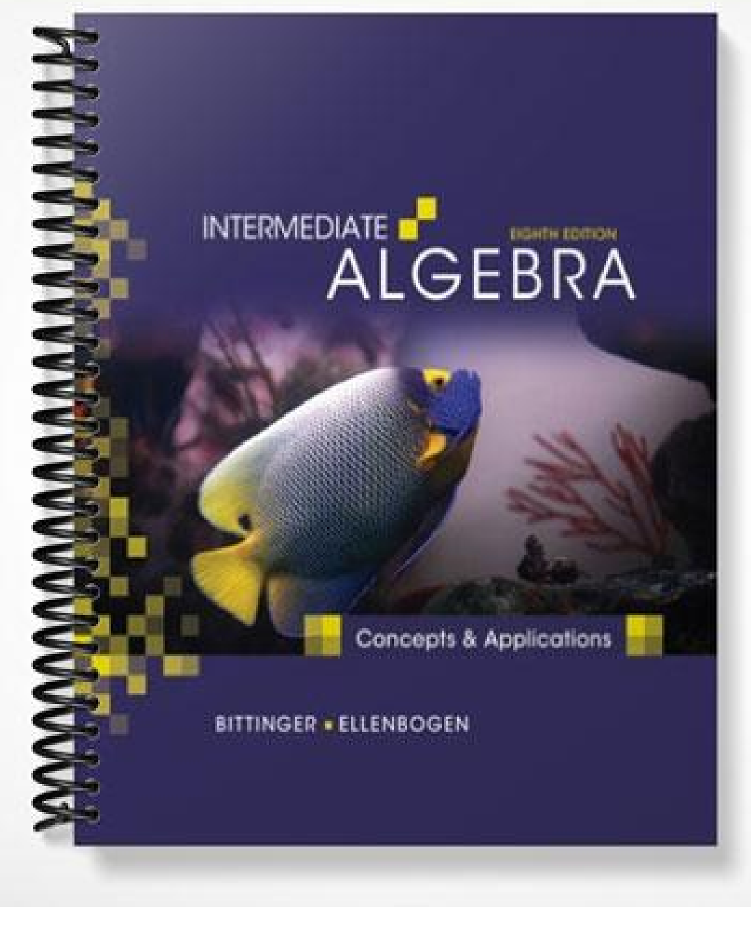
SOLUTIONS MANUAL



Chapter 2

Graphs, Functions, and Linear Equations

Exercise Set 2.1

1. The two perpendicular number lines that are used for graphing are called axes.

2. Because the order in which the numbers are listed is important, numbers listed in the form (x, y) are called ordered pairs.

3. In the third quadrant, both coordinates of a point are negative.

4. In the fourth quadrant, a point's first coordinate is positive and its second coordinate is negative.

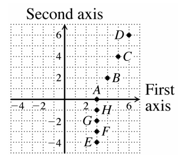
5. To graph an equation means to make a drawing that represents all solutions of the equation.

6. An equation whose graph is a straight line is said to be a linear equation.

7. A is 5 units right of the origin and 3 units up, so its coordinate are (5, 3).
B is 4 units left of the origin and 3 units up, so its coordinates are (–4, 3).
C is 0 units right or left of the origin and 2 units up, so its coordinates are (0, 2).
D is 2 units left of the origin and 3 units down, so its coordinates are (–2, –3).
E is 4 units right of the origin and 2 units down, so its coordinates are (4, –2).
F is 5 units left of the origin and 0 units up or down, so its coordinates are (–5, 0).

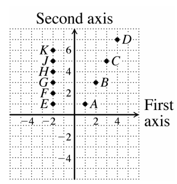
8. G is 2 units right of the origin and 4 units up, so its coordinates are (2, 4).
H is 3 units left of the origin and 1 unit up, so its coordinates are (–3, 1).
I is 0 units right or left of the origin and 2 units down, so its coordinates are (0, –2).
J is 2 units right of the origin and 2 units down, so its coordinates are (2, –2).
K is 5 units left of the origin and 4 units down, so its coordinates are (–5, –4).
L is 4 units right of the origin and 0 units up or down, so its coordinates are (4. 0).

9.

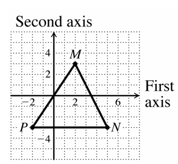


$A(3,\ 0)$ is 3 units right and 0 units up or down.
$B(4,\ 2)$ is 4 units right and 2 units up.
$C(5,\ 4)$ is 5 units right and 4 units up.
$D(6,\ 6)$ is 6 units right and 6 units up.
$E(3,-4)$ is 3 units right and 4 units down.
$F(3,-3)$ is 3 units right and 3 units down.
$G(3,-2)$ is 3 units right and 2 units down.
$H(3,-1)$ is 3 units right and 1 unit down.

10.



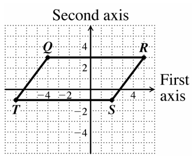
11.



A triangle is formed. The area of a triangle is found by using the formula $A=\frac{1}{2}bh$. In this triangle the base and height are 7 units and 6 units, respectively.

$A=\frac{1}{2}bh=\frac{1}{2}\cdot 7\cdot 6=\frac{42}{2}=21$ square units

12.



A parallelogram is formed.

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

13. The first coordinate is positive and the second negative, so the point (3, –5) is in quadrant IV.

14. III

15. Both coordinates are negative, so the point (–3, –12) is in quadrant III.

16. II

17. Both coordinates are positive, so the point $\left(11, \frac{1}{4}\right)$ is in quadrant I.

18. I

19. The first coordinate is negative and the second positive, so the point (–1.2, 46) is in quadrant II.

20. IV

21.
$$\begin{array}{c|c} \multicolumn{2}{c}{y = 3x - 7} \\ \hline -1 & 3\cdot 2 - 7 \\ & 6 - 7 \end{array}$$
Substituting 2 for x and -1 for y (alphabetical order of variables)

$$-1 \overset{?}{=} -1$$
Since –1 = –1 is true, (2, –1) is a solution of $y = 3x - 7$.

22.
$$\begin{array}{c|c} \multicolumn{2}{c}{y = 5x - 1} \\ \hline 4 & 5\cdot 1 - 1 \end{array}$$
$$4 \overset{?}{=} 4$$
Yes

23.
$$\begin{array}{c|c} \multicolumn{2}{c}{2x - y = 5} \\ \hline 2\cdot 3 - 2 & 5 \\ 6 - 2 & \end{array}$$
Substituting 3 for x and 2 for y (alphabetical order of variables)

$$4 \overset{?}{=} 5$$
Since 4 = 5 is false, (3, 2) is not a solution of $2x - y = 5$.

24.
$$\begin{array}{c|c} \multicolumn{2}{c}{3x - y = 5} \\ \hline 3\cdot 5 - 5 & 5 \end{array}$$
$$10 \overset{?}{=} 5$$
No

25.
$$\begin{array}{c|c} \multicolumn{2}{c}{a - 5b = 8} \\ \hline 3 - 5(-1) & 8 \\ 3 + 5 & \end{array}$$
Substituting 3 for a and -1 for b

$$8 \overset{?}{=} 8$$
Since 8 = 8 is true, (3, –1) is a solution of $a - 5b = 8$.

26.
$$\begin{array}{c|c} \multicolumn{2}{c}{2u - v = -6} \\ \hline 2\cdot 1 - (-4) & -6 \end{array}$$
$$6 \overset{?}{=} -6$$
No

27.
$$\begin{array}{c|c} \multicolumn{2}{c}{6x + 8y = 4} \\ \hline 6\cdot \frac{2}{3} + 8\cdot 0 & 4 \\ 4 + 0 & \end{array}$$
Substituting $\frac{2}{3}$ for x and 0 for y

$$4 \overset{?}{=} 4$$
Since 4 = 4 is true, $\left(\frac{2}{3}, 0\right)$ is a solution of $6x + 8y = 4$.

28.
$$\begin{array}{c|c} \multicolumn{2}{c}{7a + 10b = 6} \\ \hline 7\cdot 0 + 10\cdot \frac{3}{5} & 6 \end{array}$$
$$6 \overset{?}{=} 6$$
Yes

29.
$$\begin{array}{c|c} \multicolumn{2}{c}{r - s = 4} \\ \hline 6 - (-2) & 4 \\ 6 + 2 & \end{array}$$
Substituting 6 for r and -2 for s

$$8 \overset{?}{=} 4$$
Since 8 = 4 is false, (6, –2) is not a solution of $r - s = 4$.

30.
$$\begin{array}{c|c} \multicolumn{2}{c}{2x - y = 11} \\ \hline 2\cdot 4 - (-3) & 11 \end{array}$$
$$11 \overset{?}{=} 11$$
Yes

31.
$$\begin{array}{c|c} \multicolumn{2}{c}{y = 2x^2} \\ \hline 1 & 2(2)^2 \end{array}$$
Substituting 2 for x and 1 for y

$$1 \overset{?}{=} 8$$
Since 1 = 8 is false, (2, 1) is not a solution of $y = 2x^2$.

32.
$$\begin{array}{c|c} \multicolumn{2}{c}{r^2 - s = 5} \\ \hline (-2)^2 - (-1) & 5 \end{array}$$
$$5 \overset{?}{=} 5$$
Yes

33. $x^3 + y = 1$

$(-2)^3 + 9 \;|\; 1$ Substituting -2 for x and 9 for y

$-8 + 9 \;|$

$1 \stackrel{?}{=} 1$

Since 1 = 1 is true, (–2, 9) is a solution of $x^3 + y = 1$.

34. $y = x^3 - 5$

$2 \;|\; 3^3 - 5$

$2 \stackrel{?}{=} 22$

No

35. $y = 3x$

To find an ordered pair, we choose any number for x and then determine y by substitution.

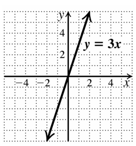
When $x = 0$, $y = 3 \cdot 0 = 0$.

When $x = 1$, $y = 3 \cdot 1 = 3$.

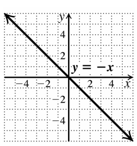
When $x = –2$, $y = 3 \cdot (-2) = -6$.

x	y	(x, y)
0	0	(0, 0)
1	3	(1, 3)
−2	−6	(−2,−6)

Plot these points, draw the line they determine, and label the graph $y = 3x$.



36. Graph $y = –x$.



37. $y = x + 4$

To find an ordered pair, we choose any number for x and then determine y by substitution.

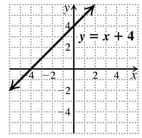
When $x = 0$, $y = 0 + 4 = 4$.

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

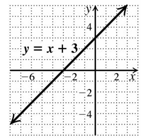
When $x = -2$, $y = -2 + 4 = 2$.

x	y	(x, y)
0	4	(0, 4)
1	5	(1, 5)
−2	2	(−2, 2)

Plot these points, draw the line they determine, and label the graph $y = x + 4$.



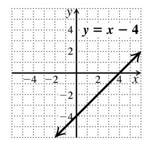
38. Graph $y = x + 3$.



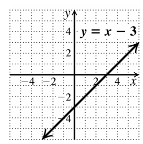
39. $y = x - 4$

To find an ordered pair, we choose any number for x and then determine y by substitution. For example, if we choose 1 for x, then y = 1 – 4 = –3. We find several ordered pairs, plot them and draw the line.

x	y	(x, y)
1	−3	(1,−3)
0	−4	(0,−4)
−2	−6	(−2,−6)



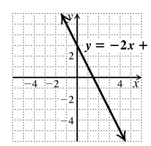
40. Graph $y = x – 3$.



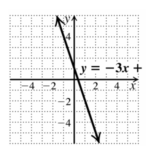
41. $y = -2x + 3$

To find an ordered pair, we choose any number for x and then determine y. For example, if $x = 1$, then $y = -2 \cdot 1 + 3 = -2 + 3 = 1$. We find several ordered pairs, plot them, and draw the line.

x	y
1	1
3	−3
−1	5
0	3



42. Graph $y = –3x + 1$.



43. $y + 2x = 3$

$y = -2x + 3$ Solving for y

Observe that this is the equation that was graphed in Exercise 41. The graph is shown above.

44. $y+3x=1$

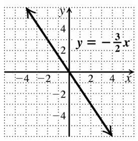
$y=-3x+1$

Observe that this is the equation that was graphed in Exercise 42. The graph is shown above.

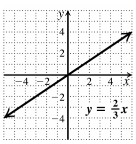
45. $y=-\frac{3}{2}x$

To find an ordered pair, we choose any number for x and then determine y by substitution. For example, if $x = 2$, then $y=-\frac{3}{2}\cdot 2=-3$. We find several ordered pairs, plot them and draw the line.

x	y
2	−3
0	0
−4	6



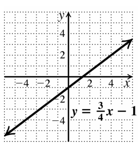
46. Graph $y=\frac{2}{3}x$.



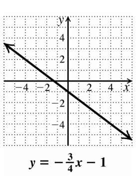
47. $y=\frac{3}{4}x-1$

To find an ordered pair, we choose any number for x and then determine y by substitution. For example, if $x = 4$, then $y=\frac{3}{4}\cdot 4-1=3-1=2$. We find several ordered pairs, plot them and draw the line.

x	y
4	2
0	−1
−8	−7



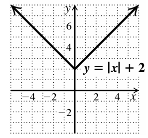
48. Graph $y=-\frac{3}{4}x-1$.



49. $y=|x|+2$

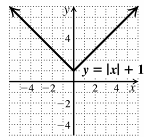
We select x-values and find the corresponding y-values. The table lists some ordered pairs. We plot these points.

x	y
3	5
1	3
0	2
−1	3
−3	5



Note that the graph is V-shaped, centered at (0, 2).

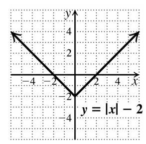
50. Graph $y=|x|+1$.



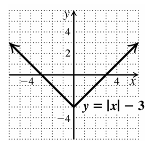
51. $y=|x|-2$

We select x-values and find the corresponding y-values. The table lists some ordered pairs. We plot these points.

x	y
3	1
1	−1
0	−2
−1	−1
−4	2



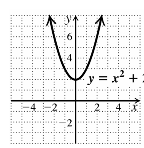
52. Graph $y=|x|-3$.



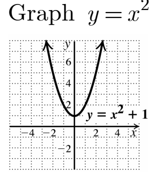
53. $y=x^2+2$

To find an ordered pair, we choose any number for x and then determine y. For example, if $x=2$, then $y=2^2+2=6$. We find several ordered pairs, plot them, and connect them with a smooth curve.

x	y
2	6
1	3
0	2
−1	3
−2	6



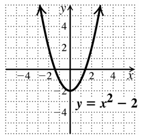
54. Graph $y=x^2+1$.



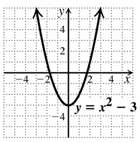
55. $y=x^2-2$

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

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



56. Graph $y = x^2 - 3$.



57. *Writing Exercise.* Suppose, for instance, we had plotted only the points (–3, 3) and (–1, 1). Drawing a line through these points would yield a straight line rather than the correct V-shaped graph.

58. *Writing Exercise.* The points are reflections of each other across the x-axis.

59. $5t - 7 = 5 \cdot 10 - 7 = 50 - 7 = 43$

60. $2r^2 - 7r = 2(-1)^2 - 7(-1) = 2 + 7 = 9$

61. $$(3-x)^2(1-2x)^3 = \left(3 - \frac{1}{2}\right)^2\left(1 - 2\cdot\frac{1}{2}\right)^3$$
$$= \left(\frac{6}{2} - \frac{1}{2}\right)^2(1-1)^3 = \left(\frac{5}{2}\right)^2(0)^3 = 0$$

62. $-x = -(-5) = 5$

63. $\dfrac{2x+3}{x-4} = \dfrac{2(0)+3}{0-4} = \dfrac{0+3}{-4} = -\dfrac{3}{4}$

64. $\dfrac{4-x}{3x+1} = \dfrac{4-4}{3\cdot 4+1} = \dfrac{0}{12+1} = \dfrac{0}{13} = 0$

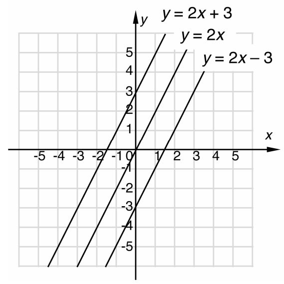
65. $x + 4 = 0$
$x = -4$
The solution is –4.

66. $5 - x = 0$
$5 = x$

67. $1 - 2x = 0$
$1 = 2x$
$\frac{1}{2} = x$
The solution is $\frac{1}{2}$.

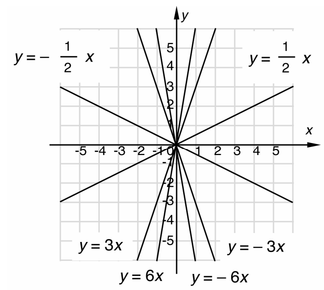
68. $5x + 3 = 0$
$5x = -3$
$x = -\frac{3}{5}$

69. *Writing Exercise.*



When –3 is added, the graph of $y = 2x$ is moved down 3 units. When 3 is added, the graph of $y = 2x$ is moved up 3 units. The three lines are parallel.

70. *Writing Exercise.*



The multiplier of x tells the direction of the slant and how steep the slant is. When $x < 0$, the line slants down from left to right; when $x > 0$, the line slants up from left to right. The slant becomes steeper as $|x|$ increases.

71. *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.

72. *Writing Exercise.* The lines will intersect at (a, b). The point of intersection must be a point that is on both lines, so its first coordinate must be a since the first coordinate of every point on the first line is a and its second coordinate must be b since the second coordinate of every point on the second line is b.

73. a) Graph III seems most appropriate for this situation. It reflects less than 40 hours of work per week until September, 40 hours per week from September until December, and more than 40 hours per week in December.

b) Graph II seems most appropriate for this situation. It reflects 40 hours of work per week until September, 20 hours per week from September until December, and 40 hours per week again in December.

c) Graph I seems most appropriate for this situation. It reflects more than 40 hours of work per week until September, 40 hours per week from September until December, and more than 40 hours per week again in December.

d) Graph IV seems most appropriate for this situation. It reflects less than 40 hours of work per week until September, approximately 20 hours per week from September until December, and about 40 hours per week in December.

74. a) Graph IV seems most appropriate for this situation. It reflects driving speeds on local streets for the first 10 and last 5 minutes and freeway cruising speeds from 10 through 30 minutes.

b) Graph III seems most appropriate for this situation. It reflects driving speeds on local streets for the first 10 minutes, and express train speed for the next 20 minutes, and walking speeds for the final 5 minutes.

c) Graph I seems most appropriate for this situation. It reflects walking speeds for the first 10 and last 5 minutes and express bus speeds from 10 through 30 minutes.

d) Graph II seems most appropriate for this situation. It reflects that the speed was 0 mph for the first 10 minutes, the time spent waiting at the bus stop. Then it shows driving speeds that fall to 0 mph several times during the next 20 minutes, indicating that the school bus stops for other students during this period of time. Finally, it shows a walking speed for the last 5 minutes.

75. a) Graph III seems most appropriate for this situation. It reflects a constant speed for a lakeshore loop.

b) Graph II seems most appropriate for this situation. In climbing a monster hill, the speed gradually decreases, the speed bottoms out at the top of the hill, and increases for the downhill ride.

c) Graph IV seems most appropriate for this situation. For interval training, the speed is constant for an interval, then increases to a new constant speed for an interval, then returns to the first speed. The sequence repeats.

d) Graph I seems most appropriate for this situation. For a variety of intervals, the speed varies with no particular pattern of increase or decrease in speed.

76. Substitute $-\frac{1}{3}$ for x and $\frac{1}{4}$ for y in each equation.

a)
$$\begin{array}{r|l} \multicolumn{2}{c}{-\frac{3}{2}x-3y=-\frac{1}{4}} \\ \hline -\frac{3}{2}\left(-\frac{1}{3}\right)-3\left(\frac{1}{4}\right) & -\frac{1}{4} \\ \frac{1}{2}-\frac{3}{4} & \end{array}$$
$$-\frac{1}{4}\stackrel{?}{=}-\frac{1}{4}$$

Since $-\frac{1}{4}=-\frac{1}{4}$ is true, $\left(-\frac{1}{3},\ \frac{1}{4}\right)$ is a solution.

b)
$$\begin{array}{r|l} \multicolumn{2}{c}{8y-15x=\frac{7}{2}} \\ \hline 8\left(\frac{1}{4}\right)-15\left(-\frac{1}{3}\right) & \frac{7}{2} \\ 2+5 & \end{array}$$
$$7\stackrel{?}{=}\frac{7}{2}$$

Since $7=\frac{7}{2}$ is false, $\left(-\frac{1}{3},\ \frac{1}{4}\right)$ is not a solution.

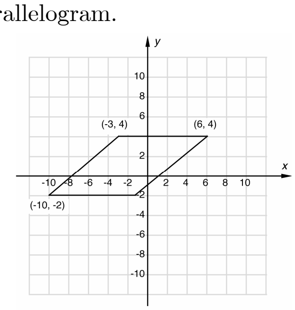
c)
$$\begin{array}{r|l} \multicolumn{2}{c}{0.16y=-0.09x+0.1} \\ \hline 0.16\left(\frac{1}{4}\right) & -0.09\left(-\frac{1}{3}\right)+0.1 \\ 0.04 & 0.03+0.1 \end{array}$$
$$0.04\stackrel{?}{=}0.13$$

Since $0.04=0.13$ is false, $\left(-\frac{1}{3},\ \frac{1}{4}\right)$ is not a solution.

d)
$$\begin{array}{r|l} \multicolumn{2}{c}{2(-y+2)-\frac{1}{4}(3x-1)=4} \\ \hline 2\left(-\frac{1}{4}+2\right)-\frac{1}{4}\left[3\left(-\frac{1}{3}\right)-1\right] & 4 \\ 2\left(\frac{7}{4}\right)-\frac{1}{4}(-2) & \\ \frac{7}{2}+\frac{1}{2} & \\ \frac{8}{2} & \end{array}$$
$$4\stackrel{?}{=}4$$

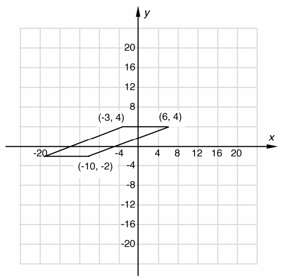
Since $4=4$ is true, $\left(-\frac{1}{3},\ \frac{1}{4}\right)$ is a solution.

77. Plot $(-10,-2)$, $(-3,\ 4)$, and $(6,\ 4)$, and sketch a parallelogram.



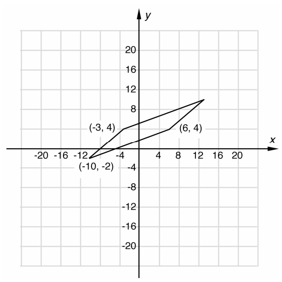
Since (6, 4) is 9 units directly to the right of $(-3,\ 4)$, a fourth vertex could lie 9 units directly to the right of $(-10,-2)$. Then its coordinates are $(-10+9,-2)$, or $(-1,-2)$.

If we connect the points in a different order, we get a second parallelogram.



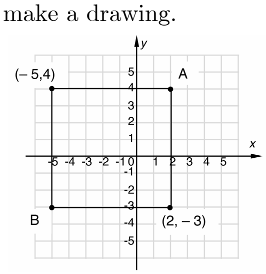
Since $(-3,\ 4)$ is 9 units directly to the left of (6, 4), a fourth vertex could lie 9 units directly to the left of $(-10,-2)$. Then its coordinates are $(-10-9,-2)$, or $(-19,-2)$.

If we connect the points in yet a different order, we get a third parallelogram.



Since $(6,\ 4)$ lies 16 units directly to the right of and 6 units above (–10, –2), a fourth vertex could lie 16 units to the right of and 6 units above $(-3,\ 4)$. Its coordinates are $(-3+16,\ 4+6)$, or $(13,\ 10)$.

78. We make a drawing.

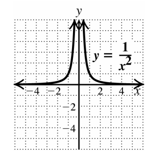


From the drawing we see that the vertex A is 2 units right and up 4 units. Thus, its coordinates are $(2,\ 4)$. We also see that vertex B is 5 units left and down 3 units, so its coordinates are $(-5,-3)$. We also see that the distance between any pair of adjacent vertices is 7 units. The area of a square whose side has length 7 units is $7\cdot 7$, or 49 square units.

79. $y=\dfrac{1}{x^2}$

Choose x-values from –4 to 4 and use a calculator to find the corresponding y-values. (Note that we cannot choose 0 as a first coordinate since $1/0^2$, or 1/0, is not defined.) Plot the points and draw the graph. Note that it has two branches, one on each side of the y-axis.

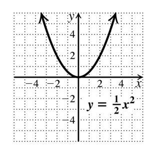
x	y
-4	0.0625
-3	$0.\bar{1}$
-2	0.25
-1	1
-0.5	4
0.5	4
1	1
2	0.25
3	$0.\bar{1}$
4	0.0625



80. $y=\dfrac{1}{2}x^2$

Choose x-values from –4 to 4 and use a calculator to find the corresponding y-values. Plot the points and draw the graph.

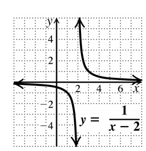
x	y
-4	8
-3	4.5
-2	2
-1	0.5
0	0
0.5	0.125
1	0.5
2	2
3	4.5
4	8



81. $y=\dfrac{1}{x-2}$

Choose x-values from –2 to 6, and use a calculator to find the corresponding y-values. (Note that we cannot choose 2 as a first coordinate since $\dfrac{1}{2-2}$, or $\dfrac{1}{0}$, is not defined.) Plot the points, and draw the graph. Note that it has two branches, one on each side of a vertical line through $(2,\ 0)$.

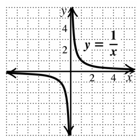
x	y
-2	-0.25
0	-0.5
1	-1
1.9	-10
2.1	10
2.5	2
3	1
4	0.5
6	0.25



82. $y = \frac{1}{x}$

Choose x-values from –4 to 4 and use a calculator to find the corresponding y-values. (Note that we cannot choose 0 as a first coordinate since 1/0 is not defined.) Plot the points and draw the graph. Note that it has two branches, one in the first quadrant and the other in the third quadrant.

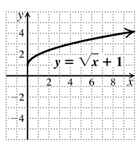
x	y
-4	-0.25
-3	-0.33
-2	-0.5
-1	-1
-0.25	-4
0.25	4
1	1
2	0.5
3	0.33
4	0.25



83. $y = \sqrt{x} + 1$

Choose x-values from 0 to 10 and use a calculator to find the corresponding y-values. Plot the points and draw the graph.

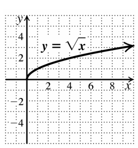
x	y
0	1
1	2
2	2.414
3	2.732
4	3
5	3.236
6	3.449
7	3.646
8	3.828
9	4
10	4.162



84. $y = \sqrt{x}$

Choose x-values from 0 to 10 and use a calculator to find the corresponding y-values. Plot the points and draw the graph.

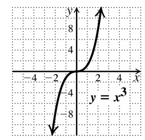
x	y
0	0
1	1
2	1.414
3	1.732
4	2
5	2.236
6	2.449
7	2.646
8	2.828
9	3
10	3.162



85. $y = x^3$

Choose x-values from –2 to 2 and use a calculator to find the corresponding y-values. Plot the points and draw the graph.

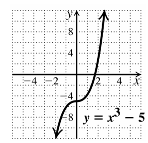
x	y
-2	-8
-1.5	-3.375
-1	-1
-0.5	-0.125
-0.25	-0.016
0	0
0.5	0.125
1	1
1.5	3.375
2	8



86. $y = x^3 - 5$

Choose x-values from –2 to 2 and use a calculator to find the corresponding y-values. Plot the points and draw the graph.

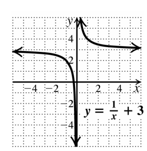
x	y
-2	-13
-1.5	-8.375
-1	-6
-0.5	-5.125
-0.25	-5.016
0	-5
0.5	-4.875
1	-4
1.5	-1.625
2	3



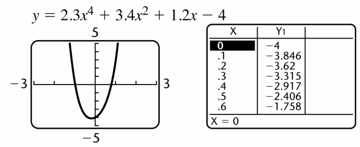
87. $y = \frac{1}{x} + 3$

Choose x-values from 3.5 to 4 and use a calculator to find the corresponding y-values. (Note that we cannot choose 0 as a first coordinate since 1/0 is not defined.) Plot the points and draw the graph. Note that it has two branches, one in the first quadrant and the other in the third quadrant.

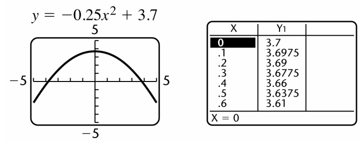
x	y
-4	2.75
-3	2.67
-2	2.5
-1	2
-0.25	-1
0.25	7
1	4
2	3.5
3	3.33
4	3.25



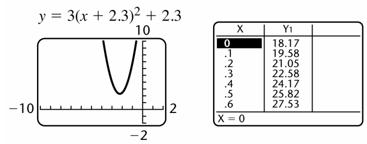
88. a)



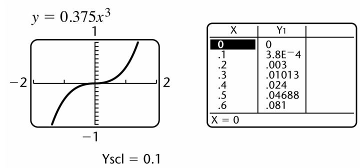
b)



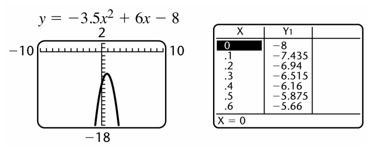
c)



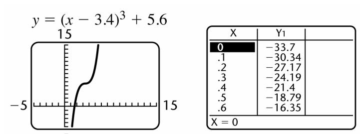
89. a)



b)



c)



Exercise Set 2.2

1. A function is a special kind of correspondence between two sets.

2. In any function, each member of the domain is paired with exactly one member of the range.

3. For any function, the set of all inputs, or first values, is called the domain.

4. For any function, the set of all outputs, or second values, is called the range.

5. When a function is graphed, members of the domain are located on the horizontal axis.

6. When a function is graphed, members of the range are located on the vertical axis.

7. The notation $f(3)$ is read "f of 3," "f at 3," or "the value of f at 3."

8. The vertical-line test can be used to determine whether or not a graph represents a function.

9. The correspondence is a function, because each member of the domain corresponds to exactly one member of the range.

10. The correspondence is not a function because a member of the domain (2 or 4) corresponds to more than one member of the range.

11. The correspondence is a function, because each member of the domain corresponds to exactly one member of the range.

12. The correspondence is a function, because each member of the domain corresponds to exactly one member of the range.

13. The correspondence is not a function because a member of the domain (June 9 or October 5) corresponds to more than one member of the range.

14. The correspondence is a function, because each member of the domain corresponds to exactly one member of the range.

15. The correspondence is a function, because each member of the domain corresponds to exactly one member of the range.

16. The correspondence is not a function because a member of the domain (Texas) corresponds to more than one member of the range.

17. The correspondence is a function, because each flash drive has only one storage capacity.

18. The correspondence is not a function, since it is reasonable to assume that at least one member of a rock band plays more than one instrument.
The correspondence is a relation, since it is reasonable to

assume that each member of a rock band plays at least one instrument.

19. This correspondence is a function, because each player has only one uniform number.

20. This correspondence is a function, because each triangle has only one number for its area.

21. a) The domain is the set of all x-values of the set. It is {–3, –2, 0, 4}.

b) The range is the set of all y-values of the set. It is {–10, 3, 5, 9}.

c) The correspondence is a function, because each member of the domain corresponds to exactly one member of the range.

22. a) Domain: {0, 1, 2, 5}

b) Range: {–1, 3}

c) Yes

23. a) The domain is the set of all x-values of the set. It is {1, 2, 3, 4, 5}.

b) The range is the set of all y-values of the set. It is {1}.

c) The correspondence is a function, because each member of the domain corresponds to exactly one member of the range.

24. a) Domain: {1}

b) Range: {1, 2, 3, 4, 5}

c) No

25. a) The domain is the set of all x-values of the set. It is {–2, 3, 4}.

b) The range is the set of all y-values of the set. It is {–8, –2, 4, 5}.

c) The correspondence is not a function, because a member of the domain (4) corresponds to more than one member of the range.

26. a) Domain: {0, 4, 7, 8}

b) Range: {0, 4, 7, 8}

c) Yes

27. 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, –2. Thus, $f(1) = -2$.

b) The set of all x-values in the graph extends from –2 to 5, so the domain is $\{x \mid -2 \le x \le 5\}$.

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 4. Thus, the x-value for which $f(x) = 2$ is 4.

d) The set of all y-values in the graph extends from –3 to 4, so the range is $\{y \mid -3 \le y \le 4\}$.

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

b) The set of all x-values in the graph is $\{x \mid -1 \le x \le 4\}$.

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 $\{y \mid 1 \le y \le 4\}$.

29. 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, –2. Thus, $f(1) = -2$.

b) The set of all x-values in the graph extends from –4 to 2, so the domain is $\{x \mid -4 \le x \le 2\}$.

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 –2. Thus, the x-value for which $f(x) = 2$ is –2.

d) The set of all y-values in the graph extends from –3 to 3, so the range is $\{y \mid -3 \le y \le 3\}$.

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

b) The set of all x-values in the graph is $\{x \mid -4 \le x \le 3\}$.

c) The only point whose second coordinate is 2 is $(0,\ 2)$, so the x-value for which $f(x) = 2$ is 0.

d) The set of all y-values in the graph is $\{y \mid -5 \le y \le 4\}$.

31. 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, 3. Thus, $f(1) = 3$.

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

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. Thus, the x-value for which $f(x)=2$ is –3.

d) The set of all y-values in the graph extends from –2 to 5, so the range is $\{y\,|\,-2 \le y \le 5\}$.

32. a) $f(1)=4$

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

c) The points whose second coordinate is 2 are (–4, 2) and $(-1,\ 2)$, so the x-values for which $f(x)=2$ are –4 and –1.

d) The set of all y-values in the graph is $\{y\,|\,0 \le y \le 5\}$.

33. 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, 3. Thus, $f(1)=3$.

b) The domain is the set of all x-values in the graph. It is $\{-4,-3,-2,-1,\ 0,\ 1,\ 2\}$.

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. There are two such points, (–2, 2) and (0, 2). Thus, the x-values for which $f(x)=2$ are –2 and 0.

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

34. 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 $\{-1,0,1,2,3\}$.

35. 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, 4. Thus, $f(1)=4$.

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

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. There are two such points, (–1, 2) and (3, 2). Thus, the x-values for which $f(x)=2$ are –1 and 3.

d) The set of all y-values in the graph extends from –4 to 5, so the range is $\{y\,|\,-4 \le y \le 5\}$.

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

b) The set of all x-values in the graph is $\{x\,|\,-5 \le x \le 2\}$.

c) There are two points whose second coordinates are 2. They are $(-5,\ 2)$ and $(1,\ 2)$. Thus, the x-values for which $f(x)=2$ are -5 and 1.

d) The set of all y-values in the graph is $\{y\,|\,-3 \le y \le 5\}$.

37. 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, 2. Thus, $f(1)=2$.

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

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. All points in the set $\{x\,|\,0 < x \le 2\}$ satisfy this condition. These are the x-values for which $f(x)=2$.

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

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

b) The set of all x-values in the graph is $\{x\,|\,-4 < x \le 5\}$.

c) The second coordinate is 2 for $\{x\,|\,2 < x \le 5\}$.

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

39. The domain of f is the set of all x-values that are used in the points on the curve.
The domain is $\{x|x \text{ is a real number}\}$ or $\mathbb{R}$.
The range of f is the set of all y-values that are used in the points on the curve.
The range is $\{y|y \text{ is a real number}\}$ or $\mathbb{R}$.

40. Domain: $\mathbb{R}$
Range: $\mathbb{R}$

41. The domain of f is the set of all x-values that are used in the points on the curve.
The domain is $\{x|x \text{ is a real number}\}$ or $\mathbb{R}$.
The range of f is the set of all y-values that are used in the points on the curve.
The range is $\{4\}$.

42. Domain: $\mathbb{R}$
Range: $\{-2\}$

43. The domain of f is the set of all x-values that are used in the points on the curve.
The domain is $\{x|x \text{ is a real number}\}$ or $\mathbb{R}$.
The range of f is the set of all y-values that are used in the points on the curve.
The range is $\{y|y \geq 1\}$.

44. Domain: $\mathbb{R}$
Range: $\{y|y \leq 4\}$

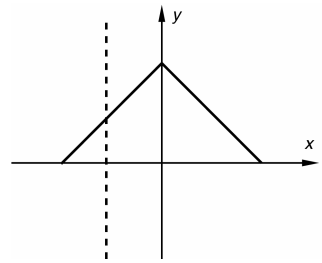
45. The domain of f is the set of all x-values that are used in the points on the curve.
The domain is $\{x|x \text{ is a real number and } x \neq -2\}$.
The range of f is the set of all y-values that are used in the points on the curve.
The range is $\{y|y \text{ is a real number and } y \neq -4\}$.

46. Domain: $\{x|x \text{ is a real number and } x \neq 5\}$
Range: $\{y|y \text{ is a real number and } y \neq 2\}$

47. The domain of f is the set of all x-values that are used in the points on the curve. The domain is $\{x|x \geq 0\}$.
The range of f is the set of all y-values that are used in the points on the curve. The range is $\{y|y \geq 0\}$.

48. Domain: $\{x|x \leq 3\}$
Range: $\{y|y \geq 0\}$

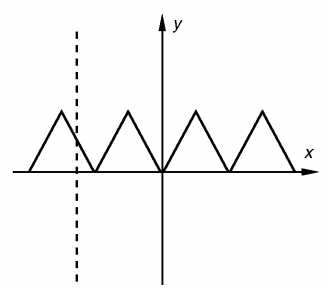
49. We can use the vertical-line test:



Visualize moving this vertical line across the graph. No vertical line will intersect the graph more than once. Thus, the graph is a graph of a function.

50. No; it fails the vertical line test.

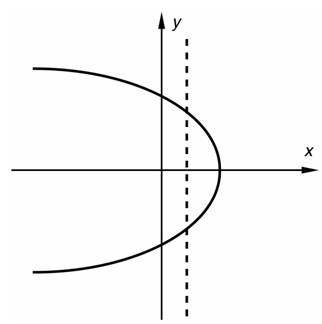
51. We can use the vertical-line test:



Visualize moving this vertical line across the graph. No vertical line will intersect the graph more than once. Thus, the graph is a graph of a function.

52. No; it fails the vertical-line test.

53. We can use the vertical line test.



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

54. Yes; it passes the vertical-line test.

55. $g(x)=2x+5$

a) $g(0)=2(0)+5=0+5=5$

b) $g(-4)=2(-4)+5=-8+5=-3$

c) $g(-7)=2(-7)+5=-14+5=-9$

d) $g(8)=2(8)+5=16+5=21$

e) $g(a+2)=2(a+2)+5=2a+4+5=2a+9$

f) $g(a)+2=2(a)+5+2=2a+7$

56. $h(x)=5x-1$

a) $h(4)=5(4)-1=20-1=19$

b) $h(8)=5(8)-1=40-1=39$

c) $h(-3)=5(-3)-1=-15-1=-16$

d) $h(-4)=5(-4)-1=-20-1=-21$

e) $h(a-1)=5(a-1)-1=5a-5-1=5a-6$

f) $h(a)+3=5(a)-1+3=5a+2$

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

a) $f(0)=5\cdot 0^2+4\cdot 0=0+0=0$

b) $f(-1)=5(-1)^2+4(-1)=5-4=1$

c) $f(3)=5\cdot 3^2+4\cdot 3=45+12=57$

d) $f(t)=5t^2+4t$

e) $f(2a)=5(2a)^2+4\cdot 2a=5\cdot 4a^2+8a=20a^2+8a$

f) $f(3)-9=5\cdot 3^2+4\cdot 3-9=5\cdot 9+4\cdot 3-9$
$=45+12-9=48$

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

a) $g(0)=3\cdot 0^2-2\cdot 0=0-0=0$

b) $g(-1)=3(-1)^2-2(-1)=3+2=5$

c) $g(3)=3\cdot 3^2-2\cdot 3=27-6=21$

d) $g(t)=3t^2-2t$

e) $g(2a)=3(2a)^2-2\cdot 2a=3\cdot 4a^2-4a=12a^2-4a$

f) $g(3)-4=3\cdot 3^2-2\cdot 3-4=3\cdot 9-2\cdot 3-4$
$=27-6-4=17$

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

a) $f(0)=\dfrac{0-3}{2\cdot 0-5}=\dfrac{-3}{0-5}=\dfrac{-3}{-5}=\dfrac{3}{5}$

b) $f(4)=\dfrac{4-3}{2\cdot 4-5}=\dfrac{1}{8-5}=\dfrac{1}{3}$

c) $f(-1)=\dfrac{-1-3}{2(-1)-5}=\dfrac{-4}{-2-5}=\dfrac{-4}{-7}=\dfrac{4}{7}$

d) $f(3)=\dfrac{3-3}{2\cdot 3-5}=\dfrac{0}{6-5}=\dfrac{0}{1}=0$

e) $f(x+2)=\dfrac{x+2-3}{2(x+2)-5}=\dfrac{x-1}{2x+4-5}=\dfrac{x-1}{2x-1}$

f) $f(a+h)=\dfrac{a+h-3}{2(a+h)-5}=\dfrac{a+h-3}{2a+2h-5}$

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

a) $r(0)=\dfrac{3\cdot 0-4}{2\cdot 0+5}=-\dfrac{4}{5}$

b) $r(2)=\dfrac{3\cdot 2-4}{2\cdot 2+5}=\dfrac{2}{9}$

c) $r\left(\dfrac{4}{3}\right)=\dfrac{3\cdot\dfrac{4}{3}-4}{2\cdot\dfrac{4}{3}+5}=\dfrac{4-4}{\dfrac{8}{3}+5}=\dfrac{0}{\dfrac{23}{3}}=0$

d) $r(-1)=\dfrac{3(-1)-4}{2(-1)+5}=\dfrac{-7}{3}$, or $-\dfrac{7}{3}$

e) $r(x+3)=\dfrac{3(x+3)-4}{2(x+3)+5}=\dfrac{3x+9-4}{2x+6+5}=\dfrac{3x+5}{2x+11}$

f) $r(a+h)=\dfrac{3(a+h)-4}{2(a+h)+5}=\dfrac{3a+3h-4}{2a+2h+5}$

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

Since $\dfrac{5}{x-3}$ cannot be computed when the denominator is 0, we find the x-value that causes $x-3$ to be 0:

$x-3=0$

$x=3$ Adding 3 to both sides

Thus, 3 is not in the domain of f, while all other real numbers are. The domain of f is $\{x\,|\,x \text{ is a real number and } x\neq 3\}$.

62. $f(x)=\dfrac{7}{6-x}$

Since $\dfrac{7}{6-x}$ cannot be computed when the denominator is 0, we find the x-value that causes $6-x$ to be 0:

$6-x=0$

$6=x$ Adding x on both sides

Thus, 6 is not in the domain of f, while all other real numbers are. The domain of f is $\{x\,|\,x \text{ is a real number and } x\neq 6\}$.

63. $g(x)=2x+1$

Since we can compute $2x+1$ for any real number x, the domain is the set of all real numbers.

64. $g(x)=x^2+3$

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

65. $h(x)=|6-7x|$

Since we can compute $|6-7x|$ for any real number x, the domain is the set of all real numbers.

66. $h(x)=|3x-4|$

Since we can compute $|3x-4|$ for any real number x, the domain is the set of all real numbers.

67. $f(x)=\frac{3}{8-5x}$

Solve: $8-5x=0$

$x=\frac{8}{5}$

The domain is $\left\{x \middle| x \text{ is a real number and } x\neq\frac{8}{5}\right\}$.

68. $f(x)=\frac{5}{2x+1}$

Solve: $2x+1=0$

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

The domain is $\left\{x \middle| x \text{ is a real number and } x\neq-\frac{1}{2}\right\}$.

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

Solve: $x+1=0$

$x=-1$

The domain is $\{x|x \text{ is a real number and } x\neq-1\}$.

70. $h(x)=\frac{3x}{x+7}$

Solve: $x+7=0$

$x=-7$

The domain is $\{x|x \text{ is a real number and } x\neq-7\}$.

71. $f(x)=\frac{3x+1}{2}$

Since we can compute $\frac{3x+1}{2}$ for any real number x, the domain is the set of all real numbers.

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

Since we can compute $\frac{4x-3}{5}$ for any real number x, the domain is the set of all real numbers.

73. $g(x)=\frac{1}{2x}$

Solve: $2x=0$

$x=0$

The domain is $\{x|x \text{ is a real number and } x\neq 0\}$.

74. $g(x)=\frac{1}{2}x$

Since we can compute $\frac{1}{2}x$ for any real number x, the domain is the set of all real numbers.

75. $A(s)=s^2\frac{\sqrt{3}}{4}$

$A(4)=4^2\frac{\sqrt{3}}{4}=4\sqrt{3}\approx 6.93$

The area is $4\sqrt{3}$ cm$^2\approx 6.93$ cm^2.

76. $A(6)=6^2\frac{\sqrt{3}}{4}=\frac{36\sqrt{3}}{4}=9\sqrt{3}$ in$^2\approx 15.59$ in^2

77. $V(r)=4\pi r^2$

$V(3)=4\pi(3)^2=36\pi$

The area is 36π in$^2\approx 113.10$ in^2.

78. $V(5)=4\pi(5)^2=100\pi$ cm$^2\approx 314.16$ cm^2

79. $H(x)=2.75x+71.48$

$H(34)=2.75(34)+71.48=164.98$

The predicted height is 164.98 cm.

80. $H(31)=2.75(31)+71.48=156.73$ cm

81. $F(C)=\frac{9}{5}C+32$

$F(-5)=\frac{9}{5}(-5)+32=-9+32=23$

The equivalent temperature is 23°F.

82. $F(10)=\frac{9}{5}(10)+32=18+32=50$°F

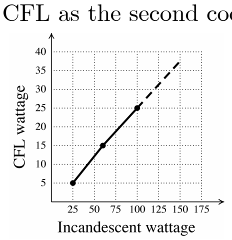
83. Locate the point that is directly above 225. Then estimate its second coordinate by moving horizontally from the point to the vertical axis. The rate is about 75 heart attacks per 10,000 men.

84. 125 heart attacks per 10,000 men

85. Locate the point on the graph that is directly above '00. Then estimate its second coordinate by moving horizontally from the point to the vertical axis. In 2000, about 500 movies were released. That is $F(2000)\approx 500$.

86. $F(2007)\approx 1000$ movies

87. Plot and connect the points, using the wattage of the incandescent as the first coordinate and the wattage of the CFL as the second coordinate.

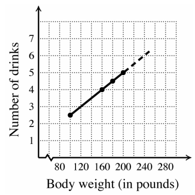


To estimate the wattage of the CFL bulb that creates light equivalent to a 75-watt incandescent bulb, first locate the point directly above 75. Then estimate the second coordinate by moving horizontally from the point to the vertical axis. Read the approximate function value there. The wattage is about 19 watts.

To predict the wattage of the CFL bulb that creates light equivalent to a 120-watt incandescent bulb, extend the graph and extrapolate. The wattage is about 30 watts.

88. 9 watts; 38 watts (See the graph in Exercise 87.)

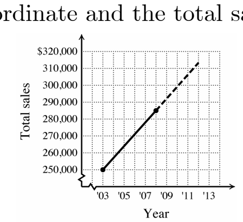
89. Plot and connect the points, using body weight as the first coordinate and the corresponding number of drinks as the second coordinate.



To estimate the number of drinks that a 140-lb person would have to drink to be considered intoxicated, first locate the point that is directly above 140. Then estimate its second coordinate by moving horizontally from the point to the vertical axis. Read the approximate function value there. The estimated number of drinks is 3.5.
To predict the number of drinks it would take for a 230-lb person to be considered intoxicated, extend the graph and extrapolate. It appears that it would take about 6 drinks.

90. 3 drinks; 6.5 drinks (See the graph in Exercise 89.)

91. Plot and connect the points, using the year as the first coordinate and the total sales as the second coordinate.



To estimate the total sales for 2004, first locate the point directly above 2004. Then estimate its second coordinate by moving horizontally to the vertical axis. Read the approximate function value there. The estimated 2004 sales total is about $257,000.
To estimate the sales for 2011, extend the graph and extrapolate. We estimate the sales for 2011 to be about $306,000.

92. About $271,000; $313,000 (See the graph in Exercise 91.)

93. *Writing Exercise*. You could measure time in years, because it seems reasonable that each graph represents a ten-year span. Answers may vary.

94. *Writing Exercise*. Yes. It seems reasonable that passion increases rapidly, then decreases sharply, and finally levels off; that intimacy increases steadily until passion peaks and then continues to increase but at a lower rate; and that commitment increases rapidly during the period when passion is decreasing, eventually leveling off at a high value.

95. $\dfrac{6-3}{-2-7}=\dfrac{3}{-9}=-\dfrac{1}{3}$

96. $\dfrac{-2-(-4)}{5-8}=\dfrac{-2+4}{5+(-8)}=\dfrac{2}{-3}=-\dfrac{2}{3}$

97. $\dfrac{-5-(-5)}{3-(-10)}=\dfrac{-5+5}{3+10}=\dfrac{0}{13}=0$

98. $\dfrac{2-(-3)}{-3-2}=\dfrac{2+3}{-3+(-2)}=\dfrac{5}{-5}=-1$

99.
$$\begin{aligned}2x-y&=8\\ -y&=-2x+8\\ y&=2x-8\end{aligned}$$

100.
$$\begin{aligned}5x+5y&=10\\ 5y&=10-5x\\ y&=\frac{10-5x}{5},\text{ or }2-x,\text{ or }-x+2\end{aligned}$$

101.
$$\begin{aligned}2x+3y&=6\\ 3y&=6-2x\\ y&=\frac{6-2x}{3},\text{ or }2-\frac{2}{3}x,\text{ or }-\frac{2}{3}x+2\end{aligned}$$

102.
$$\begin{aligned}5x-4y&=8\\ -4y&=8-5x\\ y&=\frac{8-5x}{-4},\text{ or }\frac{5x-8}{4},\text{ or }\frac{5}{4}x-2\end{aligned}$$

103. *Writing Exercise*. The independent variable should be chosen as the number of fish in an aquarium, since the survival of the fish is dependent upon an adequate food supply.

104. *Writing Exercise*. Answers may vary. Most would probably trust estimates made using interpolation more than those made using extrapolation. It is probably safer to assume that an estimated value follows the trend from one known value to another than to assume that a trend continues beyond known values.

105. To find $f(g(-4))$, we first find $g(-4)$:

$g(-4)=2(-4)+5=-8+5=-3$.

Then

$f(g(-4))=f(-3)=3(-3)^2-1=3\cdot 9-1=27-1=26$.

To find $g(f(-4))$, we first find $f(-4)$:

$f(-4)=3(-4)^2-1=3\cdot 16-1=48-1=47$.

Then $g(f(-4))=g(47)=2\cdot 47+5=94+5=99$.

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

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

107. $f(\text{tiger})=\text{dog}$
$f(\text{dog})=f(f(\text{tiger}))=\text{cat}$
$f(\text{cat})=f(f(f(\text{tiger})))=\text{fish}$
$f(\text{fish})=f(f(f(f(\text{tiger}))))=\text{worm}$

108. Locate the highest point on the graph. Then move horizontally to the vertical axis and read the corresponding pressure. It is about 22 mm.

109. Locate the highest point on the graph. Then move vertically to the horizontal axis and read the corresponding time. It is about 2 min, 50 sec.

110. *Writing Exercise.* About 12 mm; we would expect the contraction at 7 min to be about the same size as the contraction at 4 min since the largest contractions occurred about 3 min apart.

111. The two largest contractions occurred at about 2 minutes, 50 seconds and 5 minutes, 40 seconds. The difference in these times, is 2 minutes, 50 seconds, so the frequency is about 1 every 3 minutes.

112. We know that $(-1,-7)$ and $(3,\ 8)$ are both solutions of $g(x)=mx+b$. Substituting, we have

$$-7=m(-1)+b,\quad \text{or}\quad -7=-m+b,$$
$$\text{and}\quad 8=m(3)+b,\quad \text{or}\quad 8=3m+b.$$

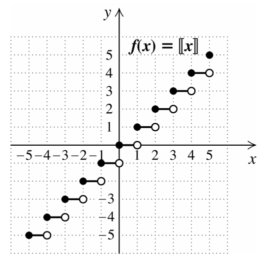
Solve the first equation for b and substitute that expression into the second equation.

$$\begin{aligned} -7&=-m+b && \text{First equation}\\ m-7&=b && \text{Solving for } b\\ 8&=3m+b && \text{Second equation}\\ 8&=3m+(m-7) && \text{Substituting}\\ 8&=3m+m-7\\ 8&=4m-7\\ 15&=4m\\ \frac{15}{4}&=m \end{aligned}$$

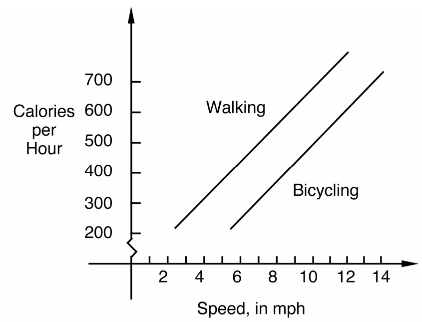
We know that $m-7=b$, so $\frac{15}{4}-7=b$, or $-\frac{13}{4}=b$.

We have $m=\frac{15}{4}$ and $b=-\frac{13}{4}$, so $g(x)=\frac{15}{4}x-\frac{13}{4}$.

113.



114. Graph the energy expenditures for walking and for bicycling on the same axes. Using the information given we plot and connect the points $\left(2\frac{1}{2},\ 210\right)$ and $\left(3\frac{3}{4},\ 300\right)$ for walking. We use the points $\left(5\frac{1}{2},\ 210\right)$ and $(13,\ 660)$ for bicycling.



From the graph we see that walking $4\frac{1}{2}$ mph burns about 350 calories per hour and bicycling 14 mph burns about 725 calories per hour. Walking for two hours at $4\frac{1}{2}$ mph, then, would burn about $2\cdot 350$, or 700 calories. Thus, bicycling 14 mph for one hour burns more calories than walking $4\frac{1}{2}$ mph for two hours.

Exercise Set 2.3

1. A y-intercept is the form (f), (0, b).

2. Slope is (c), $\dfrac{\text{difference in } y}{\text{difference in } x}$.

3. Rise is (e), the difference in y.

4. Run is (d), the difference in x.

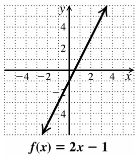
5. Slope-intercept form is (a), $y = mx + b$.

6. Translated means (b), shifted.

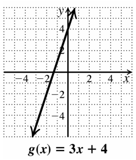
7. Graph: $f(x)=2x-1$.

We make a table of values. Then we plot the corresponding points and connect them.

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



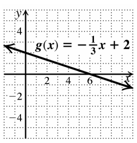
8. Graph $g(x)=3x+4$.



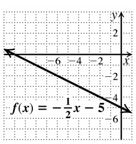
9. Graph: $g(x)=-\frac{1}{3}x+2$.

We make a table of values. Then we plot the corresponding points and connect them.

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



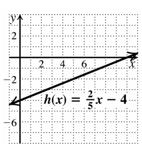
10. Graph $f(x)=-\dfrac{1}{2}x-5$.



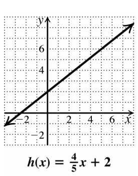
11. Graph: $h(x)=\frac{2}{5}x-4$.

We make a table of values. Then we plot the corresponding points and connect them.

x	$h(x)$
-5	-6
0	-4
5	-2



12. Graph $h(x)=\dfrac{4}{5}x+2$.



13. $y=5x+3$

The y-intercept is (0, 3), or simply 3.

14. (0, –11), or –11

15. $g(x)=-x-1$

The y-intercept is (0, –1), or simply –1.

16. (0, 5), or 5

17. $y=-\dfrac{3}{8}x-4.5$

The y-intercept is (0, –4.5), or simply –4.5.

18. (0, 2.2), or 2.2

19. $f(x)=1.3x-\dfrac{1}{4}$

The y-intercept is $\left(0,\ -\dfrac{1}{4}\right)$, or simply $-\dfrac{1}{4}$.

20. $\left(0,\ \dfrac{1}{5}\right)$, or $\dfrac{1}{5}$

21. $y=17x+138$

The y-intercept is (0, 138), or simply 138.

22. (0, –260), or –260

23. $\text{Slope}=\dfrac{\text{difference in } y}{\text{difference in } x}=\dfrac{11-3}{10-8}=\dfrac{8}{2}=4$

24. $\text{Slope}=\dfrac{9-4}{2-12}=\dfrac{5}{-10}=-\dfrac{1}{2}$

25. $\text{Slope}=\dfrac{\text{difference in } y}{\text{difference in } x}=\dfrac{-5-3}{-4-(-8)}=\dfrac{-8}{4}=-2$

26. $\text{Slope}=\dfrac{-3-(-2)}{2-6}=\dfrac{-1}{-4}=\dfrac{1}{4}$

27. $\text{Slope}=\dfrac{\text{difference in } y}{\text{difference in } x}=\dfrac{4-(-7)}{13-(-20)}=\dfrac{11}{33}=\dfrac{1}{3}$

28. $\text{Slope}=\dfrac{-11-(-21)}{-5-(-8)}=\dfrac{10}{3}$

29. $\text{Slope}=\dfrac{\text{difference in } y}{\text{difference in } x}=\dfrac{-\frac{2}{3}-\frac{1}{6}}{\frac{1}{2}-\frac{1}{6}}=\dfrac{-\frac{5}{6}}{\frac{2}{6}}=-\dfrac{5}{2}$

30. $\text{Slope}=\dfrac{-\frac{2}{5}-\left(-\frac{1}{4}\right)}{\frac{3}{4}-\frac{1}{3}}=\dfrac{-\frac{3}{20}}{\frac{5}{12}}=-\dfrac{3}{20}\cdot\dfrac{12}{5}=-\dfrac{3\cdot 3\cdot 4}{4\cdot 5\cdot 5}=-\dfrac{9}{25}$

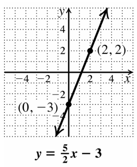
31. $\text{Slope}=\dfrac{\text{difference in } y}{\text{difference in } x}=\dfrac{43.6-43.6}{4.5-(-9.7)}=\dfrac{0}{14.2}=0$

32. $\text{Slope}=\dfrac{-2.6-(-3.1)}{-1.8-(-2.8)}=\dfrac{0.5}{1}=0.5$, or $\dfrac{1}{2}$

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

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

From the y-intercept, we go *up* 5 units and to the *right* 2 units. This gives us the point (2, 2). We can now draw the graph.

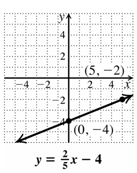


As a check, we can rename the slope and find another point.

$$\frac{5}{2}=\frac{5}{2}\cdot\frac{-1}{-1}=\frac{-5}{-2}$$

From the y-intercept, we go *down* 5 units and to the *left* 2 units. This gives us the point (–2, –8). Since (–2, –8) is on the line, we have a check.

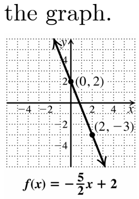
34. Slope is $\frac{2}{5}$; y-intercept is (0, –4).



35. $f(x)=-\frac{5}{2}x+2$

Slope is $-\frac{5}{2}$, or $\frac{-5}{2}$; y-intercept is (0, 2).

From the y-intercept, we go *down* 5 units and to the *right* 2 units. This gives us the point (2, –3). We can now draw the graph.

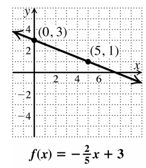


As a check, we can rename the slope and find another point.

$$\frac{-5}{2}=\frac{5}{-2}$$

From the y-intercept, we go *up* 5 units and to the *left* 2 units. This gives us the point (–2, 7). Since (–2, 7) is on the line, we have a check.

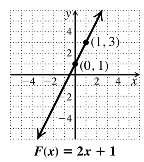
36. Slope is $-\frac{2}{5}$; y-intercept is (0, 3).



37. $F(x)=2x+1$

Slope is 2, or $\frac{2}{1}$; y-intercept is (0, 1).

From the y-intercept, we go *up* 2 units and to the *right* 1 unit. This gives us the point (1, 3). We can now draw the graph.

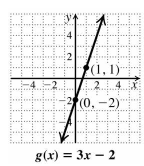


As a check, we can rename the slope and find another point.

$$2=\frac{2}{1}\cdot\frac{3}{3}=\frac{6}{3}$$

From the y-intercept, we go *up* 6 units and to the *right* 3 units. This gives us the point (3, 7). Since (3, 7) is on the line, we have a check.

38. Slope is 3; y-intercept is (0, –2).

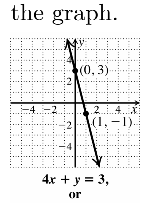


39. Convert to a slope-intercept equation.

$$4x+y=3$$
$$y=-4x+3$$

Slope is -4, or $\frac{-4}{1}$; y-intercept is (0, 3).

From the y-intercept, we go *down* 4 units and to the *right* 1 unit. This gives us the point (1, –1). We can now draw the graph.



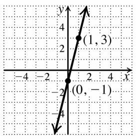
As a check, we can rename the slope and find another point.

$$\frac{-4}{1}=\frac{-4}{1}\cdot\frac{-1}{-1}=\frac{4}{-1}$$

From the y-intercept, we go *up* 4 units and to the *left* 1 unit. This gives us the point (–1, 7). Since (–1, 7) is on the line, we have a check.

40. $4x - y = 1$, or $y = 4x - 1$

Slope is 4; *y*-intercept is (0, –1).



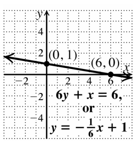
4x − y = 1, or y = 4x − 1

41. Convert to a slope-intercept equation.

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

Slope is $-\frac{1}{6}$, or $\frac{-1}{6}$; *y*-intercept is (0, 1).

From the *y*-intercept, we go *down* 1 unit and to the *right* 6 units. This gives us the point (6, 0). We can now draw the graph.



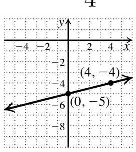
As a check, we choose some other value for *x*, say –6, and determine *y*:

$$y = -\frac{1}{6}(-6) + 1 = 1 + 1 = 2$$

We plot the point (–6, 2) and see that it *is* on the line.

42. $4y + 20 = x$, or $y = \frac{1}{4}x - 5$

Slope is $\frac{1}{4}$; *y*-intercept is (0, –5).

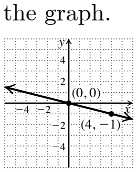


4y + 20 = x, or $y = \frac{1}{4}x - 5$

43. $g(x) = -0.25x$

Slope is –0.25, or $\frac{-1}{4}$; *y*-intercept is (0, 0).

From the *y*-intercept, we go *down* 1 unit and to the *right* 4 units. This gives us the point (4, –1). We can now draw the graph.



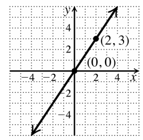
g(x) = −0.25x

As a check, we can rename the slope and find another point.

$$\frac{-1}{4} = \frac{-1}{4} \cdot \frac{-1}{-1} = \frac{1}{-4}$$

From the *y*-intercept, we go *up* 1 unit and to the *left* 4 units. This gives us the point (–4, 1). Since (–4, 1) is on the line, we have a check.

44. Slope is 1.5; *y*-intercept is (0, 0).



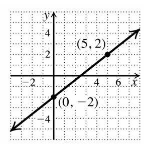
F(x) = 1.5x

45. Convert to a slope-intercept equation.

$$4x - 5y = 10$$
$$-5y = -4x + 10$$
$$y = \frac{4}{5}x - 2$$

Slope is $\frac{4}{5}$; *y*-intercept is (0, –2).

From the *y*-intercept, we go *up* 4 units and to the *right* 5 units. This gives us the point (5, 2). We can now draw the graph.



4x − 5y = 10, or $y = \frac{4}{5}x - 2$

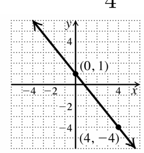
As a check, we choose some other value for *x*, say –5, and determine *y*:

$$y = \frac{4}{5}(-5) - 2 = -4 - 2 = -6$$

We plot the point (–5, –6) and see that it *is* on the line.

46. $5x + 4y = 4$, or $y = -\frac{5}{4}x + 1$

Slope is $-\frac{5}{4}$; *y*-intercept is (0, 1).



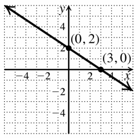
5x + 4y = 4, or $y = -\frac{5}{4}x + 1$

47. Convert to a slope-intercept equation.

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

Slope is $-\frac{2}{3}$; *y*-intercept is (0, 2).

From the *y*-intercept, we go *down* 2 units and to the *right* 3 units. This gives us the point (3, 0). We can now draw the graph.



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

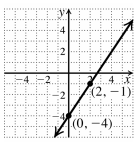
As a check, we choose some other value for x, say –3, and determine y:

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

We plot the point (–3, 4) and see that it *is* on the line.

48. $3x - 2y = 8$, or $y = \frac{3}{2}x - 4$

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



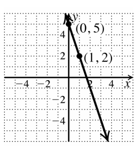
$3x - 2y = 8$,
or
$y = \frac{3}{2}x - 4$

49. Convert to a slope-intercept equation.

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

Slope is -3, or $\frac{-3}{1}$; y-intercept is (0, 5).

From the y-intercept, we go *down* 3 units and to the *right* 1 unit. This gives us the point (1, 2). We can now draw the graph.



$5 - y = 3x$,
or
$y = -3x + 5$

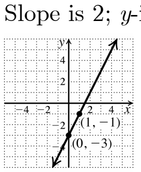
As a check, we choose some other value for x, say –1, and determine y:

$$y = -3(-1) + 5 = 3 + 5 = 8$$

We plot the point (–1, 8) and see that it *is* on the line.

50. $3 + y = 2x$, or $y = 2x - 3$

Slope is 2; y-intercept is (0, –3).

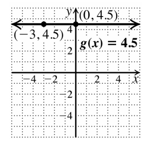


$3 + y = 2x$,
or
$y = 2x - 3$

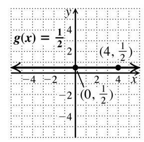
51. $g(x) = 4.5 = 0x + 4.5$

Slope is 0; y-intercept is $(0,\ 4.5)$.

From the y-intercept, we go up or down 0 units and any number of nonzero units to the left or right. Any point on the graph will lie on a horizontal line 4.5 units above the x-axis. We draw the graph.



52. Slope is 0; y-intercept is $\left(0,\ \frac{1}{2}\right)$.



53. Use the slope-intercept equation, $f(x) = mx + b$, with m = 2 and b = 5.

$$\begin{aligned} f(x) &= mx + b \\ f(x) &= 2x + 5 \end{aligned}$$

54. $f(x) = -4x + 1$

55. Use the slope-intercept equation, $f(x) = mx + b$, with $m = -\frac{2}{3}$ and b = –2.

$$\begin{aligned} f(x) &= mx + b \\ f(x) &= -\frac{2}{3}x - 2 \end{aligned}$$

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

57. Use the slope-intercept equation, $f(x) = mx + b$, with $m = -7$ and $b = \frac{1}{3}$.

$$\begin{aligned} f(x) &= mx + b \\ f(x) &= -7x + \frac{1}{3} \end{aligned}$$

58. $f(x) = 8x - \frac{1}{4}$

59. We can use the coordinates of any two points on the line. Let's use (0, 5) and (4, 6).

$$\text{Rate of change} = \frac{\text{change in } y}{\text{change in } x} = \frac{6-5}{4-0} = \frac{1}{4}$$

The distance from home is increasing at a rate of $\frac{1}{4}$ km per minute.

60. We can use the coordinates of any two points on the line. We'll use (0, 50) and (2, 200).

$$\text{Rate of change} = \frac{\text{change in } y}{\text{change in } x} = \frac{200-50}{2-0} = 75$$

The number of pages read is increasing at a rate of 75 pages per day.

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

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

or $-6\frac{2}{3}$

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

62. We can use the coordinates of any two points on the line. We'll use (1, 14) and (2, 8).

$$\text{Rate of change} = \frac{\text{change in } y}{\text{change in } x} = \frac{14-8}{1-2} = -6$$

The value is decreasing at a rate of \$600 per year.

63. We can use the coordinates of any two points on the line. We'll use (3, 2.5) and (6, 4.5).

$$\text{Rate of change} = \frac{\text{change in } y}{\text{change in } x} = \frac{2.5-4.5}{3-6} = \frac{-2}{-3} = \frac{2}{3}$$

The number of bookcases stained is increasing at a rate of $\frac{2}{3}$ bookcase per quart of stain used.

64. We can use the coordinates of any two points on the line. We'll use (0, 0) and (1, 3).

$$\text{Rate of change} = \frac{\text{change in } y}{\text{change in } x} = \frac{3-0}{1-0} = \frac{3}{1}, \text{ or } 3$$

The distance is increasing at a rate of 3 miles per hour.

65. We can use the coordinates of any two points on the line. We'll use (35, 490) and (45, 500).

$$\text{Rate of change} = \frac{\text{change in } y}{\text{change in } x} = \frac{490-500}{35-45} = \frac{-10}{-10}, \text{ or } 1$$

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

66. We can use the coordinates of any two points on the line. We'll use (25, 465) and (35, 480).

$$\text{Rate of change} = \frac{\text{change in } y}{\text{change in } x} = \frac{465-480}{25-35} = \frac{-15}{-10} = \frac{3}{2}, \text{ or } 1.5$$

The average SAT verbal score is increasing at a rate of 1.5 points per thousand dollars of family income.

67. a) Graph II indicated that 200 ml of fluid was dripped in the first 3 hr, a rate of $\frac{200}{3}$ ml/hr. It also indicates that 400 ml of fluid was dripped in the next 3 hr, a rate of $\frac{400}{3}$ ml/hr, and that this rate continues until the end of the time period shown. Since the rate of $\frac{400}{3}$ ml/hr is double the rate of $\frac{200}{3}$ ml/hr, this graph is appropriate for the given situation.

b) Graph IV indicates that 300 ml of fluid was dripped in the first 2 hr, a rate of 300/2, or 150 ml/hr. In the next 2 hr, 200 ml was dripped. This is a rate of 200/2, or 100 ml/hr. Then 100 ml was dripped in the next 3 hr, a rate of 100/3, or $33\frac{1}{3}$ ml/hr. Finally, in the remaining 2 hr, 0 ml of fluid was dripped, a rate of 0/2, or 0 ml/hr. Since the rate at which the fluid was given decreased as time progressed and eventually became 0, this graph is appropriate for the given situation.

c) Graph I is the only graph that shows a constant rate for 5 hours, in this case from 3 PM to 8 PM. Thus, it is appropriate for the given situation.

d) Graph III indicates that 100 ml of fluid was dripped in the first 4 hr, a rate of 100/4, or 25 ml/hr. In the next 3 hr, 200 ml was dripped. This is a rate of 200/3, or $66\frac{2}{3}$ ml/hr. Then 100 ml was dripped in the next hour, a rate of 100 ml/hr. In the last hour 200 ml was dripped, a rate of 200 ml/hr. Since the rate at which the fluid was given gradually increased, this graph is appropriate for the given situation.

68. The marathoner's speed is given by $\frac{\text{change in distance}}{\text{change in time}}$.

Note that the runner reaches the 22-mi point 56 min after the 15-mi point was reached or after 2 hr, 56 min. We will express time in hours: 2 hr, 56 min = $2\frac{14}{15}$ hr. Then

$$\frac{\text{change in distance}}{\text{change in time}} = \frac{22-15}{2\frac{14}{15}-2} = \frac{7}{\frac{14}{15}} = 7 \cdot \frac{15}{14} = \frac{15}{2}, \text{ or } 7.5 \text{ mph}$$

The marathoner's speed is 7.5 mph.

69. The skier's speed is given by $\frac{\text{change in distance}}{\text{change in time}}$. Note that the skier reaches the 12-km mark 45 min after the 3-km mark was reached or after $15+45$, or 60 min. We will express time in hours: $15\text{ min}=0.25\text{ hr}$ and $60\text{ min}=1\text{ hr}$. Then

$$\frac{\text{change in distance}}{\text{change in time}}=\frac{12-3}{1-0.25}=\frac{9}{0.75}=12.$$

The speed is 12 km/h.

70. The rate at which the number of recycling groups increased is given by $\frac{\text{change in number of groups}}{\text{change in time}}$.

$$\frac{\text{change in number of groups}}{\text{change in time}}=\frac{4224-2936}{28\text{ months}}=\frac{1288}{28}=46$$

The number of recycling groups is increasing at a rate of 46 groups per month.

71. The work rate is given by $\frac{\text{change in portion of house painted}}{\text{change in time}}$.

$$\frac{\text{change in portion of house painted}}{\text{change in time}}=\frac{\frac{2}{3}-\frac{1}{4}}{8-0}=\frac{\frac{5}{12}}{8}=\frac{5}{12}\cdot\frac{1}{8}=\frac{5}{96}$$

The painter's work rate is $\frac{5}{96}$ of the house per hour.

72. The average rate of descent is given by $\frac{\text{change in altitude}}{\text{change in time}}$. We will express time in minutes:

$$1\frac{1}{2}\text{ hr}=\frac{3}{2}\text{ hr}\cdot\frac{60\text{ min}}{1\text{ hr}}=90\text{ min}$$

$2\text{ hr}, 10\text{ min}=$ 2 hr + 10 min

$$=2\text{ hr}\cdot\frac{60\text{ min}}{1\text{ hr}}+10\text{ min}=120\text{ min}+10\text{ min}=130\text{ min}$$

Then

$$\frac{\text{change in altitude}}{\text{change in time}}=\frac{0-12{,}000}{130-90}=\frac{-12{,}000}{40}=-300.$$

The average rate of descent is 300 ft/min.

73. The rate at which the number of hits is increasing is given by $\frac{\text{change in number of hits}}{\text{change in time}}$.

$$\frac{\text{change in number of hits}}{\text{change in time}}=\frac{430{,}000-80{,}000}{2009-2007}=\frac{350{,}000}{2}=175{,}000$$

The number of hits is increasing at a rate of 175,000 hits/yr.

74. a) Graph III is appropriate, because it shows that the rate before January 1 is \$3000/month while it is \$2000/month after January 1.

b) Graph IV is appropriate, because it shows that the rate before January 1 is \$3000/month while it is $-\$4000$ /month after January 1.

c) Graph I is appropriate, because it shows that the rate is \$1000/month before January 1 and \$2000/month after January 1.

d) Graph II is appropriate, because it shows that the rate is \$4000/month before January 1 and $-\$2000$ /month after January 1.

75. $C(d)=0.75d+30$

0.75 signifies the cost per mile is \$0.75; 30 signifies that the minimum cost to rent a truck is \$30.

76. $P(x)=0.05x+200$

0.05 signifies that a salesperson earns a 5% commission on sales; 200 indicates that a salesperson's base salary is \$200 per week.

77. $L(t)=\frac{1}{2}t+5$

$\frac{1}{2}$ signifies that Lauren's hair grows $\frac{1}{2}$ in. per month; 5 signifies that her hair is 5 in. long immediately after she gets it cut.

78. $D(t)=\frac{191}{5}t+3439$

$\frac{191}{5}$ signifies that the demand increases $\frac{191}{5}$ billion kWh per year, for years after 2000; 3439 signifies that the demand was 3439 billion kWh in 2000.

79. $A(t)=\frac{1}{8}t+75.5$

$\frac{1}{8}$ signifies that the life expectancy of American women increases $\frac{1}{8}$ yr per year, for years after 1970; 75.5 signifies that the life expectancy in 1970 was 75.5 yr.

80. $G(t)=\frac{1}{8}t+2$

$\frac{1}{8}$ signifies that the grass grows $\frac{1}{8}$ in. per day; 2 signifies that the grass is 2 in. long immediately after is it cut.

81. $P(t)=0.89t+16.63$

0.89 signifies that the average price of a ticket increases by \$0.89 per year, for years after 2000; 16.63 signifies that the cost of a ticket is \$16.63 in 2000.

82. $C(d)=2d+2.5$ is of the form $y=mx+b$ with $m=2$ and $b=2.5$.
2 signifies that the cost per mile of a taxi ride is \$2; 2.5 signifies that the minimum cost of a taxi ride is \$2.50.

83. $C(t)=849t+5960$
849 signifies that the number of acres of organic cotton increases by 849 acres per year, for years after 2006; 5960 signifies that 5960 acres were planted in organic cotton in 2006.

84. $C(x)=25x+75$
25 signifies that the cost per person is \$25; 75 signifies that the setup cost for the party is \$75.

85. $F(t)=-5000t+90{,}000$

a) –5000 signifies that the truck's value depreciates \$5000 per year; 90,000 signifies that the original value of the truck was \$90,000.

b) We find the value of t for which $F(t)=0$.

$$\begin{aligned} 0&=-5000t+90{,}000\\ 5000t&=90{,}000\\ t&=18 \end{aligned}$$

It will take 18 yr for the truck to depreciate completely.

c) The truck's value goes from \$90,000 when $t=0$ to \$0 when $t=18$, so the domain of F is $\{x\,|\,0\le t\le 18\}$.

86. $V(t)=-2000t+15{,}000$

a) –2000 signifies that the color separator's value depreciates \$2000 per year; 15,000 signifies that the original value of the separator was \$15,000.

b)
$$\begin{aligned} 0&=-2000t+15{,}000\\ 2000t&=15{,}000\\ t&=7.5 \end{aligned}$$

It will take 7.5 yr for the machine to depreciate completely.

c) The machine's value goes from \$15,000 when $t=0$ to \$0 when $t=7.5$, so the domain of V is $\{t\,|\,0\le t\le 7.5\}$.

87. $v(n)=-200n+1800$

a) –200 signifies that the depreciation is \$200 per year; 1800 signifies that the original value of the bike was \$1800.

b) We find the value of n for which $v(n)=600$.

$$\begin{aligned} 600&=-200n+1800\\ -1200&=-200n\\ 6&=n \end{aligned}$$

The trade-in value is \$600 after 6 yrs of use.

c) First we find the value of n for which $v(n)=0$.

$$\begin{aligned} 0&=-200n+1800\\ -1800&=-200n\\ 9&=n \end{aligned}$$

The value of the bike goes from \$1800 when $n=0$, to \$0 when $n=9$, so the domain of v is $\{n\,|\,0\le n\le 9\}$.

88. $T(x)=-300x+2400$

a) –300 signifies that the mower's value depreciates \$300 per summer of use; 2400 signifies that the original value of the mower was \$2400.

b)
$$\begin{aligned} 1200&=-300x+2400\\ -1200&=-300x\\ 4&=x \end{aligned}$$

The mower's value will be \$1200 after 4 summers of use.

c)
$$\begin{aligned} 0&=-300x+2400\\ -2400&=-300x\\ 8&=x \end{aligned}$$

The domain of T is $\{x\,|\,0\le x\le 8\}$.

89. *Writing Exercise.* As president, it would be a good idea for the federal debt to decrease, so m should be negative.

90. *Writing Exercise.* m must be measured in trillions of dollars.

91. $\dfrac{-8-(-8)}{6-(-6)}=\dfrac{-8+8}{6+6}=\dfrac{0}{12}=0$

92. $\dfrac{-2-2}{-3-(-3)}=\dfrac{-2-2}{-3+3}=\dfrac{-4}{0}=\text{undefined}$

93.
$$\begin{aligned} 3\cdot 0-2y&=9\\ 0-2y&=9\\ -2y&=9\\ y&=-\frac{9}{2} \end{aligned}$$

94.
$$\begin{aligned} 4x-7\cdot 0&=3\\ 4x-0&=3\\ 4x&=3\\ x&=\frac{3}{4} \end{aligned}$$

95. $f(x)=2x-7$
$f(0)=2(0)-7=0-7=-7$

96. $f(x)=2x-7$
$0=2x-7$
$7=2x$
$\frac{7}{2}=x$

97. *Writing Exercise*. Yes, the population can be modeled as a linear function with –10%, or –0.10 as the slope and the current population for the y-intercept.

98. a) Answers will vary.
b) The profit increases each year but not as much as in the previous year.

99. a) Graph III indicates that the first 2 mi and the last 3 mi were traveled in approximately the same length of time and at a fairly rapid rate. The mile following the first two miles was traveled at a much slower rate. This could indicate that the first two miles were driven, the next mile was swum and the last three miles were driven, so this graph is most appropriate for the given situation.
b) The slope in Graph IV decreases at 2 mi and again at 3 mi. This could indicate that the first two miles were traveled by bicycle, the next mile was run, and the last 3 miles were walked, so this graph is most appropriate for the given situation.
c) The slope in Graph I decreases at 2 mi and then increases at 3 mi. This could indicate that the first two miles were traveled by bicycle, the next mile was hiked, and the last three miles were traveled by bus, so this graph is most appropriate for the given situation.
d) The slope in Graph II increases at 2 mi and again at 3 mi. This could indicate that the first two miles were hiked, the next mile was run, and the last three miles were traveled by bus, so this graph is most appropriate for the given situation.

100. Ponte sul Pesa to Panzano

101. The longest uphill climb is the widest rising line. It is the trip from Sienna to Castellina in Chianti.

102. Le Bolle

103. Reading from the graph the trip from Castellina in Chianti to Ponte sul Pesa is downhill, then to Panzano is uphill and then to Creve in Chianti is downhill. All sections are about the same grade. So the trip began at Castellina in Chianti.

104. About 4%

105. $rx+py=s-ry$
$ry+py=-rx+s$
$y(r+p)=-rx+s$
$y=-\frac{r}{r+p}x+\frac{s}{r+p}$

The slope is $-\frac{r}{r+p}$, and the y-intercept is $\left(0,\ \frac{s}{r+p}\right)$.

106. We first solve for y.
$rx+py=s$
$py=-rx+s$
$y=-\frac{r}{p}x+\frac{s}{p}$

The slope is $-\frac{r}{p}$, and the y-intercept is $\left(0,\ \frac{s}{p}\right)$. .

107. See the answer section in the text.

108. Let $c=2$ and $d=3$. Then
$f(cd)=f(2\cdot 3)=f(6)=m\cdot 6+b=6m+b$, but
$f(c)f(d)=f(2)f(3)=(m\cdot 2+b)(m\cdot 3+b)=6m^2+5mb+b^2$.
Thus, the given statement is false.

109. Let $c=1$ and $d=2$. Then
$f(c+d)=f(1+2)=f(3)=3m+b$, but
$f(c)+f(d)=(m+b)+(2m+b)=3m+2b$.
The given statement is false.

110. Let $c=5$ and $d=2$. Then
$f(c-d)=f(5-2)=f(3)=m\cdot 3+b=3m+b$, but
$f(c)-f(d)=f(5)-f(2)=(m\cdot 5+b)-(m\cdot 2+b)$.
$=5m+b-2m-b=3m$
Thus, the given statement is false.

111. Let $k=2$. Then $f(kx)=f(2x)=2mx+b$, but $kf(x)=2(mx+b)=2mx+2b$. The given statement is false.

112. Observe that parallel lines rise or fall at the same rate. Thus, their slopes are the same. For the line containing $(-3,\ k)$ and $(4,\ 8)$,
$\text{slope}=\frac{k-8}{-3-4}=\frac{k-8}{-7}$.
For the line containing $(5,\ 3)$ and $(1,-6)$,
$\text{slope}=\frac{-6-3}{1-5}=\frac{9}{4}$.

Then we have

$$\begin{aligned} \frac{k-8}{-7} &= \frac{9}{4} \\ 4k-32 &= -63 \\ 4k &= -31 \\ k &= -\frac{31}{4} \end{aligned}$$

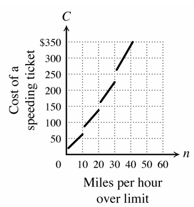
113. a) $\dfrac{-c-(-6c)}{b-5b} = \dfrac{5c}{-4b} = -\dfrac{5c}{4b}$

b) $\dfrac{(d+e)-d}{b-b} = \dfrac{e}{0}$

Since we cannot divide by 0, the slope is undefined.

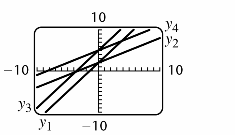
c) $$\begin{aligned} \frac{(-a-d)-(a+d)}{(c-f)-(c+f)} &= \frac{-a-d-a-d}{c-f-c-f} \\ &= \frac{-2a-2d}{-2f} \\ &= \frac{-2(a+d)}{-2f} \\ &= \frac{a+d}{f} \end{aligned}$$

114.



115.

$y_1 = 1.4x + 2$, $y_2 = 0.6x + 2$,
$y_3 = 1.4x + 5$, $y_4 = 0.6x + 5$



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

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

Exercise Set 2.4

1. Every horizontal line has a slope of 0.

2. The graph of any function of the form $f(x) = b$ is a horizontal line that crosses the y-axis at $(0, b)$.

3. The slope of a vertical line is undefined.

4. The graph of any equation of the form $x = a$ is a vertical line that crosses the x-axis at $(a, 0)$.

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

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

7. To solve $3x - 5 = 7$, we can graph $f(x) = 3x - 5$ and $g(x) = 7$ and find the x-value at the point of intersection.

8. An equation like $4x + 3y = 8$ is said to be written in standard form.

9. Only linear equations have graphs that are straight lines.

10. Linear graphs have a constant slope.

11. $$\begin{aligned} y-2 &= 6 \\ y &= 8 \end{aligned}$$
The graph of $y = 8$ is a horizontal line. Since $y - 2 = 6$ is equivalent to $y = 8$, the slope of the line $y - 2 = 6$ is 0.

12. $$\begin{aligned} x+3 &= 11 \\ x &= 8 \end{aligned}$$
The graph of $x = 8$ is a vertical line. Since $x + 3 = 11$ is equivalent to $x = 8$, the slope of the line $x + 3 = 11$ is undefined.

13. $$\begin{aligned} 8x &= 6 \\ x &= \frac{3}{4} \end{aligned}$$
The graph of $x = \frac{3}{4}$ is a vertical line. Since $8x = 6$ is equivalent to $x = \frac{3}{4}$, the slope of the line $8x = 6$ is undefined.

14. $$\begin{aligned} y-3 &= 5 \\ y &= 8 \end{aligned}$$
The graph of $y = 8$ is a horizontal line. Since $y - 3 = 5$ is equivalent to $y = 8$, the slope of the line $y - 3 = 5$ is 0.

15. $3y=28$
$y=\frac{28}{3}$

The graph of $y=\frac{28}{3}$ is a horizontal line. Since $3y = 28$ is equivalent to $y=\frac{28}{3}$, the slope of the line $3y = 28$ is 0.

16. $19=-6y$
$-\frac{19}{6}=y$

The graph of $y=-\frac{19}{6}$ is a horizontal line. Since $19=-6y$ is equivalent to $y=-\frac{19}{6}$, the slope of the line $19=-6y$ is 0.

17. $5-x=12$
$x=-7$

The graph of $x = -7$ is a vertical line. Since $5-x=12$ is equivalent to $x = -7$, the slope of the line $5-x=12$ is undefined.

18. $-5x=13$
$x=-\frac{13}{5}$

The graph of $x=-\frac{13}{5}$ is a vertical line. Since $-5x=13$ is equivalent to $x=-\frac{13}{5}$, the slope of the line $-5x=13$ is undefined.

19. $2x-4=3$
$2x=7$
$x=\frac{7}{2}$

The graph of $x=\frac{7}{2}$ is a vertical line. Since $2x-4=3$ is equivalent to $x=\frac{7}{2}$, the slope of the line $2x-4=3$ is undefined.

20. $3-2y=16$
$y=-\frac{13}{2}$

The graph of $y=-\frac{13}{2}$ is a horizontal line. Since $3-2y=16$ is equivalent to $y=-\frac{13}{2}$, the slope of the line $3-2y=16$ is 0.

21. $5y-4=35$
$5y=39$
$y=\frac{39}{5}$

The graph of $y=\frac{39}{5}$ is a horizontal line. Since $5y-4=35$ is equivalent to $y=\frac{39}{5}$, the slope of the line $5y-4=35$ is 0.

22. $2x-17=3$
$2x=20$
$x=10$

The graph of $x = 10$ is a vertical line. Since $2x-17=3$ is equivalent to $x = 10$, the slope of the line $2x-17=3$ is undefined.

23. $4y-3x=9-3x$
$y=\frac{9}{4}$

The graph of $y=\frac{9}{4}$ is a horizontal line. Since $4y-3x=9-3x$ is equivalent to $y=\frac{9}{4}$, the slope of the line $4y-3x=9-3x$ is 0.

24. $x-4y=12-4y$
$x=12$

The graph of $x=12$ is a vertical line. Since $x-4y=12-4y$ is equivalent to $x=12$, the slope of the line $x-4y=12-4y$ is undefined.

25. $5x-2=2x-7$
$5x=2x-5$
$3x=-5$
$x=-\frac{5}{3}$

The graph of $x=-\frac{5}{3}$ is a vertical line. Since $5x-2=2x-7$ is equivalent to $x=-\frac{5}{3}$, the slope of the line $5x-2=2x-7$ is undefined.

26. $5y+3=y+9$
$4y=6$
$y=\frac{3}{2}$

The graph of $y=\frac{3}{2}$ is a horizontal line. Since $5y+3=y+9$ is equivalent to $y=\frac{3}{2}$, the slope of the line $5y+3=y+9$ is 0.

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

The equation is written in slope-intercept form. We see that the slope is $-\frac{2}{3}$.

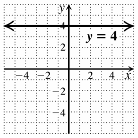
28. $y=-\frac{3}{2}x+4$

The equation is written in slope-intercept form. We see that the slope is $-\frac{3}{2}$.

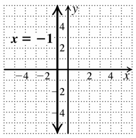
29. Graph $y=4$.

This is a horizontal line that crosses the y-axis at $(0,\ 4)$. If we find some ordered pairs, note that, for any x-value chosen, y must be 4.

x	y
-2	4
0	4
3	4



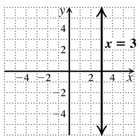
30. $x = -1$



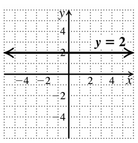
31. Graph $x = 3$.

This is a vertical line that crosses the x-axis at (3, 0). If we find some ordered pairs, note that, for any y-value chosen, x must be 3.

x	y
3	-1
3	0
3	2

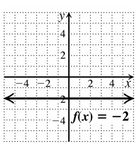


32. $y = 2$

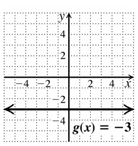


33. Graph $f(x) = -2$.

This is a horizontal line that crosses the y-axis at $(0, -2)$.



34. $g(x) = -3$

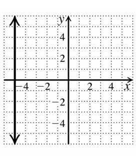


35. Graph $3x = -15$.

Since y does not appear, we solve for x.

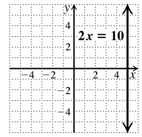
$$3x = -15$$
$$x = -5$$

This is a vertical line that crosses the x-axis at $(-5, 0)$.



36. $2x = 10$

$x = 5$

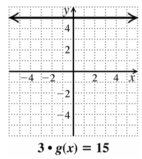


37. Graph $3 \cdot g(x) = 15$.

First solve for $g(x)$.

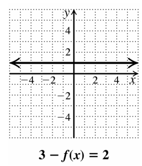
$$3 \cdot g(x) = 15$$
$$g(x) = 5$$

This is a horizontal line that crosses the vertical axis at $(0, 5)$.



38. $3 - f(x) = 2$

$1 = f(x)$



39. Graph $x + y = 4$.

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

$$0 + y = 4$$
$$y = 4$$

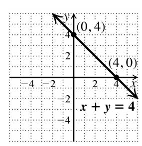
The y-intercept is (0, 4).

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

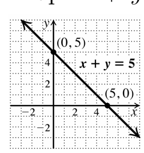
$$x + 0 = 4$$
$$x = 4$$

The x-intercept is (4, 0).

Plot these points and draw the line. A third point could be used as a check.



40. Graph $x + y = 5$.



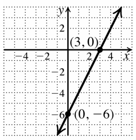
41. Graph $f(x)=2x-6$.

Because the function is in slope-intercept form, we know that the y-intercept is (0, –6). To find the x-intercept, let $f(x)=0$ and solve for x.

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

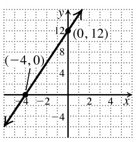
The x-intercept is $(3,\ 0)$.

Plot these points and draw the line. A third point could be used as a check.



$f(x) = 2x - 6$

42. $f(x)=3x+12$



$f(x) = 3x + 12$

43. Graph $3x+5y=-15$.

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

$$\begin{aligned}3\cdot 0+5y&=-15\\5y&=-15\\y&=-3\end{aligned}$$

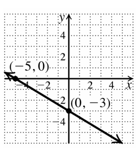
The y-intercept is $(0,-3)$.

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

$$\begin{aligned}3x+5\cdot 0&=-15\\3x&=-15\\x&=-5\end{aligned}$$

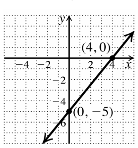
The x-intercept is $(-5,0)$.

Plot these points and draw the line. A third point could be used as a check.



$3x + 5y = -15$

44. $5x-4y=20$



$5x - 4y = 20$

45. Graph $2x-3y=18$.

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

$$\begin{aligned}2\cdot 0-3y&=18\\-3y&=18\\y&=-6\end{aligned}$$

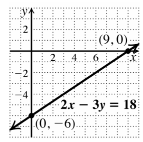
The y-intercept is $(0,-6)$.

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

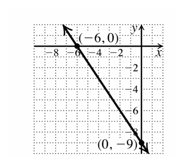
$$\begin{aligned}2x-3\cdot 0&=18\\2x&=18\\x&=9\end{aligned}$$

The x-intercept is $(9,\ 0)$.

Plot these points and draw the line. A third point could be used as a check.



46. $3x+2y=-18$



$3x + 2y = -18$

47. Graph $3y=-12x$.

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

$$\begin{aligned}3y&=-12\cdot 0\\3y&=0\\y&=0\end{aligned}$$

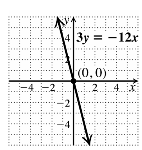
The y-intercept is (0, 0). This is also the x-intercept.

We find another point on the line. Let $x = 1$ and find the corresponding value of y.

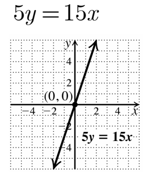
$$\begin{aligned}3y&=-12\cdot 1\\3y&=-12\\y&=-4\end{aligned}$$

The point (1, –4) is on the graph.

Plot these points and draw the line. A third point could be used as a check.



48. $5y=15x$



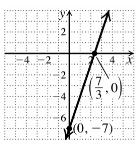
49. Graph $f(x)=3x-7$.

Because the function is in slope-intercept form, we know that the y-intercept is $(0,-7)$. To find the x-intercept, let $f(x)=0$ and solve for x.

$$0=3x-7$$
$$7=3x$$
$$\frac{7}{3}=x$$

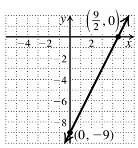
The x-intercept is $\left(\frac{7}{3},\ 0\right)$.

Plot these points and draw the line. A third point could be used as a check.



$f(x) = 3x - 7$

50. Graph $g(x)=2x-9$.



$g(x) = 2x - 9$

51. Graph $5y-x=5$.

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

$$5y-0=5$$
$$5y=5$$
$$y=1$$

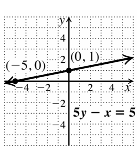
The y-intercept is $(0,\ 1)$.

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

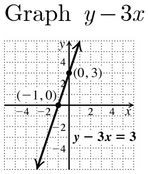
$$5\cdot 0-x=5$$
$$-x=5$$
$$x=-5$$

The x-intercept is $(-5,\ 0)$.

Plot these points and draw the line. A third point could be used as a check.



52. Graph $y-3x=3$.



53. $0.2y-1.1x=6.6$

$2y-11x=66$ Multiplying by 10

Graph $2y-11x=66$.

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

$$2y-11x=66$$
$$2y-11\cdot 0=66$$
$$2y=66$$
$$y=33$$

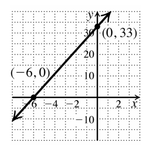
The y-intercept is (0, 33).

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

$$2y-11x=66$$
$$2\cdot 0-11x=66$$
$$-11x=66$$
$$x=-6$$

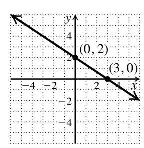
The x-intercept is (–6, 0).

Plot these points and draw the line. A third point could be used as a check.



$0.2y - 1.1x = 6.6$

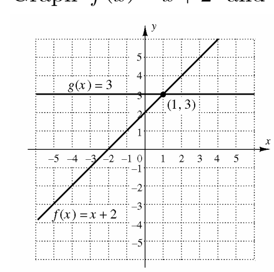
54. Graph $\frac{1}{3}x+\frac{1}{2}y=1$.



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

55. $x+2=3$

Graph $f(x)=x+2$ and $g(x)=3$ on the same grid.



The lines appear to intersect at (1, 3), so the solution is apparently 1.

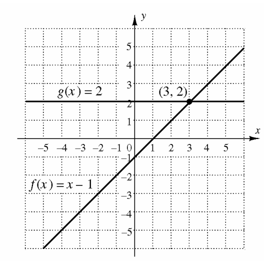
Check:

$x+2=3$	
$1+2$	3

$3 \overset{?}{=} 3$ TRUE

The solution is 1.

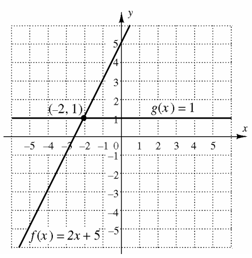
56. $x-1=2$



3 checks and is the solution.

57. $2x+5=1$

Graph $f(x)=2x+5$ and $g(x)=1$ on the same grid.



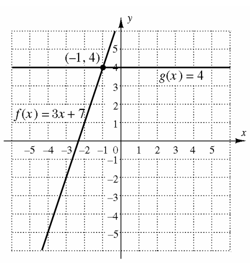
The lines appear to intersect at (–2, 1), so the solution is apparently –2.

Check:

$$\begin{array}{c|c} 2x+5 & 1 \\ \hline 2(-2)+5 & 1 \\ -4+5 & \\ 1 \stackrel{?}{=} 1 & \text{TRUE} \end{array}$$

The solution is –2.

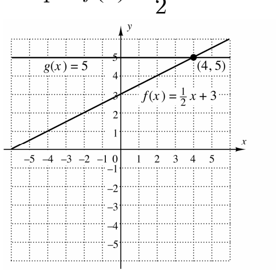
58. $3x+7=4$



–1 checks and is the solution.

59. $\frac{1}{2}x+3=5$

Graph $f(x)=\frac{1}{2}x+3$ and $g(x)=5$ on the same grid.



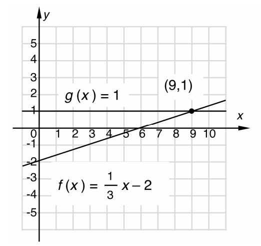
The lines appear to intersect at $(4,\ 5)$, so the solution is apparently 4.

Check:

$$\begin{array}{c|c} \frac{1}{2}x+3 & 5 \\ \hline \frac{1}{2}(4)+3 & 5 \\ 2+3 & \\ 5 \stackrel{?}{=} 5 & \text{TRUE} \end{array}$$

The solution is 4.

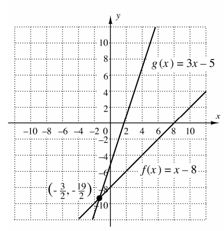
60. $\frac{1}{3}x-2=1$



9 checks and is the solution.

61. $x-8=3x-5$

Graph $f(x)=x-8$ and $g(x)=3x-5$ on the same grid.



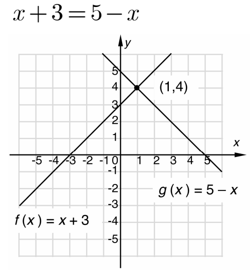
The lines appear to intersect at $\left(-\frac{3}{2},\ -\frac{19}{2}\right)$, so the solution is apparently $-\frac{3}{2}$.

Check:

$$\begin{array}{c|c} x-8 & 3x-5 \\ \hline -\frac{3}{2}-8 & 3\left(-\frac{3}{2}\right)-5 \\ -\frac{19}{2} & -\frac{9}{2}-5 \\ -\frac{19}{2} \stackrel{?}{=} -\frac{19}{2} & \text{TRUE} \end{array}$$

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

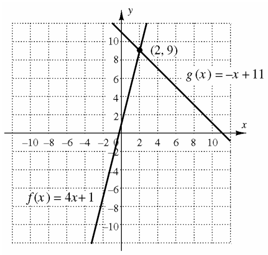
62. $x+3=5-x$



1 checks and is the solution.

63. $4x+1=-x+11$

Graph $f(x)=4x+1$ and $g(x)=-x+11$ on the same grid.



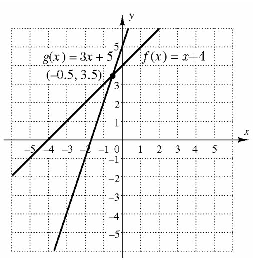
The lines appear to intersect at (2, 9), so the solution is apparently 2.

Check: $\begin{array}{c|c} 4x+1 & -x+11 \\ \hline 4\cdot 2+1 & -2+11 \\ 8+1 & \end{array}$

$9 \stackrel{?}{=} 9$ TRUE

The solution is 2.

64. $x+4=3x+5$



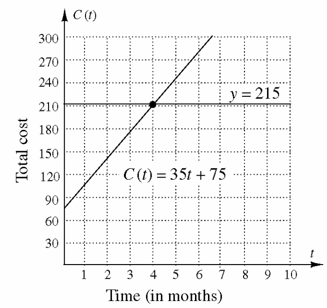
$-\dfrac{1}{2}$ or –0.5 checks and is the solution.

65. ***Familiarize***. After an initial fee of \$75, an additional fee of \$35 is charge each month. After one month, the total cost is \$75 + \$35 = \$110. After two months, the total cost is $75+2\cdot 35=\$145$. We can generalize this with a model, letting $C(t)$ represent the total cost, in dollars, for t months of membership.

Translate. We reword the problem and translate.

$$\underbrace{\text{Total Cost}} \quad \text{is} \quad \underbrace{\text{initial cost}} \quad \text{plus} \quad \underbrace{\text{\$35 per month}}.$$
$$\downarrow \qquad \downarrow \qquad \downarrow \qquad \downarrow \qquad \downarrow$$
$$C(t) \qquad = \qquad 75 \qquad + \qquad 35t$$

Carry out. First we write the model in slope-intercept form. $C(t)=35t+75$. The vertical intercept is (0, 75), and the slope, or rate, is \$35 per month. Plot (0, 75) and from there go up \$35 and to the right 1 month. This takes us to (1, 110). Draw a line passing through both points.



To estimate the time required for the total cost to reach \$215, we are estimating the solution of $35t+75=215$. We do this by graphing $y=215$ and finding the point of intersection of the graphs. This point appears to be $(4,\ 215)$. Thus, we estimate that it takes 4 months for the total cost to reach \$215.

Check. We evaluate.

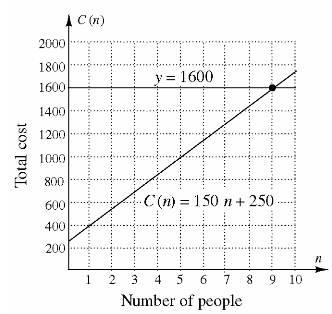
$$\begin{aligned} C(4) &= 35\cdot 4+75 \\ &= 140+75 \\ &= 215 \end{aligned}$$

The estimate is precise.

State. It takes 4 months for the total cost to reach \$215.

66. Let n = the number of people attending the seminar and $C(n)=$ the total cost.

Graph $C(n)=150n+250$ and $y=1600$.



The graphs appear to intersect at about (9, 1600). The number 9 checks, so if 9 people attend the seminar, the total cost is \$1600.

67. ***Familiarize***. After paying the first \$250, the patient must pay $\frac{1}{5}$ of all additional charges. For a \$1000 bill, the patient pays $\$250+\frac{1}{5}(\$1000-\$250)$, or \$400. We can generalize this with a model, letting $C(b)$ represent the total cost to the patient, in dollars, for a hospital bill of b dollars.

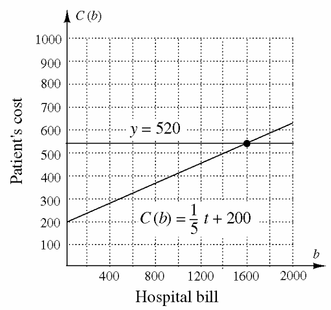
Translate. We reword the problem and translate.

Total Cost to patient	is	\$250	plus	$\frac{1}{5}$	of	Cost in excess of \$250.
↓	↓	↓	↓	↓	↓	↓
$C(b)$	$=$	250	$+$	$\frac{1}{5}$	$\times$	$(b-250)$

Carry out. First we rewrite the model in slope-intercept form.

$$\begin{aligned} C(b) &= 250+\frac{1}{5}(b-250) \\ &= 250+\frac{1}{5}b-50 \\ &= \frac{1}{5}b+200 \end{aligned}$$

The vertical intercept is (0, 200) and the slope is $\frac{1}{5}$. We plot (0, 200) and, from there, to up 1 unit and right 5 units to (5, 201). Draw a line through both points.



First we will find the value of b for which $C(b)=520$. Then we will subtract 250 to find by how much Gerry's bill exceeded \$250. We find the solution of $\frac{1}{5}b+200=520$. We graph y = 520 and find the point of intersection of the graphs. This point appears to be (1600, 520). Thus, Gerry's total hospital bill was \$1600 and it exceeded \$250 by \$1600 – \$250, or \$1350.

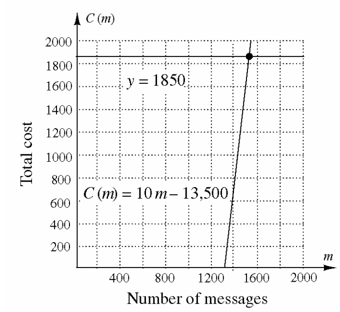
Check. We evaluate.

$C(1600)=\frac{1}{5}(1600)+200=320+200=520$

The estimate is precise.

State. Gerry's hospital bill exceeded \$250 by \$1350.

68. Let m = the number of text messages and $C(m)=$ the total cost. Graph $C(m)=10m-13{,}500$ and y = 1850 (expressing all costs in cents).



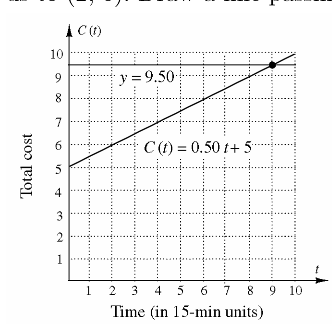
The graphs appear to intersect at about (1535, 1850). Whitney's messages exceed 1500 by 35 messages.

69. ***Familiarize.*** After an initial \$5.00 parking fee, an additional 50¢ fee is changed for each 15-min unit of time. After one 15-min unit of time, the cost is \$5.00 + \$0.50, or \$5.50. After two 15-min units, or 30 min, the cost is \$5.00 + 2(\$0.50), or \$6.00. We can generalize this with a model if we let $C(t)$ represent the total cost, in dollars, for t 15-min units of time.

Translate. We reword the problem and translate.

Total Cost	is	initial cost	plus	\$0.50 per 15-min time unit.
↓	↓	↓	↓	↓
$C(t)$	$=$	5.00	$+$	$0.50t$

Carry out. First write the model in slope-intercept form: $C(t)=0.50t+5$. The vertical intercept is (0, 5) and the slope, or rate, is 0.50, or $\frac{1}{2}$. Plot (0, 5) and from there go up \$1, and to the right 2 15-min units of time. This takes us to (2, 6). Draw a line passing through both points.



To estimate how long someone can park for \$9.50, we are estimating the solution of $0.50t+5=9.50$. We do this by graphing y = 9.50 and finding the point of intersection of the graphs. The point appears to be (9, 9.50). Thus, we estimate that someone can park for nine 15-min units of time, or 2 hr, 15 min, for \$9.50.

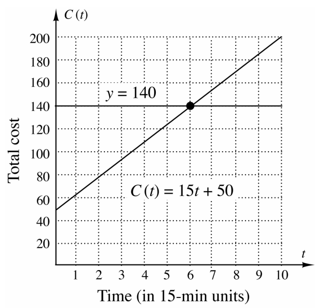
Check. We evaluate.

$$C(9) = 0.50(9) + 5$$
$$= 4.50 + 5$$
$$= 9.50$$

The estimate is precise.

State. Someone can park for 2 hr 15 min for \$9.50.

70. Let $t =$ the number of 15-min units of time and $C(t) =$ the total cost of a road call. Graph $C(t) = 15t + 50$ and $y = 140$.



The graphs appear to intersect at $(6, 140)$. The number 6 checks, so the time required for a \$140 road call is six 15-min units of time, or $1\frac{1}{2}$ hr.

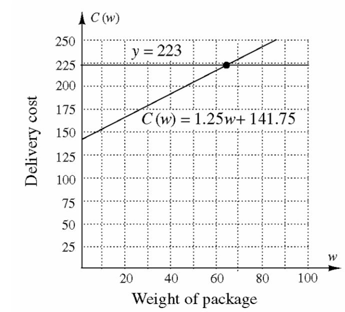
71. ***Familiarize***. In addition to a charge of \$173, FedEx charges \$1.25 per pound in excess of 25 lb. It costs $\$173 + \$1.25(30 - 25)$, or \$179.25 to ship a 30-lb package. It costs $\$173 + \$1.25(50 - 25)$, or \$204.25 to ship a 50-lb package. We can generalize this with a model if we let $C(w)$ represent the cost of shipping a package weighing w lb, where $26 \le w \le 70$.

Translate. We reword the problem and translate.

Shipping Cost	is	\$173 charge	plus	\$1.25 per pound over 25 lbs.
↓	↓	↓	↓	↓
$C(w)$	$=$	173	$+$	$1.25(w-25)$

Carry out. First write the model in slope-intercept form: $C(w) = 1.25w + 141.75$.

The vertical intercept is (0, 141.75) and the slope is 1.25, or $\frac{125}{100}$ or $\frac{5}{4}$. Plot (0, 141.75) and from there to up 5 units and to the right 4 units to (4, 146.75). Draw a line passing through both points.



To estimate the weight of a package that costs \$223 to ship, we are estimating the solution of $1.25w + 141.75 = 223$. We do this by graphing $y = 223$ and finding the point of intersection of the graphs. The point appears to be (65, 223). Thus, we estimate that a package that costs \$223 to ship, weighs 65 lbs.

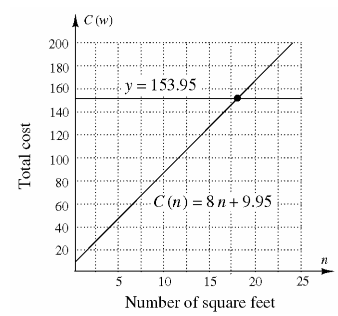
Check. We evaluate.

$$C(65) = 1.25(65) + 141.75$$
$$= 81.25 + 141.75$$
$$= 223$$

The estimate is precise.

State. A package that costs \$223 to ship weighs 65 lbs.

72. Let $n =$ the number of square feet and $C(n) =$ the total cost. Graph $C(n) = 8n + 9.95$ and $y = 153.95$.



The graphs appear to intersect at $(18, 153.95)$. The number of square feet is 18, so the area of the banner is 18 ft^2.

73. $5x - 3y = 15$

This equation is in the standard form for a linear equation, $Ax + By = C$, with $A = 5$, $B = -3$, and $C = 15$. Thus, it is a linear equation.

Solve for y to find the slope.

$$5x - 3y = 15$$
$$-3y = -5x + 15$$
$$y = \frac{5}{3}x - 5$$

The slope is $\frac{5}{3}$.

74. $3x+5y+15=0$
$3x+5y=-15$

The equation is linear.

Solve for y to find the slope.

$$3x+5y=-15$$
$$5y=-3x-15$$
$$y=-\frac{3}{5}x-3$$

The slope is $-\frac{3}{5}$.

75. $8x+40=0$
$8x=-40$
$x=-5$

The equation is linear. Its graph is a vertical line.

76. $2y-30=0$
$2y=30$
$y=15$

This is a horizontal line, so the slope is 0.

77. $4g(x)=6x^2$

Replace $g(x)$ with y and attempt to write the equation in standard form.

$$4y=6x^2$$
$$-6x^2+4y=0$$

The equation is not linear, because it has an x^2-term.

78. $2x+4f(x)=8$
$2x+4y=8$ Replacing $f(x)$ with y

The equation is linear.

Solve for y to find the slope.

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

The slope is $-\frac{1}{2}$.

79. $3y=7(2x-4)$
$3y=14x-28$
$-14x+3y=-28$

The equation can be written in the standard form for a linear equation, $Ax+By=C$, with $A=-14$, $B=3$, and $C=-28$. Thus, it is a linear equation. Solve for y to find the slope.

$$-14x+3y=-28$$
$$3y=14x-28$$
$$y=\frac{14}{3}x-\frac{28}{3}$$

The slope is $\frac{14}{3}$.

80. $y(3-x)=2$
$3y-xy=2$

The equation is not linear, because it has an xy-term.

81. $f(x)-\frac{5}{x}=0$

Replace $f(x)$ with y and attempt to write the equation in standard form.

$$y-\frac{5}{x}=0$$
$$xy-5=0 \quad \text{Multiplying by } x$$
$$xy=5$$

The equation is not linear because it has an xy-term.

82. $g(x)-x^3=0$
$y-x^3=0$ Replacing $g(x)$ with y

The equation is not linear, because it has an x^3-term.

83. $\frac{y}{3}=x$
$y=3x$
$3x-y=0$

The equation can be written in standard form for the linear equation $Ax+By=C$, with $A=3$, $B=-1$, and $C=0$. Thus, it is a linear equation. Solve for y to find the slope.

$$y=3x$$

The slope is 3.

84. $\frac{1}{2}(x-4)=y$
$\frac{1}{2}x-2=y$
$\frac{1}{2}x-y=2$

The equation is linear.

Solve for y to find the slope.

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

The slope is $\frac{1}{2}$.

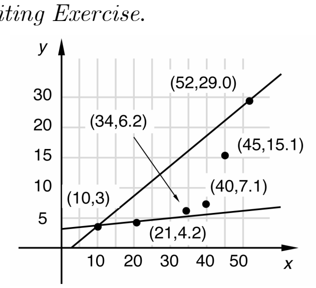
85. $xy=10$

The equation is not linear, because it has an xy-term.

86. $y=\frac{10}{x}$
$xy=10$ Multiplying by x

The equation is not linear, because it has an xy-term.

87. *Writing Exercise.*



The lines obtained by connecting different pairs of points vary greatly. For example, the line obtained by connecting (10, 3) and (21, 4.2) is quite different from the line obtained by connecting (10, 3) and (52, 29.0). There is no line that can be drawn close to all of the points plotted. Therefore, a linear function does not give a good fit.

88. *Writing Exercise.* For each 5 temperature decrease, the corresponding decrease in wind chill temperature is about 6 or 7. Thus, the slope is nearly constant, so a linear function will give an approximate fit.

89. $-\frac{3}{10}\left(\frac{10}{3}\right)=-\frac{30}{30}=-1$

90. $2\left(-\frac{1}{2}\right)=-\frac{2}{2}=-1$

91. $-3[x-(-1)]=-3[x+1]=-3x-3$

92. $-10[x-(-7)]=-10[x+7]=-10x-70$

93. $\frac{2}{3}\left[x-\left(-\frac{1}{2}\right)\right]-1=\frac{2}{3}\left[x+\frac{1}{2}\right]-1=\frac{2}{3}x+\frac{1}{3}-1=\frac{2}{3}x-\frac{2}{3}$

94. $-\frac{3}{2}\left(x-\frac{2}{5}\right)-3=-\frac{3}{2}x+\frac{3}{5}-3=-\frac{3}{2}x-\frac{12}{5}$

95. *Writing Exercise.* Consider the equation $Ax+By=C$. Writing this equation in slope-intercept form we have $y=-\frac{A}{B}x+\frac{C}{B}$. If we choose a value for x for which $-Ax+C$ is not a multiple of B, the corresponding y-value will be a fraction. Similarly, if $-Ax$ is a multiple of B but C is not then the corresponding y-value will be a fraction. Under these conditions, Jim will avoid fractions if he graphs using intercepts.

96. *Writing Exercise.* A line's x- and y-intercepts coincide only when the line passes through the origin. The equation for such a line is of the form $y=mx$.

97. The line contains the points (5, 0) and (0,−4). We use the points to find the slope.

$\text{Slope}=\frac{-4-0}{0-5}=\frac{-4}{-5}=\frac{4}{5}$

Then the slope-intercept equation is $y=\frac{4}{5}x-4$. We rewrite this equation in standard form.

$$y=\frac{4}{5}x-4$$
$$5y=4x-20 \quad \text{Multiplying by 5 on both sides}$$
$$-4x+5y=-20 \quad \text{Standard form}$$

This equation can also be written as $4x-5y=20$.

98. $y=mx+b \quad (m\neq 0)$

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

$$0=mx+b$$
$$-b=mx$$
$$-\frac{b}{m}=x$$

Thus, the x-intercept is $\left(-\frac{b}{m},\ 0\right)$.

99. $rx+3y=p^2-s$

The equation is in standard form with $A=r$, $B=3$, and $C=p^2-s$. It is linear.

100.
$$py=sx-r^2y-9$$
$$-sx+py+r^2y=-9$$
$$-sx+\left(p+r^2\right)y=-9 \quad \text{Standard form}$$

The equation is linear.

101. Try to put the equation in standard form.

$$r^2x=py+5$$
$$r^2x-py=5$$

The equation is in standard form with $A=r^2$, $B=-p$, and $C=5$. It is linear.

102. $\frac{x}{r}-py=17$

The equation is in standard form with $A=\frac{1}{r}$, $B=-p$, and $C=17$. It is linear.

103. Let equation A have intercepts $(a,\ 0)$ and $(0,\ b)$. Then equation B has intercepts $(2a,\ 0)$ and $(0,\ b)$.

Slope of $A=\frac{b-0}{0-a}=-\frac{b}{a}$

Slope of $B=\frac{b-0}{0-2a}=-\frac{b}{2a}=\frac{1}{2}\left(-\frac{b}{a}\right)$

The slope of equation B is $\frac{1}{2}$ the slope of equation A.

104.
$$ax+3y=5x-by+8$$
$$(a-5)x+(3+b)y=8$$

If the graph is a horizontal line, then the coefficient of x is 0.

$$a-5=0$$
$$a=5$$

Then we have $(3+b)y=8$.

If the graph passes through (0, 4), we have:

$$(3+b)4=8$$
$$3+b=2$$
$$b=-1.$$

105. First write the equation in standard form.

$$ax+3y=5x-by+8$$
$$ax-5x+3y+by=8 \quad \text{Adding } -5x+by \text{ on both sides}$$
$$(a-5)x+(3+b)y = 8 \quad \text{Factoring}$$

If the graph is a vertical line, then the coefficient of y is 0.

$$3+b=0$$
$$b=-3$$

Then we have $(a-5)x=8$.

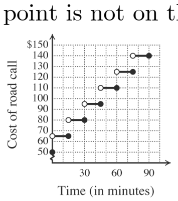
If the line passes through $(4, 0)$, we have:

$$(a-5)4=8 \quad \text{Substituting 4 for } x$$
$$a-5=2$$
$$a=7$$

106. We graph $C(t)=15t+50$, where t represents the number of 15-min units of time, as a series of steps. The cost is constant within each 15-min unit of time. Thus,

for $0<t\le 1$, $C(t)=15\cdot 1+50=65$;
for $1<t\le 2$, $C(t)=15\cdot 2+50=80$;
for $2<t\le 3$, $C(t)=15\cdot 3+50=95$;

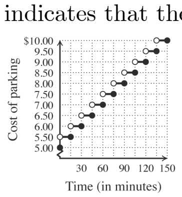
and so on. An open circle at a point indicates that the point is not on the graph.



107. We graph $C(t)=0.50t+3$, where t represents the number of 15-min units of time, as a series of steps. The cost is constant within each 15-min unit of time. Thus,

for $0<t\le 1$, $C(t)=0.5(1)+3=\$3.50$;
for $1<t\le 2$, $C(t)=0.5(2)+3=\$4.00$;
for $2<t\le 3$, $C(t)=0.5(3)+3=\$4.50$;

and so on. We draw the graph. An open circle at a point indicates that the point is not on the graph.



108. Graph $y_1=5x+3$ and $y_2=7-2x$ in the same window and use the Intersect feature to find the first coordinate of the point of intersection, 0.57142857.

We check by solving the equation algebraically.

$$5x+3=7-2x$$
$$7x=4$$
$$x=\frac{4}{7}=0.\overline{571428}\approx 0.57142857$$

109. Graph $y_1=4x-1$ and $y_2=3-2x$ in the same window and use the Intersect feature to find the first coordinate of the point of intersection, 0.66666667.

We check by solving the equation algebraically.

$$4x-1=3-2x$$
$$6x-1=3$$
$$6x=4$$
$$x=\frac{2}{3}=0.\overline{6}\approx 0.66666667$$

110. Graph $y_1=3x-2$ and $y_2=5x-9$ in the same window and use the Intersect feature to find the first coordinate of the point of intersection, 3.5.

We check by solving the equation algebraically.

$$3x-2=5x-9$$
$$-2x=-7$$
$$x=3.5$$

111. Graph $y_1=8-7x$ and $y_2=-2x-5$ in the same window and use the Intersect feature to find the first coordinate of the point of intersection, 2.6.

We check by solving the equation algebraically.

$$8-7x=-2x-5$$
$$8-5x=-5$$
$$-5x=-13$$
$$x=2.6$$

112. Graph $y = 250 + 0.035x$. Use the Intersect feature to find the x-coordinate that corresponds to the y-coordinate 401.03. We find that the sales total was about $4315.14.

113. Graph $y = 38 + 4.25x$. Use the Intersect feature to find the x-coordinate that corresponds to the y-coordinate 671.25. We find that 149 shirts were printed.

Exercise Set 2.5

1. False; see page 119 in the text.

2. True; see page 119 in the text.

3. False; given just one point, there is an infinite number of lines that can be drawn through it.

4. True; see Example 1 in the text.

5. True; see Example 2 in the text.

6. False; see page 122 in the text.

7. False; see page 122 in the text.

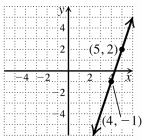
8. True; see page 121 in the text.

9. True; see page 122 in the text.

10. True.

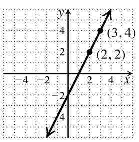
11. $y-y_1=m(x-x_1)$ Point-slope equation
$y-2=3(x-5)$ Substituting 3 for m, 5 for x_1, and 2 for y_1

To graph the equation, we count off a slope of $\frac{3}{1}$, starting at $(5,\ 2)$, and draw the line.



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

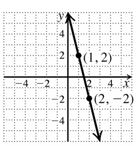
12. $y-4=2(x-3)$



$y-4=2(x-3)$

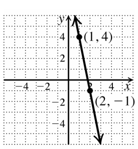
13. $y-y_1=m(x-x_1)$ Point-slope equation
$y-2=-4(x-1)$ Substituting -4 for m, 1 for x_1, and 2 for y_1

To graph the equation, we count off a slope of $-\frac{4}{1}$, starting at (1, 2), and draw the line.



$y-2=-4(x-1)$

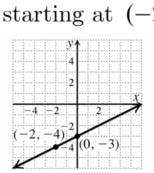
14. $y-4=-5(x-1)$



$y-4=-5(x-1)$

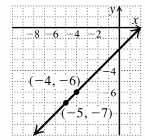
15. $y-y_1=m(x-x_1)$ Point-slope equation
$y-(-4)=\frac{1}{2}[x-(-2)]$ Substituting $\frac{1}{2}$ for m, -2 for x_1, and -4 for y_1

To graph the equation, we count off a slope of $\frac{1}{2}$, starting at $(-2,\ -4)$, and draw the line.



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

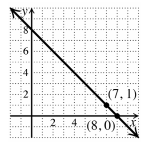
16. $y-(-7)=1\cdot[x-(-5)]$, or $y-(-7)=x-(-5)$



$y-(-7)=x-(-5)$, or $y+7=x+5$

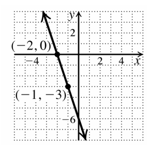
17. $y-y_1=m(x-x_1)$ Point-slope equation
$y-0=-1(x-8)$ Substituting -1 for m, 8 for x_1, and 0 for y_1

To graph the equation, we count off a slope of $\frac{-1}{1}$, starting at (8, 0), and draw the line.



$y-0=-1(x-8)$, or $y=-(x-8)$

18. $y-0=-3[x-(-2)]$



$y-0=-3(x-(-2))$, or $y=-3(x+2)$

19. $y-3=\frac{1}{4}(x-5)$
$y-y_1=m(x-x_1)$
$m=\frac{1}{4},\ x_1=5,\ y_1=3$, so the slope is $\frac{1}{4}$ and a point $(x_1,\ y_1)$ on the graph is (5, 3).

20. $y-5=6(x-1)$
Slope: 6; a point on the graph: (1, 5)

21. $y+1=-7(x-2)$
$y-(-1)=-7(x-2)$
$y-y_1=m(x-x_1)$
$m=-7,\ x_1=2,\ y_1=-1$, so the slope is –7 and a point $(x_1,\ y_1)$ on the graph is (2, –1).

22. $y-4=-\frac{2}{3}(x+8)$
$y-4=-\frac{2}{3}(x-(-8))$
Slope: $-\frac{2}{3}$; a point on the graph: (–8, 4)

23. $y-6=-\frac{10}{3}(x+4)$

$y-6=-\frac{10}{3}(x-(-4))$

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

$m=-\frac{10}{3},\ x_1=-4,\ y_1=6,$ so the slope is $-\frac{10}{3}$ and a point $(x_1,\ y_1)$ on the graph is (–4, 6).

24. $y+1=-9(x-7)$

$y-(-1)=-9(x-7)$

Slope: –9; a point on the graph: (7, –1)

25. $y=5x$

$y-0=5(x-0)$

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

$m=5,\ x_1=0,\ y_1=0,$ so the slope is 5 and a point $(x_1,\ y_1)$ on the graph is (0, 0).

26. $y=\frac{4}{5}x$

$y-0=\frac{4}{5}(x-0)$

Slope: $\frac{4}{5}$; a point on the graph: (0, 0)

27. $y-y_1=m(x-x_1)$ Point-slope equation

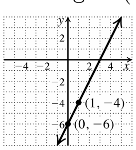
$y-(-4)=2(x-1)$ Substituting 2 for m, 1 for x_1, and -4 for y_1

$y+4=2x-2$ Simplifying

$y=2x-6$ Subtracting 4 from both sides

$f(x)=2x-6$ Using function notation

To graph the equation, we count off a slope of $\frac{2}{1}$, starting at (1, –4) or (0, –6), and draw the line.



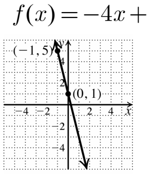
$f(x) = 2x - 6$

28. $y-5=-4[x-(-1)]$

$y-5=-4x-4$

$y=-4x+1$

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



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

29. $y-y_1=m(x-x_1)$ Point-slope equation

$y-8=-\frac{3}{5}[x-(-4)]$ Substituting $-\frac{3}{5}$ for m, -4 for x_1, and 8 for y_1

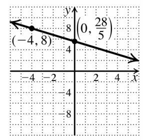
$y-8=-\frac{3}{5}(x+4)$

$y-8=-\frac{3}{5}x-\frac{12}{5}$ Simplifying

$y=-\frac{3}{5}x+\frac{28}{5}$ Adding 8 to both sides

$f(x)=-\frac{3}{5}x+\frac{28}{5}$ Using function notation

To graph the equation, we count off a slope of $\frac{-3}{5}$, starting at (–4, 8), and draw the line.



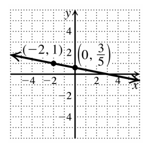
$f(x) = -\frac{3}{5}x + \frac{28}{5}$

30. $y-1=-\frac{1}{5}[x-(-2)]$

$y-1=-\frac{1}{5}(x+2)$

$y=-\frac{1}{5}x+\frac{3}{5}$

$f(x)=-\frac{1}{5}x+\frac{3}{5}$



$f(x) = -\frac{1}{5}x + \frac{3}{5}$

31. $y-y_1=m(x-x_1)$ Point-slope equation

$y-(-4)=-0.6[x-(-3)]$ Substituting -0.6 for m, -3 for x_1, and -4 for y_1

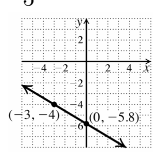
$y+4 = -0.6(x+3)$

$y+4 = -0.6x-1.8$

$y = -0.6x-5.8$

$f(x) = -0.6x-5.8$ Using function notation

To graph the equation, we count off a slope of -0.6, or $\frac{-3}{5}$, starting at (–3, –4), and draw the line.



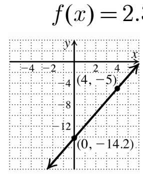
$f(x) = -0.6x - 5.8$

32. $y-(-5)=2.3(x-4)$

$y+5=2.3x-9.2$

$y=2.3x-14.2$

$f(x)=2.3x-14.2$

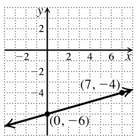


$f(x) = 2.3x - 14.2$

33. $m=\frac{2}{7}$; $(0,-6)$

Observe that the slope is $\frac{2}{7}$ and the y-intercept is $(0,-6)$. Thus, we have $f(x)=\frac{2}{7}x-6$.

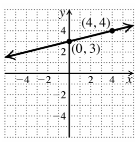
To graph the equation, we count off a slope of $\frac{2}{7}$, starting at $(0,-6)$, and draw the line.



$f(x)=\frac{2}{7}x-6$

34. $m=\frac{1}{4}$; $(0,3)$

Observe that the slope is $\frac{1}{4}$ and the y-intercept is $(0, 3)$. Thus, we have $f(x)=\frac{1}{4}x+3$.



$f(x)=\frac{1}{4}x+3$

35. $y-y_1=m(x-x_1)$ Point-slope equation

$y-6=\frac{3}{5}[x-(-4)]$ Substituting $\frac{3}{5}$ for m, -4 for x_1, and 6 for y_1

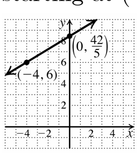
$y-6=\frac{3}{5}(x+4)$

$y-6=\frac{3}{5}x+\frac{12}{5}$

$y=\frac{3}{5}x+\frac{42}{5}$

$f(x)=\frac{3}{5}x+\frac{42}{5}$ Using function notation

To graph the equation, we count off a slope of $\frac{3}{5}$, starting at $(-4, 6)$, and draw the line.



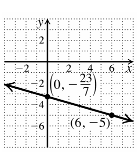
$f(x)=\frac{3}{5}x+\frac{42}{5}$

36. $y-(-5)=-\frac{2}{7}(x-6)$

$y+5=-\frac{2}{7}x+\frac{12}{7}$

$y=-\frac{2}{7}x-\frac{23}{7}$

$f(x)=-\frac{2}{7}x-\frac{23}{7}$



$f(x)=-\frac{2}{7}x-\frac{23}{7}$

37. First find the slope of the line:

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

Use the point-slope equation with $m = 4$ and $(2,\ 3)=(x_1,\ y_1)$. (We could let $(3,\ 7)=(x_1,\ y_1)$ instead to obtain an equivalent equation.)

$y-3=4(x-2)$

$y-3=4x-8$

$y=4x-5$

$f(x)=4x-5$ Using function notation

38. $m=\frac{8-4}{3-1}=\frac{4}{2}=2$

$y-8=2(x-3)$

$y-8=2x-6$

$y=2x+2$

$f(x)=2x+2$ Using function notation

39. First find the slope of the line:

$$m=\frac{5-(-4)}{3.2-1.2}=\frac{5+4}{2}=\frac{9}{2}=4.5$$

Use the point-slope equation with $m = 4.5$ and $(1.2,\ -4)=(x_1,\ y_1)$.

$y-(-4)=4.5(x-1.2)$

$y+4=4.5x-5.4$

$y=4.5x-9.4$

$f(x)=4.5x-9.4$ Using function notation

40. $m=\frac{8.5-(-2.5)}{4-(-1)}=\frac{11}{5}=2.2$

$y-8.5=2.2(x-4)$

$y-8.5=2.2x-8.8$

$y=2.2x-0.3$

$f(x)=2.2x-0.3$

41. First find the slope of the line:

$$m=\frac{-1-(-5)}{0-2}=\frac{-1+5}{0-2}=\frac{4}{-2}=-2$$

Use the point-slope equation with $m = -2$ and $(0,\ -1)=(x_1,\ y_1)$.

$y-(-1)=-2(x-0)$

$y+1=-2x$

$y=-2x-1$

$f(x)=-2x-1$ Using function notation

42. $m=\frac{-7-0}{0-(-2)}=\frac{-7}{2}$

$y-(-7)=-\frac{7}{2}(x-0)$

$y+7=-\frac{7}{2}x$

$y=-\frac{7}{2}x-7$

$f(x)=-\frac{7}{2}x-7$

43. First find the slope of the line:

$$m=\frac{-5-(-10)}{-3-(-6)}=\frac{-5+10}{-3+6}=\frac{5}{3}$$

Use the point-slope equation with $m=\frac{5}{3}$ and $(-3,\ -5)=(x_1,\ y_1)$.

$$y-(-5)=\frac{5}{3}(x-(-3))$$
$$y+5=\frac{5}{3}(x+3)$$
$$y+5=\frac{5}{3}x+5$$
$$y=\frac{5}{3}x$$
$$f(x)=\frac{5}{3}x \quad \text{Using function notation}$$

44. $m=\frac{-9-(-3)}{-4-(-1)}=\frac{-9+3}{-4+1}=\frac{-6}{-3}=2$

$$y-(-3)=2(x-(-1))$$
$$y+3=2(x+1)$$
$$y+3=2x+2$$
$$y=2x-1$$
$$f(x)=2x-1$$

45. a) Let t represent the number of years after 2000. We form the pairs (2, 14.5) and (7, 19). First we find the slope of the function that fits the data:

$$m=\frac{19-14.5}{7-2}=\frac{4.5}{5}=0.9.$$

Use the point-slope equation with m = 0.9 and $(7,\ 19)=(t_1,\ a_1)$.

$$a-19=0.9(t-7)$$
$$a-19=0.9t-6.3$$
$$a=0.9t+12.7$$
$$a(t)=0.9t+12.7$$

b) In 2013, t = 2013 – 2000 = 13

$$a(13)=0.9(13)+12.7=24.4 \text{ million cars}$$

c) We substitute 25 for $a(t)$ and solve for t.

$$25=0.9t+12.7$$
$$12.3=0.9t$$
$$13.\overline{6}=t \quad \text{or about 14}$$

There will be 25 million cars produced approximately 14 yrs after 2000 or 2014.

46. a) We have the pairs (2, 4.6) and (6, 6.1).

$$m=\frac{6.1-4.6}{6-2}=\frac{1.5}{4}=0.375$$
$$C-4.6=0.375(t-2)$$
$$C=0.375t+3.85$$
$$C(t)=0.375t+3.85$$

b) $C(11)=0.375t+3.85=7.975$ million attendees

c) Solve: $8=0.375t+3.85$.

$t\approx 11$, so the number of attendees will be 8 million about 11 years after 2000, or in 2011.

47. a) Let t represent the number of years since 1990, and form the pairs (4, 79.0) and (14, 80.4). First we find the slope of the function that fits the data:

$$m=\frac{80.4-79.0}{14-4}=\frac{1.4}{10}=0.14.$$

Use the point-slope equation with m = 0.14 and $(4,\ 79.0)=(t_1,\ E_1)$.

$$E-79.0=0.14(t-4)$$
$$E-79.0=0.14t-0.56$$
$$E=0.14t+78.44$$
$$E(t)=0.14t+78.44$$

b) In 2012, t = 2012 – 1990 = 22

$$E(22)=0.14(22)+78.44=81.52$$

The life expectancy of females in 2012 is 81.52 yrs.

48. a) We have the pairs (4, 72.4) and (14, 75.2).

$$m=\frac{75.2-72.4}{14-4}=\frac{2.8}{10}=0.28$$
$$E-72.4=0.28(t-4)$$
$$E=0.28t+71.28$$
$$E(t)=0.28t+71.28$$

b) $E(22)=0.28(22)+71.28=77.44$ yrs

49. a) Let t represent the number of years since 2000, and form the pairs (2, 282) and (6, 372.1). First we find the slope of the function that fits the data:

$$m=\frac{372.1-282}{6-2}=\frac{90.1}{4}=22.525.$$

Use the point-slope equation with m = 22.525 and $(2,\ 282)=(t_1,\ A_1)$.

$$A-282=22.525(t-2)$$
$$A-282=22.525t-45.05$$
$$A=22.525t+236.95$$
$$A(t)=22.525t+236.95$$

b) In 2010, t = 2010 – 2000 = 10

$$A(10)=22.525(10)+236.95=462.2$$

In 2010, the PAC contributions will be approximately \$462.2 million.

50. a) $m=\frac{4.0-6.5}{9-8}=-2.5$

$$A-4=-2.5(p-9)$$
$$A(p)=-2.5p+26.5$$

b) $A(6)=-2.5(6)+26.5=11.5$ million lb

51. a) Let t represent the number of years since 2000, and form the pairs (0, 52.7) and (5, 58.4). First we find the slope of the function that fits the data:

$$m=\frac{58.4-52.7}{5-0}=\frac{5.7}{5}=1.14.$$

We know the y-intercept is (0, 52.7), so we write a function in slope-intercept form.

$N(t)=1.14t+52.7$

b) In 2012, t = 2012 – 2000 = 12

$N(12)=1.14(12)+52.7=66.38$

In 2012, approximately 66.38 million tons will be recycled.

52. a) $m=\dfrac{7.0-5.0}{9-8}=2$

$A-5.0=2(p-8)$
$A(p)=2p-11$

b) $A(6)=2\cdot 6-11=1$ million lb

53. a) Let t represent the number of years since 2000, and form the pairs (0, 16) and (5, 63). First we find the slope of the function that fits the data:

$m=\dfrac{63-16}{5-0}=\dfrac{47}{5}=9.4.$

We know the y-intercept is (0, 16), so we write a function in slope-intercept form.

$N(t)=9.4t+16$

b) In 2010, t = 2010 – 2000 = 10

$N(10)=9.4(10)+16=110$

In 2010, 110 million Americans will use online banking.

c) We substitute 157 for $N(t)$ and solve for t.

$157=9.4t+16$
$141=9.4t$
$15=t$

There will be 157 million Americans using online banking 15 years after 2000, or 2015.

54. a) We have the pairs (0, 9.79) and (8, 9.77).

$m=\dfrac{9.77-9.79}{8-0}=\dfrac{-0.02}{8}=-0.0025$

$R(t)=-0.0025t+9.79$

b) $R(16)=-0.0025(16)+9.79=9.75$ sec
$R(31)=-0.0025(31)+9.79=9.71$ sec

c) Solve: $9.6=-0.0025t+9.79$.

$t=76,$ so the record will be 9.6 sec about 76 yrs after 1999, or in 2075.

55. a) Let t represent the number of years after 1990, and form the pairs (4, 74.9) and (15, 79). First we find the slope of the function that fits the data:

$m=\dfrac{79-74.9}{15-4}=\dfrac{4.1}{11}=\dfrac{41}{110}.$

Use the point-slope equation with $m=\dfrac{41}{110}$ and $(4,\ 74.9)=(t_1,\ A_1)$.

$A-74.9=\dfrac{41}{110}(t-4)$
$A-74.9=\dfrac{41}{110}t-\dfrac{82}{55}$
$A(t)=\dfrac{41}{110}t+\dfrac{1615}{22}$

b) In 2010, t = 2010 – 1990 = 20

$A(20)=\dfrac{41}{110}(20)+\dfrac{1615}{22}\approx 80.9$ million acres

In 2010, the amount of land in the National Park system will be approximately 80.9 million acres.

56. a) $m=\dfrac{7-4}{200-100}=0.03$

$P-4=0.03(d-100)$
$P(d)=0.03d+1$

b) $P(690)=0.03(690)+1=21.7$ atm

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

$x+2=y$
$y=x+2$ Reversing the order

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

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

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

The slopes are the same; the lines are parallel.

58. Write both equations in slope-intercept form.

$y=2x-1$ $(m=2)$
$y=2x+\dfrac{7}{2}$ $(m=2)$

The slopes are the same, so the lines are parallel.

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

$y+9=3x$
$y=3x-9$

The slope of $y=3x-9$ is 3.

$3x-y=-2$
$3x+2=y$
$y=3x+2$ Reversing the order

The slope of $y=3x+2$ is 3.

The slopes are the same; the lines are parallel.

60. Write both equations in slope-intercept form.

$y=-6x-8$ $(m=-6)$
$y=2x+5$ $(m=2)$

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

61. We determine the slope of each line.

The slope of $f(x)=3x+9$ is 3.

$2y=8x-2$
$y=4x-1$

The slope of $y=4x-1$ is 4.

The slopes are not the same; the lines are not parallel.

62. Write both equations in slope-intercept form.

$f(x)=-7x-9 \qquad (m=-7)$

$f(x)=-7x-\frac{7}{3} \qquad (m=-7)$

The slopes are the same, so the lines are parallel.

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

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

The slope of the given line is $\frac{1}{2}$.

The slope of every line parallel to the given line must also be $\frac{1}{2}$. We find the equation of the line with slope $\frac{1}{2}$ and containing the point (2, 5).

$$\begin{aligned} y-y_1&=m(x-x_1) && \text{Point-slope equation}\\ y-5&=\frac{1}{2}(x-2) && \text{Substituting}\\ y-5&=\frac{1}{2}x-1\\ y&=\frac{1}{2}x+4 \end{aligned}$$

64.
$$\begin{aligned} 3x+y&=5 && \text{Given line}\\ y&=-3x+5 && m=-3\\ y-4&=-3(x-1)\\ y&=-3x+7 \end{aligned}$$

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

$$\begin{aligned} x+y&=7 && \text{Given line}\\ y&=-x+7 \end{aligned}$$

The slope of the given line is –1.

The slope of every line parallel to the given line must also be –1. We find the equation of the line with slope –1 and containing the point (–3, 2).

$$\begin{aligned} y-y_1&=m(x-x_1) && \text{Point-slope equation}\\ y-2&=-1(x-(-3)) && \text{Substituting}\\ y-2&=-1(x+3)\\ y-2&=-x-3\\ y&=-x-1 \end{aligned}$$

66.
$$\begin{aligned} x-5y&=1 && \text{Given line}\\ y&=\frac{1}{5}x-\frac{1}{5} && m=\frac{1}{5}\\ y-(-6)&=\frac{1}{5}(x-(-1))\\ y+6&=\frac{1}{5}(x+1)\\ y&=\frac{1}{5}x-\frac{29}{5} \end{aligned}$$

67. The slope of $y = 4x + 3$ is 4. The given point (0, –5) is the y-intercept, so we substitute in the slope-intercept equation.

$y = 4x - 5$.

68. The slope of $y = x - 11$ is 1. The given point (0, 2) is the y-intercept, so we have $y = x + 2$.

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

$$\begin{aligned} 2x+3y&=-7 && \text{Given line}\\ 3y&=-2x-7\\ y&=-\frac{2}{3}x-\frac{7}{3} \end{aligned}$$

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

The slope of every line parallel to the given line must also be $-\frac{2}{3}$. We find the equation of the line with slope $-\frac{2}{3}$ and containing the point $(-2,\ -3)$.

$$\begin{aligned} y-y_1&=m(x-x_1) && \text{Point-slope equation}\\ y-(-3)&=-\frac{2}{3}[x-(-2)] && \text{Substituting}\\ y+3&=-\frac{2}{3}(x+2)\\ y+3&=-\frac{2}{3}x-\frac{4}{3}\\ y&=-\frac{2}{3}x-\frac{13}{3} \end{aligned}$$

70.
$$\begin{aligned} 5x-6y&=4 && \text{Given line}\\ y&=\frac{5}{6}x-\frac{2}{3} && m=\frac{5}{6}\\ y-(-4)&=\frac{5}{6}(x-3)\\ y+4&=\frac{5}{6}x-\frac{5}{2}\\ y&=\frac{5}{6}x-\frac{13}{2} \end{aligned}$$

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

$$\begin{aligned} 3x-9y&=2 && \text{Given line}\\ 3x-2&=9y\\ \frac{1}{3}x-\frac{2}{9}&=y \end{aligned}$$

The slope of the given line is $\frac{1}{3}$.

The slope of every line parallel to the given line must also be $\frac{1}{3}$. We find the equation of the line with slope $\frac{1}{3}$ and containing the point $(-6,\ 2)$.

$$\begin{aligned} y-y_1&=m(x-x_1) && \text{Point-slope equation}\\ y-2&=\frac{1}{3}[x-(-6)] && \text{Substituting}\\ y-2&=\frac{1}{3}(x+6)\\ y-2&=\frac{1}{3}x+2\\ y&=\frac{1}{3}x+4 \end{aligned}$$

72. $5x+2y=6$ Given line

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

$y-0=-\frac{5}{2}[x-(-7)]$

$y=-\frac{5}{2}x-\frac{35}{2}$

73. $x=2$ is a vertical line. A line parallel to it that passes through $(5,-4)$ is the vertical line 5 units to the right of the y-axis, or $x=5$.

74. $y=7$ is a horizontal line. A line parallel to it that passes through (–3, 6) is a horizontal line 6 units above the x-axis, or $y=6$.

75. We determine the slope of each line.

$x-2y=3$

$-2y=-x+3$

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

The slope of $x-2y=3$ is $\frac{1}{2}$.

$4x+2y=1$

$2y=-4x+1$

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

The slope of $4x+2y=1$ is –2.

The product of their slopes is $\left(\frac{1}{2}\right)(-2)$, or –1; the lines are perpendicular.

76. 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.

77. We determine the slope of each line.

The slope of $f(x)=3x+1$ is 3.

$6x+2y=5$

$2y=-6x+5$

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

The slope of $6x+2y=5$ is –3.

The product of their slopes is 3(–3), or $-9\neq-1$, so the lines are not perpendicular.

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

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

$-1\cdot1=-1$, so the lines are perpendicular.

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

$2x-3y=4$ Given line

$-3y=-2x+4$

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

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

The slope of perpendicular line is given by the opposite of the reciprocal of $\frac{2}{3}$, $-\frac{3}{2}$. We find the equation of the line with slope $-\frac{3}{2}$ and containing the point (3, 1).

$y-y_1=m(x-x_1)$ Point-slope equation

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

$y-1=-\frac{3}{2}x+\frac{9}{2}$

$y=-\frac{3}{2}x+\frac{11}{2}$

80. $5x+4y=1$ Given line

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

$y-0=\frac{4}{5}(x-6)$

$y=\frac{4}{5}x-\frac{24}{5}$

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

$x+y=6$ Given line

$y=-x+6$

The slope of the given line is –1.

The slope of perpendicular line is given by the opposite of the reciprocal of –1, 1. We find the equation of the line with slope 1 and containing the point (–4, 2).

$y-y_1=m(x-x_1)$ Point-slope equation

$y-2=1(x-(-4))$ Substituting

$y-2=x+4$

$y=x+6$

82. $x-2y=3$ Given line

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

$y-(-5)=-2[x-(-2)]$

$y+5=-2x-4$

$y=-2x-9$

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

$3x-y=2$ Given line

$-y=-3x+2$

$y=3x-2$

The slope of the given line is 3.

The slope of perpendicular line is given by the opposite of the reciprocal of 3, $-\frac{1}{3}$. We find the equation of the line with slope $-\frac{1}{3}$ and containing the point (1, –3).

$$y-y_1=m(x-x_1) \quad \text{Point-slope equation}$$
$$y-(-3)=-\frac{1}{3}(x-1) \quad \text{Substituting}$$
$$y+3=-\frac{1}{3}x+\frac{1}{3}$$
$$y=-\frac{1}{3}x-\frac{8}{3}$$

84. $4x-y=3$ Given line
$$y=4x-3 \quad m=4$$
$$y-6=-\frac{1}{4}[x-(-5)]$$
$$y-6=-\frac{1}{4}x-\frac{5}{4}$$
$$y=-\frac{1}{4}x+\frac{19}{4}$$

85. First solve the equation for y and find the slope of the given line.
$$3x-5y=6$$
$$-5y=-3x+6$$
$$y=\frac{3}{5}x-\frac{6}{5}$$
The slope of the given line is $\frac{3}{5}$. The slope of a perpendicular line is given by the opposite of the reciprocal of $\frac{3}{5}$, $-\frac{5}{3}$.

We find the equation of the line with slope $-\frac{5}{3}$ and containing the point $(-4,-7)$.
$$y-y_1=m(x-x_1) \quad \text{Point-slope equation}$$
$$y-(-7)=-\frac{5}{3}[x-(-4)] \quad \text{Substituting}$$
$$y+7=-\frac{5}{3}(x+4)$$
$$y+7=-\frac{5}{3}x-\frac{20}{3}$$
$$y=-\frac{5}{3}x-\frac{41}{3}$$

86. $7x-2y=1$ Given line
$$y=\frac{7}{2}x-\frac{1}{2} \quad m=\frac{7}{2}$$
$$y-5=-\frac{2}{7}[x-(-4)]$$
$$y-5=-\frac{2}{7}x-\frac{8}{7}$$
$$y=-\frac{2}{7}x+\frac{27}{7}$$

87. The slope of a line perpendicular to $2x-5=y$ is $-\frac{1}{2}$ and we are given the y-intercept of the desired line, (0, 6). Then we have $y=-\frac{1}{2}x+6$.

88. The slope of a line perpendicular to $4x+3=y$ is $-\frac{1}{4}$ and we are given the y-intercept of the desired line, $(0,-7)$. Then we have $y=-\frac{1}{4}x-7$.

89. $y=5$ is a horizontal line, so a line perpendicular to it must be vertical. The equation of the vertical line containing (–3, 7) is $x=-3$.

90. $x=1$ is a vertical line, so a line perpendicular to it must be horizontal. The equation of the horizontal line containing $(4,-2)$ is $y=-2$.

91. *Writing Exercise.* First the slope formula would be used to determine the slope. Then using the slope-intercept formula, the slope and y-intercept are substituted. The result is the equation of the line in slope-intercept form.

92. *Writing Exercise.* If one line is vertical and another is horizontal, they are perpendicular but, since the slope of the vertical is undefined, we cannot say that the lines have slopes that are negative reciprocals of each other. Otherwise, we can.

93.
$$\begin{aligned}(2x^2-x)+(3x-5)&=2x^2-x+3x-5\\&=2x^2+(-1+3)x-5\\&=2x^2+2x-5\end{aligned}$$

94.
$$\begin{aligned}(4t+3)-(6t+7)&=4t+3-6t-7\\&=(4-6)t+(3-7)\\&=-2t-4\end{aligned}$$

95.
$$\begin{aligned}(2t-1)-(t-3)&=2t-1-t+3\\&=(2-1)t+(-1+3)\\&=t+2\end{aligned}$$

96.
$$\begin{aligned}(5x^2-4)-(9x^2-7x)&=5x^2-4-9x^2+7x\\&=(5-9)x^2+7x-4\\&=-4x^2+7x-4\end{aligned}$$

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

Since $\frac{x}{x-3}$ cannot be computed when the denominator is 0, we find the x-value that causes $x-3$ to be 0.
$$x-3=0$$
$$x=3$$
Thus, 3 is not in the domain of f, while all other real numbers are. The domain of f is $\{x|x \text{ is a real number and } x\neq 3\}$.

98. $g(x)=x^2-1$

Since we can compute x^2-1 for any real number x, the domain is the set of all real numbers.

99. $g(x)=|6x+11|$

Since we can compute $|6x+11|$ for any real number x, the domain is the set of all real numbers.

100. $f(x)=\frac{x-7}{2x}$

Since $\frac{x-7}{2x}$ cannot be computed when the denominator is 0, we find the x-value that causes $2x$ to be 0.

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

Thus, 0 is not in the domain of f, while all other real numbers are. The domain of f is $\{x|x \text{ is a real number and } x\neq 0\}$.

101. *Writing Exercise*. In 2004, contributions were \$310.5 million. However, suing the model from Exercise 49 $A(4)=22.525(4)+236.95$, or \$327.05 million. This indicates that the answer to the exercise might be high.

102. *Writing Exercise*. The slope of the line modeling the life expectancy of males is greater than the slope of the line modeling the life expectancy of females. Thus, we would predict that at some point in the future the life expectancy of males will exceed that of females.

103. ***Familiarize***. Celsius temperature C corresponding to a Fahrenheit temperature F can be modeled by a line that contains the points (32, 0) and (212, 100).

Translate. We find an equation relating C and F.

$$m=\frac{100-0}{212-32}=\frac{100}{180}=\frac{5}{9}$$
$$C-0=\frac{5}{9}(F-32)$$
$$C=\frac{5}{9}(F-32)$$

Carry out. Using function notation we have $C(F)=\frac{5}{9}(F-32)$. Now we find $C(70)$:

$C(70)=\frac{5}{9}(70-32)=\frac{5}{9}(38)\approx 21.1$.

Check. We can repeat the calculations. We could also graph the function and determine that (70, 21.1) is on the graph.

State. A temperature of about 21.1°C corresponds to a temperature of 70°F.

104. Find the equation of the line containing the points $(6,\ 900)$ and $(8,\ 750)$:

$$m=\frac{750-900}{8-6}=\frac{-150}{2}=-75$$
$$C-900=-75(t-6)$$
$$C-900=-75t+450$$
$$C(t)=-75t+1350$$

Then $C(0)=-75\cdot 0+1350=\$1350$.

105. ***Familiarize***. The total cost C of the phone in dollars, after t months, can be modeled by a line that contains the points (5, 410) and (9, 690).

Translate. We find an equation relating C and t.

$$m=\frac{690-410}{9-5}=\frac{280}{4}=70$$
$$C-410=70(t-5)$$
$$C-410=70t-350$$
$$C=70t+60$$

Carry out. Using function notation, we have $C(t)=70t+60$. To find the costs already incurred when the service began, we find $C(0)$:

$$C(0)=70\cdot 0+60=60.$$

Check. We can repeat the calculations. We could also graph the function and determine that (0, 60) is on the graph.

State. Tam had already incurred \$60 in costs when her service just began.

106. Find an equation of the line containing (4, 7500) and $(7,\ 9250)$:

$$m=\frac{9250-7500}{7-4}=\frac{1750}{3}$$
$$C-7500=\frac{1750}{3}(t-4)$$
$$C(t)=\frac{1750}{3}t+\frac{15{,}500}{3}$$

Then $C(10)=\frac{1750}{3}(10)+\frac{15{,}500}{3}=\$11{,}000$.

107. We find the value of p for which $A(p)=-2.5p+26.5$ and $A(p)=2p-11$ are the same.

$$-2.5p+26.5=2p-11$$
$$26.5=4.5p-11$$
$$37.5=4.5p$$
$$8.\overline{3}=p$$

Supply will equal demand at a price of about \$8.33 per pound.

108. The price must be a positive number, so we have $p>0$. Furthermore, the amount of coffee sold must be a nonzero number. We have:

$$-2.5p+26.5\geq 0$$
$$-2.5p\geq -26.5$$
$$p\leq 10.6$$

Thus, the domain is $\{p\,|\,0<p\leq 10.6\}$.

109. The price must be a positive number, so we have $p > 0$. Furthermore, the amount of coffee supplied must be a positive number. We have:

$$2p - 11 > 0$$
$$2p > 11$$
$$p > 5.5$$

Thus, the domain is $\{p \mid p > 5.5\}$.

110. a) We have two pairs, $(3,-5)$ and $(7,-1)$. Use the point-slope form:

$$m = \frac{-1-(-5)}{7-3} = \frac{-1+5}{4} = \frac{4}{4} = 1$$
$$y-(-5) = 1(x-3)$$
$$y+5 = x-3$$
$$y = x-8$$
$$g(x) = x-8 \quad \text{Using function notation}$$

b) $g(-2) = -2-8 = -10$

c) $g(a) = a-8$

If $g(a) = 75$, we have

$$a-8 = 75$$
$$a = 83.$$

111. Find the slope of $5y - kx = 7$:

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

The slope is $\frac{k}{5}$.

Find the slope of the line containing $(7,-3)$ and $(-2, 5)$:

$$m = \frac{5-(-3)}{-2-7} = \frac{5+3}{-9} = -\frac{8}{9}$$

If the lines are parallel, their slopes must be equal:

$$\frac{k}{5} = -\frac{8}{9}$$
$$k = -\frac{40}{9}$$

112. Find the slope of $7y - kx = 9$:

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

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

Find the slope of the line containing $(2,-1)$ and $(-4, 5)$.

$$m = \frac{5-(-1)}{-4-2} = \frac{6}{-6} = -1$$

If the lines are perpendicular, the product of their slopes must be –1:

$$\frac{k}{7}(-1) = -1$$
$$-\frac{k}{7} = -1$$
$$k = 7 \quad \text{Multiplying by } -7$$

113. *Graphing Calculator and Writing Exercise.*

a) Following the instructions for entering data and using the linear regression option on a graphing calculator, we find the following function:

$f(x) = 0.256x - 1.746.$

b) $f(75) = 0.256(75) - 1.746 \approx 17$

The result we found in Exercise 87 was 19W. The answer found using the linear regression seems more reliable because it was found using a function that is based on more data points than the function in Section 2.2.

114. *Graphing Calculator and Writing Exercise.*

$f(x) = 0.299x - 515.362$, where x is the year.

$f(2012) = 86.226$ yr

The result we found in Exercise 47 was 81.52 yr. The answer found using linear regression seems more reliable because it was found using a function that is based on more data points than the function in Exercise 47.

115. *Graphing Calculator Exercise*

Connecting the Concepts

1. $2x + 5y = 8$ is in standard form.

2. $y = \frac{2}{3}x - \frac{11}{3}$ is in slope-intercept form.

3. $x - 13 = 5y$ is none of these forms.

4. $y - 2 = \frac{1}{3}(x-6)$ is in point-slope form.

5. $x - y = 1$ is in standard form.

6. $y = -18x + 3.6$ is in slope-intercept form.

7.
$$y = \frac{2}{5}x + 1$$
$$5y = 2x + 5$$
$$-2x + 5y = 5 \quad \text{or} \quad 2x - 5y = -5$$

8.
$$y - 1 = -2(x-6)$$
$$y - 1 = -2x + 12$$
$$2x + y = 13$$

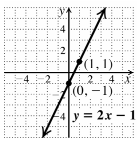
9.
$$3x - 5y = 10$$
$$-5y = -3x + 10$$
$$y = \frac{3}{5}x - 2$$

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

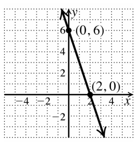
$y+2=\frac{1}{2}x-\frac{3}{2}$

$y=\frac{1}{2}x-\frac{7}{2}$

11. Graph $y = 2x - 1$.

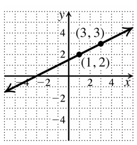


12. Graph $3x + y = 6$.



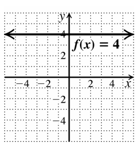
$3x + y = 6$

13. Graph $y-2=\frac{1}{2}(x-1)$.

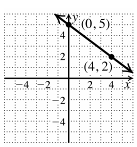


$y - 2 = \frac{1}{2}(x - 1)$

14. Graph $f(x)=4$.



15. Graph $f(x)=-\frac{3}{4}x+5$.



$f(x) = -\frac{3}{4}x + 5$

16. $x-3y=1$

$-3y=-x+1$

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

Slope is $\frac{1}{3}$; y-intercept is $\left(0,\ -\frac{1}{3}\right)$

17. $f(x)=-3x+7$

18. $y-7=5(x-(-3))$

19. $y=\frac{2}{3}x-8$

20. $m=\frac{-5-(-1)}{-2-4}=\frac{-5+1}{-6}=\frac{-4}{-6}=\frac{2}{3}$

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

$y+1=\frac{2}{3}x-\frac{8}{3}$

$y=\frac{2}{3}x-\frac{11}{3}$

Exercise Set 2.6

1. sum; see page 130 in the text.

2. subtract; see page 130 in the text.

3. evaluate; see page 130 in the text.

4. domains; see page 133 in the text.

5. excluding; see page 133 in the text.

6. sum; see page 132 in the text.

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

8. $f(4)=-2\cdot 4+3=-5$, $g(4)=4^2-5=11$,

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

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

10. $f(2)=-2\cdot 2+3=-1$, $g(2)=2^2-5=-1$,

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

11. Since $f(-2)=-2\cdot(-2)+3=7$ and

$g(-2)=(-2)^2-5=-1$ we have

$f(-2)\cdot g(-2)=7(-1)=-7$.

12. $f(-1)=-2\cdot(-1)+3=5$, $g(-1)=(-1)^2-5=-4$,

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

13. Since $f(-4)=-2\cdot(-4)+3=11$ and

$g(-4)=(-4)^2-5=11$, we have $\frac{f(-4)}{g(-4)}=\frac{11}{11}=1$.

14. $f(3)=-2\cdot 3+3=-3$, $g(3)=3^2-5=4$, $\frac{f(3)}{g(3)}=\frac{-3}{4}$

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

16. $g(-3)=(-3)^2-5=4,\quad f(-3)=-2\cdot(-3)+3=9$,

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

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

18. $(g-f)(x)=g(x)-f(x)=(x^2-5)-(-2x+3)$
$=x^2+2x-8$

19. $(F+G)(x)=F(x)+G(x)$
$=x^2-2+5-x$
$=x^2-x+3$

20. $(F+G)(a)=a^2-a+3$ (See Exercise 19.)

21. $(F-G)(x)=F(x)-G(x)$
$=x^2-2-(5-x)$
$=x^2-2-5+x$
$=x^2+x-7$

Then we have

$(F-G)(3)=3^2+3-7$
$=9+3-7$
$=5.$

22. Using our work in Exercise 21, we have

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

23. $(F\cdot G)(x)=F(x)\cdot G(x)$
$=(x^2-2)(5-x)$
$=5x^2-x^3-10+2x$

Then we have

$(F\cdot G)(-3)=5(-3)^2-(-3)^3-10+2(-3)$
$=5\cdot 9-(-27)-10-6$
$=45+27-10-6$
$=56.$

24. Using our work in Exercise 23, we have

$(F\cdot G)(-4)=5(-4)^2-(-4)^3-10+2(-4)$
$=80+64-10-8=126.$

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

26. $(G-F)(x)=G(x)-F(x)=(5-x)-(x^2-2)$
$=5-x-x^2+2=-x^2-x+7$

27. Using our work in Exercise 25, we have

$$(G/F)(-2)=\frac{5-(-2)}{(-2)^2-2}=\frac{5+2}{4-2}=\frac{7}{2}.$$

28. $(F/G)(-1)=\frac{(-1)^2-2}{5-(-1)}=-\frac{1}{6}$ (See Exercise 25.)

29. $(F+F)(x)=F(x)+F(x)=(x^2-2)+(x^2-2)=2x^2-4$
$(F+F)(x)=2(1)^2-4=-2$

30. $(G\cdot G)(x)=G(x)\cdot G(x)=(5-x)(5-x)=x^2-10x+25$
$(G\cdot G)(6)=(6)^2-10(6)+25=1$

31. $N(2004)=(C+B)(2004)=C(2004)+B(2004)$
$\approx 1.2+2.9=4.1$ million

We estimate the number of births in 2004 to be 4.1 million.

32. $N(1985)=(C+B)(1985)=C(1985)+B(1985)$
$\approx 0.8+2.9=3.7$ million

We estimate the number of births in 1985 to be 3.7 million.

33. $(P-L)(2)=P(2)-L(2)\approx 26.5\%-22.5\%\approx 4\%$

34. $(P-L)(1)=P(1)-L(1)\approx 20\%-18\%\approx 2\%$

35. $(p+r)('05)=p('05)+r('05)$
$\approx 25+70=95$ million

This represents the number of tons of municipal solid waste that was composted or recycled in 2005.

36. $(p+r+b)('05)=p('05)+r('05)+b('05)$
$\approx 25+70+25=120$ million

This represents the number of tons of municipal solid waste that was composted, recycled, or combusted for energy recovery in 2005.

37. $F('96)\approx 215$ million

This represents the number of tons of municipal solid waste in 1996.

38. $F('06)\approx 260$ million

This represents the number of tons of municipal solid waste in 2006.

39. $(F-p)('04)=F('04)-p('04)$
$\approx 260-30=230$ million

This represents the number of tons of municipal solid waste that was not composted in 2004.

40. $(F-l)('03)=F('03)-l('03)$
$\approx 250-130=120$ million

This represents the number of tons of municipal solid waste that was not land filled in 2003.

41. The domain of f and of g is all real numbers. Thus,

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

42. $\{x \mid x \text{ is a real number}\}$

43. Because division by 0 is undefined, we have
Domain of $f = \{x \mid x \text{ is a real number } \textit{and } x \neq -5\}$,
and Domain of $g = \{x \mid x \text{ is a real number}\}$.
Thus,
Domain of $f+g$ = Domain of $f-g$ = Domain of $f \cdot g$
$= \{x \mid x \text{ is a real number } \textit{and } x \neq -5\}$.

44. Since $g(x)$ is not defined for $x = 9$, we have
$\{x \mid x \text{ is a real number } \textit{and } x \neq 9\}$.

45. Because division by 0 is undefined, we have
Domain of $f = \{x \mid x \text{ is a real number } \textit{and } x \neq 0\}$,
and Domain of $g = \{x \mid x \text{ is a real number}\}$.
Thus, Domain of
$f+g$ = Domain of $f-g$ = Domain of $f \cdot g$
$= \{x \mid x \text{ is a real number } \textit{and } x \neq 0\}$.

46. Since $g(x)$ is not defined for $x = 0$, we have
$\{x \mid x \text{ is a real number and } x \neq 0\}$.

47. Because division by 0 is undefined, we have
Domain of $f = \{x \mid x \text{ is a real number } \textit{and } x \neq 1\}$,
and Domain of $g = \{x \mid x \text{ is a real number}\}$.
Thus,
Domain of $f+g$ = Domain of $f-g$ = Domain of $f \cdot g$
$= \{x \mid x \text{ is a real number } \textit{and } x \neq 1\}$.

48. Since $g(x)$ is not defined for $x = -6$, we have
$\{x \mid x \text{ is a real number } \textit{and } x \neq -6\}$.

49. Because division by 0 is undefined, we have
Domain of $f = \left\{x \middle| x \text{ is a real number } \textit{and } x \neq -\frac{9}{2}\right\}$,
and Domain of $g = \{x \mid x \text{ is a real number } \textit{and } x \neq 1\}$.
Thus, Domain of $f+g$ = Domain of $f-g$ = Domain of $f \cdot g$
$= \left\{x \middle| x \text{ is a real number } \textit{and } x \neq -\frac{9}{2} \textit{ and } x \neq 1\right\}$.

50. Since $f(x)$ is not defined for $x = 3$ and $g(x)$ is not defined for $x = \frac{1}{4}$, we have
$\left\{x \middle| x \text{ is a real number } \textit{and } x \neq 3 \textit{ and } x \neq \frac{1}{4}\right\}$.

51. Domain of f = Domain of $g = \{x \mid x \text{ is a real number}\}$.
Since $g(x) = 0$ when $x - 3 = 0$, we have $g(x) = 0$ when $x = 3$. We conclude that
Domain of $f/g = \{x \mid x \text{ is a real number } \textit{and } x \neq 3\}$.

52. Since $g(x) = 0$ for $x = 5$, we have
$\{x \mid x \text{ is a real number and } x \neq 5\}$.

53. Domain of f = Domain of $g = \{x \mid x \text{ is a real number}\}$.
Since $g(x) = 0$ when $2x + 8 = 0$, we have $g(x) = 0$ when $x = -4$. We conclude that
Domain of $f/g = \{x \mid x \text{ is a real number } \textit{and } x \neq -4\}$.

54. Since $g(x) = 0$ for $x = 3$, we have
$\{x \mid x \text{ is a real number and } x \neq 3\}$.

55. Domain of $f = \{x \mid x \text{ is a real number and } x \neq 4\}$.
Domain of $g = \{x \mid x \text{ is a real number}\}$.
Since $g(x) = 0$ when $5 - x = 0$, we have $g(x) = 0$ when $x = 5$. We conclude that Domain of
$f/g = \{x \mid x \text{ is a real number and } x \neq 4 \text{ and } x \neq 5\}$.

56. Since $f(x)$ is not defined for $x = 2$ and $g(x) = 0$ for $x = -7$, we have
$\{x | x \text{ is a real number } \textit{and } x \neq -7 \textit{ and } x \neq 2\}$.

57. Domain of $f = \{x \mid x \text{ is a real number and } x \neq -1\}$.
Domain of $g = \{x \mid x \text{ is a real number}\}$.
Since $g(x) = 0$ when $2x + 5 = 0$, we have $g(x) = 0$ when $x = -\frac{5}{2}$. We conclude that Domain of f/g
$= \left\{x \middle| x \text{ is a real number and } x \neq -1 \text{ and } x \neq -\frac{5}{2}\right\}$.

58. Since $f(x)$ is not defined for $x = 2$ and $g(x) = 0$ for $x = -\frac{7}{3}$, we have
$\left\{x \middle| x \text{ is a real number and } x \neq 2 \text{ and } x \neq -\frac{7}{3}\right\}$.

59. $(F+G)(5) = F(5) + G(5) = 1 + 3 = 4$
$(F+G)(7) = F(7) + G(7) = -1 + 4 = 3$

60. $(F \cdot G)(6) = F(6) \cdot G(6) = 0(3.5) = 0$
$(F \cdot G)(9) = F(9) \cdot G(9) = 1 \cdot 2 = 2$

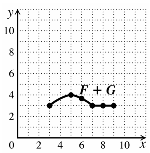
61. $(G-F)(7) = G(7) - F(7) = 4 - (-1) = 4 + 1 = 5$
$(G-F)(3) = G(3) - F(3) = 1 - 2 = -1$

62. $(F/G)(3) = \dfrac{F(3)}{G(3)} = \dfrac{2}{1} = 2$
$(F/G)(7) = \dfrac{F(7)}{G(7)} = \dfrac{-1}{4} = -\dfrac{1}{4}$

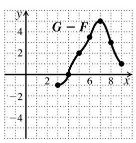
63. From the graph we see that Domain of $F = \{x \mid 0 \leq x \leq 9\}$ and Domain of $G = \{x \mid 3 \leq x \leq 10\}$. Then
Domain of $F+G = \{x \mid 3 \leq x \leq 9\}$. Since $G(x)$ is never 0,
Domain of $F/G = \{x \mid 3 \leq x \leq 9\}$.

64. Using our work in Exercise 63, we have
Domain of $F-G=\{x\,|\,3\le x\le 9\}$ and
Domain of $F\cdot G=\{x\,|\,3\le x\le 9\}$.
Since $F(6)=0$ and $F(8)=0$,
Domain $G/F=\{x\,|\,3\le x\le 9 \text{ and } x\ne 6 \text{ and } x\ne 8\}$.

65. We use $(F+G)(x)=F(x)+G(x)$.



66. $G(x) - F(x)$



67. *Writing Exercise.* For the years from 1985 through 2000, Americans consumed more soft drinks than juice, bottled water and milk combined. We are using the approximation of $S(t)-[M(t)+J(t)+W(t)]$.

68. *Writing Exercise.* The total number of births increased from 1970 to 2004. In 1970 the total was 3.7 million and in 2004 the total was 4.1 million. The percent of births by Caesarean section increased from 1970 to 2004. In 1970, the percentage of Caesarean was $\frac{0.2}{3.7}\times 100\approx 5.4\%$ and in 2004 the percent was $\frac{1.2}{4.1}\times 100\approx 29.3\%$.

69.
$$x-6y=3$$
$$-6y=-x+3$$
$$y=\frac{1}{6}x-\frac{1}{2}$$

70.
$$3x-8y=5$$
$$-8y=-3x+5$$
$$y=\frac{3}{8}x-\frac{5}{8}$$

71.
$$5x+2y=-3$$
$$2y=-5x-3 \quad \text{Subtracting } 5x$$
$$\frac{1}{2}\cdot 2y=\frac{1}{2}(-5x-3) \quad \text{Multiplying by } \frac{1}{2}$$
$$y=-\frac{5}{2}x-\frac{3}{2}$$

72.
$$x+8y=4$$
$$8y=-x+4$$
$$y=-\frac{1}{8}x+\frac{1}{2}$$

73. Let n represent the number; $2n+5=49$.

74. Let n represent the number; $\frac{1}{2}n-3=57$.

75. Let n represent the first integer; $x+(x+1)=145$.

76. Let x represent the number; $x-(-x)=20$

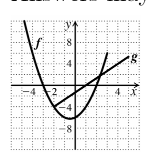
77. *Writing Exercise.* First draw four graphs with the number of hours after the first dose is taken on the horizontal axis and the amount of Advil absorbed, in mg, on the vertical axis. Each graph would show the absorption of one dose of Advil. Then superimpose the four graphs and, finally, add the amount of Advil absorbed to create the final graph.

78. *Writing Exercise.* The graph of $y=(f+g)(x)$ will be the graph of $y=g(x)$ shifted up c units.

79. Domain of $F=\{x\,|\,x \text{ is a real number and } x\ne 4\}$.
Domain of $G=\{x\,|\,x \text{ is a real number and } x\ne 3\}$.
$G(x)=0$ when $x^2-4=0$, or when $x=2$ or $x=-2$. Then Domain of $F/G=\{x|x$ is a real number and $x\ne 4$ and $x\ne 3$ and $x\ne 2$ and $x\ne -2\}$.

80. Domain of $f=\left\{x\middle|x \text{ is a real number and } x\ne -\frac{5}{2}\right\}$;
domain of $g=\{x\,|\,x \text{ is a real number and } x\ne -3\}$;
$g(x)=0$ when $x^4-1=0$, or when $x=1$ or $x=-1$.
Then domain of $f/g=\Big\{x\Big|x$ is a real number and $x\ne -\frac{5}{2}$ and $x\ne -3$ and $x\ne 1$ and $x\ne -1\}$

81. Answers may vary.



82. The domain of each function is the set of first coordinates for that function.
Domain of $f=\{-2,-1,\ 0,\ 1,\ 2\}$ and
Domain of $g=\{-4,-3,-2,-1,\ 0,\ 1\}$.
Domain of $f+g=$ Domain of $f-g$
$=$ Domain of $f\cdot g=\{-2,-1,\ 0,\ 1\}$
Since $g(-1)=0$, we conclude that
Domain of $f/g=\{-2,\ 0,\ 1\}$.

83. The problem states that Domain of $m=\{x\,|\,-1<x<5\}$. Since $n(x)=0$ when $2x-3=0$, we have $n(x)=0$ when $x=\frac{3}{2}$. We conclude that Domain of m/n $=\left\{x\,\middle|\,x \text{ is a real number and } -1<x<5 \text{ and } x\neq\frac{3}{2}\right\}$.

84. $f(-2)=1$, $g(-2)=4$, $(f+g)(-2)=1+4=5$
$f(0)=3$, $g(0)=5$, $(f\cdot g)(0)=3\cdot 5=15$
$f(1)=4$, $g(1)=6$, $(f/g)(1)=4/6=2/3$

85. Answers may vary. $f(x)=\dfrac{1}{x+2}$, $g(x)=\dfrac{1}{x-5}$

86. Because $y_2=0$ when $x=3$, the domain of $y_3=\{x\,|\,x \text{ is a real number and } x\neq 3\}$. Since the graph produced using Connected mode contains the line $x=3$, it does not represent y_3 accurately. The domain of the graph produced using Dot mode does not include 3, so it represents y_3 more accurately.

87. *Graphing Calculator Exercise*

88. *Graphing Calculator Exercise*

Chapter 2 Review

1. False; see page 83 in the text.

2. False; see page 87 in the text.

3. True; see page 98 in the text.

4. False; see page 109 in the text.

5. True; see page 110 in the text.

6. True; see page 110 in the text.

7. True; see page 109 in the text.

8. True; see page 90 in the text.

9. False; see page 122 in the text.

10. True; see page 130 in the text.

11.
$$\begin{array}{c|c} \multicolumn{2}{c}{x=2y+12} \\ \hline -2 & 2\cdot 8+12 \end{array}$$
$$-2\overset{?}{=}28$$
No

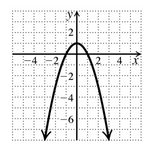
12.
$$\begin{array}{c|c} \multicolumn{2}{c}{3a-4b=2} \\ \hline 3(0)-4\left(-\frac{1}{2}\right) & 2 \\ 0+2 & \end{array}$$
$$2\overset{?}{=}2$$
Yes

13. The first coordinate is negative and the second is positive, so the point (–3, 5) is in quadrant II.

14. $y=-x^2+1$

To find an ordered pair, we choose any number for x and then determine y. We find several ordered pairs, plot them, and connect them with a smooth curve.

x	y
2	−3
1	0
0	1
−1	0
−2	−3



$y=-x^2+1$

15. We can use the coordinates of any two points on the line. Let's use (2, 75) and (8, 120).

$$\text{Rate of change}=\frac{\text{change in } y}{\text{change in } x}=\frac{75-120}{2-8}=\frac{-45}{-6}=7.5$$

The value of the apartment is increasing at a rate of \$7500 per year.

16. The rate of new homes sold is given by

$$\frac{\text{change in number of homes}}{\text{change in time}}=\frac{577{,}000-214{,}000}{5}=\frac{363{,}000}{5}=72{,}600$$

The number of homes sold is increasing by 72,600 homes per month.

17. $\text{Slope}=\dfrac{\text{difference in } y}{\text{difference in } x}=\dfrac{5-1}{4-(-3)}=\dfrac{4}{7}$

18. $\text{Slope}=\dfrac{3.5-2.8}{-16.4-(-16.4)}=\dfrac{0.7}{0}$

The slope is undefined.

19. $\text{Slope}=\dfrac{-1-(-2)}{-5-(-1)}=\dfrac{1}{-4}=-\dfrac{1}{4}$

20. $\text{Slope}=\dfrac{\frac{1}{2}-\frac{1}{2}}{\frac{1}{3}-\frac{1}{6}}=\dfrac{0}{\frac{1}{6}}=0$

21. $g(x)=-5x-11$

Slope is –5; y-intercept is (0, –11)

22. Convert to slope-intercept equation.

$$-6y + 5x = 10$$
$$-6y = -5x + 10$$
$$y = \frac{5}{6}x - \frac{5}{3}$$

Slope is $\frac{5}{6}$; y-intercept is $\left(0, -\frac{5}{3}\right)$.

23. $C(t) = 11t + 1542$

11 signifies that the number of calories consumed each day increases by 11 per year, for years after 1971.

1542 signifies that the number of calories consumed each day in 1971 was 1542.

24. $y + 3 = 7$
$$y = 4$$

The graph of $y = 4$ is a horizontal line. Since $y + 3 = 7$ is equivalent to $y = 4$, the slope is 0.

25. $-2x = 9$
$$x = -\frac{9}{2}$$

The graph of $x = -\frac{9}{2}$ is a vertical line. Since $-2x = 9$ is equivalent to $x = -\frac{9}{2}$, the slope is undefined.

26. $3x - 2y = 8$

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

$$3 \cdot 0 - 2y = 8$$
$$-2y = 8$$
$$y = -4$$

The y-intercept is (0, –4).

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

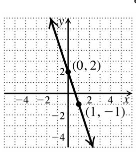
$$3x - 2 \cdot 0 = 8$$
$$3x = 8$$
$$x = \frac{8}{3}$$

The x-intercept is $\left(\frac{8}{3},\ 0\right)$.

27. Graph $f(x) = -3x + 2$.

Slope is –3 or $\frac{-3}{1}$; y-intercept is (0, 2).

From the y-intercept, we go *down* 3 units and to the *right* 1 unit. This gives us (1, –1). We can now draw the graph.



$y = -3x + 2$

28. Graph $-2x + 4y = 8$.

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

$$-2 \cdot 0 + 4y = 8$$
$$y = 2$$

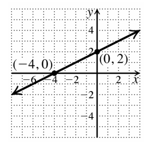
The y-intercept is (0, 2).

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

$$-2x + 4 \cdot 0 = 8$$
$$-2x = 8$$
$$x = -4$$

The x-intercept is (–4, 0).

Plot these points and draw the line.

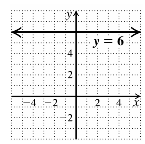


$-2x + 4y = 8$

29. Graph $y = 6$.

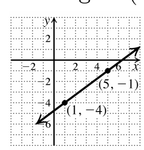
This is a horizontal line that crosses the y-axis at $(0,\ 6)$. If we find some ordered pairs, note that, for any x-value chosen, y must be 6.

x	y
3	6
0	6
6	6



30.
$$y + 1 = \frac{3}{4}(x - 5)$$
$$y - (-1) = \frac{3}{4}(x - 5)$$

To graph the equation, we count off a slope of $\frac{3}{4}$, starting at (5, –1), and draw the line.



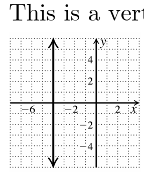
$y + 1 = \frac{3}{4}(x - 5)$

31. Graph $8x + 32 = 0$.

Since y does not appear, we solve for x.

$$8x + 32 = 0$$
$$x = -4.$$

This is a vertical line that crosses the x-axis at (–4, 0).

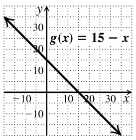


$8x + 32 = 0$

32. Graph $g(x)=15-x$ or $g(x)=-x+15.$.

Slope is $-1=\frac{-1}{1}$; y-intercept is (0, 15).

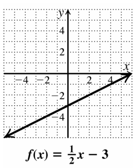
From the y-intercept, we go *down* 1 unit and *right* 1 unit. This gives us the point (1, 14). We can now draw the graph.



33. Graph $f(x)=\frac{1}{2}x-3.$

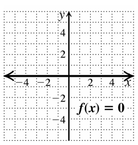
Slope is $\frac{1}{2}$; y-intercept is (0, –3).

From the y-intercept, we go *up* 1 unit and *right* 2 units. This gives us the point (2, –2). We can now draw the graph.



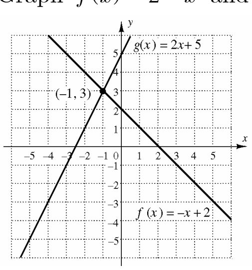
34. Graph $f(x)=0.$

This is a horizontal line that crosses the vertical axis at (0, 0).



35. $2-x=5+2x$

Graph $f(x)=2-x$ and $g(x)=5+2x$ on the same grid.

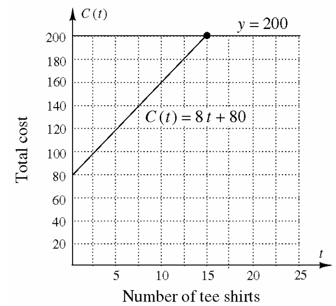


The lines appear to intersect at (–1, 3) so the solution is apparently –1.

Check:
$$\begin{array}{r|l} \multicolumn{2}{c}{2-x=5+2x} \\ \hline 2-(-1) & 5+2(-1) \\ 2+1 & 5-2 \end{array}$$
$$3\overset{?}{=}3 \quad \text{TRUE}$$

The solution is –1.

36. Let t = the number of tee shirts printed and $C(t)$ is the total cost. Graph $C(t)=8t+80$ and y = 200.



The graph appears to intersect at about (15, 200). The number 15 checks. So 15 – 5, or 10 additional tee shirts were printed.

37. First solve for y and determine the slope of each line.

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

The slope of $y + 5 = -x$ is –1.

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

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

The product of their slopes is (–1)(1), or –1; the lines are perpendicular.

38. First solve for y and determine the slope of each line.

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

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

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

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

The slopes are the same, so the lines are parallel.

39. Use the slope-intercept equation $f(x)=mx+b$, with $m=\frac{2}{9}$ and b = –4.

$$f(x)=mx+b$$
$$f(x)=\frac{2}{9}x-4$$

40. $y-y_1=m(x-x_1)$ Point-slope equation

$y-10=-5(x-1)$ Substituting -5 for m, 1 for x_1, and 10 for y_1

41. First find the slope of the line:

$$m=\frac{6-5}{-2-2}=-\frac{1}{4}$$

Use the point-slope equation with $m=-\frac{1}{4}$ and $(2,\ 5)=(x_1,\ y_1)$.

$$y-y_1=m(x-x_1)$$
$$y-5=-\frac{1}{4}(x-2)$$
$$y-5=-\frac{1}{4}x+\frac{1}{2}$$
$$y=-\frac{1}{4}x+\frac{11}{2}$$
$$f(x)=-\frac{1}{4}x+\frac{11}{2} \quad \text{Using function notation}$$

42. $3x-5y=9$

$$y=\frac{3}{5}x-\frac{9}{5} \qquad m=\frac{3}{5}$$
$$y-(-5)=\frac{3}{5}(x-2)$$
$$y+5=\frac{3}{5}x-\frac{6}{5}$$
$$y=\frac{3}{5}x-\frac{31}{5}$$

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

$$3x-5y=9$$
$$y=\frac{3}{5}x-\frac{9}{5}$$

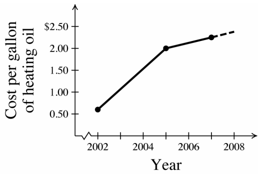
The slope of the given line is $\frac{3}{5}$.

The slope of a perpendicular line is given by the opposite of the reciprocal of $\frac{3}{5}$, $-\frac{5}{3}$.

We find the equation of the line with slope $-\frac{5}{3}$ containing the point (2, –5).

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

44. Plot and connect the points, using the years as the first coordinate and the corresponding cost per gallon of heating oils as the second coordinate.



To estimate the cost in 2004, first locate the point that is directly above 2004. Then move horizontally from the point to the vertical axis and read the approximate function value there. We estimate the cost per gallon to be $1.50 in 2004.

45. To estimate the cost per gallon in 2008, extend the graph and extrapolate. It appears that in 2008, the cost per gallon is about $2.40.

46. a) Letting t represent the number of years since 1980, we form the pairs (3, 19.75) and (27, 19.32). First we find the slope of the function that fits the data.

$$m=\frac{19.32-19.75}{27-3}=\frac{-0.43}{24}=-\frac{43}{2400}$$

Using $m=-\frac{43}{2400}$ and $t_1=3$ and $E_1=19.75$ we substitute into point-slope equation.

$$E-E_1=m(t-t_1)$$
$$E-19.75=-\frac{43}{2400}(t-3)$$
$$E=-\frac{43}{2400}t+\frac{15{,}843}{800}$$
$$E(t)=-\frac{43}{2400}t+\frac{15{,}843}{800}$$

b) In 2013, t = 2013 – 1980 = 33

$$E(33)=-\frac{43}{2400}(33)+\frac{15{,}843}{800}\approx 19.21 \text{ sec}$$

In 2020, t = 2020 – 1980 = 40

$$E(40)=-\frac{43}{2400}(40)+\frac{15{,}843}{800}\approx 19.09 \text{ sec}$$

47. $2x-7=0$

$$x=\frac{7}{2}$$

The equation is linear. The graph is a vertical line.

48. $3x-\frac{y}{8}=7$

$$24x-y=56$$

This equation is in standard form for a linear equation, $Ax+By=C$. Thus, it is a linear equation.

49. $2x^3-7y=5$

The equation is not linear, because it has an x^3-term.

50. $\frac{2}{x}=y$

$2=xy$ Multiplying by x

The equation is not linear, because it has an xy-term.

51. a) Locate 2 on the horizontal axis and find the point on the graph for which 2 is the first coordinate. From this 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 $\{x|-2\le x\le 4\}$.

c) To determine which member(s) of the domain are 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 –1. Thus $f(-1)=2$.

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

52. a) Domain of g is $\{x|x \text{ is a real number}\}$.

b) Range of g is $\{y|y \ge 0\}$.

53. We can use the vertical-line test. Visualize moving a vertical line across the graph. No vertical line will intersect the graph more than once. Thus, the graph is a graph of a function.

54. We use the vertical-line test. It is possible for a vertical line to intersect the graph more than once. Thus, this is not the graph of a function.

55. $g(0)=3\cdot 0-6=0-6=-6$

56. $h(-5)=(-5)^2+1=25+1=26$

57. $g(a+5)=3(a+5)-6=3a+15-6=3a+9$

58.
$$\begin{aligned}(g\cdot h)(4)&=g(4)\cdot h(4)=[3(4)-6]\left[(4)^2+1\right]\\&=[12-6][16+1]\\&=6\cdot 17=102\end{aligned}$$

59. $$\left(\frac{g}{h}\right)(-1)=\frac{g(-1)}{h(-1)}=\frac{3(-1)-6}{(-1)^2+1}=\frac{-3-6}{1+1}=-\frac{9}{2}$$

60.
$$\begin{aligned}(g+h)(x)&=g(x)+h(x)=(3x-6)+\left(x^2+1\right)\\&=x^2+3x-5\end{aligned}$$

61. $g(x)=3x-6$

Since we can compute $3x-6$ for any real number x, the domain is the set of all real numbers.

62. The domain of g and h is all real numbers. Thus, Domain of $g+h=\{x|x \text{ is a real number}\}$.

63. Domain of g = Domain of h = $\{x|x \text{ is a real number}\}$. Since $g(x)=0$ when $3x-6=0$, we have $g(x)=0$ when $x=2$. We conclude that Domain of $h/g=\{x|x \text{ is a real number and } x\ne 2\}$.

64. *Writing Exercise.* For a function, every member of the domain corresponds to *exactly one* member of the range. Thus, for any function, each member of the domain corresponds to *at least one* member of the range. Therefore, a function is a relation. In a relation, every member of the domain corresponds to *at least one*, but not necessarily *exactly one*, member of the range. Therefore, a relation may or may not be a function.

65. *Writing Exercise.* The slope of a line is the rise between two points on the line divided by the run between those points. For a vertical line, there is no run between any two points, and division by 0 is undefined; therefore, the slope is undefined. For a horizontal line, there is no rise between any two points, so the slope is 0/run, or 0.

66. To find the *y*-intercept, choose $x=0$.
$$\begin{aligned}f(0)+3&=0.17(0)^2+(5-2(0))^0-7\\f(0)+3&=0+1-7\\f(0)&=-9\end{aligned}$$

67. Write both equations in slope-intercept form.
$$y=\frac{3}{4}x-3 \qquad m=\frac{3}{4}$$
$$y=-\frac{a}{6}x-\frac{3}{2} \qquad m=-\frac{a}{6}$$
For parallel lines, the slopes are the same, or
$$\frac{3}{4}=-\frac{a}{6}$$
$$a=-\frac{9}{2}$$

68. Let x represent the number of packages.

Total cost = package charge + shipping charges
$$C(x)=7.99x+(2.95x+20)$$
$$C(x)=10.94x+20$$

69. a) Graph III indicates the beginning and end, walking at the same rate, with a rapid rate in between.

b) Graph IV indicates fast bike riding, followed by not as fast running, finishing with slower walking.

c) Graph I indicates fast rate of motorboat followed by constant rate of 0 for fishing, finishing with fast rate of motorboat.

d) Graph II indicates constant rate of 0 while waiting, followed by fast rate of train, and finishing with not as fast run.

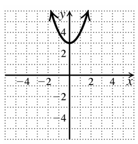
Chapter 2 Test

1.
$$\begin{array}{c|c} x+4y & = -20 \\ \hline 12+4(-3) & -20 \\ 12-12 & \end{array}$$
$$0 \stackrel{?}{=} -20$$
Since 0 = –20 is false, (12, –3) is not a solution.

2. $y = x^2 + 3$

To find an ordered pair, we choose any number for x and then determine y. We find several ordered pairs, plot them, and connect them with a smooth curve.

x	y
2	7
1	4
0	3
−1	4
−2	7



$f(x) = x^2 + 3$

3. $\text{Rate of change} = \frac{\text{change in } y}{\text{change in } x} = \frac{150-100}{2007-2005} = \frac{50}{2} = 25$

The number of people on the National Do Not Call Registry is increasing at a rate of 25 million people per year.

4. $\text{Slope} = \frac{\text{change in } y}{\text{change in } x} = \frac{3-(-2)}{6-(-2)} = \frac{3+2}{6+2} = \frac{5}{8}$

5. $\text{Slope} = \frac{\text{change in } y}{\text{change in } x} = \frac{5.2-5.2}{-4.4-(-3.1)} = \frac{0}{-4.4+3.1} = 0$

6. $f(x) = -\frac{3}{5}x + 12$

Slope is $-\frac{3}{5}$; y-intercept is (0, 12).

7. Convert to slope-intercept equation.
$$-5y - 2x = 7$$
$$-5y = 2x + 7$$
$$y = -\frac{2}{5}x - \frac{7}{5}$$
Slope is $-\frac{2}{5}$; y-intercept is $\left(0, -\frac{7}{5}\right)$.

8. $f(x) = -3$

This is a horizontal line that crosses the vertical axis at $(0, -3)$. The slope is 0.

9. $x - 5 = 11$
$$x = 16$$
The graph of x = 16 is a vertical line. Since x – 5 = 11 is equivalent to x = 16, the slope of x – 5 = 11 is undefined.

10. $5x - y = 15$

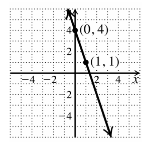
To find the y-intercept, let x = 0 and solve for y.
$$5 \cdot 0 - y = 15$$
$$y = -15$$
The y-intercept is (0, –15).

To find the x-intercept, let y = 0 and solve for x.
$$5x - 0 = 15$$
$$x = 3$$
The x-intercept is (3, 0).

11. Graph $f(x) = -3x + 4$.

Slope is –3 or $\frac{-3}{1}$; y-intercept is (0, 4).

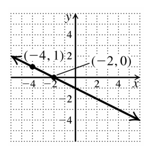
From the y-intercept, we go *down* 3 units and to the *right* 1 unit. This gives us (1, 1). We can now draw the graph.



$y = -3x + 4$

12. Convert to slope-intercept equation.
$$y - 1 = -\frac{1}{2}(x+4)$$
$$y = -\frac{1}{2}x - 1$$
Slope is $-\frac{1}{2}$; y-intercept is (0, –1).

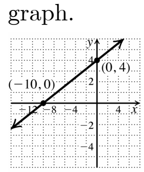
From the y-intercept, we go *down* 1 unit and *right* 2 units. This gives us the point (2, –2). We can now draw the graph.



$y - 1 = -\frac{1}{2}(x + 4)$

13. Convert to slope-intercept equation.
$$-2x + 5y = 20$$
$$y = \frac{2}{5}x + 4$$
Slope is $\frac{2}{5}$; y-intercept is (0, 4).

From the y-intercept, we go *up* 2 units and *right* 5 units. This gives us the point (5, 6). We can now draw the graph.



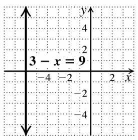
$-2x + 5y = 20$

14. Graph $3 - x = 9$.

Since y does not appear, we solve for x.

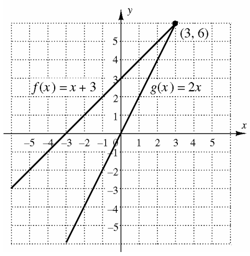
$x = -6$.

This is a vertical line that crosses the x-axis at $(-6, 0)$.



15. $x + 3 = 2x$

Graph $f(x) = x + 3$ and $g(x) = 2x$ on the same grid.



The lines appear to intersect at (3, 6) so the solution is apparently 3.

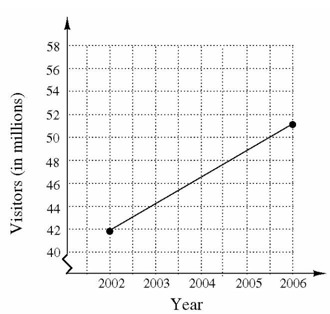
Check: $x + 3 = 2x$

$3 + 3 \mid 2 \cdot 3$

$6 \stackrel{?}{=} 6$ TRUE

The solution is 3.

16. Plot and connect the points using the year as the first coordinate and the number of visitors, in millions, as the second coordinate.



To estimate the number of international visitors in 2005, locate the point directly above 2005. Then estimate the second coordinate by moving horizontally from the point to the vertical axis. The number of visitors appears to be 49 million.

17. a) $8x - 7 = 0$

$x = \frac{7}{8}$

The equation is linear. (Its graph is a vertical line.)

b) $4x - 9y^2 = 12$

The equation is not linear, because it has a y^2-term.

c) $2x - 5y = 3$

The equation is linear.

18. Write both equations in slope-intercept form.

$4y + 2 = 3x$ $\quad -3x + 4y = -12$

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

$m = \frac{3}{4}$ $\quad m = \frac{3}{4}$

The slopes are the same, so the lines are parallel.

19. Write both equations in slope-intercept form.

$y = -2x + 5$ $\quad 2y - x = 6$

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

$m = \frac{1}{2}$

The product of their slopes is $(-2)\left(\frac{1}{2}\right)$, or -1; the lines are perpendicular.

20. Use the slope-intercept equation, $f(x) = mx + b$, with $m = -5$ and $b = -1$.

$f(x) = -5x - 1$

21. $y - (-4) = 4[x - (-2)]$ or $y + 4 = 4(x + 2)$

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

$y - (-2) = -1(x - 4)$

$y + 2 = -x + 4$

$y = -x + 2$

$f(x) = -x + 2$

23. $2x - 5y = 8$

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

The slope is $\frac{2}{5}$.

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

$y - 2 = \frac{2}{5}x + \frac{6}{5}$

$y = \frac{2}{5}x + \frac{16}{5}$

24. $2x - 5y = 8$

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

The slope is $\frac{2}{5}$.

The slope of a perpendicular line is given by the opposite of the reciprocal of $\frac{2}{5}$, $-\frac{5}{2}$.

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

$y = -\frac{5}{2}x - \frac{11}{2}$

25. a) Let $m =$ the number of miles, $C(m)$ represents the cost. We form the pairs (250, 100) and (300, 115).

$$\text{Slope} = \frac{115-100}{300-250} = \frac{15}{50} = \frac{3}{10} = 0.3$$

$$\begin{aligned} y - y_1 &= m(x - x_1) \\ C - 100 &= 0.3(m - 250) \\ C &= 0.3m + 25 \\ C(m) &= 0.3m + 25 \end{aligned}$$

b) $C(500) = 0.3(500) + 25 = \$175$

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

b) Domain is $\{x \mid -3 \le x \le 4\}$.

c) If $f(x) = \frac{1}{2}$, then $x = 3$.

d) Range is $\{y \mid -1 \le y \le 2\}$.

27. $h(-5) = 2(-5) + 1 = -9$

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

29. Domain of g: $\{x \mid x \text{ is a real number and } x \ne 0\}$

30. Domain of h: $\{x \mid x \text{ is a real number}\}$

Domain of $g + h$: $\{x \mid x \text{ is a real number and } x \ne 0\}$

31. $h(x) = 2x + 1 = 0$, if $x = -\frac{1}{2}$

Domain of g / h:

$\left\{x \,\middle|\, x \text{ is a real number and } x \ne 0 \text{ and } x \ne -\frac{1}{2}\right\}$

32. a) 1 hr and 40 min is equal to $1\frac{40}{60} = 1\frac{2}{3} = \frac{5}{3}$ hr.

We must find $f\left(\frac{5}{3}\right)$.

$$f\left(\frac{5}{3}\right) = 5 + 15 \cdot \frac{5}{3} = 5 + 25 = 30$$

The cyclist will be 30 mi from the starting point 1 hr and 40 min after passing the 5-mi marker.

b) From the equation $f(t) = 5 + 15t$, we see that the cyclist is advancing 15 mi for every hour he travels. So the rate is 15 mph.

33. If the graph is to be parallel to the line $3x - 2y = 7$, then we must determine the slope:

$$\begin{aligned} 3x - 2y &= 7 \\ -2y &= -3x + 7 \\ y &= \frac{3}{2}x - \frac{7}{2} \qquad m = \frac{3}{2} \end{aligned}$$

The line must contain the two points $(r, 3)$ and $(7, s)$. The slope of this line must be $\frac{3}{2}$.

$$\begin{aligned} \frac{3}{2} &= \frac{s-3}{7-r} \\ 3(7-r) &= 2(s-3) \\ 21 - 3r &= 2s - 6 \\ 21 - 3r + 6 &= 2s \\ 27 - 3r &= 2s \\ 2s &= -3r + 27 \\ s &= -\frac{3}{2}r + \frac{27}{2} \text{ or } s = \frac{27-3r}{2} \end{aligned}$$

34. Answers may vary. In order to have the restriction on the domain of $f/g/h$ that $x \ne \frac{3}{4}$ and $x \ne \frac{2}{7}$, we need to find some function $h(x)$ such that $h(x) = 0$ when $x = \frac{2}{7}$.

$$\begin{aligned} x &= \frac{2}{7} \\ 7x &= 2 \\ 7x - 2 &= 0 \end{aligned}$$

One possible answer is $h(x) = 7x - 2$.