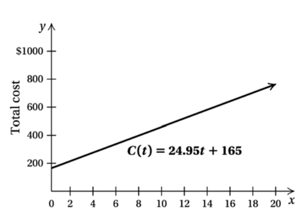
$$y - y_1 = m(x - x_1)$$
$$y - (-4) = -2(x - (-3))$$
$$y + 4 = -2(x + 3)$$
$$y + 4 = -2x - 6$$
$$y = -2x - 10$$

Using the slope-intercept equation:

$$y = mx + b$$
$$-4 = -2(-3) + 6$$
$$-10 = b$$
$$y = -2x - 10$$

46. a) $C(t) = 24.95t + 165$

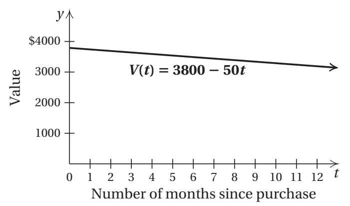
b)



c) $C(14) = 24.95(14) + 165 = \$514.30$

48. a) $V(t) = 3800 - 50t$

b)



c) $V(10.5) = 3800 - 50(10.5) = \$3275$

50. a) The data points are $(0, 174)$ and $(5, 245)$.

$$m = \frac{245 - 174}{5 - 0} = \frac{71}{5} = 14.2$$

Using the slope and the y-intercept, we write the function:

$D(x) = 14.2x + 174$, where x is the number of years since 2007 and $D(x)$ is in billions of dollars.

b) In 2010, $x = 2010 - 2007 = 3$.

$D(3) = 14.2(3) + 174 = \$216.6$ billion

In 2015, $x = 2015 - 2007 = 8$.

$D(8) = 14.2(8) + 174 = \$287.6$ billion

52. a) The data points are $(0, 46.8)$ and $(40, 43.8)$.

$$m = \frac{43.8 - 46.8}{40 - 0} = \frac{-3}{40} = -0.075$$

Using the slope and the y-intercept, we write the function $R(x) = -0.075x + 46.8$.

b) $R(73) = -0.075(73) + 46.8 = 41.325$ sec

$R(76) = -0.075(76) + 46.8 = 41.1$ sec

c) Solve: $-0.075x + 46.8 = 40$

$$x \approx 91$$

The record will be 40 sec about 91 yr after 1930, or in 2021.

54. a) The data points are $(0, 79.27)$ and $(8, 89.73)$.

$$m = \frac{89.73 - 79.27}{8 - 0} = \frac{10.46}{8} \approx 1.308$$

Using the slope and the y-intercept we write the function:

$E(t) = 1.308t + 79.27$, where t is the number of years since 2003.

b) In 2016, $t = 2016 - 2003 = 13$.

$E(13) = 1.308(13) + 79.27 \approx 96.27$ years

56. $|2x + 3| = 51$

$$\begin{aligned} 2x + 3 &= 51 \quad \text{or} \quad 2x + 3 = -51 \\ 2x &= 48 \quad \text{or} \quad 2x = -54 \\ x &= 24 \quad \text{or} \quad x = -27 \end{aligned}$$

The solution set is $\{24, -27\}$.

58. $2x + 3 \le 5x - 4$

$$\begin{aligned} 7 &\le 3x \\ \frac{7}{3} &\le x \end{aligned}$$

The solution set is $\left\{x \middle| x \ge \frac{7}{3}\right\}$, or $\left[\frac{7}{3}, \infty\right)$.

60. $|2x + 3| = |x - 4|$

$$\begin{aligned} 2x + 3 = x - 4 \quad &\text{or} \quad 2x + 3 = -(x - 4) \\ x = -7 \quad &\text{or} \quad 2x + 3 = -x + 4 \\ x = -7 \quad &\text{or} \quad 3x = 1 \\ x = -7 \quad &\text{or} \quad x = \frac{1}{3} \end{aligned}$$

The solution set is $\left\{-7, \frac{1}{3}\right\}$.

62. $-12 \le 2x + 3 < 51$

$$\begin{aligned} -15 &\le 2x < 48 \\ -\frac{15}{2} &\le x < 24 \end{aligned}$$

The solution set is $\left\{x \middle| -\frac{15}{2} \le x < 24\right\}$, or $\left[-\frac{15}{2}, 24\right)$.

64. First find the slope of the line through $(-1, 3)$ and $(2, 9)$.

$$m = \frac{9 - 3}{2 - (-1)} = \frac{6}{3} = 2$$

Then the slope of a line perpendicular to this line is $-\frac{1}{2}$.

Now we find the equation of the line with slope $-\frac{1}{2}$ passing through $(4, 5)$.

$$\begin{aligned} y - y_1 &= m(x - x_1) \\ y - 5 &= -\frac{1}{2}(x - 4) \\ y - 5 &= -\frac{1}{2}x + 2 \\ y &= -\frac{1}{2}x + 7 \end{aligned}$$

Chapter 2 Vocabulary Reinforcement

1. The graph of $x = a$ is a vertical line with x-intercept $(a, 0)$.
2. The point-slope equation of a line with slope m and passing through (x_1, y_1) is $y - y_1 = m(x - x_1)$.
3. A function is a correspondence between a first set, called the domain, and a second set, called the range, such that each member of the domain corresponds to exactly one member of the range.
4. The slope of a line containing points (x_1, y_1) and (x_2, y_2) is given by $m =$ the change in y/the change in x, also described as rise/run.

5. Two lines are perpendicular if the product of their slopes is -1.

6. The equation $y = mx+b$ is called the slope-intercept equation of a line with slope m and y-intercept $(0, b)$.

7. Lines are parallel if they have the same slope and different y-intercepts.

Chapter 2 Concept Reinforcement

1. False; the slope of a vertical line is not defined. See page 123 in the text.

2. True; see page 113 in the text.

3. False; parallel lines have the same slope and *different* y-intercepts. See page 124 in the text.

Chapter 2 Study Guide

1. A member of the domain is matched to more than one member of the range, so the correspondence is not a function.

2. $$g(x) = \frac{1}{2}x - 2$$
$$g(0) = \frac{1}{2}\cdot 0 - 2 = 0 - 2 = -2$$
$$g(-2) = \frac{1}{2}(-2) - 2 = -1 - 2 = -3$$
$$g(6) = \frac{1}{2}\cdot 6 - 2 = 3 - 2 = 1$$

3. $y = \frac{2}{5}x - 3$

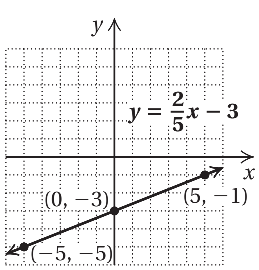
We find some ordered pairs that are solutions, plot them, and draw and label the line.

When $x = -5$, $y = \frac{2}{5}(-5) - 3 = -2 - 3 = -5$.

When $x = 0$, $y = \frac{2}{5}\cdot 0 - 3 = 0 - 3 = -3$.

When $x = 5$, $y = \frac{2}{5}\cdot 5 - 3 = 2 - 3 = -1$.

x	y
-5	-5
0	-3
5	-1



4. No vertical line can cross the graph at more than one point, so the graph is that of a function.

5. The set of all x-values on the graph extends from -4 through 5, so the domain is $\{x| -4 \le x \le 5\}$, or $[-4, 5]$.

The set of all y-values on the graph extends from -2 through 4, so the range is $\{y| -2 \le y \le 4\}$, or $[-2, 4]$.

6. Since $\frac{x-3}{3x+9}$ cannot be calculated when $3x+9$ is 0, we solve $3x + 9 = 0$.
$$3x + 9 = 0$$
$$3x = -9$$
$$x = -3$$
Thus, the domain of g is $\{x|x$ is a real number *and* $x \ne -3\}$, or $(-\infty, -3) \cup (-3, \infty)$.

7. $f(x) = 2x^2 + 3$, $g(x) = 1 - x$

a) $$(f+g)(x) = f(x) + g(x) = 2x^2 + 3 + 1 - x = 2x^2 - x + 4$$

b) $f(-4) = 2(-4)^2 + 3 = 2\cdot 16 + 3 = 32 + 3 = 35$
$g(-4) = 1 - (-4) = 1 + 4 = 5$
$(f-g)(-4) = 35 - 5 = 30$

c) $f(6) = 2\cdot 6^2 + 3 = 2\cdot 36 + 3 = 72 + 3 = 75$
$g(6) = 1 - 6 = -5$
$(f/g)(6) = \frac{75}{-5} = -15$

d) $f(1) = 2\cdot 1^2 + 3 = 2 + 3 = 5$
$g(1) = 1 - 1 = 0$
$(f\cdot g)(1) = 5\cdot 0 = 0$

8. $f(x) = \frac{6}{4x+3}$, $g(x) = x - 2$

We have $4x + 3 = 0$ when $x = -\frac{3}{4}$, so Domain of $f = \left\{x \middle| x \text{ is a real number } and\ x \ne -\frac{3}{4}\right\}$

Domain of $g = \{x|x$ is a real number$\}$

Domain of $f+g$ = Domain of $f-g$ = Domain of $f\cdot g = \left\{x \middle| x \text{ is a real number } and\ x \ne -\frac{3}{4}\right\}$

Since $g(x) = 0$ when $x = 2$, we have Domain of $f/g = \left\{x \middle| x \text{ is a real number } and\ x \ne -\frac{3}{4}\ and\ x \ne 2\right\}$.

9. $m = \frac{-8-2}{2-(-3)} = \frac{-10}{5} = -2$

10. $$3x = -6y + 12$$
$$3x - 12 = -6y$$
$$-\frac{1}{2}x + 2 = y \qquad \text{Dividing by } -6$$
The slope is $-\frac{1}{2}$, and the y-intercept is $(0, 2)$.

11. $3y - 3 = x$

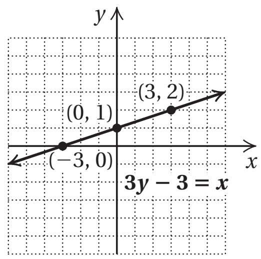
To find the y-intercept, let $x = 0$ and solve for y.
$$3y - 3 = 0$$
$$3y = 3$$
$$y = 1$$
The y-intercept is $(0, 1)$.

To find the x-intercept, let $y = 0$ and solve for x.

$$\begin{aligned} 3 \cdot 0 - 3 &= x \\ 0 - 3 &= x \\ -3 &= x \end{aligned}$$

The x-intercept is $(-3, 0)$.

We plot these points and draw the line.



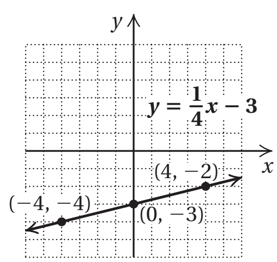
We find a third point as a check. Let $x = 3$.

$$\begin{aligned} 3y - 3 &= 3 \\ 3y &= 6 \\ y &= 2 \end{aligned}$$

We see that the point $(3, 2)$ is on the line.

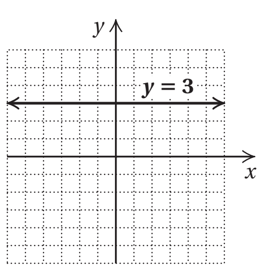
12. $y = \frac{1}{4}x - 3$

First we plot the y-intercept $(0, -3)$. Then we consider the slope $\frac{1}{4}$. Starting at the y-intercept, we find another point by moving 1 unit up and 4 units to the right. We get to the point $(4, -2)$. We can also think of the slope as $\frac{-1}{-4}$. We again start at the y-intercept and move down 1 unit and 4 units to the left. We get to a third point $(-4, -4)$. We plot the points and draw the graph.



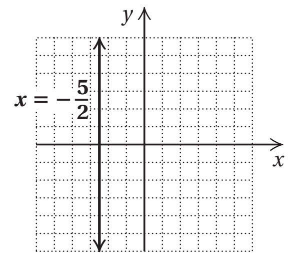
13. $y = 3$

All ordered pairs $(x, 3)$ are solutions. The graph is a horizontal line that intersects the y-axis at $(0, 3)$.



14. $x = -\frac{5}{2}$

All points $\left(-\frac{5}{2}, y\right)$ are solutions. The graph is a vertical line that intersects the x-axis at $\left(-\frac{5}{2}, 0\right)$.



15. We first solve for y and determine the slope of each line.

$$\begin{aligned} -3x + 8y &= -8 \\ 8y &= 3x - 8 \\ y &= \frac{3}{8}x - 1 \end{aligned}$$

The slope of $-3x + 8y = -8$ is $\frac{3}{8}$.

$$\begin{aligned} 8y &= 3x + 40 \\ y &= \frac{3}{8}x + 5 \end{aligned}$$

The slope of $8y = 3x + 40$ is $\frac{3}{8}$.

The slopes are the same and the y-intercepts, $(0, -1)$ and $(0, 5)$ are different, so the lines are parallel.

16. We first solve for y and determine the slope of each line.

$$\begin{aligned} 5x - 2y &= -8 \\ -2y &= -5x - 8 \\ y &= \frac{5}{2}x + 4 \end{aligned}$$

The slope of $5x - 2y = -8$ is $\frac{5}{2}$.

$$\begin{aligned} 2x + 5y &= 15 \\ 5y &= -2x + 15 \\ y &= -\frac{2}{5}x + 3 \end{aligned}$$

The slope of $2x + 5y = 15$ is $-\frac{2}{5}$.

The slopes are different, so the lines are not parallel. The product of the slopes is $\frac{5}{2}\left(-\frac{2}{5}\right) = -1$, so the lines are perpendicular.

17. $y = mx + b$ Slope-intercept equation

$y = -8x + 0.3$

18. Using the point-slope equation:

$$\begin{aligned} y - (-3) &= -4\left(x - \frac{1}{2}\right) \\ y + 3 &= -4x + 2 \\ y &= -4x - 1 \end{aligned}$$

Using the slope intercept equation:

$$-3 = -4\left(\frac{1}{2}\right) + b$$
$$-3 = -2 + b$$
$$-1 = b$$

Then, substituting in $y = mx + b$, we have $y = -4x - 1$.

19. We first find the slope:

$$m = \frac{-3-7}{4-(-2)} = \frac{-10}{6} = -\frac{5}{3}$$

We use the point-slope equation.

$$y - 7 = -\frac{5}{3}[x - (-2)]$$
$$y - 7 = -\frac{5}{3}(x + 2)$$
$$y - 7 = -\frac{5}{3}x - \frac{10}{3}$$
$$y = -\frac{5}{3}x + \frac{11}{3}$$

20. First we find the slope of the given line:

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

A line parallel to this line has slope $\frac{4}{3}$.

We use the slope-intercept equation.

$$-5 = \frac{4}{3}(2) + b$$
$$-5 = \frac{8}{3} + b$$
$$-\frac{23}{3} = b$$

Then we have $y = \frac{4}{3}x - \frac{23}{3}$.

21. From Exercise 20 above we know that the slope of the given line is $\frac{4}{3}$. The slope of a line perpendicular to this line is $-\frac{3}{4}$.

We use the point-slope equation.

$$y - (-5) = -\frac{3}{4}(x - 2)$$
$$y + 5 = -\frac{3}{4}x + \frac{3}{2}$$
$$y = -\frac{3}{4}x - \frac{7}{2}$$

Chapter 2 Review Exercises

1. No; a member of the domain, 3, is matched to more than one member of the range.

2. Yes; each member of the domain is matched to only one member of the range.

3. $g(x) = -2x + 5$

$g(0) = -2 \cdot 0 + 5 = 0 + 5 = 5$

$g(-1) = -2(-1) + 5 = 2 + 5 = 7$

4. $f(x) = 3x^2 - 2x + 7$

$f(0) = 3 \cdot 0^2 - 2 \cdot 0 + 7 = 0 - 0 + 7 = 7$

$f(-1) = 3(-1)^2 - 2(-1) + 7 = 3 \cdot 1 - 2(-1) + 7 = 3 + 2 + 7 = 12$

5. $C(t) = 309.2t + 3717.7$

$C(10) = 309.2(10) + 3717.7 = 3092 + 3717.7 = 6809.7 \approx 6810$

We estimate that the average cost of tuition and fees will be about \$6810 in 2010.

6. $y = -3x + 2$

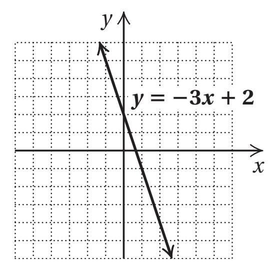
We find some ordered pairs that are solutions, plot them, and draw and label the line.

When $x = -1$, $y = -3(-1) + 2 = 3 + 2 = 5$.

When $x = 1$, $y = -3 \cdot 1 + 2 = -3 + 2 = -1$

When $x = 2$, $y = -3 \cdot 2 + 2 = -6 + 2 = -4$.

x	y	(x, y)
-1	5	$(-1, 5)$
1	-1	$(1, -1)$
2	-4	$(2, -4)$



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

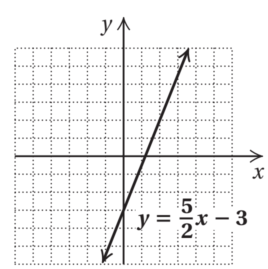
We find some ordered pairs that are solutions, using multiples of 2 to avoid fractions. Then we plot these points and draw and label the line.

When $x = 0$, $y = \frac{5}{2} \cdot 0 - 3 = 0 - 3 = -3$.

When $x = 2$, $y = \frac{5}{2} \cdot 2 - 3 = 5 - 3 = 2$.

When $x = 4$, $y = \frac{5}{2} \cdot 4 - 3 = 10 - 3 = 7$.

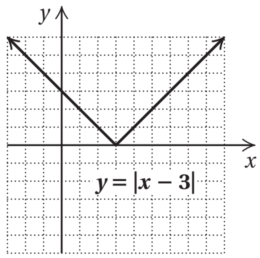
x	y	(x, y)
0	-3	$(0, -3)$
2	2	$(2, 2)$
4	7	$(4, 7)$



8. $y = |x - 3|$

To find an ordered pair, we choose any number for x and then determine y. For example, if $x = 5$, then $y = |5-3| = |2| = 2$. We find several ordered pairs, plot them, and connect them.

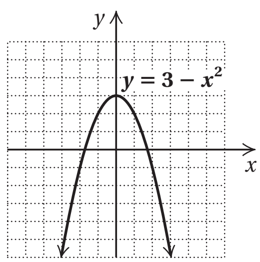
x	y
5	2
3	0
2	1
−1	4
−2	5
−3	6



9. $y = 3 - x^2$

To find an ordered pair, we choose any number for x and then determine y. For example, if $x = 2$, then $3 - 2^2 = 3 - 4 = -1$. We find several ordered pairs, plot them, and connect them with a smooth curve.

x	y
−2	−1
−1	2
0	3
1	2
2	−1
3	−6



10. No vertical line will intersect the graph more than once. Thus, the graph is the graph of a function.

11. It is possible for a vertical line to intersect the graph more than once. Thus, this is not the graph of a function.

12. a) Locate 2 on the horizontal axis and then find the point on the graph for which 2 is the first coordinate. From that point, look to the vertical axis to find the corresponding y-coordinate, 3. Thus, $f(2) = 3$.

b) The set of all x-values in the graph extends from −2 to 4, so the domain is $\{x| -2 \le x \le 4\}$, or $[-2, 4]$.

c) To determine which member(s) of the domain are paired with 2, locate 2 on the vertical axis. From there look left and right to the graph to find any points for which 2 is the second coordinate. One such point exists. Its first coordinate appears to be −1. Thus, the x-value for which $f(x) = 2$ is −1.

d) The set of all y-values in the graph extends from 1 to 5, so the range is $\{y|1 \le y \le 5\}$, or $[1, 5]$.

13. $f(x) = \dfrac{5}{x-4}$

Since $\dfrac{5}{x-4}$ cannot be calculated when the denominator is 0, we find the x-value that causes $x - 4$ to be 0:

$x - 4 = 0$

$x = 4$ Adding 4 on both sides

Thus, 4 is not in the domain of f, while all other real numbers are. The domain of f is

$\{x|x \text{ is a real number } \textit{and } x \ne 4\}$, or $(-\infty, 4) \cup (4, \infty)$.

14. $g(x) = x - x^2$

Since we can calculate $x - x^2$ for any real number x, the domain is the set of all real numbers.

15. $(f/g)(x) = f(x)/g(x) = \dfrac{x^2 - 3x}{x + 10}$

16.
$$\begin{aligned}(f-g)(x) &= f(x) - g(x)\\ &= x^2 - 3x - (x+10)\\ &= x^2 - 3x - x - 10\\ &= x^2 - 4x - 10\end{aligned}$$

$(f-g)(-2) = (-2)^2 - 4(-2) - 10 = 4 + 8 - 10 = 2$

17. $f(x) = -2x^2$, $g(x) = x + 6$

Domain of f = Domain of g = $\{x|x \text{ is a real number}\}$

Domain of $f + g$ = Domain of $f - g$ = Domain of $f \cdot g$ = $\{x|x \text{ is a real number}\}$

Since $g(x) = 0$ when $x = -6$, we have Domain of f/g = $\{x|x \text{ is a real number } \textit{and } x \ne -6\}$.

18. $f(x) = \dfrac{3}{7-x}$, $g(x) = 5 - x$

Since $7 - x = 0$ when $x = 7$, we have Domain of f = $\{x|x \text{ is a real number } \textit{and } x \ne 7\}$.

Domain of g = $\{x|x \text{ is a real number}\}$

Domain of $f + g$ = Domain of $f - g$ = Domain of $f \cdot g$ = $\{x|x \text{ is a real number } \textit{and } x \ne 7\}$

Since $g(x) = 0$ when $x = 5$, we have Domain of f/g = $\{x|x \text{ is a real number } \textit{and } x \ne 7 \textit{ and } x \ne 5\}$.

19.
$$\begin{aligned} f(x) &= -3x + 2\\ &\quad\ \uparrow \qquad \uparrow\\ f(x) &= \ \ mx + b\end{aligned}$$

The slope is −3, and the y-intercept is $(0, 2)$.

20. First we find the slope-intercept form of the equation by solving for y. This allows us to determine the slope and y-intercept easily.

$$\begin{aligned}4y + 2x &= 8\\ 4y &= -2x + 8\\ \frac{4y}{4} &= \frac{-2x+8}{4}\\ y &= -\frac{1}{2}x + 2\end{aligned}$$

The slope is $-\dfrac{1}{2}$, and the y-intercept is $(0, 2)$.

21. Slope $= \dfrac{\text{change in } y}{\text{change in } x} = \dfrac{-4-7}{10-13} = \dfrac{-11}{-3} = \dfrac{11}{3}$

22. $2y + x = 4$

To find the x-intercept we let $y = 0$ and solve for x.

$$\begin{aligned}2y + x &= 4\\ 2 \cdot 0 + x &= 4\\ x &= 4\end{aligned}$$

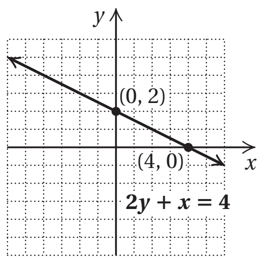
The x-intercept is $(4, 0)$.

To find the y-intercept we let $x = 0$ and solve for y.

$$2y + x = 4$$
$$2y + 0 = 4$$
$$2y = 4$$
$$y = 2$$

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

We plot these points and draw the line.



We use a third point as a check. We choose $x = -2$ and solve for y.

$$2y + (-2) = 4$$
$$2y = 6$$
$$y = 3$$

We plot $(-2, 3)$ and note that it is on the line.

23. $2y = 6 - 3x$

To find the x-intercept we let $y = 0$ and solve for x.

$$2y = 6 - 3x$$
$$2 \cdot 0 = 6 - 3x$$
$$0 = 6 - 3x$$
$$3x = 6$$
$$x = 2$$

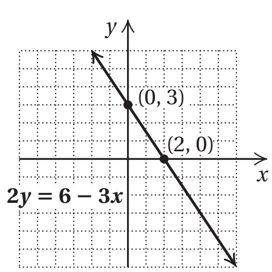
The x-intercept is $(2, 0)$.

To find the y-intercept we let $x = 0$ and solve for y.

$$2y = 6 - 3x$$
$$2y = 6 - 3 \cdot 0$$
$$2y = 6$$
$$y = 3$$

The y-intercept is $(0, 3)$.

We plot these points and draw the line.



We use a third point as a check. We choose $x = 4$ and solve for y.

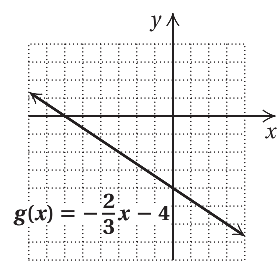
$$2y = 6 - 3 \cdot 4$$
$$2y = 6 - 12$$
$$2y = -6$$
$$y = -3$$

We plot $(4, -3)$ and note that it is on the line.

24. $g(x) = -\dfrac{2}{3}x - 4$

First we plot the y-intercept $(0, -4)$. We can think of the slope as $\dfrac{-2}{3}$. Starting at the y-intercept and using the slope, we find another point by moving 2 units down and 3 units to the right. We get to a new point $(3, -6)$.

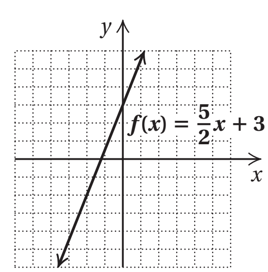
We can also think of the slope as $\dfrac{2}{-3}$. We again start at the y-intercept $(0, -4)$. We move 2 units up and 3 units to the left. We get to another new point $(-3, -2)$. We plot the points and draw the line.



25. $f(x) = \dfrac{5}{2}x + 3$

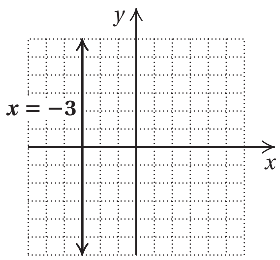
First we plot the y-intercept $(0, 3)$. Then we consider the slope $\dfrac{5}{2}$. Starting at the y-intercept and using the slope, we find another point by moving 5 units up and 2 units to the right. We get to a new point $(2, 8)$.

We can also think of the slope as $\dfrac{-5}{-2}$. We again start at the y-intercept $(0, 3)$. We move 5 units down and 2 units to the left. We get to another new point $(-2, -2)$. We plot the points and draw the line.



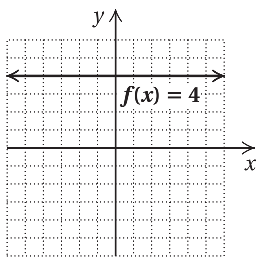
26. $x = -3$

Since y is missing, all ordered pairs $(-3, y)$ are solutions. The graph is parallel to the y-axis.



27. $f(x) = 4$

Since x is missing, all ordered pairs $(x, 4)$ are solutions. The graph is parallel to the x-axis.



28. We first solve each equation for y and determine the slope of each line.

$$y + 5 = -x$$
$$y = -x - 5$$

The slope of $y + 5 = -x$ is -1.

$$x - y = 2$$
$$x = y + 2$$
$$x - 2 = y$$

The slope of $x - y = 2$ is 1.

The slopes are not the same, so the lines are not parallel. The product of the slopes is $-1 \cdot 1$, or -1, so the lines are perpendicular.

29. We first solve each equation for y and determine the slope of each line.

$$3x - 5 = 7y$$
$$\frac{3}{7}x - \frac{5}{7} = y$$

The slope of $3x - 5 = 7y$ is $\frac{3}{7}$.

$$7y - 3x = 7$$
$$7y = 3x + 7$$
$$y = \frac{3}{7}x + 1$$

The slope of $7y - 3x = 7$ is $\frac{3}{7}$.

The slopes are the same and the y-intercepts are different, so the lines are parallel.

30. We first solve each equation for y and determine the slope of each line.

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

The slope of $4y + x = 3$ is $-\frac{1}{4}$.

$$2x + 8y = 5$$
$$8y = -2x + 5$$
$$y = -\frac{1}{4}x + \frac{5}{8}$$

The slope of $2x + 8y = 5$ is $-\frac{1}{4}$.

The slopes are the same and the y-intercepts are different, so the lines are parallel.

31. $x = 4$ is a vertical line and $y = -3$ is a horizontal line, so the lines are perpendicular.

32. We use the slope-intercept equation and substitute 4.7 for m and -23 for b..

$$y = mx + b$$
$$y = 4.7x - 23$$

33. Using the point-slope equation:

Substitute 3 for x_1, -5 for y_1, and -3 for m.

$$y - y_1 = m(x - x_1)$$
$$y - (-5) = -3(x - 3)$$
$$y + 5 = -3x + 9$$
$$y = -3x + 4$$

Using the slope-intercept equation:

Substitute 3 for x, -5 for y, and -3 for m in $y = mx + b$ and solve for b.

$$y = mx + b$$
$$-5 = -3 \cdot 3 + b$$
$$-5 = -9 + b$$
$$4 = b$$

Then we use the equation $y = mx + b$ and substitute -3 for m and 4 for b.

$$y = -3x + 4$$

34. First find the slope of the line:

$$m = \frac{6 - 3}{-4 - (-2)} = \frac{3}{-2} = -\frac{3}{2}$$

Using the point-slope equation:

We choose to use the point $(-2, 3)$ and substitute -2 for x_1, 3 for y_1, and $-\frac{3}{2}$ for m.

$$y - y_1 = m(x - x_1)$$
$$y - 3 = -\frac{3}{2}(x - (-2))$$
$$y - 3 = -\frac{3}{2}(x + 2)$$
$$y - 3 = -\frac{3}{2}x - 3$$
$$y = -\frac{3}{2}x$$

Using the slope-intercept equation:

We choose $(-2, 3)$ and substitute -2 for x, 3 for y, and $-\frac{3}{2}$ for m in $y = mx + b$. Then we solve for b.

$$3 = -\frac{3}{2}(-2) + b$$
$$3 = 3 + b$$
$$0 = b$$

Finally, we use the equation $y = mx + b$ and substitute $-\frac{3}{2}$ for m and 0 for b.

$$y = -\frac{3}{2}x + 0, \text{ or } y = -\frac{3}{2}x$$

35. First solve the equation for y and determine the slope of the given line.

$$5x + 7y = 8 \qquad \text{Given line}$$
$$7y = -5x + 8$$
$$y = -\frac{5}{7}x + \frac{8}{7}$$

The slope of the given line is $-\frac{5}{7}$. The line through $(14, -1)$ must have slope $-\frac{5}{7}$.

Using the point-slope equation:

Substitute 14 for x_1, -1 for y_1, and $-\frac{5}{7}$ for m.

$$y - y_1 = m(x - x_1)$$
$$y - (-1) = -\frac{5}{7}(x - 14)$$
$$y + 1 = -\frac{5}{7}x + 10$$
$$y = -\frac{5}{7}x + 9$$

Using the slope-intercept equation:

Substitute 14 for x, -1 for y, and $-\frac{5}{7}$ for m and solve for b.

$$y = mx + b$$
$$-1 = -\frac{5}{7} \cdot 14 + b$$
$$-1 = -10 + b$$
$$9 = b$$

Then we use the equation $y = mx + b$ and substitute $-\frac{5}{7}$ for m and 9 for b.

$$y = -\frac{5}{7}x + 9$$

36. First solve the equation for y and determine the slope of the given line.

$$3x + y = 5 \qquad \text{Given line}$$
$$y = -3x + 5$$

The slope of the given line is -3. The slope of the perpendicular line is the opposite of the reciprocal of -3. Thus, the line through $(5, 2)$ must have slope $\frac{1}{3}$.

Using the point-slope equation:

Substitute 5 for x_1, 2 for y_1, and $\frac{1}{3}$ for m.

$$y - y_1 = m(x - x_1)$$
$$y - 2 = \frac{1}{3}(x - 5)$$
$$y - 2 = \frac{1}{3}x - \frac{5}{3}$$
$$y = \frac{1}{3}x + \frac{1}{3}$$

Using the slope-intercept equation:

Substitute 5 for x, 2 for y, and $\frac{1}{3}$ for m and solve for b.

$$y = mx + b$$
$$2 = \frac{1}{3} \cdot 5 + b$$
$$2 = \frac{5}{3} + b$$
$$\frac{1}{3} = b$$

Then we use the equation $y = mx + b$ and substitute $\frac{1}{3}$ for m and $\frac{1}{3}$ for b.

$$y = \frac{1}{3}x + \frac{1}{3}$$

37. a) We form pairs of the type (x, R) where x is the number of years since 1972 and R is the record. We have two pairs, $(0, 44.66)$ and $(40, 43.94)$. These are two points on the graph of the linear function we are seeking.

First we find the slope:

$$m = \frac{43.94 - 44.66}{40 - 0} = \frac{-0.72}{40} = -0.018.$$

Using the slope and the y-intercept, $(0, 44.66)$ we write the function: $R(x) = -0.018x + 44.66$, where x is the number of years after 1972.

b) 2000 is 28 years after 1972, so to estimate the record in 2000, we find $R(28)$:

$$R(28) = -0.018(28) + 44.66$$
$$\approx 44.16$$

The estimated record was about 44.16 seconds in 2000.

2010 is 38 years after 1972, so to estimate the record in 2010, we find $R(38)$:

$$R(38) = -0.018(38) + 44.66$$
$$\approx 43.98$$

The estimated record was about 43.98 seconds in 2010.

38. $f(x) = \dfrac{x+3}{x-2}$

We cannot calculate $\dfrac{x+3}{x-2}$ when the denominator is 0, so we solve $x - 2 = 0$.

$$x - 2 = 0$$
$$x = 2$$

Thus, the domain of f is $(-\infty, 2) \cup (2, \infty)$. Answer C is correct.

39. First we find the slope of the given line.

$$3y - \frac{1}{2}x = 0$$
$$3y = \frac{1}{2}x$$
$$y = \frac{1}{6}x$$

The slope is $\dfrac{1}{6}$. The slope of a line perpendicular to the given line is -6. We use the point-slope equation.

$$y - 1 = -6[x - (-2)]$$
$$y - 1 = -6(x + 2)$$
$$y - 1 = -6x - 12$$
$$y = -6x - 11, \text{ or}$$
$$6x + y = -11$$

Answer A is correct.

40. The cost of x jars of preserves is $\$2.49x$, and the shipping charges are $\$3.75 + \$0.60x$. Then the total cost is $\$2.49x + \$3.75 + \$0.60x$, or $\$3.09x + \$3.75$. Thus, a linear function that can be used to determine the cost of buying and shipping x jars of preserves is $f(x) = 3.09x + 3.75$.

41. A line's x- and y-intercepts are the same only when the line passes through the origin. The equation for such a line is of the form $y = mx$.

42. The concept of slope is useful in describing how a line slants. A line with positive slope slants up from left to right. A line with negative slope slants down from left to right. The larger the absolute value of the slope, the steeper the slant.

43. Find the slope-intercept form of the equation.

$$4x + 5y = 12$$
$$5y = -4x + 12$$
$$y = -\frac{4}{5}x + \frac{12}{5}$$

This form of the equation indicates that the line has a negative slope and thus should slant down from left to right. The student apparently graphed $y = \dfrac{4}{5}x + \dfrac{12}{5}$.

44. For $R(t) = 50t + 35$, $m = 50$ and $b = 35$; 50 signifies that the cost per hour of a repair is \$50; 35 signifies that the minimum cost of a repair job is \$35.

45. $m = \dfrac{\text{change in } y}{\text{change in } x}$

As we move from one point to another on a vertical line, the y-coordinate changes but the x-coordinate does not. Thus, the change in y is a non-zero number while the change in x is 0. Since division by 0 is undefined, the slope of a vertical line is undefined.

As we move from one point to another on a horizontal line, the y-coordinate does not change but the x-coordinate does. Thus, the change in y is 0 while the change in x is a non-zero number, so the slope is 0.

46. Using algebra, we find that the slope-intercept form of the equation is $y = \dfrac{5}{2}x - \dfrac{3}{2}$. This indicates that the y-intercept is $\left(0, -\dfrac{3}{2}\right)$, so a mistake has been made. It appears that the student graphed $y = \dfrac{5}{2}x + \dfrac{3}{2}$.

Chapter 2 Test

1. Yes; each member of the domain is matched to only one member of the range.

2. No; a member of the domain, Lake Placid, is matched to more than one member of the range.

3. $f(x) = -3x - 4$

$f(0) = -3 \cdot 0 - 4 = 0 - 4 = -4$

$f(-2) = -3(-2) - 4 = 6 - 4 = 2$

4. $g(x) = x^2 + 7$

$g(0) = 0^2 + 7 = 0 + 7 = 7$

$g(-1) = (-1)^2 + 7 = 1 + 7 = 8$

5. $h(x) = -6$

$h(-4) = -6$

$h(-6) = -6$

6. $f(x) = |x + 7|$

$f(-10) = |-10 + 7| = |-3| = 3$

$f(-7) = |-7 + 7| = |0| = 0$

7. $y = -2x - 5$

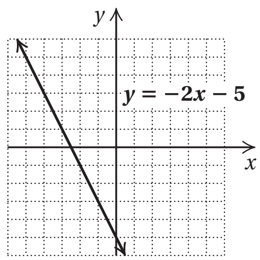
We find some ordered pairs that are solutions, plot them, and draw and label the line.

When $x = 0$, $y = -2 \cdot 0 - 5 = 0 - 5 = -5$.

When $x = -2$, $y = -2(-2) - 5 = 4 - 5 = -1$.

When $x = -4$, $y = -2(-4) - 5 = 8 - 5 = 3$.

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



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

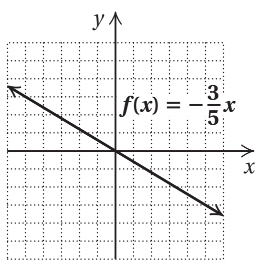
We find some function values, plot the corresponding points, and draw the graph.

$f(-5) = -\dfrac{3}{5}(-5) = 3$

$f(0) = -\dfrac{3}{5} \cdot 0 = 0$

$f(5) = -\dfrac{3}{5} \cdot 5 = -3$

x	$f(x)$
-5	3
0	0
5	-3



9. $g(x) = 2 - |x|$

We find some function values, plot the corresponding points, and draw the graph.

$g(-4) = 2 - |-4| = 2 - 4 = -2$

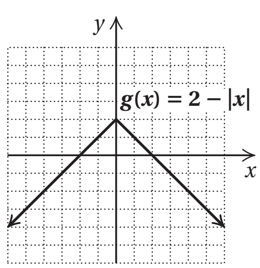
$g(-2) = 2 - |-2| = 2 - 2 = 0$

$g(0) = 2 - |0| = 2 - 0 = 2$

$g(3) = 2 - |3| = 2 - 3 = -1$

$g(5) = 2 - |5| = 2 - 5 = -3$

x	$g(x)$
-4	-2
-2	0
0	2
3	-1
5	-3



10. $f(x) = x^2 + 2x - 3$

We find some function values, plot the corresponding points, and draw the graph.

$f(-4) = (-4)^2 + 2(-4) - 3 = 16 - 8 - 3 = 5$

$f(-3) = (-3)^2 + 2(-3) - 3 = 9 - 6 - 3 = 0$

$f(-1) = (-1)^2 + 2(-1) - 3 = 1 - 2 - 3 = -4$

$f(0) = 0^2 + 2 \cdot 0 - 3 = -3$

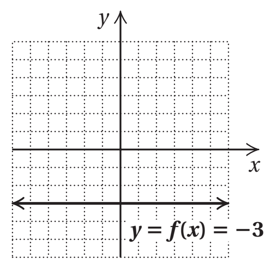
$f(1) = 1^2 + 2 \cdot 1 - 3 = 1 + 2 - 3 = 0$

$f(2) = 2^2 + 2 \cdot 2 - 3 = 4 + 4 - 3 = 5$

x	$f(x)$
-4	5
-3	0
-1	-4
0	-3
1	0
2	5

11. $y = f(x) = -3$

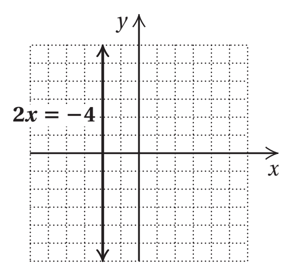
Since x is missing, all ordered pairs $(x, -3)$ are solutions. The graph is parallel to the x-axis.



12. $2x = -4$

$x = -2$

Since y is missing, all ordered pairs $(-2, y)$ are solutions. The graph is parallel to the y-axis.



13. a) In 2005, $x = 2005 - 1990 = 15$. We find $A(15)$.

$A(15) = 0.233(15) + 5.87 = 9.365 \approx 9.4$

The median age of cars in 2005 was about 9.4 yr.

b) Substitute 7.734 for $A(t)$ and solve for t.

$7.734 = 0.233t + 5.87$

$1.864 = 0.233t$

$8 = t$

The median age of cars was 7.734 yr 8 years after 1990, or in 1998.

14. No vertical line will intersect the graph more than once. Thus, the graph is the graph of a function.

15. It is possible for a vertical line to intersect the graph more than once. Thus, this is not the graph of a function.

16. $f(x) = \dfrac{8}{2x+3}$

Since $\dfrac{8}{2x+3}$ cannot be calculated when the denominator is 0, we find the x-value that causes $2x+3$ to be 0:

$$\begin{aligned} 2x+3 &= 0 \\ 2x &= -3 \\ x &= -\frac{3}{2} \end{aligned}$$

Thus, $-\dfrac{3}{2}$ is not in the domain of f, while all other real numbers are. The domain of f is

$\left\{x \middle| x \text{ is a real number } \textit{and } x \neq -\dfrac{3}{2}\right\}$, or

$\left(-\infty, -\dfrac{3}{2}\right) \cup \left(-\dfrac{3}{2}, \infty\right)$.

17. $g(x) = 5 - x^2$

Since we can calculate $5 - x^2$ for any real number x, the domain is the set of all real numbers.

18. a) Locate 1 on the horizontal axis and then find the point on the graph for which 1 is the first coordinate. From that point, look to the vertical axis to find the corresponding y-coordinate, 1. Thus, $f(1) = 1$.

b) The set of all x-values in the graph extends from -3 to 4, so the domain is $\{x| -3 \leq x \leq 4\}$, or $[-3, 4]$.

c) To determine which member(s) of the domain are paired with 2, locate 2 on the vertical axis. From there look left and right to the graph to find any points for which 2 is the second coordinate. One such point exists. Its first coordinate is -3, so the x-value for which $f(x) = 2$ is -3.

d) The set of all y-values in the graph extends from -1 to 2, so the range is $\{y| -1 \leq y \leq 2\}$, or $[-1, 2]$.

19.

$$\begin{aligned} &f(x) = -4x+3,\ g(x) = x^2 - 1 \\ &f(-2) = -4(-2) + 3 = 8 + 3 = 11 \\ &g(-2) = (-2)^2 - 1 = 4 - 1 = 3 \\ &(f-g)(-2) = f(-2) - g(-2) = 11 - 3 = 8 \\ &(f/g)(x) = f(x)/g(x) = \frac{-4x+3}{x^2-1} \end{aligned}$$

20. $f(x) = \dfrac{4}{3-x}$, $g(x) = 2x + 1$

Domain of $f = \{x|x$ is a real number *and* $x \neq 3\}$

Domain of $g = \{x|x$ is a real number$\}$

Domain of $f+g$ = Domain of $f-g$ = Domain of $f \cdot g$ = $\{x|x$ is a real number *and* $x \neq 3\}$

Since $g(x) = 0$ when $x = -\dfrac{1}{2}$, we have Domain of f/g = $\left\{x|x \text{ is a real number } \textit{and } x \neq 3 \textit{ and } x \neq -\dfrac{1}{2}\right\}$

21.

$$\begin{aligned} f(x) &= -\frac{3}{5}x + 12 \\ &\quad\ \uparrow \qquad\ \uparrow \\ f(x) &= \ mx \ + \ b \end{aligned}$$

The slope is $-\dfrac{3}{5}$, and the y-intercept is $(0, 12)$.

22. First we find the slope-intercept form of the equation by solving for y. This allows us to determine the slope and y-intercept easily.

$$\begin{aligned} -5y - 2x &= 7 \\ -5y &= 2x + 7 \\ \frac{-5y}{-5} &= \frac{2x+7}{-5} \\ y &= -\frac{2}{5}x - \frac{7}{5} \end{aligned}$$

The slope is $-\dfrac{2}{5}$, and the y-intercept is $\left(0, -\dfrac{7}{5}\right)$.

23. Slope $= \dfrac{\text{change in } y}{\text{change in } x} = \dfrac{-2-3}{-2-6} = \dfrac{-5}{-8} = \dfrac{5}{8}$

24. Slope $= \dfrac{\text{change in } y}{\text{change in } x} = \dfrac{5.2 - 5.2}{-4.4 - (-3.1)} = \dfrac{0}{-1.3} = 0$

25. We can use the coordinates of any two points on the graph. We'll use $(10, 0)$ and $(25, 12)$.

Slope $= \dfrac{\text{change in } y}{\text{change in } x} = \dfrac{12-0}{25-10} = \dfrac{12}{15} = \dfrac{4}{5}$

The slope, or rate of change is $\dfrac{4}{5}$ km/min.

26. $2x + 3y = 6$

To find the x-intercept we let $y = 0$ and solve for x.

$$\begin{aligned} 2x + 3y &= 6 \\ 2x + 3 \cdot 0 &= 6 \\ 2x &= 6 \\ x &= 3 \end{aligned}$$

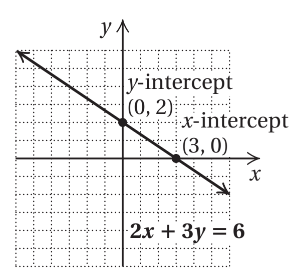
The x-intercept is $(3, 0)$.

To find the y-intercept we let $x = 0$ and solve for y.

$$\begin{aligned} 2x + 3y &= 6 \\ 2 \cdot 0 + 3y &= 6 \\ 3y &= 6 \\ y &= 2 \end{aligned}$$

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

We plot these points and draw the line.



We use a third point as a check. We choose $x = -3$ and solve for y.

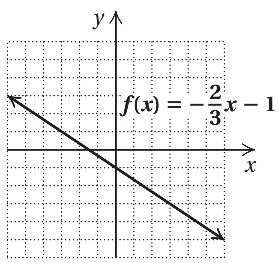
$$\begin{aligned} 2(-3) + 3y &= 6 \\ -6 + 3y &= 6 \\ 3y &= 12 \\ y &= 4 \end{aligned}$$

We plot $(-3, 4)$ and note that it is on the line.

27. $f(x) = -\frac{2}{3}x - 1$

First we plot the y-intercept $(0, -1)$. We can think of the slope as $\frac{-2}{3}$. Starting at the y-intercept and using the slope, we find another point by moving 2 units down and 3 units to the right. We get to a new point $(3, -3)$.

We can also think of the slope as $\frac{2}{-3}$. We again start at the y-intercept $(0, -1)$. We move 2 units up and 3 units to the left. We get to another new point $(-3, 1)$. We plot the points and draw the line.



28. We first solve each equation for y and determine the slope of each line.

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

The slope of $4y + 2 = 3x$ is $\frac{3}{4}$.

$$-3x + 4y = -12$$
$$4y = 3x - 12$$
$$y = \frac{3}{4}x - 3$$

The slope of $-3x + 4y = -12$ is $\frac{3}{4}$.

The slopes are the same and the y-intercepts are different, so the lines are parallel.

29. The slope of $y = -2x + 5$ is -2.

We solve the second equation for y and determine the slope.

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

The slopes are not the same, so the lines are not parallel. The product of the slopes is $-2 \cdot \frac{1}{2}$, or -1, so the lines are perpendicular.

30. We use the slope-intercept equation and substitute -3 for m and 4.8 for b.

$$y = mx + b$$
$$y = -3x + 4.8$$

31. $y = f(x) = mx + b$

$$f(x) = 5.2x - \frac{5}{8}$$

32. Using the point-slope equation:

Substitute 1 for x_1, -2 for y_1, and -4 for m.

$$y - y_1 = m(x - x_1)$$
$$y - (-2) = -4(x - 1)$$
$$y + 2 = -4x + 4$$
$$y = -4x + 2$$

Using the slope-intercept equation:

Substitute 1 for x, -2 for y, and -4 for m in $y = mx + b$ and solve for b.

$$y = mx + b$$
$$-2 = -4 \cdot 1 + b$$
$$-2 = -4 + b$$
$$2 = b$$

Then we use the equation $y = mx + b$ and substitute -4 for m and 2 for b.

$$y = -4x + 2$$

33. First find the slope of the line:

$$m = \frac{-6 - 15}{4 - (-10)} = \frac{-21}{14} = -\frac{3}{2}$$

Using the point-slope equation:

We choose to use the point $(4, -6)$ and substitute 4 for x_1, 6 for y_1, and $-\frac{3}{2}$ for m.

$$y - y_1 = m(x - x_1)$$
$$y - (-6) = -\frac{3}{2}(x - 4)$$
$$y + 6 = -\frac{3}{2}x + 6$$
$$y = -\frac{3}{2}x$$

Using the slope-intercept equation:

We choose $(4, -6)$ and substitute 4 for x, -6 for y, and $-\frac{3}{2}$ for m in $y = mx + b$. Then we solve for b.

$$y = mx + b$$
$$-6 = -\frac{3}{2} \cdot 4 + b$$
$$-6 = -6 + b$$
$$0 = b$$

Finally, we use the equation $y = mx + b$ and substitute $-\frac{3}{2}$ for m and 0 for b.

$$y = -\frac{3}{2}x + 0, \text{ or } y = -\frac{3}{2}x$$

34. First solve the equation for y and determine the slope of the given line.

$$x - 2y = 5 \qquad \text{Given line}$$
$$-2y = -x + 5$$
$$y = \frac{1}{2}x - \frac{5}{2}$$

The slope of the given line is $\frac{1}{2}$. The line through $(4, -1)$ must have slope $\frac{1}{2}$.

Using the point-slope equation:

Substitute 4 for x_1, -1 for y_1, and $\frac{1}{2}$ for m.

$$y - y_1 = m(x - x_1)$$
$$y - (-1) = \frac{1}{2}(x - 4)$$
$$y + 1 = \frac{1}{2}x - 2$$
$$y = \frac{1}{2}x - 3$$

Using the slope-intercept equation:

Substitute 4 for x, -1 for y, and $\frac{1}{2}$ for m and solve for b.

$$y = mx + b$$
$$-1 = \frac{1}{2}(4) + b$$
$$-1 = 2 + b$$
$$-3 = b$$

Then we use the equation $y = mx + b$ and substitute $\frac{1}{2}$ for m and -3 for b.

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

35. First solve the equation for y and determine the slope of the given line.

$$x + 3y = 2 \quad \text{Given line}$$
$$3y = -x + 2$$
$$y = -\frac{1}{3}x + \frac{2}{3}$$

The slope of the given line is $-\frac{1}{3}$. The slope of the perpendicular line is the opposite of the reciprocal of $-\frac{1}{3}$. Thus, the line through $(2, 5)$ must have slope 3.

Using the point-slope equation:

Substitute 2 for x_1, 5 for y_1, and 3 for m.

$$y - y_1 = m(x - x_1)$$
$$y - 5 = 3(x - 2)$$
$$y - 5 = 3x - 6$$
$$y = 3x - 1$$

Using the slope-intercept equation:

Substitute 2 for x, 5 for y, and 3 for m and solve for b.

$$y = mx + b$$
$$5 = 3 \cdot 2 + b$$
$$5 = 6 + b$$
$$-1 = b$$

Then we use the equation $y = mx + b$ and substitute 3 for m and -1 for b.

$$y = 3x - 1$$

36. a) Note that $2010 - 1970 = 40$. Thus, the data points are $(0, 23.2)$ and $(40, 28.2)$. We find the slope.

$$m = \frac{28.2 - 23.2}{40 - 0} = \frac{5}{40} = 0.125$$

Using the slope and the y-intercept, $(0, 23.2)$, we write the function: $A(x) = 0.125x + 23.2$

b) In 2008, $x = 2008 - 1970 = 38$.

$A(38) = 0.125(38) + 23.2 = 27.95$ years

In 2015, $x = 2015 - 1970 = 45$.

$A(45) = 0.125(45) + 23.2 = 28.825$ years

37. Using the point-slope equation, $y - y_1 = m(x - x_1)$, with $x_1 = 3$, $y_1 = 1$, and $m = -2$ we have $y - 1 = -2(x - 3)$. Thus, answer B is correct.

38. First solve each equation for y and determine the slopes.

$$3x + ky = 17$$
$$ky = -3x + 17$$
$$y = -\frac{3}{k}x + \frac{17}{k}$$

The slope of $3x + ky = 17$ is $-\frac{3}{k}$.

$$8x - 5y = 26$$
$$-5y = -8x + 26$$
$$y = \frac{8}{5}x - \frac{26}{5}$$

The slope of $8x - 5y = 26$ is $\frac{8}{5}$.

If the lines are perpendicular, the product of their slopes is -1.

$$-\frac{3}{k} \cdot \frac{8}{5} = -1$$
$$-\frac{24}{5k} = -1$$
$$24 = 5k \quad \text{Multiplying by } -5k$$
$$\frac{24}{5} = k$$

39. Answers may vary. One such function is $f(x) = 3$.