Chapter 2: Linear Functions and Equations

2.1: Equations of Lines

1. Find slope: $m = \dfrac{-2 - 2}{3 - 1} = \dfrac{-4}{2} = -2$. Using $(x_1, y_1) = (1, 2)$ and point-slope form $y = m(x - x_1) + y_1$, we get $y = -2(x - 1) + 2$. See Figure 1.

2. Find slope: $m = \dfrac{0 - 3}{1 - (-2)} = \dfrac{-3}{3} = -1$. Using $(x_1, y_1) = (-2, 3)$ and point-slope form $y = m(x - x_1) + y_1$, we get $y = -(x + 2) + 3$. See Figure 2.

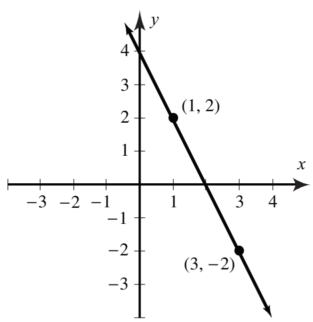

Figure 1

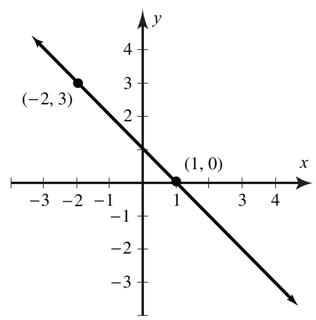

Figure 2

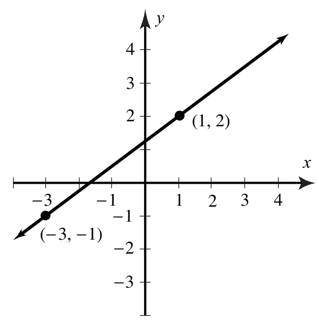

Figure 3

3. Find slope: $m = \dfrac{2 - (-1)}{1 - (-3)} = \dfrac{3}{4}$. Using $(x_1, y_1) = (-3, -1)$ and point-slope form $y = m(x - x_1) + y_1$, we get $y = \dfrac{3}{4}(x + 3) - 1$. See Figure 3.

4. Find slope: $m = \dfrac{(-3) - 2}{(-2) - (-1)} = \dfrac{-5}{-1} = 5$. Using $(x_1, y_1) = (-1, 2)$ and point-slope form $y = m(x - x_1) + y_1$, we get $y = 5(x + 1) + 2$. See Figure 4.

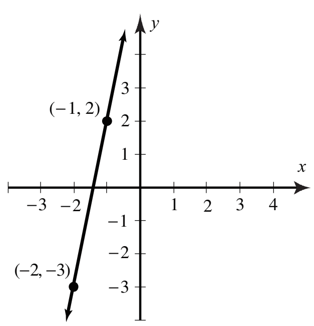

Figure 4

5. The point-slope form is given by $y = m(x - x_1) + y_1$. Thus, $m = -2.4$ and $(x_1, y_1) = (4, 5) \Rightarrow$ $y = -2.4(x - 4) + 5 \Rightarrow y = -2.4x + 9.6 + 5 \Rightarrow y = -2.4x + 14.6$ and $f(x) = -2.4x - 14.6$.

6. The point-slope form is given by $y = m(x - x_1) + y_1$. Thus, $m = 1.7$ and $(x_1, y_1) = (-8, 10) \Rightarrow$ $y = 1.7(x + 8) + 10 \Rightarrow y = 1.7x + 13.6 + 10 \Rightarrow y = 1.7x + 23.6$ and $f(x) = 1.7x + 23.6$.

7. First find the slope between the points (1, –2) and (–9, 3): $m = \frac{3 - (-2)}{-9 - 1} = -\frac{1}{2}$.

$y = -\frac{1}{2}(x - 1) - 2 \Rightarrow y = -\frac{1}{2}x + \frac{1}{2} - 2 \Rightarrow y = -\frac{1}{2}x - \frac{3}{2}$ and $f(x) = -\frac{1}{2}x - \frac{3}{2}$

8. $m = \frac{-12 - 10}{5 - (-6)} = -\frac{22}{11} = -2$; thus, $y = -2(x + 6) + 10 \Rightarrow y = -2x - 12 + 10 \Rightarrow$ $y = -2x - 2$ and $f(x) = -2x - 2$.

9. (4, 0), (0, −3); $m = \frac{-3 - 0}{0 - 4} = \frac{3}{4}$. Thus, $y = \frac{3}{4}(x - 4) + 0$ or $y = \frac{3}{4}x - 3$ and $f(x) = \frac{3}{4}x - 3$.

10. (−2, 0), (0, 5); $m = \frac{5 - 0}{0 - (-2)} = \frac{5}{2}$. Thus, $y = \frac{5}{2}(x + 2) + 0$ or $y = \frac{5}{2}x + 5$ and $f(x) = \frac{5}{2}x + 5$.

11. Using the points (0, –1) and (3, 1), we get $m = \frac{1 - (-1)}{3 - 0} = \frac{2}{3}$ and $b = -1$; $y = mx + b \Rightarrow y = \frac{2}{3}x - 1$.

12. Using the points (0, 50) and (100, 0),

we get $m = \frac{0 - 50}{100 - 0} = \frac{-50}{100} = -\frac{1}{2}$ and $b = 50$; $y = mx + b \Rightarrow y = -\frac{1}{2}x + 50$.

13. Using the points (–2, 1.8) and (1, 0), we get $m = \frac{0 - 1.8}{1 - (-2)} = \frac{-1.8}{3} = -\frac{18}{30} = -\frac{3}{5}$; to find *b*, we use (1, 0) in $y = mx + b$ and solve for *b*: $0 = -\frac{3}{5}(1) + b \Rightarrow b = \frac{3}{5}$; $y = -\frac{3}{5}x + \frac{3}{5}$.

14. Using the points (–4, –2) and (3, 1), we get $m = \frac{1 - (-2)}{3 - (-4)} = \frac{3}{7}$; to find *b*, we use (3, 1) in $y = mx + b$ and solve for *b*: $1 = \frac{3}{7}(3) + b \Rightarrow b = -\frac{2}{7}$; $y = \frac{3}{7}x - \frac{2}{7}$.

15. c

16. f

17. b

18. a

19. e

20. d

21. $m = \frac{2 - (-4)}{1 - (-1)} = 3$; $y = 3(x + 1) - 4 = 3x + 3 - 4 = 3x - 1$

22. $m = \frac{-3 - 6}{2 - (-1)} = -3$; $y = -3(x + 1) + 6 = -3x - 3 + 6 = -3x + 3$

23. $m = \frac{-3 - 5}{1 - 4} = \frac{8}{3}$; $y = \frac{8}{3}(x - 4) + 5 = \frac{8}{3}x - \frac{32}{3} + 5 = \frac{8}{3}x - \frac{17}{3}$

24. $m = \frac{-3 - (-2)}{-2 - 8} = -\frac{1}{2}$; $y = -\frac{1}{2}(x - 8) - 2 = -\frac{1}{2}x + 4 - 2 = -\frac{1}{2}x + 2$

25. $b = 5$ and $m = -7.8 \Rightarrow y = -7.8x + 5$.

26. $b = -155$ and $m = 5.6 \Rightarrow y = 5.6x - 155$.

27. The line passes through the points (0, 45) and (90, 0).

$m = \frac{0 - 45}{90 - 0} = -\frac{1}{2}$; $b = 45$ and $m = -\frac{1}{2} \Rightarrow y = -\frac{1}{2}x + 45$

28. The line passes through the points (–6, 0) and (0, –8).

$m = \dfrac{-8 - 0}{0 - (-6)} = -\dfrac{4}{3}$; $b = -8$ and $m = -\dfrac{4}{3} \Rightarrow y = -\dfrac{4}{3}x - 8$

29. $m = -3$ and $b = 5 \Rightarrow y = -3x + 5$

30. Using the point-slope form with

$m = \dfrac{1}{3}$ and $(x_1, y_1) = \left(\dfrac{1}{2}, -2\right)$, we get $y = \dfrac{1}{3}\left(x - \dfrac{1}{2}\right) - 2 = \dfrac{1}{3}x - \dfrac{1}{6} - 2 = \dfrac{1}{3}x - \dfrac{13}{6}$.

31. $m = \dfrac{0 - (-6)}{4 - 0} = \dfrac{6}{4} = \dfrac{3}{2}$ and $b = -6$; $y = mx + b \Rightarrow y = \dfrac{3}{2}x - 6$

32. $m = \dfrac{\frac{7}{4} - (-\frac{1}{4})}{\frac{5}{4} - \frac{3}{4}} = \dfrac{\frac{8}{4}}{\frac{2}{4}} = 4$; using the point-slope form with $m = 4$ and $\left(\dfrac{3}{4}, -\dfrac{1}{4}\right)$, we get

$y = 4\left(x - \dfrac{3}{4}\right) - \dfrac{1}{4} = 4x - 3 - \dfrac{1}{4} = 4x - \dfrac{13}{4}$.

33. $m = \dfrac{\frac{2}{3} - \frac{3}{4}}{\frac{1}{5} - \frac{1}{2}} = \dfrac{-\frac{1}{12}}{-\frac{3}{10}} = \dfrac{5}{18}$; using the point-slope form with $m = \dfrac{5}{18}$ and $\left(\dfrac{1}{2}, \dfrac{3}{4}\right)$, we get

$y = \dfrac{5}{18}\left(x - \dfrac{1}{2}\right) + \dfrac{3}{4} \Rightarrow y = \dfrac{5}{18}x - \dfrac{5}{36} + \dfrac{3}{4} \Rightarrow y = \dfrac{5}{18}x + \dfrac{11}{18}$.

34. $m = \dfrac{-\frac{7}{6} - \frac{5}{3}}{\frac{5}{6} - (-\frac{7}{3})} = \dfrac{-\frac{17}{6}}{\frac{19}{6}} = -\dfrac{17}{19}$; using the point-slope form with $m = -\dfrac{17}{19}$ and $\left(-\dfrac{7}{3}, \dfrac{5}{3}\right)$, we get

$y = -\dfrac{17}{19}\left(x + \dfrac{7}{3}\right) + \dfrac{5}{3} \Rightarrow y = -\dfrac{17}{19}x - \dfrac{119}{57} + \dfrac{5}{3} \Rightarrow y = -\dfrac{17}{19}x - \dfrac{24}{57} \Rightarrow y = -\dfrac{17}{19}x - \dfrac{8}{19}$.

35. The line has a slope of 4 and passes through the point (–4, –7); $y = 4(x + 4) - 7 \Rightarrow y = 4x + 9$.

36. The line has a slope of $-\dfrac{3}{4}$ and passes through the point $(1, 3)$;

$y = -\dfrac{3}{4}(x - 1) + 3 \Rightarrow y = -\dfrac{3}{4}x + \dfrac{3}{4} + 3 = -\dfrac{3}{4}x + \dfrac{15}{4}$

37. The slope of the perpendicular line is equal to $\dfrac{3}{2}$ and the line passes through the point (1980, 10);

$y = \dfrac{3}{2}(x - 1980) + 10 \Rightarrow y = \dfrac{3}{2}x - 2960$

38. The slope of the perpendicular lineis equal to $-\dfrac{1}{6}$ and the line passes through the point (15, –7);

$y = -\dfrac{1}{6}(x - 15) - 7 \Rightarrow y = -\dfrac{1}{6}x - \dfrac{27}{6} = -\dfrac{1}{6}x - \dfrac{9}{2}$

39. $y = \dfrac{2}{3}x + 3 \Rightarrow m = \dfrac{2}{3}$; the parallel line has slope $\dfrac{2}{3}$; since it passes through (0, –2.1),

the y-intercept $= -2.1$; $y = mx + b \Rightarrow y = \dfrac{2}{3}x - 2.1$.

40. $y = -4x - \dfrac{1}{4} \Rightarrow m = -4$; the parallel line has slope –4; since it passes through (2, –5), the equation is

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

41. $y = -2x \Rightarrow m = -2$; the perpendicular line has slope $\frac{1}{2}$; since it passes through (–2, 5), the equation is $y = \frac{1}{2}(x + 2) + 5 = \frac{1}{2}x + 1 + 5 = \frac{1}{2}x + 6$.

42. $y = -\frac{6}{7}x + \frac{3}{7} \Rightarrow m = -\frac{6}{7}$; the perpendicular line has slope $\frac{7}{6}$; since it passes through (3, 8), the equation is $y = \frac{7}{6}(x - 3) + 8 = \frac{7}{6}x - \frac{7}{2} + 8 = \frac{7}{6}x + \frac{9}{2}$.

43. $y = -x + 4 \Rightarrow m = -1$; the perpendicular line has slope 1; since it passes through (15, –5), the equation is $y = 1(x - 15) - 5 = x - 15 - 5 = x - 20$.

44. $y = \frac{2}{3}x + 2 \Rightarrow m = \frac{2}{3}$; the parallel line has slope $\frac{2}{3}$; since it passes through (4, –9), the equation is $y = \frac{2}{3}(x - 4) - 9 = \frac{2}{3}x - \frac{8}{3} - 9 = \frac{2}{3}x - \frac{35}{3}$.

45. $m = \frac{1 - 3}{-3 - 1} = \frac{-2}{-4} = \frac{1}{2}$; a line parallel to this line also has slope $m = \frac{1}{2}$. Using $(x_1, y_1) = (5, 7)$, $m = \frac{1}{2}$, and point-slope form $y = m(x - x_1) + y_1$, we get $y = \frac{1}{2}(x - 5) + 7 \Rightarrow y = \frac{1}{2}x + \frac{9}{2}$.

46. $m = \frac{8 - 3}{2000 - 1980} = \frac{5}{20} = \frac{1}{4}$; a line parallel to this line also has slope $m = \frac{1}{4}$. Using $(x_1, y_1) = (1990, 4)$, $m = \frac{1}{4}$, and point-slope form $y = m(x - x_1) + y_1$, we get $y = \frac{1}{4}(x - 1990) + 4 \Rightarrow y = \frac{1}{4}x - \frac{1990}{4} + 4 \Rightarrow y = \frac{1}{4}x - \frac{987}{2}$.

47. $m = \frac{\frac{2}{3} - \frac{1}{2}}{-3 - (-5)} = \frac{\frac{1}{6}}{2} = \frac{1}{12}$; a line perpendicular to this line has slope $m = -\frac{12}{1} = -12$. Using $(x_1, y_1) = (-2, 4)$, $m = -12$, and point-slope form $y = m(x - x_1) + y_1$, we get $y = -12(x + 2) + 4 \Rightarrow y = -12x - 24 + 4 \Rightarrow y = -12x - 20$.

48. $m = \frac{0 - (-5)}{-4 - (-3)} = \frac{5}{-1} = -5$. A line perpendicular to this line will have slope $m = \frac{1}{5}$. Using $(x_1, y_1) = \left(\frac{3}{4}, \frac{1}{4}\right)$, $m = \frac{1}{5}$, and point-slope form $y = m(x - x_1) + y_1$, we get $y = \frac{1}{5}\left(x - \frac{3}{4}\right) + \frac{1}{4} \Rightarrow$ $y = \frac{1}{5}x - \frac{3}{20} + \frac{1}{4} \Rightarrow y = \frac{1}{5}x + \frac{2}{20} \Rightarrow y = \frac{1}{5}x + \frac{1}{10}$.

49. $x = -5$. It is not possible to write as a linear function since a vertical line does not represent a function.

50. $x = 1.95$. It is not possible to write as a linear function since a vertical line does not represent a function.

51. $y = 6$ and $f(x) = 6$.

52. $y = 10.7$ and $f(x) = 10.7$.

53. Since the line $y = 15$ is horizontal, the perpendicular line through $(4, -9)$ is vertical and has equation $x = 4$. It is not possible to write as a linear function since a vertical line does not represent a function.

54. Since the line $x = 15$ is vertical, the perpendicular line through $(1.6, -9.5)$ is horizontal and has equation $y = -9.5$.

55. The line through (19, 5.5) and parallel to $x = 4.5$ is also vertical and has equation $x = 19$. It is not possible to write as a linear function since a vertical line does not represent a function.

56. Since the line $y = -2.5$ is horizontal, the parallel line through (1985, 67) is also horizontal with equation $y = 67$ and $f(x) = 67$.

57. Let $4x - 5y = 20$.

    x-intercept: Substitute $y = 0$ and solve for x. $4x - 5(0) = 20 \Rightarrow 4x = 20 \Rightarrow x = 5$; x-intercept: 5

    y-intercept: Substitute $x = 0$ and solve for y. $4(0) - 5y = 20 \Rightarrow -5y = 20 \Rightarrow y = -4$; y-intercept: -4

    See Figure 57.

58. Let $-3x - 5y = 15$.

    x-intercept: Substitute $y = 0$ and solve for x. $-3x - 5(0) = 15 \Rightarrow -3x = 15 \Rightarrow x = -5$; x-intercept: -5

    y-intercept: Substitute $x = 0$ and solve for y. $-3(0) - 5y = 15 \Rightarrow -5y = 15 \Rightarrow y = -3$; y-intercept: -3

    See Figure 58.

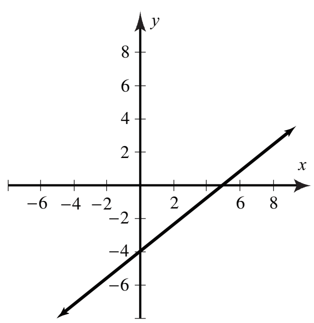

Figure 57

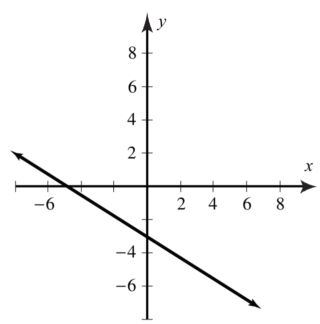

Figure 58

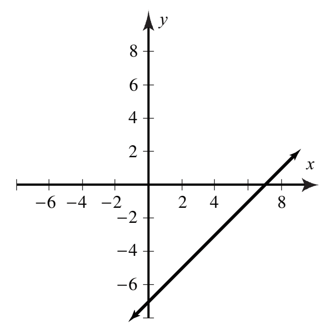

Figure 59

59. Let $x - y = 7$.

    x-intercept: Substitute $y = 0$ and solve for x. $x - 0 = 7 \Rightarrow x = 7$; x-intercept: 7

    y-intercept: Substitute $x = 0$ and solve for y. $0 - y = 7 \Rightarrow -y = 7 \Rightarrow y = -7$; y-intercept: -7

    See Figure 59.

60. Let $15x - y = 30$.

    x-intercept: Substitute $y = 0$ and solve for x. $15x - 0 = 30 \Rightarrow 15x = 30 \Rightarrow x = 2$; x-intercept: 2

    y-intercept: Substitute $x = 0$ and solve for y. $15(0) - y = 30 \Rightarrow -y = 30 \Rightarrow y = -30$; y-intercept: -30

    See Figure 60.

61. Let $6x - 7y = -42$.

    x-intercept: Substitute $y = 0$ and solve for x. $6x - 7(0) = -42 \Rightarrow 6x = -42 \Rightarrow x = -7$; x-intercept: -7

    y-intercept: Substitute $x = 0$ and solve for y. $6(0) - 7y = -42 \Rightarrow -7y = -42 \Rightarrow y = 6$; y-intercept: 6

    See Figure 61.

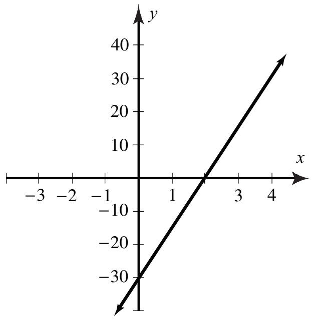

Figure 60

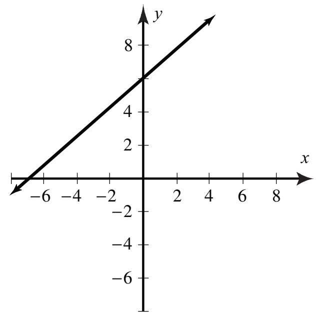

Figure 61

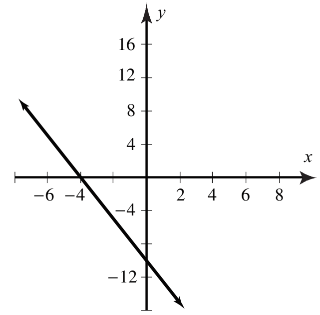

Figure 62

62. Let $5x + 2y = -20$.

x-intercept: Substitute $y = 0$ and solve for x. $5x + 2(0) = -20 \Rightarrow 5x = -20 \Rightarrow x = -4$; x-intercept: -4

y-intercept: Substitute $x = 0$ and solve for y. $5(0) + 2y = -20 \Rightarrow 2y = -20 \Rightarrow y = -10$; y-intercept: -10

See Figure 62.

63. Let $y - 3x = 7$.

x-intercept: Substitute $y = 0$ and solve for x. $0 - 3x = 7 \Rightarrow -3x = 7 \Rightarrow x = -\frac{7}{3}$; x-intercept: $-\frac{7}{3}$

y-intercept: Substitute $x = 0$ and solve for y. $y - 3(0) = 7 \Rightarrow y - 0 = 7 \Rightarrow y = 7$; y-intercept: 7

See Figure 63.

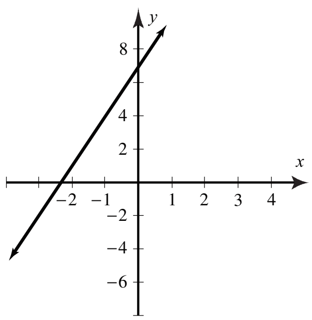

Figure 63

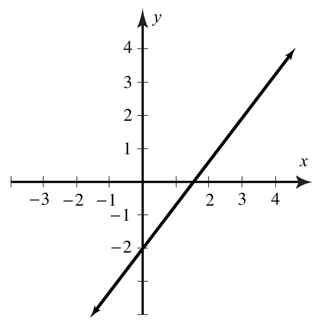

Figure 64

64. Let $4x - 3y = 6$.

x-intercept: Substitute $y = 0$ and solve for x. $4x - 3(0) = 6 \Rightarrow 4x = 6 \Rightarrow x = \frac{3}{2}$; x-intercept: $\frac{3}{2}$

y-intercept: Substitute $x = 0$ and solve for y. $4(0) - 3y = 6 \Rightarrow -3y = 6 \Rightarrow y = -2$; y-intercept: -2

See Figure 64.

65. Let $0.2x + 0.4y = 0.8$.

x-intercept: Substitute $y = 0$ and solve for x. $0.2x + 0.4(0) = 0.8 \Rightarrow 0.2x = 0.8 \Rightarrow x = 4$; x-intercept: 4

y-intercept: Substitute $x = 0$ and solve for y. $0.2(0) + 0.4y = 0.8 \Rightarrow 0.4y = 0.8 \Rightarrow y = 2$; y-intercept: 2

See Figure 65.

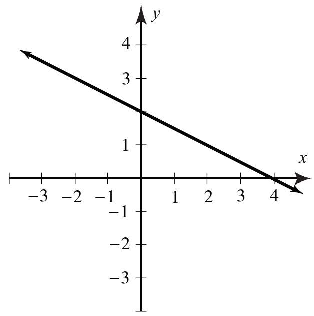

Figure 65

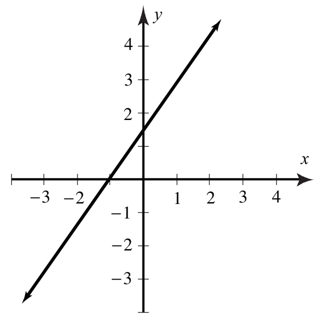

Figure 66

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

x-intercept: Substitute $y = 0$ and solve for x. $\frac{2}{3}(0) - x = 1 \Rightarrow x = -1$; x-intercept: -1

y-intercept: Substitute $x = 0$ and solve for y. $\frac{2}{3}y - 0 = 1 \Rightarrow \frac{2}{3}y = 1 \Rightarrow y = \frac{3}{2}$; y-intercept: $\frac{3}{2}$

See Figure 66.

67. Let $y = 8x - 5$.

x-intercept: Substitute $y = 0$ and solve for x. $0 = 8x - 5 \Rightarrow 5 = 8x \Rightarrow x = \frac{5}{8}$; x-intercept: $\frac{5}{8}$

y-intercept: Substitute $x = 0$ and solve for y. $y = 8(0) - 5 \Rightarrow y = -5$; y-intercept: -5

See Figure 67.

68. Let $y = -1.5x + 15$.

x-intercept: Substitute $y = 0$ and solve for x. $0 = -1.5x + 15 \Rightarrow 1.5x = 15 \Rightarrow x = 10$; y-intercept: 10

y-intercept: Substitute $x = 0$ and solve for y. $y = -1.5(0) + 15 \Rightarrow y = 15$; y-intercept: 15

See Figure 68.

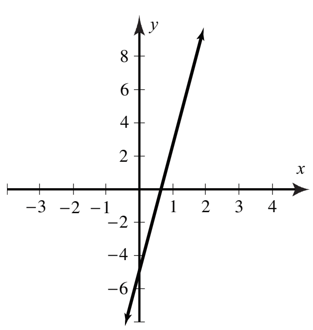

Figure 67

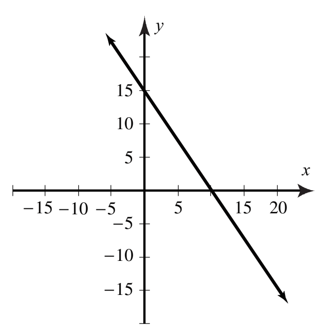

Figure 68

69. Let $\frac{x}{5} + \frac{y}{7} = 1$.

x-intercept: Substitute $y = 0$ and solve for x. $\frac{x}{5} + \frac{0}{7} = 1 \Rightarrow \frac{x}{5} = 1 \Rightarrow x = 5$; x-intercept: 5

y-intercept: Substitute $x = 0$ and solve for y. $\frac{0}{5} + \frac{y}{7} = 1 \Rightarrow \frac{y}{7} = 1 \Rightarrow y = 7$; y-intercept: 7

a and b represent the x- and y-intercepts, respectively.

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

x-intercept: Substitute $y=0$ and solve for x. $\frac{x}{2}+\frac{0}{3}=1 \Rightarrow \frac{x}{2}=1 \Rightarrow x=2$; x-intercept: 2

y-intercept: Substitute $x=0$ and solve for y. $\frac{0}{2}+\frac{y}{3}=1 \Rightarrow \frac{y}{3}=1 \Rightarrow y=3$; y-intercept: 3

a and b represent the x- and y-intercepts, respectively.

71. Let $\frac{2x}{3}+\frac{4y}{5}=1$.

x-intercept: Substitute $y=0$ and solve for x. $\frac{2x}{3}+\frac{4(0)}{5}=1 \Rightarrow \frac{2x}{3}=1 \Rightarrow x=\frac{3}{2}$; x-intercept: $\frac{3}{2}$

y-intercept: Substitute $x=0$ and solve for y. $\frac{2(0)}{3}+\frac{4y}{5}=1 \Rightarrow \frac{4y}{5}=1 \Rightarrow y=\frac{5}{4}$; y-intercept: $\frac{5}{4}$

a and b represent the x- and y-intercepts, respectively.

72. Let $\frac{5x}{6}-\frac{y}{2}=1$.

x-intercept: Substitute $y=0$ and solve for x. $\frac{5x}{6}-\frac{0}{2}=1 \Rightarrow \frac{5x}{6}=1 \Rightarrow x=\frac{6}{5}$; x-intercept: $\frac{6}{5}$

y-intercept: Substitute $x=0$ and solve for y. $\frac{5(0)}{6}-\frac{y}{2}=1 \Rightarrow -\frac{y}{2}=1 \Rightarrow y=-2$; y-intercept: -2

a and b represent the x- and y-intercepts, respectively.

73. $\frac{x}{a}+\frac{y}{b}=1$; x-intercept: $5 \Rightarrow a=5$, y-intercept: $9 \Rightarrow b=9$; $\frac{x}{5}+\frac{y}{9}=1$

74. $\frac{x}{a}+\frac{y}{b}=1$; x-intercept: $\frac{2}{3} \Rightarrow a=\frac{2}{3}$, y-intercept: $-\frac{5}{4} \Rightarrow b=-\frac{5}{4}$; $\frac{x}{\frac{2}{3}}+\frac{y}{-\frac{5}{4}}=1 \Rightarrow \frac{3x}{2}-\frac{4y}{5}=1$

75. (a) Since the point (0, –3.2) is on the graph, the y-intercept is –3.2. The data is exactly linear, so one can use any two points to determine the slope. Using the points (0, –3.2) and (1, –1.7), $m=\frac{-1.7-(-3.2)}{1-0}=1.5$. The slope-intercept form of the line is $y=1.5x-3.2$.

(b) When $x=-2.7$, $y=1.5(-2.7)-3.2=-7.25$. This calculation involves interpolation.

When $x=6.3$, $y=1.5(6.3)-3.2=6.25$. This calculation involves extrapolation.

76. (a) Since the point (0, 6.8) is on the graph, the y-intercept is 6.8. The data is exactly linear, so one can use any two points to determine the slope. Using the points (0, 6.8) and (1, 5.1), $m=\frac{5.1-6.8}{1-0}=-1.7$. The slope-intercept form of the line is $y=-1.7x+6.8$.

(b) When $x=-2.7$, $y=-1.7(-2.7)+6.8=11.39$. This calculation involves extrapolation.

When $x=6.3$, $y=-1.7(6.3)+6.8=-3.91$. This calculation involves extrapolation.

77. (a) Since the data is exactly linear, one can use any two points to determine the slope. Using the points (5, 94.7) and (23, 56.9), $m=\frac{56.9-94.7}{23-5}=-2.1$. The point-slope form of the line is $y=-2.1(x-5)+94.7$ and the slope-intercept form of the line is $y=-2.1x+105.2$.

(b) When $x=-2.7$, $y=-2.1(-2.7)+105.2=110.87$. This calculation involves extrapolation.

When $x=6.3$, $y=-2.1(6.3)+105.2=91.97$. This calculation involves interpolation.

78. (a) Since the data is exactly linear, one can use any two points to determine the slope. Using the points (–3, –0.9) and (2, 8.6), $m = \frac{8.6 - (-0.9)}{2 - (-3)} = 1.9$. The point-slope form of the line is $y = 1.9(x - 2) + 8.6$ and the slope-intercept form of the line is $y = 1.9x + 4.8$.

(b) When $x = -2.7$, $y = 1.9(-2.7) + 4.8 = -0.33$. This calculation involves interpolation. When $x = 6.3$, $y = 1.9(6.3) + 4.8 = 16.77$. This calculation involves extrapolation.

79. (a) Using the points $(2008, 3)$and $(2011, 24)$, $m = \frac{24 - 3}{2011 - 2008} = \frac{21}{3} = 7$. The point slope form of the line is $f(x) = 7x - 14053$. The function approximately models the given data.

(b) $f(2007) = 7(2007 - 2008) + 3 = -7 + 3 = -4 \Rightarrow -4\%$

(c) The calculation involved extrapolation. The result was a negative so it is not possible. Numbers were decreasing but increased after 911.

80. (a) The slope between (1998, 43) and (1999, 26) is –17, and the slope between (1999, 26) and (2000, 9) is –17; letting $m = -17$, $f(x) = -17(x - 1998) + 43$, or $f(x) = -17x + 34{,}009$ exactly models the data.

(b) $f(2003) = -17(2003) + 34{,}009 = -42$; this estimated value is not possible. Extrapolation.

81. (a) Find the slope: $m = \frac{37{,}000 - 25{,}000}{2010 - 2003} = \frac{12{,}000}{7}$. Using the first point $(2003, 25000)$ for (x_1, y_1) and $m = \frac{12{,}000}{7}$, we get $y = \frac{12{,}000}{7}(x - 2003) + 25{,}000$. The cost of attending a private college or university is increasing by $\frac{12{,}000}{7} \approx \$1714$ per year on average.

(b) $y = \frac{12{,}000}{7}(2007 - 2003) + 25{,}000 \Rightarrow y = \frac{12{,}000}{7}(4) + 25{,}000 \Rightarrow y \approx 6857 + 25{,}000 \Rightarrow$ $y \approx \$31{,}857$

82. (a) The average rate of change $= \frac{161 - 128}{4 - 1} = \frac{33}{3} = 11 \Rightarrow$the biker is traveling 11 mile per hour.

(b) Using $m = 11$ and the point $(1, 128)$, we get $y = 11(x - 1) + 128 = 11x - 11 + 128 \Rightarrow$ $y = 11x + 117$.

(c) Find the y-intercept in $y = 11x + 117 \Rightarrow b = 117$; the biker is initially 117 miles from the interstate highway.

(d) 1 hour and 15 minutes $= 1.25$ hours; $y = 11(1.25) + 117 = 13.75 + 117 = 130.75$the biker is 130.75 miles from the interstate highway after 1 hour and 15 minutes.

83. (a) Water is leaving the tank because the amount of water in the tank is decreasing. After 3 minutes there are approximately 70 gallons of water in the tank.

(b) The x-intercept is 10. This means that after 10 minutes the tank is empty. The y-intercept is 100. This means that initially there are 100 gallons of water in the tank.

(c) To determine the equation of the line, we can use 2 points. The points (0, 100) and (10, 0) lie on the line. The slope of this line is $m = \frac{0 - 100}{10 - 0} = -10$. This slope means the water is being drained at a rate of 10 gallons per minute. Since the y-intercept is 100, the slope-intercept form of this line is given by $y = -10x + 100$.

(d) From the graph, when $y = 50$ the x-value appears to be 5. Symbolically, when $y = 50$ then $-10x + 100 = 50 \Rightarrow -10x = -50 \Rightarrow x = 5$. The x-coordinate is 5.

84. (a) The annual fixed cost would be $350 \times 12 = \$4200$. The variable cost of driving x miles is $0.29x$. Thus, $f(x) = 0.29x + 4200$.

(b) The y-intercept is 4200, which represents the annual fixed costs. This means that even if the car is not driven, it will still cost \$4200 each year to own it.

85. (a) First calculate the slope: $m = \frac{15 - 9}{1999 - 2013} = \frac{6}{-14} = -\frac{3}{7}$, using the first point we have $y = -\frac{3}{7}(x - 1999) + 15$.

(b) The sales decreased, on average, by $\frac{3}{7} \approx \$0.43$ billion per year.

(c) $f(2008) = -\frac{3}{7}(2008 - 1999) + 15 \approx 11.1 \Rightarrow \$11.1$ billion. The estimate is about \$0.7 billion higher than the true value of \$10.4 billion. The calculation involves interpolation.

86. (a) First calculate the slope: $m = \frac{2.3 - 1.4}{2007 - 1998} = \frac{0.9}{9} = 0.1$, using the first point we have $y = 0.1(x - 1998) + 1.4$.

(b) The sales increased, on average, by 0.1 million per year.

(c) $f(2004) = 0.1(2004 - 1998) + 1.4 = 2 \Rightarrow 2$ million. The estimate is the same as the true value of 2 million. The calculation involves interpolation.

87. (a) See Figure 87a.

(b) Using the points (2006, 160) and (2010, 425), $m = \frac{425 - 160}{2010 - 2006} = \frac{265}{4} = 66.25$. The point slope form of the line is $f(x) = 66.25(x - 2006) + 160$.

(c) See Figure 87c.

(d) Bankruptcies increased, on average, by 66,250 per year.

(e) $f(2014) = 66.25(2014 - 2006) + 160 = 690$; The calculation involves extrapolation.

88. (a) See Figure 88a.

(b) Using the points (1995, 12,432) and (2010, 26,273), $m = \frac{26{,}273 - 12{,}432}{2010 - 1995} = \frac{13841}{15} \approx 923$. The point slope form of the line is $f(x) = 923(x - 1995) + 12{,}432$.

(c) See Figure 88c.

(d) Cost increased, on average, by \$923 per year.

(e) $f(2014) = 923(2014 - 1995) + 12{,}432 = 29{,}969$ or about 30,000; The calculation involves extrapolation.

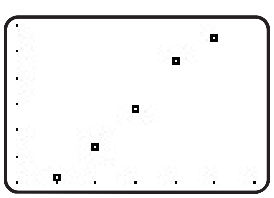
Figure 87a

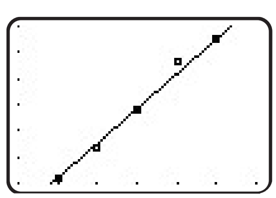
Figure 87c

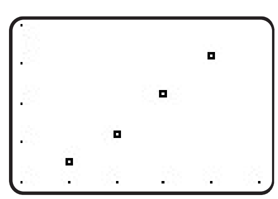
Figure 88a

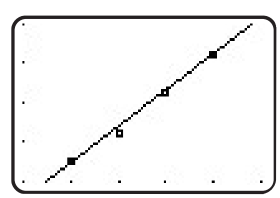
Figure 88c

89. (a) Using the points (1970, 2000) and (2010, 1590), $m = \frac{1590 - 2000}{2010 - 1970} = \frac{-410}{40} = -10.25$. Since x represents the number of years after 1970, we have a y-intercept of 2000, and the function is $f(x) = -10.25x + 2000$.