Chapter 2 Linear Equations in Two Variables and Functions

Section 2.1 Practice Exercises

1. **a.** x; y-axis

b. ordered

c. origin; (0, 0)

d. quadrants

e. negative

f. III

g. $Ax + By = C$

h. x-intercept

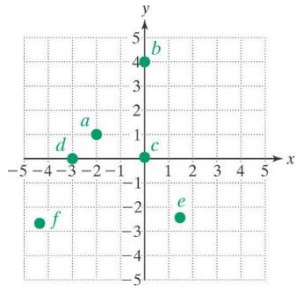
i. y-intercept

j. vertical

k. horizontal

3. For (x, y), if $x > 0$, $y > 0$, the point is in quadrant I. If $x < 0$, $y > 0$, the point is in quadrant II. If $x < 0$, $y < 0$, the point is in quadrant III. If $x > 0$, $y < 0$, the point is in quadrant IV.

5.



7. 0

9. A (–4, 5), II

B (–2, 0), x-axis

C (1, 1), I

D (4, –2), IV

E (–5, –3), III

11. **a.** $2(0)-3(-3)=9$

$0+9=9$

$9=9$

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

b. $2(-6)-3(1)=9$

$-12-3=9$

$-15=9$

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

c. $2(1)-3\left(-\frac{7}{3}\right)=9$

$2+7=9$

$9=9$

$\left(1,-\frac{7}{3}\right)$ is a solution.

13. **a.** $-1=\frac{1}{3}(0)+1$

$-1=0+1$

$-1=1$

$(-1,0)$ is not a solution.

b. $2=\frac{1}{3}(3)+1$

$2=2$

$(2,3)$ is a solution.

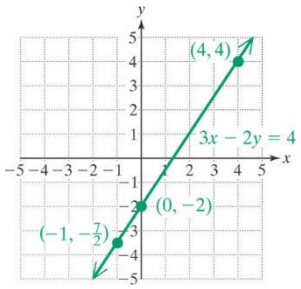
c. $-6=\frac{1}{3}(1)+1$

$-6=\frac{4}{3}$

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

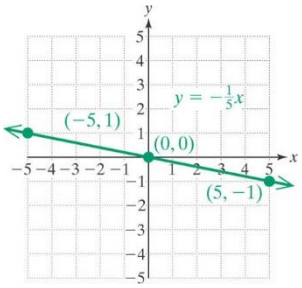
15. $3x-2y=4$

x	y
0	–2
4	4
–1	$-\frac{7}{2}$



17. $y=-\frac{1}{5}x$

x	y
0	0
5	–1
–5	1



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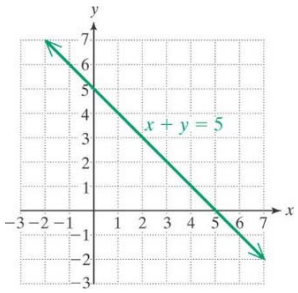

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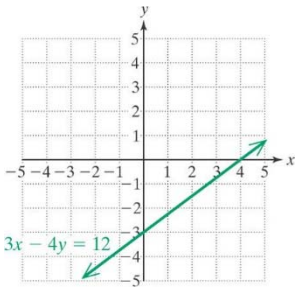

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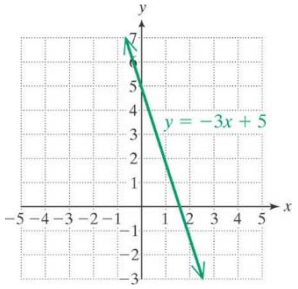

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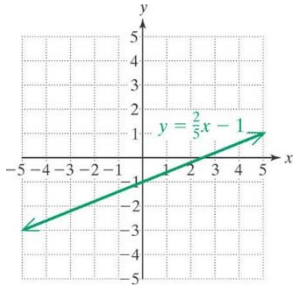

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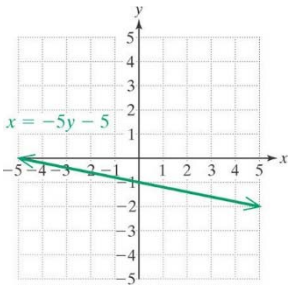

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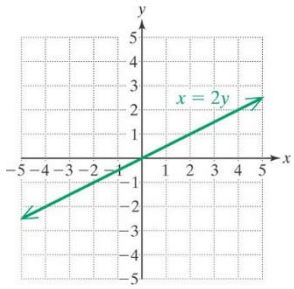
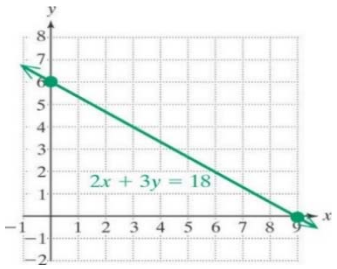


31. To find an x -intercept, substitute $y = 0$ and solve for x. To find a y-intercept, substitute $x = 0$ and solve for y.

33. **a.**
$$2x + 3y = 18$$
$$2x + 3(0) = 18$$
$$2x = 18$$
$$x = 9$$
The x -intercept is (9, 0).

b.
$$2(0) + 3y = 18$$
$$3y = 18 \Rightarrow y = 6$$
The y-intercept is (0, 6).

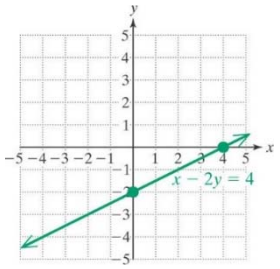
c.



35. **a.**
$$x - 2y = 4$$
$$x - 2(0) = 4$$
$$x = 4$$
The x -intercept is (4, 0).

b.
$$0 - 2y = 4$$
$$-2y = 4 \Rightarrow y = -2$$
The y-intercept is (0, –2).

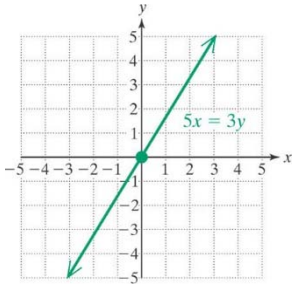
c.



37. **a.**
$$5x = 3y$$
$$5x = 3(0)$$
$$5x = 0$$
$$x = 0$$
The x -intercept is (0, 0).

b.
$$5(0) = 3y$$
$$0 = 3y$$
$$0 = y$$
The y-intercept is (0, 0).

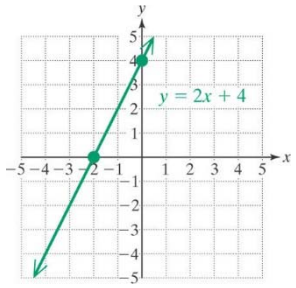
c.



39. **a.**
$$y = 2x + 4$$
$$0 = 2x + 4$$
$$-2x = 4$$
$$x = \frac{4}{-2}$$
$$x = -2$$
The x-intercept is $(-2, 0)$.

b.
$$y = 2(0) + 4$$
$$y = 4$$
The y-intercept is $(0, 4)$.

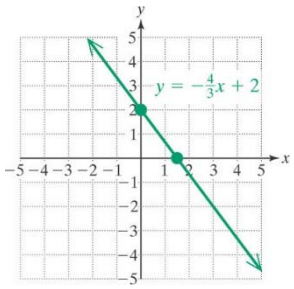
c.



41. **a.**
$$y = -\frac{4}{3}x + 2$$
$$0 = -\frac{4}{3}x + 2$$
$$\frac{4}{3}x = 2$$
$$x = \frac{3}{4} \cdot 2 = \frac{3}{2}$$
The x-intercept is $\left(\frac{3}{2}, 0\right)$.

b.
$$y = -\frac{4}{3}(0) + 2$$
$$y = 2$$
The y-intercept is $(0, 2)$.

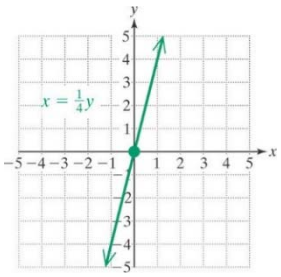
c.



43.
$$x = \frac{1}{4}y$$
$$x = \frac{1}{4}(0)$$
$$x = 0$$
The x-intercept is $(0, 0)$.
$$0 = \frac{1}{4}y$$
$$0 = y$$
The y-intercept is $(0, 0)$.

45. **a.**
$$y = 15{,}000 + 0.08x$$
$$y = 15{,}000 + 0.08(500{,}000)$$
$$= 15{,}000 + 40{,}000$$
$$= 55{,}000$$
The salary is \$55,000.

b.
$$y = 15{,}000 + 0.08(300{,}000)$$
$$= 15{,}000 + 24{,}000$$
$$= 39{,}000$$
$$y = 39{,}000$$
The salary is \$39,000.



c. $y = 15{,}000 + 0.08(0)$
$= 15{,}000 + 0$
$= 15{,}000$
The y-intercept is (0, 15,000).
For \$0 in sales, the salary is \$15,000.

d. Total sales cannot be negative.

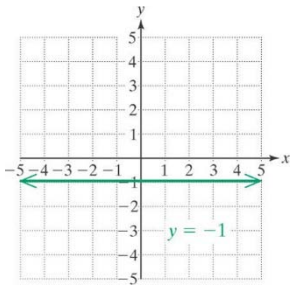
47. a. $y = 1500 - 300x$
$= 1500 - 300(1)$
$= 1500 - 300$
$= 1200$
A computer will be worth \$1200 1 yr after purchase.

b. $y = 1500 - 300x$
$300 = 1500 - 300x$
$-1200 = -300x$
$4 = x$
After 4 yr the computer will be worth \$300.

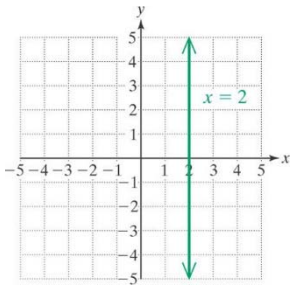
c. $y = 1500 - 300x$
$= 1500 - 300(0)$
$= 1500$
(0, 1500);
The y-intercept represents the initial value of the computer.

d. $y = 1500 - 300x$
$0 = 1500 - 300x$
$300x = 1500$
$x = 5$
(5, 0);
The x-intercept indicates that once the computer is 5 yr old, its value is \$0.

49. $y = -1$ Horizontal;
No x-intercept;
y-intercept (0, –1)



51. $x = 2$ Vertical;
x-intercept (2, 0);
No y-intercept



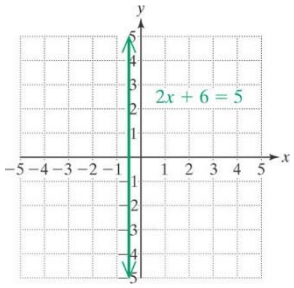
53. $2x+6=5$

$2x=-1$

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

Vertical;

x-intercept $\left(-\frac{1}{2},0\right)$; No y-intercept



55. $-2y+1=9$

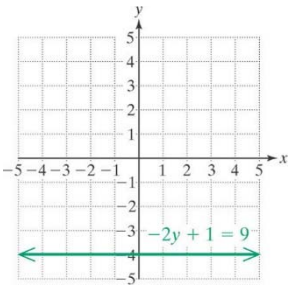
$-2y=8$

$y=-4$

Horizontal;

No x-intercept;

y-intercept (0, –4)



57. A horizontal line parallel to the x-axis will not have an x-intercept. A vertical line parallel to the y-axis will not have a y-intercept.

59. b, c, d

61. $\frac{x}{2}+\frac{y}{3}=1$ $\qquad$ $\frac{0}{2}+\frac{y}{3}=1$

$\frac{x}{2}+\frac{0}{3}=1$ $\qquad$ $\frac{y}{3}=1$

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

$x=2$

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

63. $\frac{x}{a}+\frac{y}{b}=1$ $\qquad$ $\frac{0}{a}+\frac{y}{b}=1$

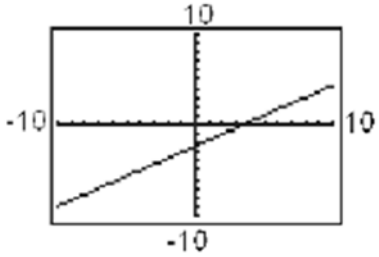
$\frac{x}{a}+\frac{0}{b}=1$ $\qquad$ $\frac{y}{b}=1$

$\frac{x}{a}=1$ $\qquad$ $y=b$

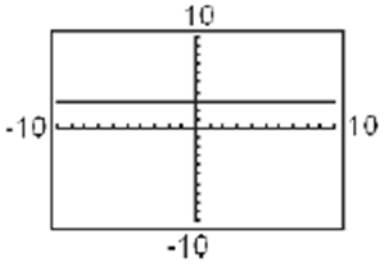
$x=a$

The x-intercept is (a, 0) and the y-intercept is (0, b).

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



67. $y=3$



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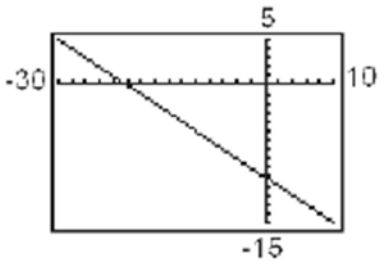
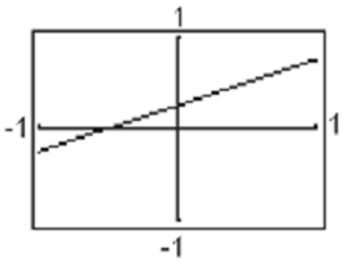
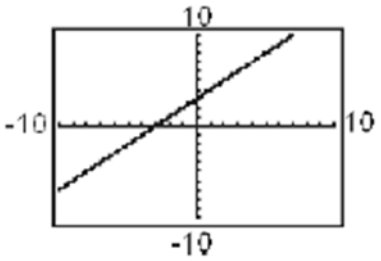


71.



73. The lines look nearly indistinguishable. However, the linear equations are different so the lines are different.



Section 2.2 Practice Exercises

1. **a.** slope; $\dfrac{y_2 - y_1}{x_2 - x_1}$

b. parallel; same

c. right

d. -1

3. **a.** $\dfrac{1}{2}x + y = 4$

$\dfrac{1}{2}(0) + y = 4 \Rightarrow y = 4$

The ordered pair is (0, 4).

b. $\dfrac{1}{2}x + 0 = 4$

$\dfrac{1}{2}x = 4 \Rightarrow x = 8$

The ordered pair is (8, 0).

c. $\dfrac{1}{2}(-4) + y = 4$

$-2 + y = 4$

$y = 6$

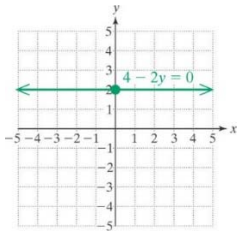
The ordered pair is (–4, 6).

5. $4 - 2y = 0$

$-2y = -4 \Rightarrow y = 2$

There is no x-intercept.

The y-intercept is (0, 2).



7. $m = \frac{24}{7} = \frac{24}{7}$

9. $m = \frac{8}{72} = \frac{1}{9}$

11. $m = \frac{4}{100} = \frac{1}{25}$

13.
$$m = \frac{y_2 - y_1}{x_2 - x_1} = \frac{-3-0}{0-6} = \frac{-3}{-6} = \frac{1}{2}$$

15.
$$m = \frac{y_2 - y_1}{x_2 - x_1} = \frac{-7-3}{4-(-2)} = \frac{-10}{6} = -\frac{5}{3}$$

17.
$$m = \frac{y_2 - y_1}{x_2 - x_1} = \frac{-3-5}{2-(-2)} = \frac{-8}{4} = -2$$

19.
$$m = \frac{y_2 - y_1}{x_2 - x_1} = \frac{-0.8-(-1.1)}{-0.1-0.3} = \frac{0.3}{-0.4} = -\frac{3}{4}$$

21.
$$m = \frac{y_2 - y_1}{x_2 - x_1} = \frac{7-3}{2-2} = \frac{4}{0} \text{ Undefined}$$

23.
$$m = \frac{y_2 - y_1}{x_2 - x_1} = \frac{-1-(-1)}{-3-5} = \frac{0}{-8} = 0$$

25.
$$m = \frac{y_2 - y_1}{x_2 - x_1} = \frac{6.4-4.1}{0-(-4.6)} = \frac{2.3}{4.6} = \frac{1}{2}$$

27.
$$m = \frac{y_2 - y_1}{x_2 - x_1} = \frac{1-\frac{4}{3}}{\frac{7}{2}-\frac{3}{2}} = \frac{-\frac{1}{3}}{\frac{4}{2}} = -\frac{1}{3}\cdot\frac{1}{2} = -\frac{1}{6}$$

29. $$m = \frac{y_2 - y_1}{x_2 - x_1} = \frac{2\frac{1}{3} - \frac{7}{3}}{\frac{1}{2} - \frac{3}{4}} = \frac{\frac{7}{3} - \frac{7}{3}}{\frac{2}{4} - \frac{3}{4}} = \frac{0}{-\frac{1}{4}} = 0$$

31. The slope of a line is positive if the graph increases from left to right. The slope of a line is negative if the graph decreases from left to right. The slope of a line is *z*ero if the graph is hori*z*ontal. The slope of a line is undefined if the graph is vertical.

33. $m = 0$

35. $m = \frac{1}{10}$

37. $m = -1$

39. **a.** $m = 5$

b. $m = -\frac{1}{5}$

41. **a.** $m = -\frac{4}{7}$

b. $m = \frac{7}{4}$

43. **a.** $m = 0$

b. m is undefined.

45. No, because the product of the slopes of perpendicular lines must be –1. The product of two positive numbers is not negative.

47. $y = -5$ is the equation of a horizontal line; thus a perpendicular line will be a vertical line whose slope is undefined.

49. $m = 0$

51. undefined

53.
$$m_{L_1} = \frac{9-5}{4-2} = \frac{4}{2} = 2$$
$$m_{L_2} = \frac{2-4}{3-(-1)} = \frac{-2}{4} = -\frac{1}{2}$$
The lines are perpendicular.

55.
$$m_{L_1} = \frac{-1-(-2)}{3-4} = \frac{1}{-1} = -1$$
$$m_{L_2} = \frac{-16-(-1)}{-10-(-5)} = \frac{-15}{-5} = 3$$
The lines are neither parallel nor perpendicular.

57. $m_{L_1} = \dfrac{9-3}{5-5}$

$= \dfrac{6}{0}$ Undefined

$m_{L_2} = \dfrac{2-2}{0-4}$

$= \dfrac{0}{-4} = 0$

The lines are perpendicular. One line is horizontal and the other is vertical.

59. $m_{L_1} = \dfrac{3-(-2)}{2-(-3)}$

$= \dfrac{5}{5} = 1$

$m_{L_2} = \dfrac{5-1}{0-(-4)}$

$= \dfrac{4}{4} = 1$

The lines are parallel.

61. a. $m = \dfrac{313-70}{2010-1998}$

$= \dfrac{243}{12}$

$= 20.25$

b. The number of cell phone subscriptions increased at a rate of 20.25 million per year during this period.

63. a. $m = \dfrac{74.5-44.5}{10-5}$

$= \dfrac{30}{5}$

$= 6$

b. The weight of boys tends to increase by 6 lb/yr during this period of growth.

65. a. $(-1, -4)$ and $(0, -2)$

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

$= \dfrac{2}{1}$

$= 2$

b. $(0, -2)$ and $(3, 4)$

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

$= \dfrac{6}{3} = 2$

c. $(-1, -4)$ and $(3, 4)$

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

$= \dfrac{8}{4} = 2$

67. a. $(-2, 0)$ and $(0, -4)$

$m = \dfrac{-4-0}{0-(-2)}$

$= \dfrac{-4}{2}$

$= -2$

b. $(0, -4)$ and $(2, 0)$

$m = \dfrac{0-(-4)}{2-0}$

$= \dfrac{4}{2}$

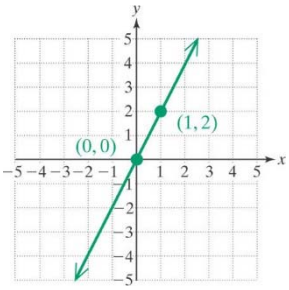
$= 2$

c. $(0, -4)$ and $(3, 5)$

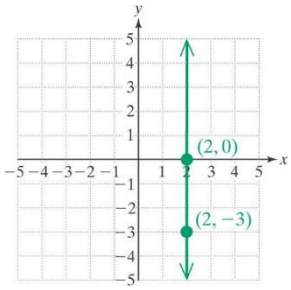
$m = \dfrac{5-(-4)}{3-0}$

$= \dfrac{9}{3} = 3$

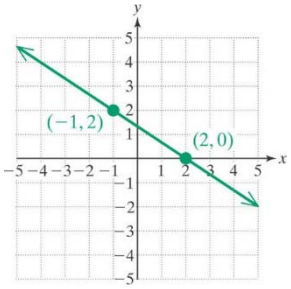
69. For example: (1, 2)



71. For example: (2, 0)



73. For example: (2, 0)



75. $\dfrac{6-y}{4-(-2)} = -\dfrac{3}{2}$

$\dfrac{6-y}{6} = -\dfrac{3}{2}$

$6-y = 6\left(-\dfrac{3}{2}\right)$

$6-y = -9$

$-y = -15 \Rightarrow y = 15$

77. a. $\text{Pitch} = \dfrac{4}{24} = \dfrac{1}{6}$

Section 2.3 Practice Exercises

1. a. $y = mx + b$

b. standard

c. horizontal

d. vertical

e. slope; y-intercept

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

3. a. 0

b. undefined

5. If the slope of one line is the opposite of the reciprocal of the slope of the other line, then the lines are perpendicular.

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

Slope: $-\frac{2}{3}$

y-intercept: (0, –4)

9. $y = 2 + 3x$

$y = 3x + 2$

Slope: 3

y-intercept: (0, 2)

11. $17x + y = 0$

$y = -17x$

Slope: -17

y-intercept: $(0, 0)$

13. $18 = 2y$

$9 = y$

$y = 0x + 9$

Slope: 0

y-intercept: $(0, 9)$

15. $8x + 12y = 9$

$12y = -8x + 9$

$y = -\frac{8}{12}x + \frac{9}{12}$

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

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

17. $y = 0.625x - 1.2$

Slope: 0.625

y-intercept: $(0, -1.2)$

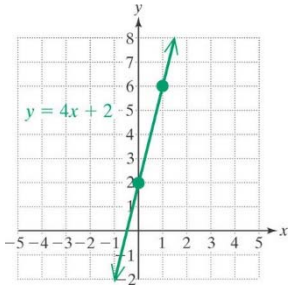
19. d

21. f

23. b

25. $y - 2 = 4x$

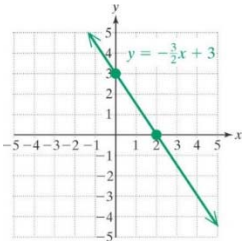
$y = 4x + 2$



27. $3x + 2y = 6$

$2y = -3x + 6$

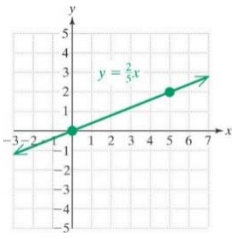
$y = -\frac{3}{2}x + 3$



29. $2x - 5y = 0$

$-5y = -2x$

$y = \frac{2}{5}x$



31. $Ax + By = C$

$By = -Ax + C$

$y = -\frac{A}{B}x + \frac{C}{B}$

The slope is given by $m = -\frac{A}{B}$.

The y-intercept is $\left(0, \frac{C}{B}\right)$.

33. $-3y = 5x - 1$ $\qquad$ $6x = 10y - 12$

$y = -\frac{5}{3}x + \frac{1}{3}$ $\qquad$ $10y = 6x + 12$

$m_1 = -\frac{5}{3}$ $\qquad$ $y = \frac{3}{5}x + \frac{6}{5}$

$m_2 = \frac{3}{5}$

The lines are perpendicular.

35. $3x - 4y = 12$

$-4y = -3x + 12$

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

$m_1 = \frac{3}{4}$

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

$6\left(\frac{1}{2}x - \frac{2}{3}y\right) = 6 \cdot 1$

$3x - 4y = 6$

$-4y = -3x + 6$

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

$m_2 = \frac{3}{4}$

The lines are parallel.

37. $3y = 5x + 6$ $\qquad$ $5x + 3y = 9$

$y = \frac{5}{3}x + 2$ $\qquad$ $3y = -5x + 9$

$m_1 = \frac{5}{3}$ $\qquad$ $y = -\frac{5}{3}x + 3$

$m_2 = -\frac{5}{3}$

The lines are neither parallel nor perpendicular.

39. $m = 3$, point: $(0,5)$

$y = mx + b$

$y = 3x + 5$

41. $m = 2$,

point: $(4,-3)$

$y = mx + b$

$-3 = 2(4) + b$

$-3 = 8 + b$

$-3 - 8 = b$

$-11 = b$

$y = 2x - 11$

43. $m = -\frac{4}{5}$, point: $(10,0)$

$y = mx + b$

$0 = -\frac{4}{5}(10) + b$

$0 = -8 + b$

$8 = b$

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

45. $m = 3$, y-intercept: $(0,-2)$

$y = 3x - 2$

or

$3x - y = 2$

47. $m = 2$, point: $(2,7)$

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

$y - 7 = 2(x - 2)$

$y - 7 = 2x - 4$

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

49. $m = -3$, point: $(-2,-5)$

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

$y - (-5) = -3(x - (-2))$

$y + 5 = -3x - 6$

$y = -3x - 11$ or $3x + y = -11$

51. $m = -\frac{4}{5}$, point: $(6,-3)$

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

$y - (-3) = -\frac{4}{5}(x - 6)$

$y + 3 = -\frac{4}{5}x + \frac{24}{5}$

$y = -\frac{4}{5}x + \frac{9}{5}$

or

$\frac{4}{5}x + y = \frac{9}{5}$

$4x + 5y = 9$

53. $m = \frac{0-4}{3-0} = \frac{-4}{3} = -\frac{4}{3}$

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

$y - 4 = -\frac{4}{3}(x - 0)$

$y - 4 = -\frac{4}{3}x + 0$

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

or

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

$4x + 3y = 12$

55. $m = \frac{10-12}{4-6} = \frac{-2}{-2} = 1$

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

$y - 12 = 1(x - 6)$

$y - 12 = x - 6$

$y = x + 6$

or

$x - y = -6$

57. $m = \frac{2-2}{-1-(-5)}$

$= \frac{0}{4}$

$= 0$

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

$y - 2 = 0(x - (-5))$

$y - 2 = 0 \Rightarrow y = 2$

59. $m = -\frac{3}{4}$, point: $(3,2)$

61. $m = \frac{4}{3}$, point: $(3,2)$

$$y-y_1=m\left(x-x_1\right)$$
$$y-2=-\frac{3}{4}\left(x-3\right)$$
$$y-2=-\frac{3}{4}x+\frac{9}{4}$$
$$y=-\frac{3}{4}x+\frac{17}{4}$$
or
$$\frac{3}{4}x+y=\frac{17}{4}$$
$$3x+4y=17$$

$$y-y_1=m\left(x-x_1\right)$$
$$y-2=\frac{4}{3}\left(x-3\right)$$
$$y-2=\frac{4}{3}x-4$$
$$y=\frac{4}{3}x-2$$
or
$$\frac{4}{3}x-y=2$$
$$4x-3y=6$$

63. $3x-4y=-7$
$$-4y=-3x-7$$
$$y=\frac{3}{4}x+\frac{7}{4}$$
$$m=\frac{3}{4},\quad \text{point: } \left(2,-5\right)$$
$$y-y_1=m\left(x-x_1\right)$$
$$y-\left(-5\right)=\frac{3}{4}\left(x-2\right)$$
$$y+5=\frac{3}{4}x-\frac{3}{2}$$
$$y=\frac{3}{4}x-\frac{13}{2}$$
or $\frac{3}{4}x-y=\frac{13}{2}$
$$3x-4y=26$$

65. $-15x+3y=9$
$$3y=15x+9$$
$$y=5x+3$$
$$m=5,\ \ m_{\perp}=-\frac{1}{5},\ \text{point: } \left(-8,-1\right)$$
$$y-y_1=m\left(x-x_1\right)$$
$$y-\left(-1\right)=-\frac{1}{5}\left(x-\left(-8\right)\right)$$
$$y+1=-\frac{1}{5}x-\frac{8}{5}$$
$$y=-\frac{1}{5}x-\frac{13}{5}$$
or $\frac{1}{5}x+y=-\frac{13}{5}$
$$x+5y=-13$$

67. $3x=2y$
$$y=\frac{3}{2}x$$
$$m=\frac{3}{2},\quad \text{point: } \left(4,0\right)$$
$$y-y_1=m\left(x-x_1\right)$$
$$y-0=\frac{3}{2}\left(x-4\right)$$
$$y=\frac{3}{2}x-6$$

69. $3y+2x=21$
$$3y=-2x+21$$
$$y=-\frac{2}{3}x+7$$
$$m_{\perp}=\frac{3}{2},\quad \text{point: } \left(2,4\right)$$
$$y-y_1=m\left(x-x_1\right)$$
$$y-4=\frac{3}{2}\left(x-2\right)$$
$$y-4=\frac{3}{2}x-3$$

or $\frac{3}{2}x - y = 6$
$3x - 2y = 12$

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

71. $\frac{1}{2}y = x$
$y = 2x$
$m_{\perp} = -\frac{1}{2}$, point: $(-3,5)$
$y - y_1 = m(x - x_1)$
$y - 5 = -\frac{1}{2}(x - (-3))$
$y - 5 = -\frac{1}{2}x - \frac{3}{2}$
$y = -\frac{1}{2}x + \frac{7}{2}$ or $\frac{1}{2}x + y = \frac{7}{2}$
$x + 2y = 7$

73. $3x + y = 7$
$y = -3x + 7$
$m_{||} = -3$, point: $(0,0)$
$y - y_1 = m(x - x_1)$
$y - 0 = -3(x - 0)$
$y = -3x$
or
$3x + y = 0$

75. $m = 0$, point: $(2,-3)$
$y - y_1 = m(x - x_1)$
$y - (-3) = 0(x - 2)$
$y + 3 = 0$
$y = -3$

77. A line with an undefined slope is a vertical line, which is in the form $x = c$. Therefore, a line containing (2, –3) would have the equation $x = 2$.

79. A line parallel to the *x*-axis has the form $y = c$. Therefore, a line containing the point (4, 5) would have the equation $y = 5$.

81. A line parallel to the line $x = 4$ is a vertical line and has the form $x = c$. Therefore, a line containing the point (5, 1) would have the equation $x = 5$.

83. $x = -2$ is not in the slope-intercept form. It has no *y*-intercept and its slope is undefined.

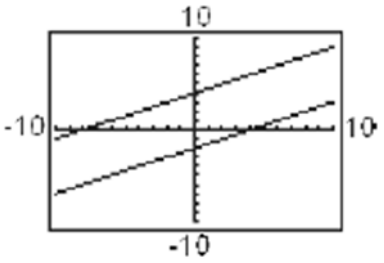
85. $y = 3$ is in the slope-intercept form, $y = 0x + 3$. Its slope is 0 and the *y*-intercept is (0, 3).

87. Two points on the line are (0, 3) and (1, 1).
$m = \frac{1-3}{1-0} = \frac{-2}{1} = -2$

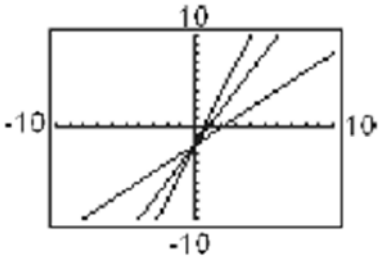
89. This is a horizontal line of the form $y = k$. The *y*-intercept is 2, so the line is $y = 2$.

$$y - y_1 = m(x - x_1) \qquad (x_1, y_1) = (0, 3)$$
$$y - 3 = -2(x - 0)$$
$$y = -2x + 3$$

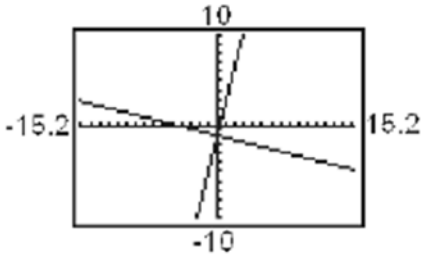
91. The lines have the same slope but different y-intercepts; they are parallel lines.



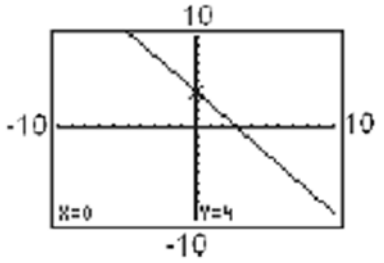
93. The lines have different slopes but the same y-intercept.

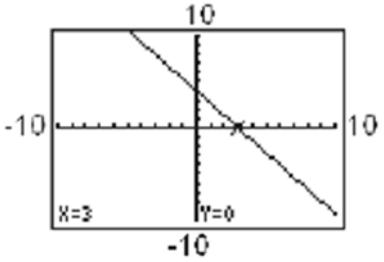


95. The lines are perpendicular.



97.





Problem Recognition Exercises

1. b, f

3. a

5. c, e

7. c, h

9. e

11. c, h

13. g

15. h

17. e

19. d, h

Section 2.4 Practice Exercises

1. model

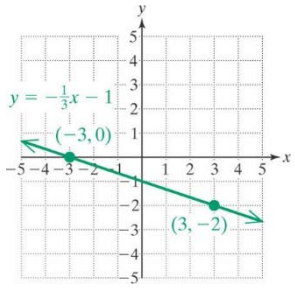
3. a. $m = \dfrac{-2-0}{3-(-3)} = \dfrac{-2}{6} = -\dfrac{1}{3}$

b. $y - 0 = -\dfrac{1}{3}\left(x-(-3)\right)$

$y = -\dfrac{1}{3}x - 1$ or $\dfrac{1}{3}x + y = -1$

$x + 3y = -3$

c.



5. a. $m = \dfrac{3-3}{-2-(-4)}$

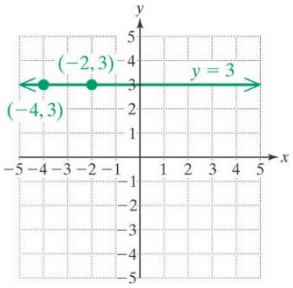
$= \dfrac{0}{2} = 0$

b. $y - 3 = 0\left(x-(-4)\right)$

$y - 3 = 0$

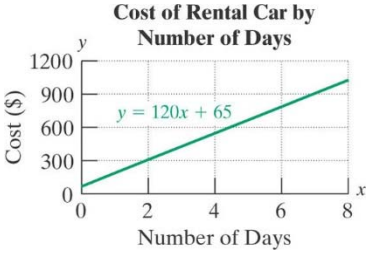
$y = 3$

c.



7. a. $y = 120x + 65$

b.



c. The y-intercept is (0, 65). The base cost to rent the car is \$65.

e. Yes; \$799 is less expensive than \$905.

f. $y = 1.06\left(120x + 65\right)$

$= 1.06\left(120(4) + 65\right)$

$= 1.06\left(480 + 65\right)$

$= 1.06(545)$

$= 577.7$

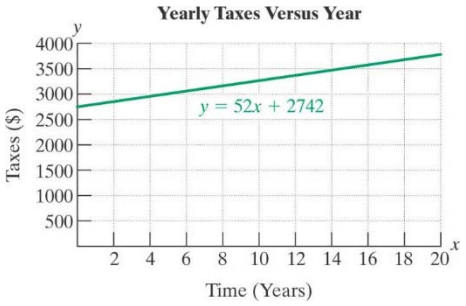
A 4-day rental with 6% sales tax costs \$577.70.

d. $y = 120(2) + 65$
$= 240 + 65$
$= 305$
A 2-day rental costs \$305.
$y = 120(5) + 65$
$= 600 + 65$
$= 665$
A 5-day rental costs \$665.
$y = 120(7) + 65$
$= 840 + 65$
$= 905$
A 7-day rental costs \$905.

g. No, the car cannot be driven for a negative number of days.

9. a. $y = 52x + 2742$

b.



c. $m = 52$. The taxes increase \$52 per year.

d. The y-intercept is (0, 2742). In the initial year ($x = 0$) the taxes were \$2742.

e. $y = 52(10) + 2742$
$= 520 + 2742 = 3262$
After 10 years the taxes are \$3262.
$y = 52(15) + 2742$
$= 780 + 2742 = 3522$
After 15 years the taxes are \$3522.

11. a. $y = 0.2(4) = 0.8$
The storm is 0.8 mi away when the time difference is 4 sec.
$y = 0.2(12) = 2.4$
The storm is 2.4 mi away when the time difference is 12 sec.
$y = 0.2(16) = 3.2$
The storm is 3.2 mi away when the time difference is 16 sec.

b. $4.2 = 0.2x$
$21 = x$
When the storm is 4.2 miles away, the time difference is 21 sec.

13. a. The average amount spent per person in Year 4 is calculated as follows:

b. The average amount spent per person in Year 2 is calculated as follows:

$$\begin{aligned} y &= 9.4x + 35.7 \\ &= 9.4(4) + 35.7 \\ &= 37.6 + 35.7 \\ &= 73.3 \end{aligned}$$

The average amount spent per person in Year 4 is \$73.30.

c. $m = 9.4$; The amount spent per person on video games increased by an average rate of \$9.40 per year.

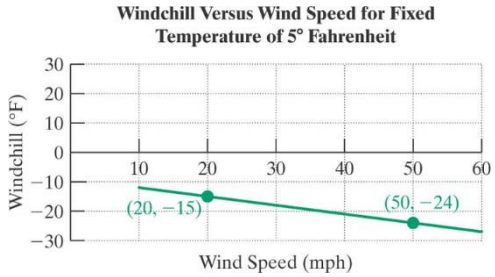
$$\begin{aligned} y &= 9.4x + 35.7 \\ &= 9.4(2) + 35.7 \\ &= 18.8 + 35.7 \\ &= 54.5 \end{aligned}$$

$55.80 - 54.50 = 1.30$

The approximate value differs from the actual value by \$1.30.

d. (0, 35.7); The y-intercept means that the average amount spent on video games per person was \$35.70 at the start of the study (Year 0).

15. a.



b.
$$m = \frac{-24-(-15)}{50-20} = \frac{-9}{30} = -\frac{3}{10} = -0.3$$
$$\begin{aligned} y-(-15) &= -0.3(x-20) \\ y+15 &= -0.3x+6 \\ y &= -0.3x-9 \end{aligned}$$

c.
$$\begin{aligned} y &= -0.3(40)-9 \\ &= -12-9 \\ &= -21^\circ\text{F} \end{aligned}$$

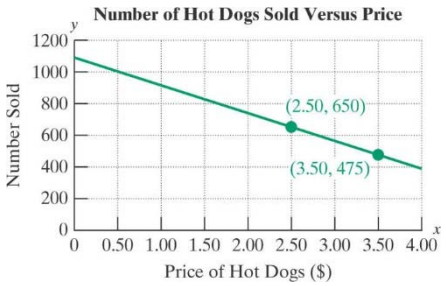
d.
$$\begin{aligned} y &= -0.3(50)-9 \\ &= -15-9 \\ &= -24^\circ\text{F} \end{aligned}$$

e. $m = -0.3$. This means that temperature decreases at a rate of 0.3ºF for every 1 mph increase in wind speed.

17. a.
$$\begin{aligned} m &= \frac{665-455}{34-20} = \frac{210}{14} \\ &= 15 \end{aligned}$$
$$\begin{aligned} y-455 &= 15(x-20) \\ y-455 &= 15x-300 \\ y &= 15x+155 \end{aligned}$$

b. The slope is 15 and means that the number of associate degrees awarded in the United States increased by 15 thousand per year.

19. a.



b.
$$m = \frac{475-650}{3.50-2.50} = \frac{-175}{1.00} = -175$$
$$\begin{aligned} y-650 &= -175(x-2.50) \\ y-650 &= -175x+437.5 \\ y &= -175x+1087.5 \end{aligned}$$

c. $y = 15(45) + 155 = 675 + 155 = 830$

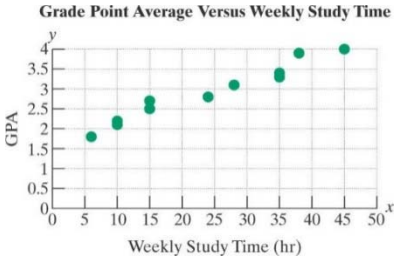
The number of associate degrees awarded in the United States for Year 45 will be about 830 thousand (equivalently 830,000).

c. $y = -175(4.00) + 1087.5$

$= -700 + 1087.5 = 387.5$

Approximately 388 hotdogs would be sold when the price of a hotdog is \$4.00.

21. a.



b. Yes, there is a linear trend.

c. $m = \dfrac{3.1 - 2.2}{28 - 10} = \dfrac{0.9}{18} = 0.05$

$y - 2.2 = 0.05(x - 10)$

$y - 2.2 = 0.05x - 0.5 \Rightarrow y = 0.05x + 1.7$

d. $y = 0.05(30) + 1.7 = 1.5 + 1.7 = 3.2$

A student who studies 30 hours per week will have a GPA of approximately 3.2.

e. $y = 0.05(46) + 1.7 = 2.3 + 1.7 = 4.0$

This model is not reasonable for study times greater than 46 hours per week, because the GPA would exceed 4.0.

23.

$$m = \frac{-5 - (-4)}{0 - 3} = \frac{-1}{-3} = \frac{1}{3}$$

$$m = \frac{-2 - (-5)}{9 - 0} = \frac{3}{9} = \frac{1}{3}$$

$$m = \frac{-2 - (-4)}{9 - 3} = \frac{2}{6} = \frac{1}{3}$$

Since the slopes are equal, the points are collinear.

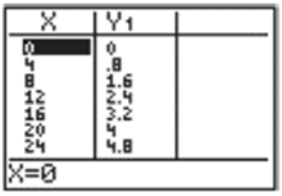
25.

$$m = \frac{12 - 2}{-2 - 0} = \frac{10}{-2} = -5$$

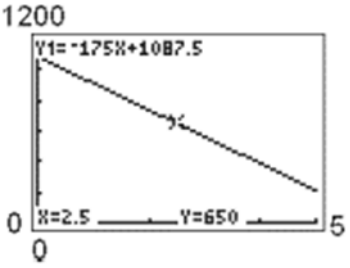
$$m = \frac{6 - 12}{-1 - (-2)} = \frac{-6}{1} = -6$$

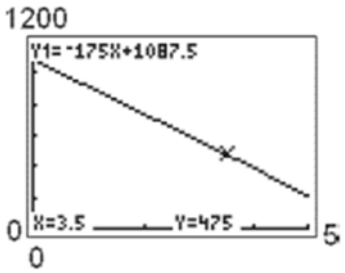
Since the slopes are not equal, the points are not collinear.

27.



29.





Section 2.5 Practice Exercises

1. **a.** relation **b.** domain

c. range

3. **a.** $2x-3=4$

$2x=7$

$x=\frac{7}{2}$ vertical line

b. The slope is undefined because this is a vertical line.

c. The x-intercept is $\left(\frac{7}{2}, 0\right)$.

d. There is no y-intercept.

5. **a.** $3x-2y=4$

$-2y=-3x+4$

$y=\frac{3}{2}x-2$ slanted line

b. $m=\frac{3}{2}$

c. $3x-2(0)=4$

$3x=4$

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

The x-intercept is $\left(\frac{4}{3}, 0\right)$.

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

7. **a.** $\{(\text{Northeast}, 54.1), (\text{Midwest}, 65.6), (\text{South}, 110.7), (\text{West}, 70.7)\}$

b. Domain: $\{\text{Northeast, Midwest, South, West}\}$; Range: $\{54.1, 65.6, 110.7, 70.7\}$

9. **a.** $\{(\text{USSR}, 1961), (\text{USA}, 1962), (\text{Poland}, 1978), (\text{Vietnam}, 1980), (\text{Cuba}, 1980)\}$

b. Domain: $\{\text{USSR, USA, Poland, Vietnam, Cuba}\}$; Range: $\{1961, 1962, 1978, 1980\}$

11. **a.** $\{(A,1), (A,2), (B,2), (C,3), (D,5), (E,4)\}$

b. Domain: $\{\text{A, B, C, D, E}\}$; Range: $\{1,2,3,4,5\}$

13. **a.** $\{(-4,4),(1,1),(2,1),(3,1),(4,-2)\}$

b. Domain: $\{-4,1,2,3,4\}$; Range: $\{-2,1,4\}$

15. Domain: $[0,4]$; Range: $[-2,2]$

17. Domain: $[-5,3]$; Range: $[-2.1,2.8]$

19. Domain: $(-\infty,2]$

Range: $(-\infty,\infty)$

21. Domain: $(-\infty,\infty)$

Range: $(-\infty,\infty)$

23. Domain: $\{-3\}$

Range: $(-\infty,\infty)$

25. Domain: $(-\infty,2)$

Range: $[-1.3,\infty)$

27. Domain: $\{-3,-1,1,3\}$

Range: $\{0,1,2,3\}$

29. Domain: $[-4,5)$

Range: $\{-2,1,3\}$

31. **a.** 2.85

b. 9.33

c. December

d. (November, 2.66)

e. (Sept., 7.63)

f. {Jan., Feb., Mar., Apr., May, June, July, Aug., Sept., Oct., Nov., Dec.}

33. **a.** $y = 0.146x + 31$

$y = 0.146(6) + 31 = 0.876 + 31$

$y = 31.876$ million or 31,876,000

b. $32.752 = 0.146x + 31$

$1.752 = 0.146x$

$x = 12$

The year 2012.

35. **a.** For example:
{(Julie, New York), (Peggy, Florida),(Stephen, Kansas), (Pat, New York)}

b. Domain: {Julie, Peggy, Stephen, Pat}
Range: {New York, Florida, Kansas}

37. $y = 2x - 1$

39. $y = x^2$

Section 2.6 Practice Exercises

1. **a.** function
b. vertical
c. $2x+1$
d. domain; range
e. denominator; negative
f. -2
g. 3
h. (1, 6)

3. **a.** {(Kevin, Kayla), (Kevin, Kira), (Kathleen, Katie), (Kathleen, Kira)}
b. Domain: {Kevin, Kathleen}
c. Range: {Kayla, Katie, Kira}

5. Function

7. Not a function

9. Function

11. Not a function

13. Function

15. Not a function

17. When x is 2, the function value y is 5.

19. $(0,-2)$

21. $g(2)=-(2)^2-4(2)+1$
$=-4-8+1=-11$

23. $g(0)=-(0)^2-4(0)+1$
$=0-0+1=1$

25. $k(0)=|0-2|$
$=|-2|$
$=2$

27. $f(t)=6(t)-2$
$=6t-2$

29. $h(u)=7$

31. $g(-3)=-(-3)^2-4(-3)+1$
$=-9+12+1$
$=4$

33. $k(-2)=|-2-2|$
$=|-4|$
$=4$

35. $f(x+1)=6(x+1)-2$
$=6x+6-2$
$=6x+4$

37. $g(2x) = -(2x)^2 - 4(2x) + 1$
$= -(4x^2) - 8x + 1$
$= -4x^2 - 8x + 1$

39. $g(-\pi) = -(-\pi)^2 - 4(-\pi) + 1$
$= -\pi^2 + 4\pi + 1$

41. $h(a+b) = 7$

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

45. $k(-c) = |-c - 2|$

47. $f\left(\frac{1}{2}\right) = 6\left(\frac{1}{2}\right) - 2$
$= 3 - 2 = 1$

49. $h\left(\frac{1}{7}\right) = 7$

51. $f(-2.8) = 6(-2.8) - 2$
$= -16.8 - 2$
$= -18.8$

53. $p(2) = -7$

55. $p(3) = 2\pi$

57. $q(2) = -5$

59. $q(6) = 4$

61.
a. $f(0) = 3$
b. $f(3) = 1$
c. $f(-2) = 1$
d. $x = -3$
e. $x = 0, x = 2$
f. Domain: $(-\infty, 3]$
g. Range: $(-\infty, 5]$

63.
a. $H(-3) = 3$
b. $H(4)$ = not defined (4 not in domain)
c. $H(3) = 4$
d. $x = -3$ and $x = 2$
e. all x in the interval $[-2, 1]$
f. Domain: $[-4, 4)$
g. Range: $[2, 5)$

65.
a. $p(2) = -4$
b. $p(-1) = 0$
c. $p(1) = -3$
d. $x = -1$
e. There are no such values of x.
f. $(-\infty, \infty)$
g. $(-\infty, -3] \cup (-2, \infty)$

67. Domain: $\left\{-3,-7,-\frac{3}{2},1.2\right\}$

69. Range: $\left\{6,0\right\}$

71. –3 and 1.2

73. 6 and 1

75. $f\left(-7\right)=-3$

77. The domain is the set of all real numbers for which the denominator is not zero. Set the denominator equal to zero, and solve the resulting equation. The solution(s) to the equation must be excluded from the domain. In this case setting $x-2=0$ indicates that $x=2$ must be excluded from the domain, The domain is $\left(-\infty,2\right)\cup\left(2,\infty\right)$.

79. $k\left(x\right)=\dfrac{x-3}{x+6}$

$x+6=0\Rightarrow x=-6$

Domain: $\left(-\infty,-6\right)\cup\left(-6,\infty\right)$

81. $f\left(t\right)=\dfrac{5}{t}$

$t=0$

Domain: $\left(-\infty,0\right)\cup\left(0,\infty\right)$

83. $h\left(p\right)=\dfrac{p-4}{p^2+1}$

p^2+1 will never equal zero.

Domain: $\left(-\infty,\infty\right)$

85. $h\left(t\right)=\sqrt{t+7}$

$t+7\geq 0$

$t\geq -7$

Domain: $\left[-7,\infty\right)$

87. $f\left(a\right)=\sqrt{a-3}$

$a-3\geq 0$

$a\geq 3$

Domain: $\left[3,\infty\right)$

89. $m\left(x\right)=\sqrt{1-2x}$

$1-2x\geq 0$

$-2x\geq -1$

$x\leq \dfrac{1}{2}$

Domain: $\left(-\infty,\frac{1}{2}\right]$

91. $p(t) = 2t^2 + t - 1$

There are no restrictions on the domain.

Domain: $(-\infty, \infty)$

93. $f(x) = x + 6$

There are no restrictions on the domain.

Domain: $(-\infty, \infty)$

95. a.
$$h(t) = -16t^2 + 80$$
$$h(1) = -16(1)^2 + 80$$
$$= -16 + 80$$
$$= 64$$
$$h(1.5) = -16(1.5)^2 + 80$$
$$= -16(2.25) + 80$$
$$= -36 + 80$$
$$= 44$$

b. After 1 sec, the height of the ball is 64 ft. After 1.5 sec, the height of the ball is 44 ft.

97. a.
$$d(t) = 11.5t$$
$$d(1) = 11.5(1)$$
$$= 11.5$$
$$d(1.5) = 11.5(1.5)$$
$$= 17.25$$

b. After 1 hr, the distance is 11.5 mi. After 1.5 hr, the distance is 17.25 mi.

99. $f(x) = 2x + 3$

101. $f(x) = |x| - 10$

103.
$$q(x) = \frac{2}{\sqrt{x+2}}$$
$$x + 2 > 0$$
$$x > -2$$

Domain: $(-2, \infty)$

105.