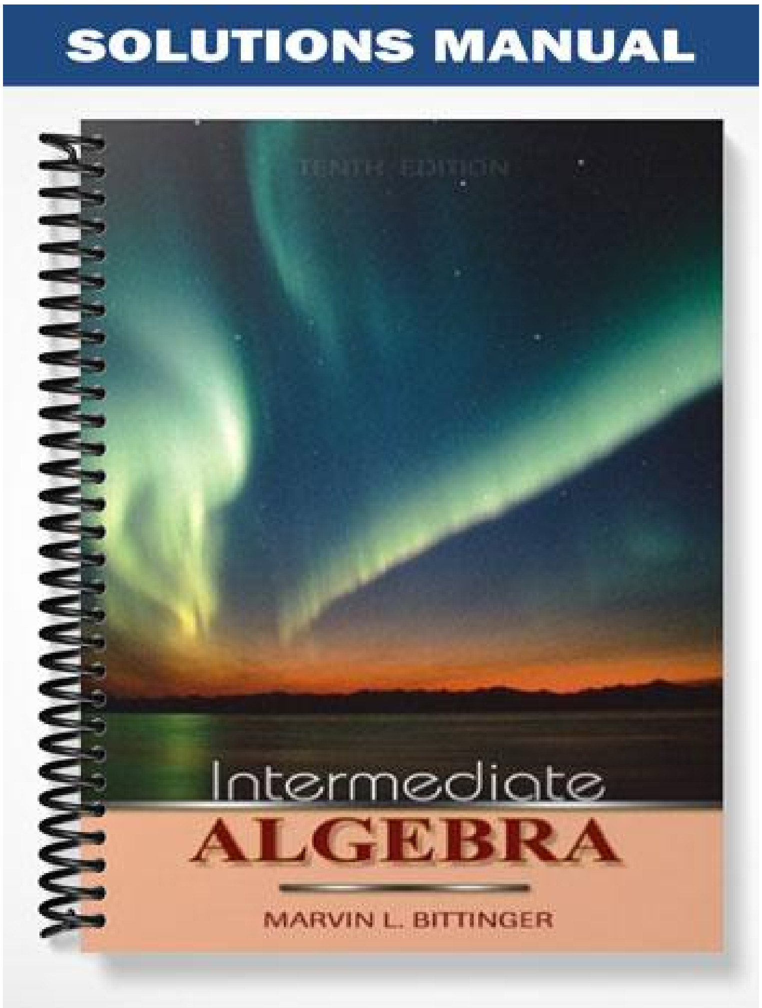
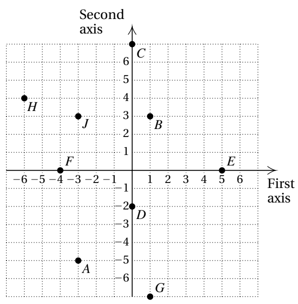

SOLUTIONS MANUAL
TENTH EDITION
Intermediate
ALGEBRA
MARVIN L. BITTINGER

Chapter 2

Graphs, Functions, and Applications

Exercise Set 2.1

2.



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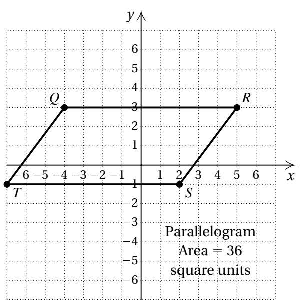


Parallelogram

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

6.

$$\begin{array}{r|l} \multicolumn{2}{c}{3s + t = 4} \\ \hline 3 \cdot 3 + 4 \;?\; & 4 \quad \text{Substituting 3 for } s \text{ and 4 for } t \\ 9 + 4 & \quad\;\; \text{(alphabetical order of variables)} \\ 13 & \end{array}$$

Since $13 = 4$ is false, $(3, 4)$ is not a solution of $3s + t = 4$.

8.

$$\begin{array}{r|l} \multicolumn{2}{c}{4r + 3s = 5} \\ \hline 4 \cdot 2 + 3 \cdot (-1) \;?\; & 5 \quad \text{Substituting 2 for } r \text{ and } -1 \text{ for } s \\ 8 - 3 & \quad\;\; \text{(alphabetical order of variables)} \\ 5 & \end{array}$$

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

10.

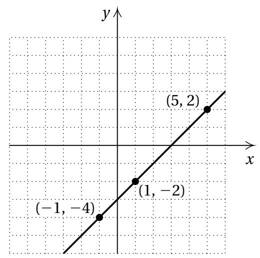
$$\begin{array}{r|l} \multicolumn{2}{c}{2p - 3q = -13} \\ \hline 2(-5) - 3 \cdot 1 \;?\; & -13 \quad \text{Substituting } -5 \text{ for } p \text{ and 1 for } q \\ -10 - 3 & \\ -13 & \end{array}$$

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

12.

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

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 $y = x - 3$.

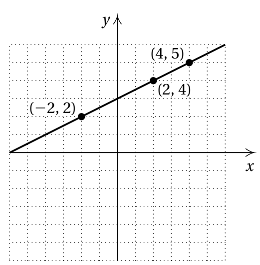
$$\begin{array}{c|l} \multicolumn{2}{c}{y = x - 3} \\ \hline -3 \;?\; & 0 - 3 \\ & -3 \qquad \text{TRUE} \end{array}$$

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

14.

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

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

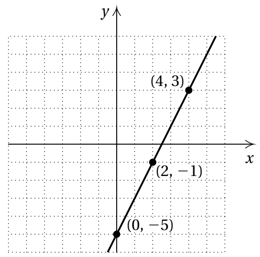
$$\begin{array}{c|l} \multicolumn{2}{c}{y = \frac{1}{2}x + 3} \\ \hline 4 \;?\; & \frac{1}{2} \cdot 2 + 3 \\ & 1 + 3 \\ & 4 \qquad \text{TRUE} \end{array}$$

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

16.

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

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



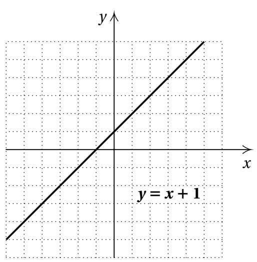
The line appears to pass through $(5, 5)$ as well. We check to see if $(5, 5)$ is a solution of $4x - 2y = 10$.

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

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

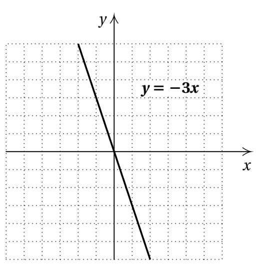
18.

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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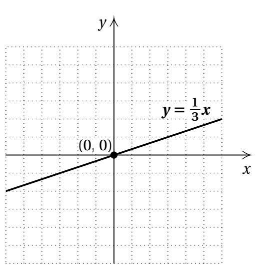

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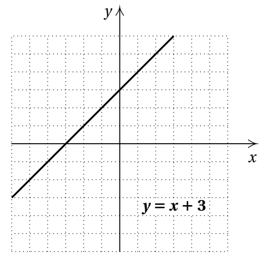

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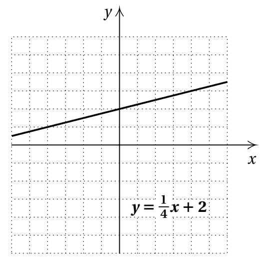

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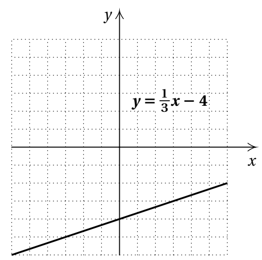

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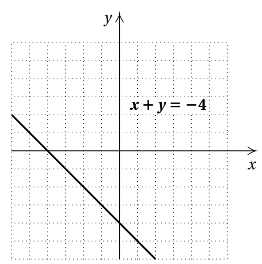

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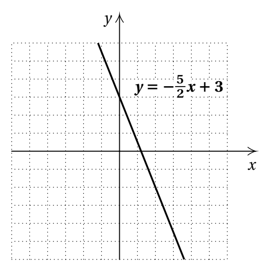

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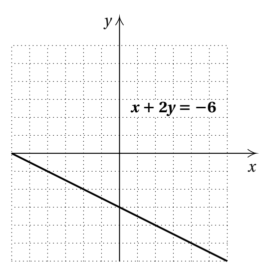

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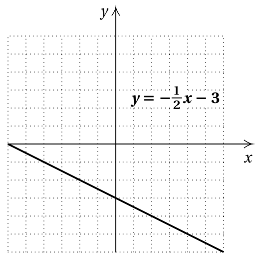

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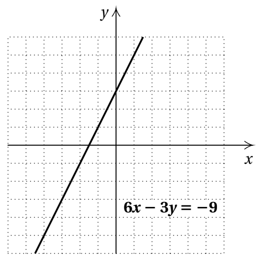

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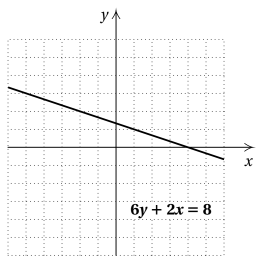
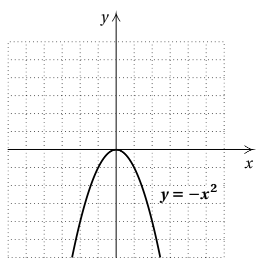


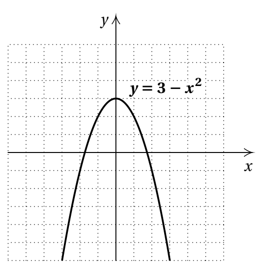
42.

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



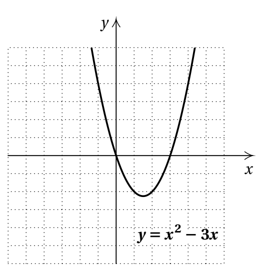
44.

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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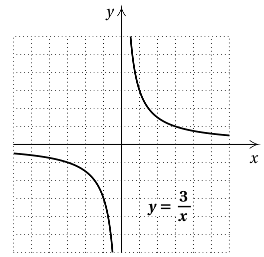

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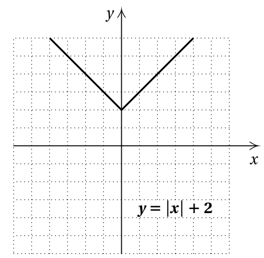
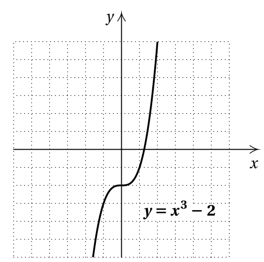


52.



53. *Discussion and Writing Exercise.* It might not be possible to determine the shape of a graph after plotting just two points. This would be the case, for example, if when graphing $y = |x|$ we plotted only two first quadrant points or only two second quadrant points.

54. *Discussion and Writing Exercise.* 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.

56.
$$\begin{aligned} 2x - 5 \geq -10 \quad &\textit{or} \quad -4x - 2 < 10 \\ 2x \geq -5 \quad &\textit{or} \quad -4x < 12 \\ x \geq -\frac{5}{2} \quad &\textit{or} \quad x > -3 \end{aligned}$$

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

58.
$$\begin{aligned} -13 < 3x + 5 < 23 \\ -18 < 3x < 18 \\ -6 < x < 6 \end{aligned}$$

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

60. a) After 1 yr: $v = -0.68(1) + 3.4 = \$2.72$ thousand, or \$2720.

After 2 yr: $v = -0.68(2) + 3.4 = \$2.04$ thousand, or \$2040.

After 4 yr: $v = -0.68(4) + 3.4 = \$0.68$ thousand, or \$680.

After 5 yr: $v = -0.68(5) + 3.4 = \$0$ thousand, or \$0.

b) \$1500 = \$1.5 thousand

Solve: $1.5 = -0.68t + 3.4$

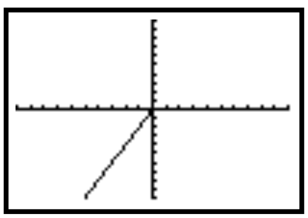
$t \approx 2.8$ yr

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

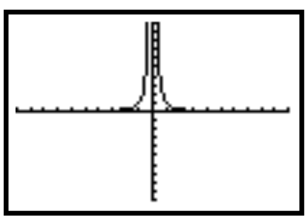
Solve:

$$0.07(100,000) + 0.04(x - 100,000) = 16,200$$
$$x = \$330,000$$

64.



66.



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

70. 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

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. No; a member of the domain (in fact, both of them) is matched to more than one member of the range.

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

14. This correspondence is not a function, since it is reasonable to assume that many students in a first-grade class have the same year of birth.

16. 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) $g\left(\frac{7}{8}\right) = \frac{7}{8} - 6 = -5\frac{1}{8}$

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

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

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

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

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

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

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

b) $h(-6) = 19$

c) $h(12) = 19$

d) $h(0) = 19$

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

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

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

24. 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) $g(a+1) = |a + 1 - 1| = |a|$

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

28. a) $M(30) = 2.89(30) + 70.64 = 157.34$ cm

b) $M(35) = 2.89(35) + 70.64 = 171.79$ cm

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

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

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

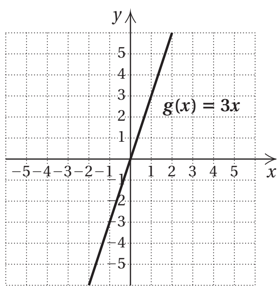
32. $C(62) = \frac{5}{9}(62 - 32) = \frac{5}{9} \cdot 30 = \frac{50}{3} = 16\frac{2}{3}°\text{C}$

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

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

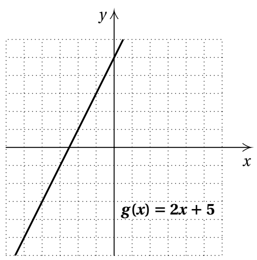
34.

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



36.

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



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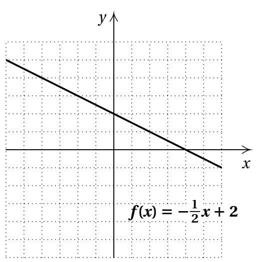

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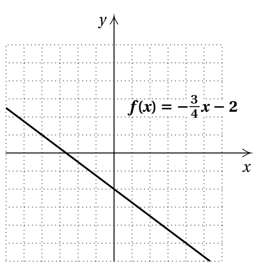
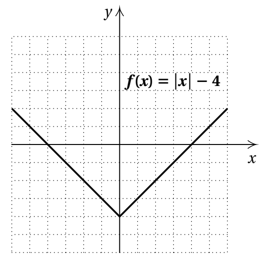


42.

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



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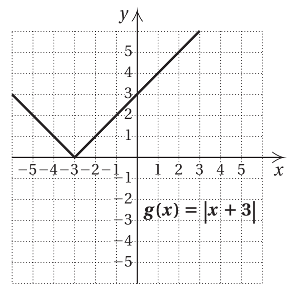
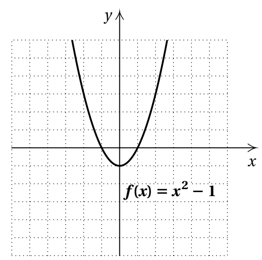


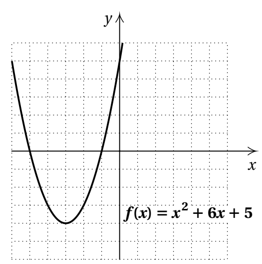
46.

x	y
-3	8
-2	3
-1	0
0	-1
1	0
2	3
3	8

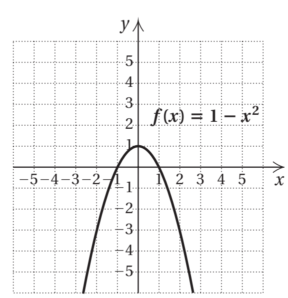


48.

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

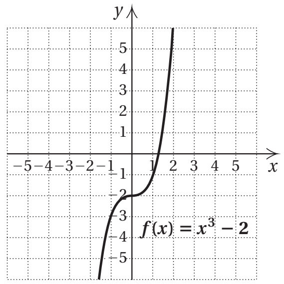


50.



52.

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



54. No; it fails the vertical line test.

56. No; it fails the vertical line test.

58. Yes; it passes the vertical line test.

60. Yes; it passes the vertical line test.

62. About 1215 stations

64. About 4 billion images

65. *Discussion and Writing Exercise.* No; since each input has exactly one output, the number of outputs cannot exceed the number of inputs.

66. *Discussion and Writing Exercise.* One definition of "function" is "the proper or characteristic action of a person, living thing, manufactured or created thing." In mathematics a function acts in a prescribed, or characteristic, manner on an input to produce the corresponding output.

68. A relation is a correspondence between two sets such that each member of the first set corresponds to at least one member of the second set.

70. The graph of an equation is a drawing that represents all of its solutions.

72. The replacements for the variable that makes an equation true are its solutions.

74. The vertical-line test can be used to determine whether a graph represents a function.

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

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) $f(1) \approx 2\frac{2}{3}$

b) The set of all x-values in the graph is $\{x| -2 \le x \le 3\}$, or $[-2, 3]$.

c) The only point whose second coordinate is 2 is about $\left(1\frac{3}{4}, 2\right)$, so the x-value for which $f(x) = 2$ is about $1\frac{3}{4}$.

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

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

b) The set of all x-values in the graph is $\{x| -4 \le x \le 2\}$, 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 $\{y| -3 \le y \le 3\}$, or $[-3, 3]$.

8. 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.)

10. 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 $(-\infty, 4]$.

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

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

c) The points with second coordinate 2 are all points with x-values in the set $\{x|0 < x \le 2\}$, or in the interval $(0, 2]$.

d) The set of all y-values in the graph is $\{1, 2, 3, 4\}$.

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

Solve: $5 - x = 0$

$$x = 5$$

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

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

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

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

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

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

Solve: $3x + 4 = 0$

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

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

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

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

24. $f(x) = \dfrac{x^2 - 3x}{|4x - 7|}$

Solve: $|4x - 7| = 0$

$$x = \frac{7}{4}$$

The domain is $\left\{x \middle| x \text{ is a real number } \textit{and } x \neq \frac{7}{4}\right\}$, or $\left(-\infty, \frac{7}{4}\right) \cup \left(\frac{7}{4}, \infty\right)$.

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

Solve: $4 + x = 0$

$$x = -4$$

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

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

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

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

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

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

Solve: $6x - 12 = 0$

$$x = 2$$

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

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

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

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

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

$$x = 2$$

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

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

39. *Discussion and Writing Exercise.* The domain of a function is the set of all inputs, and the range is the set of all outputs.

40. *Discussion and Writing Exercise.* 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.

42. Let $x =$ the score on the fourth test.

Solve: $92 + 90 + 88 + x \geq 360$

$$x \geq 90$$

The solution set is $\{x|x \geq 90\}$.

44. $|x| = -8$

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

46. $|2x + 3| = 13$

$$\begin{aligned} 2x + 3 &= -13 \quad \textit{or} \quad 2x + 3 = 13 \\ 2x &= -16 \quad \textit{or} \quad 2x = 10 \\ x &= -8 \quad \textit{or} \quad x = 5 \end{aligned}$$

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

48. $|5x - 6| = |3 - 8x|$

$$\begin{aligned} 5x - 6 = 3 - 8x \quad &\textit{or} \quad 5x - 6 = -(3 - 8x) \\ 13x = 9 \quad &\textit{or} \quad 5x - 6 = -3 + 8x \\ x = \frac{9}{13} \quad &\textit{or} \quad -3x = 3 \\ x = \frac{9}{13} \quad &\textit{or} \quad x = -1 \end{aligned}$$

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

50. $|3x - 8| = 0$

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

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

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

For the function in Exercise 26, the range is $\{x|x \text{ is a real number and } x \neq 0\}$, or $(-\infty, 0) \cup (0, \infty)$.

For the function in Exercise 27, the range is $\{x|x \geq 0\}$, or $[0, \infty)$.

For the function in Exercise 28, the range is $\{x|x \leq 8\}$, or $(-\infty, 8]$.

For the function in Exercise 34, the range is $\{x|x \geq 1\}$, or $[1, \infty)$.

Exercise Set 2.4

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 $= \frac{-1 - 7}{2 - 8} = \frac{-8}{-6} = \frac{4}{3}$

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

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

28. $m = \frac{2.6}{8.2} = \frac{13}{41}$, or about 31.7%

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

32.
$$\begin{aligned} \text{Rate of change} &= \frac{17{,}634 - 11{,}037}{1995 - 1986} \\ &= \frac{6597}{9} \\ &= \$733 \text{ per year} \end{aligned}$$

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

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

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

The distance is decreasing at a rate of $6\frac{2}{3}$ m per second.

36. We can use the coordinates of any two points on the line. We'll use $(35, 495)$ and $(65, 525)$:

$$\text{Slope} = \frac{\text{change in } y}{\text{change in } x} = \frac{525 - 495}{65 - 35} = \frac{30}{30} = 1$$

The average SAT verbal score is increasing at a rate of 1 point per thousand dollars of family income.

37. *Discussion and Writing Exercise.* Find the slope-intercept form of the equation.

$$\begin{aligned} 4x + 5y &= 12 \\ 5y &= -4x + 12 \\ y &= -\frac{4}{5}x + \frac{12}{5} \end{aligned}$$

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

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

40.
$$\begin{aligned} & 9\{2x - 3[5x + 2(-3x + y^0 - 2)]\} \\ &= 9\{2x - 3[5x + 2(-3x + 1 - 2)]\} \quad (y^0 = 1) \\ &= 9\{2x - 3[5x + 2(-3x - 1)]\} \\ &= 9\{2x - 3[5x - 6x - 2]\} \\ &= 9\{2x - 3[-x - 2]\} \\ &= 9\{2x + 3x + 6\} \\ &= 9\{5x + 6\} \\ &= 45x + 54 \end{aligned}$$

42. $5^4 \div 625 \div 5^2 \cdot 5^7 \div 5^3$
$= 1 \div 5^2 \cdot 5^7 \div 5^3$
$= 5^{-2} \cdot 5^7 \div 5^3$
$= 5^5 \div 5^3$
$= 5^2,$ or 25

44. $|5x - 8| \geq 32$

$$5x - 8 \leq -32 \quad or \quad 5x - 8 \geq 32$$
$$5x \leq -24 \quad or \quad 5x \geq 40$$
$$x \leq -\frac{24}{5} \quad or \quad x \geq 8$$

The solution set is $\left\{x \middle| x \leq -\frac{24}{5} \textit{ or } x \geq 8\right\}$, or $\left(-\infty, -\frac{24}{5}\right] \cup [8, \infty)$.

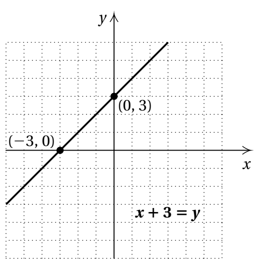
46. $|5x - 8| = 32$

$$5x - 8 = -32 \quad or \quad 5x - 8 = 32$$
$$5x = -24 \quad or \quad 5x = 40$$
$$x = -\frac{24}{5} \quad or \quad x = 8$$

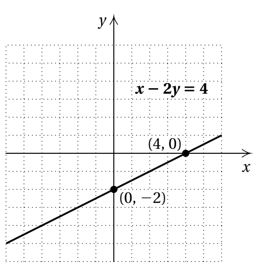
The solution set is $\left\{-\frac{24}{5}, 8\right\}$.

Exercise Set 2.5

2.



4.



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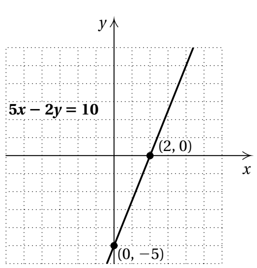

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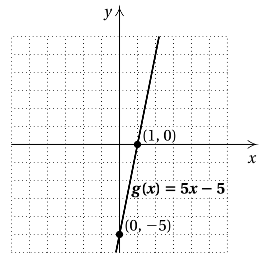

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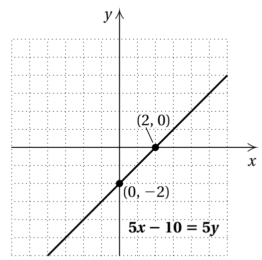

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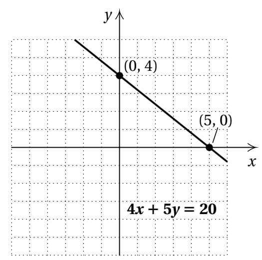
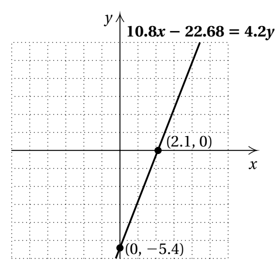
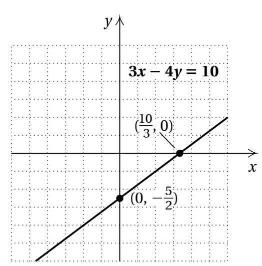


14.



16.

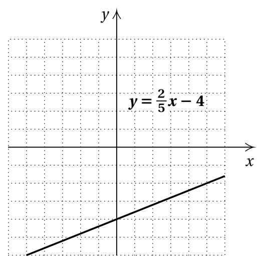


18. $y = \frac{2}{5}x - 4$

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 $(-5, -6)$.

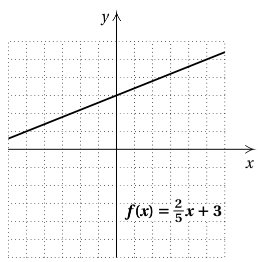


20. $y = \dfrac{2}{5}x + 3$

Slope: $\dfrac{2}{5}$; 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 $(-5, 1)$.

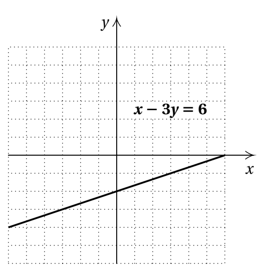


22.
$$\begin{aligned} x - 3y &= 6 \\ -3y &= -x + 6 \\ y &= \frac{1}{3}x - 2 \end{aligned}$$

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

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

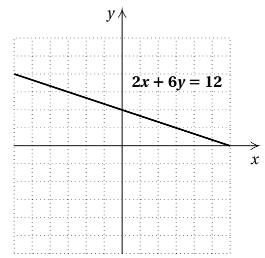
From $(3, -1)$, move 1 unit up and 3 units to the left again to $(6, 0)$.



24.
$$\begin{aligned} 2x + 6y &= 12 \\ 6y &= -2x + 12 \\ y &= -\frac{1}{3}x + 2 \end{aligned}$$

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

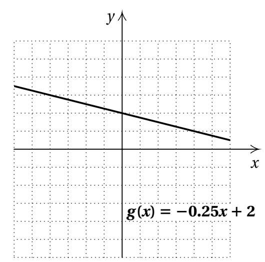
Starting at $(0, 2)$, find another point by moving 1 unit up and 3 units to the left to $(-3, 3)$. Starting at $(0, 2)$ again, move 1 unit down and 3 units to the right to $(3, 1)$.



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

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

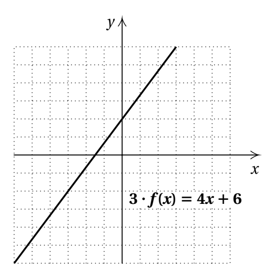
Starting at $(0, 2)$, find another point by moving 1 unit up and 4 units to the left to $(-4, 3)$. Starting at $(0, 2)$ again, move 1 unit down and 4 units to the right to $(4, 1)$.



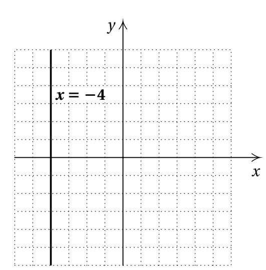
28.
$$\begin{aligned} 3 \cdot f(x) &= 4x + 6 \\ f(x) &= \frac{4}{3}x + 2 \end{aligned}$$

Slope: $\dfrac{4}{3}$; 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 $(-3, -2)$.

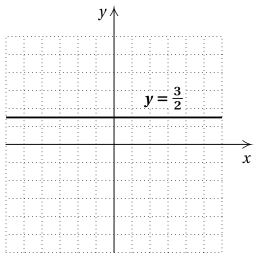


30.



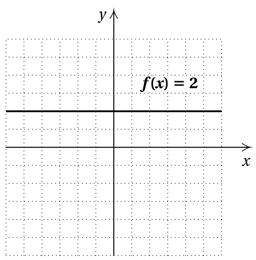
The slope is not defined.

32.



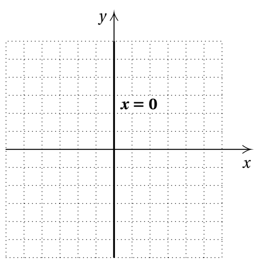
The slope is 0.

34.



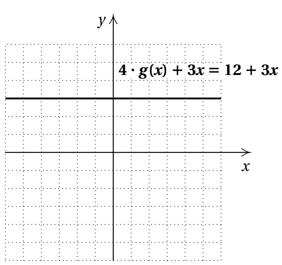
The slope is 0.

36.



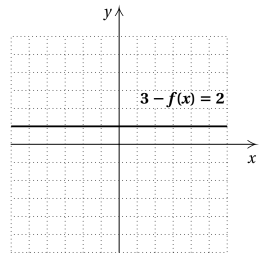
The slope is not defined.

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.

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

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

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

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

50. Write both equations in slope-intercept form.

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

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

$\frac{2}{5}\left(-\frac{2}{5}\right) = -\frac{4}{25} \neq -1$, 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 $y = -\frac{4}{9}$ are both horizontal lines, they are not perpendicular.

57. *Discussion and Writing Exercise.* 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 $y = mx$.

58. *Discussion and Writing Exercise.*

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

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.

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

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

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

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

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

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

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

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

68. $12a + 21ab = 3a(4 + 7b)$

70. $64x - 128y + 256 = 64(x - 2y + 4)$

72. If a vertical line passes through $(-2, 3)$, then we must have $x = -2$.

74.
$$x + 7y = 70$$
$$y = -\frac{1}{7}x + 10 \qquad \left(m = -\frac{1}{7}\right)$$
$$y + 3 = kx$$
$$y = kx - 3 \qquad (m = k)$$

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

$$\begin{aligned} -\frac{1}{7} \cdot k &= -1 \\ k &= 7 \end{aligned}$$

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

78. 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.

80.
$$\begin{aligned} 2y &= -7x + 3b \\ 2(-13) &= -7 \cdot 0 + 3b \\ -26 &= 3b \\ -\frac{26}{3} &= b \end{aligned}$$

Exercise Set 2.6

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:

$$\begin{aligned} y &= mx + b \\ 4 &= 0 \cdot 0 + b \\ 4 &= b \end{aligned}$$

$y = 0x + 4$, or $y = 4$

20. Using the point-slope equation:

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

Using the slope-intercept equation:

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

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

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

Using the point-slope equation:

$$\begin{aligned} y - y_1 &= m(x - x_1) \\ y - 5 &= 1(x - 2) \\ y - 5 &= x - 2 \\ y &= x + 3 \end{aligned}$$

Using the slope-intercept equation:

$$\begin{aligned} y &= mx + b \\ 5 &= 1 \cdot 2 + b \\ 3 &= b \end{aligned}$$

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

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

Using the point-slope equation:

$$\begin{aligned} y - y_1 &= m(x - x_1) \\ y - 9 &= 1(x - 9) \\ y - 9 &= x - 9 \\ y &= x \end{aligned}$$

Using the slope-intercept equation:

$$\begin{aligned} y &= mx + b \\ 9 &= 1 \cdot 9 + b \\ 0 &= b \end{aligned}$$

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

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

Using the point-slope equation:

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

Using the slope-intercept equation:

$$\begin{aligned} y &= mx + b \\ -5 &= \frac{5}{3} \cdot 0 + b \\ -5 &= b \end{aligned}$$

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

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

Using the point-slope equation:

$$\begin{aligned} y - y_1 &= m(x - x_1) \\ y - (-7) &= 3(x - (-4)) \\ y + 7 &= 3(x + 4) \\ y + 7 &= 3x + 12 \\ y &= 3x + 5 \end{aligned}$$

Using the slope-intercept equation:

$$\begin{aligned} y &= mx + b \\ -7 &= 3(-4) + b \\ 5 &= b \end{aligned}$$

$y = 3x + 5$

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

Using the point-slope equation:

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

Using the slope-intercept equation:

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

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

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:

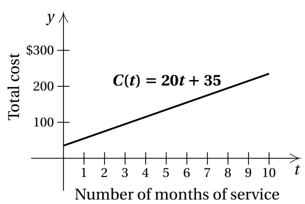
$$\begin{aligned} y - y_1 &= m(x - x_1) \\ y - (-4) &= -2(x - (-3)) \\ y + 4 &= -2(x + 3) \\ y + 4 &= -2x - 6 \\ y &= -2x - 10 \end{aligned}$$

Using the slope-intercept equation:

$$\begin{aligned} y &= mx + b \\ -4 &= -2(-3) + 6 \\ -10 &= b \\ y &= -2x - 10 \end{aligned}$$

46. a) $C(t) = 20t + 35$

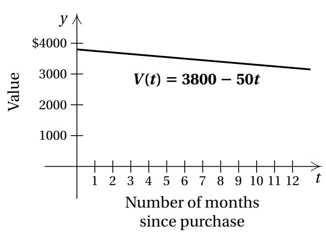
b)



c) $C(9) = 20 \cdot 9 + 35 = \$215$

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

b)



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

50. a) The data points are $(0, 20.8)$ and $(33, 25.0)$.

$$m = \frac{25.0 - 20.8}{33 - 0} = \frac{4.2}{33} \approx 0.127$$

Using the slope, 0.127, and the y-intercept $(0, 20.8)$, we write the function: $A(x) = 0.127x + 20.8$.

b) In 2008: $A(38) = 0.127(38) + 20.8 \approx 25.6$ yr

In 2015: $A(45) = 0.127(45) + 20.8 \approx 26.5$ yr

52. a) The data points are $(0, 43.8)$ and $(8, 68.0)$.

$$m = \frac{68.0 - 43.8}{8 - 0} = \frac{24.2}{8} = 3.025$$

Using the slope, 3.025, and the y-intercept $(0, 43.8)$, we write the function: $N(t) = 3.025t + 43.8$.

b) $N(12) = 3.025(12) + 43.8 = 80.1$ million tons

54. a) The data points are $(0, 78.8)$ and $(11, 79.8)$.

$$m = \frac{79.8 - 78.8}{11 - 0} = \frac{1.0}{11} \approx 0.091$$

Using the slope, 0.091, and the y-intercept, $(0, 78.8)$, we write the function:

$F(t) = 0.091t + 78.8$.

b) $F(20) = 0.091(20) + 78.8 \approx 80.6$ yr

55. *Discussion and Writing Exercise.* 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.

56. *Discussion and Writing Exercise.* For $C(d) = 0.75d + 2$, $m = 0.75$ and $b = 2$; 0.75 signifies that the cost per mile of a taxi ride is \$0.75; 2 signifies that the minimum cost of a taxi ride is \$2.

58. $|2x + 3| = 51$

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

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

60.
$$\begin{aligned} 2x + 3 &\le 5x - 4 \\ 7 &\le 3x \\ \frac{7}{3} &\le x \end{aligned}$$

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

62. $|2x + 3| = |x - 4|$

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

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

64.
$$\begin{aligned} -12 \le 2x &+ 3 < 51 \\ -15 \le 2x &< 48 \\ -\frac{15}{2} \le x &< 24 \end{aligned}$$

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

66. The total cost C of the phone, in dollars, after t months, can be modeled by a line that contains the points $(5, 230)$ and $(9, 390)$.

$$m = \frac{390 - 230}{9 - 5} = \frac{160}{4} = 40$$

$$\begin{aligned} C - 230 &= 40(t - 5) \\ C - 230 &= 40t - 200 \\ C &= 40t + 30 \end{aligned}$$

Using function notation we have $C(t) = 40t + 30$. To find the costs already incurred when the service began we find $C(0)$:

$$C(0) = 40 \cdot 0 + 30 = 30$$

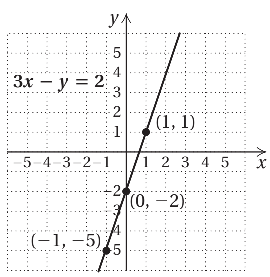
Mel had already incurred \$30 in costs when his service just began.

Chapter 2 Review Exercises

1. To show that a pair is a solution, we substitute, replacing x with the first coordinate and y with the second coordinate in each pair.

$$\begin{array}{r|l} \multicolumn{2}{c}{3x - y = 2} \\ \hline 3 \cdot 0 - (-2) \ ? & 2 \\ 0 + 2 & \\ 2 & \text{TRUE} \end{array} \qquad \begin{array}{r|l} \multicolumn{2}{c}{3x - y = 2} \\ \hline 3(-1) - (-5) \ ? & 2 \\ -3 + 5 & \\ 2 & \text{TRUE} \end{array}$$

In each case the substitution results in a true equation. Thus, $(0, -2)$ and $(-1, -5)$ are both solutions of $3x - y = 2$. We plot these points and sketch the line passing through them.



The line appears to pass through $(1, 1)$ also. We check to determine if $(1, 1)$ is a solution of $3x - y = 2$.

$$\begin{array}{r|l} \multicolumn{2}{c}{3x - y = 2} \\ \hline 3 \cdot 1 - 1 \ ? & 2 \\ 3 - 1 & \\ 2 & \text{TRUE} \end{array}$$

Thus, $(1, 1)$ is another solution. There are other correct answers, including $(2, 4)$.

2. $y = 3x + 2$

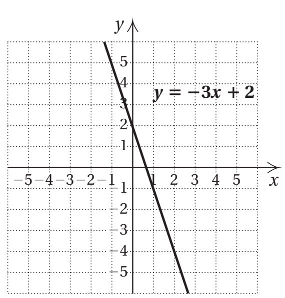
We find some ordered pairs that are solutions, plot them, and draw and label the line.

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	$(2, -4)$



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

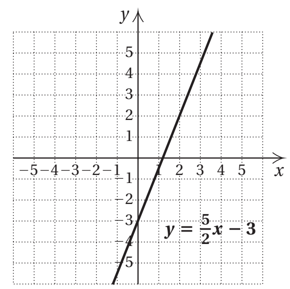
We find some ordered pairs that are solutions, using multiples of 2 to avoid fractions. Then we plot these points and draw and label the line.

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

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

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

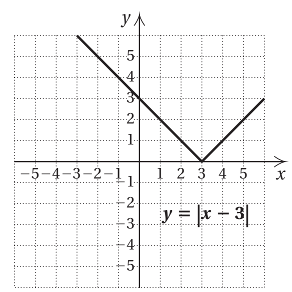
x	y	(x, y)
0	-3	$(0, -3)$
2	2	$(2, 2)$
4	7	$(4, 7)$



4. $y = |x - 3|$

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 with a smooth curve.

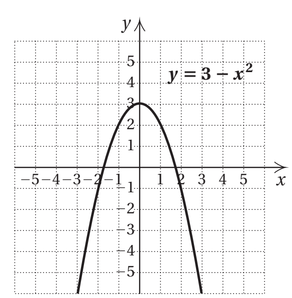
x	y
5	2
3	0
2	1
-1	4
-2	5
-3	6



5. $y = 3 - x^2$

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



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

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

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

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

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

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

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

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

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

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

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

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

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

13. 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 $[1, 5]$.

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

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:

$$\begin{aligned} x - 4 &= 0 \\ x &= 4 \quad \text{Adding 4 on both sides} \end{aligned}$$

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 $(-\infty, 4) \cup (4, \infty)$.

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

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

16.
$$\begin{aligned} f(x) &= -3x \;+\; 2 \\ & \quad\;\; \uparrow \qquad \uparrow \\ f(x) &= \;\; mx \;+\; b \end{aligned}$$

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

17. 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 $(0, 2)$.

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

19. $2y + x = 4$

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

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

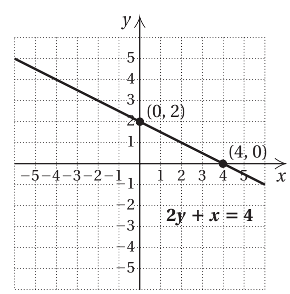
The x-intercept is $(4, 0)$.

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

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

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

We plot these points and draw the line.



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

$$\begin{aligned} 2y + (-2) &= 4 \\ 2y &= 6 \\ y &= 3 \end{aligned}$$

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

20. $2y = 6 - 3x$

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

$$\begin{aligned} 2y &= 6 - 3x \\ 2 \cdot 0 &= 6 - 3x \\ 0 &= 6 - 3x \\ 3x &= 6 \\ x &= 2 \end{aligned}$$

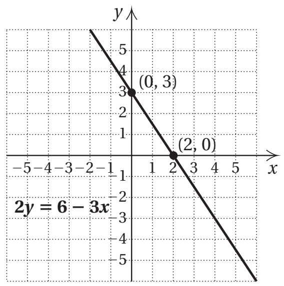
The x-intercept is $(2, 0)$.

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.

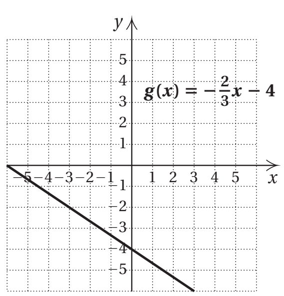
$$2y = 6 - 3 \cdot 4$$
$$2y = 6 - 12$$
$$2y = -6$$
$$y = -3$$

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

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

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 $(3, -6)$.

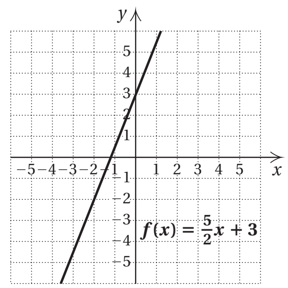
We can also think of the slope as $\dfrac{2}{-3}$. We again start at the y-intercept $(0, -4)$. We move 2 units up and 3 units to the left. We get to another new point $(-3, -2)$. We plot the points and draw the line.



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

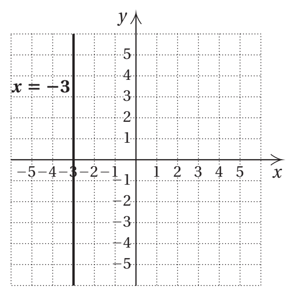
First we plot the y-intercept $(0, 3)$. Then we consider the slope $\dfrac{5}{2}$. Starting at the y-intercept and using the slope, we find another point by moving 5 units up and 2 units to the right. We get to a new point $(2, 8)$.

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.



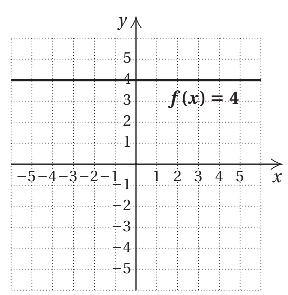
23. $x = -3$

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



24. $f(x) = 4$

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



25. 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.

26. 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.

27. 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.

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

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

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

30. 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.

$$y = -3x + 4$$

31. 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.

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

32. 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.

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

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

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

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

$$
\begin{aligned}
3x + y &= 5 \qquad \text{Given line} \\
y &= -3x + 5
\end{aligned}
$$

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.

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

Using the slope-intercept equation:

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

$$
\begin{aligned}
y &= mx + b \\
2 &= \frac{1}{3} \cdot 5 + b \\
2 &= \frac{5}{3} + b \\
\frac{1}{3} &= b
\end{aligned}
$$

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

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

34. a) We form pairs of the type (t, R) where t is the number of years since 1970 and R is the record. We have two pairs, $(0, 46.8)$ and $(34, 44.63)$. These are two points on the graph of the linear function we are seeking.

First we find the slope:

$$m = \frac{44.63 - 46.8}{34 - 0} = \frac{-2.17}{34} \approx -0.064$$

Using the slope and the y-intercept, $(0, 46.8)$ we write the function: $R(t) = -0.064t + 46.8$.

b) 2008 is 38 years since 1970, so to predict the record in 2008, we find $R(38)$:

$$
\begin{aligned}
R(38) &= -0.064(38) + 46.8 \\
&\approx 44.37
\end{aligned}
$$

The estimated record is 44.37 seconds in 2008.

2010 is 40 years since 1970, so to predict the record in 2010, we find $R(40)$:

$$
\begin{aligned}
R(40) &= -0.064(40) + 46.8 \\
&= 44.24
\end{aligned}
$$

The estimated record is 44.24 seconds in 2010.

35. *Discussion and Writing Exercise.* 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.

36. *Discussion and Writing Exercise.* The notation $f(x)$ can be read "f of x" or "f at x" or "the value of f at x." It represents the output of the function f for the input x. The notation $f(a) = b$ provides a concise way to indicate that for the input a, the output of the function f is b.

37. 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 $f(x) = 3.09x + 3.75$.

Chapter 2 Test

1. To show that a pair is a solution, we substitute, replacing x with the first coordinate and y with the second coordinate.

$$
\begin{array}{c|l}
\multicolumn{2}{c}{y = 5 - 4x} \\
\hline
-3 \ ? & 5 - 4 \cdot 2 \\
 & 5 - 8 \\
 & -3 \qquad \text{TRUE}
\end{array}
$$

The substitution results in a true equation. Thus, $(2, -3)$ is a solution of $y = 5 - 4x$.

2. To show that a pair is a solution, we substitute, replacing a with the first coordinate and b with the second coordinate.

$$
\begin{array}{r|l}
\multicolumn{2}{c}{5b - 7a = 10} \\
\hline
5(-3) - 7 \cdot 2 \ ? & 10 \\
-15 - 14 & \\
-29 & \qquad \text{FALSE}
\end{array}
$$

The substitution results in a false equation, so $(2, -3)$ is not a solution of $5b - 7a = 10$.

3. $y = -2x - 5$

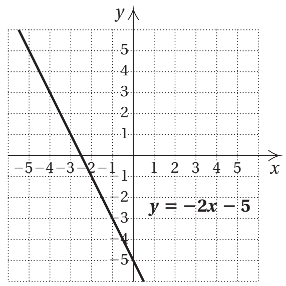
We find some ordered pairs that are solutions, plot them, and draw and label the line.

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



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

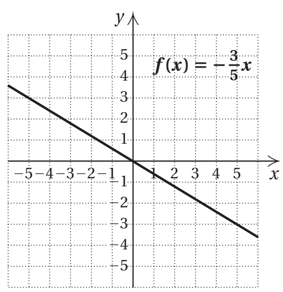
We find some function values, plot the corresponding points, and draw the curve.

$f(-5) = -\dfrac{3}{5}(-5) = 3$

$f(0) = -\dfrac{3}{5} \cdot 0 = 0$

$f(5) = -\dfrac{3}{5} \cdot 5 = -3$

x	$f(x)$
-5	3
0	0
5	-3



5. $g(x) = 2 - |x|$

We find some function values, plot the corresponding points, and draw the curve.

$g(-4) = 2 - |-4| = 2 - 4 = -2$

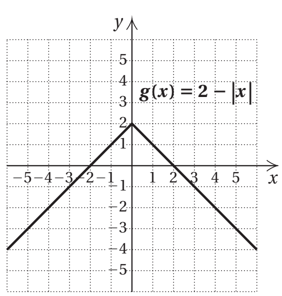
$g(-2) = 2 - |-2| = 2 - 2 = 0$

$g(0) = 2 - |0| = 2 - 0 = 2$

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

$g(5) = 2 - |5| = 2 - 5 = -3$

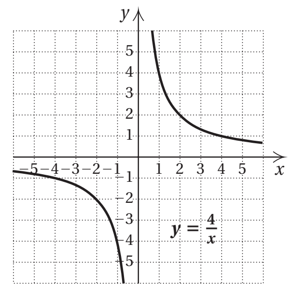
x	$g(x)$
-4	-2
-2	0
0	2
3	-1
5	-3



6. $y = \dfrac{4}{x}$

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

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



Note that we cannot use 0 as a first-coordinate, since 4/0 is undefined. Thus, the graph has two branches, one on each side of the y-axis.

7. a) In 2002, $x = 2002 - 1990 = 12$. We find $A(12)$.

$A(12) = 0.233(12) + 5.87 = 8.666$

The median age of cars in 2002 was 8.666 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.

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

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

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

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

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

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

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

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

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

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

14. a) Locate 2000 on the x-axis and then move directly up to the graph. The point directly above 2000 lies on the y-axis at about 32. Thus, there were about 32 million persons 65 and older in 2000.

b) Locate 2040 on the x-axis and then move directly up to the graph. Next move across to the y-axis. We come to about 80, so there will be about 80 million persons 65 and older in 2040.

15. a) Locate 2 on the horizontal axis and the 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. It appears to be about 1.2. Thus, $f(2) \approx 1.2$.

b) The set of all x-values in the graph extends from -3 to 4, so the domain is $\{x| -3 \le x \le 4\}$, 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 $[-1, 2]$.

16. $g(x) = 5 - x^2$

Since we can calculate $5 - x^2$ for any real number x, the domain is the set of all real numbers.

17. $f(x) = \dfrac{8}{2x+3}$

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

$\left(-\infty, -\dfrac{3}{2}\right) \cup \left(-\dfrac{3}{2}, \infty\right)$.

18.
$$\begin{array}{l} f(x) = -\frac{3}{5}x + 12 \\ \qquad\quad\;\uparrow \qquad\; \uparrow \\ f(x) = \;\; mx \;\; + \;\; b \end{array}$$

The slope is $-\dfrac{3}{5}$, and the y-intercept is $(0, 12)$.

19. 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 $\left(0, -\dfrac{7}{5}\right)$.

20. Slope $= \dfrac{\text{change in } y}{\text{change in } x} = \dfrac{-2-3}{-2-6} = \dfrac{-5}{-8} = \dfrac{5}{8}$

21. Slope $= \dfrac{\text{change in } y}{\text{change in } x} = \dfrac{5.2 - 5.2}{-4.4 - (-3.1)} = \dfrac{0}{-1.3} = 0$

22. 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.

23. $2x + 3y = 6$

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

$$\begin{aligned} 2x + 3y &= 6 \\ 2x + 3 \cdot 0 &= 6 \\ 2x &= 6 \\ x &= 3 \end{aligned}$$

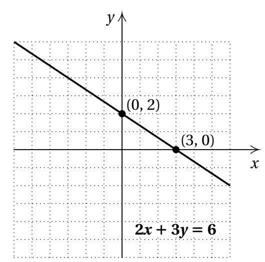
The x-intercept is $(3, 0)$.

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.

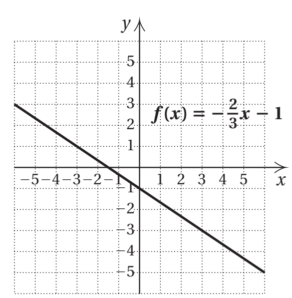
$$\begin{aligned} 2(-3) + 3y &= 6 \\ -6 + 3y &= 6 \\ 3y &= 12 \\ y &= 4 \end{aligned}$$

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

24. $f(x) = -\dfrac{2}{3}x - 1$

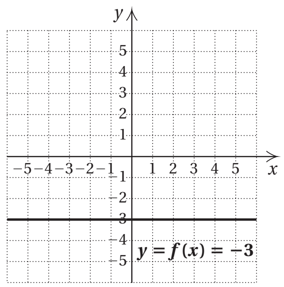
First we plot the y-intercept $(0, -1)$. We can think of the slope as $\dfrac{-2}{3}$. Starting at the y-intercept and using the slope, we find another point by moving 2 units down and 3 units to the right. We get to a new point $(3, -3)$.

We can also think of the slope as $\dfrac{2}{-3}$. 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.



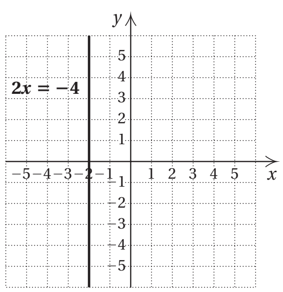
25. $y = f(x) = -3$

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



26.
$$2x = -4$$
$$x = -2$$

Since y is missing, all ordered pairs $(-2, y)$ are solutions. The graph is parallel to the y-axis.



27. 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.

28. 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.

29. We use the slope-intercept equation and substitute -3 for m and 4.8 for b.

$$y = mx + b$$
$$y = -3x + 4.8$$

30.
$$y = f(x) = mx + b$$
$$f(x) = 5.2x - \frac{5}{8}$$

31. 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.

$$y = -4x + 2$$

32. 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.

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

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

$$\begin{aligned} x - 2y &= 5 \qquad \text{Given line} \\ -2y &= -x + 5 \\ y &= \frac{1}{2}x - \frac{5}{2} \end{aligned}$$

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.

$$\begin{aligned} y - y_1 &= m(x - x_1) \\ y - (-1) &= \frac{1}{2}(x - 4) \\ y + 1 &= \frac{1}{2}x - 2 \\ y &= \frac{1}{2}x - 3 \end{aligned}$$

Using the slope-intercept equation:

Substitute 4 for x, -1 for y, and $\frac{1}{2}$ for m and solve for b.

$$\begin{aligned} y &= mx + b \\ -1 &= \frac{1}{2}(4) + b \\ -1 &= 2 + b \\ -3 &= b \end{aligned}$$

Then we use the equation $y = mx + b$ and substitute $\frac{1}{2}$ for m and -3 for b.

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

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

$$\begin{aligned} x + 3y &= 2 \qquad \text{Given line} \\ 3y &= -x + 2 \\ y &= -\frac{1}{3}x + \frac{2}{3} \end{aligned}$$

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.

$$\begin{aligned} y - y_1 &= m(x - x_1) \\ y - 5 &= 3(x - 2) \\ y - 5 &= 3x - 6 \\ y &= 3x - 1 \end{aligned}$$

Using the slope-intercept equation:

Substitute 2 for x, 5 for y, and 3 for m and solve for b.

$$\begin{aligned} y &= mx + b \\ 5 &= 3 \cdot 2 + b \\ 5 &= 6 + b \\ -1 &= b \end{aligned}$$

Then we use the equation $y = mx + b$ and substitute 3 for m and -1 for b.

$$y = 3x - 1$$

35. a) Note that $2003 - 1970 = 33$. Thus, the data points are $(0, 23.2)$ and $(33, 27.0)$. We find the slope.

$$m = \frac{27.0 - 23.2}{33 - 0} = \frac{3.8}{33} \approx 0.115$$

Using the slope and the y-intercept, $(0, 23.2)$, we write the function: $A(x) = 0.115x + 23.2$

b) In 2008, $x = 2008 - 1970 = 38$.

$A(38) = 0.115(38) + 23.2 = 27.57$ yr

In 2015, $x = 2015 - 1970 = 45$.

$A(45) = 0.115(45) + 23.2 \approx 28.38$ yr

36. First solve each equation for y and determine the slopes.

$$\begin{aligned} 3x + ky &= 17 \\ ky &= -3x + 17 \\ y &= -\frac{3}{k}x + \frac{17}{k} \end{aligned}$$

The slope of $3x + ky = 17$ is $-\frac{3}{k}$.

$$\begin{aligned} 8x - 5y &= 26 \\ -5y &= -8x + 26 \\ y &= \frac{8}{5}x - \frac{26}{5} \end{aligned}$$

The slope of $8x - 5y = 26$ is $\frac{8}{5}$.

If the lines are perpendicular, the product of their slopes is -1.

$$\begin{aligned} -\frac{3}{k} \cdot \frac{8}{5} &= -1 \\ -\frac{24}{5k} &= -1 \\ 24 &= 5k \qquad \text{Multiplying by } -5k \\ \frac{24}{5} &= k \end{aligned}$$

37. Answers may vary. One such function is $f(x) = 3$.

Cumulative Review Chapters R - 2

1. a) Note that $2004 - 1950 = 54$, so 2004 is 54 yr after 1950. Then the data points are $(0, 3.85)$ and $(54, 3.50)$.

First we find the slope.

$$m = \frac{3.50 - 3.85}{54 - 0} = \frac{-0.35}{54} \approx -0.006$$

Using the slope and the y-intercept, $(0, 3.85)$, we write the function: $R(x) = -0.006x + 3.85$.

b) In 2008, $x = 2008 - 1950 = 58$.

$R(58) = -0.006(58) + 3.85 \approx 3.50$ min

In 2010, $x = 2010 - 1950 = 60$.

$R(60) = -0.006(60) + 3.85 \approx 3.49$ min

2. a) Locate 15 on the x-axis and the find the point on the graph for which 15 is the first coordinate. From that point, look to the vertical axis to find the corresponding y-coordinate, 6. Thus, $f(15) = 6$.

b) The set of all x-values in the graph extends from 0 to 30, so the domain is $\{x|0 \le x \le 30\}$, or $[0, 30]$.

c) To determine which member(s) of the domain are paired with 14, locate 14 on the vertical axis. From there look left and right to the graph to find any points for which 14 is the second coordinate. One such point exists. Its first coordinate is 25. Thus, the x-value for which $f(x) = 14$ is 25.

d) The set of all y-values in the graph extends from 0 to 15, so the range is $\{y|0 \le y \le 15\}$, or $[0, 15]$.

3. $a^3+b^0-c = 3^3+7^0-(-3) = 27+1-(-3) = 27+1+3 = 31$

4. $|4.3 - 2.1| = |2.2| = 2.2$

5. $\left|-\dfrac{2}{3}\right| = \dfrac{2}{3}$

6. $-\dfrac{1}{3} - \left(-\dfrac{5}{6}\right) = -\dfrac{1}{3} + \dfrac{5}{6} = -\dfrac{2}{6} + \dfrac{5}{6} = \dfrac{3}{6} = \dfrac{1}{2}$

7. $-3.2(-11.4) = 36.48$

8. $2x - 4(3x - 8) = 2x - 12x + 32 = -10x + 32$

9. $(-16x^3y^{-4})(-2x^5y^3) = -16(-2)x^3 \cdot x^5 \cdot y^{-4} \cdot y^3 =$

$32x^{3+5}y^{-4+3} = 32x^8y^{-1} = \dfrac{32x^8}{y}$

10. $\dfrac{27x^0y^3}{-3x^2y^5} = \dfrac{27 \cdot 1 \cdot y^3}{-3x^2y^5} = \dfrac{27}{-3} \cdot \dfrac{1}{x^2} \cdot \dfrac{y^3}{y^5} =$

$-9 \cdot \dfrac{1}{x^2} \cdot y^{3-5} = -9 \cdot \dfrac{1}{x^2} \cdot y^{-2} = -\dfrac{9}{x^2y^2}$

11.
$$\begin{aligned} 3(x-7) - 4[2-5(x+3)] &= 3x - 21 - 4[2 - 5x - 15] \\ &= 3x - 21 - 4[-13 - 5x] \\ &= 3x - 21 + 52 + 20x \\ &= 23x + 31 \end{aligned}$$

12. $-128 \div 16 + 32 \cdot (-10) = -8 - 320 = -328$

13.
$$\begin{aligned} &2^3 - (4 \cdot 2 - 3)^2 + 23^0 \cdot 16^1 \\ &= 2^3 - (8-3)^2 + 23^0 \cdot 16^1 \\ &= 2^3 - 5^2 + 23^0 \cdot 16^1 \\ &= 8 - 25 + 1 \cdot 16 \\ &= 8 - 25 + 16 \\ &= -17 + 16 \\ &= -1 \end{aligned}$$

14.
$$\begin{aligned} x + 9.4 &= -12.6 \\ x + 9.4 - 9.4 &= -12.6 - 9.4 \\ x &= -22 \end{aligned}$$

The solution is -22.

15.
$$\begin{aligned} \frac{2}{3}x - \frac{1}{4} &= -\frac{4}{5}x \\ 60\left(\frac{2}{3}x - \frac{1}{4}\right) &= 60\left(-\frac{4}{5}x\right) \quad \text{Clearing fractions} \\ 60 \cdot \frac{2}{3}x - 60 \cdot \frac{1}{4} &= -48x \\ 40x - 15 &= -48x \\ 40x - 15 - 40x &= -48x - 40x \\ -15 &= -88x \\ \frac{-15}{-88} &= \frac{-88x}{-88} \\ \frac{15}{88} &= x \end{aligned}$$

The solution is $\dfrac{15}{88}$.

16.
$$\begin{aligned} -2.4t &= -48 \\ \frac{-2.4t}{-2.4} &= \frac{-48}{-2.4} \\ t &= 20 \end{aligned}$$

The solution is 20.

17.
$$\begin{aligned} 4x + 7 &= -14 \\ 4x &= -21 \quad \text{Subtracting 7} \\ x &= -\frac{21}{4} \quad \text{Dividing by 4} \end{aligned}$$

The solution is $-\dfrac{21}{4}$.

18.
$$\begin{aligned} 3n - (4n - 2) &= 7 \\ 3n - 4n + 2 &= 7 \\ -n + 2 &= 7 \\ -n &= 5 \\ n &= -5 \quad \text{Multiplying by } -1 \end{aligned}$$

The solution is -5.

19.
$$\begin{aligned} W &= Ax + By \\ W - By &= Ax \qquad \text{Subtracting } By \\ \frac{W - By}{A} &= x \qquad \text{Dividing by } A \end{aligned}$$

20.
$$\begin{aligned} M &= A + 4AB \\ M &= A(1 + 4B) \quad \text{Factoring out } A \\ \frac{M}{1 + 4B} &= A \qquad \text{Dividing by } 1 + 4B \end{aligned}$$

21.
$$\begin{aligned} y - 12 &\le -5 \\ y &\le 7 \quad \text{Adding 12} \end{aligned}$$

The solution set is $\{y|y \le 7\}$, or $(-\infty, 7]$.

22. $6x - 7 < 2x - 13$

$4x - 7 < -13$

$4x < -6$

$x < -\dfrac{3}{2}$

The solution set is $\left\{x \middle| x < -\dfrac{3}{2}\right\}$, or $\left(-\infty, -\dfrac{3}{2}\right)$.

23. $5(1 - 2x) + x < 2(3 + x)$

$5 - 10x + x < 6 + 2x$

$5 - 9x < 6 + 2x$

$5 - 11x < 6$

$-11x < 1$

$x > -\dfrac{1}{11}$ Reversing the inequality symbol

The solution set is $\left\{x \middle| x > -\dfrac{1}{11}\right\}$, or $\left(-\dfrac{1}{11}, \infty\right)$.

24. $x + 3 < -1$ *or* $x + 9 \geq 1$

$x < -4$ *or* $x \geq -8$

The intersection of $\{x|x < -4\}$ and $\{x|x \geq -8\}$ is the set of all real numbers. This is the solution set.

25. $-3 < x + 4 \leq 8$

$-7 < x \leq 4$

The solution set is $\{x| -7 < x \leq 4\}$, or $(-7, 4]$.

26. $-8 \leq 2x - 4 \leq -1$

$-4 \leq 2x \leq 3$

$-2 \leq x \leq \dfrac{3}{2}$

The solution set is $\left\{x \middle| -2 \leq x \leq \dfrac{3}{2}\right\}$, or $\left[-2, \dfrac{3}{2}\right]$.

27. $|x| = 8$

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

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

28. $|y| > 4$

$x < -4$ *or* $y > 4$

The solution set is $\{y|y < -4 \text{ or } y > 4\}$, or $(-\infty, -4) \cup (4, \infty)$.

29. $|4x - 1| \leq 7$

$-7 \leq 4x - 1 \leq 7$

$-6 \leq 4x \leq 8$

$-\dfrac{3}{2} \leq x \leq 2$

The solution set is $\left\{x \middle| -\dfrac{3}{2} \leq x \leq 2\right\}$, or $\left[-\dfrac{3}{2}, 2\right]$.

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

$4y - x = 3$ Given line

$4y = x + 3$

$y = \dfrac{1}{4}x + \dfrac{3}{4}$

The slope of the given line is $\dfrac{1}{4}$. The slope of the perpendicular line is the opposite of the reciprocal of $\dfrac{1}{4}$. Thus, the line through $(-4, -6)$ must have slope -4.

Using the point-slope equation:

Substitute -4 for x_1, -6 for y_1, and -4 for m.

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

$y - (-6) = -4(x - (-4))$

$y + 6 = -4(x + 4)$

$y + 6 = -4x - 16$

$y = -4x - 22$

Using the slope-intercept equation:

Substitute -4 for x, -6 for y, and -4 for m.

$y = mx + b$

$-6 = -4(-4) + b$

$-6 = 16 + b$

$-22 = b$

Then we use the equation $y = mx + b$ and substitute -4 for m and -22 for b.

$y = -4x - 22$

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

$4y - x = 3$ Given line

$4y = x + 3$

$y = \dfrac{1}{4}x + \dfrac{3}{4}$

The slope of the given line is $\dfrac{1}{4}$. The line through $(-4, -6)$ must have slope $\dfrac{1}{4}$.

Using the point-slope equation:

Substitute -4 for x_1, -6 for y_1, and $\dfrac{1}{4}$ for m.

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

$y - (-6) = \dfrac{1}{4}(x - (-4))$

$y + 6 = \dfrac{1}{4}(x + 4)$

$y + 6 = \dfrac{1}{4}x + 1$

$y = \dfrac{1}{4}x - 5$

Using the slope-intercept equation:

Substitute -4 for x, -6 for y, and $\dfrac{1}{4}$ for m and solve for b.

$$\begin{aligned} y &= mx+b \\ -6 &= \frac{1}{4}(-4)+b \\ -6 &= -1+b \\ -5 &= b \end{aligned}$$

Then we use the equation $y = mx+b$ and substitute $\dfrac{1}{4}$ for m and -5 for b.

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

32. $y = -2x + 3$

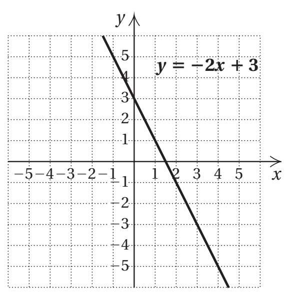
We find some ordered pairs that are solutions, plot them, and draw and label the graph.

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

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

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

x	y
-1	5
1	1
3	-3



33. $3x = 2y + 6$

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

$$\begin{aligned} 3x &= 2y+6 \\ 3x &= 2 \cdot 0 + 6 \\ 3x &= 6 \\ x &= 2 \end{aligned}$$

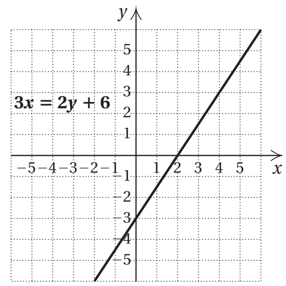
The x-intercept is $(2, 0)$.

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

$$\begin{aligned} 3x &= 2y+6 \\ 3 \cdot 0 &= 2y+6 \\ 0 &= 2y+6 \\ -2y &= 6 \\ y &= -3 \end{aligned}$$

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.

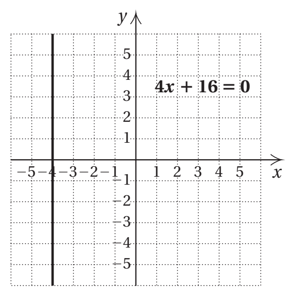
$$\begin{aligned} 3 \cdot 4 &= 2y+6 \\ 12 &= 2y+6 \\ 6 &= 2y \\ 3 &= y \end{aligned}$$

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

34. $4x + 16 = 0$

$$\begin{aligned} 4x &= -16 \\ x &= -4 \end{aligned}$$

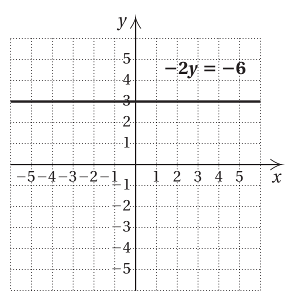
Since y is missing, all ordered pairs $(-4, y)$ are solutions. The graph is parallel to the y-axis.



35. $-2y = -6$

$$y = 3$$

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



36. $f(x) = \dfrac{2}{3}x + 1$

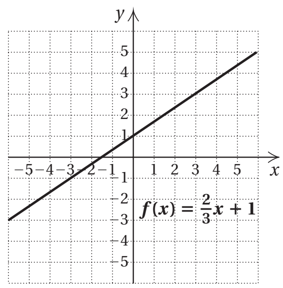
We calculate some function values, plot the corresponding points, and connect them.

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

$f(0) = \frac{2}{3} \cdot 0 + 1 = 0 + 1 = 1$

$f(3) = \frac{2}{3} \cdot 3 + 1 = 2 + 1 = 3$

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



37. $g(x) = 5 - |x|$

We calculate some function values, plot the corresponding points, and connect them.

$g(-2) = 5 - |-2| = 5 - 2 = 3$

$g(-1) = 5 - |-1| = 5 - 1 = 4$

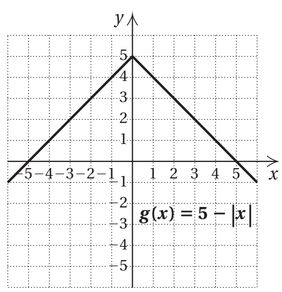
$g(0) = 5 - |0| = 5 - 0 = 5$

$g(1) = 5 - |1| = 5 - 1 = 4$

$g(2) = 5 - |2| = 5 - 2 = 3$

$g(3) = 5 - |3| = 5 - 3 = 2$

x	$g(x)$
-2	3
-1	4
0	5
1	4
2	3
3	2



38. 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.

$$-4y + 9x = 12$$
$$-4y = -9x + 12$$
$$\frac{-4y}{-4} = \frac{-9x + 12}{-4}$$
$$y = \frac{9}{4}x - 3$$

The slope is $\frac{9}{4}$, and the y-intercept is $(0, -3)$.

39. Slope $= \frac{\text{change in } y}{\text{change in } x} = \frac{3-7}{-1-2} = \frac{-4}{-3} = \frac{4}{3}$

40. Using the point-slope equation:

Substitute 2 for x_1, -11 for y_1, and -3 for m.

$$y - y_1 = m(x - x_1)$$
$$y - (-11) = -3(x - 2)$$
$$y + 11 = -3x + 6$$
$$y = -3x - 5$$

Using the slope-intercept equation:

Substitute 2 for x, -11 for y, and -3 for m in $y = mx + b$ and solve for b.

$$y = mx + b$$
$$-11 = -3 \cdot 2 + b$$
$$-11 = -6 + b$$
$$-5 = b$$

Then use the equation $y = mx + b$ and substitute -3 for m and -5 for b.

$$y = -3x - 5$$

41. First find the slope of the line:

$$m = \frac{3-2}{-6-4} = \frac{1}{-10} = -\frac{1}{10}$$

Using the point-slope equation:

We choose to use the point $(4, 2)$ and substitute 4 for x_1, 2 for y_1, and $-\frac{1}{10}$ for m.

$$y - y_1 = m(x - x_1)$$
$$y - 2 = -\frac{1}{10}(x - 4)$$
$$y - 2 = -\frac{1}{10}x + \frac{2}{5}$$
$$y = -\frac{1}{10}x + \frac{12}{5}$$

Using the slope-intercept equation:

We choose $(4, 2)$ and substitute 4 for x, 2 for y, and $-\frac{1}{10}$ for m in $y = mx + b$. Then we solve for b.

$$y = mx + b$$
$$2 = -\frac{1}{10} \cdot 4 + b$$
$$2 = -\frac{2}{5} + b$$
$$\frac{12}{5} = b$$

Finally, we use the equation $y = mx + b$ and substitute $-\frac{1}{10}$ for m and $\frac{12}{5}$ for b.

$$y = -\frac{1}{10}x + \frac{12}{5}$$

42. ***Familiarize***. Let $w =$ the width, in meters. Then $w + 6 =$ the length. Recall that the formula for the perimeter of a rectangle is $P = 2l + 2w$.

Translate. We use the formula for perimeter.

$$80 - 2(w + 6) + 2w$$

Solve. We solve the equation.

$$80 = 2(w+6) + 2w$$
$$80 = 2w + 12 + 2w$$
$$80 = 4w + 12$$
$$68 = 4w$$
$$17 = w$$

If $w = 17$, then $w + 6 = 17 + 6 = 23$.

Check. 23 m is 6 m more than 17 m, and $2 \cdot 23 + 2 \cdot 17 = 46 + 34 = 80$ m. The answer checks.

State. The length is 23 m and the width is 17 m.

43. ***Familiarize***. Let s = David's old salary. Then his new salary is $s + 20\%$, or $s + 0.2s$, or $1.2s$.

Translate.

$$\underbrace{\text{New salary}}\ \text{is}\ \$27,000$$
$$\downarrow \qquad \downarrow \quad \downarrow$$
$$1.2s \quad = \ 27,000$$

Solve. We solve the equation.

$$1.2s = 27,000$$
$$s = 22,500$$

Check. 20% of \$22,500 is $0.2(\$22,500)$, or \$4500, and $\$22,500 + \$4500 = \$27,000$. The answer checks.

State. David's old salary was \$22,500.

44.

$$\left(\frac{1}{8}\right)^2 = \frac{1}{8} \cdot \frac{1}{8} = \frac{1}{64}$$
$$\left(\frac{1}{8}\right)^{-2} = \left(\frac{8}{1}\right)^2 = 8^2 = 64$$
$$8^{-2} = \frac{1}{8^2} = \frac{1}{64}$$
$$8^2 = 64$$
$$-8^2 = -64$$
$$(-8)^2 = 64$$
$$\left(-\frac{1}{8}\right)^{-2} = \left(-\frac{8}{1}\right)^2 = (-8)^2 = 64$$
$$\left(-\frac{1}{8}\right)^2 = -\frac{1}{8} \cdot \left(-\frac{1}{8}\right) = \frac{1}{64}$$

45. 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.

46. If we let x = the length of the longer piece, in feet, then $\frac{1}{3}x$ = the length of the shorter piece. The problem translates to the equation $x + \frac{1}{3}x = 28$. We solve the equation.

$$x + \frac{1}{3}x = 28$$
$$\frac{4}{3}x = 28$$
$$x = \frac{3}{4} \cdot 28 = 21$$

If $x = 21$, then $\frac{1}{3}x = \frac{1}{3} \cdot 21 = 7$. Thus, answer (b) is correct.

47. $a = a^1$, so answer (d) is correct.

48.

$$\begin{aligned} & [9(2a+3) - (a-2)] - [3(2a-1)] \\ &= [18a + 27 - a + 2] - [6a - 3] \\ &= [17a + 29] - [6a - 3] \\ &= 17a + 29 - 6a + 3 \\ &= 11a + 32 \end{aligned}$$

Thus, answer (e) is correct.

49. We have two data points, $(1000,\ 101,000)$ and $(1250,\ 126,000)$. We find the slope of the line containing these points.

$$m = \frac{126,000 - 101,000}{1250 - 1000} = \frac{25,000}{250} = 100$$

We will use the point-slope equation with $x_1 = 1000$, $y_1 = 101,000$ and $m = 100$.

$$\begin{aligned} y - y_1 &= m(x - x_1) \\ y - 101,000 &= 100(x - 1000) \\ y - 101,000 &= 100x - 100,000 \\ y &= 100x + 1000 \end{aligned}$$

Now we find the value of y when $x = 1500$.

$$y = 100 \cdot 1500 + 1000 = 150,000 + 1000 = 151,000$$

Thus, when \$1500 is spent on advertising, weekly sales increase by \$151,000.

50. First we solve each equation for y and determine the slopes.

a)
$$\begin{aligned} 7y - 3x &= 21 \\ 7y &= 3x + 21 \\ y &= \frac{3}{7}x + 3 \end{aligned}$$

The slope is $\frac{3}{7}$.

b)
$$\begin{aligned} -3x - 7y &= 12 \\ -7y &= 3x + 12 \\ y &= -\frac{3}{7}x - \frac{12}{7} \end{aligned}$$

The slope is $-\frac{3}{7}$.

c)
$$\begin{aligned} 7y + 3x &= 21 \\ 7y &= -3x + 21 \\ y &= -\frac{3}{7}x + 3 \end{aligned}$$

The slope is $-\frac{3}{7}$.

d)
$$\begin{aligned} 3y + 7x &= 12 \\ 3y &= -7x + 12 \\ y &= -\frac{7}{3}x + 4 \end{aligned}$$

The slope is $-\frac{7}{3}$.

The only pair of slopes whose product is -1 is $\frac{3}{7}$ and $-\frac{7}{3}$. Thus, equations (1) and (4) represent perpendicular lines.

51. $x+5<3x-7\le x+13$

$$\begin{aligned} x+5<3x-7 \quad &\textit{and} \quad 3x-7\le x+13 \\ 5<2x-7 \quad &\textit{and} \quad 2x-7\le 13 \\ 12<2x \quad &\textit{and} \quad 2x\le 20 \\ 6<x \quad &\textit{and} \quad x\le 10 \end{aligned}$$

The solution set is $\{x|6<x \textit{ and } x\le 10\}$, or $\{x|6<x\le 10\}$, or $(6,10]$.