Chapter 1

Graphs, Functions, and Models

Exercise Set 1.1

1. Point A is located 5 units to the left of the y-axis and 4 units up from the x-axis, so its coordinates are $(-5, 4)$.

Point B is located 2 units to the right of the y-axis and 2 units down from the x-axis, so its coordinates are $(2, -2)$.

Point C is located 0 units to the right or left of the y-axis and 5 units down from the x-axis, so its coordinates are $(0, -5)$.

Point D is located 3 units to the right of the y-axis and 5 units up from the x-axis, so its coordinates are $(3, 5)$.

Point E is located 5 units to the left of the y-axis and 4 units down from the x-axis, so its coordinates are $(-5, -4)$.

Point F is located 3 units to the right of the y-axis and 0 units up or down from the x-axis, so its coordinates are $(3, 0)$.

2. G: $(2, 1)$; H: $(0, 0)$; I: $(4, -3)$; J: $(-4, 0)$; K: $(-2, 3)$; L: $(0, 5)$

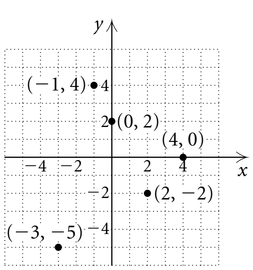
3. To graph $(4, 0)$ we move from the origin 4 units to the right of the y-axis. Since the second coordinate is 0, we do not move up or down from the x-axis.

To graph $(-3, -5)$ we move from the origin 3 units to the left of the y-axis. Then we move 5 units down from the x-axis.

To graph $(-1, 4)$ we move from the origin 1 unit to the left of the y-axis. Then we move 4 units up from the x-axis.

To graph $(0, 2)$ we do not move to the right or the left of the y-axis since the first coordinate is 0. From the origin we move 2 units up.

To graph $(2, -2)$ we move from the origin 2 units to the right of the y-axis. Then we move 2 units down from the x-axis.



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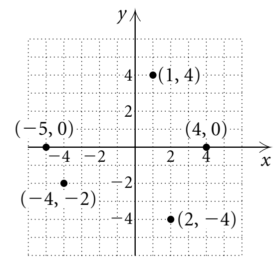


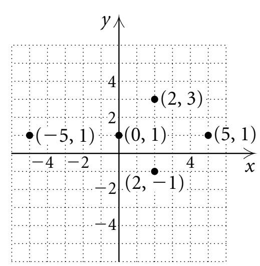
5. To graph $(-5, 1)$ we move from the origin 5 units to the left of the y-axis. Then we move 1 unit up from the x-axis.

To graph $(5, 1)$ we move from the origin 5 units to the right of the y-axis. Then we move 1 unit up from the x-axis.

To graph $(2, 3)$ we move from the origin 2 units to the right of the y-axis. Then we move 3 units up from the x-axis.

To graph $(2, -1)$ we move from the origin 2 units to the right of the y-axis. Then we move 1 unit down from the x-axis.

To graph $(0, 1)$ we do not move to the right or the left of the y-axis since the first coordinate is 0. From the origin we move 1 unit up.



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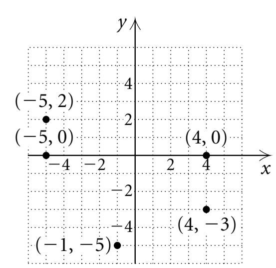


7. The first coordinate represents the year and the corresponding second coordinate represents the length of the average spring break. The ordered pairs are (2002, 5.9), (2003, 5.9), (2004, 5.8), (2005, 5.6), (2006, 5.2), and (2007, 4.9).

8. The first coordinate represents the year and the corresponding second coordinate represents total advertisement spending, in millions of dollars. The ordered pairs are (2000, 310.6), (2001, 311.2), (2002, 348.2), (2003, 361.6), (2004, 435.8), and (2005, 467.7).

9. To determine whether $(-1,-9)$ is a solution, substitute -1 for x and -9 for y.

$$\begin{array}{r|l} \multicolumn{2}{c}{y = 7x-2} \\ \hline -9 \ ? & 7(-1)-2 \\ & -7-2 \\ -9 & -9 \qquad \text{TRUE} \end{array}$$

The equation $-9=-9$ is true, so $(-1,-9)$ is a solution.

To determine whether $(0,2)$ is a solution, substitute 0 for x and 2 for y.

$$\begin{array}{r|l} \multicolumn{2}{c}{y = 7x-2} \\ \hline 2 \ ? & 7\cdot 0-2 \\ & 0-2 \\ 2 & -2 \qquad \text{FALSE} \end{array}$$

The equation $2=-2$ is false, so $(0,2)$ is not a solution.

10. For $\left(\frac{1}{2},8\right)$:

$$\begin{array}{r|l} \multicolumn{2}{c}{y = -4x+10} \\ \hline 8 \ ? & -4\cdot\frac{1}{2}+10 \\ & -2+10 \\ 8 & 8 \qquad \text{TRUE} \end{array}$$

$\left(\frac{1}{2},8\right)$ is a solution.

For $(-1,6)$:

$$\begin{array}{r|l} \multicolumn{2}{c}{y = -4x+10} \\ \hline 6 \ ? & -4(-1)+10 \\ & 4+10 \\ 6 & 14 \qquad \text{FALSE} \end{array}$$

$(-1,6)$ is not a solution.

11. To determine whether $\left(\frac{2}{3},\frac{3}{4}\right)$ is a solution, substitute $\frac{2}{3}$ for x and $\frac{3}{4}$ for y.

$$\begin{array}{r|l} \multicolumn{2}{c}{6x-4y = 1} \\ \hline 6\cdot\frac{2}{3}-4\cdot\frac{3}{4} \ ? & 1 \\ 4-3 & \\ 1 & 1 \quad \text{TRUE} \end{array}$$

The equation $1=1$ is true, so $\left(\frac{2}{3},\frac{3}{4}\right)$ is a solution.

To determine whether $\left(1,\frac{3}{2}\right)$ is a solution, substitute 1 for x and $\frac{3}{2}$ for y.

$$\begin{array}{r|l} \multicolumn{2}{c}{6x-4y = 1} \\ \hline 6\cdot 1-4\cdot\frac{3}{2} \ ? & 1 \\ 6-6 & \\ 0 & 1 \quad \text{FALSE} \end{array}$$

The equation $0=1$ is false, so $\left(1,\frac{3}{2}\right)$ is not a solution.

12. For $(1.5,2.6)$:

$$\begin{array}{r|l} \multicolumn{2}{c}{x^2+y^2 = 9} \\ \hline (1.5)^2+(2.6)^2 \ ? & 9 \\ 2.25+6.76 & \\ 9.01 & 9 \quad \text{FALSE} \end{array}$$

$(1.5,2.6)$ is not a solution.

For $(-3,0)$:

$$\begin{array}{r|l} \multicolumn{2}{c}{x^2+y^2 = 9} \\ \hline (-3)^2+0^2 \ ? & 9 \\ 9+0 & \\ 9 & 9 \quad \text{TRUE} \end{array}$$

$(-3,0)$ is a solution.

13. To determine whether $\left(-\frac{1}{2},-\frac{4}{5}\right)$ is a solution, substitute $-\frac{1}{2}$ for a and $-\frac{4}{5}$ for b.

$$\begin{array}{r|l} \multicolumn{2}{c}{2a+5b = 3} \\ \hline 2\left(-\frac{1}{2}\right)+5\left(-\frac{4}{5}\right) \ ? & 3 \\ -1-4 & \\ -5 & 3 \quad \text{FALSE} \end{array}$$

The equation $-5=3$ is false, so $\left(-\frac{1}{2},-\frac{4}{5}\right)$ is not a solution.

To determine whether $\left(0,\frac{3}{5}\right)$ is a solution, substitute 0 for a and $\frac{3}{5}$ for b.

$$\begin{array}{r|l} \multicolumn{2}{c}{2a+5b = 3} \\ \hline 2\cdot 0+5\cdot\frac{3}{5} \ ? & 3 \\ 0+3 & \\ 3 & 3 \quad \text{TRUE} \end{array}$$

The equation $3=3$ is true, so $\left(0,\frac{3}{5}\right)$ is a solution.

14. For $\left(0,\frac{3}{2}\right)$:

$$\begin{array}{r|l} \multicolumn{2}{c}{3m+4n = 6} \\ \hline 3\cdot 0+4\cdot\frac{3}{2} \ ? & 6 \\ 0+6 & \\ 6 & 6 \quad \text{TRUE} \end{array}$$

$\left(0,\frac{3}{2}\right)$ is a solution.

For $\left(\frac{2}{3},1\right)$:

$$\begin{array}{r|l} \multicolumn{2}{c}{3m+4n = 6} \\ \hline 3\cdot\frac{2}{3}+4\cdot 1 \ ? & 6 \\ 2+4 & \\ 6 & 6 \quad \text{TRUE} \end{array}$$

The equation $6=6$ is true, so $\left(\frac{2}{3},1\right)$ is a solution.

15. To determine whether $(-0.75, 2.75)$ is a solution, substitute -0.75 for x and 2.75 for y.

$$\begin{array}{r|l} x^2 - y^2 & = 3 \\ \hline (-0.75)^2 - (2.75)^2 & ?\ 3 \\ 0.5625 - 7.5625 & \\ -7 & 3 \quad \text{FALSE} \end{array}$$

The equation $-7 = 3$ is false, so $(-0.75, 2.75)$ is not a solution.

To determine whether $(2, -1)$ is a solution, substitute 2 for x and -1 for y.

$$\begin{array}{r|l} x^2 - y^2 & = 3 \\ \hline 2^2 - (-1)^2 & ?\ 3 \\ 4 - 1 & \\ 3 & 3 \quad \text{TRUE} \end{array}$$

The equation $3 = 3$ is true, so $(2, -1)$ is a solution.

16. For $(2, -4)$:

$$\begin{array}{r|l} 5x + 2y^2 & = 70 \\ \hline 5 \cdot 2 + 2(-4)^2 & ?\ 70 \\ 10 + 2 \cdot 16 & \\ 10 + 32 & \\ 42 & 70 \quad \text{FALSE} \end{array}$$

$(2, -4)$ is not a solution.

For $(4, -5)$:

$$\begin{array}{r|l} 5x + 2y^2 & = 70 \\ \hline 5 \cdot 4 + 2(-5)^2 & ?\ 70 \\ 20 + 2 \cdot 25 & \\ 20 + 50 & \\ 70 & 70 \quad \text{TRUE} \end{array}$$

$(4, -5)$ is a solution.

17. Graph $5x - 3y = -15$.

To find the x-intercept we replace y with 0 and solve for x.

$$5x - 3 \cdot 0 = -15$$
$$5x = -15$$
$$x = -3$$

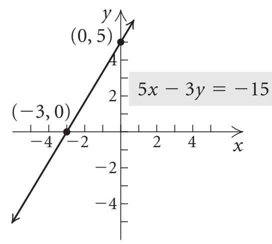
The x-intercept is $(-3, 0)$.

To find the y-intercept we replace x with 0 and solve for y.

$$5 \cdot 0 - 3y = -15$$
$$-3y = -15$$
$$y = 5$$

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

We plot the intercepts and draw the line that contains them. We could find a third point as a check that the intercepts were found correctly.



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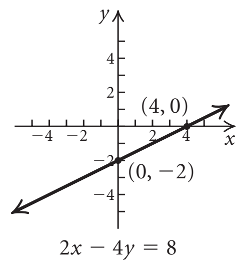


19. Graph $2x + y = 4$.

To find the x-intercept we replace y with 0 and solve for x.

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

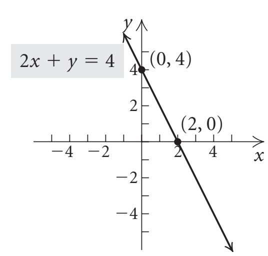
The x-intercept is $(2, 0)$.

To find the y-intercept we replace x with 0 and solve for y.

$$2 \cdot 0 + y = 4$$
$$y = 4$$

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

We plot the intercepts and draw the line that contains them. We could find a third point as a check that the intercepts were found correctly.



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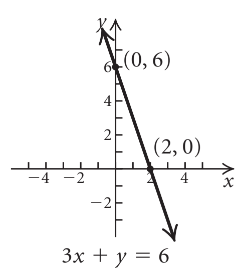


21. Graph $4y - 3x = 12$.

To find the x-intercept we replace y with 0 and solve for x.

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

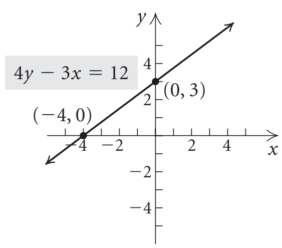
The x-intercept is $(-4, 0)$.

To find the y-intercept we replace x with 0 and solve for y.

$$4y - 3 \cdot 0 = 12$$
$$4y = 12$$
$$y = 3$$

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

We plot the intercepts and draw the line that contains them. We could find a third point as a check that the intercepts were found correctly.



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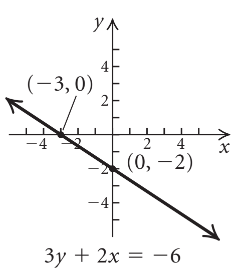


23. Graph $y = 3x + 5$.

We choose some values for x and find the corresponding y-values.

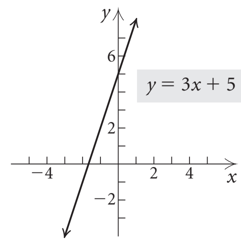
When $x = -3$, $y = 3x + 5 = 3(-3) + 5 = -9 + 5 = -4$.

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

When $x = 0$, $y = 3x + 5 = 3 \cdot 0 + 5 = 0 + 5 = 5$

We list these points in a table, plot them, and draw the graph.

x	y	(x, y)
-3	-4	$(-3, -4)$
-1	2	$(-1, 2)$
0	5	$(0, 5)$



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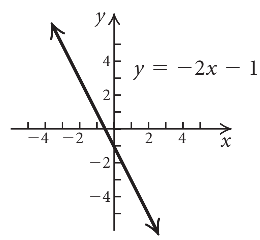
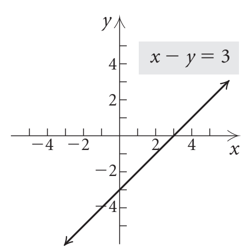


25. Graph $x - y = 3$.

Make a table of values, plot the points in the table, and draw the graph.

x	y	(x, y)
-2	-5	$(-2, -5)$
0	-3	$(0, -3)$
3	0	$(3, 0)$



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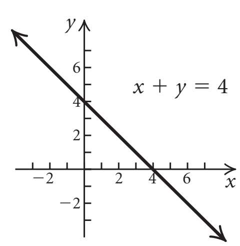
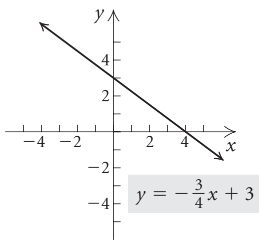


27. Graph $y = -\dfrac{3}{4}x + 3$.

By choosing multiples of 4 for x, we can avoid fraction values for y. Make a table of values, plot the points in the table, and draw the graph.

x	y	(x, y)
-4	6	$(-4, 6)$
0	3	$(0, 3)$
4	0	$(4, 0)$



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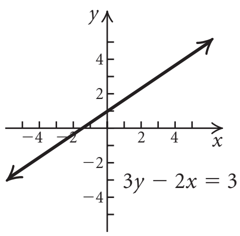


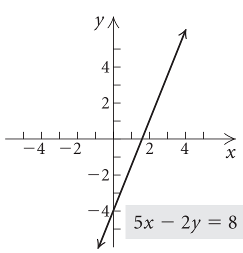
29. Graph $5x - 2y = 8$.

We could solve for y first.

$$5x - 2y = 8$$
$$-2y = -5x + 8 \quad \text{Subtracting } 5x \text{ on both sides}$$
$$y = \frac{5}{2}x - 4 \quad \text{Multiplying by } -\frac{1}{2} \text{ on both sides}$$

By choosing multiples of 2 for x we can avoid fraction values for y. Make a table of values, plot the points in the table, and draw the graph.

x	y	(x, y)
0	-4	$(0, -4)$
2	1	$(2, 1)$
4	6	$(4, 6)$



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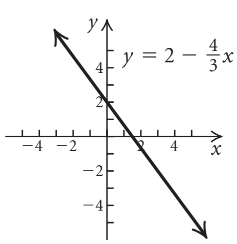
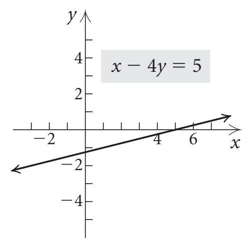


31. Graph $x - 4y = 5$.

Make a table of values, plot the points in the table, and draw the graph.

x	y	(x, y)
-3	-2	$(-3, -2)$
1	-1	$(1, -1)$
5	0	$(5, 0)$



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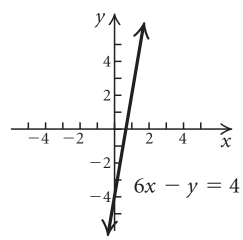
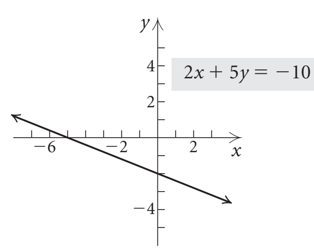


33. Graph $2x + 5y = -10$.

In this case, it is convenient to find the intercepts along with a third point on the graph. Make a table of values, plot the points in the table, and draw the graph.

x	y	(x, y)
-5	0	$(-5, 0)$
0	-2	$(0, -2)$
5	-4	$(5, -4)$



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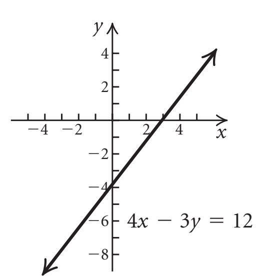
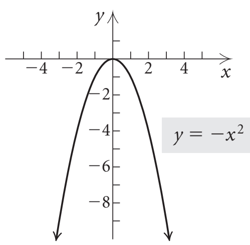


35. Graph $y = -x^2$.

Make a table of values, plot the points in the table, and draw the graph.

x	y	(x, y)
-2	-4	$(-2, -4)$
-1	-1	$(-1, -1)$
0	0	$(0, 0)$
1	-1	$(1, -1)$
2	-4	$(2, -4)$



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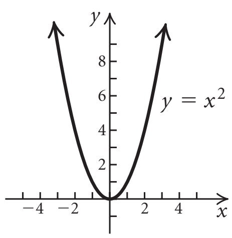
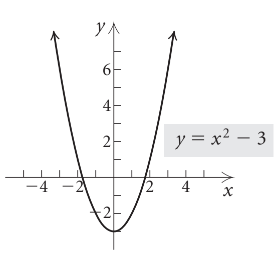


37. Graph $y = x^2 - 3$.

Make a table of values, plot the points in the table, and draw the graph.

x	y	(x, y)
-3	6	$(-3, 6)$
-1	-2	$(-1, -2)$
0	-3	$(0, -3)$
1	-2	$(1, -2)$
3	6	$(3, 6)$



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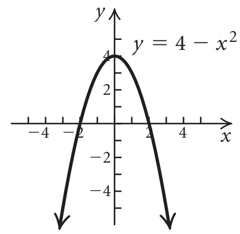
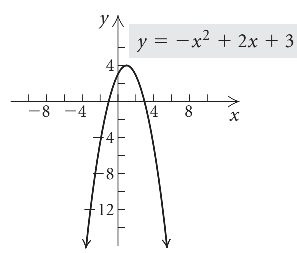


39. Graph $y = -x^2 + 2x + 3$.

Make a table of values, plot the points in the table, and draw the graph.

x	y	(x, y)
-2	-5	$(-2, -5)$
-1	0	$(-1, 0)$
0	3	$(0, 3)$
1	4	$(1, 4)$
2	3	$(2, 3)$
3	0	$(3, 0)$
4	-5	$(4, -5)$



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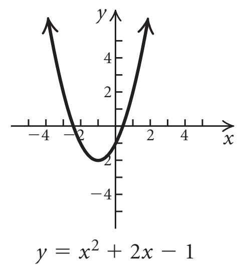


41. Graph (b) is the graph of $y = 3 - x$.

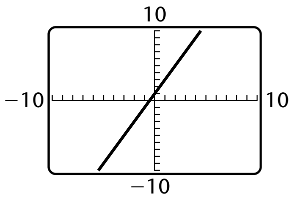
42. Graph (d) is the graph of $2x - y = 6$.

43. Graph (a) is the graph of $y = x^2 + 2x + 1$.

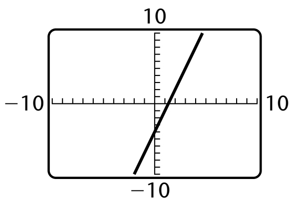
44. Graph (c) is the graph of $y = 8 - x^2$.

45. Enter the equation, select the standard window, and graph the equation as described in the Graphing Calculator Manual that accompanies the text.

$y = 2x + 1$

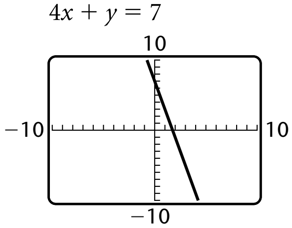


46. $y = 3x - 4$



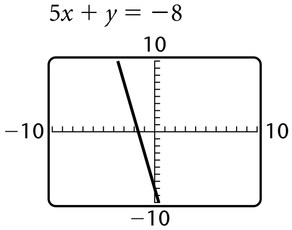
47. First solve the equation for y: $y = -4x + 7$. Enter the equation in this form, select the standard window, and graph the equation as described in the Graphing Calculator Manual that accompanies the text.

$4x + y = 7$



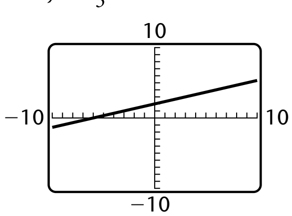
48. $5x + y = -8$, so $y = -5x - 8$.

$5x + y = -8$

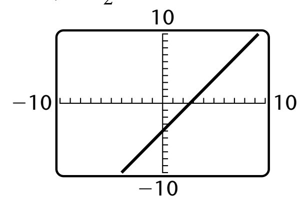


49. Enter the equation, select the standard window, and graph the equation as described in the Graphing Calculator Manual that accompanies the text.

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



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

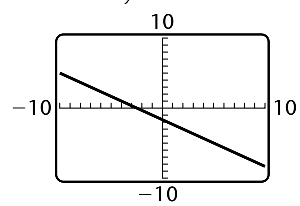


51. First solve the equation for y.

$$2x + 3y = -5$$
$$3y = -2x - 5$$
$$y = \frac{-2x - 5}{3}, \text{ or } \frac{1}{3}(-2x - 5)$$

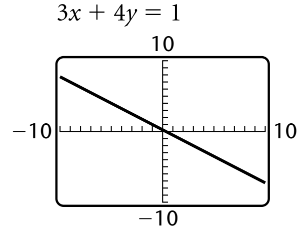
Enter the equation in "$y =$" form, select the standard window, and graph the equation as described in the Graphing Calculator Manual that accompanies the text.

$2x + 3y = -5$



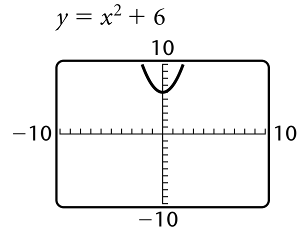
52. $3x + 4y = 1$, so $y = \dfrac{-3x + 1}{4}$, or $y = -\dfrac{3}{4}x + \dfrac{1}{4}$

$3x + 4y = 1$

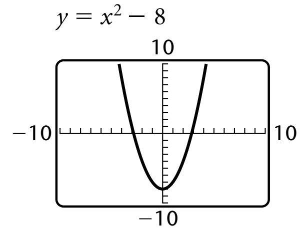


53. Enter the equation, select the standard window, and graph the equation as described in the Graphing Calculator Manual that accompanies the text.

$y = x^2 + 6$

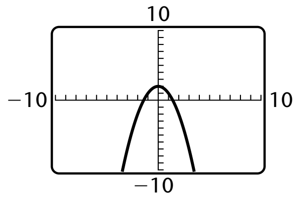


54. $y = x^2 - 8$

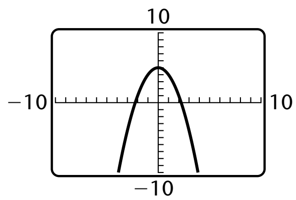


55. Enter the equation, select the standard window, and graph the equation as described in the Graphing Calculator Manual that accompanies the text.

$y = 2 - x^2$

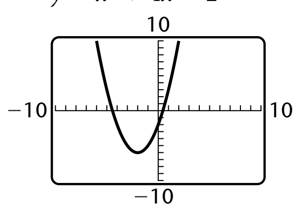


56. $y = 5 - x^2$

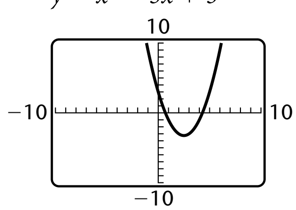


57. Enter the equation, select the standard window, and graph the equation as described in the Graphing Calculator Manual that accompanies the text.

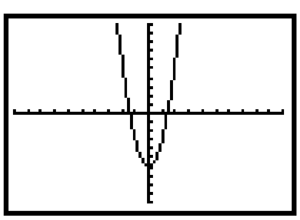
$y = x^2 + 4x - 2$



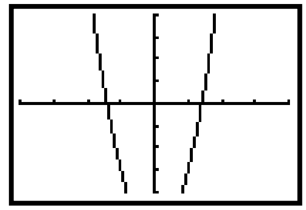
58. $y = x^2 - 5x + 3$



59. Standard window:

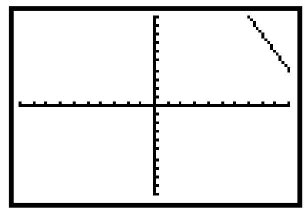


$[-4, 4, -4, 4]$

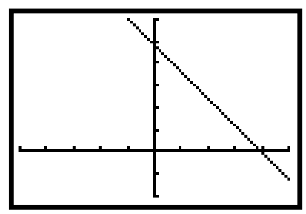


We see that the standard window is a better choice for this graph.

60. Standard window:

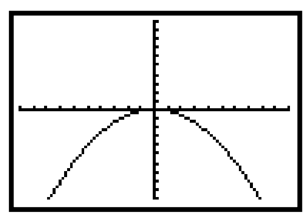


$[-15, 15, -10, 30]$, Xscl $= 3$, Yscl $= 5$

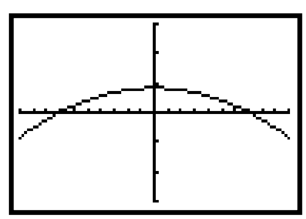


We see that $[-15, 15, -10, 30]$ is a better choice for this graph.

61. Standard window:

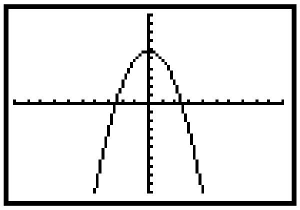


$[-1, 1, -0.3, 0.3]$, Xscl $= 0.1$, Yscl $= 0.1$

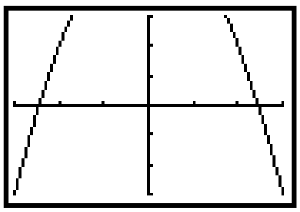


We see that $[-1, 1, -0.3, 0.3]$ is a better choice for this graph.

62. Standard window:



$[-3, 3, -3, 3]$



We see that the standard window is a better choice for this graph.

63. Either point can be considered as (x_1, y_1).

$$d = \sqrt{(4-5)^2 + (6-9)^2}$$
$$= \sqrt{(-1)^2 + (-3)^2} = \sqrt{10} \approx 3.162$$

64. $d = \sqrt{(-3-2)^2 + (7-11)^2} = \sqrt{41} \approx 6.403$

65. Either point can be considered as (x_1, y_1).

$$d = \sqrt{(-13-(-8))^2 + (1-(-11))^2}$$
$$= \sqrt{(-5)^2 + 12^2} = \sqrt{169} = 13$$

66. $d = \sqrt{(-20-(-60))^2 + (35-5)^2} = \sqrt{2500} = 50$

67. Either point can be considered as (x_1, y_1).

$$d = \sqrt{(6-9)^2 + (-1-5)^2}$$
$$= \sqrt{(-3)^2 + (-6)^2} = \sqrt{45} \approx 6.708$$

68. $d = \sqrt{(-4-(-1))^2 + (-7-3)^2} = \sqrt{109} \approx 10.440$

69. Either point can be considered as (x_1, y_1).

$$d = \sqrt{(-8-8)^2 + \left(\frac{7}{11} - \frac{7}{11}\right)^2}$$
$$= \sqrt{(-16)^2 + 0^2} = 16$$

70. $d = \sqrt{\left(\frac{1}{2} - \frac{1}{2}\right)^2 + \left(-\frac{4}{25} - \left(-\frac{13}{25}\right)\right)^2} = \sqrt{\left(\frac{9}{25}\right)^2} = \frac{9}{25}$

71. $d = \sqrt{\left[-\frac{3}{5} - \left(-\frac{3}{5}\right)\right]^2 + \left(-4 - \frac{2}{3}\right)^2}$

$$= \sqrt{0^2 + \left(-\frac{14}{3}\right)^2} = \frac{14}{3}$$

72. $d = \sqrt{\left(-\frac{11}{3} - \frac{1}{3}\right)^2 + \left(-\frac{1}{2} - \frac{5}{2}\right)^2} = \sqrt{16+9} = \sqrt{25} = 5$

73. Either point can be considered as (x_1, y_1).

$$d = \sqrt{(-4.2-2.1)^2 + [3-(-6.4)]^2}$$
$$= \sqrt{(-6.3)^2 + (9.4)^2} = \sqrt{128.05} \approx 11.316$$

74. $d = \sqrt{[0.6-(-8.1)]^2 + [-1.5-(-1.5)]^2} = \sqrt{(8.7)^2} = 8.7$

75. Either point can be considered as (x_1, y_1).

$$d = \sqrt{(0-a)^2 + (0-b)^2} = \sqrt{a^2 + b^2}$$

76. $d = \sqrt{[r-(-r)]^2 + [s-(-s)]^2} = \sqrt{4r^2 + 4s^2} = 2\sqrt{r^2 + s^2}$

77. First we find the length of the diameter:

$$d = \sqrt{(-3-9)^2 + (-1-4)^2}$$
$$= \sqrt{(-12)^2 + (-5)^2} = \sqrt{169} = 13$$

The length of the radius is one-half the length of the diameter, or $\frac{1}{2}(13)$, or 6.5.

78. Radius $= \sqrt{(-3-0)^2 + (5-1)^2} = \sqrt{25} = 5$

Diameter $= 2 \cdot 5 = 10$

79. First we find the distance between each pair of points.

For $(-4, 5)$ and $(6, 1)$:

$$d = \sqrt{(-4-6)^2 + (5-1)^2}$$
$$= \sqrt{(-10)^2 + 4^2} = \sqrt{116}$$

For $(-4, 5)$ and $(-8, -5)$:

$$d = \sqrt{(-4-(-8))^2 + (5-(-5))^2}$$
$$= \sqrt{4^2 + 10^2} = \sqrt{116}$$

For $(6, 1)$ and $(-8, -5)$:

$$d = \sqrt{(6-(-8))^2 + (1-(-5))^2}$$
$$= \sqrt{14^2 + 6^2} = \sqrt{232}$$

Since $(\sqrt{116})^2 + (\sqrt{116})^2 = (\sqrt{232})^2$, the points could be the vertices of a right triangle.

80. For $(-3, 1)$ and $(2, -1)$:

$$d = \sqrt{(-3-2)^2 + (1-(-1))^2} = \sqrt{29}$$

For $(-3, 1)$ and $(6, 9)$:

$$d = \sqrt{(-3-6)^2 + (1-9)^2} = \sqrt{145}$$

For $(2, -1)$ and $(6, 9)$:

$$d = \sqrt{(2-6)^2 + (-1-9)^2} = \sqrt{116}$$

Since $(\sqrt{29})^2 + (\sqrt{116})^2 = (\sqrt{145})^2$, the points could be the vertices of a right triangle.

81. First we find the distance between each pair of points.

For $(-4, 3)$ and $(0, 5)$:

$$d = \sqrt{(-4-0)^2 + (3-5)^2}$$
$$= \sqrt{(-4)^2 + (-2)^2} = \sqrt{20}$$

For $(-4, 3)$ and $(3, -4)$:

$$d = \sqrt{(-4-3)^2 + [3-(-4)]^2}$$
$$= \sqrt{(-7)^2 + 7^2} = \sqrt{98}$$

For $(0,5)$ and $(3,-4)$:

$$d=\sqrt{(0-3)^2+[5-(-4)]^2}$$
$$=\sqrt{(-3)^2+9^2}=\sqrt{90}$$

The greatest distance is $\sqrt{98}$, so if the points are the vertices of a right triangle, then it is the hypotenuse. But $(\sqrt{20})^2+(\sqrt{90})^2\neq(\sqrt{98})^2$, so the points are not the vertices of a right triangle.

82. See the graph of this rectangle in Exercise 93.

The segments with endpoints $(-3,4)$, $(2,-1)$ and $(5,2)$, $(0,7)$ are one pair of opposite sides. We find the length of each of these sides.

For $(-3,4)$, $(2,-1)$:

$$d=\sqrt{(-3-2)^2+(4-(-1))^2}=\sqrt{50}$$

For $(5,2)$, $(0,7)$:

$$d=\sqrt{(5-0)^2+(2-7)^2}=\sqrt{50}$$

The segments with endpoints $(2,-1)$, $(5,2)$ and $(0,7)$, $(-3,4)$ are the second pair of opposite sides. We find their lengths.

For $(2,-1)$, $(5,2)$:

$$d=\sqrt{(2-5)^2+(-1-2)^2}=\sqrt{18}$$

For $(0,7)$, $(-3,4)$:

$$d=\sqrt{(0-(-3))^2+(7-4)^2}=\sqrt{18}$$

The endpoints of the diagonals are $(-3,4)$, $(5,2)$ and $(2,-1)$, $(0,7)$. We find the length of each.

For $(-3,4)$, $(5,2)$:

$$d=\sqrt{(-3-5)^2+(4-2)^2}=\sqrt{68}$$

For $(2,-1)$, $(0,7)$:

$$d=\sqrt{(2-0)^2+(-1-7)^2}=\sqrt{68}$$

The opposite sides of the quadrilateral are the same length and the diagonals are the same length, so the quadrilateral is a rectangle.

83. We use the midpoint formula.

$$\left(\frac{4+(-12)}{2},\frac{-9+(-3)}{2}\right)=\left(-\frac{8}{2},-\frac{12}{2}\right)=(-4,-6)$$

84. $\left(\frac{7+9}{2},\frac{-2+5}{2}\right)=\left(8,\frac{3}{2}\right)$

85. We use the midpoint formula.

$$\left(\frac{0+\left(-\frac{2}{5}\right)}{2},\frac{\frac{1}{2}-0}{2}\right)=\left(\frac{-\frac{2}{5}}{2},\frac{\frac{1}{2}}{2}\right)=\left(-\frac{1}{5},\frac{1}{4}\right)$$

86. $\left(\frac{0+\left(-\frac{7}{13}\right)}{2},\frac{0+\frac{2}{7}}{2}\right)=\left(-\frac{7}{26},\frac{1}{7}\right)$

87. We use the midpoint formula.

$$\left(\frac{6.1+3.8}{2},\frac{-3.8+(-6.1)}{2}\right)=\left(\frac{9.9}{2},-\frac{9.9}{2}\right)=$$
$$(4.95,-4.95)$$

88. $\left(\frac{-0.5+4.8}{2},\frac{-2.7+(-0.3)}{2}\right)=(2.15,-1.5)$

89. We use the midpoint formula.

$$\left(\frac{-6+(-6)}{2},\frac{5+8}{2}\right)=\left(-\frac{12}{2},\frac{13}{2}\right)=\left(-6,\frac{13}{2}\right)$$

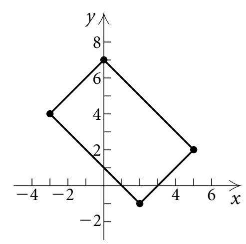
90. $\left(\frac{1+(-1)}{2},\frac{-2+2}{2}\right)=(0,0)$

91. We use the midpoint formula.

$$\left(\frac{-\frac{1}{6}+\left(-\frac{2}{3}\right)}{2},\frac{-\frac{3}{5}+\frac{5}{4}}{2}\right)=\left(\frac{-\frac{5}{6}}{2},\frac{\frac{13}{20}}{2}\right)=$$
$$\left(-\frac{5}{12},\frac{13}{40}\right)$$

92. $\left(\frac{\frac{2}{9}+\left(-\frac{2}{5}\right)}{2},\frac{\frac{1}{3}+\frac{4}{5}}{2}\right)=\left(-\frac{4}{45},\frac{17}{30}\right)$

93.



For the side with vertices $(-3,4)$ and $(2,-1)$:

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

For the side with vertices $(2,-1)$ and $(5,2)$:

$$\left(\frac{2+5}{2},\frac{-1+2}{2}\right)=\left(\frac{7}{2},\frac{1}{2}\right)$$

For the side with vertices $(5,2)$ and $(0,7)$:

$$\left(\frac{5+0}{2},\frac{2+7}{2}\right)=\left(\frac{5}{2},\frac{9}{2}\right)$$

For the side with vertices $(0,7)$ and $(-3,4)$:

$$\left(\frac{0+(-3)}{2},\frac{7+4}{2}\right)=\left(-\frac{3}{2},\frac{11}{2}\right)$$

For the quadrilateral whose vertices are the points found above, the diagonals have endpoints

$$\left(-\frac{1}{2},\frac{3}{2}\right),\left(\frac{5}{2},\frac{9}{2}\right)\text{ and }\left(\frac{7}{2},\frac{1}{2}\right),\left(-\frac{3}{2},\frac{11}{2}\right).$$

We find the length of each of these diagonals.

For $\left(-\frac{1}{2},\frac{3}{2}\right)$, $\left(\frac{5}{2},\frac{9}{2}\right)$:

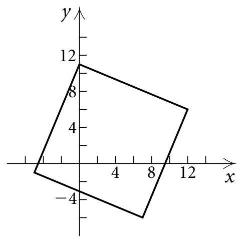
$$d=\sqrt{\left(-\frac{1}{2}-\frac{5}{2}\right)^2+\left(\frac{3}{2}-\frac{9}{2}\right)^2}$$
$$=\sqrt{(-3)^2+(-3)^2}=\sqrt{18}$$

For $\left(\frac{7}{2},\frac{1}{2}\right)$, $\left(-\frac{3}{2},\frac{11}{2}\right)$:

$$d=\sqrt{\left(\frac{7}{2}-\left(-\frac{3}{2}\right)\right)^2+\left(\frac{1}{2}-\frac{11}{2}\right)^2}$$
$$=\sqrt{5^2+(-5)^2}=\sqrt{50}$$

Since the diagonals do not have the same lengths, the midpoints are not vertices of a rectangle.

94.



For the side with vertices $(-5,-1)$ and $(7,-6)$:

$$\left(\frac{-5+7}{2}, \frac{-1+(-6)}{2}\right) = \left(1, -\frac{7}{2}\right)$$

For the side with vertices $(7,-6)$ and $(12,6)$:

$$\left(\frac{7+12}{2}, \frac{-6+6}{2}\right) = \left(\frac{19}{2}, 0\right)$$

For the side with vertices $(12,6)$ and $(0,11)$:

$$\left(\frac{12+0}{2}, \frac{6+11}{2}\right) = \left(6, \frac{17}{2}\right)$$

For the side with vertices $(0,11)$ and $(-5,-1)$:

$$\left(\frac{0+(-5)}{2}, \frac{11+(-1)}{2}\right) = \left(-\frac{5}{2}, 5\right)$$

For the quadrilateral whose vertices are the points found above, one pair of opposite sides has endpoints $\left(1, -\frac{7}{2}\right)$, $\left(\frac{19}{2}, 0\right)$ and $\left(6, \frac{17}{2}\right)$, $\left(-\frac{5}{2}, 5\right)$. The length of each of these sides is $\frac{\sqrt{338}}{2}$. The other pair of opposite sides has endpoints $\left(\frac{19}{2}, 0\right)$, $\left(6, \frac{17}{2}\right)$ and $\left(-\frac{5}{2}, 5\right)$, $\left(1, -\frac{7}{2}\right)$. The length of each of these sides is also $\frac{\sqrt{338}}{2}$. The endpoints of the diagonals of the quadrilateral are $\left(1, -\frac{7}{2}\right)$, $\left(6, \frac{17}{2}\right)$ and $\left(\frac{19}{2}, 0\right)$, $\left(-\frac{5}{2}, 5\right)$. The length of each diagonal is 13. Since the four sides of the quadrilateral are the same length and the diagonals are the same length, the midpoints are vertices of a square.

95. We use the midpoint formula.

$$\left(\frac{\sqrt{7}+\sqrt{2}}{2}, \frac{-4+3}{2}\right) = \left(\frac{\sqrt{7}+\sqrt{2}}{2}, -\frac{1}{2}\right)$$

96. $\left(\frac{-3+1}{2}, \frac{\sqrt{5}+\sqrt{2}}{2}\right) = \left(-1, \frac{\sqrt{5}+\sqrt{2}}{2}\right)$

97. Square the viewing window. For the graph shown, one possibility is $[-12, 9, -4, 10]$.

98. Square the viewing window. For the graph shown, one possibility is $[-10, 20, -15, 5]$.

99. $(x-h)^2 + (y-k)^2 = r^2$

$(x-2)^2 + (y-3)^2 = \left(\frac{5}{3}\right)^2$ Substituting

$(x-2)^2 + (y-3)^2 = \frac{25}{9}$

100. $(x-4)^2 + (y-5)^2 = (4.1)^2$

$(x-4)^2 + (y-5)^2 = 16.81$

101. The length of a radius is the distance between $(-1,4)$ and $(3,7)$:

$$r = \sqrt{(-1-3)^2 + (4-7)^2}$$
$$= \sqrt{(-4)^2 + (-3)^2} = \sqrt{25} = 5$$

$$(x-h)^2 + (y-k)^2 = r^2$$
$$[x-(-1)]^2 + (y-4)^2 = 5^2$$
$$(x+1)^2 + (y-4)^2 = 25$$

102. Find the length of a radius:

$r = \sqrt{(6-1)^2 + (-5-7)^2} = \sqrt{169} = 13$

$$(x-6)^2 + [y-(-5)]^2 = 13^2$$
$$(x-6)^2 + (y+5)^2 = 169$$

103. The center is the midpoint of the diameter:

$$\left(\frac{7+(-3)}{2}, \frac{13+(-11)}{2}\right) = (2,1)$$

Use the center and either endpoint of the diameter to find the length of a radius. We use the point $(7,13)$:

$$r = \sqrt{(7-2)^2 + (13-1)^2}$$
$$= \sqrt{5^2 + 12^2} = \sqrt{169} = 13$$

$$(x-h)^2 + (y-k)^2 = r^2$$
$$(x-2)^2 + (y-1)^2 = 13^2$$
$$(x-2)^2 + (y-1)^2 = 169$$

104. The points $(-9,4)$ and $(-1,-2)$ are opposite vertices of the square and hence endpoints of a diameter of the circle. We use these points to find the center and radius.

Center: $\left(\frac{-9+(-1)}{2}, \frac{4+(-2)}{2}\right) = (-5,1)$

Radius: $\frac{1}{2}\sqrt{(-9-(-1))^2+(4-(-2))^2} = \frac{1}{2}\cdot 10 = 5$

$$[x-(-5)]^2 + (y-1)^2 = 5^2$$
$$(x+5)^2 + (y-1)^2 = 25$$

105. Since the center is 2 units to the left of the y-axis and the circle is tangent to the y-axis, the length of a radius is 2.

$$(x-h)^2 + (y-k)^2 = r^2$$
$$[x-(-2)]^2 + (y-3)^2 = 2^2$$
$$(x+2)^2 + (y-3)^2 = 4$$

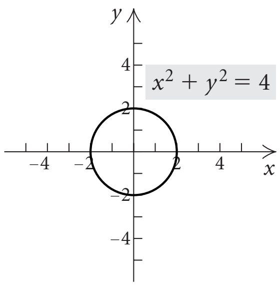
106. Since the center is 5 units below the x-axis and the circle is tangent to the x-axis, the length of a radius is 5.

$$(x-4)^2 + [y-(-5)]^2 = 5^2$$
$$(x-4)^2 + (y+5)^2 = 25$$

107. $x^2 + y^2 = 4$

$(x-0)^2 + (y-0)^2 = 2^2$

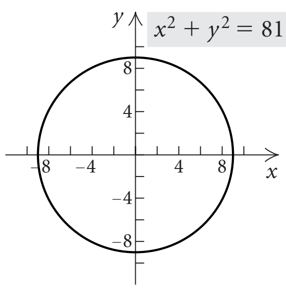
Center: $(0,0)$; radius: 2



108. $x^2 + y^2 = 81$

$(x-0)^2 + (y-0)^2 = 9^2$

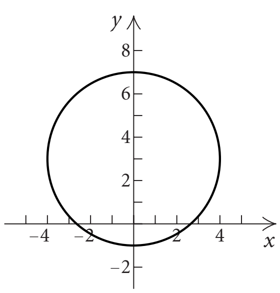
Center: $(0,0)$; radius: 9



109. $x^2 + (y-3)^2 = 16$

$(x-0)^2 + (y-3)^2 = 4^2$

Center: $(0,3)$; radius: 4

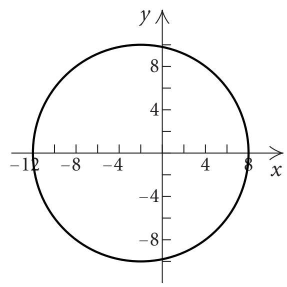


$x^2 + (y-3)^2 = 16$

110. $(x+2)^2 + y^2 = 100$

$[x-(-2)]^2 + (y-0)^2 = 10^2$

Center: $(-2,0)$; radius: 10

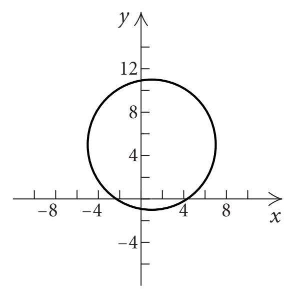


$(x+2)^2 + y^2 = 100$

111. $(x-1)^2 + (y-5)^2 = 36$

$(x-1)^2 + (y-5)^2 = 6^2$

Center: $(1,5)$; radius: 6

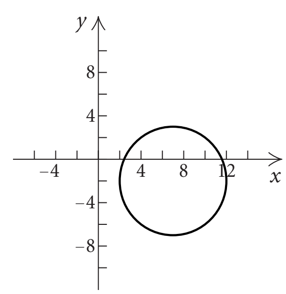


$(x-1)^2 + (y-5)^2 = 36$

112. $(x-7)^2 + (y+2)^2 = 25$

$(x-7)^2 + [y-(-2)]^2 = 5^2$

Center: $(7,-2)$; radius: 5

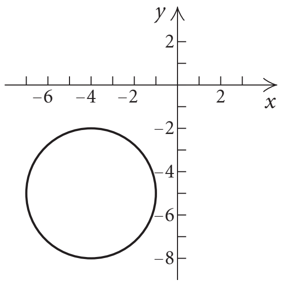


$(x-7)^2 + (y+2)^2 = 25$

113. $(x+4)^2+(y+5)^2=9$

$[x-(-4)]^2+[y-(-5)]^2=3^2$

Center: $(-4,-5)$; radius: 3

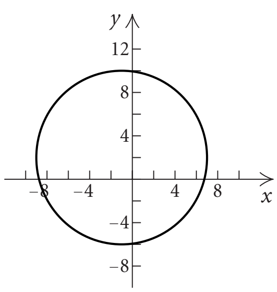


$(x+4)^2+(y+5)^2=9$

114. $(x+1)^2+(y-2)^2=64$

$[x-(-1)]^2+(y-2)^2=8^2$

Center: $(-1,2)$; radius: 8



$(x+1)^2+(y-2)^2=64$

115. From the graph we see that the center of the circle is $(-2,1)$ and the radius is 3. The equation of the circle is $[x-(-2)]^2+(y-1)^2=3^2$, or $(x+2)^2+(y-1)^2=3^2$.

116. Center: $(3,-5)$, radius: 4

Equation: $(x-3)^2+[y-(-5)]^2=4^2$, or

$(x-3)^2+(y+5)^2=4^2$

117. From the graph we see that the center of the circle is $(5,-5)$ and the radius is 15. The equation of the circle is $(x-5)^2+[y-(-5)]^2=15^2$, or $(x-5)^2+(y+5)^2=15^2$.

118. Center: $(-8,2)$, radius: 4

Equation: $[x-(-8)]^2+(y-2)^2=4^2$, or

$(x+8)^2+(y-2)^2=4^2$

119. The Pythagorean theorem is used to derive the distance formula, and the distance formula is used to derive the equation of a circle in standard form.

120. Let $A=(a,b)$ and $B=(c,d)$. The coordinates of a point C one-half of the way from A to B are $\left(\dfrac{a+c}{2},\dfrac{b+d}{2}\right)$. A point D that is one-half of the way from C to B is $\dfrac{1}{2}+\dfrac{1}{2}\cdot\dfrac{1}{2}$, or $\dfrac{3}{4}$ of the way from A to B. Its coordinates are $\left(\dfrac{\frac{a+c}{2}+c}{2},\dfrac{\frac{b+d}{2}+d}{2}\right)$, or $\left(\dfrac{a+3c}{4},\dfrac{b+3d}{4}\right)$. Then a point E that is one-half of the way from D to B is $\dfrac{3}{4}+\dfrac{1}{2}\cdot\dfrac{1}{4}$, or $\dfrac{7}{8}$ of the way from A to B. Its coordinates are $\left(\dfrac{\frac{a+3c}{4}+c}{2},\dfrac{\frac{b+3d}{4}+d}{2}\right)$, or $\left(\dfrac{a+7c}{8},\dfrac{b+7d}{8}\right)$.

121. If the point (p,q) is in the fourth quadrant, then $p>0$ and $q<0$. If $p>0$, then $-p<0$ so both coordinates of the point $(q,-p)$ are negative and $(q,-p)$ is in the third quadrant.

122. Use the distance formula:

$$d=\sqrt{(a+h-a)^2+\left(\frac{1}{a+h}-\frac{1}{a}\right)^2}=$$

$$\sqrt{h^2+\left(\frac{-h}{a(a+h)}\right)^2}=\sqrt{h^2+\frac{h^2}{a^2(a+h)^2}}=$$

$$\sqrt{\frac{h^2a^2(a+h)^2+h^2}{a^2(a+h)^2}}=\sqrt{\frac{h^2(a^2(a+h)^2+1)}{a^2(a+h)^2}}=$$

$$\left|\frac{h}{a(a+h)}\right|\sqrt{a^2(a+h)^2+1}$$

Find the midpoint:

$$\left(\frac{a+a+h}{2},\frac{\frac{1}{a}+\frac{1}{a+h}}{2}\right)=\left(\frac{2a+h}{2},\frac{2a+h}{2a(a+h)}\right)$$

123. Use the distance formula. Either point can be considered as (x_1,y_1).

$$d=\sqrt{(a+h-a)^2+(\sqrt{a+h}-\sqrt{a})^2}$$
$$=\sqrt{h^2+a+h-2\sqrt{a^2+ah}+a}$$
$$=\sqrt{h^2+2a+h-2\sqrt{a^2+ah}}$$

Next we use the midpoint formula.

$$\left(\frac{a+a+h}{2},\frac{\sqrt{a}+\sqrt{a+h}}{2}\right)=\left(\frac{2a+h}{2},\frac{\sqrt{a}+\sqrt{a+h}}{2}\right)$$

124. $C=2\pi r$

$10\pi=2\pi r$

$5=r$

Then $[x-(-5)]^2+(y-8)^2=5^2$, or $(x+5)^2+(y-8)^2=25$.

125. First use the formula for the area of a circle to find r^2:

$A=\pi r^2$

$36\pi=\pi r^2$

$36=r^2$

Then we have:

$(x-h)^2+(y-k)^2=r^2$

$(x-2)^2+[y-(-7)]^2=36$

$(x-2)^2+(y+7)^2=36$

126. Let the point be $(x,0)$. We set the distance from $(-4,-3)$ to $(x,0)$ equal to the distance from $(-1,5)$ to $(x,0)$ and solve for x.

$$\begin{aligned}
\sqrt{(-4-x)^2+(-3-0)^2} &= \sqrt{(-1-x)^2+(5-0)^2}\\
\sqrt{16+8x+x^2+9} &= \sqrt{1+2x+x^2+25}\\
\sqrt{x^2+8x+25} &= \sqrt{x^2+2x+26}\\
x^2+8x+25 &= x^2+2x+26\\
&\quad \text{Squaring both sides}\\
8x+25 &= 2x+26\\
6x &= 1\\
x &= \frac{1}{6}
\end{aligned}$$

The point is $\left(\frac{1}{6}, 0\right)$.

127. Let $(0, y)$ be the required point. We set the distance from $(-2, 0)$ to $(0, y)$ equal to the distance from $(4, 6)$ to $(0, y)$ and solve for y.

$$\begin{aligned}
\sqrt{[0-(-2)]^2+(y-0)^2} &= \sqrt{(0-4)^2+(y-6)^2}\\
\sqrt{4+y^2} &= \sqrt{16+y^2-12y+36}\\
4+y^2 &= 16+y^2-12y+36\\
&\quad \text{Squaring both sides}\\
-48 &= -12y\\
4 &= y
\end{aligned}$$

The point is $(0, 4)$.

128. We first find the distance between each pair of points.

For $(-1, -3)$ and $(-4, -9)$:

$$\begin{aligned}
d_1 &= \sqrt{[-1-(-4)]^2+[-3-(-9)]^2}\\
&= \sqrt{3^2+6^2} = \sqrt{9+36}\\
&= \sqrt{45} = 3\sqrt{5}
\end{aligned}$$

For $(-1, -3)$ and $(2, 3)$:

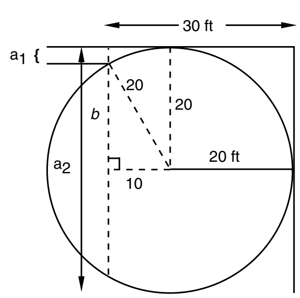
$$\begin{aligned}
d_2 &= \sqrt{(-1-2)^2+(-3-3)^2}\\
&= \sqrt{(-3)^2+(-6)^2} = \sqrt{9+36}\\
&= \sqrt{45} = 3\sqrt{5}
\end{aligned}$$

For $(-4, -9)$ and $(2, 3)$:

$$\begin{aligned}
d_3 &= \sqrt{(-4-2)^2+(-9-3)^2}\\
&= \sqrt{(-6)^2+(-12)^2} = \sqrt{36+144}\\
&= \sqrt{180} = 6\sqrt{5}
\end{aligned}$$

Since $d_1 + d_2 = d_3$, the points are collinear.

129. Label the drawing with additional information and lettering.



Find b using the Pythagorean theorem.

$$\begin{aligned}
b^2+10^2 &= 20^2\\
b^2+100 &= 400\\
b^2 &= 300\\
b &= 10\sqrt{3}\\
b &\approx 17.3
\end{aligned}$$

Find a_1:

$a_1 = 20 - b \approx 20 - 17.3 \approx 2.7$ ft

Find a_2:

$a_2 = 2b + a_1 \approx 2(17.3) + 2.7 \approx 37.3$ ft

130. a) When the circle is positioned on a coordinate system as shown in the text, the center lies on the y-axis and is equidistant from $(-4, 0)$ and $(0, 2)$.

Let $(0, y)$ be the coordinates of the center.

$$\begin{aligned}
\sqrt{(-4-0)^2+(0-y)^2} &= \sqrt{(0-0)^2+(2-y)^2}\\
4^2+y^2 &= (2-y)^2\\
16+y^2 &= 4-4y+y^2\\
12 &= -4y\\
-3 &= y
\end{aligned}$$

The center of the circle is $(0, -3)$.

b) Use the point $(-4, 0)$ and the center $(0, -3)$ to find the radius.

$$\begin{aligned}
(-4-0)^2+[0-(-3)]^2 &= r^2\\
25 &= r^2\\
5 &= r
\end{aligned}$$

The radius is 5 ft.

131.

$$\begin{array}{r|l}
\multicolumn{2}{c}{x^2+y^2 = 1}\\
\hline
\left(\frac{\sqrt{3}}{2}\right)^2+\left(-\frac{1}{2}\right)^2 & ?\ 1\\
\frac{3}{4}+\frac{1}{4} & \\
1 & 1 \quad \text{TRUE}
\end{array}$$

$\left(\frac{\sqrt{3}}{2}, -\frac{1}{2}\right)$ lies on the unit circle.

132.

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

$(0, -1)$ lies on the unit circle.

133.

$$\begin{array}{r|l}
\multicolumn{2}{c}{x^2+y^2 = 1}\\
\hline
\left(\frac{\sqrt{2}}{2}\right)^2+\left(\frac{\sqrt{2}}{2}\right)^2 & ?\ 1\\
\frac{2}{4}+\frac{2}{4} & \\
1 & 1 \quad \text{TRUE}
\end{array}$$

$\left(\frac{\sqrt{2}}{2}, \frac{\sqrt{2}}{2}\right)$ lies on the unit circle.

134.
$$\begin{array}{c|c} x^2+y^2 & 1 \\ \hline \left(\frac{1}{2}\right)^2+\left(-\frac{\sqrt{3}}{2}\right)^2 & ?\ 1 \\ \frac{1}{4}+\frac{3}{4} & \\ 1 & 1 \text{ TRUE} \end{array}$$

$\left(\frac{1}{2}, -\frac{\sqrt{3}}{2}\right)$ lies on the unit circle.

135. a), b) See the answer section in the text.

136. The coordinates of P are $\left(\frac{b}{2}, \frac{h}{2}\right)$ by the midpoint formula. By the distance formula, each of the distances from P to $(0,h)$, from P to $(0,0)$, and from P to $(b,0)$ is $\frac{\sqrt{b^2+h^2}}{2}$.

Exercise Set 1.2

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

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

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

4. This correspondence is not a function, because there is a member of the domain (1) that corresponds to more than one member of the range (4 and 6).

5. This correspondence is not a function, because there is a member of the domain (m) that corresponds to more than one member of the range (A and B).

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

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

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

9. This correspondence is a function, because each car has exactly one license number.

10. This correspondence is not a function, because we can safely assume that at least one person uses more than one doctor.

11. This correspondence is a function, because each member of the family has exactly one eye color.

12. This correspondence is not a function, because we can safely assume that at least one band member plays more than one instrument.

13. This correspondence is not a function, because at least one student will have more than one neighboring seat occupied by another student.

14. This correspondence is a function, because each bag has exactly one weight.

15. The relation is a function, because no two ordered pairs have the same first coordinate and different second coordinates.

The domain is the set of all first coordinates: $\{2, 3, 4\}$.

The range is the set of all second coordinates: $\{10, 15, 20\}$.

16. The relation is a function, because no two ordered pairs have the same first coordinate and different second coordinates.

Domain: $\{3, 5, 7\}$

Range: $\{1\}$

17. The relation is not a function, because the ordered pairs $(-2, 1)$ and $(-2, 4)$ have the same first coordinate and different second coordinates.

The domain is the set of all first coordinates: $\{-7, -2, 0\}$.

The range is the set of all second coordinates: $\{3, 1, 4, 7\}$.

18. The relation is not a function, because each of the ordered pairs has the same first coordinate and different second coordinates.

Domain: $\{1\}$

Range: $\{3, 5, 7, 9\}$

19. The relation is a function, because no two ordered pairs have the same first coordinate and different second coordinates.

The domain is the set of all first coordinates: $\{-2, 0, 2, 4, -3\}$.

The range is the set of all second coordinates: $\{1\}$.

20. The relation is not a function, because the ordered pairs $(5, 0)$ and $(5, -1)$ have the same first coordinates and different second coordinates. This is also true of the pairs $(3, -1)$ and $(3, -2)$.

Domain: $\{5, 3, 0\}$

Range: $\{0, -1, -2\}$

21. $g(x) = 3x^2 - 2x + 1$

a) $g(0) = 3 \cdot 0^2 - 2 \cdot 0 + 1 = 1$

b) $g(-1) = 3(-1)^2 - 2(-1) + 1 = 6$

c) $g(3) = 3 \cdot 3^2 - 2 \cdot 3 + 1 = 22$

d) $g(-x) = 3(-x)^2 - 2(-x) + 1 = 3x^2 + 2x + 1$

e) $g(1-t) = 3(1-t)^2 - 2(1-t) + 1 =$
$3(1-2t+t^2) - 2(1-t) + 1 = 3 - 6t + 3t^2 - 2 + 2t + 1 =$
$3t^2 - 4t + 2$

22. $f(x) = 5x^2 + 4x$

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) $f(t-1) = 5(t-1)^2 + 4(t-1) = 5t^2 - 6t + 1$

23. $g(x) = x^3$

a) $g(2) = 2^3 = 8$

b) $g(-2) = (-2)^3 = -8$

c) $g(-x) = (-x)^3 = -x^3$

d) $g(3y) = (3y)^3 = 27y^3$

e) $g(2+h) = (2+h)^3 = 8 + 12h + 6h^2 + h^3$

24. $f(x) = 2|x| + 3x$

a) $f(1) = 2|1| + 3 \cdot 1 = 2 + 3 = 5$

b) $f(-2) = 2|-2| + 3(-2) = 4 - 6 = -2$

c) $f(-x) = 2|-x| + 3(-x) = 2|x| - 3x$

d) $f(2y) = 2|2y| + 3 \cdot 2y = 4|y| + 6y$

e) $f(2-h) = 2|2-h| + 3(2-h) =$
$2|2-h| + 6 - 3h$

25. $g(x) = \dfrac{x-4}{x+3}$

a) $g(5) = \dfrac{5-4}{5+3} = \dfrac{1}{8}$

b) $g(4) = \dfrac{4-4}{4+7} = 0$

c) $g(-3) = \dfrac{-3-4}{-3+3} = \dfrac{-7}{0}$

Since division by 0 is not defined, $g(-3)$ does not exist.

d) $g(-16.25) = \dfrac{-16.25-4}{-16.25+3} = \dfrac{-20.25}{-13.25} = \dfrac{81}{53} \approx 1.5283$

e) $g(x+h) = \dfrac{x+h-4}{x+h+3}$

26. $f(x) = \dfrac{x}{2-x}$

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

Since division by 0 is not defined, $f(2)$ does not exist.

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

c) $f(-16) = \dfrac{-16}{2-(-16)} = \dfrac{-16}{18} = -\dfrac{8}{9}$

d) $f(-x) = \dfrac{-x}{2-(-x)} = \dfrac{-x}{2+x}$

e) $f\left(-\dfrac{2}{3}\right) = \dfrac{-\frac{2}{3}}{2-\left(-\frac{2}{3}\right)} = \dfrac{-\frac{2}{3}}{\frac{8}{3}} = -\dfrac{1}{4}$

27. $g(x) = \dfrac{x}{\sqrt{1-x^2}}$

$g(0) = \dfrac{0}{\sqrt{1-0^2}} = \dfrac{0}{\sqrt{1}} = \dfrac{0}{1} = 0$

$g(-1) = \dfrac{-1}{\sqrt{1-(-1)^2}} = \dfrac{-1}{\sqrt{1-1}} = \dfrac{-1}{\sqrt{0}} = \dfrac{-1}{0}$

Since division by 0 is not defined, $g(-1)$ does not exist.

$g(5) = \dfrac{5}{\sqrt{1-5^2}} = \dfrac{5}{\sqrt{1-25}} = \dfrac{5}{\sqrt{-24}}$

Since $\sqrt{-24}$ is not defined as a real number, $g(5)$ does not exist as a real number.

$g\left(\dfrac{1}{2}\right) = \dfrac{\frac{1}{2}}{\sqrt{1-\left(\frac{1}{2}\right)^2}} = \dfrac{\frac{1}{2}}{\sqrt{1-\frac{1}{4}}} = \dfrac{\frac{1}{2}}{\sqrt{\frac{3}{4}}} =$

$\dfrac{\frac{1}{2}}{\frac{\sqrt{3}}{2}} = \dfrac{1}{2} \cdot \dfrac{2}{\sqrt{3}} = \dfrac{1 \cdot 2}{2\sqrt{3}} = \dfrac{1}{\sqrt{3}}$, or $\dfrac{\sqrt{3}}{3}$

28. $h(x) = x + \sqrt{x^2-1}$

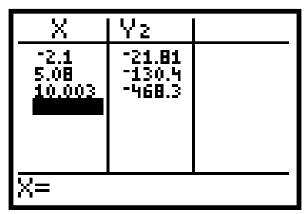
$h(0) = 0 + \sqrt{0^2-1} = 0 + \sqrt{-1}$

Since $\sqrt{-1}$ is not defined as a real number, $h(0)$ does not exist as a real number.

$h(2) = 2 + \sqrt{2^2-1} = 2 + \sqrt{3}$

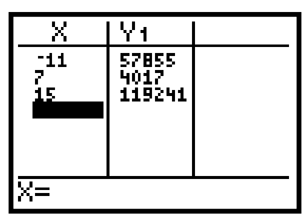
$h(-x) = -x + \sqrt{(-x)^2-1} = -x + \sqrt{x^2-1}$

29.



Rounding to the nearest tenth, we see that $g(-2.1) \approx -21.8$, $g(5.08) \approx -130.4$, and $g(10.003) \approx -468.3$.

30.

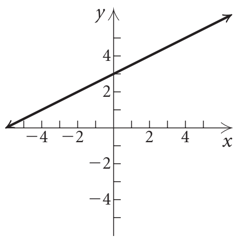


We see that $h(-11) = 57,885$, $h(7) = 4017$, and $h(15) = 119,241$.

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

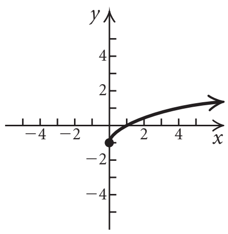
We select values for x and find the corresponding values of $f(x)$. Then we plot the points and connect them with a smooth curve.

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



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

32.

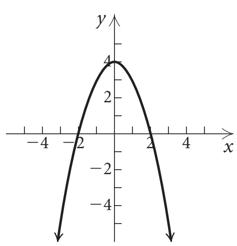


$f(x) = \sqrt{x} - 1$

33. Graph $f(x) = -x^2 + 4$.

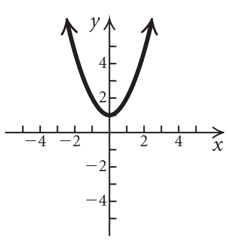
We select values for x and find the corresponding values of $f(x)$. Then we plot the points and connect them with a smooth curve.

x	$f(x)$	$(x, f(x))$
-3	-5	$(-3, -5)$
-2	0	$(-2, 0)$
-1	3	$(-1, 3)$
0	4	$(0, 4)$
1	3	$(1, 3)$
2	0	$(2, 0)$
3	-5	$(3, -5)$



$f(x) = -x^2 + 4$

34.

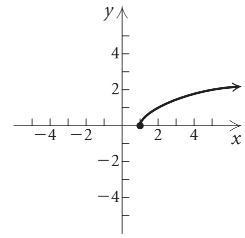


$f(x) = x^2 + 1$

35. Graph $f(x) = \sqrt{x-1}$.

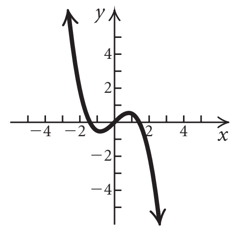
We select values for x and find the corresponding values of $f(x)$. Then we plot the points and connect them with a smooth curve.

x	$f(x)$	$(x, f(x))$
1	0	$(1, 0)$
2	1	$(2, 1)$
4	1.7	$(4, 1.7)$
5	2	$(5, 2)$



$f(x) = \sqrt{x - 1}$

36.



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

37. From the graph we see that, when the input is 1, the output is -2, so $h(1) = -2$. When the input is 3, the output is 2, so $h(3) = 2$. When the input is 4, the output is 1, so $h(4) = 1$.

38. $t(-4) = 3$; $t(0) = 3$; $t(3) = 3$

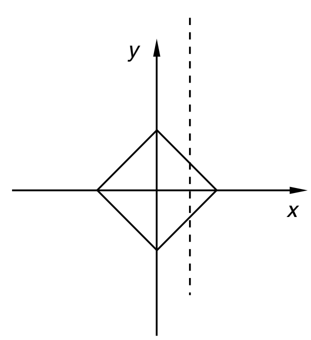
39. From the graph we see that, when the input is -4, the output is 3, so $s(-4) = 3$. When the input is -2, the output is 0, so $s(-2) = 0$. When the input is 0, the output is -3, so $s(0) = -3$.

40. $g(-4) = \dfrac{3}{2}$; $g(-1) = -3$; $g(0) = -\dfrac{5}{2}$

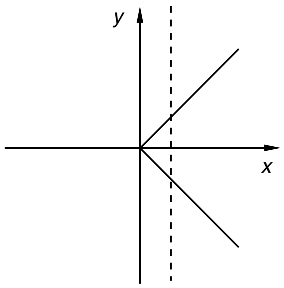
41. From the graph we see that, when the input is -1, the output is 2, so $f(-1) = 2$. When the input is 0, the output is 0, so $f(0) = 0$. When the input is 1, the output is -2, so $f(1) = -2$.

42. $g(-2) = 4$; $g(0) = -4$; $g(2.4) = -2.6176$

43. This is not the graph of a function, because we can find a vertical line that crosses the graph more than once.



44. This is not the graph of a function, because we can find a vertical line that crosses the graph more than once.



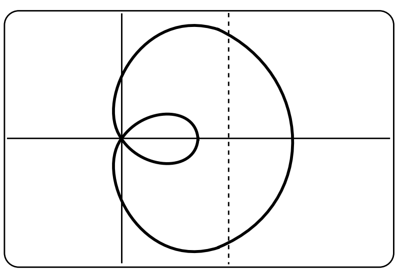
45. This is the graph of a function, because there is no vertical line that crosses the graph more than once.

46. This is the graph of a function, because there is no vertical line that crosses the graph more than once.

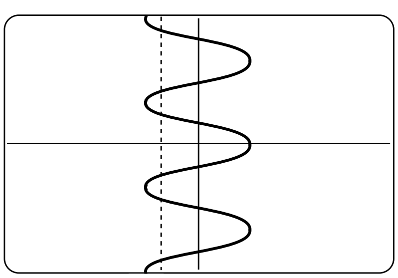
47. This is the graph of a function, because there is no vertical line that crosses the graph more than once.

48. This is the graph of a function, because there is no vertical line that crosses the graph more than once.

49. This is not the graph of a function, because we can find a vertical line that crosses the graph more than once.



50. This is not the graph of a function, because we can find a vertical line that crosses the graph more than once.



51. We can substitute any real number for x. Thus, the domain is the set of all real numbers, or $(-\infty, \infty)$.

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56. We can substitute any real number for x. Thus, the domain is the set of all real numbers, or $(-\infty, \infty)$.

57. We can substitute any real number in the numerator, but we must avoid inputs that make the denominator 0. We find these inputs.

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

The domain is $\{x|x \neq 2\}$, or $(-\infty, 2) \cup (2, \infty)$.

58. We find the inputs that make the denominator 0:

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

The domain is $\{x|x \neq -4\}$, or $(-\infty, -4) \cup (-4, \infty)$.

59. We find the inputs that make the denominator 0:

$$x^2 - 4x - 5 = 0$$
$$(x - 5)(x + 1) = 0$$
$$x - 5 = 0 \quad or \quad x + 1 = 0$$
$$x = 5 \quad or \quad x = -1$$

The domain is $\{x|x \neq 5 \textit{ and } x \neq -1\}$, or $(-\infty, -1) \cup (-1, 5) \cup (5, \infty)$.

60. We can substitute any real number in the numerator, but the input 0 makes the denominator 0. Thus, the domain is $\{x|x \neq 0\}$, or $(-\infty, 0) \cup (0, \infty)$.

61. We can substitute any real number in the numerator, but we must avoid inputs that make the denominator 0. We find these inputs.

$$x^2 - 7x = 0$$
$$x(x - 7) = 0$$
$$x = 0 \quad or \quad x - 7 = 0$$
$$x = 0 \quad or \quad x = 7$$

The domain is $\{x|x \neq 0 \textit{ and } x \neq 7\}$, or $(-\infty, 0) \cup (0, 7) \cup (7, \infty)$.

62. We can substitute any real number in the numerator, but we must avoid inputs that make the denominator 0. We find these inputs.

$$3x^2 - 10x - 8 = 0$$
$$(3x + 2)(x - 4) = 0$$
$$3x + 2 = 0 \quad or \quad x - 4 = 0$$
$$3x = -2 \quad or \quad x = 4$$
$$x = -\frac{2}{3} \quad or \quad x = 4$$

The domain is $\left\{x \middle| x \neq -\frac{2}{3} \textit{ and } x \neq 4\right\}$, or $\left(-\infty, -\frac{2}{3}\right) \cup \left(-\frac{2}{3}, 4\right) \cup (4, \infty)$.

63. We can substitute any real number for x. Thus, the domain is the set of all real numbers, or $(-\infty, \infty)$.

64. We can substitute any real number for x. Thus, the domain is the set of all real numbers, or $(-\infty, \infty)$.

65. The inputs on the x-axis that correspond to points on the graph extend from 0 to 5, inclusive. Thus, the domain is $\{x|0 \leq x \leq 5\}$, or $[0, 5]$.

The outputs on the y-axis extend from 0 to 3, inclusive. Thus, the range is $\{y|0 \leq y \leq 3\}$, or $[0, 3]$.

66. The inputs on the x-axis that correspond to points on the graph extend from -3 up to but not including 5. Thus, the domain is $\{x| -3 \leq x < 5\}$, or $[-3, 5)$.

The outputs on the y-axis extend from -4 up to but not including 1. Thus, the range is $\{y|-4 \leq y < 1\}$, or $[-4, 1)$.

67. The inputs on the x-axis that correspond to points on the graph extend from -2π to 2π inclusive. Thus, the domain is $\{x| -2\pi \leq x \leq 2\pi\}$, or $[-2\pi, 2\pi]$.

The outputs on the y-axis extend from -1 to 1, inclusive. Thus, the range is $\{y| -1 \leq y \leq 1\}$, or $[-1, 1]$.

68. The inputs on the x-axis that correspond to points on the graph extend from -2 to 1, inclusive. Thus, the domain is $\{x| -2 \leq x \leq 1\}$, or $[-2, 1]$.

The outputs on the y-axis extend from -1 to 4, inclusive. Thus, the range is $\{y| -1 \leq y \leq 4\}$, or $[-1, 4]$.

69. The graph extends to the left and to the right without bound. Thus, the domain is the set of all real numbers, or $(-\infty, \infty)$.

The only output is -3, so the range is $\{-3\}$.

70. The graph extends to the left and to the right without bound. Thus, the domain is the set of all real numbers, or $(-\infty, \infty)$.

The outputs on the y-axis start at -3 and increase without bound. Thus, the range is $[-3, \infty)$.

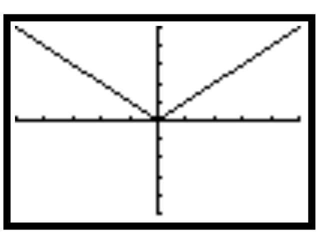
71. The inputs on the x-axis extend from -5 to 3, inclusive. Thus, the domain is $[-5, 3]$.

The outputs on the y-axis extend from -2 to 2, inclusive. Thus, the range is $[-2, 2]$.

72. The inputs on the x-axis extend from -2 to 4, inclusive. Thus, the domain is $[-2, 4]$.

The only output is 4. Thus, the range is $\{4\}$.

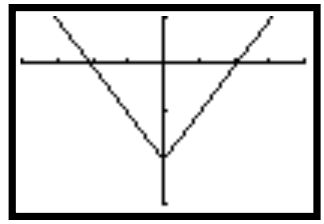
73.



To find the domain we look for the inputs on the x-axis that correspond to a point on the graph. We see that each point on the x-axis corresponds to a point on the graph so the domain is the set of all real numbers, or $(-\infty, \infty)$.

To find the range we look for outputs on the y-axis. The number 0 is the smallest output, and every number greater than 0 is also an output. Thus, the range is $[0, \infty)$.

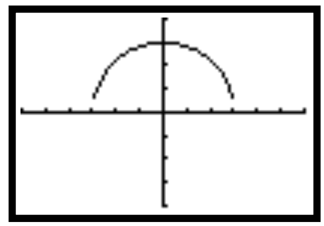
74.



Domain: all real numbers, or $(-\infty, \infty)$

Range: $[-2, \infty)$

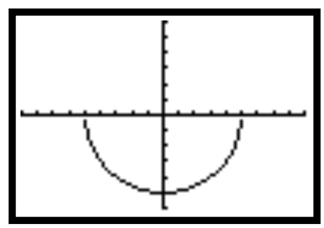
75.



The inputs on the x-axis extend from -3 to 3, so the domain is $[-3, 3]$.

The outputs on the y-axis extend from 0 to 3, so the range is $[0, 3]$.

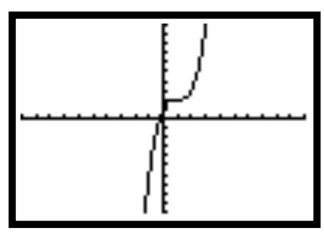
76.



Domain: $[-5, 5]$

Range: $[-5, 0]$

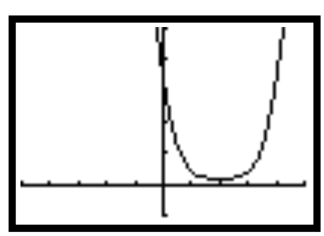
77.



Each point on the x-axis corresponds to a point on the graph, so the domain is the set of all real numbers, or $(-\infty, \infty)$.

Each point on the y-axis also corresponds to a point on the graph, so the range is the set of all real numbers, $(-\infty, \infty)$.

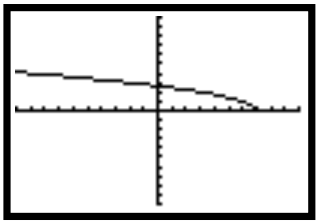
78.



Domain: all real numbers, or $(-\infty, \infty)$

Range: $[1, \infty)$

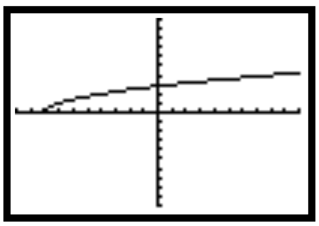
79.



The largest input on the x-axis is 7 and every number less than 7 is also an input. Thus, the domain is $(-\infty, 7]$.

The number 0 is the smallest output, and every number greater than 0 is also an output. Thus, the range is $[0, \infty)$.

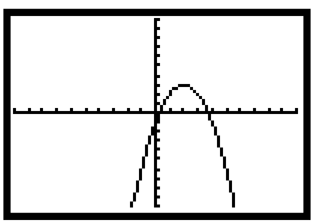
80.



Domain: $[-8, \infty)$

Range: $[0, \infty)$

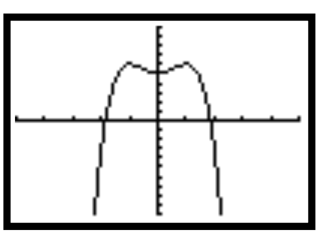
81.



Each point on the x-axis corresponds to a point on the graph, so the domain is the set of all real numbers, or $(-\infty, \infty)$.

The largest output is 3 and every number less than 3 is also an output. Thus, the range is $(-\infty, 3]$.

82.



Domain: all real numbers, or $(-\infty, \infty)$

Range: $(-\infty, 6]$

83. $E(t) = 1000(100 - t) + 580(100 - t)^2$

a) $$\begin{aligned} E(99.5) &= 1000(100-99.5)+580(100-99.5)^2 \\ &= 1000(0.5) + 580(0.5)^2 \\ &= 500 + 580(0.25) = 500 + 145 \\ &= 645 \text{ m above sea level} \end{aligned}$$

b) $$\begin{aligned} E(100) &= 1000(100 - 100) + 580(100 - 100)^2 \\ &= 1000 \cdot 0 + 580(0)^2 = 0 + 0 \\ &= 0 \text{ m above sea level, or at sea level} \end{aligned}$$

84. $T(0.5) = 0.5^{1.31} \approx 0.4$ acre

$T(10) = 10^{1.31} \approx 20.4$ acres

$T(20) = 20^{1.31} \approx 50.6$ acres

$T(100) = 100^{1.31} \approx 416.9$ acres

$T(200) = 200^{1.31} \approx 1033.6$ acres

85. a) $V(18) = 0.4123(18) + 13.2617 \approx \$20.68$

$V(25) = 0.4123(25) + 13.2617 \approx \$23.57$

b) Substitute 30 for $V(x)$ and solve for x.

$$\begin{aligned} 30 &= 0.4123x + 13.2617 \\ 16.7383 &= 0.4123x \\ 41 &\approx x \end{aligned}$$

$x \approx 41$, so it will take about \$30 to equal the value of \$1 in 1913 approximately 41 yr after 1990, or in 2031.

86. A function is a correspondence between two sets in which each member of the first set corresponds to exactly one member of the second set.

87. The domain of a function is the set of all inputs of the function. The range is the set of all outputs. The range depends on the domain.

88. For $(-3, -2)$:

$$\begin{array}{r|l} y^2 - x^2 & = -5 \\ \hline (-2)^2 - (-3)^2 & ?\ -5 \\ 4 - 9 & \\ -5 & -5 \quad \text{TRUE} \end{array}$$

$(-3, -2)$ is a solution.

For $(2, -3)$:

$$\begin{array}{r|l} y^2 - x^2 & = -5 \\ \hline (-3)^2 - 2^2 & ?\ -5 \\ 9 - 4 & \\ 5 & -5 \quad \text{FALSE} \end{array}$$

$(2, -3)$ is not a solution.

89. To determine whether $(0, -7)$ is a solution, substitute 0 for x and -7 for y.

$$\begin{array}{r|l} y & = 0.5x + 7 \\ \hline -7 & ?\ 0.5(0) + 7 \\ & 0 + 7 \\ -7 & 7 \qquad \text{FALSE} \end{array}$$

The equation $-7 = 7$ is false, so $(0, -7)$ is not a solution.

To determine whether $(8, 11)$ is a solution, substitute 8 for x and 11 for y.

$$\begin{array}{r|l} y & = 0.5x + 7 \\ \hline 11 & ?\ 0.5(8) + 7 \\ & 4 + 7 \\ 11 & 11 \qquad \text{TRUE} \end{array}$$

The equation $11 = 11$ is true, so $(8, 11)$ is a solution.

90. For $\left(\frac{4}{5}, -2\right)$:

$$\begin{array}{c|c} 15x - 10y & 32 \\ \hline 15 \cdot \frac{4}{5} - 10(-2) \ ? & 32 \\ 12 + 20 & \\ 32 & 32 \quad \text{TRUE} \end{array}$$

$\left(\frac{4}{5}, -2\right)$ is a solution.

For $\left(\frac{11}{5}, \frac{1}{10}\right)$:

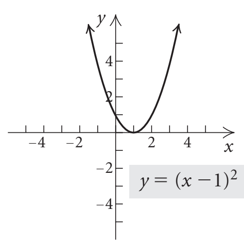
$$\begin{array}{c|c} 15x - 10y & 32 \\ \hline 15 \cdot \frac{11}{5} - 10 \cdot \frac{1}{10} \ ? & 32 \\ 33 - 1 & \\ 32 & 32 \quad \text{TRUE} \end{array}$$

$\left(\frac{11}{5}, \frac{1}{10}\right)$ is a solution.

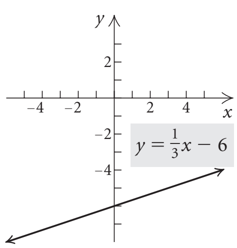
91. Graph $y = (x - 1)^2$.

Make a table of values, plot the points in the table, and draw the graph.

x	y	(x, y)
-1	4	$(-1, 4)$
0	1	$(0, 1)$
1	0	$(1, 0)$
2	1	$(2, 1)$
3	4	$(3, 4)$



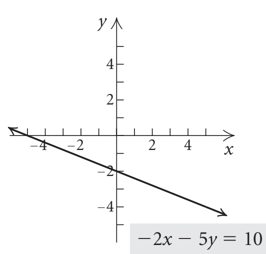
92.



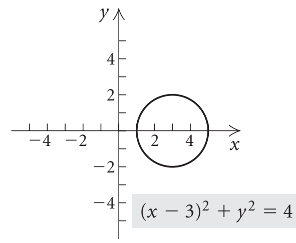
93. Graph $-2x - 5y = 10$.

Make a table of values, plot the points in the table, and draw the graph.

x	y	(x, y)
-5	0	$(-5, 0)$
0	-2	$(0, -2)$
5	-4	$(5, -4)$



94.



95. We can substitute any real number for x. Thus, the domain is the set of all real numbers, or $(-\infty, \infty)$.

96. We find the inputs for which $2x + 5$ is nonnegative.

$$2x + 5 \geq 0$$
$$2x \geq -5$$
$$x \geq -\frac{5}{2}$$

Thus, the domain is $\left\{x \middle| x \geq -\frac{5}{2}\right\}$, or $\left[-\frac{5}{2}, \infty\right)$.

97. We can substitute any real number for which the radicand is nonnegative. We see that $8 - x \geq 0$ for $x \leq 8$, so the domain is $\{x|x \leq 8\}$, or $(-\infty, 8]$.

98. In the numerator we can substitute any real number for which the radicand is nonnegative. We see that $x + 1 \geq 0$ for $x \geq -1$. The denominator is 0 when $x = 0$, so 0 cannot be an input. Thus the domain is $\{x|x \geq -1 \textit{ and } x \neq 0\}$, or $[-1, 0) \cup (0, \infty)$.

99. $\sqrt{x + 6}$ is not defined for values of x for which $x + 6$ is negative. We find the inputs for which $x+6$ is nonnegative.

$$x + 6 \geq 0$$
$$x \geq -6$$

We must also avoid inputs that make the denominator 0.

$$(x + 2)(x - 3) = 0$$
$$x + 2 = 0 \quad \textit{or} \quad x - 3 = 0$$
$$x = -2 \quad \textit{or} \quad x = 3$$

Then the domain is $\{x|x \geq -6 \textit{ and } x \neq -2 \textit{ and } x \neq 3\}$, or $[-6, -2) \cup (-2, 3) \cup (3, \infty)$.

100. First we find the inputs for which $x - 1$ is nonnegative.

$$x - 1 \geq 0$$
$$x \geq 1$$

We also find the inputs that make the denominator 0.

$$x^2 + x - 6 = 0$$
$$(x + 3)(x - 2) = 0$$
$$x = -3 \textit{ or } x = 2$$

The domain is $\{x|x \geq 1 \textit{ and } x \neq 2\}$, or $[1, 2) \cup (2, \infty)$.

101. First we find the inputs for which $3 - x$ is nonnegative.

$$3 - x \geq 0$$
$$3 \geq x, \text{ or } x \leq 3$$

Next we find the inputs for which $x + 5$ is nonnegative.

$$x + 5 \geq 0$$
$$x \geq -5$$

The domain is $\{x| - 5 \leq x \leq 3\}$, or $[-5, 3]$.

102. $\sqrt{x}$ is defined for $x \geq 0$.

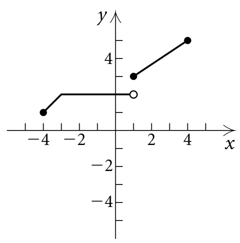
We find the inputs for which $4 - x$ is nonnegative.

$$4 - x \geq 0$$
$$4 \geq x, \text{ or } x \leq 4$$

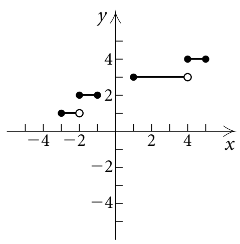
The domain is $\{x|0 \leq x \leq 4\}$, or $[0, 4]$.

103. Answers may vary. Two possibilities are $f(x) = x$, $g(x) = x + 1$ and $f(x) = x^2$, $g(x) = x^2 - 4$.

104.



105.



106. $f(x - 1) = 5x$

$f(6) = f(7 - 1) = 5 \cdot 7 = 35$

107. First find the value of x for which $x + 3 = -1$.

$$x + 3 = -1$$
$$x = -4$$

Then we have:

$g(x + 3) = 2x + 1$

$g(-1) = g(-4 + 3) = 2(-4) + 1 = -8 + 1 = -7$

108. $f(x) = |x + 3| - |x - 4|$

a) If x is in the interval $(-\infty, -3)$, then $x + 3 < 0$ and $x - 4 < 0$. We have:

$$\begin{aligned} f(x) &= |x + 3| - |x - 4| \\ &= -(x + 3) - [-(x - 4)] \\ &= -(x + 3) - (-x + 4) \\ &= -x - 3 + x - 4 \\ &= -7 \end{aligned}$$

b) If x is in the interval $[-3, 4)$, then $x + 3 \geq 0$ and $x - 4 < 0$. We have:

$$\begin{aligned} f(x) &= |x + 3| - |x - 4| \\ &= x + 3 - [-(x - 4)] \\ &= x + 3 - (-x + 4) \\ &= x + 3 + x - 4 \\ &= 2x - 1 \end{aligned}$$

c) If x is in the interval $[4, \infty)$, then $x + 3 > 0$ and $x - 4 \geq 0$. We have:

$$\begin{aligned} f(x) &= |x + 3| - |x - 4| \\ &= x + 3 - (x - 4) \\ &= x + 3 - x + 4 \\ &= 7 \end{aligned}$$

109. $f(x) = |x| + |x - 1|$

a) If x is in the interval $(-\infty, 0)$, then $x < 0$ and $x - 1 < 0$. We have:

$$\begin{aligned} f(x) &= |x| + |x - 1| \\ &= -x - (x - 1) \\ &= -x - x + 1 \\ &= -2x + 1 \end{aligned}$$

b) If x is in the interval $[0, 1)$, then $x \geq 0$ and $x - 1 < 0$. We have:

$$\begin{aligned} f(x) &= |x| + |x - 1| \\ &= x - (x - 1) \\ &= x - x + 1 \\ &= 1 \end{aligned}$$

c) If x is in the interval $[1, \infty)$, then $x > 0$ and $x - 1 \geq 0$. We have:

$$\begin{aligned} f(x) &= |x| + |x - 1| \\ &= x + x - 1 \\ &= 2x + 1 \end{aligned}$$

Exercise Set 1.3

1. a) Yes. Each input is 1 more than the one that precedes it.

b) Yes. Each output is 3 more than the one that precedes it.

c) Yes. Constant changes in inputs result in constant changes in outputs.

2. a) Yes. Each input is 10 more than the one that precedes it.

b) No. The change in the outputs varies.

c) No. Constant changes in inputs do not result in constant changes in outputs.

3. a) Yes. Each input is 15 more than the one that precedes it.

b) No. The change in the outputs varies.

c) No. Constant changes in inputs do not result in constant changes in outputs.

4. a) Yes. Each input is 2 more than the one that precedes it.

b) Yes. Each output is 4 less than the one that precedes it.

c) Yes. Constant changes in inputs result in constant changes in outputs.

5. Two points on the line are $(-4,-2)$ and $(1,4)$.

$m=\frac{y_2-y_1}{x_2-x_1}=\frac{4-(-2)}{1-(-4)}=\frac{6}{5}$

6. $m=\frac{-5-1}{3-(-3)}=\frac{-6}{6}=-1$

7. Two points on the line are $(0,3)$ and $(5,0)$.

$m=\frac{y_2-y_1}{x_2-x_1}=\frac{0-3}{5-0}=\frac{-3}{5}$, or $-\frac{3}{5}$

8. $m=\frac{0-(-3)}{-2-(-2)}=\frac{3}{0}$

The slope is not defined.

9. $m=\frac{y_2-y_1}{x_2-x_1}=\frac{3-3}{3-0}=\frac{0}{3}=0$

10. $m=\frac{1-(-4)}{5-(-3)}=\frac{5}{8}$

11. $m=\frac{y_2-y_1}{x_2-x_1}=\frac{2-4}{-1-9}=\frac{-2}{-10}=\frac{1}{5}$

12. $m=\frac{-1-7}{5-(-3)}=\frac{-8}{8}=-1$

13. $m=\frac{y_2-y_1}{x_2-x_1}=\frac{6-(-9)}{4-4}=\frac{15}{0}$

Since division by 0 is not defined, the slope is not defined.

14. $m=\frac{-13-(-1)}{2-(-6)}=\frac{-12}{8}=-\frac{3}{2}$

15. $m=\frac{y_2-y_1}{x_2-x_1}=\frac{-0.4-(-0.1)}{-0.3-0.7}=\frac{-0.3}{-1}=0.3$

16. $m=\frac{-\frac{5}{7}-\left(-\frac{1}{4}\right)}{\frac{2}{7}-\left(-\frac{3}{4}\right)}=\frac{-\frac{20}{28}+\frac{7}{28}}{\frac{8}{28}+\frac{21}{28}}=\frac{-\frac{13}{28}}{\frac{29}{28}}=$

$-\frac{13}{28}\cdot\frac{28}{29}=-\frac{13}{29}$

17. $m=\frac{y_2-y_1}{x_2-x_1}=\frac{-2-(-2)}{4-2}=\frac{0}{2}=0$

18. $m=\frac{-6-8}{7-(-9)}=\frac{-14}{16}=-\frac{7}{8}$

19. $m=\frac{y_2-y_1}{x_2-x_1}=\frac{\frac{3}{5}-\left(-\frac{3}{5}\right)}{-\frac{1}{2}-\frac{1}{2}}=\frac{\frac{6}{5}}{-1}=-\frac{6}{5}$

20. $m=\frac{-2.16-4.04}{3.14-(-8.26)}=\frac{-6.2}{11.4}=-\frac{62}{114}=-\frac{31}{57}$

21. $m=\frac{y_2-y_1}{x_2-x_1}=\frac{-5-(-13)}{-8-16}=\frac{8}{-24}=-\frac{1}{3}$

22. $m=\frac{y_2-y_1}{x_2-x_1}=\frac{2-(-3)}{\pi-\pi}=\frac{5}{0}$

The slope is not defined.

23. $m=\frac{7-(-7)}{10-(-10)}=\frac{14}{0}$

Since division by 0 is not defined, the slope is not defined.

24. $m=\frac{-4-(-4)}{0.56-\sqrt{2}}=\frac{0}{0.56-\sqrt{2}}=0$

25. We have the points $(4,3)$ and $(-2,15)$.

$m=\frac{y_2-y_1}{x_2-x_1}=\frac{15-3}{-2-4}=\frac{12}{-6}=-2$

26. $m=\frac{-5-1}{-4-4}=\frac{-6}{-8}=\frac{3}{4}$

27. We have the points $\left(\frac{1}{5},\frac{1}{2}\right)$ and $\left(-1,-\frac{11}{2}\right)$.

$m=\frac{y_2-y_1}{x_2-x_1}=\frac{-\frac{11}{2}-\frac{1}{2}}{-1-\frac{1}{5}}=\frac{-6}{-\frac{6}{5}}=-6\cdot\left(-\frac{5}{6}\right)=5$

28. $m=\frac{\frac{10}{3}-(-1)}{-\frac{2}{3}-8}=\frac{\frac{13}{3}}{-\frac{26}{3}}=\frac{13}{3}\cdot\left(-\frac{3}{26}\right)=-\frac{1}{2}$

29. $y=1.3x-5$ is in the form $y=mx+b$ with $m=1.3$, so the slope is 1.3.

30. $-\frac{2}{5}$

31. The graph of $x=-2$ is a vertical line, so the slope is not defined.

32. 4

33. $f(x)=-\frac{1}{2}x+3$ is in the form $y=mx+b$ with $m=-\frac{1}{2}$, so the slope is $-\frac{1}{2}$.

34. The graph of $y=\frac{3}{4}$ is a horizontal line, so the slope is 0. (We also see this if we write the equation in the form $y=0x+\frac{3}{4}$.)

35. $y=9-x$ can be written as $y=-x+9$, or $y=-1\cdot x+9$. Now we have an equation in the form $y=mx+b$ with $m=-1$, so the slope is -1.

36. The graph of $x=8$ is a vertical line, so the slope is not defined.

37. The graph of $y=0.7$ is a horizontal line, so the slope is 0. (We also see this if we write the equation in the form $y=0x+0.7$).

38. $y=\frac{4}{5}-2x$, or $y=-2x+\frac{4}{5}$

The slope is -2.

39. We have the points (1997, 198.2) and (2006, 154.8), where the second coordinates represent millions of pounds. We find the average rate of change, or slope.

$m=\frac{154.8-198.2}{2006-1997}=\frac{-43.4}{9}\approx-4.8$

The average rate of change over the 9-year period was about -4.8 million lb per year.

40. $m = \dfrac{40.3 - 2}{2005 - 1985} = \dfrac{38.3}{20} = 1.915$

The average rate of change over the 20-year period was 1.915 million cases per year.

41. We have the points (1, 59,368) and (29, 107,097). We find the average rate of change, or slope.

$$m = \frac{107,097 - 59,368}{29 - 1} = \frac{47,729}{28} \approx 1705$$

The average rate of change in attendance was about 1705 per race.

42. $m = \dfrac{8.3 - 16.3}{2004 - 1995} = \dfrac{-8.0}{9} \approx -0.89$

The average rate of change over the 9-yr period was about −0.89% per year.

43. We have the points (2001, 191) and (2006, 172), where the second coordinates represent millions. We find the average rate of change, or slope.

$$m = \frac{172 - 191}{2006 - 2001} = \frac{19}{-5} = -3.8$$

The average rate of change over the 5-year period was −3.8 million land-lines per year.

44. $m = \dfrac{8900 - 3275}{2006 - 1992} = \dfrac{5625}{14} \approx 401.79$

The average rate of change over the 14-yr period was about $401.79 per year.

45. First we convert the times to minutes.

$10 \text{ sec} = 10 \text{ sec} \cdot \dfrac{1 \text{ min}}{60 \text{ sec}} = \dfrac{10}{60} \cdot \dfrac{\text{sec}}{\text{sec}} \cdot \text{ min} = \dfrac{1}{6} \text{ min}$

Thus, $31 \text{ min } 10 \text{ sec} = 31 \text{ min} + \dfrac{1}{6} \text{ min} = 31\dfrac{1}{6} \text{ min}$, or $\dfrac{187}{6}$ min.

1 hr = 60 min

$38 \text{ sec} = 38 \text{ sec} \cdot \dfrac{1 \text{ min}}{60 \text{ sec}} = \dfrac{38}{60} \cdot \dfrac{\text{sec}}{\text{sec}} \cdot \text{min} = \dfrac{19}{30} \text{ min}$

Thus, $1 \text{ hr } 1 \text{ min } 38 \text{ sec} = 60 \text{ min} + 1 \text{ min} + \dfrac{19}{30} \text{ min} = 61\dfrac{19}{30} \text{ min}$, or $\dfrac{1849}{30}$ min.

Now we find the speed.

$$\frac{10 - 5}{\frac{1849}{30} - \frac{187}{6}} = \frac{5}{\frac{1849}{30} - \frac{935}{30}} = \frac{5}{\frac{914}{30}} = 5 \cdot \frac{30}{914} =$$

$$\frac{150}{914} = \frac{\not{2} \cdot 75}{\not{2} \cdot 457} = \frac{75}{457} \approx \frac{1}{6}$$

Lucie's speed was $\dfrac{75}{457}$ mi per minute, or about 0.16 mi per minute.

46.
$$\text{Typing rate} = \frac{\frac{3}{4} - \frac{1}{6}}{6} = \frac{\frac{7}{12}}{6} = \frac{7}{72} \text{ of the paper per hour}$$

47. $y = \dfrac{3}{5}x - 7$

The equation is in the form $y = mx + b$ where $m = \dfrac{3}{5}$ and $b = -7$. Thus, the slope is $\dfrac{3}{5}$, and the y-intercept is $(0, -7)$.

48. $f(x) = -2x + 3$

Slope: −2; y-intercept: $(0, 3)$

49. $x = -\dfrac{2}{5}$

This is the equation of a vertical line $\dfrac{2}{5}$ unit to the left of the y-axis. The slope is not defined, and there is no y-intercept.

50. $y = \dfrac{4}{7} = 0 \cdot x + \dfrac{4}{7}$

Slope: 0; y-intercept: $\left(0, \dfrac{4}{7}\right)$

51. $f(x) = 5 - \dfrac{1}{2}x$, or $f(x) = -\dfrac{1}{2}x + 5$

The second equation is in the form $y = mx + b$ where $m = -\dfrac{1}{2}$ and $b = 5$. Thus, the slope is $-\dfrac{1}{2}$ and the y-intercept is $(0, 5)$.

52. $y = 2 + \dfrac{3}{7}x$

Slope: $\dfrac{3}{7}$; y-intercept: $(0, 2)$

53. Solve the equation for y.

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

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

54.
$$\begin{aligned} 2x - 3y &= 12 \\ -3y &= -2x + 12 \\ y &= \frac{2}{3}x - 4 \end{aligned}$$

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

55. $y = -6 = 0 \cdot x - 6$

Slope: 0; y-intercept: $(0, -6)$

56. $x = 10$

This is the equation of a vertical line 10 units to the right of the y-axis. The slope is not defined, and there is no y-intercept.

57. Solve the equation for y.

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

Slope: $\dfrac{4}{5}$; y-intercept: $\left(0, \dfrac{8}{5}\right)$

58.
$$\begin{aligned} 5x - 2y + 9 &= 0 \\ -2y &= -5x - 9 \\ y &= \frac{5}{2}x + \frac{9}{2} \end{aligned}$$

Slope: $\frac{5}{2}$; y-intercept: $\left(0, \frac{9}{2}\right)$

59. Solve the equation for y.

$$\begin{aligned} 4y - x + 2 &= 0 \\ 4y &= x - 2 \\ y &= \frac{1}{4}x - \frac{1}{2} \end{aligned}$$

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

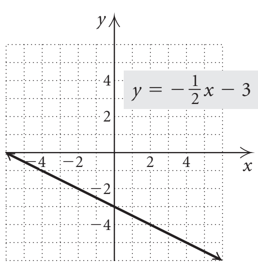
60. $f(x) = 0.3 + x$; or $f(x) = x + 0.3$

Slope: 1; y-intercept: $(0, 0.3)$

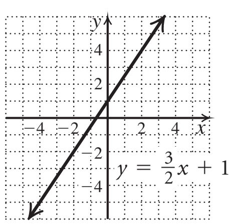
61. Graph $y = -\frac{1}{2}x - 3$.

Plot the y-intercept, $(0, -3)$. We can think of the slope as $\frac{-1}{2}$. Start at $(0, -3)$ and find another point by moving down 1 unit and right 2 units. We have the point $(2, -4)$.

We could also think of the slope as $\frac{1}{-2}$. Then we can start at $(0, -3)$ and get another point by moving up 1 unit and left 2 units. We have the point $(-2, -2)$. Connect the three points to draw the graph.

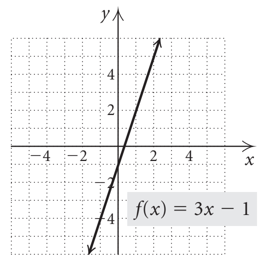


62.

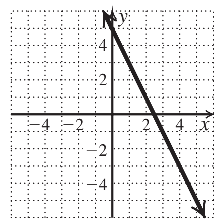


63. Graph $f(x) = 3x - 1$.

Plot the y-intercept, $(0, -1)$. We can think of the slope as $\frac{3}{1}$. Start at $(0, -1)$ and find another point by moving up 3 units and right 1 unit. We have the point $(1, 2)$. We can move from the point $(1, 2)$ in a similar manner to get a third point, $(2, 5)$. Connect the three points to draw the graph.



64.

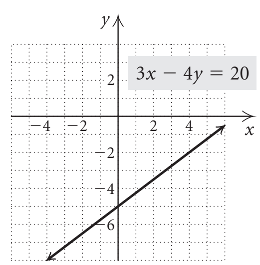


$f(x) = -2x + 5$

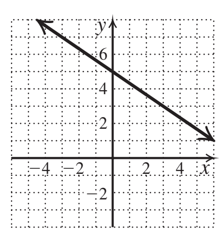
65. First solve the equation for y.

$$\begin{aligned} 3x - 4y &= 20 \\ -4y &= -3x + 20 \\ y &= \frac{3}{4}x - 5 \end{aligned}$$

Plot the y-intercept, $(0, -5)$. Then using the slope, $\frac{3}{4}$, start at $(0, -5)$ and find another point by moving up 3 units and right 4 units. We have the point $(4, -2)$. We can move from the point $(4, -2)$ in a similar manner to get a third point, $(8, 1)$. Connect the three points to draw the graph.



66.

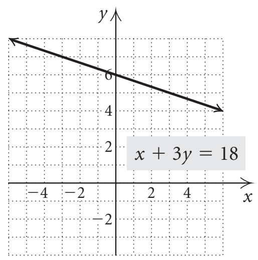


$2x + 3y = 15$

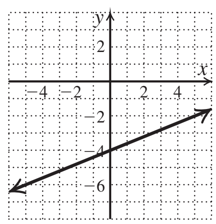
67. First solve the equation for y.

$$\begin{aligned} x + 3y &= 18 \\ 3y &= -x + 18 \\ y &= -\frac{1}{3}x + 6 \end{aligned}$$

Plot the y-intercept, $(0,6)$. We can think of the slope as $\frac{-1}{3}$. Start at $(0,6)$ and find another point by moving down 1 unit and right 3 units. We have the point $(3,5)$. We can move from the point $(3,5)$ in a similar manner to get a third point, $(6,4)$. Connect the three points and draw the graph.



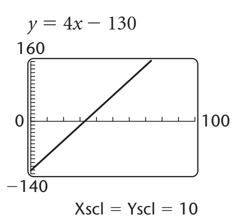
68.



$5y - 2x = -20$

69. a) $W(h) = 4h - 130$

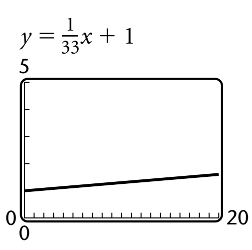
b)



c) $W(62) = 4 \cdot 62 - 130 = 248 - 130 = 118$ lb

70. $P(d) = \frac{1}{33}d + 1$

a)



b) $P(0) = \frac{1}{33} \cdot 0 + 1 = 1$ atm

$P(5) = \frac{1}{33} \cdot 5 + 1 = 1\frac{5}{33}$ atm

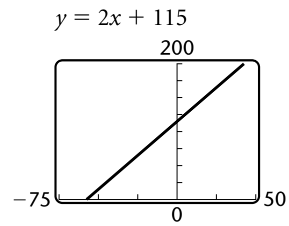
$P(10) = \frac{1}{33} \cdot 10 + 1 = 1\frac{10}{33}$ atm

$P(33) = \frac{1}{33} \cdot 33 + 1 = 2$ atm

$P(200) = \frac{1}{33} \cdot 200 + 1 = \frac{233}{33}$ atm, or $7\frac{2}{33}$ atm

71. $D(F) = 2F + 115$

a)



b) $D(0) = 2 \cdot 0 + 115 = 115$ ft

$D(-20) = 2(-20) + 115 = -40 + 115 = 75$ ft

$D(10) = 2 \cdot 10 + 115 = 20 + 115 = 135$ ft

$D(32) = 2 \cdot 32 + 115 = 64 + 115 = 179$ ft

c) Below $-57.5°$, stopping distance is negative; above $32°$, ice doesn't form.

72. a) $M(x) = 2.89x + 70.64$

$M(26) = 2.89(26) + 70.64 = 145.78$ cm

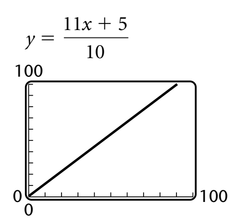
b) The length of the humerus must be positive, so the domain is $\{x|x > 0\}$, or $(0, \infty)$. Realistically, however, we might expect the length of the humerus to be between 20 cm and 60 cm, so the domain could be $\{x|20 \leq x \leq 60\}$, or $[20, 60]$. Answers may vary.

73. a) $D(r) = \frac{11r + 5}{10} = \frac{11}{10}r + \frac{5}{10}$

The slope is $\frac{11}{10}$.

For each mph faster the car travels, it takes $\frac{11}{10}$ ft longer to stop.

b)



c) $D(5) = \frac{11 \cdot 5 + 5}{10} = \frac{60}{10} = 6$ ft

$D(10) = \frac{11 \cdot 10 + 5}{10} = \frac{115}{10} = 11.5$ ft

$D(20) = \frac{11 \cdot 20 + 5}{10} = \frac{225}{10} = 22.5$ ft

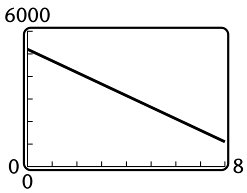
$D(50) = \frac{11 \cdot 50 + 5}{10} = \frac{555}{10} = 55.5$ ft

$D(65) = \frac{11 \cdot 65 + 5}{10} = \frac{720}{10} = 72$ ft

d) The speed cannot be negative. $D(0) = \frac{1}{2}$ which says that a stopped car travels $\frac{1}{2}$ ft before stopping. Thus, 0 is not in the domain. The speed can be positive, so the domain is $\{r|r > 0\}$, or $(0, \infty)$.

74. $V(t) = \$5200 - \$512.50t$

a) $y = 5200 - 512.50x$



b) $V(0) = \$5200 - \$512.50(0) = \$5200 - \$0 = \$5200$

$V(1) = \$5200 - \$512.50(1) = \$5200 - \$512.50 = \$4687.50$

$V(2) = \$5200 - \$512.50(2) = \$5200 - \$1025 = \$4175$

$V(3) = \$5200 - \$512.50(3) = \$5200 - \$1537.50 = \$3662.50$

$V(8) = \$5200 - \$512.50(8) = \$5200 - \$4100 = \$1100$

c) Since the time must be nonnegative and not more than 8 years, the domain is $[0, 8]$. The value starts at \$5200 and declines to \$1100, so the range is $[1100, 5200]$.

75. $C(t) = 60 + 29t$

$C(6) = 60 + 29 \cdot 6 = \$234$

76. $C(t) = 65 + 105t$

$C(8) = 65 + 105 \cdot 8 = \$905$

77. Let x = the number of shirts produced.

$C(x) = 800 + 3x$

$C(75) = 800 + 3 \cdot 75 = \$1025$

78. Let x = the number of rackets restrung.

$C(x) = 950 + 24x$

$C(150) = 950 + 24 \cdot 150 = \$4550$

79. A vertical line ($x = a$) crosses the graph more than once.

80. The sign of the slope indicates the slant of a line. A line that slants up from left to right has positive slope because corresponding changes in x and y have the same sign. A line that slants down from left to right has negative slope, because corresponding changes in x and y have opposite signs. A horizontal line has zero slope, because there is no change in y for a given change in x. A vertical line has undefined slope, because there is no change in x for a given change in y and division by 0 is undefined. The larger the absolute value of slope, the steeper the line. This is because a larger absolute value corresponds to a greater change in y, compared to the change in x, than a smaller absolute value.

81. $f(x) = x^2 - 3x$

$$f\left(\frac{1}{2}\right) = \left(\frac{1}{2}\right)^2 - 3 \cdot \frac{1}{2} = \frac{1}{4} - \frac{3}{2} = -\frac{5}{4}$$

82. $f(5) = 5^2 - 3 \cdot 5 = 10$

83. $f(x) = x^2 - 3x$

$f(-5) = (-5)^2 - 3(-5) = 25 + 15 = 40$

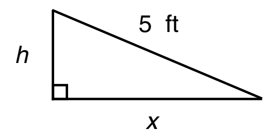
84. $f(x) = x^2 - 3x$

$f(-a) = (-a)^2 - 3(-a) = a^2 + 3a$

85. $f(x) = x^2 - 3x$

$f(a + h) = (a + h)^2 - 3(a + h) = a^2 + 2ah + h^2 - 3a - 3h$

86. We make a drawing and label it. Let h = the height of the triangle, in feet.



Using the Pythagorean theorem we have:

$$x^2 + h^2 = 25$$
$$x^2 = 25 - h^2$$
$$x = \sqrt{25 - h^2}$$

We know that the grade of the treadmill is 8%, or 0.08. Then we have

$$\frac{h}{x} = 0.08$$

$$\frac{h}{\sqrt{25 - h^2}} = 0.08 \quad \text{Substituting } \sqrt{25 - h^2} \text{ for } x$$

$$\frac{h^2}{25 - h^2} = 0.0064 \quad \text{Squaring both sides}$$

$$h^2 = 0.16 - 0.0064h^2$$

$$1.0064h^2 = 0.16$$

$$h^2 = \frac{0.16}{1.0064}$$

$$h \approx 0.4 \text{ ft}$$

87. $m = \dfrac{y_2 - y_1}{x_2 - x_1} = \dfrac{-2d - (-d)}{9c - (-c)} = \dfrac{-2d + d}{9c + c} = \dfrac{-d}{10c} = -\dfrac{d}{10c}$

88. $m = \dfrac{s - (s + t)}{r - r} = \dfrac{s - s - t}{0}$

The slope is not defined.

89. $m = \dfrac{y_2 - y_1}{x_2 - x_1} = \dfrac{z - z}{2 - q - (z + q)} = \dfrac{0}{z - q - z - q} = \dfrac{0}{-2q} = 0$

90. $m = \dfrac{p - q - (p + q)}{a + b - (-a - b)} = \dfrac{p - q - p - q}{a + b + a + b} = \dfrac{-2q}{2a + 2b} = -\dfrac{q}{a + b}$

91. $m = \dfrac{y_2 - y_1}{x_2 - x_1} = \dfrac{(a+h)^2 - a^2}{a + h - a} = \dfrac{a^2 + 2ah + h^2 - a^2}{h} = \dfrac{2ah + h^2}{h} = \dfrac{h(2a + h)}{h} = 2a + h$

92. $m = \dfrac{3(a+h)+1-(3a+1)}{a+h-a} =$

$\dfrac{3a+3h+1-3a-1}{h} = \dfrac{3h}{h} = 3$

93. False. For example, let $f(x) = x+1$. Then $f(cd) = cd+1$, but $f(c)f(d) = (c+1)(d+1) = cd+c+d+1 \neq cd+1$ for $c \neq -d$.

94. False. For example, let $f(x) = x+1$. Then $f(c+d) = c+d+1$, but $f(c)+f(d) = c+1+d+1 = c+d+2$.

95. False. For example, let $f(x) = x+1$. Then $f(c-d) = c-d+1$, but $f(c)-f(d) = c+1-(d+1) = c-d$.

96. False. For example, let $f(x) = x+1$. Then $f(kx) = kx+1$, but $kf(x) = k(x+1) = kx+k \neq kx+1$ for $k \neq 1$.

97.
$$\begin{aligned} f(x) &= mx+b \\ f(x+2) &= f(x)+2 \\ m(x+2)+b &= mx+b+2 \\ mx+2m+b &= mx+b+2 \\ 2m &= 2 \\ m &= 1 \end{aligned}$$
Thus, $f(x) = 1\cdot x+b$, or $f(x) = x+b$.

98.
$$\begin{aligned} 3mx+b &= 3(mx+b) \\ 3mx+b &= 3mx+3b \\ b &= 3b \\ 0 &= 2b \\ 0 &= b \end{aligned}$$
Thus, $f(x) = mx+0$, or $f(x) = mx$.

Exercise Set 1.4

1. We see that the y-intercept is $(0,-2)$. Another point on the graph is $(1,2)$. Use these points to find the slope.

$m = \dfrac{y_2-y_1}{x_2-x_1} = \dfrac{2-(-2)}{1-0} = \dfrac{4}{1} = 4$

We have $m = 4$ and $b = -2$, so the equation is $y = 4x-2$.

2. We see that the y-intercept is $(0,2)$. Another point on the graph is $(4,-1)$.

$m = \dfrac{-1-2}{4-0} = -\dfrac{3}{4}$

The equation is $y = -\dfrac{3}{4}x+2$.

3. We see that the y-intercept is $(0,0)$. Another point on the graph is $(3,-3)$. Use these points to find the slope.

$m = \dfrac{y_2-y_1}{x_2-x_1} = \dfrac{-3-0}{3-0} = \dfrac{-3}{3} = -1$

We have $m = -1$ and $b = 0$, so the equation is $y = -1\cdot x+0$, or $y = -x$.

4. We see that the y-intercept is $(0,-1)$. Another point on the graph is $(3,1)$.

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

The equation is $y = \dfrac{2}{3}x-1$.

5. We see that the y-intercept is $(0,-3)$. This is a horizontal line, so the slope is 0. We have $m = 0$ and $b = -3$, so the equation is $y = 0\cdot x-3$, or $y = -3$.

6. We see that the y-intercept is $(0,0)$. Another point on the graph is $(3,3)$.

$m = \dfrac{3-0}{3-0} = \dfrac{3}{3} = 1$

The equation is $y = 1\cdot x+0$, or $y = x$.

7. We substitute $\dfrac{2}{9}$ for m and 4 for b in the slope-intercept equation.

$$\begin{aligned} y &= mx+b \\ y &= \frac{2}{9}x+4 \end{aligned}$$

8. $y = -\dfrac{3}{8}x+5$

9. We substitute -4 for m and -7 for b in the slope-intercept equation.

$$\begin{aligned} y &= mx+b \\ y &= -4x-7 \end{aligned}$$

10. $y = \dfrac{2}{7}x-6$

11. We substitute -4.2 for m and $\dfrac{3}{4}$ for b in the slope-intercept equation.

$$\begin{aligned} y &= mx+b \\ y &= -4.2x+\frac{3}{4} \end{aligned}$$

12. $y = -4x-\dfrac{3}{2}$

13. Using the point-slope equation:

$$\begin{aligned} y-y_1 &= m(x-x_1) \\ y-7 &= \frac{2}{9}(x-3) && \text{Substituting} \\ y-7 &= \frac{2}{9}x-\frac{2}{3} \\ y &= \frac{2}{9}x+\frac{19}{3} && \text{Slope-intercept equation} \end{aligned}$$

Using the slope-intercept equation:

Substitute $\dfrac{2}{9}$ for m, 3 for x, and 7 for y in the slope-intercept equation and solve for b.

$$\begin{aligned} y &= mx+b \\ 7 &= \frac{2}{9}\cdot 3+b \\ 7 &= \frac{2}{3}+b \\ \frac{19}{3} &= b \end{aligned}$$

Now substitute $\dfrac{2}{9}$ for m and $\dfrac{19}{3}$ for b in $y = mx+b$.

$y = \dfrac{2}{9}x+\dfrac{19}{3}$

14. Using the point-slope equation:

$$y - 6 = -\frac{3}{8}(x - 5)$$
$$y = -\frac{3}{8}x + \frac{63}{8}$$

Using the slope-intercept equation:

$$6 = -\frac{3}{8} \cdot 5 + b$$
$$\frac{63}{8} = b$$

We have $y = -\frac{3}{8}x + \frac{63}{8}$.

15. The slope is 0 and the second coordinate of the given point is 8, so we have a horizontal line 8 units above the x-axis. Thus, the equation is $y = 8$.

We could also use the point-slope equation or the slope-intercept equation to find the equation of the line.

Using the point-slope equation:

$$y - y_1 = m(x - x_1)$$
$$y - 8 = 0(x - (-2)) \quad \text{Substituting}$$
$$y - 8 = 0$$
$$y = 8$$

Using the slope-intercept equation:

$$y = mx + b$$
$$y = 0(-2) + 8$$
$$y = 8$$

16. Using the point-slope equation:

$$y - 1 = -2(x - (-5))$$
$$y = -2x - 9$$

Using the slope-intercept equation:

$$1 = -2(-5) + b$$
$$-9 = b$$

We have $y = -2x - 9$.

17. Using the point-slope equation:

$$y - y_1 = m(x - x_1)$$
$$y - (-1) = -\frac{3}{5}(x - (-4))$$
$$y + 1 = -\frac{3}{5}(x + 4)$$
$$y + 1 = -\frac{3}{5}x - \frac{12}{5}$$
$$y = -\frac{3}{5}x - \frac{17}{5} \quad \text{Slope-intercept equation}$$

Using the slope-intercept equation:

$$y = mx + b$$
$$-1 = -\frac{3}{5}(-4) + b$$
$$-1 = \frac{12}{5} + b$$
$$-\frac{17}{5} = b$$

Then we have $y = -\frac{3}{5}x - \frac{17}{5}$.

18. Using the point-slope equation:

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

Using the slope-intercept equation:

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

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

19. First we find the slope.

$$m = \frac{-4 - 5}{2 - (-1)} = \frac{-9}{3} = -3$$

Using the point-slope equation:

Using the point $(-1, 5)$, we get

$$y - 5 = -3(x - (-1)), \text{ or } y - 5 = -3(x + 1).$$

Using the point $(2, -4)$, we get

$$y - (-4) = -3(x - 2), \text{ or } y + 4 = -3(x - 2).$$

In either case, the slope-intercept equation is $y = -3x + 2$.

Using the slope-intercept equation and the point $(-1, 5)$:

$$y = mx + b$$
$$5 = -3(-1) + b$$
$$5 = 3 + b$$
$$2 = b$$

Then we have $y = -3x + 2$.

20. First we find the slope:

$$m = \frac{\frac{1}{2} - \frac{1}{2}}{-3 - 1} = \frac{0}{-4} = 0$$

We have a horizontal line $\frac{1}{2}$ unit above the x-axis. The equation is $y = \frac{1}{2}$.

(We could also have used the point-slope equation or the slope-intercept equation.)

21. First we find the slope.

$$m = \frac{4 - 0}{-1 - 7} = \frac{4}{-8} = -\frac{1}{2}$$

Using the point-slope equation:

Using the point $(7, 0)$, we get

$$y - 0 = -\frac{1}{2}(x - 7).$$

Using the point $(-1, 4)$, we get

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

In either case, the slope-intercept equation is $y = -\frac{1}{2}x + \frac{7}{2}$.

Using the slope-intercept equation and the point $(7, 0)$:

$$0 = -\frac{1}{2} \cdot 7 + b$$
$$\frac{7}{2} = b$$

Then we have $y = -\frac{1}{2}x + \frac{7}{2}$.

22. First we find the slope.

$$m = \frac{-5-7}{-1-(-3)} = \frac{-12}{2} = -6$$

Using the point-slope equation:

Using $(-3, 7)$: $y - 7 = -6(x - (-3))$, or

$$y - 7 = -6(x + 3)$$

Using $(-1, -5)$: $y - (-5) = -6(x - (-1))$, or

$$y + 5 = -6(x + 1)$$

In either case, we have $y = -6x - 11$.

Using the slope-intercept equation and the point $(-1, -5)$:

$$-5 = -6(-1) + b$$
$$-11 = b$$

We have $y = -6x - 11$.

23. First we find the slope.

$$m = \frac{-4-(-6)}{3-0} = \frac{2}{3}$$

We know the y-intercept is $(0, -6)$, so we substitute in the slope-intercept equation.

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

24. First we find the slope.

$$m = \frac{\frac{4}{5} - 0}{0 - (-5)} = \frac{\frac{4}{5}}{5} = \frac{4}{25}$$

We know the y-intercept is $\left(0, \frac{4}{5}\right)$, so we substitute in the slope-intercept equation.

$$y = \frac{4}{25}x + \frac{4}{5}$$

25. First we find the slope.

$$m = \frac{7.3 - 7.3}{-4 - 0} = \frac{0}{-4} = 0$$

We know the y-intercept is $(0, 7.3)$, so we substitute in the slope-intercept equation.

$$y = mx + b$$
$$y = 0 \cdot x + 7.3$$
$$y = 7.3$$

26. First we find the slope.

$$m = \frac{-5-0}{-13-0} = \frac{5}{13}$$

We know the y-intercept is $(0, 0)$, so we substitute in the slope intercept equation.

$$y = \frac{5}{13}x + 0$$
$$y = \frac{5}{13}x$$

27. The equation of the horizontal line through $(0, -3)$ is of the form $y = b$ where b is -3. We have $y = -3$.

The equation of the vertical line through $(0, -3)$ is of the form $x = a$ where a is 0. We have $x = 0$.

28. Horizontal line: $y = 7$

Vertical line: $x = -\frac{1}{4}$

29. The equation of the horizontal line through $\left(\frac{2}{11}, -1\right)$ is of the form $y = b$ where b is -1. We have $y = -1$.

The equation of the vertical line through $\left(\frac{2}{11}, -1\right)$ is of the form $x = a$ where a is $\frac{2}{11}$. We have $x = \frac{2}{11}$.

30. Horizontal line: $y = 0$

Vertical line: $x = 0.03$

31. We have the points $(1, 4)$ and $(-2, 13)$. First we find the slope.

$$m = \frac{13-4}{-2-1} = \frac{9}{-3} = -3$$

We will use the point-slope equation, choosing $(1, 4)$ for the given point.

$$y - 4 = -3(x - 1)$$
$$y - 4 = -3x + 3$$
$$y = -3x + 7, \text{ or}$$
$$h(x) = -3x + 7$$

Then $h(2) = -3 \cdot 2 + 7 = -6 + 7 = 1$.

32. $m = \dfrac{3-(-6)}{2-\left(-\frac{1}{4}\right)} = \dfrac{9}{\frac{9}{4}} = 9 \cdot \dfrac{4}{9} = 4$

Using the point-slope equation and the point $(2, 3)$:

$$y - 3 = 4(x - 2)$$
$$y - 3 = 4x - 8$$
$$y = 4x - 5, \text{ or}$$
$$g(x) = 4x - 5$$

Then $g(-3) = 4(-3) - 5 = -12 - 5 = -17$.

33. We have the points $(5, 1)$ and $(-5, -3)$. First we find the slope.

$$m = \frac{-3-1}{-5-5} = \frac{-4}{-10} = \frac{2}{5}$$

We will use the slope-intercept equation, choosing $(5,1)$ for the given point.

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

Then we have $f(x) = \frac{2}{5}x - 1$.

Now we find $f(0)$.

$$f(0) = \frac{2}{5}\cdot 0 - 1 = -1.$$

34. $m = \frac{2-3}{0-(-3)} = \frac{-1}{3} = -\frac{1}{3}$

Using the slope-intercept equation and the point $(0,2)$, which is the y-intercept, we have $h(x) = -\frac{1}{3}x + 2$.

Then $h(-6) = -\frac{1}{3}(-6) + 2 = 2 + 2 = 4$.

35. The slopes are $\frac{26}{3}$ and $-\frac{3}{26}$. Their product is -1, so the lines are perpendicular.

36. The slopes are -3 and $-\frac{1}{3}$. The slopes are not the same and their product is not -1, so the lines are neither parallel nor perpendicular.

37. The slopes are $\frac{2}{5}$ and $-\frac{2}{5}$. The slopes are not the same and their product is not -1, so the lines are neither parallel nor perpendicular.

38. The slopes are the same $\left(\frac{3}{2} = 1.5\right)$ and the y-intercepts, -8 and 8, are different, so the lines are parallel.

39. We solve each equation for y.

$x + 2y = 5$ $\quad$ $2x + 4y = 8$

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

We see that $m_1 = -\frac{1}{2}$ and $m_2 = -\frac{1}{2}$. Since the slopes are the same and the y-intercepts, $\frac{5}{2}$ and 2, are different, the lines are parallel.

40. $2x - 5y = -3$ $\quad$ $2x + 5y = 4$

$y = \frac{2}{5}x + \frac{3}{5}$ $\quad$ $y = -\frac{2}{5}x + \frac{4}{5}$

$m_1 = \frac{2}{5}$, $m_2 = -\frac{2}{5}$; $m_1 \neq m_2$; $m_1m_2 = -\frac{4}{25} \neq -1$

The lines are neither parallel nor perpendicular.

41. We solve each equation for y.

$y = 4x - 5$ $\quad$ $4y = 8 - x$

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

We see that $m_1 = 4$ and $m_2 = -\frac{1}{4}$. Since $m_1m_2 = 4\left(-\frac{1}{4}\right) = -1$, the lines are perpendicular.

42. $y = 7 - x$,

$y = x + 3$

$m_1 = -1$, $m_2 = 1$; $m_1m_2 = -1\cdot 1 = -1$

The lines are perpendicular.

43. $y = \frac{2}{7}x + 1$; $m = \frac{2}{7}$

The line parallel to the given line will have slope $\frac{2}{7}$. We use the point-slope equation for a line with slope $\frac{2}{7}$ and containing the point $(3,5)$:

$$y - y_1 = m(x - x_1)$$
$$y - 5 = \frac{2}{7}(x - 3)$$
$$y - 5 = \frac{2}{7}x - \frac{6}{7}$$
$$y = \frac{2}{7}x + \frac{29}{7} \quad \text{Slope-intercept form}$$

The slope of the line perpendicular to the given line is the opposite of the reciprocal of $\frac{2}{7}$, or $-\frac{7}{2}$. We use the point-slope equation for a line with slope $-\frac{7}{2}$ and containing the point $(3,5)$:

$$y - y_1 = m(x - x_1)$$
$$y - 5 = -\frac{7}{2}(x - 3)$$
$$y - 5 = -\frac{7}{2}x + \frac{21}{2}$$
$$y = -\frac{7}{2}x + \frac{31}{2} \quad \text{Slope-intercept form}$$

44. $f(x) = 2x + 9$

$m = 2$, $-\frac{1}{m} = -\frac{1}{2}$

Parallel line: $y - 6 = 2(x - (-1))$

$y = 2x + 8$

Perpendicular line: $y - 6 = -\frac{1}{2}(x - (-1))$

$y = -\frac{1}{2}x + \frac{11}{2}$

45. $y = -0.3x + 4.3$; $m = -0.3$

The line parallel to the given line will have slope -0.3. We use the point-slope equation for a line with slope -0.3 and containing the point $(-7,0)$:

$$y - y_1 = m(x - x_1)$$
$$y - 0 = -0.3(x - (-7))$$
$$y = -0.3x - 2.1 \quad \text{Slope-intercept form}$$

The slope of the line perpendicular to the given line is the opposite of the reciprocal of -0.3, or $\frac{1}{0.3} = \frac{10}{3}$.

We use the point-slope equation for a line with slope $\frac{10}{3}$ and containing the point $(-7,0)$:

$$y - y_1 = m(x - x_1)$$
$$y - 0 = \frac{10}{3}(x - (-7))$$
$$y = \frac{10}{3}x + \frac{70}{3} \quad \text{Slope-intercept form}$$

46. $2x + y = -4$

$$y = -2x - 4$$
$$m = -2,\ -\frac{1}{m} = \frac{1}{2}$$

Parallel line: $y - (-5) = -2(x - (-4))$

$$y = -2x - 13$$

Perpendicular line: $y - (-5) = \frac{1}{2}(x - (-4))$

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

47. $3x + 4y = 5$

$$4y = -3x + 5$$
$$y = -\frac{3}{4}x + \frac{5}{4};\ m = -\frac{3}{4}$$

The line parallel to the given line will have slope $-\frac{3}{4}$. We use the point-slope equation for a line with slope $-\frac{3}{4}$ and containing the point $(3, -2)$:

$$y - y_1 = m(x - x_1)$$
$$y - (-2) = -\frac{3}{4}(x - 3)$$
$$y + 2 = -\frac{3}{4}x + \frac{9}{4}$$
$$y = -\frac{3}{4}x + \frac{1}{4} \quad \text{Slope-intercept form}$$

The slope of the line perpendicular to the given line is the opposite of the reciprocal of $-\frac{3}{4}$, or $\frac{4}{3}$. We use the point-slope equation for a line with slope $\frac{4}{3}$ and containing the point $(3, -2)$:

$$y - y_1 = m(x - x_1)$$
$$y - (-2) = \frac{4}{3}(x - 3)$$
$$y + 2 = \frac{4}{3}x - 4$$
$$y = \frac{4}{3}x - 6 \quad \text{Slope-intercept form}$$

48. $y = 4.2(x - 3) + 1$

$$y = 4.2x - 11.6$$
$$m = 4.2;\ -\frac{1}{m} = -\frac{1}{4.2} = -\frac{5}{21}$$

Parallel line: $y - (-2) = 4.2(x - 8)$

$$y = 4.2x - 35.6$$

Perpendicular line: $y - (-2) = -\frac{5}{21}(x - 8)$

$$y = -\frac{5}{21}x - \frac{2}{21}$$

49. $x = -1$ is the equation of a vertical line. The line parallel to the given line is a vertical line containing the point $(3, -3)$, or $x = 3$.

The line perpendicular to the given line is a horizontal line containing the point $(3, -3)$, or $y = -3$.

50. $y = -1$ is a horizontal line.

Parallel line: $y = -5$

Perpendicular line: $x = 4$

51. $x = -3$ is a vertical line and $y = 5$ is a horizontal line, so it is true that the lines are perpendicular.

52. The slope of $y = 2x - 3$ is 2, and the slope of $y = -2x - 3$ is -2. Since $2(-2) = -4 \neq -1$, it is false that the lines are perpendicular.

53. The lines have the same slope, $\frac{2}{5}$, and different y-intercepts, $(0, 4)$ and $(0, -4)$, so it is true that the lines are parallel.

54. $y = 2$ is a horizontal line 2 units above the x-axis; $x = -\frac{3}{4}$ is a vertical line $\frac{3}{4}$ unit to the left of the y-axis. Thus it is true that their intersection is the point $\frac{3}{4}$ unit to the left of the y-axis and 2 units above the x-axis, or $\left(-\frac{3}{4}, 2\right)$.

55. $x = -1$ and $x = 1$ are both vertical lines, so it is false that they are perpendicular.

56. The slope of $2x+3y = 4$, or $y = -\frac{2}{3}x + \frac{4}{3}$ is $-\frac{2}{3}$; the slope of $3x - 2y = 4$, or $y = \frac{3}{2}x - 2$, is $\frac{3}{2}$. Since $-\frac{2}{3} \cdot \frac{3}{2} = -1$, it is true that the lines are perpendicular.

57. No. The data points fall faster from 0 to 2 than after 2 (that is, the rate of change is not constant), so they cannot be modeled by a linear function.

58. Yes. The rate of change seems to be constant, so the scatterplot might be modeled by a linear function.

59. Yes. The rate of change seems to be constant, so the scatterplot might be modeled by a linear function.

60. No. The data points rise, fall, and then rise again in a way that cannot be modeled by a linear function.

61. a) Answers may vary depending on the data points used. We will use (5, 96.7) and (13, 128.7).

$$m = \frac{128.7 - 96.7}{13 - 5} = \frac{32}{8} = 4$$

We will use the point slope equation, letting $(x_1, y_1) = (5,\ 96.7)$.

$$y - 96.7 = 4(x - 5)$$
$$y - 96.7 = 4x - 20$$
$$y = 4x + 76.7,$$

where x is the number of years after 1990 and y is in thousands.

b) In 2009, $x = 2009 - 1990 = 19$.

$y = 4 \cdot 19 + 76.7 = 152.7$

We estimate the number of twin births in 2009 to be 152.7 thousand, or 152,700.

In 2012, $x = 2012 - 1990 = 22$.

$y = 4 \cdot 22 + 76.7 = 164.7$

We estimate the number of twin births in 2012 to be 164.7 thousand, or 164,700.

62. a) Answers may vary depending on the data points used. We will use (10, 6742) and (13, 7110).

$$m = \frac{7110 - 6742}{13 - 10} = \frac{368}{3} \approx 122.7$$

Using the point-slope equation:

$$y - 6742 = 122.7(x - 10)$$
$$y - 6742 = 122.7x - 1227$$
$$y = 122.7x + 5515,$$

where x is the number of years after 1990.

b) 2009: $y = 122.7(19) + 5515 \approx 7846$ triplet births

2012: $y = 122.7(22) + 5515 \approx 8214$ triplet births

63. Answers may vary depending on the data points used. We will use (2, 300) and (9, 328).

$$m = \frac{328 - 300}{9 - 2} = \frac{28}{7} = 4$$

We will use the slope-intercept equation with the point (2, 300).

$$y = mx + b$$
$$300 = 4 \cdot 2 + b$$
$$300 = 8 + b$$
$$292 = b$$

We have $y = 4x + 292$, where x is the number of years after 1995 and y is in millions.

In 2006, $x = 2006 - 1995 = 11$.

$y = 4 \cdot 11 + 292 = 336$

We estimate attendance at U.S. amusement/theme parks in 2006 to be 336 million.

In 2010, $x = 2010 - 1995 = 15$

$y = 4 \cdot 15 + 292 = 352$

We estimate attendance at U.S. amusement/theme parks in 2010 to be 352 million.

64. Answers may vary depending on the data points used. We will use (1, 183) and (4, 230).

$$m = \frac{230 - 183}{4 - 1} = \frac{47}{3} \approx 15.67$$

Using the slope-intercept equation with the point (1, 183):

$$183 = 15.67 \cdot 1 + b$$
$$167.33 = b$$

We have $y = 15.67x + 167.33$ where x is the number of years after 2001 and y is in billions of dollars.

2007: $y = 15.67(6) + 167.33 \approx \$261$ billion

2011: $y = 15.67(10) + 167.33 \approx \$324$ billion

65. Answers may vary depending on the data points used. We will use (10, 321) and (35, 955).

$$m = \frac{955 - 321}{35 - 10} = \frac{634}{25} = 25.36$$

We will use the point-slope equation with the point (10, 321):

$$y - 321 = 25.36(x - 10)$$
$$y - 321 = 25.36x - 253.6$$
$$y = 25.36x + 67.4,$$

where x is the number of years after 1970.

In 2009, $x = 2009 - 1970 = 39$.

$y = 25.36(39) + 67.4 \approx \$1056$

In 2012, $x = 2012 - 1970 = 42$.

$y = 25.36(42) + 67.4 \approx \$1133$

In 2020, $x = 2020 - 1970 = 50$.

$y = 25.36(50) + 67.4 \approx \$1335$

66. Answers will vary depending on the data points used. We will use (0, 20.423) and (20, 11.358).

$$m = \frac{11.358 - 20.423}{20 - 0} = \frac{-9.065}{20} = -0.45325$$

Substituting in the slope-intercept equation we have $y = -0.45325x + 20.423$, where x is the number of years after 1970 and y is in millions.

2008: $y = -0.45325(38) + 20.423 = 3.1995$

We estimate the number of sheep and lambs on farms in 2008 to be 3.1995 million, or 3,199,500.

2013: $y = -0.45325(43) + 20.423 = 0.93325$

There will be about 0.93325 million, or 933,250 sheep and lambs on farms in 2013.

67. a) Using the linear regression feature on a graphing calculator, we get $M = 0.2H + 156$.

b) For $H = 40$: $M = 0.2(40) + 156 = 164$ beats per minute

For $H = 65$: $M = 0.2(65) + 156 = 169$ beats per minute

For $H = 76$: $M = 0.2(76) + 156 \approx 171$ beats per minute

For $H = 84$: $M = 0.2(84) + 156 \approx 173$ beats per minute

c) $r = 1$; all the data points are on the regression line so it should be a good predictor.

68. a) $y = 0.072050673x + 81.99920823$

b) For $x = 24$:
$y = 0.072050673(24) + 81.99920823 \approx 84\%$

For $x = 6$:
$y = 0.072050673(6) + 81.99920823 \approx 82\%$

For $x = 18$:
$y = 0.072050673(18) + 81.99920823 \approx 83\%$

c) $r = 0.0636$; since there is a very low correlation, the regression line is not a good predictor.

69. a) Using the linear regression feature on a graphing calculator, we get $y = 5.6524x + 8.731$, where x is the number of years after 1995 and y is in millions.

b) In 2010, $x = 2010 - 1995 = 15$.

$y = 5.6524(15) + 8.731 = 93.517$

We estimate the number of tax returns filed electronically in 2010 to be 93.517 million, or 93,517,000.

In 2014, $x = 2014 - 1995 = 19$.

$y = 5.6524(19) + 8.731 \approx 116.127$

We estimate the number of tax returns filed electronically in 2014 to be 116.127 million, or 116,127,000.

c) $r \approx 0.9931$; since $|r|$ is close to 1, the line fits the data closely.

70. a) $y = 315.5867925x + 3036.122642$, where x is the number of years after 1990.

b) When $x = 22$, we have $y = 9979$ triplet births. This estimate is 1765 higher (or about 21.5% higher) than the estimate found in Exercise 62.

c) $r \approx 0.9686$; since $|r|$ is close to 1, the line fits the data closely.

71. a) Using the linear regression feature on a graphing calculator, we have $y = 3.176981132x+88.15660377$, where x is the number of years after 1990 and y is in thousands.

b) In 2012, $x = 2012 - 1990 = 22$. When $x = 22$, we have $y = 158.05$ thousand, or 158,050. This estimate is 6650 lower (or about 4% lower) than the estimate found in Exercise 61.

c) $r \approx 0.9584$; since $|r|$ is close to 1, the line fits the data closely.

72. Answers will vary.

73. Answers will vary.

74. $m = \dfrac{-7-7}{5-5} = \dfrac{-14}{0}$

The slope is not defined.

75.
$$m = \frac{y_2 - y_1}{x_2 - x_1} = \frac{-1-(-8)}{-5-2} = \frac{-1+8}{-7} = \frac{7}{-7} = -1$$

76. $r = \dfrac{d}{2} = \dfrac{5}{2}$

$$(x-0)^2 + (y-3)^2 = \left(\frac{5}{2}\right)^2$$
$$x^2 + (y-3)^2 = \frac{25}{4}, \text{ or}$$
$$x^2 + (y-3)^2 = 6.25$$

77.
$$(x-h)^2 + (y-k)^2 = r^2$$
$$[x-(-7)]^2 + [y-(-1)]^2 = \left(\frac{9}{5}\right)^2$$
$$(x+7)^2 + (y+1)^2 = \frac{81}{25}$$

78. $m = \dfrac{920.58}{13,740} = 0.067$

The road grade is 6.7%.

We find an equation of the line with slope 0.067 and containing the point $(13,740, 920.58)$:

$$y - 920.58 = 0.067(x - 13,740)$$
$$y - 920.58 = 0.067x - 920.58$$
$$y = 0.067x$$

79. The slope of the line containing $(-3, k)$ and $(4, 8)$ is $\dfrac{8-k}{4-(-3)} = \dfrac{8-k}{7}$.

The slope of the line containing $(5, 3)$ and $(1, -6)$ is $\dfrac{-6-3}{1-5} = \dfrac{-9}{-4} = \dfrac{9}{4}$.

The slopes must be equal in order for the lines to be parallel:

$$\frac{8-k}{7} = \frac{9}{4}$$
$$32 - 4k = 63 \quad \text{Multiplying by 28}$$
$$-4k = 31$$
$$k = -\frac{31}{4}, \text{ or } -7.75$$

80. The slope of the line containing $(-1, 3)$ and $(2, 9)$ is $\dfrac{9-3}{2-(-1)} = \dfrac{6}{3} = 2$.

Then the slope of the desired line is $-\dfrac{1}{2}$. We find the equation of that line:

$$y - 5 = -\frac{1}{2}(x-4)$$
$$y - 5 = -\frac{1}{2}x + 2$$
$$y = -\frac{1}{2}x + 7$$

Exercise Set 1.5

1.
$$4x + 5 = 21$$
$$4x = 16 \quad \text{Subtracting 5 on both sides}$$
$$x = 4 \quad \text{Dividing by 4 on both sides}$$

The solution is 4.

2.
$$2y - 1 = 3$$
$$2y = 4$$
$$y = 2$$

The solution is 2.

3. $23-\frac{2}{5}x=-\frac{2}{5}x+23$

$23=23$ Adding $\frac{2}{5}x$ on both sides

We get an equation that is true for any value of x, so the solution set is the set of real numbers, $\{x|x \text{ is a real number}\}$, or $(-\infty,\infty)$.

4. $\frac{6}{5}y+3=\frac{3}{10}$ The LCD is 10.

$$10\left(\frac{6}{5}y+3\right)=10\cdot\frac{3}{10}$$
$$12y+30=3$$
$$12y=-27$$
$$y=-\frac{9}{4}$$

The solution is $-\frac{9}{4}$.

5. $4x+3=0$

$4x=-3$ Subtracting 3 on both sides

$x=-\frac{3}{4}$ Dividing by 4 on both sides

The solution is $-\frac{3}{4}$.

6. $3x-16=0$

$$3x=16$$
$$x=\frac{16}{3}$$

The solution is $\frac{16}{3}$.

7. $3-x=12$

$-x=9$ Subtracting 3 on both sides

$x=-9$ Multiplying (or dividing) by -1 on both sides

The solution is -9.

8. $4-x=-5$

$$-x=-9$$
$$x=9$$

The solution is 9.

9. $3-\frac{1}{4}x=\frac{3}{2}$ The LCD is 4.

$4\left(3-\frac{1}{4}x\right)=4\cdot\frac{3}{2}$ Multiplying by the LCD to clear fractions

$12-x=6$

$-x=-6$ Subtracting 12 on both sides

$x=6$ Multiplying (or dividing) by -1 on both sides

The solution is 6.

10. $10x-3=8+10x$

$-3=8$ Subtracting $10x$ on both sides

We get a false equation. Thus, the original equation has no solution.

11. $\frac{2}{11}-4x=-4x+\frac{9}{11}$

$\frac{2}{11}=\frac{9}{11}$ Adding $4x$ on both sides

We get a false equation. Thus, the original equation has no solution.

12. $8-\frac{2}{9}x=\frac{5}{6}$ The LCD is 18.

$$18\left(8-\frac{2}{9}x\right)=18\cdot\frac{5}{6}$$
$$144-4x=15$$
$$-4x=-129$$
$$x=\frac{129}{4}$$

The solution is $\frac{129}{4}$.

13. $8=5x-3$

$11=5x$ Adding 3 on both sides

$\frac{11}{5}=x$ Dividing by 5 on both sides

The solution is $\frac{11}{5}$.

14. $9=4x-8$

$$17=4x$$
$$\frac{17}{4}=x$$

The solution is $\frac{17}{4}$.

15. $\frac{2}{5}y-2=\frac{1}{3}$ The LCD is 15.

$15\left(\frac{2}{5}y-2\right)=15\cdot\frac{1}{3}$ Multiplying by the LCD to clear fractions

$6y-30=5$

$6y=35$ Adding 30 on both sides

$y=\frac{35}{6}$ Dividing by 6 on both sides

The solution is $\frac{35}{6}$.

16. $-x+1=1-x$

$1=1$ Adding x on both sides

We get an equation that is true for any value of x, so the solution set is the set of real numbers, $\{x|x \text{ is a real number}\}$, or $(-\infty,\infty)$.

17. $y+1=2y-7$

$1=y-7$ Subtracting y on both sides

$8=y$ Adding 7 on both sides

The solution is 8.

18. $5-4x=x-13$

$$18=5x$$
$$\frac{18}{5}=x$$

The solution is $\frac{18}{5}$.

19. $2x+7=x+3$

$x+7=3$ Subtracting x on both sides

$x=-4$ Subtracting 7 on both sides

The solution is -4.

20. $5x-4=2x+5$

$3x-4=5$

$3x=9$

$x=3$

The solution is 3.

21. $3x-5=2x+1$

$x-5=1$ Subtracting $2x$ on both sides

$x=6$ Adding 5 on both sides

The solution is 6.

22. $4x+3=2x-7$

$2x=-10$

$x=-5$

The solution is -5.

23. $4x-5=7x-2$

$-5=3x-2$ Subtracting $4x$ on both sides

$-3=3x$ Adding 2 on both sides

$-1=x$ Dividing by 3 on both sides

The solution is -1.

24. $5x+1=9x-7$

$8=4x$

$2=x$

The solution is 2.

25. $5x-2+3x=2x+6-4x$

$8x-2=6-2x$ Collecting like terms

$8x+2x=6+2$ Adding $2x$ and 2 on both sides

$10x=8$ Collecting like terms

$x=\frac{8}{10}$ Dividing by 10 on both sides

$x=\frac{4}{5}$ Simplifying

The solution is $\frac{4}{5}$.

26. $5x-17-2x=6x-1-x$

$3x-17=5x-1$

$-2x=16$

$x=-8$

The solution is -8.

27. $7(3x+6)=11-(x+2)$

$21x+42=11-x-2$ Using the distributive property

$21x+42=9-x$ Collecting like terms

$21x+x=9-42$ Adding x and subtracting 42 on both sides

$22x=-33$ Collecting like terms

$x=-\frac{33}{22}$ Dividing by 22 on both sides

$x=-\frac{3}{2}$ Simplifying

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

28. $4(5y+3)=3(2y-5)$

$20y+12=6y-15$

$14y=-27$

$y=-\frac{27}{14}$

The solution is $-\frac{27}{14}$.

29. $3(x+1)=5-2(3x+4)$

$3x+3=5-6x-8$ Removing parentheses

$3x+3=-6x-3$ Collecting like terms

$9x+3=-3$ Adding $6x$

$9x=-6$ Subtracting 3

$x=-\frac{2}{3}$ Dividing by 9

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

30. $4(3x+2)-7=3(x-2)$

$12x+8-7=3x-6$

$12x+1=3x-6$

$9x+1=-6$

$9x=-7$

$x=-\frac{7}{9}$

The solution is $-\frac{7}{9}$.

31. $2(x-4)=3-5(2x+1)$

$2x-8=3-10x-5$ Using the distributive property

$2x-8=-10x-2$ Collecting like terms

$12x=6$ Adding $10x$ and 8 on both sides

$x=\frac{1}{2}$ Dividing by 12 on both sides

The solution is $\frac{1}{2}$.

32.
$$\begin{aligned} 3(2x-5)+4 &= 2(4x+3) \\ 6x-15+4 &= 8x+6 \\ 6x-11 &= 8x+6 \\ -2x &= 17 \\ x &= -\frac{17}{2} \end{aligned}$$

The solution is $-\dfrac{17}{2}$.

33. ***Familiarize***. Let w = the wholesale sales of bottled water in 2001, in billions of dollars. An increase of 54% over this amount is $54\% \cdot w$, or $0.54w$.

Translate.

Wholesale sales in 2001	plus	increase in sales	is	Wholesale sales in 2006.
w	$+$	$0.54w$	$=$	10.6

Carry out. We solve the equation.

$$\begin{aligned} w+0.54w &= 10.6 \\ 1.54w &= 10.6 \\ w &= \frac{10.6}{1.54} \\ w &\approx 6.9 \end{aligned}$$

Check. 54% of 6.9 is 0.54(6.9) or about 3.7, and $6.9+3.7 = 10.6$. The answer checks.

State. Wholesale sales of bottled water in 2001 were about \$6.9 billion.

34. Let d = the daily global demand for oil in 2005, in millions of barrels.

Solve: $d + 0.23d = 103$

$d \approx 84$ million barrels per day

35. ***Familiarize***. Let d = the average credit card debt per household in 1990.

Translate.

Debt in 1990	plus	additional debt	is	debt in 2004.
d	$+$	6346	$=$	9312

Carry out. We solve the equation.

$$\begin{aligned} d+6346 &= 9312 \\ d &= 2966 \quad \text{Subtracting 6346} \end{aligned}$$

Check. $\$2966 + \$6346 = \$9312$, so the answer checks.

State. The average credit card debt in 1990 was \$2966 per household.

36. Let n = the number of nesting pairs of bald eagles in the lower 48 states in 1963.

Solve: $n + 6649 = 7066$

$n = 417$ pairs of bald eagles

37. ***Familiarize***. Let d = the number of gigabytes of digital data stored in a typical household in 2004.

Translate.

Data stored in 2004	plus	additional data	is	data stored in 2010.
d	$+$	4024	$=$	4430

Carry out. We solve the equation.

$$\begin{aligned} d+4024 &= 4430 \\ d &= 406 \quad \text{Subtracting 4024} \end{aligned}$$

Check. $406 + 4024 = 4430$, so the answer checks.

State. In 2004, 406 GB of digital data were stored in a typical household.

38. Let s = the amount of a student's expenditure for books that goes to the college store.

Solve: $s = 0.232(940)$

$s = \$218.08$

39. ***Familiarize***. Let v = the number of visitors to the Grand Canyon in 2005, in millions. Then $v + 4.8$ = the number of visitors to the Great Smokey Mountains Park.

Translate.

Number of visitors to the Grand Canyon	plus	Number of visitors to Great Smokey Mountains	is	Total number of visitors.
v	$+$	$v + 4.8$	$=$	13.6

Carry out. We solve the equation.

$$\begin{aligned} v+v+4.8 &= 13.6 \\ 2v+4.8 &= 13.6 \\ 2v &= 8.8 \\ v &= 4.4 \end{aligned}$$

Then $v + 4.8 = 9.2$.

Check. 9.2 million is 4.8 million more than 4.4 million, and 4.4 million + 9.2 million = 13.6 million, so the answer checks.

State. In 2005 there were 4.4 million visitors to the Grand Canyon and 9.2 million visitors to the Great Smokey Mountains Park.

40. Let c = the average daily calorie requirement for many adults.

Solve: $1560 = \dfrac{3}{4}c$

$c = 2080$ calories

41. ***Familiarize***. Let v = the number of ABC viewers, in millions. Then $v + 1.7$ = the number of CBS viewers and $v - 1.7$ = the number of NBC viewers.

Translate.

ABC viewers	plus	CBS viewers	plus	NBC viewers	is	total viewers.
v	$+$	$(v+1.7)$	$+$	$(v-1.7)$	$=$	29.1

Carry out.

$$v + (v + 1.7) + (v - 1.7) = 29.1$$
$$3v = 29.1$$
$$v = 9.7$$

Then $v+1.7 = 9.7+1.7 = 11.4$ and $v-1.7 = 9.7-1.7 = 8.0$.

Check. $9.7 + 11.4 + 8.0 = 29.1$, so the answer checks.

State. ABC had 9.7 million viewers, CBS had 11.4 million viewers, and NBC had 8.0 million viewers.

42. Let h = the number of households represented by the rating.

Solve: $h = 11.0(1,102,000)$

$h = 12,122,000$ households

43. ***Familiarize***. Let P = the amount Tamisha borrowed. We will use the formula $I = Prt$ to find the interest owed. For $r = 5\%$, or 0.05, and $t = 1$, we have $I = P(0.05)(1)$, or $0.05P$.

Translate.

Amount borrowed	plus	interest	is	\$1365.
↓	↓	↓	↓	↓
P	$+$	$0.05P$	$=$	1365

Carry out. We solve the equation.

$$P + 0.05P = 1365$$
$$1.05P = 1365 \quad \text{Adding}$$
$$P = 1300 \quad \text{Dividing by 1.05}$$

Check. The interest due on a loan of \$1300 for 1 year at a rate of 5% is \$1300(0.05)(1), or \$65, and \$1300 + \$65 = \$1365. The answer checks.

State. Tamisha borrowed \$1300.

44. Let P = the amount invested.

Solve: $P + 0.04P = \$1560$

$P = \$1500$

45. ***Familiarize***. Let s = Ryan's sales for the month. Then his commission is 8% of s, or $0.08s$.

Translate.

Base salary	plus	commission	is	total pay.
↓	↓	↓	↓	↓
1500	$+$	$0.08s$	$=$	2284

Carry out. We solve the equation.

$$1500 + 0.08s = 2284$$
$$0.08s = 784 \quad \text{Subtracting 1500}$$
$$s = 9800$$

Check. 8% of \$9800, or 0.08(\$9800), is \$784 and \$1500 + \$784 = \$2284. The answer checks.

State. Ryan's sales for the month were \$9800.

46. Let s = the amount of sales for which the two choices will be equal.

Solve: $1800 = 1600 + 0.04s$

$s = \$5000$

47. ***Familiarize***. Let d = the number of miles Diego traveled in the cab.

Translate.

Pickup fee	plus	cost per mile	times	number of miles traveled	is	\$19.75.
↓	↓	↓	↓	↓	↓	↓
1.75	$+$	1.50	$\cdot$	d	$=$	19.75

Carry out. We solve the equation.

$$1.75 + 1.50 \cdot d = 19.75$$
$$1.5d = 18 \quad \text{Subtracting 1.75}$$
$$d = 12 \quad \text{Dividing by 1.5}$$

Check. If Diego travels 12 mi, his fare is $\$1.75 + \$1.50 \cdot 12$, or \$1.75 + \$18, or \$19.75. The answer checks.

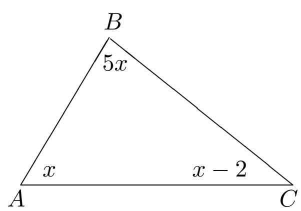
State. Diego traveled 12 mi in the cab.

48. Let w = Soledad's regular hourly wage. She worked $48 - 40$, or 8 hr, of overtime.

Solve: $40w + 8(1.5w) = 442$

$w = \$8.50$

49. ***Familiarize***. We make a drawing.



We let x = the measure of angle A. Then $5x$ = the measure of angle B, and $x - 2$ = the measure of angle C. The sum of the angle measures is 180°.

Translate.

Measure of angle A	+	Measure of angle B	+	Measure of angle C	= 180.	
↓	↓	↓	↓	↓	↓	↓
x	$+$	$5x$	$+$	$x-2$	$=$	180

Carry out. We solve the equation.

$$x + 5x + x - 2 = 180$$
$$7x - 2 = 180$$
$$7x = 182$$
$$x = 26$$

If $x = 26$, then $5x = 5 \cdot 26$, or 130, and $x - 2 = 26 - 2$, or 24.

Check. The measure of angle B, 130°, is five times the measure of angle A, 26°. The measure of angle C, 24°, is 2° less than the measure of angle A, 26°. The sum of the angle measures is 26° + 130° + 24°, or 180°. The answer checks.

State. The measure of angles A, B, and C are 26°, 130°, and 24°, respectively.

50. Let $x =$ the measure of angle A.

Solve: $x + 2x + x + 20 = 180$

$x = 40°$, so the measure of angle A is $40°$; the measure of angle B is $2 \cdot 40°$, or $80°$; and the measure of angle C is $40° + 20°$, or $60°$.

51. ***Familiarize***. Using the labels on the drawing in the text, we let $w =$ the width of the test plot and $w + 25 =$ the length, in meters. Recall that for a rectangle, Perimeter $= 2 \cdot \text{length} + 2 \cdot \text{width}$.

Translate.

$$\underbrace{\text{Perimeter}} = \underbrace{2 \cdot \text{ length}} + \underbrace{2 \cdot \text{ width}}$$

$$\downarrow \quad \downarrow \quad \downarrow \quad \downarrow \quad \downarrow$$

$$322 \quad = 2(w + 25) + \quad 2 \cdot w$$

Carry out. We solve the equation.

$$322 = 2(w + 25) + 2 \cdot w$$
$$322 = 2w + 50 + 2w$$
$$322 = 4w + 50$$
$$272 = 4w$$
$$68 = w$$

When $w = 68$, then $w + 25 = 68 + 25 = 93$.

Check. The length is 25 m more than the width: $93 = 68 + 25$. The perimeter is $2 \cdot 93 + 2 \cdot 68$, or $186 + 136$, or 322 m. The answer checks.

State. The length is 93 m; the width is 68 m.

52. Let $w =$ the width of the garden.

Solve: $2 \cdot 2w + 2 \cdot w = 39$

$w = 6.5$, so the width is 6.5 m, and the length is $2(6.5)$, or 13 m.

53. ***Familiarize***. Let $l =$ the length of the soccer field and $l - 35 =$ the width, in yards.

Translate. We use the formula for the perimeter of a rectangle. We substitute 330 for P and $l - 35$ for w.

$$P = 2l + 2w$$
$$330 = 2l + 2(l - 35)$$

Carry out. We solve the equation.

$$330 = 2l + 2(l - 35)$$
$$330 = 2l + 2l - 70$$
$$330 = 4l - 70$$
$$400 = 4l$$
$$100 = l$$

If $l = 100$, then $l - 35 = 100 - 35 = 65$.

Check. The width, 65 yd, is 35 yd less than the length, 100 yd. Also, the perimeter is

$$2 \cdot 100 \text{ yd} + 2 \cdot 65 \text{ yd} = 200 \text{ yd} + 130 \text{ yd} = 330 \text{ yd}.$$

The answer checks.

State. The length of the field is 100 yd, and the width is 65 yd.

54. Let $h =$ the height of the poster and $\frac{2}{3}h =$ the width, in inches.

Solve: $100 = 2 \cdot h + 2 \cdot \frac{2}{3}h$

$h = 30$, so the height is 30 in. and the width is $\frac{2}{3} \cdot 30$, or 20 in.

55. ***Familiarize***. Let $w =$ the number of pounds of Kimiko's body weight that is water.

Translate.

$$50\% \text{ of } \underbrace{\text{body weight}} \text{ is water.}$$

$$\downarrow \quad \downarrow \quad \downarrow \quad \downarrow \quad \downarrow$$

$$0.5 \quad \times \quad 135 \quad = \quad w$$

Carry out. We solve the equation.

$$0.5 \times 135 = w$$
$$67.5 = w$$

Check. Since 50% of 138 is 67.5, the answer checks.

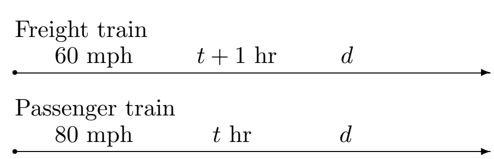
State. 67.5 lb of Kimiko's body weight is water.

56. Let $w =$ the number of pounds of Emilio's body weight that is water.

Solve: $0.6 \times 186 = w$

$w = 111.6$ lb

57. ***Familiarize***. We make a drawing. Let $t =$ the number of hours the passenger train travels before it overtakes the freight train. Then $t+1 =$ the number of hours the freight train travels before it is overtaken by the passenger train. Also let $d =$ the distance the trains travel.



We can also organize the information in a table.

$$d \quad = \quad r \quad \cdot \quad t$$

	Distance	Rate	Time
Freight train	d	60	$t + 1$
Passenger train	d	80	t

Translate. Using the formula $d = rt$ in each row of the table, we get two equations.

$$d = 60(t + 1) \text{ and } d = 80t.$$

Since the distances are the same, we have the equation

$$60(t + 1) = 80t.$$

Carry out. We solve the equation.

$$60(t + 1) = 80t$$
$$60t + 60 = 80t$$
$$60 = 20t$$
$$3 = t$$

When $t = 3$, then $t + 1 = 3 + 1 = 4$.

Check. In 4 hr the freight train travels $60 \cdot 4$, or 240 mi. In 3 hr the passenger train travels $80 \cdot 3$, or 240 mi. Since the distances are the same, the answer checks.

State. It will take the passenger train 3 hr to overtake the freight train.

58. Let t = the time the private airplane travels.

	Distance	Rate	Time
Private airplane	d	180	t
Jet	d	900	$t - 2$

From the table we have the following equations:

$d = 180t$ and $d = 900(t - 2)$

Solve: $180t = 900(t - 2)$

$t = 2.5$

In 2.5 hr the private airplane travels 180(2.5), or 450 km. This is the distance from the airport at which it is overtaken by the jet.

59. ***Familiarize***. Let t = the number of hours it takes the kayak to travel 36 mi upstream. The kayak travels upstream at a rate of $12 - 4$, or 8 mph.

Translate. We use the formula $d = rt$.

$36 = 8 \cdot t$

Carry out. We solve the equation.

$$36 = 8 \cdot t$$
$$4.5 = t$$

Check. At a rate of 8 mph, in 4.5 hr the kayak travels 8(4.5), or 36 mi. The answer checks.

State. It takes the kayak 4.5 hr to travel 36 mi upstream.

60. Let t = the number of hours it will take Angelo to travel 20 km downstream. The kayak travels downstream at a rate of $14 + 2$, or 16 km/h.

Solve: $20 = 16t$

$t = 1.25$ hr

61. ***Familiarize***. Let t = the number of hours it will take the plane to travel 1050 mi into the wind. The speed into the headwind is $450 - 30$, or 420 mph.

Translate. We use the formula $d = rt$.

$1050 = 420 \cdot t$

Carry out. We solve the equation.

$$1050 = 420 \cdot t$$
$$2.5 = t$$

Check. At a rate of 420 mph, in 2.5 hr the plane travels 420(2.5), or 1050 mi. The answer checks.

State. It will take the plane 2.5 hr to travel 1050 mi into the wind.

62. Let t = the number of hours it will take the plane to travel 700 mi with the wind. The speed with the wind is $375+25$, or 400 mph.

Solve: $700 = 400t$

$t = 1.75$ hr

63. ***Familiarize***. Let x = the amount invested at 3% interest. Then $5000 - x$ = the amount invested at 4%. We organize the information in a table, keeping in mind the simple interest formula, $I = Prt$.

	Amount invested	Interest rate	Time	Amount of interest
3% invest-ment	x	3%, or 0.03	1 yr	$x(0.03)(1)$, or $0.03x$
4% invest-ment	$5000-x$	4%, or 0.04	1 yr	$(5000-x)(0.04)(1)$, or $0.04(5000-x)$
Total	5000			176

Translate.

Interest on 3% investment plus interest on 4% investment is \$176.

$$0.03x + 0.04(5000 - x) = 176$$

Carry out. We solve the equation.

$$0.03x + 0.04(5000 - x) = 176$$
$$0.03x + 200 - 0.04x = 176$$
$$-0.01x + 200 = 176$$
$$-0.01x = -24$$
$$x = 2400$$

If $x = 2400$, then $5000 - x = 5000 - 2400 = 2600$.

Check. The interest on \$2400 at 3% for 1 yr is \$2400(0.03)(1) = \$72. The interest on \$2600 at 4% for 1 yr is \$2600(0.04)(1) = \$104. Since \$72 + \$104 = \$176, the answer checks.

State. \$2400 was invested at 3%, and \$2600 was invested at 4%.

64. Let x = the amount borrowed at 5%. Then $9000 - x$ = the amount invested at 6%.

Solve: $0.05x + 0.06(9000 - x) = 492$

$x = 4800$, so \$4800 was borrowed at 5% and \$9000 − \$4800 = \$4200 was borrowed at 6%.

65. ***Familiarize***. Let c = the calcium content of the cheese, in mg. Then $2c + 4$ = the calcium content of the yogurt.

Translate.

Calcium content of cheese plus calcium content of yogurt is total calcium content.

$$c + (2c + 4) = 676$$

Carry out. We solve the equation.

$$\begin{aligned} c + (2c+4) &= 676 \\ 3c + 4 &= 676 \\ 3c &= 672 \\ c &= 224 \end{aligned}$$

Then $2c + 4 = 2 \cdot 224 + 4 = 448 + 4 = 452$.

Check. $224 + 452 = 676$, so the answer checks.

State. The cheese contains 224 mg of calcium, and the yogurt contains 452 mg.

66. Let p = the number of people in the United States without health insurance in 1987, in millions.

Solve: $55.8 = 2p - 17.2$

$p = 36.5$ million people

67. ***Familiarize***. Let l = the elevation of Lucas Oil Stadium, in feet.

Translate.

$$\underbrace{\text{Elevation of Invesco Field}} \;\text{is}\; \underbrace{247\text{ ft}} \; \underbrace{\text{more than}} \;\text{7 times}\; \underbrace{\text{Elevation of Lucas Oil Stadium}}$$

$$\downarrow \quad \downarrow \quad \downarrow \quad \downarrow \quad \downarrow \quad \downarrow \quad \downarrow$$

$$5210 \quad = \quad 247 \quad + \quad 7 \quad \cdot \quad l$$

Carry out. We solve the equation.

$$\begin{aligned} 5210 &= 247 + 7l \\ 4963 &= 7l \\ 709 &= l \end{aligned}$$

Check. 247 more than 7 times 709 is $247 + 7 \cdot 709 = 247 + 4963 = 5210$. The answer checks.

State. The elevation of Lucas Oil Stadium is 709 ft.

68. Let a = the number of adults in prison in the United States in 1980, in millions.

Solve: $1.7 = 5.4a$

$a \approx 0.31$ million adults

69. ***Familiarize***. Let n = the number of inches the volcano rises in a year. We will express one-half mile in inches:

$$\frac{1}{2}\text{ mi} \times \frac{5280\text{ ft}}{1\text{ mi}} \times \frac{12\text{ in.}}{1\text{ ft}} = 31,680\text{ in.}$$

Translate.

$$\underbrace{50{,}000\text{ yr}} \;\text{times}\; \underbrace{\text{number of inches per year}} \;\text{is}\; \underbrace{31{,}680\text{ in.}}$$

$$\downarrow \quad \downarrow \quad \downarrow \quad \downarrow \quad \downarrow$$

$$50,000 \quad \cdot \quad n \quad = \quad 31,680$$

Carry out. We solve the equation.

$$\begin{aligned} 50,000n &= 31,680 \\ n &= 0.6336 \end{aligned}$$

Check. Rising at a rate of 0.6336 in. per year, in 50,000 yr the volcano will rise $50,000(0.6336)$, or 31,680 in. The answer checks.

State. On average, the volcano rises 0.6336 in. in a year.

70. Let x = the number of years it will take Horseshoe Falls to migrate one-fourth mile upstream. We will express one-fourth mile in feet:

$$\frac{1}{4}\text{ mi} \times \frac{5280\text{ ft}}{1\text{ mi}} = 1320\text{ ft}$$

Solve: $2x = 1320$

$x = 660$ yr

71.

$$\begin{aligned} x + 5 &= 0 && \text{Setting } f(x) = 0 \\ x + 5 - 5 &= 0 - 5 && \text{Subtracting 5 on both sides} \\ x &= -5 \end{aligned}$$

The zero of the function is -5.

72.

$$\begin{aligned} 5x + 20 &= 0 \\ 5x &= -20 \\ x &= -4 \end{aligned}$$

73.

$$\begin{aligned} -2x + 11 &= 0 && \text{Setting } f(x) = 0 \\ -2x + 11 - 11 &= 0 - 11 && \text{Subtracting 11 on both sides} \\ -2x &= -11 \\ x &= \frac{11}{2} && \text{Dividing by } -2 \text{ on both sides} \end{aligned}$$

The zero of the function is $\frac{11}{2}$.

74.

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

75.

$$\begin{aligned} 16 - x &= 0 && \text{Setting } f(x) = 0 \\ 16 - x + x &= 0 + x && \text{Adding } x \text{ on both sides} \\ 16 &= x \end{aligned}$$

The zero of the function is 16.

76.

$$\begin{aligned} -2x + 7 &= 0 \\ -2x &= -7 \\ x &= \frac{7}{2} \end{aligned}$$

77.

$$\begin{aligned} x + 12 &= 0 && \text{Setting } f(x) = 0 \\ x + 12 - 12 &= 0 - 12 && \text{Subtracting 12 on both sides} \\ x &= -12 \end{aligned}$$

The zero of the function is -12.

78.

$$\begin{aligned} 8x + 2 &= 0 \\ 8x &= -2 \\ x &= -\frac{1}{4},\text{ or } -0.25 \end{aligned}$$

79.

$$\begin{aligned} -x + 6 &= 0 && \text{Setting } f(x) = 0 \\ -x + 6 + x &= 0 + x && \text{Adding } x \text{ on both sides} \\ 6 &= x \end{aligned}$$

The zero of the function is 6.

80.

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

81. $20 - x = 0$ Setting $f(x) = 0$

$20 - x + x = 0 + x$ Adding x on both sides

$20 = x$

The zero of the function is 20.

82. $-3x + 13 = 0$

$-3x = -13$

$x = \frac{13}{3}$, or $4.\overline{3}$

83. $\frac{2}{5}x - 10 = 0$ Setting $f(x) = 0$

$\frac{2}{5}x = 10$ Adding 10 on both sides

$\frac{5}{2} \cdot \frac{2}{5}x = \frac{5}{2} \cdot 10$ Multiplying by $\frac{5}{2}$ on both sides

$x = 25$

The zero of the function is 25.

84. $3x - 9 = 0$

$3x = 9$

$x = 3$

85. $-x + 15 = 0$ Setting $f(x) = 0$

$15 = x$ Adding x on both sides

The zero of the function is 15.

86. $4 - x = 0$

$4 = x$

87. a) The graph crosses the x-axis at $(4, 0)$. This is the x-intercept.

b) The zero of the function is the first coordinate of the x-intercept. It is 4.

88. a) $(5, 0)$

b) 5

89. a) The graph crosses the x-axis at $(-2, 0)$. This is the x-intercept.

b) The zero of the function is the first coordinate of the x-intercept. It is -2.

90. a) $(2, 0)$

b) 2

91. a) The graph crosses the x-axis at $(-4, 0)$. This is the x-intercept.

b) The zero of the function is the first coordinate of the x-intercept. It is -4.

92. a) $(-2, 0)$

b) -2

93. $A = \frac{1}{2}bh$

$2A = bh$ Multiplying by 2 on both sides

$\frac{2A}{h} = b$ Dividing by h on both sides

94. $A = \pi r^2$

$\frac{A}{r^2} = \pi$

95. $P = 2l + 2w$

$P - 2l = 2w$ Subtracting $2l$ on both sides

$\frac{P - 2l}{2} = w$ Dividing by 2 on both sides

96. $A = P + Prt$

$A - P = Prt$

$\frac{A - P}{Pt} = r$

97. $A = \frac{1}{2}h(b_1 + b_2)$

$\frac{2A}{h} = b_1 + b_2$ Multiplying by $\frac{2}{h}$ on both sides

$\frac{2A}{h} - b_1 = b_2$, or Subtracting b_1 on both sides

$\frac{2A - b_1 h}{h} = b_2$ Using a common demoninator

98. $A = \frac{1}{2}h(b_1 + b_2)$

$2A = h(b_1 + b_2)$

$\frac{2A}{b_1 + b_2} = h$

99. $V = \frac{4}{3}\pi r^3$

$3V = 4\pi r^3$ Multiplying by 3 on both sides

$\frac{3V}{4r^3} = \pi$ Dividing by $4r^3$ on both sides

100. $V = \frac{4}{3}\pi r^3$

$\frac{3V}{4\pi} = r^3$

101. $F = \frac{9}{5}C + 32$

$F - 32 = \frac{9}{5}C$ Subtracting 32 on both sides

$\frac{5}{9}(F - 32) = C$ Multiplying by $\frac{5}{9}$ on both sides

102. $Ax + By = C$

$By = C - Ax$

$y = \frac{C - Ax}{B}$

103. $Ax + By = C$

$Ax = C - By$ Subtracting By on both sides

$A = \frac{C - By}{x}$ Dividing by x on both sides

104. $2w + 2h + l = p$

$2w = p - 2h - l$

$w = \frac{p - 2h - l}{2}$

105. $2w + 2h + l = p$

$2h = p - 2w - l$ Subtracting $2w$ and l

$h = \dfrac{p - 2w - l}{2}$ Dividing by 2

106. $3x + 4y = 12$

$4y = 12 - 3x$

$y = \dfrac{12 - 3x}{4}$

107. $2x - 3y = 6$

$-3y = 6 - 2x$ Subtracting $2x$

$y = \dfrac{6 - 2x}{-3}$, or $\dfrac{2x - 6}{3}$ Dividing by -3

108. $T = \dfrac{3}{10}(I - 12{,}000)$

$\dfrac{10}{3}T = I - 12{,}000$

$\dfrac{10}{3}T + 12{,}000 = I$, or

$\dfrac{10T + 36{,}000}{3} = I$

109. $a = b + bcd$

$a = b(1 + cd)$ Factoring

$\dfrac{a}{1 + cd} = b$ Dividing by $1 + cd$

110. $q = p - np$

$q = p(1 - n)$

$\dfrac{q}{1 - n} = p$

111. $z = xy - xy^2$

$z = x(y - y^2)$ Factoring

$\dfrac{z}{y - y^2} = x$ Dividing by $y - y^2$

112. $st = t - 4$

$st - t = -4$

$t(s - 1) = -4$

$t = \dfrac{-4}{s - 1}$, or $\dfrac{4}{1 - s}$

113. The graph of $f(x) = mx + b$, $m \neq 0$, is a straight line that is not horizontal. The graph of such a line intersects the x-axis exactly once. Thus, the function has exactly one zero.

114. If a person wanted to convert several Fahrenheit temperatures to Celsius, it would be useful to solve the formula for C and then use the formula in that form.

115. First find the slope of the given line.

$3x + 4y = 7$

$4y = -3x + 7$

$y = -\dfrac{3}{4}x + \dfrac{7}{4}$

The slope is $-\dfrac{3}{4}$. Now write a slope-intersect equation of the line containing $(-1, 4)$ with slope $-\dfrac{3}{4}$.

$y - 4 = -\dfrac{3}{4}[x - (-1)]$

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

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

$y = -\dfrac{3}{4}x + \dfrac{13}{4}$

116. $m = \dfrac{4 - (-2)}{-5 - 3} = \dfrac{6}{-8} = -\dfrac{3}{4}$

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

$y - 4 = -\dfrac{3}{4}x - \dfrac{15}{4}$

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

117. $d = \sqrt{(x_2 - x_1)^2 + (y_2 - y_1)^2}$

$= \sqrt{(-10 - 2)^2 + (-3 - 2)^2}$

$= \sqrt{144 + 25} = \sqrt{169} = 13$

118. $\left(\dfrac{x_1 + x_2}{2}, \dfrac{y_1 + y_2}{2}\right) = \left(\dfrac{-\frac{1}{2} + \left(-\frac{3}{2}\right)}{2}, \dfrac{\frac{2}{5} + \frac{3}{5}}{2}\right) = \left(-\dfrac{2}{2}, \dfrac{1}{2}\right) = \left(-1, \dfrac{1}{2}\right)$

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

$f(-3) = \dfrac{-3}{-3 - 3} = \dfrac{-3}{-6} = \dfrac{1}{2}$

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

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

Since division by 0 is not defined, $f(3)$ does not exist.

120. $7x - y = \dfrac{1}{2}$

$-y = -7x + \dfrac{1}{2}$

$y = 7x - \dfrac{1}{2}$

With the equation in the form $y = mx + b$, we see that the slope is 7 and the y-intercept is $\left(0, -\dfrac{1}{2}\right)$.

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

The function can be written in the form $y = mx + b$, so it is a linear function.

122. $f(x) = \dfrac{3}{2x} + 5$ cannot be written in the form $f(x) = mx + b$, so it is not a linear function.

123. $f(x) = x^2+1$ cannot be written in the form $f(x) = mx+b$, so it is not a linear function.

124. $f(x) = \frac{3}{4}x - (2.4)^2$ is in the form $f(x) = mx + b$, so it is a linear function.

125.
$$\begin{aligned}
2x - \{x - [3x - (6x + 5)]\} &= 4x - 1 \\
2x - \{x - [3x - 6x - 5]\} &= 4x - 1 \\
2x - \{x - [-3x - 5]\} &= 4x - 1 \\
2x - \{x + 3x + 5\} &= 4x - 1 \\
2x - \{4x + 5\} &= 4x - 1 \\
2x - 4x - 5 &= 4x - 1 \\
-2x - 5 &= 4x - 1 \\
-6x - 5 &= -1 \\
-6x &= 4 \\
x &= -\frac{2}{3}
\end{aligned}$$

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

126.
$$\begin{aligned}
14 - 2[3 + 5(x - 1)] &= 3\{x - 4[1 + 6(2 - x)]\} \\
14 - 2[3 + 5x - 5] &= 3\{x - 4[1 + 12 - 6x]\} \\
14 - 2[5x - 2] &= 3\{x - 4[13 - 6x]\} \\
14 - 10x + 4 &= 3\{x - 52 + 24x\} \\
18 - 10x &= 3\{25x - 52\} \\
18 - 10x &= 75x - 156 \\
174 &= 85x \\
\frac{174}{85} &= x
\end{aligned}$$

127. The size of the cup was reduced 8 oz − 6 oz, or 2 oz, and $\frac{2\text{ oz}}{8\text{ oz}} = 0.25$, so the size was reduced 25%. The price per ounce of the 8 oz cup was $\frac{89¢}{8\text{ oz}}$, or 11.25¢/oz. The price per ounce of the 6 oz cup is $\frac{71¢}{6\text{ oz}}$, or $11.8\overline{3}$¢/oz. Since the price per ounce was not reduced, it is clear that the price per ounce was not reduced by the same percent as the size of the cup. The price was increased by $11.8\overline{3} - 11.125$¢, or $0.708\overline{3}$¢ per ounce. This is an increase of $\frac{0.708\overline{3}¢}{11.8\overline{3}¢} \approx 0.064$, or about 6.4% per ounce.

128. The size of the container was reduced 100 oz − 80 oz, or 20 oz, and $\frac{20\text{ oz}}{100\text{ oz}} = 0.2$, so the size of the container was reduced 20%. The price per ounce of the 100-oz container was $\frac{\$6.99}{100\text{ oz}}$, or \$0.0699/oz. The price per ounce of the 80-oz container is $\frac{\$5.75}{80\text{ oz}}$, or \$0.071875. Since the price per ounce was not reduced, it is clear that the price per ounce was not reduced by the same percent as the size of the container. The price increased by \$0.071875 − \$0.0699, or \$0.001975. This is an increase of $\frac{\$0.001975}{\$0.0699} \approx 0.028$, or about 2.8% per ounce.

129. We use a proportion to determine the number of calories c burned running for 75 minutes, or 1.25 hr.
$$\begin{aligned}
\frac{720}{1} &= \frac{c}{1.25} \\
720(1.25) &= c \\
900 &= c
\end{aligned}$$

Next we use a proportion to determine how long the person would have to walk to use 900 calories. Let t represent this time, in hours. We express 90 min as 1.5 hr.
$$\begin{aligned}
\frac{1.5}{480} &= \frac{t}{900} \\
\frac{900(1.5)}{480} &= t \\
2.8125 &= t
\end{aligned}$$

Then, at a rate of 4 mph, the person would have to walk 4(2.8125), or 11.25 mi.

130. Let x = the number of copies of *The Secret* that were sold. Then $7367 - x$ = the number of copies of *The Measure of a Man* that were sold.

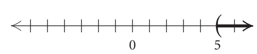
Solve: $\frac{x}{7367 - x} = \frac{10}{3.9}$

$x = 5300$, so 7367 copies of *The Secret* were sold and $7367 - 5300 = 2067$ copies of *The Measure of a Man* were sold.

Exercise Set 1.6

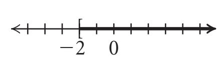
1.
$$\begin{aligned}
4x - 3 &> 2x + 7 \\
2x - 3 &> 7 \quad \text{Subtracting } 2x \\
2x &> 10 \quad \text{Adding } 3 \\
x &> 5 \quad \text{Dividing by } 2
\end{aligned}$$

The solution set $\{x|x > 5\}$, or $(5, \infty)$. The graph is shown below.



2.
$$\begin{aligned}
8x + 1 &\ge 5x - 5 \\
3x &\ge -6 \\
x &\ge -2
\end{aligned}$$

The solution set $\{x|x \ge -2\}$, or $[-2, \infty)$. The graph is shown below.

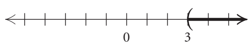


3.
$$\begin{aligned}
x + 6 &< 5x - 6 \\
6 + 6 &< 5x - x \quad \text{Subtracting } x \text{ and adding 6 on both sides} \\
12 &< 4x \\
\frac{12}{4} &< x \quad \text{Dividing by 4 on both sides} \\
3 &< x
\end{aligned}$$

This inequality could also be solved as follows:

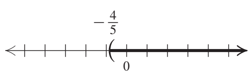
$$\begin{aligned} x+6 &< 5x-6 \\ x-5x &< -6-6 \quad \text{Subtracting } 5x \text{ and 6 on both sides} \\ -4x &< -12 \\ x &> \frac{-12}{-4} \quad \text{Dividing by } -4 \text{ on both sides and reversing the inequality symbol} \\ x &> 3 \end{aligned}$$

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



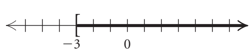
4.
$$\begin{aligned} 3-x &< 4x+7 \\ -5x &< 4 \\ x &> -\frac{4}{5} \end{aligned}$$

The solution set is $\left\{x\middle|x > -\frac{4}{5}\right\}$, or $\left(-\frac{4}{5}, \infty\right)$. The graph is shown below.



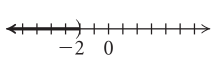
5.
$$\begin{aligned} 4-2x &\le 2x+16 \\ 4-4x &\le 16 \quad \text{Subtracting } 2x \\ -4x &\le 12 \quad \text{Subtracting 4} \\ x &\ge -3 \quad \text{Dividing by } -4 \text{ and reversing the inequality symbol} \end{aligned}$$

The solution set is $\{x|x \ge -3\}$, or $[-3, \infty)$. The graph is shown below.



6.
$$\begin{aligned} 3x-1 &> 6x+5 \\ -3x &> 6 \\ x &< -2 \end{aligned}$$

The solution set is $\{x|x < -2\}$, or $(-\infty, -2)$. The graph is shown below.

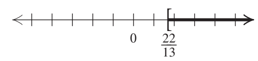


7.
$$\begin{aligned} 14-5y &\le 8y-8 \\ 14+8 &\le 8y+5y \\ 22 &\le 13y \\ \frac{22}{13} &\le y \end{aligned}$$

This inequality could also be solved as follows:

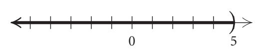
$$\begin{aligned} 14-5y &\le 8y-8 \\ -5y-8y &\le -8-14 \\ -13y &\le -22 \\ y &\ge \frac{22}{13} \quad \text{Dividing by } -13 \text{ on both sides and reversing the inequality symbol} \end{aligned}$$

The solution set is $\left\{y\middle|y \ge \frac{22}{13}\right\}$, or $\left[\frac{22}{13}, \infty\right)$. The graph is shown below.



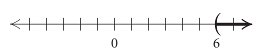
8.
$$\begin{aligned} 8x-7 &< 6x+3 \\ 2x &< 10 \\ x &< 5 \end{aligned}$$

The solution set is $\{x|x < 5\}$, or $(-\infty, 5)$. The graph is shown below.



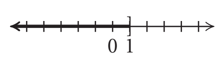
9.
$$\begin{aligned} 7x-7 &> 5x+5 \\ 2x-7 &> 5 \quad \text{Subtracting } 5x \\ 2x &> 12 \quad \text{Adding 7} \\ x &> 6 \quad \text{Dividing by 2} \end{aligned}$$

The solution set is $\{x|x > 6\}$, or $(6, \infty)$. The graph is shown below.



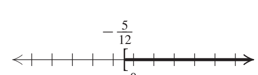
10.
$$\begin{aligned} 12-8y &\ge 10y-6 \\ -18y &\ge -18 \\ y &\le 1 \end{aligned}$$

The solution set is $\{y|y \le 1\}$, or $(-\infty, 1]$. The graph is shown below.



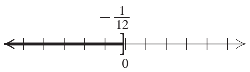
11.
$$\begin{aligned} 3x-3+2x &\ge 1-7x-9 \\ 5x-3 &\ge -7x-8 \quad \text{Collecting like terms} \\ 5x+7x &\ge -8+3 \quad \text{Adding } 7x \text{ and 3 on both sides} \\ 12x &\ge -5 \\ x &\ge -\frac{5}{12} \quad \text{Dividing by 12 on both sides} \end{aligned}$$

The solution set is $\left\{x\middle|x \ge -\frac{5}{12}\right\}$, or $\left[-\frac{5}{12}, \infty\right)$. The graph is shown below.



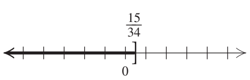
12.
$$\begin{aligned} 5y - 5 + y &\le 2 - 6y - 8 \\ 6y - 5 &\le -6y - 6 \\ 12y &\le -1 \\ y &\le -\frac{1}{12} \end{aligned}$$

The solution set is $\left\{y\middle|y \le -\frac{1}{12}\right\}$, or $\left(-\infty, -\frac{1}{12}\right]$. The graph is shown below.



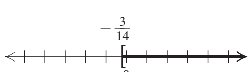
13.
$$\begin{aligned} -\frac{3}{4}x &\ge -\frac{5}{8} + \frac{2}{3}x \\ \frac{5}{8} &\ge \frac{3}{4}x + \frac{2}{3}x \\ \frac{5}{8} &\ge \frac{9}{12}x + \frac{8}{12}x \\ \frac{5}{8} &\ge \frac{17}{12}x \\ \frac{12}{17}\cdot\frac{5}{8} &\ge \frac{12}{17}\cdot\frac{17}{12}x \\ \frac{15}{34} &\ge x \end{aligned}$$

The solution set is $\left\{x\middle|x \le \frac{15}{34}\right\}$, or $\left(-\infty, \frac{15}{34}\right]$. The graph is shown below.



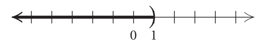
14.
$$\begin{aligned} -\frac{5}{6}x &\le \frac{3}{4} + \frac{8}{3}x \\ -\frac{21}{6}x &\le \frac{3}{4} \\ x &\ge -\frac{3}{14} \end{aligned}$$

The solution set is $\left\{x\middle|x \ge -\frac{3}{14}\right\}$, or $\left[-\frac{3}{14}, \infty\right)$. The graph is shown below.



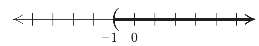
15.
$$\begin{aligned} 4x(x-2) &< 2(2x-1)(x-3) \\ 4x(x-2) &< 2(2x^2 - 7x + 3) \\ 4x^2 - 8x &< 4x^2 - 14x + 6 \\ -8x &< -14x + 6 \\ -8x + 14x &< 6 \\ 6x &< 6 \\ x &< \frac{6}{6} \\ x &< 1 \end{aligned}$$

The solution set is $\{x|x < 1\}$, or $(-\infty, 1)$. The graph is shown below.



16.
$$\begin{aligned} (x+1)(x+2) &> x(x+1) \\ x^2 + 3x + 2 &> x^2 + x \\ 2x &> -2 \\ x &> -1 \end{aligned}$$

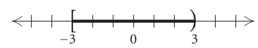
The solution set is $\{x|x > -1\}$, or $(-1, \infty)$. The graph is shown below.



17. $-2 \le x + 1 < 4$

$-3 \le x < 3$ Subtracting 1

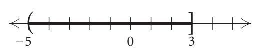
The solution set is $[-3, 3)$. The graph is shown below.



18. $-3 < x + 2 \le 5$

$-5 < x \le 3$

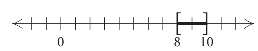
$(-5, 3]$



19. $5 \le x - 3 \le 7$

$8 \le x \le 10$ Adding 3

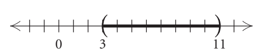
The solution set is $[8, 10]$. The graph is shown below.



20. $-1 < x - 4 < 7$

$3 < x < 11$

$(3, 11)$



21. $-3 \le x + 4 \le 3$

$-7 \le x \le -1$ Subtracting 4

The solution set is $[-7, -1]$. The graph is shown below.

22. $-5 < x + 2 < 15$

$-7 < x < 13$

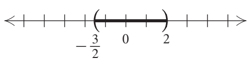
$(-7, 13)$

23. $-2 < 2x + 1 < 5$

$-3 < 2x < 4$ Adding −1

$-\frac{3}{2} < x < 2$ Multiplying by $\frac{1}{2}$

The solution set is $\left(-\frac{3}{2}, 2\right)$. The graph is shown below.

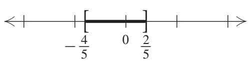


24. $-3 \leq 5x + 1 \leq 3$

$-4 \leq 5x \leq 2$

$-\frac{4}{5} \leq x \leq \frac{2}{5}$

$\left[-\frac{4}{5}, \frac{2}{5}\right]$



25. $-4 \leq 6 - 2x < 4$

$-10 \leq -2x < -2$ Adding -6

$5 \geq x > 1$ Multiplying by $-\frac{1}{2}$

or $1 < x \leq 5$

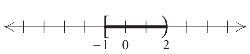
The solution set is $(1, 5]$. The graph is shown below.

26. $-3 < 1 - 2x \leq 3$

$-4 < -2x \leq 2$

$2 > x \geq -1$

$[-1, 2)$



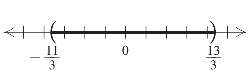
27. $-5 < \frac{1}{2}(3x + 1) < 7$

$-10 < 3x + 1 < 14$ Multiplying by 2

$-11 < 3x < 13$ Adding -1

$-\frac{11}{3} < x < \frac{13}{3}$ Multiplying by $\frac{1}{3}$

The solution set is $\left(-\frac{11}{3}, \frac{13}{3}\right)$. The graph is shown below.

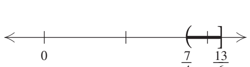


28. $\frac{2}{3} \leq -\frac{4}{5}(x - 3) < 1$

$-\frac{5}{6} \geq x - 3 > -\frac{5}{4}$

$\frac{13}{6} \geq x > \frac{7}{4}$

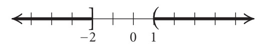
$\left(\frac{7}{4}, \frac{13}{6}\right]$



29. $3x \leq -6$ *or* $x - 1 > 0$

$x \leq -2$ *or* $x > 1$

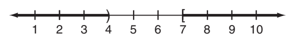
The solution set is $(-\infty, -2] \cup (1, \infty)$. The graph is shown below.



30. $2x < 8$ *or* $x + 3 \geq 10$

$x < 4$ *or* $x \geq 7$

$(-\infty, 4) \cup [7, \infty)$

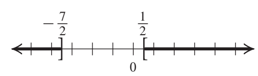


31. $2x + 3 \leq -4$ *or* $2x + 3 \geq 4$

$2x \leq -7$ *or* $2x \geq 1$

$x \leq -\frac{7}{2}$ *or* $x \geq \frac{1}{2}$

The solution set is $\left(-\infty, -\frac{7}{2}\right] \cup \left[\frac{1}{2}, \infty\right)$. The graph is shown below.

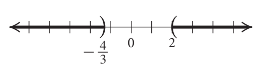


32. $3x - 1 < -5$ *or* $3x - 1 > 5$

$3x < -4$ *or* $3x > 6$

$x < -\frac{4}{3}$ *or* $x > 2$

$\left(-\infty, -\frac{4}{3}\right) \cup (2, \infty)$



33. $2x - 20 < -0.8$ *or* $2x - 20 > 0.8$

$2x < 19.2$ *or* $2x > 20.8$

$x < 9.6$ *or* $x > 10.4$

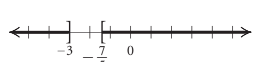
The solution set is $(-\infty, 9.6) \cup (10.4, \infty)$. The graph is shown below.

34. $5x + 11 \leq -4$ *or* $5x + 11 \geq 4$

$5x \leq -15$ *or* $5x \geq -7$

$x \leq -3$ *or* $x \geq -\frac{7}{5}$

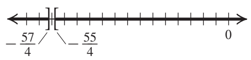
$(-\infty, -3] \cup \left[-\frac{7}{5}, \infty\right)$



35. $x + 14 \le -\frac{1}{4}$ *or* $x + 14 \ge \frac{1}{4}$

$x \le -\frac{57}{4}$ *or* $x \ge -\frac{55}{4}$

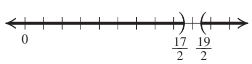
The solution set is $\left(-\infty, -\frac{57}{4}\right] \cup \left[-\frac{55}{4}, \infty\right)$. The graph is shown below.



36. $x - 9 < -\frac{1}{2}$ *or* $x - 9 > \frac{1}{2}$

$x < \frac{17}{2}$ *or* $x > \frac{19}{2}$

$\left(-\infty, \frac{17}{2}\right) \cup \left(\frac{19}{2}, \infty\right)$



37. ***Familiarize and Translate***. Spending is given by the equation $y = 12.7x + 15.2$. We want to know when the spending will be more than \$66 billion, so we have

$12.7x + 15.2 > 66$.

Carry out. We solve the inequality.

$$12.7x + 15.2 > 66$$
$$12.7x > 50.8$$
$$x > 4$$

Check. When $x = 4$, the spending is $12.7(4) + 15.2 = 66$. As a partial check, we could try a value of x less than 4 and one greater than 4. When $x = 3.9$, we have $y = 12.7(3.9) + 15.2 = 64.73 < 66$; when $x = 4.1$, we have $y = 12.7(4.1) + 15.2 = 67.27 > 66$. Since $y = 66$ when $x = 4$ and $y > 66$ when $x = 4.1 > 4$, the answer is probably correct.

State. The spending will be more than \$66 billion more than 4 yr after 2002.

38. Solve: $5x + 5 \ge 20$

$x \ge 3$, so 3 or more yr after 2002, or in 2005 and later, there will be at least 20 million homes with devices installed that receive and manage broadband TV and Internet content.

39. ***Familiarize***. Let t = the number of hours worked. Then Acme Movers charge $100 + 30t$ and Hank's Movers charge $55t$.

Translate.

Hank's charge	is less than	Acme's charge.
↓	↓	↓
$55t$	$<$	$100 + 30t$

Carry out. We solve the inequality.

$$55t < 100 + 30t$$
$$25t < 100$$
$$t < 4$$

Check. When $t = 4$, Hank's Movers charge $55 \cdot 4$, or \$220 and Acme Movers charge $100 + 30 \cdot 4 = 100 + 120 = \$220$, so the charges are the same. As a partial check, we find the charges for a value of $t < 4$. When $t = 3.5$, Hank's Movers charge $55(3.5) = \$192.50$ and Acme Movers charge $100 + 30(3.5) = 100 + 105 = \$205$. Since Hank's charge is less than Acme's, the answer is probably correct.

State. For times less than 4 hr it costs less to hire Hank's Movers.

40. Let x = the amount invested at 4%. Then $12,000 - x$ = the amount invested at 6%.

Solve: $0.04x + 0.06(12,000 - x) \ge 650$

$x \le 3500$, so at most \$3500 can be invested at 4%.

41. ***Familiarize***. Let x = the amount invested at 4%. Then $7500 - x$ = the amount invested at 5%. Using the simple-interest formula, $I = Prt$, we see that in one year the 4% investment earns $0.04x$ and the 5% investment earns $0.05(7500 - x)$.

Translate.

Interest at 4%	plus	interest at 5%	is at least	\$325.
↓	↓	↓	↓	↓
$0.04x$	$+$	$0.05(7500 - x)$	$\ge$	325

Carry out. We solve the inequality.

$$0.04x + 0.05(7500 - x) \ge 325$$
$$0.04x + 375 - 0.05x \ge 325$$
$$-0.01x + 375 \ge 325$$
$$-0.01x \ge -50$$
$$x \le 5000$$

Check. When \$5000 is invested at 4%, then \$7500−\$5000, or \$2500, is invested at 5%. In one year the 4% investment earns 0.04(\$5000), or \$200, in simple interest and the 5% investment earns 0.05(\$2500), or \$125, so the total interest is \$200 + \$125, or \$325. As a partial check, we determine the total interest when an amount greater than \$5000 is invested at 4%. Suppose \$5001 is invested at 4%. Then \$2499 is invested at 5%, and the total interest is 0.04(\$5001) + 0.05(\$2499), or \$324.99. Since this amount is less than \$325, the answer is probably correct.

State. The most that can be invested at 4% is \$5000.

42. Let c = the number of checks written per month.

Solve: $0.20c < 6 + 0.05c$

$c < 40$, so the Smart Checking plan will cost less than the Consumer Checking plan when fewer than 40 checks are written per month.

43. ***Familiarize***. Let c = the number of checks written per month. Then the No Frills plan costs $0.35c$ per month and the Simple Checking plan costs $5 + 0.10c$ per month.

Translate.

Simple Checking cost	is less than	No Frills cost.
↓	↓	↓
$5 + 0.10c$	$<$	$0.35c$

Carry out. We solve the inequality.

$$5 + 0.10c < 0.35c$$
$$5 < 0.25c$$
$$20 < c$$

Check. When 20 checks are written the No Frills plan costs 0.35(20), or \$7 per month and the Simple Checking plan costs $5 + 0.10(20)$, or \$7, so the costs are the same. As a partial check, we compare the cost for some number of checks greater than 20. When 21 checks are written, the No Frills plan costs 0.35(21), or \$7.35 and the Simple Checking plan costs 5+0.10(21), or \$7.10. Since the Simple Checking plan costs less than the No Frills plan, the answer is probably correct.

State. The Simple Checking plan costs less when more than 20 checks are written per month.

44. Let $s =$ the monthly sales.

Solve: $750 + 0.1s > 1000 + 0.08(s - 2000)$

$s > 4500$, so Plan A is better for monthly sales greater than \$4500.

45. ***Familiarize***. Let $s =$ the monthly sales. Then the amount of sales in excess of \$8000 is $s - 8000$.

Translate.

Income from plan B	is greater than	income from plan A.
↓	↓	↓
$1200 + 0.15(s - 8000)$	$>$	$900 + 0.1s$

Carry out. We solve the inequality.

$$1200 + 0.15(s - 8000) > 900 + 0.1s$$
$$1200 + 0.15s - 1200 > 900 + 0.1s$$
$$0.15s > 900 + 0.1s$$
$$0.05s > 900$$
$$s > 18,000$$

Check. For sales of \$18,000 the income from plan A is \$900+0.1(\$18,000), or \$2700, and the income from plan B is $1200 + 0.15(18,000 - 8000)$, or \$2700 so the incomes are the same. As a partial check we can compare the incomes for an amount of sales greater than \$18,000. For sales of \$18,001, for example, the income from plan A is \$900 + 0.1(\$18,001), or \$2700.10, and the income from plan B is \$1200 + 0.15(\$18,001 − \$8000), or \$2700.15. Since plan B is better than plan A in this case, the answer is probably correct.

State. Plan B is better than plan A for monthly sales greater than \$18,000.

46. Solve: $200 + 12n > 20n$

$n < 25$

47. The solution set of a disjunction is a union of sets, so it is not possible for a disjunction to have no solution.

48. By definition, the notation $3 < x < 4$ indicates that $3 < x$ *and* $x < 4$. The disjunction $x < 3$ *or* $x > 4$ cannot be written $3 > x > 4$, or $4 < x < 3$, because it is not possible for x to be greater than 4 *and* less than 3.

49.
$$5x - 7 = 8$$
$$5x = 15$$
$$x = 3$$

The solution is 3.

50.
$$2 - 3x = x - 8$$
$$-4x = -10$$
$$x = \frac{5}{2}, \text{ or } 2.5$$

The solution is $\frac{5}{2}$, or 2.5.

51.
$$3(x + 1) = 4 - 2(x - 3)$$
$$3x + 3 = 4 - 2x + 6$$
$$3x + 3 = 10 - 2x$$
$$5x = 7$$
$$x = \frac{7}{5}, \text{ or1.4}$$

The solution is $\frac{7}{5}$, or 1.4.

52.
$$4(2x - 5) + 12 = 3(2x - 6)$$
$$8x - 20 + 12 = 6x - 18$$
$$8x - 8 = 6x - 18$$
$$2x = -10$$
$$x = -5$$

The solution is -5.

53. ***Familiarize***. Let $a =$ the number of passengers, in millions, who travel on airlines each day. Then $a + 12.2 =$ the number of passengers on mass transit systems each day.

Translate.

Airline passengers	plus	Mass transit passengers	is	Total number of passengers
↓	↓	↓	↓	↓
a	$+$	$a + 12.2$	$=$	15.8

Carry out. We solve the equation.

$$a + a + 12.2 = 15.8$$
$$2a + 12.2 = 15.8$$
$$2a = 3.6$$
$$a = 1.8$$

Then $a + 12.2 = 1.8 + 12.2 = 14$.

Check. 14 million is 12.2 million more than 1.8 million, and 1.8 million + 14 million = 15.8 million, so the answer checks.

State. Each day 1.8 million Americans travel on airlines and 14 million travel on mass transit systems.

54. Let $s =$ the total sales of organic pet food in 2003, in millions of dollars.

Solve: $s + 37 = 51$

$s = \$14$ million

55. $2x \le 5 - 7x < 7 + x$

$2x \le 5 - 7x$ *and* $5 - 7x < 7 + x$

$9x \le 5$ *and* $-8x < 2$

$x \le \frac{5}{9}$ *and* $x > -\frac{1}{4}$

The solution set is $\left(-\frac{1}{4}, \frac{5}{9}\right]$.

56. $x \le 3x - 2 \le 2 - x$

$x \le 3x - 2$ *and* $3x - 2 \le 2 - x$

$-2x \le -2$ *and* $4x \le 4$

$x \ge 1$ *and* $x \le 1$

The solution is 1.

57. $3y < 4 - 5y < 5 + 3y$

$0 < 4 - 8y < 5$ Subtracting $3y$

$-4 < -8y < 1$ Subtracting 4

$\frac{1}{2} > y > -\frac{1}{8}$ Dividing by -8 and reversing the inequality symbols

The solution set is $\left(-\frac{1}{8}, \frac{1}{2}\right)$.

58. $y - 10 < 5y + 6 \le y + 10$

$-10 < 4y + 6 \le 10$ Subtracting y

$-16 < 4y \le 4$

$-4 < y \le 1$

The solution set is $(-4, 1]$.

Chapter 1 Review Exercises

1. Because the line passes through the origin, its x-intercept is $(0, 0)$. Thus, the statement is false.

2. The statement is true. See pages 82 and 83 in the text.

3. First we solve each equation for y.

$$ax + y = c \qquad\qquad x - by = d$$
$$y = -ax + c \qquad\qquad -by = -x + d$$
$$y = \frac{1}{b}x - \frac{d}{b}$$

If the lines are perpendicular, the product of their slopes is -1, so we have $-a \cdot \frac{1}{b} = -1$, or $-\frac{a}{b} = -1$, or $\frac{a}{b} = 1$. The statement is true.

4. The line parallel to the y-axis that passes through $(-5, 25)$ is $x = -5$, so the statement is false.

5. For the lines $y = \frac{1}{2}$ and $x = -5$, the x-coordinate of the point of intersection is -5 and the y-coordinate is $\frac{1}{2}$, so the statement is true.

6. $f(-3) = \frac{\sqrt{3 - (-3)}}{-3} = \frac{\sqrt{6}}{-3}$, so -3 is in the domain of $f(x)$. Thus, the statement is false.

7. For $\left(3, \frac{24}{9}\right)$:

$$2x - 9y = -18$$
$$2 \cdot 3 - 9 \cdot \frac{24}{9} \ ? \ -18$$
$$6 - 24$$
$$-18 \ \big| \ -18 \quad \text{TRUE}$$

$\left(3, \frac{24}{9}\right)$ is a solution.

For $(0, -9)$:

$$2x - 9y = -18$$
$$2(0) - 9(-9) \ ? \ -18$$
$$0 + 81$$
$$81 \ \big| \ -18 \quad \text{FALSE}$$

$(0, -9)$ is not a solution.

8. For $(0, 7)$: $y = 7$

$$7 \ ? \ 7 \quad \text{TRUE}$$

$(0, 7)$ is a solution.

For $(7, 1)$: $y = 7$

$$1 \ ? \ 7 \quad \text{FALSE}$$

$(7, 1)$ is not a solution.

9. $2x - 3y = 6$

To find the x-intercept we replace y with 0 and solve for x.

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

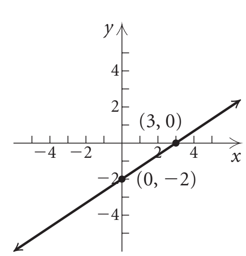
The x-intercept is $(3, 0)$.

To find the y-intercept we replace x with 0 and solve for y.

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

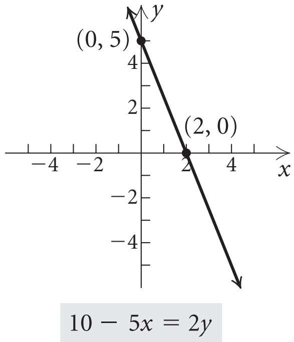
The y-intercept is $(0, -2)$.

We plot the intercepts and draw the line that contains them. We could find a third point as a check that the intercepts were found correctly.

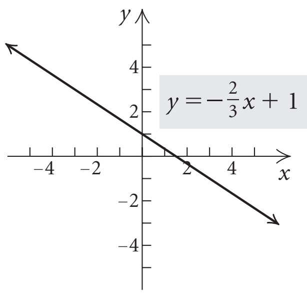


$2x - 3y = 6$

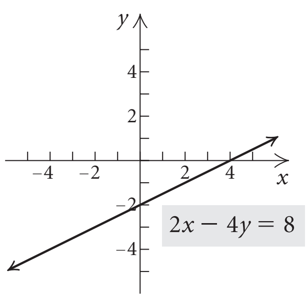
10.



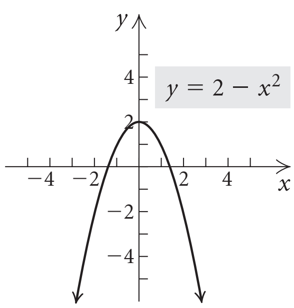
11.



12.



13.



14. $d = \sqrt{(x_1 - x_2)^2 + (y_1 - y_2)^2}$

$= \sqrt{(3 - (-2))^2 + (7 - 4)^2}$

$= \sqrt{5^2 + 3^2} = \sqrt{34} \approx 5.831$

15. $m = \left(\frac{x_1 + x_2}{2}, \frac{y_1 + y_2}{2}\right)$

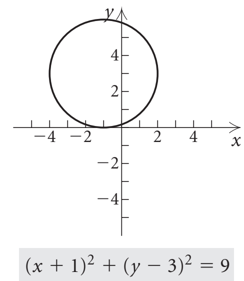
$= \left(\frac{3 + (-2)}{2}, \frac{7 + 4}{2}\right)$

$= \left(\frac{1}{2}, \frac{11}{2}\right)$

16. $(x + 1)^2 + (y - 3)^2 = 9$

$[x - (-1)]^2 + (y - 3)^2 = 3^2$ Standard form

The center is $(-1, 3)$ and the radius is 3.



17. $(x - h)^2 + (y - k)^2 = r^2$

$(x - 0)^2 + [y - (-4)]^2 = \left(\frac{3}{2}\right)^2$ Substituting

$x^2 + (y + 4)^2 = \frac{9}{4}$

18. $(x - h)^2 + (y - k)^2 = r^2$

$[x - (-2)]^2 + (y - 6)^2 = (\sqrt{13})^2$

$(x + 2)^2 + (y - 6)^2 = 13$

19. The center is the midpoint of the diameter:

$\left(\frac{-3 + 7}{2}, \frac{5 + 3}{2}\right) = \left(\frac{4}{2}, \frac{8}{2}\right) = (2, 4)$

Use the center and either endpoint of the diameter to find the radius. We use the point $(7, 3)$.

$r = \sqrt{(7 - 2)^2 + (3 - 4)^2} = \sqrt{5^2 + (-1)^2} =$
$\sqrt{25 + 1} = \sqrt{26}$

The equation of the circle is $(x - 2)^2 + (y - 4)^2 = (\sqrt{26})^2$, or $(x - 2)^2 + (y - 4)^2 = 26$.

20. The correspondence is not a function because one member of the domain, 2, corresponds to more than one member of the range.

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

22. The relation is not a function, because the ordered pairs $(3, 1)$ and $(3, 5)$ have the same first coordinate and different second coordinates.

Domain: $\{3, 5, 7\}$

Range: $\{1, 3, 5, 7\}$

23. The relation is a function, because no two ordered pairs have the same first coordinate and different second coordinates. The domain is the set of first coordinates: $\{-2, 0, 1, 2, 7\}$. The range is the set of second coordinates: $\{-7, -4, -2, 2, 7\}$.

24. $f(x) = x^2 - x - 3$

a) $f(0) = 0^2 - 0 - 3 = -3$

b) $f(-3) = (-3)^2 - (-3) - 3 = 9 + 3 - 3 = 9$

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

d) $f(-x) = (-x)^2 - (-x) - 3$
$= x^2 + x - 3$

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

a) $f(7) = \dfrac{7-7}{7+5} = \dfrac{0}{12} = 0$

b) $f(x+1) = \dfrac{x+1-7}{x+1+5} = \dfrac{x-6}{x+6}$

c) $f(-5) = \dfrac{-5-7}{-5+5} = \dfrac{-12}{0}$

Since division by 0 is not defined, $f(-5)$ does not exist.

d) $f\left(-\dfrac{1}{2}\right) = \dfrac{-\frac{1}{2} - 7}{-\frac{1}{2} + 5} = \dfrac{-\frac{15}{2}}{\frac{9}{2}} = -\dfrac{15}{2} \cdot \dfrac{2}{9} =$

$-\dfrac{\cancel{3} \cdot 5 \cdot \cancel{2}}{\cancel{2} \cdot \cancel{3} \cdot 3} = -\dfrac{5}{3}$

26. From the graph we see that when the input is 2, the output is -1, so $f(2) = -1$. When the input is -4, the output is -3, so $f(-4) = -3$. When the input is 0, the output is -1, so $f(0) = -1$.

27. This is not the graph of a function, because we can find a vertical line that crosses the graph more than once.

28. This is the graph of a function, because there is no vertical line that crosses the graph more than once.

29. This is not the graph of a function, because we can find a vertical line that crosses the graph more than once.

30. This is the graph of a function, because there is no vertical line that crosses the graph more than once.

31. We can substitute any real number for x. Thus, the domain is the set of all real numbers, or $(-\infty, \infty)$.

32. The input 0 results in a denominator of zero. Thus, the domain is $\{x|x \neq 0\}$, or $(-\infty, 0) \cup (0, \infty)$.

33. Find the inputs that make the denominator zero:

$$x^2 - 6x + 5 = 0$$
$$(x-1)(x-5) = 0$$
$$x - 1 = 0 \quad or \quad x - 5 = 0$$
$$x = 1 \quad or \quad x = 5$$

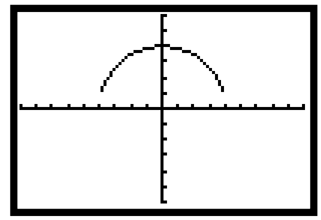
The domain is $\{x|x \neq 1 \text{ and } x \neq 5\}$, or $(-\infty, 1) \cup (1, 5) \cup (5, \infty)$.

34. Find the inputs that make the denominator zero:

$$|16 - x^2| = 0$$
$$16 - x^2 = 0$$
$$(4+x)(4-x) = 0$$
$$4 + x = 0 \quad or \quad 4 - x = 0$$
$$x = -4 \quad or \quad 4 = x$$

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

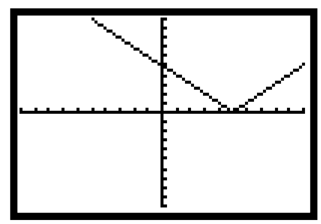
35. We graph $y = \sqrt{16 - x^2}$ in the squared window $[-9, 9, -6, 6]$.



The inputs on the x axis extend from -4 to 4, so the domain is $[-4, 4]$.

The outputs on the y-axis extend from 0 to 4, so the range is $[0, 4]$.

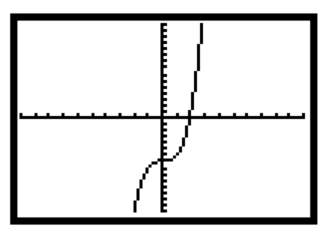
36. We graph $y = |x - 5|$ in the standard window.



Each point on the x-axis corresponds to a point on the graph, so the domain is the set of all real numbers, or $(-\infty, \infty)$.

The number 0 is the smallest output on the y-axis and every number greater than 0 is also an output, so the range is $[0, \infty)$.

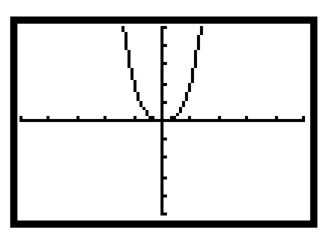
37. We graph $y = x^3 - 7$ in the window $[-10, 10, -15, 15]$.



Every point on the x-axis corresponds to a point on the graph, so the domain is the set of all real numbers, or $(-\infty, \infty)$.

Each point on the y-axis also corresponds to a point on the graph, so the range is the set of all real numbers, or $(-\infty, \infty)$.

38. We graph $y = x^4 + x^2$ in the window $[-5, 5, -5, 5]$.



Each point on the x-axis corresponds to a point on the graph, so the domain is the set of all real numbers, or $(-\infty, \infty)$.

The number 0 is the smallest output on the y-axis and every number greater than 0 is also an output, so the range is $[0, \infty)$.

39. a) Yes. Each input is 1 more than the one that precedes it.

b) No. The change in the output varies.

c) No. Constant changes in inputs do not result in constant changes in outputs.

40. a) Yes. Each input is 10 more than the one that precedes it.

b) Yes. Each output is 12.4 more than the one that precedes it.

c) Yes. Constant changes in inputs result in constant changes in outputs.

41. $m = \dfrac{y_2 - y_1}{x_2 - x_1} = \dfrac{-6-(-11)}{5-2} = \dfrac{5}{3}$

42. $m = \dfrac{4-4}{-3-5} = \dfrac{0}{-8} = 0$

43. $m = \dfrac{y_2 - y_1}{x_2 - x_1} = \dfrac{0-3}{\frac{1}{2} - \frac{1}{2}} = \dfrac{-3}{0}$

The slope is not defined.

44. We have the data points $(1980, 3.10)$ and $(2006, 5.15)$. We find the average rate of change, or slope.

$m = \dfrac{5.15 - 3.10}{2006 - 1980} = \dfrac{2.05}{26} \approx 0.08$

The average rate of change over the 26-year period was about \$0.08 per year.

45. $y = -\dfrac{7}{11}x - 6$

The equation is in the form $y = mx + b$. The slope is $-\dfrac{7}{11}$, and the y-intercept is $(0, -6)$.

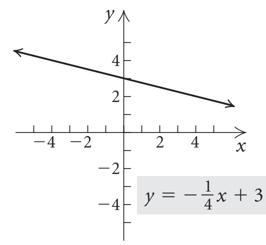
46.
$$\begin{aligned} -2x - y &= 7 \\ -y &= 2x + 7 \\ y &= -2x - 7 \end{aligned}$$

Slope: -2; y-intercept: $(0, -7)$

47. Graph $y = -\dfrac{1}{4}x + 3$.

Plot the y-intercept, $(0, 3)$. We can think of the slope as $\dfrac{-1}{4}$. Start at $(0, 3)$ and find another point by moving down 1 unit and right 4 units. We have the point $(4, 2)$.

We could also think of the slope as $\dfrac{1}{-4}$. Then we can start at $(0, 3)$ and find another point by moving up 1 unit and left 4 units. We have the point $(-4, 4)$. Connect the three points and draw the graph.



48. Let t = number of months of basic service.

$C(t) = 60 + 44t$

$C(12) = 60 + 44 \cdot 12 = \$588$

49. a) $T(d) = 10d + 20$

$T(5) = 10(5) + 20 = 70°\text{C}$

$T(20) = 10(20) + 20 = 220°\text{C}$

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

b) 5600 km is the maximum depth. Domain: $[0, 5600]$.

50. $y = mx + b$

$y = -\dfrac{2}{3}x - 4$ Substituting $-\dfrac{2}{3}$ for m and -4 for b

51.
$$\begin{aligned} y - y_1 &= m(x - x_1) \\ y - (-1) &= 3(x - (-2)) \\ y + 1 &= 3(x + 2) \\ y + 1 &= 3x + 6 \\ y &= 3x + 5 \end{aligned}$$

52. First we find the slope.

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

Use the point-slope equation:

Using $(4, 1)$: $y - 1 = \dfrac{1}{3}(x - 4)$

Using $(-2, -1)$: $y - (-1) = \dfrac{1}{3}(x - (-2))$, or

$y + 1 = \dfrac{1}{3}(x + 2)$

In either case, we have $y = \dfrac{1}{3}x - \dfrac{1}{3}$.

53. The horizontal line that passes through $\left(-4, \dfrac{2}{5}\right)$ is $\dfrac{2}{5}$ unit above the x-axis. An equation of the line is $y = \dfrac{2}{5}$.

The vertical line that passes through $\left(-4, \dfrac{2}{5}\right)$ is 4 units to the left of the y-axis. An equation of the line is $x = -4$.

54. Two points on the line are $(-2, -9)$ and $(4, 3)$. First we find the slope.

$m = \dfrac{y_2 - y_1}{x_2 - x_1} = \dfrac{3-(-9)}{4-(-2)} = \dfrac{12}{6} = 2$

Now we use the point-slope equation with the point $(4,3)$.

$$\begin{aligned} y-y_1 &= m(x-x_1) \\ y-3 &= 2(x-4) \\ y-3 &= 2x-8 \\ y &= 2x-5, \text{ or} \\ h(x) &= 2x-5 \end{aligned}$$

Then $h(0)=2\cdot 0-5=-5$.

55. $3x-2y=8$ $\qquad$ $6x-4y=2$

$y=\frac{3}{2}x-4$ $\qquad$ $y=\frac{3}{2}x-\frac{1}{2}$

The lines have the same slope, $\frac{3}{2}$, and different y-intercepts, $(0,-4)$ and $\left(0,-\frac{1}{2}\right)$, so they are parallel.

56. $y-2x=4$ $\qquad$ $2y-3x=-7$

$y=2x+4$ $\qquad$ $y=\frac{3}{2}x-\frac{7}{2}$

The lines have different slopes, 2 and $\frac{3}{2}$, so they are not parallel. The product of the slopes, $2\cdot\frac{3}{2}$, or 3, is not -1, so the lines are not perpendicular. Thus the lines are neither parallel nor perpendicular.

57. The slope of $y=\frac{3}{2}x+7$ is $\frac{3}{2}$ and the slope of $y=-\frac{2}{3}x-4$ is $-\frac{2}{3}$. Since $\frac{3}{2}\left(-\frac{2}{3}\right)=-1$, the lines are perpendicular.

58.

$$\begin{aligned} 2x+3y &= 4 \\ 3y &= -2x+4 \\ y &= -\frac{2}{3}x+\frac{4}{3};\ m=-\frac{2}{3} \end{aligned}$$

The slope of a line parallel to the given line is $-\frac{2}{3}$.

We use the point-slope equation.

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

59. From Exercise 58 we know that the slope of the given line is $-\frac{2}{3}$. The slope of a line perpendicular to this line is the negative reciprocal of $-\frac{2}{3}$, or $\frac{3}{2}$.

We use the slope-intercept equation to find the y-intercept.

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

Then the equation of the desired line is $y=\frac{3}{2}x-\frac{5}{2}$.

60. a) Answers may vary depending on the data points used. We will use $(3,\ 837)$ and $(15,\ 648)$.

$$m=\frac{648-837}{15-3}=\frac{-189}{12}=-15.75$$

Use the point-slope equation with $(3,\ 837)$.

$$\begin{aligned} y-837 &= -15.75(x-3) \\ y-837 &= -15.75x+47.25 \\ y &= -15.75x+884.25, \text{ where } x \text{ is the number of years after 1990} \end{aligned}$$

In 2009, $y=-15.75(19)+884.25=585$ sites.

b) $y=-18.72380952x+902.0952381$, where x is the number of years after 1990

In 2009, $y=-18.72380952(19)+902.0952381\approx 546$ sites.

$r\approx -0.9587$; since $|r|$ is close to 1, the line fits the data well.

61.

$$\begin{aligned} 4y-5 &= 1 \\ 4y &= 6 \\ y &= \frac{3}{2} \end{aligned}$$

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

62.

$$\begin{aligned} 3x-4 &= 5x+8 \\ -12 &= 2x \\ -6 &= x \end{aligned}$$

63.

$$\begin{aligned} 5(3x+1) &= 2(x-4) \\ 15x+5 &= 2x-8 \\ 13x &= -13 \\ x &= -1 \end{aligned}$$

The solution is -1.

64.

$$\begin{aligned} 2(n-3) &= 3(n+5) \\ 2n-6 &= 3n+15 \\ -21 &= n \end{aligned}$$

65.

$$\begin{aligned} \frac{3}{5}y-2 &= \frac{3}{8} && \text{The LCD is 40} \\ 40\left(\frac{3}{5}y-2\right) &= 40\cdot\frac{3}{8} && \text{Multiplying to clear fractions} \\ 24y-80 &= 15 \\ 24y &= 95 \\ y &= \frac{95}{24} \end{aligned}$$

The solution is $\frac{95}{24}$.

66.

$$\begin{aligned} 5-2x &= -2x+3 \\ 5 &= 3 && \text{False equation} \end{aligned}$$

The equation has no solution.

67.

$$\begin{aligned} x-13 &= -13+x \\ -13 &= -13 && \text{Subtracting } x \end{aligned}$$

We have an equation that is true for any real number, so the solution set is the set of all real numbers, $\{x|x \text{ is a real number}\}$, or $(-\infty, \infty)$.

68. Let r = the number of orphans adopted from Russia in 2006. Then $r + 2787$ = the number of orphans adopted from China.

Solve: $r + r + 2787 = 10,199$

$r = 3706$, so $r + 2787 = 3706 + 2787 = 6493$.

In 2006, Americans adopted 3706 orphans from Russia and 6493 from China.

69. ***Familiarize***. Let a = the amount originally invested. Using the simple interest formula, $I = Prt$, we see that the interest earned at 5.2% interest for 1 year is $a(0.052) \cdot 1 = 0.052a$.

Translate.

Amount invested	plus	interest earned	is	$2419.60
↓	↓	↓	↓	↓
a	$+$	$0.052a$	$=$	2419.60

Carry out. We solve the equation.

$$a + 0.052a = 2419.60$$
$$1.052a = 2419.60$$
$$a = 2300$$

Check. 5.2% of \$2300 is 0.052(\$2300), or \$119.60, and \$2300 + \$119.60 = \$2419.60. The answer checks.

State. \$2300 was originally invested.

70. Let t = the time it will take the plane to travel 1802 mi.

Solve: $1802 = (550 - 20)t$

$t = 3.4$ hr

71. $6x - 18 = 0$

$6x = 18$

$x = 3$

The zero of the function is 3.

72. $x - 4 = 0$

$x = 4$

The zero of the function is 4.

73. $2 - 10x = 0$

$-10x = -2$

$x = \frac{1}{5}$, or 0.2

The zero of the function is $\frac{1}{5}$, or 0.2.

74. $8 - 2x = 0$

$-2x = -8$

$x = 4$

The zero of the function is 4.

75. $V = lwh$

$\frac{V}{lw} = h$ Dividing by lw

76. $M = n + 0.3s$

$M - n = 0.3s$

$\frac{M - n}{0.3} = s$

77. $A = P + Prt$

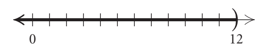
$A - P = Prt$

$\frac{A - P}{Pr} = t$

78. $2x - 5 < x + 7$

$x < 12$

The solution set is $\{x|x < 12\}$, or $(-\infty, 12)$.



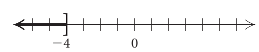
79. $3x + 1 \geq 5x + 9$

$-2x + 1 \geq 9$ Subtracting $5x$

$-2x \geq 8$ Subtracting 1

$x \leq -4$ Dividing by -2 and reversing the inequality symbol

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

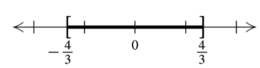


80. $-3 \leq 3x + 1 \leq 5$

$-4 \leq 3x \leq 4$

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

$\left[-\frac{4}{3}, \frac{4}{3}\right]$

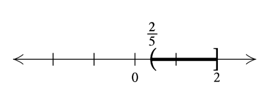


81. $-2 < 5x - 4 \leq 6$

$2 < 5x \leq 10$ Adding 4

$\frac{2}{5} < x \leq 2$ Dividing by 5

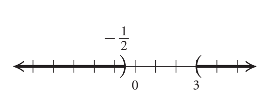
The solution set is $\left(\frac{2}{5}, 2\right]$.



82. $2x < -1$ *or* $x - 3 > 0$

$x < -\frac{1}{2}$ *or* $x > 3$

The solution set is $\left\{x \middle| x < -\frac{1}{2} \text{ or } x > 3\right\}$, or $\left(-\infty, -\frac{1}{2}\right) \cup (3, \infty)$.

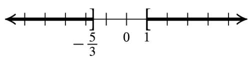


83. $3x + 7 \le 2$ *or* $2x + 3 \ge 5$

$$3x \le -5 \quad or \quad 2x \ge 2$$

$$x \le -\frac{5}{3} \quad or \quad x \ge 1$$

The solution set is $\left(-\infty, -\frac{5}{3}\right] \cup [1, \infty)$.



84. ***Familiarize and Translate***. The number of faculty, in thousands, is given by the equation $y = 6x + 121$. We want to know when this number will exceed 325 thousand, so we have

$$6x + 121 > 325.$$

Carry out. We solve the inequality.

$$6x + 121 > 325$$
$$6x > 204$$
$$x > 34$$

Check. When $x = 34$. the number of faculty is $6 \cdot 34 + 121 = 325$. As a partial check, we could try a value of x less than 34 and one greater than 34. When $x = 33.9$ we have $y = 6(33.9) + 121 = 324.4 < 325$; when $x = 34.1$ we have $y = 6(34.1) + 121 = 325.6 > 325$. Since $y = 325$ when $x = 34$ and $y > 325$ when $x > 34$, the answer is probably correct.

State. There will be more than 325 thousand faculty members more than 34 years after 1970, or in years after 2004.

85. ***Familiarize***. We will use the formula given in the exercise, $C = \frac{5}{9}(F - 32)$.

Translate.

$$\underbrace{\text{Celsius temperature}}_{\frac{5}{9}(F-32)} \quad \underbrace{\text{is lower than}}_{<} \quad \underset{45}{45^\circ.}$$

Carry out. We solve the inequality.

$$\frac{5}{9}(F - 32) < 45$$
$$F - 32 < \frac{9}{5} \cdot 45$$
$$F - 32 < 81$$
$$F < 113$$

Check. When the temperature is 113°F, the corresponding Celsius temperature is

$$\frac{5}{9}(113 - 32) = \frac{5}{9} \cdot 81 = 45^\circ \text{ C}.$$

Then it seems reasonable that for Fahrenheit temperatures lower than 113°F, the corresponding Celsius temperatures are lower than 45°C.

State. For Fahrenheit temperatures less than 113°F, Celsius temperatures are lower than 45°C.

86. $f(x) = \dfrac{x + 3}{8 - 4x}$

When $x = 2$, the denominator is 0, so 2 is not in the domain of the function. Thus, the domain is $(-\infty, 2) \cup (2, \infty)$ and answer B is correct.

87. $(x - 1)^2 + y^2 = 9$

$$(x - 1)^2 + (y - 0)^2 = 3^2$$

The center is $(1, 0)$, so answer B is correct.

88. The graph of $f(x) = -\frac{1}{2}x - 2$ has slope $-\frac{1}{2}$, so it slants down from left to right. The y-intercept is $(0, -2)$. Thus, graph C is the graph of this function.

89. If an equation contains no fractions, using the addition principle before using the multiplication principle eliminates the need to add or subtract fractions.

90. Think of the slopes are $\dfrac{-3/5}{1}$ and $\dfrac{1/2}{1}$. The graph of $f(x)$ changes $\frac{3}{5}$ unit vertically for each unit of horizontal change while the graph of $g(x)$ changes $\frac{1}{2}$ unit vertically for each unit of horizontal change. Since $\frac{3}{5} > \frac{1}{2}$, the graph of $f(x) = -\frac{3}{5}x + 4$ is steeper than the graph of $g(x) = \frac{1}{2}x - 6$.

91. Let $(x, 0)$ be the point on the x-axis that is equidistant from the points $(1, 3)$ and $(4, -3)$. Then we have:

$$\sqrt{(x-1)^2 + (0-3)^2} = \sqrt{(x-4)^2 + (0-(-3))^2}$$
$$\sqrt{x^2 - 2x + 1 + 9} = \sqrt{x^2 - 8x + 16 + 9}$$
$$\sqrt{x^2 - 2x + 10} = \sqrt{x^2 - 8x + 25}$$
$$x^2 - 2x + 10 = x^2 - 8x + 25 \quad \text{Squaring both sides}$$
$$6x = 15$$
$$x = \frac{5}{2}$$

The point is $\left(\frac{5}{2}, 0\right)$.

92. $f(x) = \dfrac{\sqrt{1 - x}}{x - |x|}$

We cannot find the square root of a negative number, so $x \le 1$. Division by zero is undefined, so $x < 0$.

Domain of f is $\{x | x < 0\}$, or $(-\infty, 0)$.

93. $f(x) = (x - 9x^{-1})^{-1} = \dfrac{1}{x - \frac{9}{x}}$

Division by zero is undefined, so $x \ne 0$. Also, note that we can write the function as $f(x) = \dfrac{x}{x^2 - 9}$, so $x \ne -3$, 0, 3.

Domain of f is $\{x | x \ne -3 \text{ and } x \ne 0 \text{ and } x \ne 3\}$, or $(-\infty, -3) \cup (-3, 0) \cup (0, 3) \cup (3, \infty)$.

Chapter 1 Test

1.
$$\begin{array}{c|c} 5y-4 & x \\ \hline 5\cdot\frac{9}{10}-4 & \frac{1}{2} \\ \frac{9}{2}-4 & \\ \frac{1}{2} & \frac{1}{2} \end{array}$$
$5y-4=x$; $5\cdot\frac{9}{10}-4\ ?\ \frac{1}{2}$; $\frac{9}{2}-4$; $\frac{1}{2} \mid \frac{1}{2}$ TRUE

$\left(\frac{1}{2},\frac{9}{10}\right)$ is a solution.

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

To find the x-intercept we replace y with 0 and solve for x.

$$5x-2\cdot 0=-10$$
$$5x=-10$$
$$x=-2$$

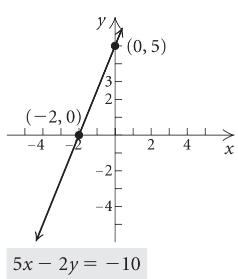
The x-intercept is $(-2,0)$.

To find the y-intercept we replace x with 0 and solve for y.

$$5\cdot 0-2y=-10$$
$$-2y=-10$$
$$y=5$$

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

We plot the intercepts and draw the line that contains them. We could find a third point as a check that the intercepts were found correctly.



3. $d=\sqrt{(5-(-1))^2+(8-5)^2}=\sqrt{6^2+3^2}=\sqrt{36+9}=\sqrt{45}\approx 6.708$

4. $m=\left(\frac{-2+(-4)}{2},\frac{6+3}{2}\right)=\left(\frac{-6}{2},\frac{9}{2}\right)=\left(-3,\frac{9}{2}\right)$

5.
$$(x+4)^2+(y-5)^2=36$$
$$[x-(-4)]^2+(y-5)^2=6^2$$

Center: $(-4,5)$; radius: 6

6.
$$[x-(-1)]^2+(y-2)^2=(\sqrt{5})^2$$
$$(x+1)^2+(y-2)^2=5$$

7. a) The relation is a function, because no two ordered pairs have the same first coordinate and different second coordinates.

b) The domain is the set of first coordinates: $\{-4,0,1,3\}$.

c) The range is the set of second coordinates: $\{0,5,7\}$.

8. $f(x)=2x^2-x+5$

a) $f(-1)=2(-1)^2-(-1)+5=2+1+5=8$

b)
$$\begin{aligned} f(a+2)&=2(a+2)^2-(a+2)+5\\ &=2(a^2+4a+4)-(a+2)+5\\ &=2a^2+8a+8-a-2+5\\ &=2a^2+7a+11\end{aligned}$$

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

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

Since the division by 0 is not defined, $f(0)$ does not exist.

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

10. From the graph we see that when the input is -3, the output is 0, so $f(-3)=0$.

11. a) This is not the graph of a function, because we can find a vertical line that crosses the graph more than once.

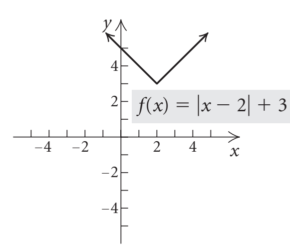
b) This is the graph of a function, because there is no vertical line that crosses the graph more than once.

12. The input 4 results in a denominator of 0. Thus the domain is $\{x|x\neq 4\}$, or $(-\infty,4)\cup(4,\infty)$.

13. We can substitute any real number for x. Thus the domain is the set of all real numbers, or $(-\infty,\infty)$.

14. We cannot find the square root of a negative number. Thus $25-x^2\geq 0$ and the domain is $\{x|-5\leq x\leq 5\}$, or $[-5,5]$.

15. a)



b) Each point on the x-axis corresponds to a point on the graph, so the domain is the set of all real numbers, or $(-\infty,\infty)$.

c) The number 3 is the smallest output on the y-axis and every number greater than 3 is also an output, so the range is $[3,\infty)$.

16. $m=\frac{5-\frac{2}{3}}{-2-(-2)}=\frac{\frac{13}{3}}{0}$

The slope is not defined.

17. $m = \dfrac{12-(-10)}{-8-4} = \dfrac{22}{-12} = -\dfrac{11}{6}$

18. $m = \dfrac{6-6}{\frac{3}{4}-(-5)} = \dfrac{0}{\frac{23}{4}} = 0$

19. We have the points $(1995, 5.3)$ and $(2004, 6.8)$.

$m = \dfrac{6.8-5.3}{2004-1995} = \dfrac{1.5}{9} \approx 0.167$

The average rate of change in weekend attendance from 1995 to 2004 was about 0.167 million per year, or about 167,000 per year.

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

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

21. $C(t) = 80 + 39.95t$

2 yr $= 2 \cdot 1$ yr $= 2 \cdot 12$ months $= 24$ months

$C(24) = 80 + 39.95(24) = \$1038.80$

22.
$$y = mx+b$$
$$y = -\frac{5}{8}x-5$$

23. First we find the slope:

$m = \dfrac{-2-4}{3-(-5)} = \dfrac{-6}{8} = -\dfrac{3}{4}$

Use the point-slope equation.

Using $(-5, 4)$: $y-4 = -\dfrac{3}{4}(x-(-5))$, or

$y-4 = -\dfrac{3}{4}(x+5)$

Using $(3, -2)$: $y-(-2) = -\dfrac{3}{4}(x-3)$, or

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

In either case, we have $y = -\dfrac{3}{4}x+\dfrac{1}{4}$.

24. The vertical line that passes through $\left(-\dfrac{3}{8}, 11\right)$ is $\dfrac{3}{8}$ unit to the left of the y-axis. An equation of the line is $x = -\dfrac{3}{8}$.

25.
$$2x+3y = -12 \qquad\qquad 2y-3x = 8$$
$$y = -\frac{2}{3}x-4 \qquad\qquad y = \frac{3}{2}x+4$$

$m_1 = -\dfrac{2}{3}$, $m_2 = \dfrac{3}{2}$; $m_1 m_2 = -1$.

The lines are perpendicular.

26. First find the slope of the given line.
$$x+2y = -6$$
$$2y = -x-6$$
$$y = -\frac{1}{2}x-3;\ m = -\frac{1}{2}$$

A line parallel to the given line has slope $-\dfrac{1}{2}$. We use the point-slope equation.
$$y-3 = -\frac{1}{2}(x-(-1))$$
$$y-3 = -\frac{1}{2}(x+1)$$
$$y-3 = -\frac{1}{2}x-\frac{1}{2}$$
$$y = -\frac{1}{2}x+\frac{5}{2}$$

27. First we find the slope of the given line.
$$x+2y = -6$$
$$2y = -x-6$$
$$y = -\frac{1}{2}x-3,\ m = -\frac{1}{2}$$

The slope of a line perpendicular to this line is the negative reciprocal of $-\dfrac{1}{2}$, or 2. Now we find an equation of the line with slope 2 and containing $(-1, 3)$.

Using the slope-intercept equation:
$$y = mx+b$$
$$3 = 2(-1)+b$$
$$3 = -2+b$$
$$5 = b$$

The equation is $y = 2x+5$.

Using the point-slope equation.
$$y-y_1 = m(x-x_1)$$
$$y-3 = 2(x-(-1))$$
$$y-3 = 2(x+1)$$
$$y-3 = 2x+2$$
$$y = 2x+5$$

28. a) Answers may vary depending on the data points used. We will use $(0, 203)$ and $(3, 212)$.

$$m = \frac{212-203}{3-0} = \frac{9}{3} = 3$$

We know that the y-intercept is $(0, 203)$, so we have $y = 3x+203$, where x is the number of years after 2002 and y is in billions.

In 2010, $x = 2010 - 2002 = 8$.

$y = 3 \cdot 8 + 203 = 24 + 203 = 227$ billion pieces of mail.

b) Using the linear regression feature on a graphing calculator, we have $y = 3x + 201.2$, where x is the number of years after 2002 and y is in billions.

In 2010, $y = 3 \cdot 8 + 201.2 = 225.2$ billion pieces of mail.

29.
$$6x+7 = 1$$
$$6x = -6$$
$$x = -1$$

The solution is -1.

30. $2.5 - x = -x + 2.5$

$2.5 = 2.5$ True equation

The solution set is $\{x|x$ is a real number$\}$, or $(-\infty, \infty)$.

31. $\frac{3}{2}y - 4 = \frac{5}{3}y + 6$ The LCD is 6.

$$6\left(\frac{3}{2}y - 4\right) = 6\left(\frac{5}{3}y + 6\right)$$
$$9y - 24 = 10y + 36$$
$$-24 = y + 36$$
$$-60 = y$$

The solution is -60.

32. $2(4x + 1) = 8 - 3(x - 5)$

$$8x + 2 = 8 - 3x + 15$$
$$8x + 2 = 23 - 3x$$
$$11x + 2 = 23$$
$$11x = 21$$
$$x = \frac{21}{11}$$

The solution is $\frac{21}{11}$.

33. ***Familiarize***. Let l = the length, in meters. Then $\frac{3}{4}l$ = the width. Recall that the formula for the perimeter P of a rectangle with length l and width w is $P = 2l + 2w$.

Translate.

$\underbrace{\text{The perimeter}}$ is $\underbrace{\text{210 m.}}$

$$2l + 2 \cdot \frac{3}{4}l \quad = \quad 210$$

Carry out. We solve the equation.

$$2l + 2 \cdot \frac{3}{4}l = 210$$
$$2l + \frac{3}{2}l = 210$$
$$\frac{7}{2}l = 210$$
$$l = 60$$

If $l = 60$, then $\frac{3}{4}l = \frac{3}{4} \cdot 60 = 45$.

Check. The width, 45 m, is three-fourths of the length, 60 m. Also, $2 \cdot 60 \text{ m} + 2 \cdot 45 \text{ m} = 210$ m, so the answer checks.

State. The length is 60 m and the width is 45 m.

34. ***Familiarize***. Let p = the wholesale price of the juice.

Translate. We express 25¢ as \$0.25.

Wholesale price	plus	50% of wholesale price	plus	\$0.25	is	\$2.95.
↓	↓	↓	↓	↓	↓	↓
p	$+$	$0.5p$	$+$	0.25	$=$	2.95

Carry out. We solve the equation.

$$p + 0.5p + 0.25 = 2.95$$
$$1.5p + 0.25 = 2.95$$
$$1.5p = 2.7$$
$$p = 1.8$$

Check. 50% of \$1.80 is \$0.90 and \$1.80 + \$0.90 + \$0.25 = \$2.95, so the answer checks.

State. The wholesale price of a bottle of juice is \$1.80.

35. $3x + 9 = 0$ Setting $f(x) = 0$

$$3x = -9$$
$$x = -3$$

The zero of the function is -3.

36. $V = \frac{2}{3}\pi r^2 h$

$\frac{3V}{2} = \pi r^2 h$ Multiplying by $\frac{3}{2}$

$\frac{3V}{2\pi r^2} = h$ Dividing by πr^2

37. $r = s - ts$

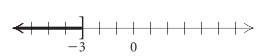
$$r = s(1 - t)$$
$$\frac{r}{1 - t} = s$$

38. $5 - x \geq 4x + 20$

$$5 - 5x \geq 20$$
$$-5x \geq 15$$

$x \leq -3$ Dividing by -5 and reversing the inequality symbol

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

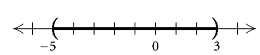


39. $-7 < 2x + 3 < 9$

$-10 < 2x < 6$ Subtracting 3

$-5 < x < 3$ Dividing by 2

The solution set is $(-5, 3)$.

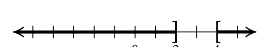


40. $2x - 1 \leq 3$ *or* $5x + 6 \geq 26$

$2x \leq 4$ *or* $5x \geq 20$

$x \leq 2$ *or* $x \geq 4$

The solution set is $(-\infty, 2] \cup [4, \infty)$.



41. ***Familiarize***. Let t = the number of hours a move requires. Then Morgan Movers charges $90+25t$ to make a move and McKinley Movers charges $40t$.

Translate.

$$\underbrace{\text{Morgan Movers' charge}}_{\downarrow \atop 90+25t} \quad \underbrace{\text{is less than}}_{\downarrow \atop <} \quad \underbrace{\text{McKinley Movers' charge.}}_{\downarrow \atop 40t}$$

Carry out. We solve the inequality.

$$90+25t < 40t$$
$$90 < 15t$$
$$6 < t$$

Check. For $t = 6$, Morgan Movers charge $90 + 25 \cdot 6$, or \$240, and McKinley Movers charge $40 \cdot 6$, or \$240, so the charge is the same for 6 hours. As a partial check, we can find the charges for a value of t greater than 6. For instance, for 6.5 hr Morgan Movers charge $90 + 25(6.5)$, or \$252.50, and McKinley Movers charge $40(6.5)$, or \$260. Since Morgan Movers cost less for a value of t greater than 6, the answer is probably correct.

State. It costs less to hire Morgan Movers when a move takes more than 6 hr.

42. The slope is $-\frac{1}{2}$, so the graph slants down from left to right. The y-intercept is $(0, 1)$. Thus, graph B is the graph of $g(x) = 1 - \frac{1}{2}x$.

43. First we find the value of x for which $x + 2 = -2$:

$$x + 2 = -2$$
$$x = -4$$

Now we find $h(-4+2)$, or $h(-2)$.

$$h(-4+2) = \frac{1}{2}(-4) = -2$$