Chapter 1: Linear Functions, Equations, and Inequalities

1.1: Real Numbers and the Rectangular Coordinate System

1. (a) The only natural number is 10.
   (b) The whole numbers are 0 and 10.
   (c) The integers are $-6, -\frac{12}{4}$ (or -3), 0, 10.
   (d) The rational numbers are $-6, -\frac{12}{4}$ (or -3), $-\frac{5}{8}$, 0, .31, $.\overline{3}$, and 10.
   (e) The irrational numbers are $-\sqrt{3}$, 2π and $\sqrt{17}$.
   (f) All of the numbers listed are real numbers.
2. (a) The natural numbers are $\frac{6}{2}$ (or3), 8, and $\sqrt{81}$ (or 9).
   (b) The whole numbers are 0, $\frac{6}{2}$ (or 3), 8, and $\sqrt{81}$ (or 9).
   (c) The integers are $-8, -\frac{14}{7}$ (or -2), 0, $\frac{6}{2}$ (or 3), 8, and $\sqrt{81}$ (or 9).
   (d) The rational numbers are $-8, -\frac{14}{7}$ (or -2), $-.245$, $\frac{6}{2}$ (or 3), 8, and $\sqrt{81}$ (or 9).
   (e) The only irrational number is $\sqrt{12}$.
   (f) All of the numbers listed are real numbers.
3. (a) There are no natural numbers listed.
   (b) There are no whole numbers listed.
   (c) The integers are $-\sqrt{100}$ (or -10) and -1.
   (d) The rational numbers are $-\sqrt{100}$ (or -10), $-\frac{13}{6}$, -1, 5.23, $9.\overline{14}$, 3.14, and $\frac{22}{7}$.
   (e) There are no irrational numbers listed.
   (f) All of the numbers listed are real numbers.
4. (a) The natural numbers are 3, 18, and 56.
   (b) The whole numbers are 3, 18, and 56.
   (c) The integers are $-\sqrt{49}$ (or -7), 3, 18, and 56.
   (d) The rational numbers are $-\sqrt{49}$ (or -7), $-.405$, $-.\overline{3}$, .1, 3, 18, and 56.
   (e) The only irrational number is 6π.
   (f) All of the numbers listed are real numbers.
5. The number 16,351,000,000,000 is a natural number, integer, rational number, and real number.
6. The number 700,000,000,000 is a natural number, integer, rational number, and real number.
7. The number -25 is an integer, rational, and real number.

8. The number -3 is an integer, rational number, and real number

9. The number $\frac{7}{3}$ is a rational and real number.

10. The number -3.5 is a rational number and real number.

11. The number $5\sqrt{2}$ is a real number.

12. The number π is a real number.

13. Natural numbers would be appropriate because population is only measured in positive whole numbers.

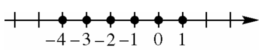
14. Natural numbers would be appropriate because distance on road signs is only given in positive whole numbers.

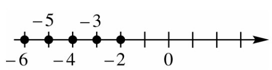
15. Rational numbers would be appropriate because shoes come in fraction sizes.

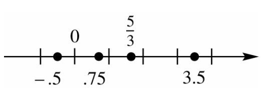
16. Rational numbers would be appropriate because gas is paid for in dollars and cents, a decimal part of a dollar.

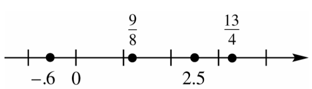
17. Integers would be appropriate because temperature is given in positive and negative whole numbers.

18. Integers would be appropriate because golf scores are given in positive and negative whole numbers.

19. 

20. 

21. 

22. 

23. A rational number can be written as a fraction, $\frac{p}{q}$, $q \neq 0$, where p and q are integers. An irrational number cannot be written in this way.

24. She should write $\sqrt{2} \approx 1.414213562$. Calculators give only approximations of irrational numbers.

25. The point $\left(2, \frac{5}{7}\right)$ is in Quadrant I. See Figure 25-34.

26. The point $(-1, 2)$ is in Quadrant II. See Figure 25-34.

27. The point $(-3, -2)$ is in Quadrant III. See Figure 25-34.

28. The point $(1, -4)$ is in Quadrant IV. See Figure 25-34.

29. The point $(0, 5)$ is located on the *y*-axis, therefore is not in a quadrant. See Figure 25-34.

30. The point $(-2, -4)$ is in Quadrant III. See Figure 25-34.

31. The point $(-2,4)$ is in Quadrant II. See Figure 25-34.

32. The point $(3,0)$ is located on the x-axis, therefore is not in a quadrant. See Figure 25-34.

33. The point $(-2,0)$ is located on the x-axis, therefore is not in a quadrant. See Figure 25-34.

34. The point $(3,-3)$ is in Quadrant IV. See Figure 25-34.

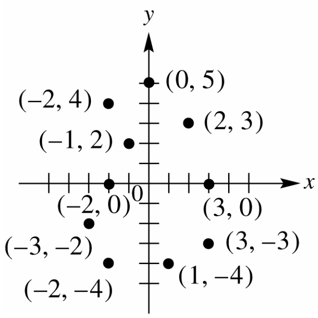


Figure 25-34

35. If $xy > 0$, then either $x > 0$ and $y > 0 \Rightarrow$ Quadrant I, or $x < 0$ and $y < 0 \Rightarrow$ Quadrant III.

36. If $xy < 0$, then either $x > 0$ and $y < 0 \Rightarrow$ Quadrant IV, or $x < 0$ and $y > 0 \Rightarrow$ Quadrant II.

37. If $\frac{x}{y} < 0$, then either $x > 0$ and $y < 0 \Rightarrow$ Quadrant IV, or $x < 0$ and $y > 0 \Rightarrow$ Quadrant II.

38. If $\frac{x}{y} > 0$, then either $x > 0$ and $y > 0 \Rightarrow$ Quadrant I, or $x < 0$ and $y < 0 \Rightarrow$ Quadrant III.

39. Any point of the form $(0,b)$ is located on the y-axis.

40. Any point of the form $(a,0)$ is located on the x-axis.

41. $[-5,5]$ by $[-25,25]$

42. $[-25,25]$ by $[-5,5]$

43. $[-60,60]$ by $[-100,100]$

44. $[-100,100]$ by $[-60,60]$

45. $[-500,300]$ by $[-300,500]$

46. $[-300,300]$ by $[-375,150]$

47. See Figure 47.

48. See Figure 48.

49. See Figure 49.

50. See Figure 50.

[-10,10] by [-10,10]
Xscl = 1 Yscl = 1

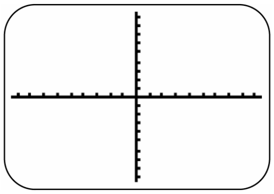


Figure 47

[-40,40] by [-30,30]
Xscl = 5 Yscl = 5

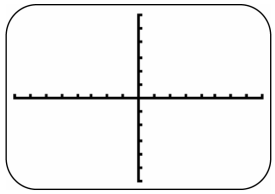


Figure 48

[-5,10] by [-5,10]
Xscl= 3 Yscl = 3

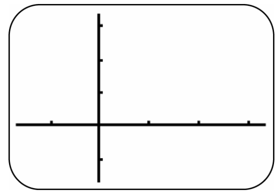


Figure 49

[-3.5,3.5] by [-4,10]
Xscl = 1 Yscl= 1

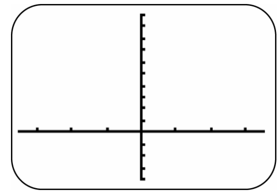


Figure 50

51. See Figure 51.

52. See Figure 52.

[-100,100] by [-50,50]
Xscl = 20 Yscl = 25

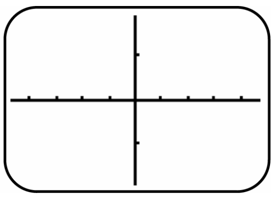


Figure 51

[-4.7,4.7] by [-3.1,3.1]
Xscl = 1 Yscl = 1

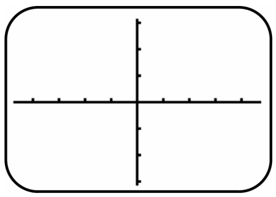


Figure 52

53. There are no tick marks, which is a result of setting Xscl and Yscl to 0.

54. The axes appear thicker because the tick marks are so close together. The problem can be fixed by using larger values for Xscl and Yscl such as $\text{Xscl} = \text{Yscl} = 10$.

55. $\sqrt{58} \approx 7.615773106 \approx 7.616$

56. $\sqrt{97} \approx 9.848857802 \approx 9.849$

57. $\sqrt[3]{33} \approx 3.20753433 \approx 3.208$

58. $\sqrt[3]{91} \approx 4.497941445 \approx 4.498$

59. $\sqrt[4]{86} \approx 3.045261646 \approx 3.045$

60. $\sqrt[4]{123} \approx 3.330245713 \approx 3.330$

61. $19^{1/2} \approx 4.35889844 \approx 4.359$

62. $29^{1/3} \approx 3.072316826 \approx 3.072$

63. $46^{1.5} \approx 311.9871792 \approx 311.987$

64. $23^{2.75} \approx 5555.863268 \approx 5555.863$

65. $(5.6-3.1)/(8.9+1.3) \approx .25$

66. $(34+25)/23 \approx 2.57$

67. $\sqrt{(\pi \wedge 3+1)} \approx 5.66$

68. $\sqrt[3]{(2.1-6^2)} \approx -3.24$

69. $3(5.9)^2 - 2(5.9) + 6 = 98.63$

70. $2\pi \wedge 3 - 5\pi - 3 \approx 9.66$

71. $\sqrt{(4-6)^2 + (7+1)^2)} \approx 8.25$

72. $\sqrt{(-1-(-3))^2 + (-5-3)^2} \approx 8.25$

73. $\sqrt{(\pi - 1)} / \sqrt{(1+\pi)} \approx .72$

74. $\sqrt[3]{(4.3\text{E}5 + 3.7\text{E}2)} \approx 76.65$

75. $2/(1-\sqrt[3]{5}) \approx -2.82$

76. $1 - 4.5/(3-\sqrt{2}) \approx -1.84$

77. $a^2 + b^2 = c^2 \Rightarrow 8^2 + 15^2 = c^2 \Rightarrow 64 + 225 = c^2 \Rightarrow 289 = c^2 \Rightarrow c = 17$

78. $a^2 + b^2 = c^2 \Rightarrow 7^2 + 24^2 = c^2 \Rightarrow 49 + 576 = c^2 \Rightarrow 625 = c^2 \Rightarrow c = 25$

79. $a^2 + b^2 = c^2 \Rightarrow 13^2 + b^2 = 85^2 \Rightarrow 169 + b^2 = 7225 \Rightarrow b^2 = 7056 \Rightarrow b = 84$

80. $a^2 + b^2 = c^2 \Rightarrow 14^2 + b^2 = 50^2 \Rightarrow 196 + b^2 = 2500 \Rightarrow b^2 = 2304 \Rightarrow b = 48$

81. $a^2 + b^2 = c^2 \Rightarrow 5^2 + 8^2 = c^2 \Rightarrow 25 + 64 = c^2 \Rightarrow 89 = c^2 \Rightarrow c = \sqrt{89}$

82. $a^2 + b^2 = c^2 \Rightarrow 9^2 + 10^2 = c^2 \Rightarrow 81 + 100 = c^2 \Rightarrow 181 = c^2 \Rightarrow c = \sqrt{181}$

83. $a^2 + b^2 = c^2 \Rightarrow a^2 + (\sqrt{13})^2 = (\sqrt{29})^2 \Rightarrow a^2 + 13 = 29 \Rightarrow a^2 = 16 \Rightarrow a = 4$

84. $a^2 + b^2 = c^2 \Rightarrow a^2 + (\sqrt{7})^2 = (\sqrt{11})^2 \Rightarrow a^2 + 7 = 11 \Rightarrow a^2 = 4 \Rightarrow a = 2$

85. (a) $d = \sqrt{(2-(-4))^2 + (5-3)^2} = \sqrt{(6)^2 + (2)^2} = \sqrt{36+4} = \sqrt{40} = 2\sqrt{10}$

(b) $M = \left(\frac{-4+2}{2}, \frac{3+5}{2}\right) = \left(\frac{-2}{2}, \frac{8}{2}\right) = (-1, 4)$

86. (a) $d = \sqrt{(2-(-3))^2 + (1-4)^2} = \sqrt{(5)^2 + (-5)^2} = \sqrt{25+25} = \sqrt{50} = 5\sqrt{2}$

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

87. (a) $d = \sqrt{(6-(-7))^2 + (-2-4)^2} = \sqrt{(13)^2 + (-6)^2} = \sqrt{169+36} = \sqrt{205}$

(b) $M = \left(\frac{-7+6}{2}, \frac{4+(-2)}{2}\right) = \left(\frac{-1}{2}, \frac{2}{2}\right) = \left(-\frac{1}{2}, 1\right)$

88. (a) $d = \sqrt{(1-(-3))^2 + (4-(-3))^2} = \sqrt{(4)^2 + (7)^2} = \sqrt{16+49} = \sqrt{65}$

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

89. (a) $d = \sqrt{(2-5)^2 + (11-7)^2} = \sqrt{(-3)^2 + (4)^2} = \sqrt{9+16} = \sqrt{25} = 5$

(b) $M = \left(\frac{5+2}{2}, \frac{7+11}{2}\right) = \left(\frac{7}{2}, \frac{18}{2}\right) = \left(\frac{7}{2}, 9\right)$

90. (a) $d = \sqrt{(4-(-2))^2 + (-3-5)^2} = \sqrt{(6)^2 + (-8)^2} = \sqrt{36+16} = \sqrt{100} = 10$

(b) $M=\left(\frac{-2+4}{2},\frac{5+(-3)}{2}\right)=\left(\frac{2}{2},\frac{2}{2}\right)=(1,1)$

91. (a) $d=\sqrt{(-3-(-8))^2+((-5)-(-2))^2}=\sqrt{(5)^2+(-3)^2}=\sqrt{25+9}=\sqrt{34}$

(b) $M=\left(\frac{-8+(-3)}{2},\frac{-2+(-5)}{2}\right)=\left(\frac{-11}{2},\frac{-7}{2}\right)=\left(-\frac{11}{2},-\frac{7}{2}\right)$

92. (a) $d=\sqrt{(6-(-6))^2+(5-(-10))^2}=\sqrt{(12)^2+(15)^2}=\sqrt{144+225}=\sqrt{369}=3\sqrt{41}$

(b) $M=\left(\frac{-6+6}{2},\frac{-10+5}{2}\right)=\left(\frac{0}{2},\frac{-5}{2}\right)=\left(0,-\frac{5}{2}\right)$

93. (a) $d=\sqrt{(6.2-9.2)^2+(7.4-3.4)^2}=\sqrt{(-3)^2+(4)^2}=\sqrt{9+16}=\sqrt{25}=5$

(b) $M=\left(\frac{9.2+6.2}{2},\frac{3.4+7.4}{2}\right)=\left(\frac{15.4}{2},\frac{10.8}{2}\right)=(7.7,5.4)$

94. (a) $d=\sqrt{(3.9-8.9)^2+(13.6-1.6)^2}=\sqrt{(-5)^2+(12)^2}=\sqrt{25+144}=\sqrt{169}=13$

(b) $M=\left(\frac{8.9+3.9}{2},\frac{1.6+13.6}{2}\right)=\left(\frac{12.8}{2},\frac{15.2}{2}\right)=(6.4,7.6)$

95. (a) $d=\sqrt{(6x-13x)^2+(x-(-23x))^2}=\sqrt{(-7x)^2+(24x)^2}=\sqrt{49x^2+576x^2}=\sqrt{625x^2}=25x$

(b) $M=\left(\frac{13x+6x}{2},\frac{-23x+x}{2}\right)=\left(\frac{19x}{2},\frac{-22x}{2}\right)=\left(\frac{19}{2}x,-11x\right)$

96. (a) $d=\sqrt{(20y-12y)^2+(12y-(-3y))^2}=\sqrt{(8y)^2+(15y)^2}=\sqrt{64y^2+225y^2}=\sqrt{289y^2}=17y$

(b) $M=\left(\frac{12y+20y}{2},\frac{-3y+12y}{2}\right)=\left(\frac{32y}{2},\frac{9y}{2}\right)=\left(16y,\frac{9}{2}y\right)$

97. Using the midpoint formula we get: $\left(\frac{7+x_2}{2},\frac{-4+y_2}{2}\right)=(8,5)\Rightarrow\left(\frac{7+x_2}{2}\right)=8\Rightarrow 7+x_2=16\Rightarrow x_2=9$ and

$\frac{-4+y_2}{2}=5\Rightarrow -4+y_2=10\Rightarrow y_2=14$. Therefore the coordinates are: $Q(19,14)$.

98. Using the midpoint formula we get: $\left(\frac{13+x_2}{2},\frac{5+y_2}{2}\right)=(-2,-4)\Rightarrow\frac{13+x_2}{2}=-2\Rightarrow 13+x_2=-4\Rightarrow$

$x_2=-17$ and $\frac{5+y_2}{2}=-4\Rightarrow 5+y_2=-8\Rightarrow y_2=-13$. Therefore the coordinates are: $Q(-17,-13)$.

99. Using the midpoint formula we get: $\left(\frac{5.64+x_2}{2},\frac{8.21+y_2}{2}\right)=(-4.04,1.60)\Rightarrow\frac{5.64+x_2}{2}=-4.04\Rightarrow$

$5.64+x_2=-8.08\Rightarrow x_2=-13.72$ and $\frac{8.21+y_2}{2}=1.60\Rightarrow 8.21+y_2=3.20\Rightarrow y_2=-5.01$. Therefore the coordinates are: $Q(-13.72,-5.01)$.

100. Using the midpoint formula we get:

$$\left(\frac{-10.32+x_2}{2},\frac{8.55+y_2}{2}\right)=(1.55,-2.75)\Rightarrow\frac{-10.32+x_2}{2}=1.55\Rightarrow-10.32+x_2=3.10\Rightarrow$$

$x_2=13.42.$ $\frac{8.55+y_2}{2}=-2.75\Rightarrow 8.55+y_2=-5.50\Rightarrow y_2=-14.05.$ Therefore the coordinates are: $Q(-13.42,-13.05)$.

101. $M=\left(\frac{2007+2011}{2},\frac{17+36}{2}\right)=\left(\frac{4018}{2},\frac{53}{2}\right)=(2009,26.5)$; the revenue was about \$26.5 billion.

102. For 2013, $M=\left(\frac{2012+2014}{2},\frac{7601+7689}{2}\right)=\left(\frac{4026}{2},\frac{15,290}{2}\right)=(2013,7645)$; enrollment was 7645 thousand. For 2015, $M=\left(\frac{2014+2016}{2},\frac{7689+7952}{2}\right)=\left(\frac{4030}{2},\frac{15,641}{2}\right)=(2015,7820.5)$; Enrollment was about 7821 thousand.

103. In 2005 , $M=\left(\frac{2003+2007}{2},\frac{18,810+21,203}{2}\right)=\left(\frac{4010}{2},\frac{40,013}{2}\right)=(2005,20,006.5)$; poverty level was approximately \$20,007. In 2009, $M=\left(\frac{2007+2011}{2},\frac{21,203+22,350}{2}\right)=\left(\frac{4018}{2},\frac{43,553}{2}\right)=$ $(2009,21,776.5)$; poverty level was approximately \$21,777.

104. (a) From (0, 0) to (3, 4): $d_1=\sqrt{(3-0)^2+(4-0)^2}=\sqrt{(3)^2+(4)^2}=\sqrt{9+16}=\sqrt{25}=5.$

From (3,4) to (7, 1): $d_2=\sqrt{(7-3)^2+(1-4)^2}=\sqrt{(4)^2+(-3)^2}=\sqrt{16+9}=\sqrt{25}=5.$ From (0, 0) to (7, 1): $d_3=\sqrt{(7-0)^2+(1-0)^2}=\sqrt{(7)^2+(1)^2}=\sqrt{49+1}=\sqrt{50}=5\sqrt{2}.$ Since d_1=d_2, the triangle is isosceles.

(b) From (−1, −1) to (2, 3): $d_1=\sqrt{(2-(-1))^2+(3-(-1))^2}=\sqrt{(3)^2+(4)^2}=\sqrt{9+16}=\sqrt{25}=5.$

From (2, 3) to (−4, 3): $d_2=\sqrt{(-4-2)^2+(3-3)^2}=\sqrt{(-6)^2+(0)^2}=\sqrt{36+0}=\sqrt{36}=6.$

From (−4, 3) to (−1, −1): $d_3=\sqrt{(-1-(-4))^2+(-1-3)^2}=\sqrt{(3)^2+(-4)^2}=\sqrt{9+16}=\sqrt{25}=5.$

Since $d_1\neq d_2$, the triangle is not equilateral.

(c) From (−1, 0) to (1, 0): $d_1=\sqrt{(1-(-1))^2+(0-0)^2}=\sqrt{(2)^2+(0)^2}=\sqrt{4+0}=\sqrt{4}=2.$

From (-1, 0) to $\left(0,\sqrt{3}\right)$: $d_2=\sqrt{(-1-0)^2+(0-\sqrt{3})^2}=\sqrt{(-1)^2+(-\sqrt{3})^2}=\sqrt{1+3}=\sqrt{4}=2.$

From (1, 0) to $\left(0,\sqrt{3}\right)$: $d_3=\sqrt{(1-0)^2+(0-\sqrt{3})^2}=\sqrt{(1)^2+(\sqrt{3})^2}=\sqrt{1+3}=\sqrt{4}=2.$

Since $d_1=d_2=d_3$, the triangle is equilateral and isosceles.

(d) From (−3, 3) to (-1, 3): $d_1 = \sqrt{(-3-(-1))^2 + (3-3)^2} = \sqrt{(-2)^2 + (0)^2} = \sqrt{4+0} = \sqrt{4} = 2.$

From (-3, 3) to (−2, 5): $d_2 = \sqrt{(-3-(-2))^2 + (3-5)^2} = \sqrt{(-1)^2 + (-2)^2} = \sqrt{1+4} = \sqrt{5}.$

From (−1, 3) to (−2, 5): $d_3 = \sqrt{(-1-(-2))^2 + (3-5)^2} = \sqrt{(1)^2 + (-2)^2} = \sqrt{1+4} = \sqrt{5}.$

Since $d_2 = d_3$, the triangle is not isosceles.

105. (a) See Figure 105.

(b) $d = \sqrt{(50-0)^2 + (0-40)^2} = \sqrt{(50)^2 + (-40)^2} = \sqrt{2500+1600} = \sqrt{4100} \approx 64.0$ miles.

106. (a) See Figure 106

(b) $d = \sqrt{(0-15t)^2 + (20t-0)^2} = \sqrt{(-15t)^2 + (20t)^2} = \sqrt{225t^2 + 400t^2} = \sqrt{625t^2} = 25t.$ That is $d = 25t$ miles.

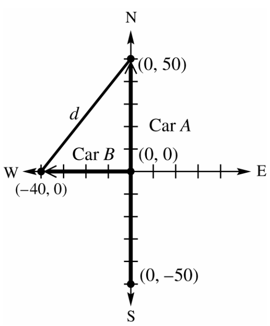


Figure 105

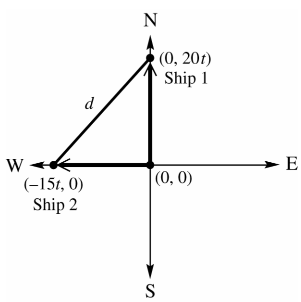


Figure 106

107. Using the area of a square produces: $(a+b)^2 = a^2 + 2ab + b^2$. Now, using the sum of the small square and the four right triangles produces $c^2 + 4\left(\frac{1}{2}ab\right) = c^2 + 2ab.$ Therefore $a^2 + 2ab + b^2 = c^2 + 2ab,$ and subtracting $2ab$ from both sides produces $a^2 + b^2 = c^2$.

108. Let d_1 represent the distance between P and M and let d_2 represent the distance between M and Q.

$$d_1 = \sqrt{\left(x_1 - \frac{x_1 + x_2}{2}\right)^2 + \left(y_1 - \frac{y_1 + y_2}{2}\right)^2}^2 = \sqrt{\left(\frac{2x_1 - x_1 - x_2}{2}\right)^2 + \left(\frac{2y_1 - y_1 - y_2}{2}\right)^2} \Rightarrow$$

$$d_1 = \sqrt{\frac{(x_1 - x_2)^2}{4} + \frac{(y_1 - y_2)^2}{4}} = \frac{1}{2}\sqrt{(x_1 - x_2)^2 + (y_1 - y_2)^2}$$

$$d_2 = \sqrt{\left(x_2 - \frac{x_1 + x_2}{2}\right)^2 + \left(y_2 - \frac{y_1 + y_2}{2}\right)^2} = \sqrt{\left(\frac{2x_2 - x_1 - x_2}{2}\right)^2 + \left(\frac{2y_2 - y_1 - y_2}{2}\right)^2} \Rightarrow$$

$$d_2 = \sqrt{\frac{(x_2 - x_1)^2}{4} + \frac{(y_2 - y_1)^2}{4}} = \frac{1}{2}\sqrt{(x_2 - x_1)^2 + (y_2 - y_1)^2}$$

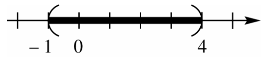
Since $(x_1 - x_2)^2 = (x_2 - x_1)^2$ and $(y_1 - y_2)^2 = (y_2 - y_1)^2$, the distances are the same.

Since $d_1 = d_2$, the sum $d_1 + d_2 = 2d_2 = 2\left(\frac{1}{2}\sqrt{(x_2 - x_1)^2 + (y_2 - y_1)^2}\right) = \sqrt{(x_2 - x_1)^2 + (y_2 - y_1)^2}.$

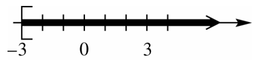
That is, the sum is equal to the distance between P and Q.

1.2: Introduction to Relations and Functions

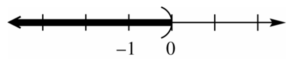
1. The interval is $(-1, 4)$.



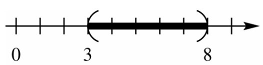
2. The interval is $[-3, \infty)$.



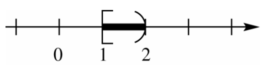
3. The interval is $(-\infty, 0)$.



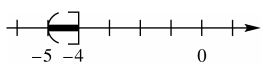
4. The interval is $(3, 8)$.



5. The interval is $[1, 2)$.



6. The interval is



$(-5, -4]$.

7. $(-4, 3) \Rightarrow \{x \mid -4 < x < 3\}$
8. $[2, 7) \Rightarrow \{x \mid 2 \le x < 7\}$
9. $(-\infty, -1] \Rightarrow \{x \mid x \le -1\}$
10. $(3, \infty) \Rightarrow \{x \mid x > 3\}$
11. $\{x \mid -2 \le x < 6\}$
12. $\{x \mid 0 < x < 8\}$
13. $\{x \mid x \le -4\}$
14. $\{x \mid x > 3\}$
15. A parenthesis is used if the symbol is $<$, $>$, $-\infty$, or ∞ or . A square bracket is used if the symbol is $\le$ or $\ge$.
16. No real number is both greater than -7 and less than -10. Part (d) should be written $-10 < x < -7$.
17. See Figure 17
18. See Figure 18
19. See Figure 19

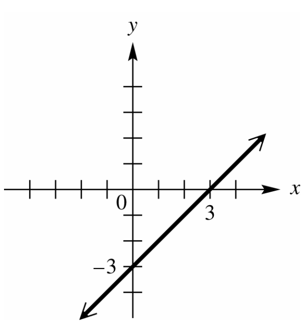


Figure 17

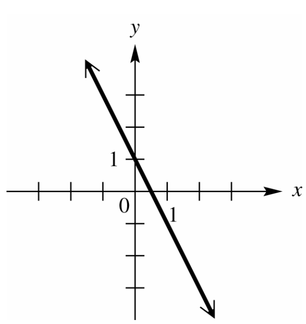


Figure 18

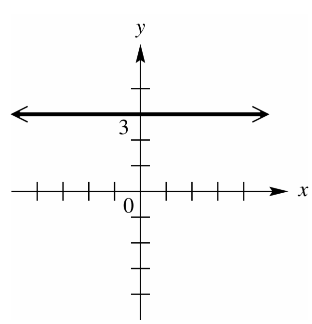


Figure 19

20. See Figure 20
21. See Figure 21

22. See Figure 22

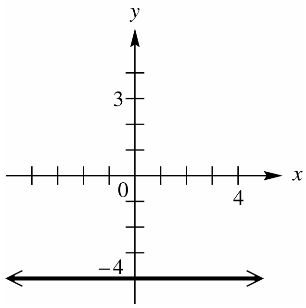


Figure 20

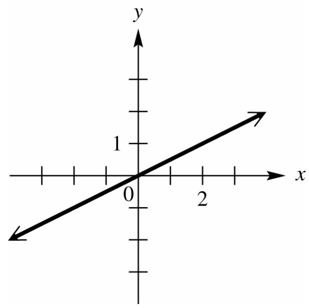


Figure 21

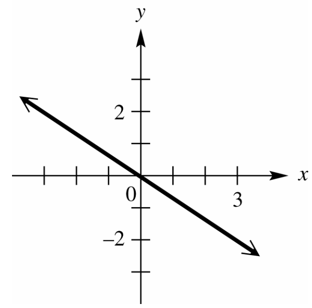


Figure 22

23. See Figure 23

24. See Figure 24

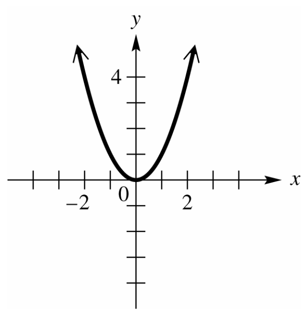


Figure 23

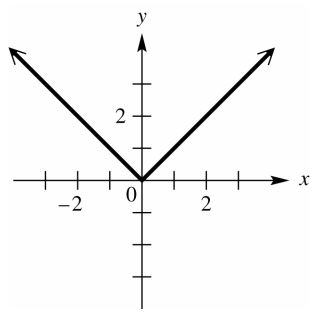


Figure 24

25. The relation is a function. Domain: $\{5,3,4,7\}$ Range: $\{1,2,9,6\}$.

26. The relation is a function. Domain: $\{8,5,9,3\}$, Range: $\{0,4,3,8\}$.

27. The relation is a function. Domain: $\{1,2,3\}$, Range: $\{6\}$.

28. The relation is a function. Domain: $\{-10,-20,-30\}$, Range: $\{5\}$.

29. The relation is not a function. Domain: $\{4,3,-2\}$, Range: $\{1,-5,3,7\}$.

30. The relation is not a function. Domain: $\{0,1\}$, Range: $\{5,3,-4\}$.

31. The relation is a function. Domain: $\{11,12,13,14\}$, Range: $\{-6,-7\}$.

32. The relation is not a function. Domain: $\{1\}$, Range: $\{12,13,14,15\}$.

33. The relation is a function. Domain: $\{0,1,2,3,4\}$, Range: $\left\{\sqrt{2},\sqrt{3},\sqrt{5},\sqrt{6},\sqrt{7}\right\}$.

34. The relation is a function. Domain: $\left\{1,\frac{1}{2},\frac{1}{4},\frac{1}{8},\frac{1}{16}\right\}$, Range: $\{0,-1,-2,-3,-4\}$.

35. The relation is a function. Domain: $(-\infty,\infty)$, Range: $(-\infty,\infty)$.

36. The relation is a function. Domain: $(-\infty,\infty)$, Range: $(-\infty,4]$.

37. The relation is not a function. Domain: $[-4,4]$, Range: $[-3,3]$.

38. The relation is a function. Domain: $[-2,2]$, Range: $[0,4]$.

39. The relation is a function. Domain: $[2,\infty)$, Range: $[0,\infty)$.

40. The relation is a function. Domain: $(-\infty,\infty)$, Range: $[1,\infty)$.

41. The relation is not a function. Domain: $[-9,\infty)$, Range: $(-\infty,\infty)$.

42. The relation is a function. Domain: $(-\infty,\infty)$, Range: $(-\infty,\infty)$.

43. The relation is a function. Domain: $\{-5,-2,-1,-.5,0,1.75,3.5\}$, Range: $\{-1,2,3,3.5,4,5.75,7.5\}$.

44. The relation is a function. Domain: $\{-2,-1,0,5,9,10,13\}$, Range: $\{5,0,-3,12,60,77,140\}$.

45. The relation is a function. Domain: $\{2,3,5,11,17\}$ Range: $\{1,7,20\}$.

46. The relation is not a function. Domain: $\{1,2,3,5\}$, Range: $\{10,15,19,27\}$

47. From the diagram, $f(-2)=2$.

48. From the diagram, $f(5)=12$.

49. From the diagram, $f(11)=7$.

50. From the diagram, $f(5)=1$.

51. f(1) is undefined since 1 is not in the domain of the function.

52. f(10) is undefined since 10 is not in the domain of the function.

53. $f(-2)=3(-2)-4=-6-4=-10$

54. $f(-5)=5(-5)+6=-25+6=-19$

55. $f(1)=2(1)^2-(1)+3=2-1+3=4$

56. $f(2)=3(2)^2+2(2)-5=12+4-5=11$

57. $f(4)=-(4)^2+(4)+2=-16+4+2=-10$

58. $f(3)=-(3)^2-(3)-6=-9-3-6=-18$

59. $f(9)=5$

60. $f(12)=-4$

61. $f(-2)=\sqrt{(-2)^3+12}=\sqrt{-8+12}=\sqrt{4}=2$

62. $f(2)=\sqrt[3]{(2)^2-(2)+6}=\sqrt[3]{4-2+6}=\sqrt[3]{8}=2$

63. $f(8)=|5-2(8)|=|-11|=11$

64. $f(20)=\left|6-\frac{1}{2}(20)\right|=|6-10|=|-4|=4$

65. Given that $f(x)=5x$, then $f(a)=5a$, $f(b+1)=5(b+1)=5b+5$, and $f(3x)=5(3x)=15x$

66. Given that $f(x) = x - 5$, then $f(a) = a - 5$, $f(b+1) = b + 1 - 5 = b - 4$, and $f(3x) = 3x - 5$

67. Given that $f(x) = 2x - 5$, then $f(a) = 2a - 5$, $f(b+1) = 2(b+1) - 5 = 2b + 2 - 5 = 2b - 3$, and $f(3x) = 2(3x) - 5 = 6x - 5$

68. Given that $f(x) = x^2$, then $f(a) = a^2$, $f(b+1) = (b+1)^2 = (b+1)(b+1) = b^2 + 2b + 1$, and $f(3x) = (3x)^2 = 9x^2$

69. Given that $f(x) = 1 - x^2$, then $f(a) = 1 - a^2$, $f(b+1) = 1 - (b+1)^2 = 1 - (b^2 + 2b + 1) = -b^2 - 2b$, and $f(3x) = 1 - (3x)^2 = 1 - 9x^2$

70. Given that $f(x) = |x| + 4$, then $f(a) = |a| + 4$, $f(b+1) = |b+1| + 4$, and $f(3x) = |3x| + 4$

71. Since $f(-2) = 3$, the point $(-2, 3)$ lies on the graph of f.

72. Since $f(3) = -9.7$, the point $(3, -9.7)$ lies on the graph of f.

73. Since the point $(7, 8)$ lies on the graph of f, $f(7) = 8$.

74. Since the point $(-3, 2)$ lies on the graph of f, $f(-3) = 2$.

75. From the graph: (a) $f(-2) = 0$, (b) $f(0) = 4$, (c) $f(1) = 2$, and (d) $f(4) = 4$.

76. From the graph: (a) $f(-2) = 5$, (b) $f(0) = 0$, (c) $f(1) = 2$, and (d) $f(4) = 4$.

77. From the graph: (a) $f(-2)$ is undefined , (b) $f(0) = -2$, (c) $f(1) = 0$, and (d) $f(4) = 2$.

78. From the graph: (a) $f(-2) = 3$, (b) $f(0) = 3$, (c) $f(1) = 3$, and (d) $f(4)$ is undefined.

79. (a) – (f) Answers will vary. Refer to the definitions in the text.

80. (a) See Figure 80.

(b) $f(2000) = 12.8$ In 2000 there were 12,800 radio stations on the air.

(c) Domain: $\{1975, 1990, 2000, 2005, 2012\}$, Range: $\{7.7, 10.8, 12.8, 13.5, 15.1\}$.

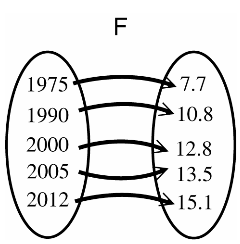


Figure 80

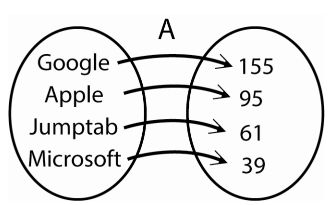


Figure 81

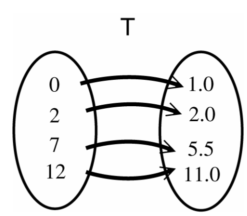


Figure 82

81. (a) $A = \{(\text{Google}, 155), (\text{Apple}, 95), (\text{Jumptab}, 61), (\text{Microsof}t, 39)\}$, The U.S. mobile advertising revenue in 2011 for Google was $155,000,000 dollars.

(b) See Figure 81.

(c) $D = \{\text{Google, Apple, Jumptab, Microsoft}\}$, $R = \{155, 95, 61, 39\}$

82. (a) $T = \{(0, 1.0), (2, 2.0), (7, 5.5), (12, 11.0)\}$

(b) See Figure 82

(c) $D = \{0, 2, 7, 12\}$; $R = \{1.0, 2.0, 5.5, 11.0\}$

Reviewing Basic Concepts (Sections 1.1 and 1.2)

1. See Figure 1.
2. The distance is $d = \sqrt{(6-(-4))^2 + (-2-5)^2} = \sqrt{100+49} = \sqrt{149}$.

   The midpoint is $M = \left(\frac{-4+6}{2}, \frac{5-2}{2}\right) = \left(1, \frac{3}{2}\right)$.
3. $\frac{\sqrt{5+\pi}}{(\sqrt[3]{3}+1)} \approx 1.168$
4. $d = \sqrt{(12-(-4))^2 + (-3-27)^2} = \sqrt{256+900} = \sqrt{1156} = 34$
5. Using Pythagorean Theorem, $11^2 + b^2 = 61^2 \Rightarrow b^2 = 61^2 - 11^2 \Rightarrow b^2 = 3600 \Rightarrow b = 60$ inches.
6. The set $\{x \mid -2 < x \le 5\}$ is the interval $(-2, 5]$. The set $\{x \mid x \ge 4\}$ is the interval $[4, \infty)$.
7. The relation is not a function because it does not pass the vertical line test. Domain: $[-2, 2]$,

   Range: $[-3, 3]$.
8. See Figure 8.
9. Given $f(x) = 3 - 4x$ then $f(-5) = 3 - 4(-5) = 23$ and $f(a+4) = 3 - 4(a+4) = 3 - 4a - 16 = -4a - 13$
10. From the graph, $f(2) = 3$ and $f(-1) = -3$.

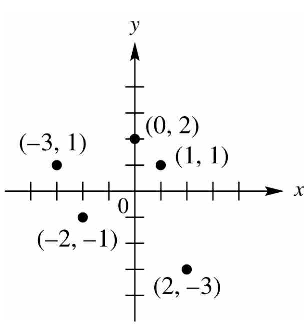


Figure 1

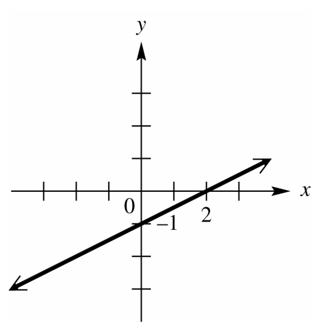


Figure 8

1.3: Linear Functions

1. The graph is shown in Figure 1.

   (a) x-intercept: 4 (b) y-intercept: -4 (c) Domain: $(-\infty, \infty)$ (d) Range: $(-\infty, \infty)$

   (e) The equation is in slope-intercept form, therefore $m = 1$.
2. The graph is shown in Figure 2.

   (a) x-intercept: 4 (b) y-intercept: 4 (c) Domain: $(-\infty, \infty)$ (d) Range: $(-\infty, \infty)$

   (e) The equation is in slope-intercept form, therefore $m = -1$.

3. The graph is shown in Figure 3.

   (a) x-intercept: 2 (b) y-intercept: -6 (c) Domain: $(-\infty, \infty)$ (d) Range: $(-\infty, \infty)$

   (e) The equation is in slope-intercept form, therefore $m = 3$.

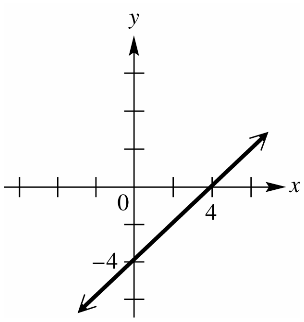


Figure 1

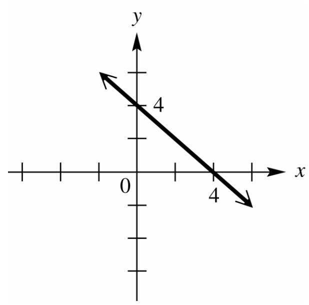


Figure 2

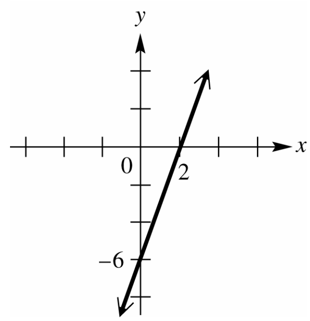


Figure 3

4. The graph is shown in Figure 4.

   (a) x-intercept: 3 (b) y-intercept: -2 (c) Domain: $(-\infty, \infty)$ (d) Range: $(-\infty, \infty)$

   (e) The equation is in slope-intercept form, therefore $m = \frac{2}{3}$.

5. The graph is shown in Figure 5.

   (a) x-intercept: 5 (b) y-intercept: 2 (c) Domain: $(-\infty, \infty)$ (d) Range: $(-\infty, \infty)$

   (e) The equation is in slope-intercept form, therefore $m = -\frac{2}{5}$.

6. The graph is shown in Figure 6.

   (a) x-intercept: $\frac{9}{4}$ (b) y-intercept: -3 (c) Domain: $(-\infty, \infty)$ (d) Range: $(-\infty, \infty)$

   (e) The equation is in slope-intercept form, therefore $m = \frac{4}{3}$.

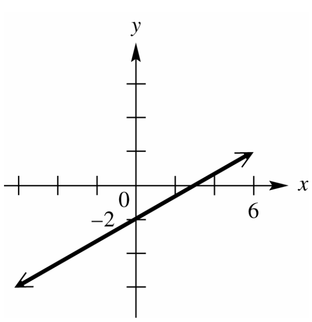


Figure 4

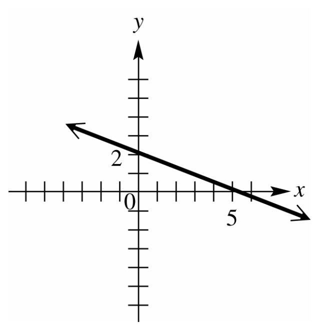


Figure 5

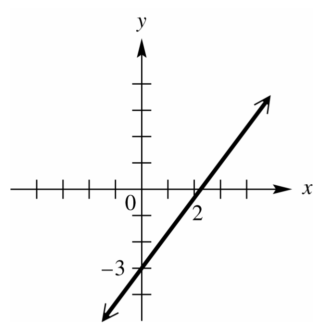


Figure 6

7. The graph is shown in Figure 7.

   (a) x-intercept: 0 (b) y-intercept: 0 (c) Domain: $(-\infty, \infty)$ (d) Range: $(-\infty, \infty)$

   (e) The equation is in slope-intercept form, therefore $m = 3$.

8. The graph is shown in Figure 8.

(a) x-intercept: 0 (b) y-intercept: 0 (c) Domain: $(-\infty, \infty)$ (d) Range: $(-\infty, \infty)$

(e) The equation is in slope-intercept form, therefore $m = -.5$.

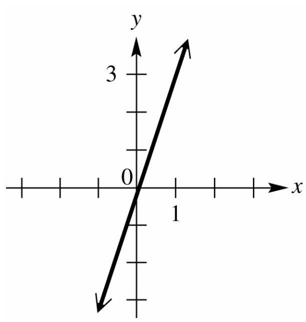


Figure 7

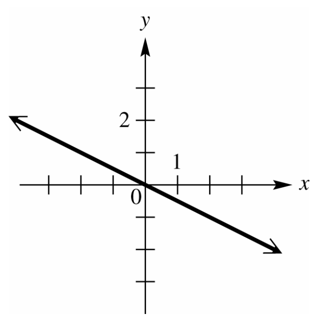


Figure 8

9. (a) $f(-2) = (-2) + 2 = 0$ and $f(4) = (4) + 2 = 6$

(b) The x-intercept is -2 and corresponds to the zero of f. See Figure 9.

(c) $x + 2 = 0 \Rightarrow x = -2$

10. (a) $f(-2) = -3(-2) + 2 = 8$ and $f(4) = -3(4) + 2 = -10$

(b) The x-intercept is $\frac{2}{3}$ and corresponds to the zero of f. See Figure 10.

(c) $-3x + 2 = 0 \Rightarrow -3x = -2 \Rightarrow x = \frac{2}{3}$

11. (a) $f(-2) = 2 - \frac{1}{2}(-2) = 3$ and $f(4) = 2 - \frac{1}{2}(4) = 0$

(b) The x-intercept is 4 and corresponds to the zero of f. See Figure 11.

(c) $2 - \frac{1}{2}x = 0 \Rightarrow \frac{1}{2}x = 2 \Rightarrow x = 4$

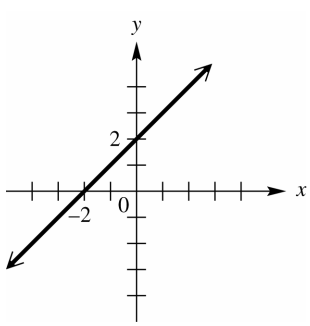


Figure 9

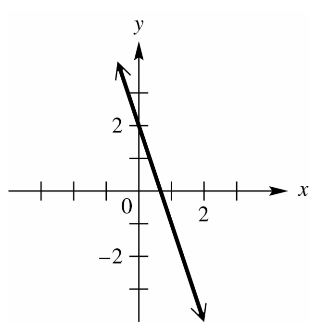


Figure 10

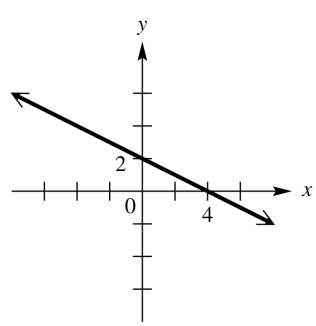


Figure 11

12. (a) $f(-2) = \frac{1}{4}(-2) + \frac{1}{2} = 0$ and $f(4) = \frac{1}{4}(4) + \frac{1}{2} = \frac{3}{2}$

(b) The x-intercept is -2 and corresponds to the zero of f. See Figure 12.

(c) $\frac{1}{4}x+\frac{1}{2}=0 \Rightarrow \frac{1}{4}x=-\frac{1}{2} \Rightarrow x=-2$

13. (a) $f(-2)=\frac{1}{3}(-2)=-\frac{2}{3}$ and $f(4)=\frac{1}{3}(4)=\frac{4}{3}$

(b) The x-intercept is 0 and corresponds to the zero of f. See Figure 13.

(c) $\frac{1}{3}x=0 \Rightarrow x=0$

14. (a) $f(-2)=-3(-2)=6$ and $f(4)=-3(4)=-12$

(b) The x-intercept is 0 and corresponds to the zero of f. See Figure 14.

(c) $-3x=0 \Rightarrow x=0$

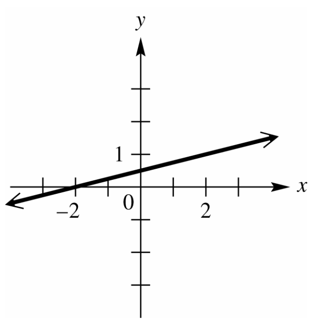


Figure 12

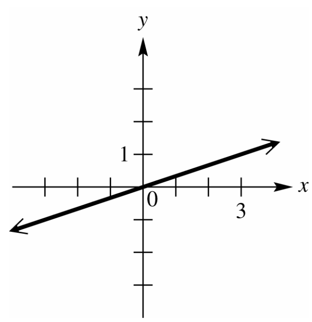


Figure 13

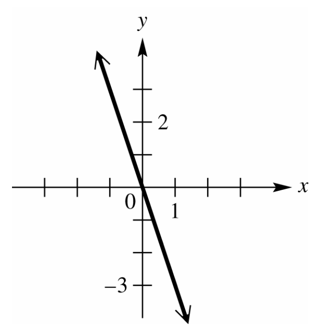


Figure 14

15. (a) $f(-2)=.4(-2)+.15=-.65$ and $f(4)=.4(4)+.15=1.75$

(b) The x-intercept is $-.375$ and corresponds to the zero of f. See Figure 15.

(c) $.4x+.15=0 \Rightarrow .4x=-.15 \Rightarrow x=-.375$

16. (a) $f(-2)=(-2)+0.5=-1.5$ and $f(4)=.5+(4)=4.5$

(b) The x-intercept is $-.5$ and corresponds to the zero of f. See Figure 16.

(c) $0.5+x=0 \Rightarrow x=-0.5$

17. (a) $f(-2)=\frac{2-(-2)}{4}=1$ and $f(4)=\frac{2-(4)}{4}=-\frac{1}{2}$

(b) The x-intercept is 2 and corresponds to the zero of f. See Figure 17.

(c) $\frac{2-x}{4}=0 \Rightarrow 2-x=0 \Rightarrow x=2$

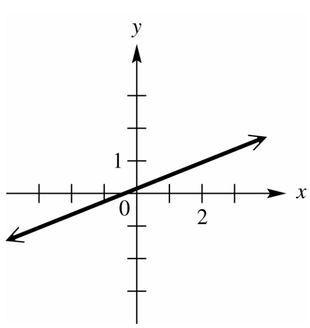


Figure 15

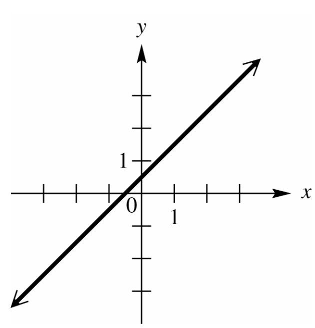


Figure 16

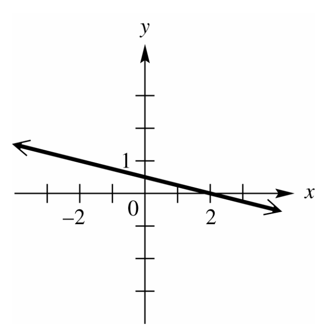


Figure 17

18. (a) $f(-2)=\dfrac{3-3(-2)}{6}=\dfrac{9}{6}=1.5$ and $f(4)=\dfrac{3-3(4)}{6}=\dfrac{-9}{6}=-1.5$

(b) The x-intercept is 1 and corresponds to the zero of f. See Figure 18.

(c) $\dfrac{3-3x}{6}=0\Rightarrow 3-3x=0\Rightarrow -3x=-3\Rightarrow x=1$

19. (a) $f(-2)=\dfrac{-2+5}{15}=\dfrac{3}{15}=\dfrac{1}{5}$ and $f(4)=\dfrac{4+5}{15}=\dfrac{9}{15}=\dfrac{3}{5}$

(b) The x-intercept is –5 and corresponds to the zero of f. See Figure 19

(c) $\dfrac{x+5}{15}=0\Rightarrow x+5=0\Rightarrow x=-5$

20. (a) $f(-2)=\dfrac{-2-4}{2}=\dfrac{-6}{2}=-3$ and $f(4)=\dfrac{4-4}{2}=\dfrac{0}{2}=0$

(b) The x-intercept is 4 and corresponds to the zero of f. See Figure 20.

(c) $\dfrac{x-4}{2}=0\Rightarrow x-4=0\Rightarrow x=4$

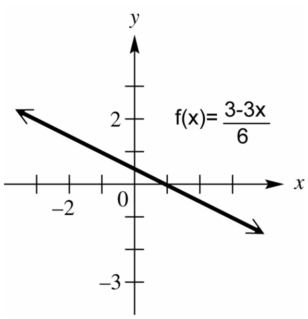


Figure 18

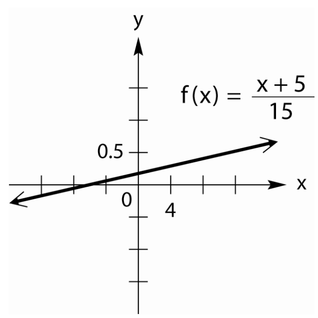


Figure 19

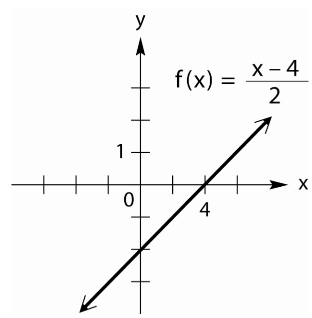


Figure 20

21. The graph of $y = ax$ always passes through (0, 0).

22. Since $m=\dfrac{4}{1}=4$, the equation of the line is $y = 4x$.

23. The graph is shown in Figure 23.

(a) x-intercept: none (b) y-intercept: -3 (c) Domain: $(-\infty,\infty)$ (d) Range: $\{-3\}$

(e) The slope of all horizontal line graphs or constant functions is $m = 0$.

24. The graph is shown in Figure 24.

(a) x-intercept: none (b) y-intercept: 5 (c) Domain: $(-\infty,\infty)$ (d) Range: $\{5\}$

(e) The slope of all horizontal line graphs or constant functions is $m = 0$.

25. The graph is shown in Figure 25.

(a) x-intercept: -1.5 (b) y-intercept: none (c) Domain: $\{-1.5\}$ (d) Range: $(-\infty,\infty)$

(e) All vertical line graphs are not functions, therefore the slope is undefined.

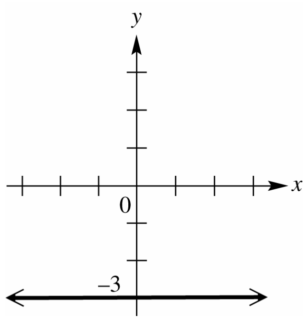


Figure 23

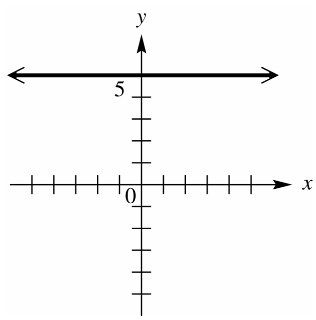


Figure 24

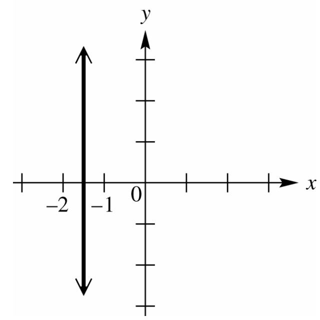


Figure 25

26. The graph is shown in Figure 26.

(a) x-intercept: none (b) y-intercept: $\frac{5}{4}$ (c) Domain: $(-\infty,\infty)$ (d) Range: $\left\{\frac{5}{4}\right\}$

(e) The slope of all horizontal line graphs or constant functions is $m = 0$.

27. The graph is shown in Figure 27.

(a) x-intercept: 2 (b) y-intercept: none (c) Domain: $\{2\}$

(d) Range: $(-\infty,\infty)$ (e) All vertical line graphs are not functions, therefore the slope is undefined.

28. The graph is shown in Figure 28.

(a) x-intercept:-3 (b) y-intercept: none (c) Domain: $\{-3\}$ (d) Range: $(-\infty,\infty)$

(e) All vertical line graphs are not functions, therefore the slope is undefined.

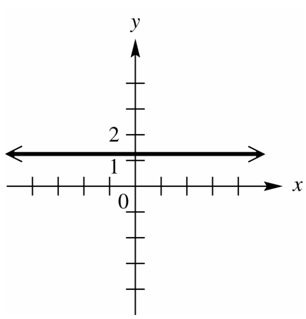


Figure 26

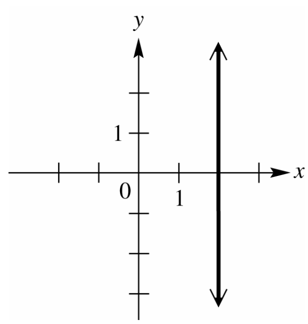


Figure 27

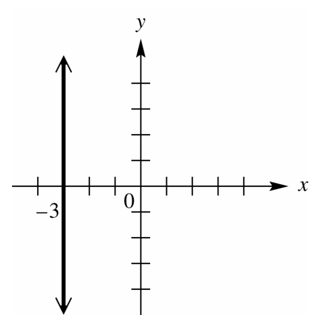


Figure 28

29. All functions in the form $f(x) = a$ are constant functions.
30. This is a vertical line graph, therefore $x = 4$.
31. This is a horizontal line graph, therefore $y = 3$.
32. This is a horizontal line graph on the x-axis, therefore $y = 0$.
33. This is a vertical line graph on the y-axis, therefore $x = 0$.
34. (a) The equation of the x-axis is $y = 0$.

    (b) The equation of the y-axis is $x = 0$.
35. Window B gives the more comprehensive graph. See Figures 35a and 35b.
36. Window A gives the more comprehensive graph. See Figures 36a and 36b.

[-10,10] by [-10,10]
Xscl = 1 Yscl = 1

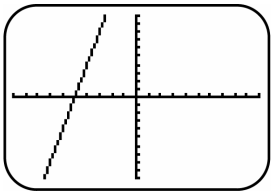


Figure 35a

[-10,10] by [-5,25]
Xscl = 1 Yscl = 5

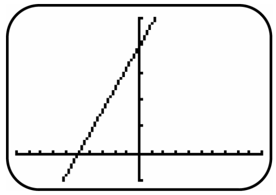


Figure 35b

[-10,10] by [-10,40]
Xscl= 1 Yscl = 5

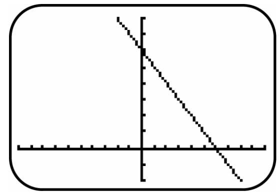


Figure 36a

[-5,5] by [-5,40]
Xscl = 1 Yscl= 5

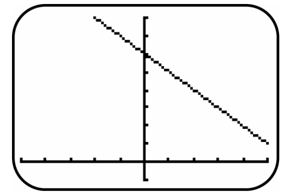


Figure 36b

37. Window B gives the more comprehensive graph. See Figures 37a and 37b.

38. Window B gives the more comprehensive graph. See Figures 38a and 38b.

[-3,3] by [-5,5]
Xscl = 1 Yscl = 1

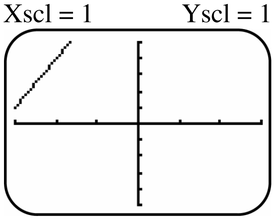


Figure 37a

[-5,5] by [-10,14]
Xscl = 1 Yscl = 2

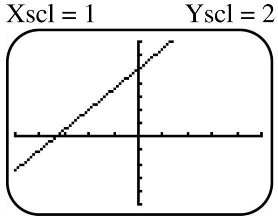


Figure 37b

[-5,5] by [-5,5]
Xscl= 1 Yscl = 1

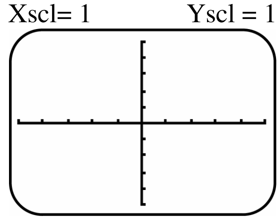


Figure 38a

[-10,10] by [-10,10]
Xscl = 1 Yscl= 1

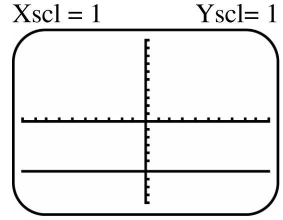


Figure 38b

39. $m=\dfrac{6-1}{3-(-2)}=\dfrac{5}{5}=1$

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

41. $m=\dfrac{4-(-3)}{8-(-1)}=\dfrac{7}{9}$

42. $m=\dfrac{-3-0}{-4-5}=\dfrac{-3}{-9}=\dfrac{1}{3}$

43. $m=\dfrac{5-3}{-11-(-11)}=\dfrac{2}{0}\Rightarrow$ undefined slope

44. $m=\dfrac{1-2}{-8-(-8)}=\dfrac{-1}{0}\Rightarrow$ undefined slope

45. $m=\dfrac{9-9}{\frac{1}{2}-\frac{2}{3}}=\dfrac{0}{-\frac{1}{6}}\Rightarrow 0$

46. $m=\dfrac{.36-.36}{.18-.12}=\dfrac{0}{.06}\Rightarrow 0$

47. $m=\dfrac{-\frac{2}{3}-\frac{1}{6}}{\frac{1}{2}-\left(-\frac{3}{4}\right)}=\dfrac{-\frac{5}{6}}{\frac{5}{4}}\Rightarrow -\dfrac{2}{3}$

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

49. The average rate of change is evaluated as $m = \frac{y_2 - y_1}{x_2 - x_1} = \frac{20-4}{0-4} = -\frac{16}{4} = -4$. The value of the machine is decreasing \$4000 each year during these years.

50. The average rate of change is evaluated as $m = \frac{y_2 - y_1}{x_2 - x_1} = \frac{200-0}{4-0} = \frac{200}{4} = 50$. The amount saved is increasing \$50 each month during these months.

51. The average rate of change is evaluated as $m = \frac{y_2 - y_1}{x_2 - x_1} = \frac{3-3}{4-0} = \frac{0}{4} = 0$. The percent of pay raise is not changing but will remain constant at 3% per year.

52. The average rate of change is evaluated as $m = \frac{y_2 - y_1}{x_2 - x_1} = \frac{10-10}{3-0} = \frac{0}{3} = 0$. The number of named hurricanes remained at the same value of 10 for the four consecutive years.

53. Since $m = 3$ and $b = 6$, graph A most closely resembles the equation.
54. Since $m = -3$ and $b = 6$, graph D most closely resembles the equation.
55. Since $m = -3$ and $b = -6$, graph C most closely resembles the equation.
56. Since $m = 3$ and $b = -6$, graph F most closely resembles the equation.
57. Since $m = 3$ and $b = 0$, graph H most closely resembles the equation.
58. Since $m = -3$ and $b = 0$, graph G most closely resembles the equation.
59. Since $m = 0$ and $b = 3$, graph B most closely resembles the equation.
60. Since $m = 0$ and $b = -3$, graph E most closely resembles the equation.

61. (a) The graph passes through (0,1) and (1,-1) $\Rightarrow$ $m = \frac{-1-1}{1-0} = \frac{-2}{1} = -2$. The y-intercept is $(0,1)$ and the x-intercept is $\left(\frac{1}{2}, 0\right)$.

    (b) Using the slope and y-intercept, the formula is $f(x) = -2x + 1$.

    (c) The x-intercept is the zero of $f \Rightarrow \frac{1}{2}$.

62. (a) The graph passes through (0, –1) and (1,1) $\Rightarrow$ $m = \frac{1-(-1)}{1-0} = \frac{2}{1} = 2$. The y-intercept is $(0,-1)$ and the x-intercept is $\left(\frac{1}{2}, 0\right)$.

    (b) Using the slope and y-intercept, the formula is $f(x) = 2x - 1$.

    (c) The x-intercept is the zero of $f \Rightarrow \frac{1}{2}$.

63. (a) The graph passes through (0, 2) and (3,1) $\Rightarrow m = \dfrac{1-2}{3-0} = \dfrac{-1}{3} = -\dfrac{1}{3}$.. The y-intercept is $(0,2)$ and the x-intercept is $(6,0)$.

(b) Using the slope and y-intercept, the formula is $f(x) = -\dfrac{1}{3}x + 2$.

(c) The x-intercept is the zero of $f \Rightarrow 6$.

64. (a) The graph passes through (4, 0) and (0, –3) $\Rightarrow m = \dfrac{-3-0}{0-4} = \dfrac{-3}{-4} = \dfrac{3}{4}$. The y-intercept is $(0,-3)$ and the x-intercept is $(4,0)$.

(b) Using the slope and y-intercept, the formula is $f(x) = \dfrac{3}{4}x - 3$.

(c) The x-intercept is the zero of $f \Rightarrow 4$.

65. (a) The graph passes through (0, 300) and (2, –100) $\Rightarrow m = \dfrac{-100-300}{2-0} = \dfrac{-400}{2} = -200$.

The y-intercept is $(0,300)$ and the x-intercept is $\left(\dfrac{3}{2},0\right)$.

(b) Using the slope and y-intercept, the formula is $f(x) = -200x + 300$.

(c) The x-intercept is the zero of $f \Rightarrow \dfrac{3}{2}$.

66. (a) The graph passes through (5, 50) and (0, –50) $\Rightarrow m = \dfrac{-50-50}{0-5} = \dfrac{-100}{-5} = 20$.

The y-intercept is $(0,-50)$ and the x-intercept is $\left(\dfrac{5}{2},0\right)$.

(b) Using the slope and y-intercept the formula is $f(x) = 20x - 50$.

(c) The x-intercept is the zero of $f \Rightarrow \dfrac{5}{2}$.

67. Using (0, 2) and (1, 6), $m = \dfrac{6-2}{1-0} = \dfrac{4}{1} = 4$. From the table, the y-intercept is $(0,2)$. Using these two answers and slope-intercept form, the equation is $f(x) = 4x + 2$.

68. Using (0, –5) and (1,–2), $m = \dfrac{-2-(-5)}{1-0} = \dfrac{3}{1} = 3$. From the table, the y-intercept is $(0,-5)$. Using these two answers and slope-intercept form, the equation is $f(x) = 3x - 5$.

69. Using (0, –3.1) and (.2, –3.38), $m = \dfrac{-3.38-(-3.1)}{.2-0} = \dfrac{-.28}{.2} = -1.4$. From the table, the y-intercept is $(0,-3.1)$. Using these two answers and slope-intercept form, the equation is $f(x) = -1.4x - 3.1$.

70. Using (0, −4) and (50, −4), $m = \frac{-4-(-4)}{50-0} = \frac{0}{50} = 0$. From the table, the y-intercept is $(0,-4)$. Using these two answers and slope-intercept form, the equation is $f(x) = -4$.

71. The graph of a constant function with positive k is a horizontal graph above the x-axis. Graph A

72. The graph of a constant function with negative k is a horizontal graph below the x-axis. Graph C

73. The graph of an equation of the form $x = k$ with $k > 0$ is a vertical line right of the y-axis. Graph D

74. The graph of an equation of the form $x = -k$ with $k > 0$ is a vertical line left of the y-axis. Graph B

75. Using (−1, 3) with a rise of 3 and a run of 2, the graph also passes through (1, 6). See Figure 75.

76. Using (−2, 8) with a rise of −1 and a run of 1, the graph also passes through (−1, 7). See Figure 76

77. Using (3, −4) with a rise of −1 and a run of 3, the graph also passes through (6, −5). See Figure 77.

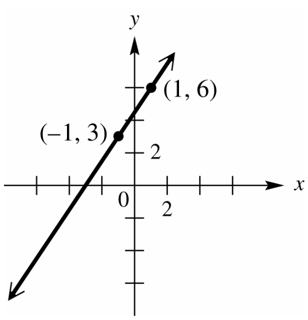


Figure 75

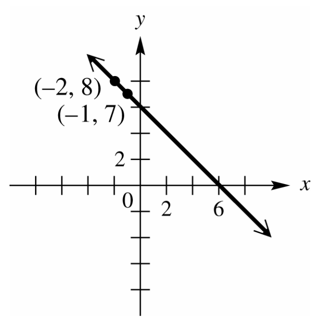


Figure 76

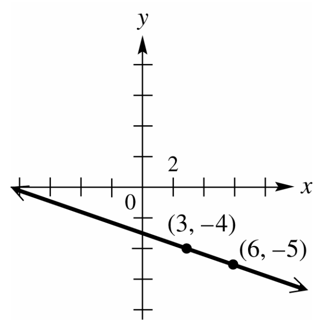


Figure 77

78. Using (−2, −3) with a rise of −3 and a run of 4, the graph also passes through (2, −6). See Figure 78.

79. Using (−1, 4) with slope of 0, the graph is a horizontal line which also passes through (2, 4). See Figure 79.

80. Using $\left(\frac{9}{4}, 2\right)$ with undefined slope, the graph is a vertical line which also passes through $\left(\frac{9}{4}, -2\right)$. See Figure 80.

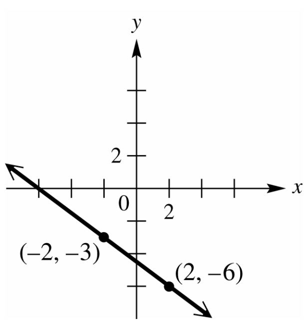


Figure 78

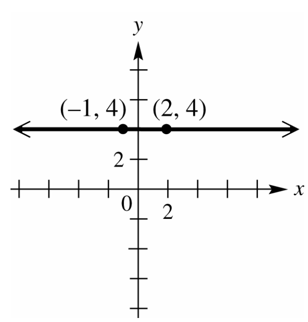


Figure 79

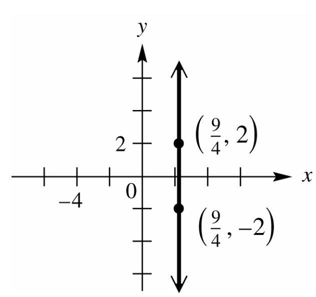


Figure 80

81. Using (0, −4) with a rise of 3 and a run of 4, the graph also passes through (4, −1). See Figure 81.

82. Using (0, 5) with a rise of −5 and a run of 2, the graph also passes through (2, 0). See Figure 82.

83. Using (−3, 0) with undefined slope, the graph is a vertical line which also passes through (−3, 2). See Figure 83.

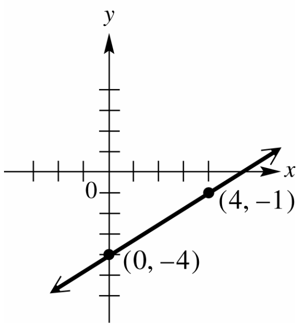


Figure 81

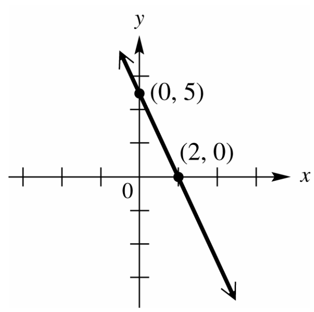


Figure 82

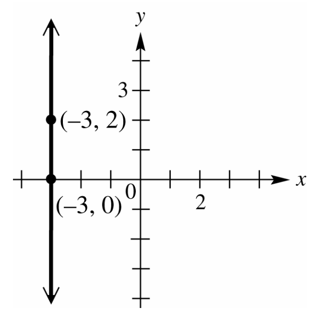


Figure 83

84. (a) Since $m = \frac{3}{4}$ and $b = -4$, the equation is $y = \frac{3}{4}x - 4$.

(b) Since $m = -2.5$ and $b = 5$, the equation is $y = -2.5x + 5$.

85. (a) Using the points (0, 2000) and (4, 4000), $m = \frac{4000-2000}{4-0} = \frac{2000}{4} = 500$. The y-intercept is $(0, 2000)$. The formula is $f(x) = 500x + 2000$.

(b) Water is entering the pool at a rate of 500 gallons per hour. The pool contains 2000 gallons initially.

(c) From the graph $f(7) = 5500$ gallons. By evaluating, $f(7) = 500(7) + 2000 = 5500$ gallons.

86. (a) Using the points (5, 115) and (10,230), $m = \frac{230-115}{10-5} = \frac{115}{5} = 23$. Using the slope-intercept form, $115 = 23(5) + b \Rightarrow 115 = 115 + b \Rightarrow b = 0$, Therefore $a = 23$ and $b = 0$.

(b) The car's gas mileage is 23 miles per gallon.

(c) Since $f(x) = ax + b$ models the data and $a = 23$, $b = 0$ the equation $f(x) = 23x$ can be used to find miles traveled. Therefore $f(20) = 23(20) \Rightarrow f(20) = 460$ miles traveled.

87. (a) The rain fell at a rate of $\frac{1}{4}$ inches per hour, so $m = \frac{1}{4}$. The initial amount of rain at noon was 3 inches, so $b = 3$. The equation $f(x) = \frac{1}{4}x + 3$.

(b) By 2:30 P.M. ($x = 2.5$), the total rainfall was $f(2.5) = \frac{1}{4}(2.5) + 3 = 3.625$ in.

88. (a) Since the rate of increase is 50,000 people per year, $m = 0.05$. Since there were 1.2 million cases in 2010, $b = 1.2$. Therefore the equation that models this is $f(x) = 0.05x + 1.2$

(b) $x = 2014 - 2010 = 4 \Rightarrow f(4) = 0.05(4) + 1.2 = 1.4$. Approximately, 1.4 million people lived with HIV/AIDS in 2014.

89. (a) $f(15) = \frac{15}{5} = 3$, The delay of a bolt of lightning 3 miles away is 15 seconds.

(b) See Figure 89.

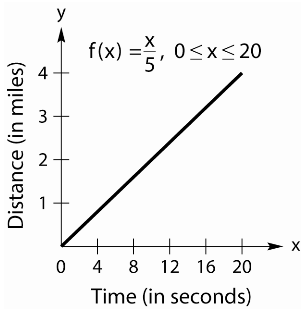


Figure 89

90. $f(3) = 80 - 5.8(3) = 62.6$, At an altitude of 3 miles, the temperature is about 62.6 degrees farenheit.

91. $f(x) = 0.075x,\ f(86) = 0.075(86) = 6.45$, The tax on \$86 is \$6.45.

92. (a) $f = \{(N, 21,484), (H, 31,286), (B, 57,181), (M, 70,181)\}$

    (b) $D = \{N, H, B, M\};\ R = \{21,484,\ 31,286,\ 57,181,\ 70,181\}$

    (c) According to this function an increase in the years of schooling corresponds to an increase in income.

93. The increase of \$192 per credit can be shown as the slope and the fixed fees of \$275 can be shown as the y-intercept. The function is $f(x) = 192x + 275$. $f(11) = 192(11) + 275 = \$2387$

94. Since there are 4 quarts in a gallon the function will be shown as $f(x) = 4x$. $f(19) = 4(19) = 76$ quarts

95. (a) Since the average rate of change has been 0.9 degrees per decade we will write the slope as 0.09 degrees per year. The function is $W(x) = 0.09x$.

    (b) $W(15) = 0.09(15) = 1.35$, In 15 years the Antarctic has warmed 1.35 degrees farenheit, on average.

96. $4.5 = 0.09x \Rightarrow x = 50$ years

1.4: Equations of Lines and Linear Models

1. Using Point-Slope Form yields $y - 3 = -2(x - 1) \Rightarrow y - 3 = -2x + 2 \Rightarrow y = -2x + 5.$

2. Using Point-Slope Form yields $y - 4 = -1(x - 2) \Rightarrow y - 4 = -x + 2 \Rightarrow y = -x + 6.$

3. Using Point-Slope Form yields $y - 4 = 1.5(x - (-5)) \Rightarrow y - 4 = 1.5x + 7.5 \Rightarrow y = 1.5x + 11.5.$

4. Using Point-Slope Form yields $y - 3 = .75(x - (-4)) \Rightarrow y - 3 = .75x + 3 \Rightarrow y = .75x + 6.$

5. Using Point-Slope Form yields $y - 1 = -.5(x - (-8)) \Rightarrow y - 1 = -.5x - 4 \Rightarrow y = -.5x - 3.$

6. Using Point-Slope Form yields $y - 9 = -.75(x - (-5)) \Rightarrow y - 9 = -.75x - 3.75 \Rightarrow y = -.75x + 5.25.$

7. Using Point-Slope Form yields $y - (-4) = 2\left(x - \frac{1}{2}\right) \Rightarrow y + 4 = 2x - 1 \Rightarrow y = 2x - 5.$

8. Using Point-Slope Form yields $y-\left(-\frac{1}{3}\right)=3(x-5) \Rightarrow y+\frac{1}{3}=3x-15 \Rightarrow y=3x-\frac{46}{3}$. 9. Using Point-Slope Form yields $y-\frac{2}{3}=\frac{1}{2}\left(x-\frac{1}{4}\right) \Rightarrow y-\frac{2}{3}=\frac{1}{2}x-\frac{1}{8} \Rightarrow y=\frac{1}{2}x+\frac{13}{24}$.

10. The slope of a line passing through (12, 6) and (12, −2) is $m=\frac{-2-6}{12-12}=\frac{-8}{0}$, which is undefined. You cannot write an equation in slope-intercept form with an undefined slope. The line is vertical and has the equation $x = 12$.

11. Use the points to (−4, −6) and (6, 2) find the slope: $m=\frac{2-(-6)}{6-(-4)} \Rightarrow m=\frac{4}{5}$. Now using Point-Slope Form yields $y-2=\frac{4}{5}(x-6) \Rightarrow y-2=\frac{4}{5}x-\frac{24}{5} \Rightarrow y=\frac{4}{5}x-\frac{14}{5}$.

12. Use the points (6, -2) and (-2, 2) to find the slope: $m=\frac{2-(-2)}{-2-6} \Rightarrow m=\frac{4}{-8} \Rightarrow m=-\frac{1}{2}$. Now using Point-Slope Form yields $y-2=-\frac{1}{2}(x-(-2)) \Rightarrow y-2=-\frac{1}{2}x-1 \Rightarrow y=-\frac{1}{2}x+1$.

13 Use the points (−12, 8) and (8, −12) to find the slope: $m=\frac{-12-8}{8-(-12)} \Rightarrow m=\frac{-20}{20} \Rightarrow m=-1$. Now using Point-Slope Form yields $y-8=-1(x+12) \Rightarrow y-8=-x-12 \Rightarrow y=-x-4$.

14. Use the points (12, 6) and (−6, −12) to find the slope: $m=\frac{-12-6}{-6-12} \Rightarrow m=\frac{-18}{-18} \Rightarrow m=1$. Now using Point-Slope Form yields $y-6=1(x-12) \Rightarrow y-6=x-12 \Rightarrow y=x-6$.

15. Use the points (4, 8) and (0, 4) to find the slope: $m=\frac{4-8}{0-4} \Rightarrow m=\frac{-4}{-4} \Rightarrow m=1$. Now using Slope-Intercept Form yields $b=4 \Rightarrow y=x+4$.

16. Use the points (3, 6) and (0, 10) to find the slope: $m=\frac{10-6}{0-3} \Rightarrow m=\frac{4}{-3} \Rightarrow m=-\frac{4}{3}$. Now using Point-Slope Form yields $y-6=-\frac{4}{3}(x-3) \Rightarrow y-6=-\frac{4}{3}x+4 \Rightarrow y=-\frac{4}{3}x+10$.

17. Use the points (3, −8) and (5, −3) to find the slope: $m=\frac{-3-(-8)}{5-3} \Rightarrow m=\frac{5}{2}$. Now using Point-Slope Form yields $y-(-8)=\frac{5}{2}(x-3) \Rightarrow y+8=\frac{5}{2}x-\frac{15}{2} \Rightarrow y=\frac{5}{2}x-\frac{31}{2}$.

18. Use the points (−5, 4) and (−3, 2) to find the slope: $m=\frac{2-4}{-3-(-5)} \Rightarrow m=\frac{-2}{2} \Rightarrow m=-1$. Now using Point-Slope Form yields $y-4=-1(x-(-5)) \Rightarrow y-4=-x-5 \Rightarrow y=-x-1$.

19. Use the points (2, 3.5) and (6, −2.5) to find the slope: $m=\frac{-2.5-3.5}{6-2}\Rightarrow m=\frac{-6}{4}\Rightarrow m=-1.5.$ Now using Point-Slope Form yields $y-3.5=-1.5(x-2)\Rightarrow y-3.5=-1.5x+3\Rightarrow y=-1.5x+6.5.$

20. Use the points (−1, 6.25) and (2, –4.25) to find the slope: $m=\frac{6.25-(-4.25)}{-1-2}\Rightarrow m=\frac{10.5}{-3}\Rightarrow m=-3.5.$ Now using Point-Slope Form yields $y-6.25=-3.5(x+1)\Rightarrow y-6.25=-3.5x-3.5\Rightarrow y=-3.5x+2.75$.

21. Use the points (0, 5) and (10, 0) to find the slope: $m=\frac{0-5}{10-0}\Rightarrow m=\frac{-5}{10}\Rightarrow m=-\frac{1}{2}$. Now using Point-Slope Form yields $y-5=-\frac{1}{2}(x-0)\Rightarrow y-5=-\frac{1}{2}x\Rightarrow y-\frac{1}{2}x+5.$

22. Use the points (0, −8) and (4, 0) to find the slope: $m=\frac{-8-0}{0-4}\Rightarrow m=\frac{-8}{-4}\Rightarrow m=2$. Now using Slope-Intercept Form yields $b=-8\Rightarrow y=2x-8.$

23. Use the points (−5, −28) and (−4, −20) to find the slope: $m=\frac{-20-(-28)}{-4-(-5)}\Rightarrow m=\frac{8}{1}\Rightarrow m=8.$ Now using Point-Slope Form yields $y-(-20)=8(x-(-4))\Rightarrow y+20=8x+32\Rightarrow y=8x+12.$

24. Use the points (−2.4, 5.2) and (1.3, −24.4) to find the slope: $m=\frac{-24.4-5.2}{1.3-(-2.4)}\Rightarrow m=\frac{-29.6}{3.7}\Rightarrow m=-8.$ Now using Point-Slope Form yields $y-5.2=-8(x-(-2.4))\Rightarrow y-5.2=-8x-19.2\Rightarrow y=-8x-14.$

25. Use the points (2, - 5) and (4, − 11) to find the slope: $m=\frac{-11-(-5)}{4-2}\Rightarrow m=\frac{-6}{2}\Rightarrow m=-3.$ Now using Point-Slope Form yields $y-(-5)=-3(x-2)\Rightarrow y+5=-3x+6\Rightarrow y=-3x+1.$

26. Use the points (−1.1, 1.5) and (-0.8, 3) to find the slope: $m=\frac{3-1.5}{-0.8-(-1.1)}\Rightarrow m=\frac{1.5}{0.3}\Rightarrow m=5.$ Now using Point-Slope Form yields $y-1.5=5(x-(-1.1))\Rightarrow y-1.5=5x+5.5\Rightarrow y=5x+7.$

27. To find the *x*-intercept set $y=0,$ then $x-0=4\Rightarrow x=4.$ Therefore (4, 0) is the *x*-intercept. To find the *y*-intercept set $x=0,$ then $0-y=4\Rightarrow y=-4.$ Therefore (0, −4) is the *y*-intercept. See Figure 27.

28. To find the *x*-intercept set $y=0$, then $x+0=4\Rightarrow x=4$. Therefore (4, 0) is the *x*-intercept. To find the *y*-intercept set $x=0$, then $0+y=4\Rightarrow y=4$. Therefore $(0,4)$ is the *y*-intercept. See Figure 28.

29. To find the *x*-intercept set $y=0,$ then $3x-0=6\Rightarrow 3x=6\Rightarrow x=2.$ Therefore (2, 0) is the *x*-intercept. To find the *y*-intercept set $x=0,$ then $3(0)-y=6\Rightarrow y=-6.$ Therefore (0, −6) is the *y*-intercept. See Figure 29.

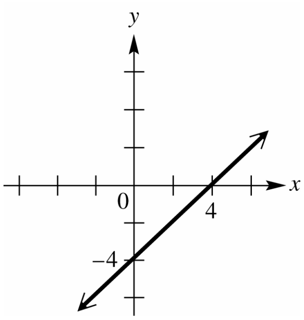


Figure 27

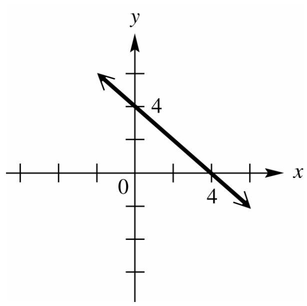


Figure 28

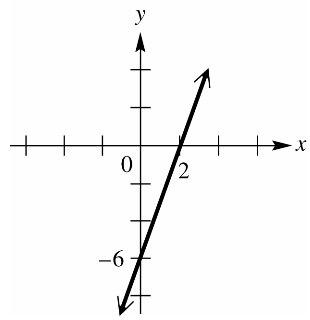


Figure 29

30. To find the x-intercept: set $y = 0$, then $2x - 3(0) = 6 \Rightarrow 2x = 6 \Rightarrow x = 3$. Therefore $(3,0)$ is the x-intercept To find the y-intercept: set $x = 0$, then $2(0) - 3y = 6 \Rightarrow -3y = 6 \Rightarrow y = -2$. Therefore $(0,-2)$ is the y-intercept. See Figure 30.

31. To find the x-intercept: set $y = 0$, then $2x + 5(0) = 10 \Rightarrow 2x = 10 \Rightarrow x = 5$. Therefore $(5,0)$ is the x-intercept. To- find the y-intercept: set $x = 0$, then $2(0) + 5y = 10 \Rightarrow 5y = 10 \Rightarrow y = 2$. Therefore $(0,2)$ is the y-intercept. See Figure 31.

32. To find the x-intercept: set $y = 0$, then $4x - 3(0) = 9 \Rightarrow 4x = 9 \Rightarrow x = \frac{9}{4}$. Therefore $\left(\frac{9}{4},0\right)$ is the x-intercept. To find the y-intercept: set $x = 0$, then $4(0) - 3y = 9 \Rightarrow -3y = 9 \Rightarrow y = -3$. Therefore $(0,-3)$ is the y-intercept. See Figure 32.

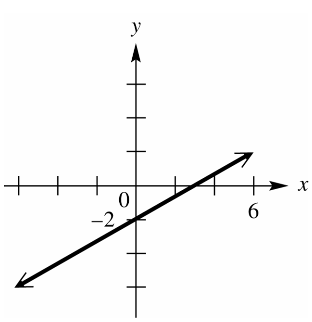


Figure 30

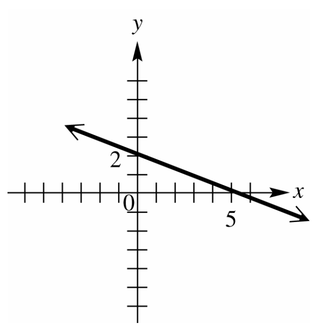


Figure 31

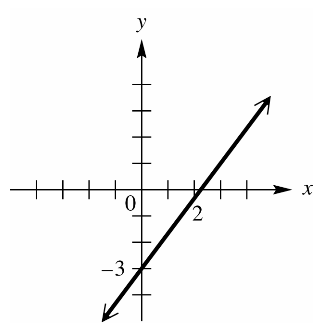


Figure 32

33. To find a second point set $x = 1$, then $y = 3(1) \Rightarrow y = 3$. A second point is $(1,3)$. See Figure 33.

34. To find a second point set $x = 1$, then $y = -2(1) \Rightarrow y = -2$. A second point is $(1,-2)$. See Figure 34.

35. To find a second point set $x = 4$, then $y = -.75(4) \Rightarrow y = -3$. A second point is $(4,-3)$. See Figure 35.

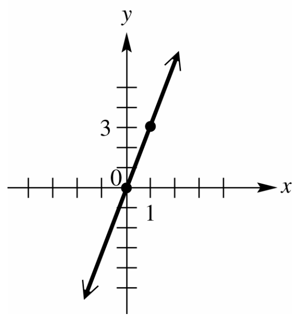


Figure 33

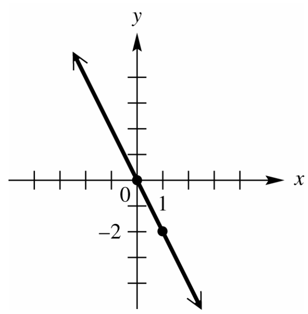


Figure 34

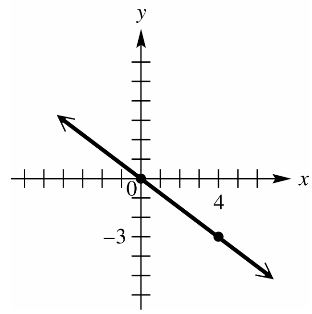


Figure 35

36 To find a second point set $x = 2$, then $y = 1.5(2) \Rightarrow y = 3$. A second point is $(2,3)$. See Figure 36.

37. $5x + 3y = 15 \Rightarrow 3y = -5x + 15 \Rightarrow y = -\frac{5}{3}x + 5$. See Figure 37.

38. $6x + 5y = 9 \Rightarrow 5y = -6x + 9 \Rightarrow y = -\frac{6}{5}x + \frac{9}{5}$. See Figure 38.

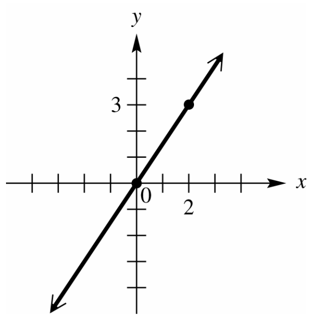


Figure 36

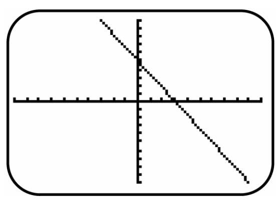


Figure 37

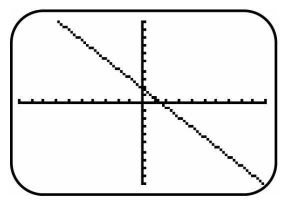


Figure 38

39. $-2x + 7y = 4 \Rightarrow 7y = 2x + 4 \Rightarrow y = \frac{2}{7}x + \frac{4}{7}$. See Figure 39.

40. $-.23x - .46y = .82 \Rightarrow -23x - 46y = 82 \Rightarrow -46y = 23x + 82 \Rightarrow y = -\frac{23}{46}x + \frac{82}{46} \Rightarrow y = -\frac{82}{46} \Rightarrow y = -\frac{1}{2}x - \frac{41}{23}$.

See Figure 40.

41. $1.2x + 1.6y = 5.0 \Rightarrow 12x + 16y = 50 \Rightarrow 16y = -12x + 50 \Rightarrow y = -\frac{12}{16}x + \frac{50}{16} \Rightarrow y = -\frac{3}{4}x + \frac{25}{8}$. See Figure 41.

42. $2y - 5x = 0 \Rightarrow 2y = 5x + 0 \Rightarrow y = \frac{5}{2}x$. See Figure 42.

[-5,5] by [-5,5]
Xscl = 1 Yscl = 1

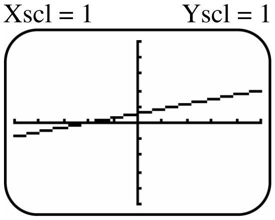


Figure 39

[-5,5] by [-5,5]
Xscl = 1 Yscl = 1

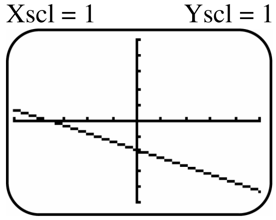


Figure 40

[-6,6] by [-4,4]
Xscl= 1 Yscl = 1

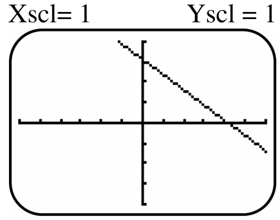


Figure 41

[-10,10] by [-10,10]
Xscl = 1 Yscl= 1

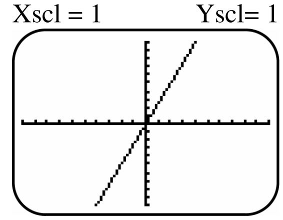


Figure 42

43. Put into slope-intercept form to find slope: $x+3y=5 \Rightarrow 3y=-x+5 \Rightarrow y=-\frac{1}{3}x+\frac{5}{3} \Rightarrow m=-\frac{1}{3}.$

Since parallel lines have equal slopes, use $m=-\frac{1}{3}$ and $(-1, 4)$ in point-slope form to find the equation:

$y-4=-\frac{1}{3}(x-(-1)) \Rightarrow y-4=-\frac{1}{3}x-\frac{1}{3} \Rightarrow y=-\frac{1}{3}x+\frac{11}{3}.$

44. Put into slope-intercept form to find slope: $2x-y=5 \Rightarrow -y=-2x+5 \Rightarrow y=2x-5 \Rightarrow m=2.$ Since parallel lines have equal slopes, use $m = 2$ and $(3, -2)$ in point-slope form to find the equation:

$y-(-2)=2(x-3) \Rightarrow y+2=2x-6 \Rightarrow y=2x-8.$

45. Put into slope-intercept form to find slope: $3x+5y=1 \Rightarrow 5y=-3x+1 \Rightarrow y=-\frac{3}{5}x+\frac{1}{5} \Rightarrow m=-\frac{3}{5}.$ Since perpendicular lines have negative reciprocal slopes, use $m=\frac{5}{3}$ and $(1, 6)$ in point-slope form to find the equation: $y-6=\frac{5}{3}(x-1) \Rightarrow y-6=\frac{5}{3}x-\frac{5}{3} \Rightarrow y=\frac{5}{3}x+\frac{13}{3}.$

46. Put into slope-intercept form to find slope: $8x-3y=7 \Rightarrow -3y=-8x+7 \Rightarrow y=\frac{8}{3}x-\frac{7}{3} \Rightarrow m=\frac{8}{3}.$ Since perpendicular lines have negative reciprocal slopes, use $m=-\frac{3}{8}$ and $(-2, 0)$ in point-slope form to find the equation: $y-0=-\frac{3}{8}(x-(-2)) \Rightarrow y=-\frac{3}{8}x-\frac{3}{4}.$

47. The equation $y = -2$ has a slope $m = 0$. A line perpendicular to this would have an undefined slope which would have an equation in the form $x = a$. An equation in the form $x = a$ through $(-5, 7)$ is $x = -5$.

48. The equation $x = 4$ has an undefined slope. A line perpendicular to this would have a slope $m = 0$, which would have an equation in the form $y = b$. An equation in the form $y = b$ through $(1, -4)$ is $y = -4$.

49. The equation $y = -.2x + 6$ has a slope $m = -0.2$. Since parallel lines have equal slopes, use $m = -2$ and $(-5, 8)$ in point-slope form to find the equation

$y-8=-0.2(x-(-5)) \Rightarrow y-8=-0.2x-1 \Rightarrow y=-0.2x+7.$

50. Put into slope-intercept form to find slope $x+y=5 \Rightarrow y=-x+5 \Rightarrow m=-1.$ Since parallel lines have equal slopes, use $m = -1$ and $(-4, -7)$ in point-slope form to find the equation

$y-(-7)=-1(x-(-4)) \Rightarrow y+7=-x-4 \Rightarrow y=-x-11.$

51. Put into slope-intercept form to find slope: $2x+y=6 \Rightarrow y=-2x+6 \Rightarrow m=-2.$ Since perpendicular lines have negative reciprocal slopes, use $m=\frac{1}{2}$ and the origin $(0, 0)$ in point-slope form to find the equation

$y-0=\frac{1}{2}(x-0) \Rightarrow y=\frac{1}{2}x.$

52. The equation $y = -3.5x + 7.4$ has a slope $m = -3.5$. Since parallel lines have equal slopes, use $m = -3.5$ and the origin (0, 0) in point-slope form to find the equation $y - 0 = -3.5(x - 0) \Rightarrow y = -3.5x$.

53. The equation $x = 3$ has an undefined slope. A line perpendicular to this would have a slope $m = 0$, which would have an equation in the form $y = b$. An equation in the form $y = b$ through (1, 2) is $y = 2$.

54. The equation y = -1 has a slope equal to zero. A line perpendicular to this would have an undefined slope, which would have an equation in the form $x = c$. An equation in the form $x = c$ through (- 4,5) is x= -4.

55. We will first find the slope of the line through the given points: $m = \dfrac{\frac{2}{3} - \frac{1}{2}}{-3 - (-5)} = \dfrac{\frac{1}{6}}{2} \Rightarrow m = \dfrac{1}{12}$. Since perpendicular lines have negative reciprocal slopes, use $m = -12$ and the point (-2,4) in point-slope form to find the equation $y - 4 = -12(x - (-2)) \Rightarrow y = -12x - 20$.

56. We will first find the slope of the line through the given points: $m = \dfrac{-5 - 0}{-3 - (-4)} = \dfrac{-5}{1} \Rightarrow m = -5$. Since perpendicular lines have negative reciprocal slopes, use $m = \dfrac{1}{5}$ and the point $\left(\dfrac{3}{4}, \dfrac{1}{4}\right)$ in point-slope form to find the equation $y - \dfrac{1}{4} = \dfrac{1}{5}\left(x - \dfrac{3}{4}\right) \Rightarrow y = \dfrac{1}{5}x + \dfrac{1}{10}$.

57. The slope of the perpendicular bisector will have a negative reciprocal slope and will pass through the midpoint of the line segment joined by the two points. We will first find the slope of the line through the given points: $m = \dfrac{10 - 2}{2 - (-4)} = \dfrac{8}{6} \Rightarrow m = \dfrac{4}{3}$. The midpoint of the line segment is $\left(\dfrac{-4 + 2}{2}, \dfrac{2 + 10}{2}\right) = (-1, 6)$. Use $m = -\dfrac{3}{4}$ and the point (-1,6) in point-slope form to find the equation $y - 6 = -\dfrac{3}{4}(x - (-1)) \Rightarrow y = -\dfrac{3}{4}x + \dfrac{21}{4}$.

58. The slope of the perpendicular bisector will have a negative reciprocal slope and will pass through the midpoint of the line segment joined by the two points. We will first find the slope of the line through the given points: $m = \dfrac{9 - 5}{4 - (-3)} = \dfrac{4}{7} \Rightarrow m = \dfrac{4}{7}$. The midpoint of the line segment is $\left(\dfrac{-3 + 4}{2}, \dfrac{5 + 9}{2}\right) = \left(\dfrac{1}{2}, 7\right)$. Use $m = -\dfrac{7}{4}$ and the point $\left(\dfrac{1}{2}, 7\right)$ in point-slope form to find the equation $y - 7 = -\dfrac{7}{4}\left(x - \dfrac{1}{2}\right) \Rightarrow y = -\dfrac{7}{4}x + \dfrac{63}{8}$.

59. (a) The Pythagorean Theorem and its converse.

(b) Using the distance formula from (0, 0) to (x_1, m_1x_1) yields: $d(0, P) = \sqrt{(x_1)^2 + (m_1x_1)^2}$.

(c) Using the distance formula from (0, 0) to (x_2, m_2x_2) yields: $d(0, Q) = \sqrt{(x_2)^2 + (m_2x_2)^2}$.

(d) Using the distance formula from (x_1, m_1x_1) to (x_2, m_2x_2) yields:

$d(P,Q) = \sqrt{(x_2 - x_1)^2 + (m_2x_2 - m_1x_1)^2}$.

(e) Using Pythagorean Theorem yields: $[d(0,P)]^2 + [d(0,Q)]^2 = [d(P,Q)]^2 \Rightarrow$

$(x_1)^2 + (m_1x_1)^2 + (x_2)^2 + (m_2x_2)^2 = (x_1 - x_2)^2 + (m_1x_1 - m_2x_2)^2 \Rightarrow (x_1)^2 + (m_1x_1)^2 + (x_2)^2 + (m_2x_2)^2 =$

$(x_1)^2 - 2x_1x_2 + (x_2)^2 + (m_1x_1)^2 - 2m_1m_2x_1x_2 + (m_2x_2)^2 \Rightarrow 0 = -2m_1m_2x_1x_2 - 2x_1x_2$.

(f) $0 = -2x_1x_2 - 2m_1m_2x_1x_2 \Rightarrow 0 = -2x_1x_2(1 + m_1m_2)$

(g) By the zero-product property, for $-2x_1x_2(1 + m_1m_2) = 0$ either $-2x_1x_2 = 0$ or $1 + m_1m_2 = 0$.

Since $x_1 \neq 0$ and $x_2 \neq 0$, $-2x_1x_2 \neq 0$, and it follows that $1 + m_1m_2 = 0 \Rightarrow m_1m_2 = -1$.

(h) The product of the slopes of two perpendicular lines, neither of which is parallel to an axis, is -1.

60. (a) To find the slope of Y_1 use (0, −3) and (1, 1): $m = \frac{-3-1}{0-1} = \frac{-4}{-1} = 4$. To find the slope of Y_2 use (0, 4) and (4,3): $m = \frac{4-3}{0-4} = \frac{1}{-4} = -\frac{1}{4}$. Since $4\left(-\frac{1}{4}\right) = -1$ the lines are perpendicular.

(b) To find the slope of Y_1 use (0, −3) and (1, 2): $m = \frac{-3-2}{0-1} = \frac{-5}{-1} = 5$. To find the slope of Y_2 use (0,5) and (5,6): $m = \frac{6-5}{5-0} = \frac{1}{5}$. Since $5\left(\frac{1}{5}\right) = 1$, not −1, and they are not equal, the lines are neither perpendicular nor parallel.

(c) To find the slope of Y_1 use $(0,-3)$ and $(1,2)$: $m = \frac{-3-2}{0-1} = \frac{-5}{-1} = 5$. To find the slope of Y_2 use $(0,12)$ and $(1,17)$: $m = \frac{17-12}{1-0} = \frac{5}{1} = 5$. Since 5 = 5 the lines are parallel.

(d) To find the slope of Y_1 use $(0,2)$ and (1,-2): $m = \frac{-2-2}{1-0} = \frac{-4}{1} = -4$. To find the slope of Y_2 use $(0,-2)$ and (1,2): $m = \frac{2-(-2)}{1-0} = \frac{4}{1} = 4$. Since $4 \neq -4$ and $4(-4) \neq -1$ the lines are neither parallel nor perpendicular.

61. (a) Use the given points to find slope, then $m = \frac{161-128}{4-1} = \frac{33}{3} \Rightarrow m = 11$. Now use point-slope form to find the equation: $y - 128 = 11(x-1) \Rightarrow y - 128 = 11x - 11 \Rightarrow y = 11x + 117$.

(b) From the slope the biker is traveling 11 mph.

(c) At $x = 0$, $y = 11(0) + 117 \Rightarrow y = 117$, therefore 117 miles from the highway.

(d) Since at 1 hour and 15 minutes $x = 1.25$, then $y = 11(1.25) + 117 \Rightarrow y = 130.75$, so 130.75 miles away.

62. (a) Since the graph is falling as time increases, water is leaving the tank. 70 gallons after 3 minutes.

(b) The *x*-intercept: $(0,10)$ and the *y*-intercept: $(100,0)$. The tank initially held 100 gallons and is empty after 10 minutes.

(c) Find the slope: $m=\frac{0-100}{10-0}=\frac{-100}{10}=-10$, since b = 100, the equation is $y=-10x=100$.

The slope of $m=-10$ shows the rate at which the water is being drained from the tank is 10 gal/min.

(d) At $y = 50$, $x=5\Rightarrow(5,50)$. The *x*-coordinate is: 5.

63. (a) Use the points (2007, 18), (2010, 24) to find slope, then $m=\frac{24-18}{2010-2007}=\frac{6}{3}\Rightarrow m=2$. Now use point-slope form to find the equation: $y-18=2(x-2007)\Rightarrow y-18=2x-4014\Rightarrow y=2x-3996$.

(b) y = 2(2013) – 3996 =30. There was approximately $30 billion in betting revenue in 2013.

64. (a) First find the slope: $m=\frac{8.27-7.66}{2009-1990}=\frac{0.61}{19}\approx 0.03211$, now use point-slope form to find the equation.

$y-7.66=0.03211(x-1990)\Rightarrow y=0.03211(x-1990)+7.66$

(b) The hourly wage increased at a rate of approximately $0.03 per year between 1990 and 2009.

(c) At $x = 2005$, $y=0.03211(2005-1990)+7.66\Rightarrow y=0.03211(15)+7.66\Rightarrow y\approx 8.14$, which does compare favorably to the actual value of $8.18.

65. (a) Since the plotted points form a line, it is a linear relation. See Figure 65.

(b) Using the first two points find the slope: $m=\frac{0-(-40)}{32-(-40)}=\frac{40}{72}=\frac{5}{9}$, now use slope-intercept form to find the function: $C(x)-0=\frac{5}{9}(x-32)\Rightarrow C(x)=\frac{5}{9}(x-32)$. The slope of $\frac{5}{9}$ means that the Celsius temperature changes 5° for every 9° change in Fahrenheit temperature.

(c) $C(83)=\frac{5}{9}(83-32)=28\frac{1}{3}°C$

66. (a) The slope is $\frac{11.8-14.0}{2003-2009}=\frac{-2.2}{-6}=\frac{11}{30}$:. Using point-slope form produces the equation:

$y-11.8=\frac{11}{30}(x-2003)$.

(b) At $x = 2013$, $y-11.8=\frac{11}{30}(2013-2003)\Rightarrow y-11.8=\frac{11}{30}(10)\Rightarrow y\approx 15.5$ million

67. (a) The slope is $\frac{37-6}{2011-2005}=\frac{31}{6}$:. Using point-slope form produces the equation:

$y-6=\frac{31}{6}(x-2005)$.

(b) Every year from 2005 to 2011, Google advertising revenue increased by about $5.2 billion on average.

(c) 2007 Revenue: $y-6=\frac{31}{6}(2007-2005) \Rightarrow y=\frac{31}{6}(2)+6 \Rightarrow y \approx 16.3$ billion

2009 Revenue: $y-6=\frac{31}{6}(2009-2005) \Rightarrow y=\frac{31}{6}(4)+6 \Rightarrow y \approx 26.67$ billion

The 2007 value compares favorably and the 2009 value is too high.

68. (a) The slope is $\frac{48-22}{2006-2010}=\frac{26}{-4}=-6.5$:. Using point-slope form produces the equation:

$y-48=-6.5(x-2006)$.

(b) The slope is $\frac{35-10}{2008-2012}=\frac{25}{-4}=-6.25$:. Using point-slope form produces the equation:

$y-35=-6.25(x-2008)$.

(c) Every year from 2006 to 2012, newspaper ad revenue decreased by \$6.25 billion on average.

(d) Model (a): $y-48=-6.5(2009-2006) \Rightarrow y=-6.5(3)+48=\$28.5$ billion

Model (b): $y-35=-6.25(2009-2008) \Rightarrow y=-6.25(1)+35=\$28.75$ billion

69. (a) Enter the years in L_1 and enter tuition and fees in L_2. The regression equation is: $y \approx 586.89x-1{,}147{,}738$.

(b) See Figure 69.

(c) At $x=2005, y \approx 586.89(2005)-1{,}147{,}738 \Rightarrow \$28{,}976$ this is close to the actual value of \$29,307.

70. (a) Enter the years in L_1 and enter tuition and fees in L_2. The regression equation is: $y \approx 236.6897x-463{,}127$

(b) See Figure 70.

(c) At $x=2007, y \approx 236.6897(2007)-463{,}127 \Rightarrow y \approx \$11{,}909$.

(d) At $x=2016, y \approx 236.6897(2016)-463{,}127 \Rightarrow y \approx \$14{,}039$.

[-50,250] by [-50,110]
Xscl = 50 Yscl = 50

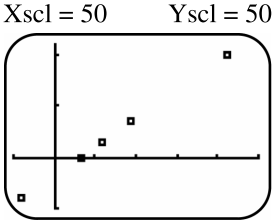


Figure 65

[1975,2015] by [13000,32000]
Xscl = 10 Yscl = 10

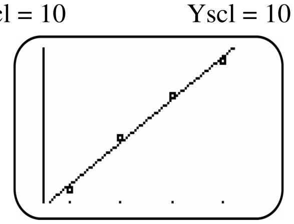


Figure 69

[1960,2015] by [5500,13500]
Xscl= 10 Yscl = 10

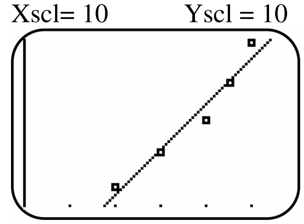


Figure 70

71. (a) Enter the distance in L_1 and enter velocity in L_2. The regression equation is: $y \approx 0.06791x-16.32$.

(b) At $y=37{,}000$, $y \approx 0.06791(37{,}000)-16.32 \approx 2500$ or approximately 2500 light-years.

72. (a) Enter the velocity in L_1 and enter distance in L_2. The regression equation is: $y \approx 62.65x-125{,}820$.

(b) Every year from 2009 to 2015, household spending on Apple products has increased by \$62.65 on average.

(c) $y \approx 62.65(2014) - 125{,}820 = \$357$, This result is slightly high.

73. Enter the Gestation Period in L_1 and enter Life Span in L_2. The regression equation is: $y \approx .101x + 11.6$ and the correlation coefficient is: $r \approx .909$. There is a strong positive correlation, because .909 is close to 1.

74. Enter the Population in L_1 and enter Area in L_2. The regression equation is: $y \approx 91.44x - 355.7$ and the correlation coefficient is: $r \approx 0.3765$. There is a positive correlation.

Reviewing Basic Concepts (Sections 1.3 and 1.4)

1. Since $m = 1.4$ and $b = -3.1$, slope-intercept form gives the function: $f(x) = 1.4x - 3.1$.

   $f(1.3) = 1.4(1.3) - 3.1 \Rightarrow f(1.3) = -1.28$

2. See Figure 2. x-intercept: $\frac{1}{2}$, y-intercept: 1, slope: -2, domain: $(-\infty, \infty)$, range: $(-\infty, \infty)$

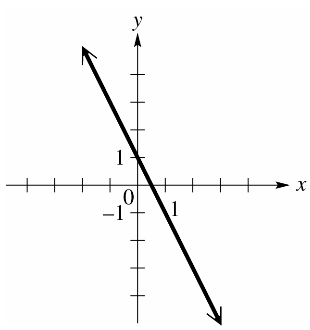


Figure 2

3. $m = \dfrac{6-4}{5-(-2)} = \dfrac{2}{7}$

4. Vertical line graphs are in the form $x = a$; through point $(-2, 10)$ would be $x = -2$.

   Horizontal line graphs are in the form $y = b$; through point $(-2, 10)$ would be $y = 10$.

5. See Figures 5a and 5b.

[-10,10] by [-10,10]
Xscl = 1 Yscl = 1

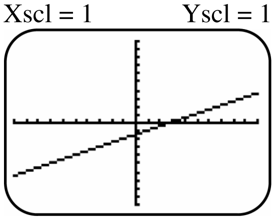


Figure 5a

[-10,10] by [-10,10]
Xscl = 1 Yscl = 1

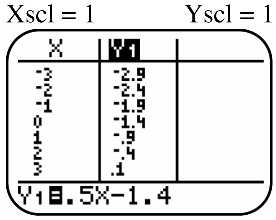


Figure 5b

[1940,2020] by [2,4]
Xscl= 10 Yscl = .5

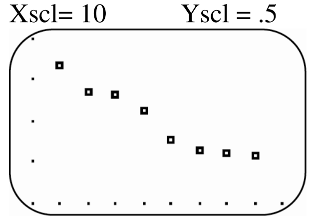


Figure 9

6. The line of the graph rises 2 units for each 1 unit to the right, therefore the slope is: $m = \frac{2}{1} = 2.$

   The y-intercept is: $b = -3$. The slope-intercept form of the equation is: $y = 2x - 3.$

7. The slope is: $m = \frac{4-2}{(-2)-5} = \frac{2}{-7} = -\frac{2}{7}$; now using point-slope form the equation is:

   $y - 4 = -\frac{2}{7}(x+2) \Rightarrow y - 4 = -\frac{2}{7}x - \frac{4}{7} \Rightarrow y = -\frac{2}{7}x + \frac{24}{7}.$

8. Find the given equation in slope-intercept form: $3x - 2y = 5 \Rightarrow -2y = -3x + 5 \Rightarrow y = \frac{3}{2}x - \frac{5}{2}.$

   The slope of this equation is $m = \frac{3}{2}$, therefore the slope of a perpendicular line will be the negative

   reciprocal: $m = -\frac{2}{3}$. Using point-slope form yields the equation:

   $y - 3 = -\frac{2}{3}(x+1) \Rightarrow y - 3 = -\frac{2}{3}x - \frac{2}{3} \Rightarrow y = -\frac{2}{3}x + \frac{7}{3}.$

9. (a) See Figure 9.

   (b) As x increases, y decreases, therefore a negative correlation coefficient.

   (c) Enter the years in L_1 and enter people per household in L_2. The regression equation is:
   $y \approx -0.0165x + 35.6$ and the correlation coefficient is: $r = -0.9648$

   (d) The regression equation is: $y \approx -0.0165(1975) + 35.6 \Rightarrow y \approx 3.01$, which is close to the actual value 2.94.

1.5: Linear Equations and Inequalities

1. $-3x - 12 = 0 \Rightarrow -3x = 12 \Rightarrow x = -4$
2. $5x - 30 = 0 \Rightarrow 5x = 30 \Rightarrow x = 6$
3. $5x = 0 \Rightarrow x = 0$
4. $-2x = 0 \Rightarrow x = 0$
5. $2(3x-5) + 8(4x+7) = 0 \Rightarrow 6x - 10 + 32x + 56 = 0 \Rightarrow 38x = -46 \Rightarrow x = -\frac{46}{38} \Rightarrow x = -\frac{23}{19}$
6. $-4(2x-3) + 8(2x+1) = 0 \Rightarrow -8x + 12 + 16x + 8 = 0 \Rightarrow 8x = -20 \Rightarrow x = -\frac{20}{8} \Rightarrow x = -\frac{5}{2}$
7. $3x + 6(x-4) = 0 \Rightarrow 3x + 6x - 24 = 0 \Rightarrow 9x = 24 \Rightarrow x = \frac{24}{9} \Rightarrow x = \frac{8}{3}$
8. $-8x + 0.5(2x+8) = 0 \Rightarrow -8x + x + 4 = 0 \Rightarrow -7x = -4 \Rightarrow x = \frac{-4}{-7} \Rightarrow x = \frac{4}{7}$
9. $1.5x + 2(x-3) + 5.5(x+9) = 0 \Rightarrow 1.5x + 2x - 6 + 5.5x + 49.5 = 0 \Rightarrow 9x = -43.5 \Rightarrow$

$x=\frac{-43.5}{9} \Rightarrow x=-\frac{29}{6}$

10. Since c is a zero, c is the value of x when $y=0$, therefore the coordinate at the point the line intersects the x-axis is: $(c,0)$.

11. The solution to $y_1=y_2$ is the intersection of the lines or $x=\{10\}$.

12. The solution to $y_1=y_2$ is the intersection of the lines or $x=\{-2\}$.

13. The solution to $y_1=y_2$ is the intersection of the lines or $x=\{1\}$.

14. When $y_1=y_2, y=0$. $y=0$ when the graph crosses the x-axis or at the zero $x=\{-.8\}$.

15. When $y_1=y_2,\ y=0$. $y=0$ when the graph crosses the x-axis or at the zero $x=\{3\}$.

16. When $y_1=y_2,\ y=0$. $y=0$ when the graph crosses the x-axis or at the zero $x=\{2\}$.

17. When $x=10$ is substituted into each function the result is 20.

18. Using the x-intercept method means using $y_1=y_2$, which would yield:

$y_1=2x+3-(4x-12) \Rightarrow y_1=2x+3-4x+12$, which is not the same as graphing: $y_1=2x+3-4x-12$.

19. There is no real solution if y_1-y_2 yields a contradiction, $y=b$, where $b\neq 0$. This equation is called a contradiction and the solution set is: $\varnothing$.

20. The solution set is: $x=(-\infty,\infty)$ if y_1-y_2 is the line $y=0$. This equation is called an identity.

21. $2x-5=x+7 \Rightarrow x-5=7 \Rightarrow x=12$ **Check:** $2(12)-5=12+7 \Rightarrow 19=19$ The graphs of the left and right sides of the equation intersect when $x=12$. The solution set is $\{12\}$.

22. $9x-17=2x+4 \Rightarrow 7x-17=4 \Rightarrow 7x=21 \Rightarrow x=3$

Check: $9(3)-17=2(3)+4 \Rightarrow 27-17=6+4 \Rightarrow 10=10$ The graphs of the left and right sides of the equation intersect when $x=3$. The solution set is $\{3\}$.

23. $0.01x+3.1=2.03x-2.96 \Rightarrow 3.1=2.02x-2.96 \Rightarrow 6.06=2.02x \Rightarrow x=3$

Check: $0.01(3)+3.1=2.03(3)-2.96 \Rightarrow .03+3.1=6.09-2.96 \Rightarrow 3.13=3.13$

The graphs of the left and right sides of the equation intersect when $x=3$. The solution set is $\{3\}$.

24. $0.04x+2.1=0.02x+1.92 \Rightarrow 0.02x+2.1=1.92 \Rightarrow 0.02x=-0.18 \Rightarrow x=-9$

Check: $0.04(-9)+2.1=0.02(-9)+1.92 \Rightarrow 0.36+2.1=-0.18+1.92 \Rightarrow 1.74=1.74$

The graphs of the left and right sides of the equation intersect when $x=-9$. The solution set is $\{-9\}$.

25. $-(x+5)-(2+5x)+8x=3x-5 \Rightarrow -x-5-2-5x+8x=3x-5 \Rightarrow 2x-7=3x-5 \Rightarrow -2=x$

Check: $-(-2+5)-(2+5(-2))+8(-2)=3(-2)-5 \Rightarrow -2-5-2+10-16=-6-5 \Rightarrow -11=-11$. The graphs of the left and right sides of the equation intersect when $x=-2$. The solution set is $\{-2\}$.

26. $-(8+3x)+5=2x+3 \Rightarrow -8-3x+5=2x+3 \Rightarrow -3=5x+3 \Rightarrow -6=5x \Rightarrow x=-\frac{6}{5}$

Check: $-\left(8+3\left(\frac{6}{5}\right)\right)+5=2\left(\frac{6}{5}\right)+3 \Rightarrow -8-\frac{18}{5}+5=-\frac{12}{5}+3 \Rightarrow \frac{18}{5}=\frac{12}{5}+6 \Rightarrow 6=6$

The graphs of the left and right sides of the equation intersect when $x=-\frac{6}{5}$. The solution set is $\left\{-\frac{6}{5}\right\}$.

27. $\frac{2x+1}{3}+\frac{x-1}{4}=\frac{13}{2} \Rightarrow 12\left(\frac{2x+1}{3}+\frac{x-1}{4}\right)=12\left(\frac{13}{2}\right) \Rightarrow 8x+4+3x-3=78 \Rightarrow 11x+1$

$=78 \Rightarrow 11x=77 \Rightarrow x=7$ **Check:** $\frac{2(7)+1}{3}+\frac{7-1}{4}=\frac{13}{2} \Rightarrow 5+\frac{6}{4}=\frac{13}{2} \Rightarrow \frac{13}{2}=\frac{13}{2}$

The graphs of the left and right sides of the equation intersect when $x=7$. The solution set is $\{7\}$.

28. $\frac{x-2}{4}+\frac{x+1}{2}=1 \Rightarrow 4\left[\frac{x-2}{4}+\frac{x+1}{2}=1\right] \Rightarrow x-2+2x+2=4 \Rightarrow 3x=4 \Rightarrow x=\frac{4}{3}$

Check: $\frac{\frac{4}{3}-2}{4}+\frac{\frac{4}{3}+1}{2}=1 \Rightarrow \frac{\frac{-2}{3}}{4}+\frac{\frac{-2}{3}}{4}+\frac{\frac{14}{3}}{4}=1 \Rightarrow \frac{\frac{12}{3}}{4}=\frac{4}{4}=1$

The graphs of the left and right sides of the equation intersect when $x=\frac{4}{3}$. The solution set is $\left\{\frac{4}{3}\right\}$.

29. $\frac{1}{2}(x-3)=\frac{5}{12}+\frac{2}{3}(2x-5) \Rightarrow 12\left[\frac{1}{2}(x-3)=\frac{5}{12}+\frac{2}{3}(2x-5)\right] \Rightarrow 6x-18=5+16x-40 \Rightarrow$

$-10x=-17 \Rightarrow x=\frac{17}{10}$ **Check:** $\frac{1}{2}\left(\frac{17}{10}-3\right)=\frac{5}{12}+\frac{2}{3}\left(2\left(\frac{17}{10}\right)-5\right) \Rightarrow \frac{1}{2}\left(-\frac{13}{10}\right)=\frac{5}{12}+\frac{2}{3}\left(-\frac{16}{10}\right)$

$\Rightarrow \frac{13}{20}=\frac{5}{12}+\left(\frac{32}{30}\right) \Rightarrow \frac{78}{120}=\frac{50}{120}+\left(-\frac{128}{120}\right) \Rightarrow \frac{78}{120}=-\frac{78}{120}$. The graphs of the left and right sides of the equation intersect when $x=\frac{17}{10}$. The solution set is $\left\{\frac{17}{10}\right\}$.

30. $\frac{7}{3}(2x-1)=\frac{1}{5}x+\frac{2}{5}(4-3x) \Rightarrow 15\left[\frac{7}{3}(2x-1)=\frac{1}{5}x+\frac{2}{5}(4-3x)\right] \Rightarrow 35(2x-1)=3x+6(4-3x)$

$\Rightarrow 70x-35=3x+(24-18x) \Rightarrow 70x-35=-15x+24 \Rightarrow 85x=59 \Rightarrow x=\frac{59}{85}$

Check: $\frac{7}{3}\left(2\left(\frac{59}{85}\right)-1\right)=\frac{1}{5}\left(\frac{59}{85}\right)+\frac{2}{5}\left(4-3\left(\frac{59}{85}\right)\right) \Rightarrow \frac{7}{3}\left(\frac{118}{85}-1\right)=\frac{59}{425}+\frac{2}{5}\left(4-\frac{177}{85}\right)$

$\Rightarrow \frac{7}{3}\left(\frac{33}{85}\right)=\frac{59}{425}+\frac{2}{5}\left(\frac{163}{85}\right) \Rightarrow \frac{59}{425}+\frac{326}{425} \Rightarrow \frac{231}{255}=\frac{385}{425} \Rightarrow \frac{77}{85}=\frac{77}{85}$. The graphs of the left and right sides of the equation intersect when $x=\frac{59}{85}$. The solution set is $\left\{\frac{59}{85}\right\}$.

31. $0.1x-0.05=-0.07x \Rightarrow 0.17x=0.05 \Rightarrow 17x=5 \Rightarrow x=\frac{5}{17}$

Check: $1\left(\frac{5}{17}\right)-0.05=-0.07\left(\frac{5}{17}\right)\Rightarrow 10\left(\frac{5}{17}\right)-5=-7\left(\frac{5}{17}\right)\Rightarrow \frac{50}{17}-5=-\frac{35}{17}=-\frac{35}{17}$

The graphs of the left and right sides of the equation intersect when $x=\frac{5}{17}$. The solution set is $\left\{\frac{5}{17}\right\}$.

32. $1.1x-2.5=0.3(x-2)\Rightarrow 11x-25=3(x-2)\Rightarrow 11x-25=3x-6\Rightarrow 8x=19\Rightarrow x=\frac{19}{8}$

Check: $1.1\left(\frac{19}{8}\right)-2.5=0.3\left(\left(\frac{19}{8}\right)-2\right)\Rightarrow 11\left(\frac{19}{8}\right)-25=3\left(\left(\frac{19}{8}\right)-2\right)\Rightarrow \frac{209}{8}-25=3\left(\frac{3}{8}\right)\Rightarrow$

$\frac{9}{8}=\frac{9}{8}$. The graphs of the left and right sides of the equation intersect when $x=\frac{19}{8}$.

The solution set is $\left\{\frac{19}{8}\right\}$.

33. $0.40x+0.60(100-x)=0.45(100)\Rightarrow 0.40x+60-0.60x=45\Rightarrow -0.20x=-15\Rightarrow 20x=-1500\Rightarrow x=75$

Check: $0.40(75)+0.60(100-75)=0.45(100)\Rightarrow 30+15=45\Rightarrow 45=45$. The graphs of the left and right sides of the equation intersect when $x=75$. The solution set is $\{75\}$.

34. $1.30x+0.90(0.50-x)=1.00(50)\Rightarrow 1.30x+0.45-0.90x=50\Rightarrow 0.40x=49.55\Rightarrow x=123.875$

Check: $1.30(123.875)+.90(.50-123.875)=1.00(50)\Rightarrow 161.0375-111.0975=50\Rightarrow 50=50$

The graphs of the left and right sides of the equation intersect when $x=123.875$.
The solution set is $\{123.875\}$.

35. $2[x-(4+2x)+3]=2x+2\Rightarrow 2[x-4-2x+3]=2x+2\Rightarrow 2[-x-1]=2x+2\Rightarrow$

$-2x-2=2x+2\Rightarrow -4x=4\Rightarrow x=-1$

Check: $2[-1-(4+2(-1))+3]=2(-1)+2\Rightarrow 2[-1-2+3]=0\Rightarrow 2[0]=0\Rightarrow 0=0$

The graphs of the left and right sides of the equation intersect when $x=-1$. The solution set is $\{-1\}$.

36. $6[x-(2-3x)+1]=4x-6\Rightarrow 6[4x-1]=4x-6\Rightarrow 24x-6=4x-6\Rightarrow 20x=0\Rightarrow x=0$

Check: $6[0-(2-3(0))+1]=4(0)-6\Rightarrow 6[-1]=-6\Rightarrow -6=-6$

The graphs of the left and right sides of the equation intersect when $x=0$. The solution set is $\{0\}$.

37. $\frac{5}{6}x-2x+\frac{1}{3}=\frac{1}{3}\Rightarrow 6\left(\frac{5}{6}x-2x+\frac{1}{3}=\frac{1}{3}\right)\Rightarrow 5x-12x+2=2\Rightarrow -7x=0\Rightarrow x=0$

Check: $\frac{5}{6}(0)-2(0)+\frac{1}{3}=\frac{1}{3}\Rightarrow \frac{1}{3}=\frac{1}{3}$

The graphs of the left and right sides of the equation intersect when $x=0$. The solution set is $\{0\}$.

38. $\frac{3}{4}+\frac{1}{5}x-\frac{1}{2}=\frac{4}{5}x\Rightarrow 20\left(\frac{3}{4}+\frac{1}{5}x-\frac{1}{2}=\frac{4}{5}x\right)\Rightarrow 15+4x-10=16x\Rightarrow 5=12x\Rightarrow x=\frac{5}{12}$

Check: $\frac{3}{4}+\frac{1}{5}\left(\frac{5}{12}\right)-\frac{1}{2}=\frac{4}{5}\left(\frac{5}{12}\right)\Rightarrow\frac{3}{4}+\frac{1}{12}-\frac{1}{2}=\frac{4}{12}\Rightarrow\frac{9}{12}+\frac{1}{12}-\frac{6}{12}=\frac{4}{12}\Rightarrow\frac{4}{12}=\frac{4}{12}$

The graphs of the left and right sides of the equation intersect when $1.99\le r\le 2.01$

The solution set is $\left\{\frac{5}{12}\right\}$.

39. $5x-(8-x)=2\left[-4-(3+5x-13)\right]\Rightarrow 6x-8=2[-5x+6]\Rightarrow 6x-8=-10x+12\Rightarrow$

$16x=20\Rightarrow x=\frac{20}{16}=\frac{5}{4}$

Check: $5\left(\frac{5}{4}\right)-\left(8-\frac{5}{4}\right)=2\left[-4-\left(3+5\left(\frac{5}{4}\right)-13\right)\right]\Rightarrow\frac{25}{4}-\frac{27}{4}=2\left[-4-\left(\frac{25}{4}\right)-10\right]\Rightarrow$

$-\frac{2}{4}=2\left[6-\frac{25}{4}\right]\Rightarrow-\frac{1}{2}=2\left[-\frac{1}{4}\right]\Rightarrow-\frac{1}{2}=-\frac{1}{2}$. The graphs of the left and right sides of the equation intersect when $x=\frac{5}{4}$.The solution set is $\left\{\frac{5}{4}\right\}$.

40. $-\left[x-(4x+2)\right]=2+(2x+7)\Rightarrow-[-3x+2]=2x+9\Rightarrow 3x+2=2x+9\Rightarrow x=7$

Check: $-\left[7-(4(7)+2)\right]=2+(2(7)+7)\Rightarrow-[7-30]=2+21\Rightarrow 23=23$ The graphs of the left and right sides of the equation intersect when $x=7$. The solution set is $\{7\}$.

41. When $x=4$, both Y_1 and Y_2 have a value of 8. Therefore the solution set is $\{4\}$.

42. When $x=1.5$, both Y_1 and Y_2 have a value of 4.5. So $Y_1-Y_2=4.5-4.5=0$. The solution set is $\{1.5\}$.

43. Graph $Y_1=4\left(0.23+\sqrt{5}\right)$ and $Y_2=\sqrt{2}x+1$ as shown in Figure 43. The graphs intersect when $x\approx 16.07$. Therefore the solution set is $\{16.07\}$.

44. Graph $Y_1=9\left(-0.48x+\sqrt{17}\right)$ and $Y_2=\sqrt{6}x-4$ as shown in Figure 44. The graphs intersect when $x\approx 4.11$. Therefore the solution set is $\{4.11\}$.

45. Graph $Y_1=2\pi x+\sqrt[3]{4}$ and $Y_2=0.5\pi x-\sqrt{28}$ as shown in Figure 45. The graphs intersect when $x\approx-1.46$. Therefore the solution set is $\{-1.46\}$.

[-10,30] by [-10,30]
Xscl = 2 Yscl = 2

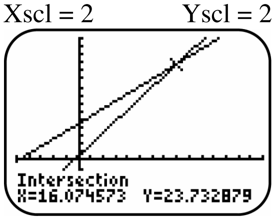


Figure 43

[-10,10] by [-10,10]
Xscl = 1 Yscl = 1

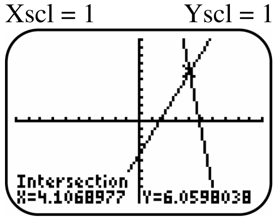


Figure 44

[-15,5] by [-15,5]
Xscl= 1 Yscl = 1

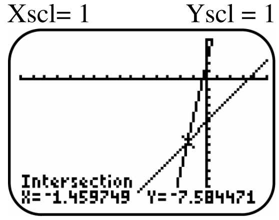


Figure 45

46. Graph $Y_1 = 3\pi x - \sqrt[4]{3}$ and $Y_2 = 0.75\pi x + \sqrt{19}$ as shown in Figure 46. The graphs intersect when $x \approx 0.80$. Therefore the solution set is $\{0.80\}$.

47. Graph $Y_1 = 0.23\left(\sqrt{3} + 4x\right) - 0.82(\pi x + 2.3)$ and $Y_2 = 5$ as shown in Figure 47. The graphs intersect when $x \approx -3.92$. Therefore the solution set is $\{-3.92\}$.

48. Graph $Y_1 = -0.15\left(6 + \sqrt{2}x\right) + 1.4(2\pi x - 6.1)$ and $Y_2 = 10$ as shown in Figure 48. The graphs intersect when $x \approx 2.26$. Therefore the solution set is $\{2.26\}$.

[-10,10] by [-10,10]
Xscl = 1 Yscl = 1

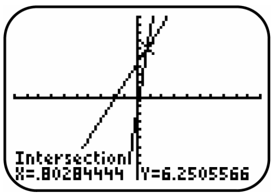


Figure 46

[-10,10] by [-10,10]
Xscl = 1 Yscl = 1

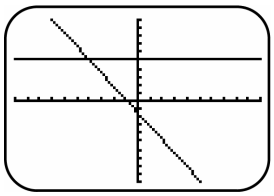


Figure 47

[-10,10] by [-5,15]
Xscl= 1 Yscl = 1

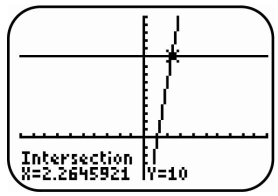


Figure 48

49. $5x + 5 = 5(x+3) - 3 \Rightarrow 5x + 5 = 5x + 15 - 3 \Rightarrow 5x + 5 = 5x + 12 \Rightarrow 5 = 12 \Rightarrow$ Contradiction. The solution set is $\varnothing$ The table of $Y_1 = 5x + 5$ and $Y_2 = 5(x+3) - 3$ never produces the same answers, therefore supports the Contradiction.

50. $5 - 4x = 5x - (9 + 9x) \Rightarrow 5 - 4x = -9 - 4x \Rightarrow 5 = -9 \Rightarrow$ Contradiction. The solution set is $\varnothing$. The table of $Y_1 = 5 - 4x$ and $Y_2 = 5x - (9 + 9x)$ never produces the same answers, therefore supports the Contradiction.

51. $6(2x+1) = 4x + 8\left(x + \frac{3}{4}\right) \Rightarrow 12x + 6 = 4x + 8x + 6 \Rightarrow 12x + 6 = 12x + 6 \Rightarrow 6 = 6 \Rightarrow$ Identity. The solution set is $(-\infty, \infty)$ The table of $Y_1 = 6(2x+1)$ and $Y_2 = 4x + 8\left(x + \frac{3}{4}\right)$ produces all the same answers, therefore supports the Identity.

52. $3(x+2) - 5(x+2) = -2x - 4 \Rightarrow 3x + 6 - 5x - 10 = -2x - 4 \Rightarrow -2x + 4 = -2x + 4 \Rightarrow -4 = -4$ $\Rightarrow$ Identity. The solution set is $(-\infty, \infty)$. The table of $Y_1 = 3(x+2) - 5(x+2)$ and $Y_1 = -2x - 4$ produces all the same answers, therefore supports the Identity.

53. $7x - 3[5x - (5 + x)] = 1 - 4x \Rightarrow 7x - 3[4x - 5] = 1 - 4x \Rightarrow 7x - 12x + 15 = 1 - 4x \Rightarrow$
$-5x + 15 = 1 - 4x \Rightarrow -x = -14 \Rightarrow x = 14 \Rightarrow$ Conditional.
The solution set is 14. The table of $Y_1 =$ $7x - 3[5x - (5 + x)]$ and $Y_2 =$ $1 - 4x$ shows that the answers are the same when x = 14.

54. $5\left[1-(3-x)\right]=3(5x+2)-7 \Rightarrow 5[-2+x]=15x+6-7 \Rightarrow -10+5x=15x-1 \Rightarrow$

$-10x=9 \Rightarrow x=-\frac{9}{10} \Rightarrow$ Conditional.

The solution set is $-\frac{9}{10}$. The table of $Y_1 = 5\left[1-(3-x)\right]$ and $Y_2 = 3(5x+2)-7$ shows that the answers are the same when x = $-\frac{9}{10}$.

55. $0.2(5x-4)-0.1(6-3x)=0.4 \Rightarrow x-0.8-0.6+0.3x=0.4 \Rightarrow 1.3x-1.4=0.4 \Rightarrow 1.3x=1.8 \Rightarrow$

$x=\frac{18}{13} \Rightarrow$ Conditional. The solution set is $\frac{18}{13}$ The table of $Y_1 = 0.2(5x-4)-0.1(6-3x)$ and $Y_2 =$ 0.4 shows that the answers are the same when x = $\frac{18}{13}$.

56. $1.5(6x-3)-7x=3-(7-x) \Rightarrow 9x-4.5-7x=x-4 \Rightarrow 2x-4.5=x-4 \Rightarrow x=\frac{1}{2} \Rightarrow$

Conditional. The solution set is $\left\{\frac{1}{2}\right\}$. The table of $Y_1=1.5(6x-3)-7x$ and $Y_2=3-(7-x)$ shows that the answers are the same when x = $\frac{1}{2}$.

57. $-4\left[6-(-2+3x)\right]=21+12x \Rightarrow -4[8-3x]=21+2x \Rightarrow -32+12x=21+2x \Rightarrow -32=21 \Rightarrow$

Contradiction. The solution set is $\varnothing$. The table of $Y_1=-4\left[6-(-2+3x)\right]$ and $Y_2=21+12x$ never produces the same answers, therefore supports the Contradiction.

58. $-3\left[-5-(-9+2x)\right]=2(3x-1) \Rightarrow -3[4-2x]=6x-2 \Rightarrow -12+6x=6x-2 \Rightarrow -12=-2 \Rightarrow$

Contradiction. The solution set is $\varnothing$. The table of $Y_1=-3\left[-5-(-9+2x)\right]$ and $Y_2=2(3x-1)$ never produces the same answers, therefore supports the Contradiction.

59. $\frac{1}{2}x-2(x-1)=2-\frac{3}{2}x \Rightarrow \frac{1}{2}x-2x+2=2-\frac{3}{2}x \Rightarrow -\frac{3}{2}+2=-\frac{3}{2}+2 \Rightarrow 2=2 \Rightarrow$ Identity.

The solution set is $(-\infty,\infty)$. The table of $Y_1=\frac{1}{2}x-2(x-1)$ and $Y_2=2-\frac{3}{2}x$ produces all the same answers, therefore supports the Identity.

60. $0.5(x-2)+12=0.5x+11 \Rightarrow 1(x-2)+24=1x+22 \Rightarrow x-2+24=x+22 \Rightarrow$

$x+22=x+22 \Rightarrow 22=22 \Rightarrow$ Identity. The solution set is $(-\infty,\infty)$. The table of $Y_1=3(x+2)-5(x+2)$ and $Y_1=-2x-4$ produces all the same answers, therefore supports the Identity.

61. $\frac{x-1}{2}=\frac{3x-2}{6} \Rightarrow 6\left[\frac{x-1}{2}=\frac{3x-2}{6}\right] \Rightarrow 3(x-2)=3x-2 \Rightarrow 3x-6=3x-3 \Rightarrow -6=-3 \Rightarrow$

Contradiction. The solution set is $\varnothing$. The table of $Y_1=\frac{x-1}{2}$ and $Y_2=\frac{3x-2}{6}$ never produces the same answers, therefore supports the Contradiction.

62. $\frac{2x-1}{3}=\frac{2x+1}{3}\Rightarrow 3\left[\frac{2x-1}{3}=\frac{2x+1}{3}\right]\Rightarrow 2x-1=2x+1\Rightarrow -1=1\Rightarrow$ Contradiction. The solution set is $\varnothing$.

The table of $Y_2=\frac{2x-1}{3}$ and $Y_2=\frac{2x+1}{3}$ never produces the same answers, therefore supports the Contradiction.

63. For the given functions, $f(x)=g(x)$ when the graphs intersect or when $x=3$. The solution is $\{3\}$.

64. For the given functions, $f(x)>g(x)$ when the graph of $f(x)$ is above the graph of $g(x)$ or when $x<3$. The solution is $(-\infty,3)$.

65. For the given functions, $f(x)<g(x)$ when the graph of $f(x)$ is below the graph of $g(x)$ or when $x>3$. The solution is $(3,\infty)$.

66. For the given functions, $g(x)-f(x)\geq 0\Rightarrow g(x)\geq f(x)$ when the graph of $g(x)$ is above or intersects the graph of $f(x)$ or when $x\geq 3$. The solution is $[3,\infty)$.

67. For the given inequality, $y_1-y_2\geq 0\Rightarrow f(x)-g(x)\geq 0\Rightarrow f(x)\geq g(x)$ when the graph of $f(x)$ is above or intersects the graph of $g(x)$ or when $x\leq 3$. The solution is $(-\infty,3]$.

68. For the given inequality, $y_2>y_1\Rightarrow g(x)>f(x)$ when the graph of $g(x)$ is above the graph of $f(x)$ or when $x>3$. The solution is $(3,\infty)$.

69. For the given functions, $f(x)\leq f(x)$ when the graph of is $f(x)$ below or intersects the graph $g(x)$ of or when $x\geq 3$. The solution is $[3,\infty)$.

70. For the given functions, $f(x)\geq g(x)$ when the graph of $f(x)$ is above or intersects the graph $g(x)$ of or when $x\leq 3$. The solution is $(-\infty,\ 3]$.

71. For the given functions, $f(x)\leq 2$ when the graph of $f(x)$ is below or equal to 2 or when $x\geq 3$. The solution is $[3,\infty)$.

72. For the given functions, $g(x)\leq 2$ when the graph of $g(x)$ is below or equal to 2 or when $x\leq 3$. The solution is $(-\infty,\ 3]$.

73. (a) The function $f(x) > 0$ when the graph is above the x-axis for the interval $(20, \infty)$.

(b) The function $f(x) < 0$ when the graph is below the x-axis for the interval $(-\infty, 20)$.

(c) The function $f(x) \geq 0$ when the graph intersects or is above the x-axis for the interval $[20, \infty)$.

(d) The function $f(x) \leq 0$ when the graph intersects or is below the x-axis for the interval $(-\infty, 20]$.

74. (a) The function $f(x) < 0$ when the graph is below the x-axis for the interval $(-\infty, 8)$.

(b) The function $f(x) \leq 0$ when the graph intersects or is below the x-axis for the interval $(-\infty, 8]$.

(c) The function $f(x) \geq 0$ when the graph intersects or is above the x-axis for the interval $[8, \infty)$.

(d) The function $f(x) > 0$ when the graph is above the x-axis for the interval $(8, \infty)$.

75. (a) If the solution set of $f(x) \geq g(x)$ is $[4, \infty)$, then $f(x) = g(x)$ at the intersection of the graphs, $x = 4$ or $\{4\}$.

(b) If the solution set of $f(x) \geq g(x)$ is $[4, \infty)$, then $f(x) > g(x)$ is the same, but does not include the intersection of the graphs for the interval $(4, \infty)$.

(c) If the solution set of $f(x) \geq g(x)$ is $[4, \infty)$, then $f(x) < g(x)$ is left of the intersection of the graphs for the interval: $(-\infty, 4)$.

76. (a) If the solution set of $f(x) < g(x)$ is $(-\infty, 3)$, then $f(x) = g(x)$ at the intersection of the graphs, $x = 3$ or $\{3\}$.

(b) If the solution set of $f(x) < g(x)$ is $(-\infty, 3)$, then $f(x) \geq g(x)$ is right of and does include the intersection of the graphs for the interval $[3, \infty)$.

(c) If the solution set of $f(x) < g(x)$ is $(-\infty, 3)$, then $f(x) \leq g(x)$ is the same, but does include the intersection of the graphs for the interval $(-\infty, 3]$.

77. (a) $3x - 6 = 0 \Rightarrow 3x = 6 \Rightarrow x = 2,$ Interval Notation: $\{2\}$

(b) $3x - 6 > 0 \Rightarrow 3x > 6 \Rightarrow x > 2,$ Interval Notation: $(2, \infty)$

(c) $3x - 6 < 0 \Rightarrow 3x < 6 \Rightarrow x < 2,$ Interval Notation: $(-\infty, 2)$

78. (a) $5x + 10 = 0 \Rightarrow 5x = -10 \Rightarrow x = -2,$ Interval Notation: $\{-2\}$

(b) $5x + 10 > 0 \Rightarrow 5x > -10 \Rightarrow x > -2,$ Interval Notation: $(-2, \infty)$

(c) $5x + 10 < 0 \Rightarrow 5x < -10 \Rightarrow x < -2,$ Interval Notation: $(-\infty, -2)$

79. (a) $1 - 2x = 0 \Rightarrow -2x = -1 \Rightarrow x = \frac{1}{2},$ Interval Notation: $\left\{\frac{1}{2}\right\}$

(b) $1 - 2x \leq 0 \Rightarrow -2x \leq -1 \Rightarrow x \geq \frac{1}{2},$ Interval Notation: $\left[\frac{1}{2}, \infty\right)$

(c) $1-2x \ge 0 \Rightarrow -2x \ge -1 \Rightarrow x \le \frac{1}{2}$, Interval Notation : $\left(-\infty, \frac{1}{2}\right]$

80. (a) $4-3x = 0 \Rightarrow -3x = -4 \Rightarrow x = \frac{4}{3}$, Interval Notation : $\left\{\frac{4}{3}\right\}$

(b) $4-3x \le 0 \Rightarrow -3x \le -4 \Rightarrow x \ge \frac{4}{3}$, Interval Notation : $\left[\frac{4}{3}, \infty\right)$

(c) $4-3x \ge 0 \Rightarrow -3x \ge -4 \Rightarrow x \le \frac{4}{3}$, Interval Notation : $\left(-\infty, \frac{4}{3}\right]$

81. (a) $x+12 = 4x \Rightarrow -3x = -12 \Rightarrow x = 4$, Interval Notation : $\{4\}$

(b) $x+12 > 4x \Rightarrow -3x > -12 \Rightarrow x < 4$, Interval Notation : $(-\infty, 4)$

(c) $x+12 < 4x \Rightarrow -3x < -12 \Rightarrow x > 4$, Interval Notation : $(4, \infty)$

82. (a) $5-3x = x+1 \Rightarrow -4x = -4 \Rightarrow x = 1$, Interval Notation : $\{1\}$

(b) $5-3x \le x+1 \Rightarrow -4x \le -4 \Rightarrow x \ge 1$, Interval Notation : $[1, \infty)$

(c) $5-3x \ge x+1 \Rightarrow -4x \ge -4 \Rightarrow x \le 1$, Interval Notation : $(-\infty, 1]$

83. (a) $9-(x+1) < 0 \Rightarrow -x+8 < 0 \Rightarrow -x < -8 \Rightarrow x > 8 \Rightarrow$ the interval is $(8, \infty)$. The graph of $y_1 = 9-(x+1)$ is below the x-axis for the interval $(8, \infty)$.

(b) If $9-(x+1) < 0$ for $(8, \infty)$, then $9-(x+1) \ge 0$ for the interval $(-\infty, 8]$. The graph of $y_1 = 9-(x+1)$ intersects or is above the x-axis for the interval $(-\infty, 8]$.

84. (a) $6+3(1-x) \ge 0 \Rightarrow -3x+9 \ge 0 \Rightarrow -1x \ge -3 \Rightarrow x \le 3 \Rightarrow$ the interval is $(-\infty, 3]$. The graph of $y_1 = 6+3(1-x)$ intersects or is above the x-axis for the interval $(-\infty, 3]$.

(b) $6+3(1-x) \ge 0$ for $(-\infty, 3]$, then $6+3(1-x) < 0$ for the interval $(3, \infty)$. The graph of $y_1 = 6+3(1-x)$ is below the x-axis for the interval $(3, \infty)$.

85. (a) $2x-3 > x+2 \Rightarrow x-3 > 2 \Rightarrow x > 5 \Rightarrow$ the interval is $(5, \infty)$. The graph of $y_1 = 2x-3$ is above the graph of $y_2 = x+2$ for the interval $(5, \infty)$.

(b) If $2x-3 > x+2$ for $(5, \infty)$, then $2x-3 \le x+2$ for the interval $(-\infty, 5]$. The graph $y_1 = 2x-3$ intersects or is below the graph $y_2 = x+2$ for the interval $(-\infty, 5]$.

86. (a) $5-3x \le -11+x \Rightarrow -4x \le -16 \Rightarrow x \ge 4$ the interval is $[4, \infty)$. The graph of $y_1 = 5-3x$ intersects or is below the graph of $y_2 = -11+x$ for the interval $[4, \infty)$.

(b) If $5-3x \le -11+x$ for $[4, \infty)$, then $5-3x > -11+x$ for the interval $(-\infty, 4)$.

The graph of $y_1 = 5-3x$ is above the graph $y_2 = -11+x$ for the interval $(-\infty, 4)$.

87. (a) $10x+5-7x \ge 8(x+2)+4 \Rightarrow 3x+5 \ge 8x+20 \Rightarrow -5x \ge 15 \Rightarrow x \le -3 \Rightarrow$ the interval is $(-\infty,-3]$. The graph of $y_1 = 10x+5-7x$ intersects or is above the graph of $y_2 = 8(x+2)+4$ for the interval $(-\infty,-3]$.

(b) If $10x+5-7x \ge 8(x+2)+4$ for $(-\infty,-3)$, then $10x+5-7x < 8(x+2)+4$ for the interval $(-3,\infty)$. The graph of $y_1 = 10x+5-7x$ is below the graph of $y_2 = 8(x+2)+4$ for the interval $(-3,\infty)$.

88. (a) $6x+2+10x > -2(2x+4)+10 \Rightarrow 16x+2 > -4x+2 \Rightarrow 20x > 0 \Rightarrow x > 0 \Rightarrow$ the interval is $(0,\infty)$. The graph of $y_1 = 6x+2+10x$ is above the graph of $y_2 = -2(2x+4)+10$ for the interval $(0,\infty)$.

(b) If $6x+2+10x > -2(2x+4)+10$ for $(0,\infty)$, then $6x+2+10x \le -2(2x+4)+10$ for the interval $(-\infty,0]$. The graph of $y_1 = 6x+2+10x$ intersects or is below the graph of $y_2 = -2(2x+4)+10$ for the interval $(-\infty,0]$.

89. (a) $x+2(-x+4)-3(x+5) < -4 \Rightarrow x-2x+8-3x-15 < -4 \Rightarrow -4x < 3 \Rightarrow x > -\dfrac{3}{4} \Rightarrow$ the interval is $\left(-\dfrac{3}{4},\infty\right)$. The graph of $y_1 = x+2(-x+4)-3(x+5)$ is below the graph of $y_2 = -4$ for the interval $\left(-\dfrac{3}{4},\infty\right)$.

(b) If $x+2(-x+4)-3(x+5) < -4$ for $\left(-\dfrac{3}{4},\infty\right)$, then $x+2(-x+4)-3(x+5) \ge -4$ for the interval $\left(-\infty,-\dfrac{3}{4}\right]$. The graph of $y_1 = x+2(-x+4)-3(x+5)$ intersects or is above the graph $y_2 = -4$ for the interval $\left(-\infty,-\dfrac{3}{4}\right]$.

90. (a) $-11x-(6x-4)+5-3x \le 1 \Rightarrow -20x+9 \le 1 \Rightarrow -20x \le -8 \Rightarrow x \ge \dfrac{2}{5} \Rightarrow$ the interval is $\left[\dfrac{2}{5},\infty\right)$. The graph of $y_1 = -11x-(6x-4)+5-3x$ intersects or is below the graph of $y_2 = 1$ for the interval $\left[\dfrac{2}{5},\infty\right)$.

(b) If $-11x-(6x-4)+5-3x \le 1$ for $\left(\dfrac{2}{5},\infty\right)$, then $-11x-(6x-4)+5-3x > 1$ for the interval $\left(-\infty,\dfrac{2}{5}\right)$. The graph of $y_1 = -11x-(6x-4)+5-3x$ is below the graph $y_2 = 1$ for the interval $\left(-\infty,\dfrac{2}{5}\right)$.

91. $\frac{1}{3}x-\frac{1}{5}x\le 2\Rightarrow\left[\frac{1}{3}x-\frac{1}{5}x\le 2\right]\Rightarrow 5x-3x\le 30\Rightarrow 2x\le 30\Rightarrow x\le 15\Rightarrow(-\infty,15]$. The graph of $y_1=\frac{1}{3}x-\frac{1}{5}x$ intersects or is below the graph of $y_2=2$ for the interval $(-\infty,15]$.

92. $\frac{3x}{2}+\frac{4x}{7}\ge -5\Rightarrow 14\left[\frac{3x}{2}+\frac{4x}{7}\ge -5\right]\Rightarrow 21x+8x\ge -70\Rightarrow 29x\ge -70\Rightarrow x\ge -\frac{70}{29}\Rightarrow\left[-\frac{70}{29},\infty\right)$.

The graph of $y_1=\frac{3x}{2}+\frac{4x}{7}$ intersects or is above the graph of $y_2=-5$ for the interval $\left[-\frac{70}{29},\infty\right)$.

93. $\frac{x-2}{2}-\frac{x+6}{3}>-4\Rightarrow 6\left[\frac{x-2}{2}-\frac{x+6}{3}>-4\right]\Rightarrow 3x-6-(2x+12)>-24\Rightarrow$

$x-18>-24\Rightarrow\ x>-6\Rightarrow(-6,\infty)$. The graph of $y_1=\frac{x-2}{2}-\frac{x+6}{3}$ is above the graph of $y_2=5$ for the interval: $(-6,\infty)$.

94. $\frac{2x+3}{5}-\frac{3x-1}{2}<\frac{4x+7}{2}\Rightarrow 10\left[\frac{2x+3}{5}-\frac{3x-1}{2}<\frac{4x+7}{2}\right]\Rightarrow$

$4x+6-(15-5)<20x+35\ \Rightarrow -11x+11<20x+35\Rightarrow -31x<24\Rightarrow x>-\frac{24}{31}\Rightarrow\left(-\frac{24}{31},\infty\right)$.

The graph of $y_1=\frac{2x+3}{5}-\frac{3x-1}{2}$ is below the graph of $y_2=\frac{4x+7}{2}$ for the interval $\left(-\frac{24}{31},\infty\right)$.

95. $0.6x-2(0.5x+.2)\le 0.4-0.3x\Rightarrow .6x-1x-0.4\le 0.4-0.3x\Rightarrow 10[0.6x-1x-0.4\le 0.4-0.3x]\Rightarrow$

$6x-10x-4\le 4-3x\Rightarrow -4x-4\le 4-3x\Rightarrow -x\le 8\Rightarrow x\ge -8\Rightarrow[-8,\infty)$. The graph of $y_1=0.6x-2(0.5x+.2)$ intersects or is below the graph of $y_2=0.4-0.3x$ for the interval $[-8,\infty)$.

96. $-0.9x-(.5+.1x)>-0.3x-0.5\Rightarrow -0.9x-0.5-0.1x>-0.3x-0.5\Rightarrow -x-0.5>-0.3x-0.5\Rightarrow$

$10[-x-0.5>-0.3x-0.5]\Rightarrow -10x-5>-3x-5\Rightarrow -7x>0x<0\Rightarrow(-\infty,0)$. The graph of $y_1=-0.9x-(0.5x+0.1x)$ is above the graph of $y_2=-.3x-.5$ for the interval $(-\infty,0)$.

97. $-\frac{1}{2}x+0.7x-5>0\Rightarrow 10\left[-\frac{1}{2}x+0.7x-5>0\right]\Rightarrow -5x+7x-50>0\Rightarrow 2x>50\Rightarrow$

$x>25\Rightarrow(25,\infty)$. The graph of $y_1=-\frac{1}{2}x+.7x-5$ is above the graph of $y_2=0$ for the interval $(25,\infty)$.

98. $\frac{3}{4}x-.2x-6\le 0\Rightarrow 20\left[\frac{3}{4}x-.2x-6\le 0\right]\Rightarrow 15x-4x-120\le 0\Rightarrow 11x\le 120\Rightarrow\ x\le\frac{120}{11}\Rightarrow\left(-\infty,\frac{120}{11}\right]$. The graph of $y_1=\frac{3}{4}x-.2x-6$ intersects or is below the graph of $y_2=0$ for the interval $\left(-\infty,\frac{120}{11}\right]$.

99. $-4(3x+2)\ge -2(6x+1) \Rightarrow -12x-8 \ge -12x-2 \Rightarrow -8 \ge -2;$ since this is false the solution is $\varnothing$.

The graph of $y_1 = -4(3x+2)$ never intersects or is above the graph of $y_2 = -2(6x+1)$, therefore the solution is $\varnothing$.

100. $8(4-3x)\ge 6(6-4x) \Rightarrow 32-24x \ge 36-24x \Rightarrow 32 \ge 36;$ since this is false the solution is $\varnothing$. The graph of $y_1 = 8(4-3x)$ never intersects or is below the graph of $y_2 = 6(6-4x)$ therefore the solution is $\varnothing$.

101. (a) As time increases, distance increases, therefore the car is moving away from Omaha.

(b) The distance function $f(x)$ intersects the 100 mile line at 1 hour and the 200 mile line at 3 hours.

(c) Using the answers from (b) the interval is [1, 3].

(d) Because x hours is $0 \le x \le 6$, the interval is (1, 6].

102. (a) The graph of $f(x)$ intersects the graph of $g(x)$ at: $x = 4$

(b) The graph of $g(x)$ intersects the graph of $h(x)$ at: $x = 2$.

(c) $f(x) < g(x) < h(x)$ when the graph of the function $g(x)$ is between the graphs of the functions $f(x)$ and $h(x)$ for the interval $(2,4)$.

(d) The function $g(x)$ is greater than $h(x)$ when its graph is above the graph of $h(x)$ for the interval: $[0,2)$.

(e) The graph of $f(x)$ does not intersect the graph of $h(x)$, therefore the solution is $\varnothing$.

(f) The function of $f(x)$ is always graphed below the function of $h(x)$ for the interval $[0,6]$.

(g) The function of $h(x)$ is greater than $g(x)$ when its graph is above the graph of $g(x)$ for the interval (2, 6].

(h) The function of $h(x)$ is always graphed below 500 for the interval $[0,6]$.

(i) The function $g(x)$ is graphed below 200 for the interval (4, 6].

(j) The function of $f(x)$ always is equal to 200 for the interval $[0,6]$.

103. $4 \le 2x+2 \le 10 \Rightarrow 2 \le 2x \le 8 \Rightarrow 1 \le x \le 4 \Rightarrow [1,4]$ The graph of $y_2 = 2x+2$ is between the graphs of $y_1 = 4$ and $y_3 = 10$ for the interval [1, 4].

104. $-4 \le 2x-1 \le 5 \Rightarrow -3 \le 2x \le 6 \Rightarrow -\frac{3}{2} \le x \le 3 \Rightarrow \left[-\frac{3}{2},3\right]$ The graph of $y_2 = 2x-1$ is on or between the graphs of $y_1 = -4$ and $y_3 = 5$ for the interval $\left[-\frac{3}{2},3\right]$.

105. $-10 > 3x+2 > -16 \Rightarrow -12 > 3x > -18 \Rightarrow -4 > x > -6 \Rightarrow -6 < x < -4 \Rightarrow (-6,-4)$

The graph of $y_2 = 3x+2$ is between the graphs of $y_1 = -10$ and $y_3 = -16$ for the interval $(-6,-4)$.

106. $4 > 6x+5 > -1 \Rightarrow -1 > 6x > -6 \Rightarrow -\frac{1}{6} > x > -1 \Rightarrow -1 < x < -\frac{1}{6} \Rightarrow \left(-1,-\frac{1}{6}\right)$. The graph of $y_2 = 6x+5$ is between the graphs of $y_1 = 4$ and $y_3 = -1$ for the interval $\left(-1,-\frac{1}{6}\right)$.

107. $-3 \le \frac{x-4}{-5} < 4 \Rightarrow 15 \ge x-4 > -20 \Rightarrow 19 \ge x > -16 \Rightarrow -16 < x\,19 \Rightarrow (-16,19]$ The graph of $y_2 = \frac{x-4}{-5}$ is between the graphs of $y_1 = -3$ and $y_3 = 4$ for the interval $(-16,19]$.

108. $1 < \frac{4x-5}{-2} < 9 \Rightarrow -2 > 4x-5 > -18 \Rightarrow 3 > 4x > -13 \Rightarrow \frac{3}{4} > x > -\frac{13}{4} \Rightarrow -\frac{13}{4} < x < \frac{3}{4} \Rightarrow$ $\left(-\frac{13}{4},\frac{3}{4}\right)$. The graph of $y_2 = \frac{4x-5}{-2}$ is between the graphs of $y_1 = 1$ and $y_3 = 9$ for the interval$\left(-\frac{13}{4},\frac{3}{4}\right)$.

109. $-\frac{1}{2} < x-4 < \frac{1}{2} \Rightarrow \frac{7}{2} < x < \frac{9}{2} \Rightarrow \left(\frac{7}{2},\frac{9}{2}\right)$. The graph of $y_2 = x-4$ is between $y_1 = -\frac{1}{2}$ and $y_3 = \frac{1}{2}$ for the interval $\left(\frac{7}{2},\frac{9}{2}\right)$.

110. $-\frac{3}{4} < 2x-1 < \frac{3}{4} \Rightarrow \frac{1}{4} < 2x < \frac{7}{4} \Rightarrow \frac{1}{8} < x < \frac{7}{8} \Rightarrow \left(\frac{1}{8},\frac{7}{8}\right)$. The graph of $y_2 = 2x-1$ is between $y_1 = -\frac{3}{4}$ and $y_3 = \frac{3}{4}$ for the interval $\left(\frac{1}{8},\frac{7}{8}\right)$.

111. $-4 \le \frac{1}{2}x-5 \le 4 \Rightarrow 1 \le \frac{1}{2}x \le 9 \Rightarrow 2 \le x \le 18 \Rightarrow [2,18]$. The graph of $y_2 = \frac{1}{2}x-5$ is on or between $y_1 = -4$ and $y_3 = 4$ for the interval $(2,18)$.

112. $-2 < \frac{x-4}{6} < 2 \Rightarrow -12 < x-4 < 12 \Rightarrow -8 < x < 16 \Rightarrow (-8,16)$. The graph of $y_2 = \frac{x-4}{6}$ is between $y_1 = -2$ and $y_3 = 2$ for the interval $(-8,16)$.

113. $\sqrt{2} \le \frac{2x+1}{3} \le \sqrt{5} \Rightarrow 3\sqrt{2} \le 2x+1 \le 3\sqrt{5} \Rightarrow 3\sqrt{2}-1 \le 2x \le 3\sqrt{5}-1 \Rightarrow$ $\frac{3\sqrt{2}-1}{2} \le x \le \frac{3\sqrt{5}-1}{2} \Rightarrow \left[\frac{3\sqrt{2}-1}{2},\frac{3\sqrt{5}-1}{2}\right]$; The graph of $y_2 = \frac{2x+1}{3}$ is on or between the graphs of $y_1 = \sqrt{2}$ and $y = \sqrt{5}$. for the interval $\left[\frac{3\sqrt{2}-1}{2},\frac{3\sqrt{5}-1}{2}\right]$.

114. $\pi \le 5-4x < 7\pi \Rightarrow \pi - 5 \le -4x < 7\pi - 5 \Rightarrow \frac{\pi-5}{-4} \ge x > \frac{7\pi-5}{-4} \Rightarrow \frac{5-\pi}{4} \ge x > \frac{5-7\pi}{4} \Rightarrow$

$\frac{5-7\pi}{4} < x \le \frac{5-\pi}{4} \Rightarrow \left(\frac{5-7\pi}{4}, \frac{5-\pi}{4}\right]$. The graph of $y_2 = 5-4x$ is between the graphs of

$y_1 = \pi$ and $y_3 = 7\pi$ for the interval $\left(\frac{5-7\pi}{4}, \frac{5-\pi}{4}\right]$.

115. (a) The graph of $T(x) = 65 - 19x$ intersects the graph of $D(x) = 50 - 5.8x$ at $\approx (1.136, 43.41)$. Since the x-coordinate is altitude, the clouds will not form below 1.14 miles or for the interval: [0, 1.14).

(b) Clouds will not form when air temperature is above dew point temperature or $T(x) > D(x)$.

Then $65 - 19x > 50 - 5.8x \Rightarrow -13.2x > -15 \Rightarrow x < \frac{15}{13.2}$ for the interval $\left[0, \frac{15}{13.2}\right)$.

116. (a) Use the points (0, 28.7) and (4, 31.2) to model the number of passengers.

$m = \frac{31.2-28.7}{4-0} = \frac{2.5}{4} = 0.625$ and the y intercept is the point (0, 28.7). The linear function is

$P(x) = 0.625x + 28.7$.

(b) Amtrak passengers increased, on average, by 0.625 million per year.

(c) Since 2014 is 6 years since 2008 we will let $x = 6$, $P(6) = 0.625(6) + 28.7 = 32.45$ million

(d) $35 = 0.625x + 28.7 \Rightarrow 6.3 = 0.625x \Rightarrow x = 10.8$, Amtrak might have 35 million passengers in 2018.

117. Since $C = 2\pi r$ and radius is in the range $1.99 \le r \le 2.01$, circumference is in the range

$2\pi(1.99) \le 2\pi r \le 2\pi(2.01) \Rightarrow 3.98\pi \le C \le 4.02\pi.$

118. Since $P = 4s$ and side length is in the range $9.9 \le s \le 10.1$, perimeter is in the range

$4(9.9) \le 4s \le 4(10.1) \Rightarrow 39.6 \le P \le 40.4.$

119. The graph of $y_1 = 3.7x - 11.1$ crosses the x-axis at $x = 3$. There is one solution to this equation. Because a linear equation can only cross the x-axis in one location, there is only one solution to any linear equation.

120. $3.7x - 11.1 < 0 \Rightarrow 3.7x < 11.1 \Rightarrow x < 3 \Rightarrow (-\infty, 3)$ $3.7x - 11.1 > 0 \Rightarrow 3.7x > 11.1 \Rightarrow x > 3 \Rightarrow (3, \infty)$

The value of $x = 3$ given by the equation represents the boundary between the sets of real numbers given by the inequality solutions $(-\infty, 3)$ and $(3, \infty)$.

121. The graph of $y_1 = -4x + 6$ crosses the x-axis at $x = 1.5$.

$-4x + 6 < 0 \Rightarrow -4x < -6 \Rightarrow x > \frac{-6}{-4} \Rightarrow x > 1.5 \Rightarrow (1.5, \infty)$

$-4x + 6 > 0 \Rightarrow -4x > -6 \Rightarrow x < \frac{-6}{-4} \Rightarrow x > 1.5 \Rightarrow (-\infty, 1.5)$

122. (a) If $a \ne 0$, then $ax + b = 0 \Rightarrow ax = -b \Rightarrow x = -\frac{b}{a}$

(b) If $a > 0,$ a positive slope, then $ax + b < 0 \Rightarrow ax < -b \Rightarrow x < \frac{-b}{a} \Rightarrow \left(-\infty, \frac{-b}{a}\right)$

If $a > 0,$ a positive slope, then $ax + b < 0 \Rightarrow ax > -b \Rightarrow x > \frac{-b}{a} \Rightarrow \left(\frac{-b}{a}, \infty\right)$

(c) If $a < 0,$ a negative slope, then $ax + b < 0 \Rightarrow ax < -b \Rightarrow x > \frac{-b}{a} \Rightarrow \left(\frac{-b}{a}, \infty\right)$

If $a < 0$, a positive slope, then $ax + b > 0 \Rightarrow ax > -b \Rightarrow x < \frac{-b}{a} \Rightarrow \left(-\infty, \frac{-b}{a}\right)$

1.6: Applications of Linear Functions

1. $.75(40) = 30L$
2. If y varies directly with x, then $y = kx$ or $2 = k(4) \Rightarrow k = \frac{1}{2}$. Then $y = \frac{1}{2}(12) \Rightarrow y = 6.$
3. When combining a 26% acid solution to a 32% acid solution the result will be a solution with between 26% and 32% acid. (A) 36% is not in between these percent values and not a possible concentration.
4. (D) only discounts the original price x by \$.30 and not by 30% of the original price.
5. If x is the second number, then $6x - 3$ is the first number. The equation with the sum of these two numbers equal to 32 is: (D) $(6x - 3) + x = 32.$
6. The difference between six times a number and 9 is $6x - 9.$ This is equal to five times the sum (answer) of a number and 2 or $5(n + 2).$ The equation is (A) $6x - 9 = 5(x + 2).$
7. If $P = 2L + 2W$ then $P = 2L + 2(19) \Rightarrow 98 = 2L + 38 \Rightarrow 60 = 2L \Rightarrow L = 30$cm.
8. Let x = width and x + 3 = length. If $P = 2W + 2L,$ then
 $22 = 2x + 2(x + 3) \Rightarrow 22 = 2x + 2x + 6 \Rightarrow 16 = 4x \Rightarrow x = 4$. The width is 4 and the length is 7 feet
9. Let x = width and $2x - 2.5$ = length. If $P = 2W + 2L,$ then
 $40.6 = 2x + 2(2x - 2.5) \Rightarrow 40.6 = 6x - 5 \Rightarrow 45.6 = 6x \Rightarrow x = 7.6.$ The width is 7.6 cm.
10. Let x = width and $2x - 3$ = length. If $P = 2W + 2L$ then
 $54 = 2x + 2(2x - 3) \Rightarrow 54 = 6x - 6 \Rightarrow 60 = 6x \Rightarrow x = 10.$ The width is 10 and the length is 17 cm
11. Let x = the original square side length and $2x$ − 3 = the new square side length. If $P = 4s$, then
 $4(x + 3) = 2x + 40 \Rightarrow 4x + 12 = 2x + 40 \Rightarrow 2x = 28 \Rightarrow x = 14.$ The original side length is 14 cm.
12. Let x = width and x + 8 = length in feet. If $P = 2W + 2L,$ then
 $112 = 2x + 2(x + 8) \Rightarrow 112 = 4x + 16 \Rightarrow 96 = 4x \Rightarrow x = 24.$ The width is 24 feet, therefore the length is 32 feet.

13. With an aspect ratio of 4:3, let x = width and $\frac{4}{3}x$ = length. If $P = 2W + 2L,$ then

$98 = 2x + 2\left(\frac{4}{3}x\right) \Rightarrow 98 = 2x + \frac{8}{3}x \Rightarrow 98 = \frac{14}{3}x \Rightarrow 294 = 14x \Rightarrow x = 21.$ The width is 21 inches and the length is $\frac{4}{3}(21) = 28$ inches. Use the Pythagorean theorem to find the diagonal $c^2 = (21)^2 + (28)^2 \Rightarrow c^2 = 441 + 784 \Rightarrow c^2 = 1225 \Rightarrow c = 35.$ The television is advertised as a 35 inch screen.

14. With an aspect ratio of 4:3, let x = width and $\frac{4}{3}x$ = length. If $P = 2W + 2L,$ then

$126 = 2x + 2\left(\frac{4}{3}x\right) \Rightarrow 126 = 2x + \frac{8}{3}x \Rightarrow 126 = \frac{14}{3}x \Rightarrow 378 = 14x \Rightarrow x = 27.$ The width is 27 inches and the length is $\frac{4}{3}(27) = 36$ inches. Use Pythagorean theorem to find the diagonal: $c^2 = (27)^2 + (36)^2 \Rightarrow c^2 = 729 + 1296 \Rightarrow c^2 = 2025 \Rightarrow c = 45.$ The television is advertised as a 45 inch screen.

15. Let x = the short side length and $2x$ = the longer two side lengths. If $P = s + s + s,$ then $30 = x + 2x + 2x \Rightarrow 30 = 5x \Rightarrow x = 6.$ The shortest side is 6 cm long.

16. Let x = the short side length, $2x - 200$ = the longest side, and $(2x - 200) - 200$ = the middle length side. If $P = s + s + s,$ then $P = s + s + s,$ then

$2400 = x + (2x - 200) + [(2x - 200) - 200] \Rightarrow 2400 = 5x - 600 \Rightarrow 3000 = 5x \Rightarrow x = 600.$

The side lengths are 600 feet, 2(600) − 200 = 1000 feet, and 1000 − 200 = 800 feet.

17. Let x = the number of hours traveled at 70 mph, and (6-x) = the number of hours traveled at 55 mph. Since D = RT and the total distance traveled by the car was 372 miles, then 55(6-x) + 70x = $372 \Rightarrow 330 - 55x + 70x = 372 \Rightarrow 15x = 42 \Rightarrow x = 2.8.$ The car traveled for 2.8 hours at 70 mph and (6-2.8)=3.2 hours at 55 mph.

18. Let x = the number of hours traveled at 55 mph, and $\left(x + \frac{1}{2}\right)$ = the number of hours traveled at 10 mph.

Since D=RT and the driver will catch the runner when the distances are equal we have.

$55x = 10\left(x + \frac{1}{2}\right) \Rightarrow 55x = 10x + 5 \Rightarrow 45x = 5 \Rightarrow x = \frac{1}{9}$ hr. The car will reach the runner in $\frac{1}{9}$ hr or $6\frac{2}{3}$ minutes.

19. Let x = gallons of 5% acid solution. Then

$5(.10) + x(.05) = (x + 5)(.07) \Rightarrow .50 + .05x = .07x + .35 \Rightarrow .15 = .02x \Rightarrow 15 = 2x \Rightarrow x = 7.5$.

Mix in 7.5 gallons of 5% acid solution.

20. Let x = mL of 5% acid solution. Then

$60(.20)+x(.05)=(x+60)(.10) \Rightarrow 12+.05x=.10x+6 \Rightarrow 6=.05x \Rightarrow 600=5x \Rightarrow x=120.$

Mix in 120 mL of 5% acid solution.

21. Let $x =$ gallons of pure alcohol. Then

$20(.15)+x(1.00)=(x+20)(.25) \Rightarrow 3+x=.25x+5 \Rightarrow .75x=2 \Rightarrow x=2.67$ or $2\frac{2}{3}$.

Mix in $2\frac{2}{3}$ gallons of pure alcohol.

22. Let $x =$ liters of pure alcohol. Then

$7(.10)+x(1.00)=(x+7)(.30) \Rightarrow .7+x=.30x+2.10 \Rightarrow 0.7x=1.4 \Rightarrow x=2$

Mix in 2 liters of pure alcohol.

23. Let $x =$ milliliters of water. Then $8(.06)+x(0)=(x+8)(.04) \Rightarrow .48=.04x+.32 \Rightarrow$

$0.16=0.04 \Rightarrow 4x=16 \Rightarrow x=4.$ Mix in 4 milliliters of water.

24. Let $x =$ liters of water. Then

$20(0.18)+x(0)=(x+20)(0.15) \Rightarrow 3.6=0.15x+3 \Rightarrow 0.6=0.15x \Rightarrow 15x=60 \Rightarrow x=4.$

Mix in 4 liters of water.

25. Let $x =$ liters of fluid to be drained and pure antifreeze added. Then

$16(0.80)-x(0.80)+x(1.00)=16(0.90) \Rightarrow 12.8-0.80x+x=14.4 \Rightarrow 0.20x=1.6$

$\Rightarrow 20x=160 \Rightarrow x=8.$ Drain and add in 8 liters of antifreeze.

26. Let $x =$ quarts of fluid to be drained and pure antifreeze added. Then

$10(0.40)-x(0.40)+x(1.00)=10(0.80) \Rightarrow 4-0.40x+x=8 \Rightarrow 0.60x=4$

$\Rightarrow 6x=40 \Rightarrow x=6.67$ or $6\frac{2}{3}$. Drain and add in $6\frac{2}{3}$ quarts of antifreeze.

27. Let $x =$ gallons of 94-octane gasoline. Then

$400(0.99)+x(0.94)=(x+400)(0.97) \Rightarrow 396+0.94x=0.97x+388$

$8=0.03x \Rightarrow 3x=800 \Rightarrow x=266.67$ or $266\frac{2}{3}$. Mix in $266\frac{2}{3}$ gallons of 94-octane gasoline.

28. Let $x =$ gallons of 92-octane gasoline and $120-x=$ gallons of 98-octane gasoline. Then

$x(0.92)+(120-x)(0.98)=120(0.96) \Rightarrow 0.92x+117.6-0.98x=115.2$

$\Rightarrow -0.06x=-2.4 \Rightarrow 6x=240 \Rightarrow x=40.$ Mix 40 gallons of 92-octane gasoline and $120-40=80$ gallons of 98-octane gasoline.

29. (a) $F(2008)=-\frac{5}{44}(2008)+276.18 \approx 48$, IN 2008 the winning men's 100-meter freestyle time was about 48 seconds.

(b) $53=-\frac{5}{44}x+276.18 \Rightarrow x \approx 1963.98$. The years would have been from 1948 to about 1964.

30. (a) $H(1920)=\frac{1}{48}(1920)-35.83\approx 4.17$, In 1920 the winning men's height was about 4.17 meters.

(b) $5=\frac{1}{48}x-35.83\Rightarrow x\approx 1959.84$. The years would have been from 1896 to about 1960.

31. (a) Use the points (2011, 192) and (2014, 249) to find the slope, $m=\frac{249-192}{2014-2011}=\frac{57}{3}=19$ and the point (2014, 249) to find the equation of the line. $S(x)-249=19(x-2014)\Rightarrow S(x)=19x-38017$

(b) Sales increased , on average by \$19 billion per year.

(c) $325=19x-38017\Rightarrow x=2018$ The sales will reach \$325 billion in 2018.

32. (a) The function is: $f(x)=0.76x.$

(b) If 38.7 riders do not wear helmets, then the equation is: $0.76x=38,700,000$ and the solution to the equation $x=50,900,000$ is the total number of bike riders.

33. (a) If the fixed cost $=\$200$ and the variable cost $=\$.02$ the cost function is: $C(x)=0.02x+200.$

(b) If she gets paid \$.04 per envelope stuffed and x = number of envelopes, the revenue function is $R(x)=0.04x.$

(c) $R(x)=C(x)$ when $0.02x+200=0.04x\Rightarrow 200=0.02x\Rightarrow x=10,000.$

(d) Graph $C(x)$ and $R(x)$, see Figure 33. Rebecca takes a loss when stuffing less than 10,000 envelopes and makes a profit when stuffing over 10,000 envelopes.

34. (a) If the fixed cost $=\$3500$ and the variable cost $=\$.01$ the cost function is: $C(x)=0.01x+3500.$

(b) If he gets paid \$.05 per copy and x = number of copies, the revenue function is: $R(x)=0.05x.$

(c) $R(x)=C(x)$ when $0.01x+3500=0.05x\Rightarrow 3500=0.04x\Rightarrow x=87,500.$

(d) Graph $C(x)$ and $R(x)$. See Figure 34. B.K. takes a loss when making fewer than 87,500 copies and makes a profit when making over 87,500 copies.

35. (a) If the fixed cost $=\$2300$ and the variable cost $=\$3.00$ the cost function is: $C(x)=3.00x+2300.$

(b) If he gets paid \$5.50 per delivery and x = number of deliveries, the revenue function is: $R(x)=5.50x.$

(c) $R(x)=C(x)$ when $3.00x+2300=5.50x\Rightarrow 2300=2.50x\Rightarrow x=920.$

(d) Graph $C(x)$ and $R(x)$. See Figure 35. Tom takes a loss when making fewer than 920 deliveries and makes a profit when making over 920 deliveries.

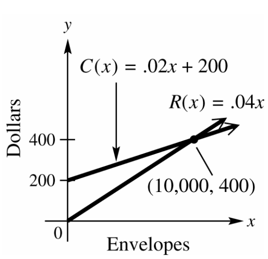


Figure 33

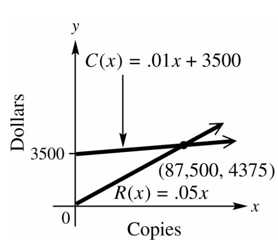


Figure 34

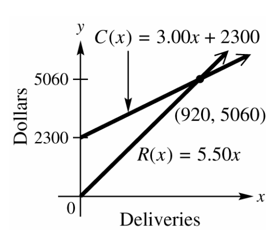


Figure 35

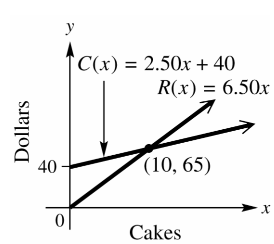


Figure 36

36. (a) If the fixed cost = \$40 and the variable cost = \$2.50 the cost function is: $C(x) = 2.50x + 40$.

(b) If he gets paid \$6.50 per cake and x = number of cakes sold, the revenue function is: $R(x) = 6.50x$

(c) $R(x) = C(x)$ when $2.50x + 40 = 6.50x \Rightarrow 40 = 4.00x \Rightarrow x = 10$.

(d) Graph $C(x)$ and $R(x)$, See Figure 36. Pat takes a loss when selling fewer than 10 cakes and makes a profit when selling over 10 cakes.

37. If $y = kx$, $x = 3$, and $y = 7.5$, then $7.5 = k(3) \Rightarrow k = 2.5$. Now, with $k = 2.5$ and $x = 8$, $y = 2.5(8) \Rightarrow y = 20$ when $x = 8$.

38. If $y = kx$, $x = 1.2$, and $y = 3.96$, then $3.96 = k(1.2) \Rightarrow k = 3.3$. Now, with $k = 3.3$ and $y = 23.43$, $23.43 = 3.3x \Rightarrow x = 7.1$ when $y = 23.43$.

39. If $y = kx$, $x = 25$, and $y = 1.5$, then $1.50 = k(25) \Rightarrow k = 0.06$. Now, with $k = 0.06$ and $y = 5.10$, $5.10 = 0.06x \Rightarrow x = \$85$ when $y = \$5.10$

40. If $y = kx$, $x = 3$, and $y = 41.97$, then $41.97 = k(3) \Rightarrow k = 13.99$. Now, with $k = 13.99$ and $x = 5$, $y = 13.99(5) \Rightarrow y = \$69.95$ when $x = 5$.

41. Let y = pressure and x = depth for the direct proportion: $y = kx$. Then $13 = k(30) \Rightarrow k = \frac{13}{30}$.

Now use $k = \frac{13}{30}$ and a depth of 70 feet to find the pressure: $y = \frac{13}{30}(70) \Rightarrow y = \frac{91}{3} \Rightarrow y = 30\frac{1}{3}\text{ lb/in}^2$.

42. Let y = rate transmitted and x = diameter for the direct proportion $y = kx$. Then

$40 = k(6) \Rightarrow k = \frac{40}{6} = \frac{20}{3}$. Now use $k = \frac{20}{3}$ and a diameter of 8 micrometers to find the

rate: $y = \frac{20}{3}(8) \Rightarrow y = \frac{160}{3} \Rightarrow y = 53\frac{1}{3}$ m/sec.

43. Let t = tuition and c = credits taken for the direct proportion $t = kc$. Then $720.50 = k(11) \Rightarrow k = 65.5$. Now use the constant of variation $k = 65.5$ and 16 credits to find the tuition: $y = 65.5(16) \Rightarrow y = \$1048$.

44. Let l = load and w = width for the direct proportion: $l = kw$. Then $250 = k(1.5) \Rightarrow k = 166.67 = 166\frac{2}{3}$.

Now use the constant of variation $k = 166\frac{2}{3}$ and a width of 3.5 inches to find the load that can supported:

$y = 166\frac{2}{3}(3.5) \Rightarrow y = 583\frac{1}{3}$ pounds.

45. First use proportion to find the radius of the water at a depth of 44 feet $\frac{5}{11} = \frac{x}{6} \Rightarrow 11x = 30 \Rightarrow x \approx 2.727.$

Now use the cone volume formula to find the water's volume:

$V = \frac{1}{3}\pi r^2 h \Rightarrow V = \frac{1}{3}\pi(2.727)^2(6) \approx 46.7 \text{ ft}^3.$

46. First use proportion to find the radius of the water at a depth of 7 feet. $\frac{2}{6} = \frac{x}{3.5} \Rightarrow 6x = 7 \Rightarrow x \approx 1.167.$

Now use the cone volume formula to find the water's volume:

$V = \frac{1}{3}\pi r^2 h \Rightarrow V = \frac{1}{3}\pi(1.167)^2(3.5) \approx 4.99 \text{ ft}^3.$

47. Since the triangles are similar, use a proportion to solve: $\frac{1.75}{2} = \frac{45}{x} \Rightarrow 1.75x = 90 \Rightarrow x \approx 51.43$ or

$x = 51\frac{3}{7}$ feet tall.

48. Draw a picture and create similar triangles, then use a proportion to solve:

$\frac{66 \text{ in}}{84 \text{ in}} = \frac{x}{15 \text{ft} + 84 \text{ in}} \Rightarrow \frac{66}{84} = \frac{x}{264} \Rightarrow 84x = 17{,}424 \Rightarrow x \approx 207.43$ inches or $x \approx 17.3$ ft.

49. Let $w =$ weight, $d =$ distance, and use the direct proportion $w = kd$ to find k:

$3 = k(2.5) \Rightarrow k = 1.2.$ Now use $k = 1.2$ and a weight of 17 pounds to find the stretch

length: $17 = 1.2(d) \Rightarrow d = 14.17$ or $14\frac{1}{6}$ in.

50. Let $w =$ weight, $d =$ distance, and the direct proportion $w = kd$ to find k: $9.8 = k(.75) \Rightarrow k = \frac{196}{15}.$

Now use $k = \frac{196}{15}$ and a stretch of 3.1 inches to find the weight: $w = \frac{196}{15}(3.1) \Rightarrow w = 40\frac{38}{75}$ or $w \approx 40.5$ lb.

51. With direct proportion $y_1 = kx_1$ and $y_2 = kx_2$, then $k = \frac{y_1}{x_1} = \frac{y_2}{x_2}$. Now let $y_1 = 250$ tagged

trout, $y_2 = 7$ tagged trout, $x_2 = 350$ sample trout, and $x_1 =$ total trout. Therefore

$\frac{250}{x_1} = \frac{7}{350} \Rightarrow 7x_1 = 87{,}500 \Rightarrow x_1 = 12{,}500$ is the estimate for total population of trout.

52. With direct proportion $y_1 = kx_1$ and $y_2 = kx_2$, so $k = \frac{y_1}{x_1} = \frac{y_2}{x_2}$. Now let $y_1 = 4693$ tagged seal

pups, $y_2 = 218$ tagged seal pups, $x_2 = 900$ sample seal pups, and $x_1 =$ total seal pups. Therefore,

$\frac{4963}{x_1} = \frac{218}{900} \Rightarrow 218x_1 = 4{,}466{,}700 \Rightarrow x_1 = 20{,}489.45 \Rightarrow x_1 \approx 20{,}500.$

Therefore $x = 20{,}500$ is the estimate for total population of seal pups.

53. (a) Let $x =$ number of heaters produced and $y =$ cost. Then (10, 7500) and (20, 13900) are two points on the graph of the linear function. Find the slope: $m = \frac{13900 - 7500}{20 - 10} = \frac{6400}{10} = 640$.

Now use point-slope form to find the linear function:

$y - 7500 = 640(x - 10) \Rightarrow y - 7500 = 640x - 640 \Rightarrow y = 640x + 1100.$

(b) $y = 640(25) + 1100 \Rightarrow y = 16,000 + 1100 \Rightarrow y = \$17,100.$

(c) Graph $y = 640x + 1100$ and locate the point (25, 17,100) on the graph.

54 (a) Let x = degrees Fahrenheit and y = chirps, then (68, 24) and (40, 86) are two points on the graph of the linear function. Find the slope: $m = \frac{86 - 24}{40 - 68} = \frac{62}{-28} = -\frac{31}{14}$. Now use point-slope form to find the linear function:

$y - 86 = -\frac{31}{14}(x - 40) \Rightarrow y - 86 = -\frac{31}{14}x + \frac{620}{7} \Rightarrow y = -\frac{31}{14}x + \frac{1222}{7}$.

(b) $y = -\frac{31}{14}(60) + \frac{1222}{7} \Rightarrow y = -\frac{1860}{14} + \frac{2444}{14} \Rightarrow y = \frac{584}{14} \approx 41.71 \approx 42$ times.

(c) 40 chirps in one-half minute is 80 chirps per minute. Therefore:

$80 = -\frac{31}{14}x + \frac{1222}{7} \Rightarrow 1120 = -31x + 2444 \Rightarrow -1324 = -31x \Rightarrow x \approx 42.71 \approx 43°$ F

55. (a) Let x = number of years after 2002 and y = value, then (0, 120,000) and (10, 146,000) are two points on the graph of the linear function. Find the slope: $m = \frac{146,000 - 120,000}{10 - 0} = \frac{26,000}{10} = 2,600.$

The y-intercept is: 120,000. Therefore the linear function is: $y = 2,600x + 120,000.$

(b) $y = 2,600(7) + 120,000 \Rightarrow y = 18200 + 120,000 \Rightarrow y = \$138,200$ value of the house.

(c) The value of the house increased, on average, \$2,600 per year.

56. (a) Let x = number of years after 2006 and y = value; then (0, 3000) and (8, 600) are two points on the graph of the linear function. Find the slope: $m = \frac{600 - 3000}{8 - 0} = \frac{-2400}{8} = -300$. The y-intercept is 3000. Therefore the linear function is: $y = -300x + 3,000.$

(b) See Figure 56. The y-intercept = \$3,000, the initial value of the photocopier.

(c) $y = -300(4) + 3000 \Rightarrow y = -1200 + 3000 \Rightarrow y = \$1,800.$ Locate the point (4, 1800) on the graph of the linear function $y = -300x + 3000.$

[0,10] by [0,4000]
Xscl = 1 Yscl = 1000

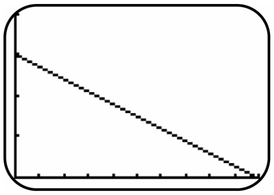


Figure 56

57. (a) Surface area = $4\pi r^2 \Rightarrow 4\pi(3960)^2 \approx 197,000,000 \text{ mi}^2$.

(b) $(197,000,000)(0.71) \approx 140,000,000 \text{ mi}^2$

(c) $\frac{680,000}{140,000,000} \approx 0.00486$ miles. Converted to feet is $(0.00486)(5280) \approx 25.7$ feet.

(d) Since this height is greater than the heights of both Boston and San Diego these cities would be flooded.

(e) We know from above that oceans cover approximately 140,000,000 square miles of the earth. The Antarctic ice cap contains 6,300,000 cubic miles of water.

$\frac{6,300,000}{140,000,000} = 0.045$ miles. Converted to feet is $(0.045)(5280) \approx 238$ feet.

58. (a) $y = 10(76-65)+50 \Rightarrow y = 10(11)+50 \Rightarrow y = 110+50 \Rightarrow y = \$160$ fine.

(b) $100 = 10(x-65)+50 \Rightarrow 100 = 10x - 650 + 50 \Rightarrow 700 = 10x \Rightarrow x = 70$ mph.

(c) Because the function states $x > 65$, tickets start at 66 mph.

(d) $200 < 10(x-65)+50 \Rightarrow 200 < 10x - 650 + 50 \Rightarrow 800 < 10x \Rightarrow x > 80$ mph.

59. (a) $y = \frac{5}{3}(27) + 455 \Rightarrow y = 45 + 455 \Rightarrow y = 500 \text{cm}^3$.

(b) $605 = \frac{5}{3}x + 455 \Rightarrow 150 = \frac{5}{3}x \Rightarrow x = 90°$ C.

(c) $0 = \frac{5}{3}x + 455 \Rightarrow -455 = \frac{5}{3}x \Rightarrow x = -273°$C.

60. (a) Using (2002,75) and (2006,45), find the slope: $m = \frac{45-75}{2006-2002} = -\frac{30}{4} = -7.5$; therefore,

$C(x) = -7.5(x-2002)+75 \Rightarrow C(x) = -7.5x + 15,090.$

Now assuming (2002,29) and (2006, 88), find the slope: $m = \frac{88-29}{2006-2002} = \frac{59}{4} = 14.75.$

Therefore, $L(x) = 14.75(x-2002)+29 \Rightarrow L(x) = 14.75x - 29,500.5$

(b) Set L(x) = C(x). $-7.5x + 15,090 = 14.75x - 29,500.5 \Rightarrow 44,590.5 = 22.25x \Rightarrow 2004 \approx x$.

61. $I = PRT \Rightarrow \frac{I}{RT} = P$ or $P = \frac{I}{RT}$

62. $V = LWH \Rightarrow \dfrac{V}{WH} = L$ or $L = \dfrac{V}{WH}$

63. $P = 2L + 2W \Rightarrow P - 2L = 2W \Rightarrow W = \dfrac{P-2L}{2}$ or $W = \dfrac{P}{2} - L$

64. $P = a + b + c \Rightarrow c = P - a - b$

65. $A = \dfrac{1}{2}h(b_1 + b_2) \Rightarrow 2A = h(b_1 + b_2) \Rightarrow h = \dfrac{2A}{b_1 + b_2}$

66. $A = \dfrac{1}{2}h(b_1 + b_2) \Rightarrow 2A = h(b_1 + b_2) \Rightarrow \dfrac{2A}{h} = b_1 + b_2 \Rightarrow b_2 = \dfrac{2A}{h} - b_1$

67. $S = 2LW + 2WH + 2HL \Rightarrow S - 2LW = H(2W + 2L) \Rightarrow \dfrac{S - 2LW}{2W + 2L}$

68. $S = 2\pi rh + 2\pi r^2 \Rightarrow S - 2\pi r^2 = 2\pi rh \Rightarrow h = \dfrac{S - 2\pi r^2}{2\pi r}$ or $h = \dfrac{S}{2\pi r} - r$

69. $V = \dfrac{1}{3}\pi r^2 h \Rightarrow 3V = \pi r^2 h \Rightarrow h = \dfrac{3V}{\pi r^2}$

70. $y = a(x-h)^2 + k \Rightarrow y - k = a(x-h)^2 \Rightarrow a = \dfrac{y-k}{(x-h)^2}$

71. $S = \dfrac{n}{2}(a_1 + a_n) \Rightarrow 2S = n(a_1 + a_n) \Rightarrow n = \dfrac{2S}{a_1 + a_n}$

72. $S = \dfrac{n}{2}[2a_1 + (n-1)d] \Rightarrow \dfrac{2S}{n} = 2a_1 + (n-1)d \Rightarrow \dfrac{2S}{n} - (n-1)d = 2a_1 \Rightarrow$

$\dfrac{2S - (n-1)dn}{n} = 2a_1 \Rightarrow a_1 = \dfrac{2S - (n-1)dn}{2n}$

73. $s = \dfrac{1}{2}gt^2 \Rightarrow 2s = gt^2 \Rightarrow g = \dfrac{2s}{t^2}$

74. $A = \dfrac{24f}{B(p+1)} \Rightarrow AB(p+1) = 24f \Rightarrow p + 1 = ABp + AB = 24f \Rightarrow ABp = 24f - AB \Rightarrow p = \dfrac{24f - AB}{AB}$ or

$p = \dfrac{24f}{AB} - 1$

75. Let P = the amount put into the short-term note, then $240,000 - P$ = the amount put into the long-term note. With \$13,000 one year interest income, solve:

$P(.06)(1) + (240,000 - P)(0.05)(1) = 13,000 \Rightarrow 0.06P + 120,000 - 0.05P = 13,000 \Rightarrow$

$0.01P = 1,000 \Rightarrow P \Rightarrow 100,000.$ The short-term note was \$100,000 and the long-term was \$140,000.

76. Let P = the amount paid on the land that made a profit, then 120,000 – P = the amount paid on the land that produced a loss. With a combined profit of \$5500, solve:

$0.15P - .10(120,000 - P) = 5500 \Rightarrow 0.15P - 12,000 + .10P = 5500 \Rightarrow .25P = 17,500 \Rightarrow P = 70,000.$

Therefore, \$70,000 was paid for the land that made a profit and \$50,000 was paid for the land that produced a loss.

77. Let P = the amount deposited at 2.5% interest rate, then $2P$ = the amount deposited at 3% interest rate. With a one year interest income of \$850, solve:

$0.025P(1)+0.03(2P)(1)=850 \Rightarrow 0.025P+0.06P=850 \Rightarrow 0.085P=850 \Rightarrow P=10{,}000.$

Therefore, \$10,000 was deposited at 2.5% and \$20,000 was deposited at 3%.

78. Let P = the amount invested at 4% interest rate, then $4P$ = the amount invested at 3.5% interest rate. With a one year interest income of \$3600, solve:

$0.04P(1)+0.035(4P)(1)=3600 \Rightarrow 0.04P+0.14P=3600 \Rightarrow 0.18P=3600 \Rightarrow P=20{,}000.$

Therefore, \$20,000 was invested at 4% and \$80,000 was invested at 3.5%.

79. After taxes, Marietta was able to invest 70% of the original winnings. This is $0.70(200{,}000)=\$140{,}000$. Now let P = amount invested at 1.5%, then $140{,}000-P$ = the amount invested at 4%. With a one year interest income of \$4350, solve: $0.015P+0.04(140{,}000-P)=4350 \Rightarrow 0.015P+5600-0.04P=4350 \Rightarrow$ $-0.025P=-1250 \Rightarrow P=50{,}000.$ Therefore, \$50,000 was invested at 1.5% and \$90,000 was invested at 4%.

80. After income taxes, Latasha was able to invest 72% of the original royalties. This is $0.72(48{,}000)=\$34{,}560$. Now let P = the amount invested at 3.25%, then $34{,}560-P=$ the amount invested at 1.75%. With a one year interest income of \$904.80, solve:

$0.0325P+0.0175(34{,}560-P)=904.80 \Rightarrow 0.0325P+604.80-0.0175P=904.80 \Rightarrow$

$0.015P=300 \Rightarrow P=20{,}000.$ Therefore, \$20,000 was invested at 3.25% and \$14,560 was invested at 1.75%.

Reviewing Basic Concepts (Sections 1.5 and 1.6)

1. $3(x-5)+2=1-(4+2x) \Rightarrow 3x-15+2=1-4-2x \Rightarrow 3x-13=-2x-3 \Rightarrow 5x=10 \Rightarrow x=2.$ The graphs of the left and right sides of the equation intersect at $x=2;$ this supports the solution set: $\{2\}$.

2. Graph $y_1=\pi(1-x)$ and $y_2=.6(3x-1)$. See Figure 2. The graphs intersect at $x=.757$.

3. $0=\frac{1}{3}(4x-2)+1 \Rightarrow 0=\frac{4}{3}x-\frac{2}{3}+1 \Rightarrow -\frac{1}{3}=\frac{4}{3}x \Rightarrow -\frac{1}{4}.$ Graph $y_1=\frac{1}{3}(4x-2)+1.$ See Figure 3.

The graph intersects the x-axis at $x=-\frac{1}{4}$.

[-10,10] by [-10,10]

Xscl = 1 Yscl = 1

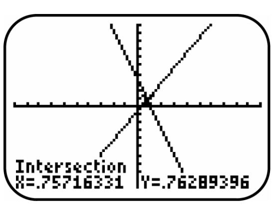


Figure 2

[-10,10] by [-10,10]

Xscl = 1 Yscl = 1

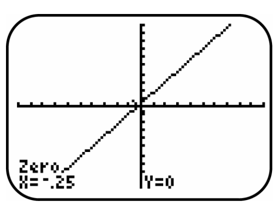


Figure 3

4. (a) $4x-5=-2(3-2x)+3 \Rightarrow 4x-5=-6+4x+3 \Rightarrow -5=-3.$ Since this is false, the equation is a contradiction and the solution set is: $\varnothing$.

   (b) $5x-9=5(-2+x)+1 \Rightarrow 4x-5=-6+4x+3 \Rightarrow -5=-3.$ Since this is true the equation is an identity and the solution set is: $(-\infty,\infty)$.

   (c) $5x-4=3(6-x) \Rightarrow 5x-4=18-3x \Rightarrow 8x=22 \Rightarrow x=\frac{11}{4}.$ The equation is a conditional equation and the solution set is: $\left\{\frac{11}{4}\right\}$.

5. $2x+3(x+2)<1-2x \Rightarrow 2x+3x+6<1-2x \Rightarrow 7x<-5 \Rightarrow x<-\frac{5}{7}.$ The solution set is: $\left(-\infty,\frac{5}{7}\right)$.

   Graph $y_1=2x+3(x+2)$ and $y_2=1-2x$; the graph of y_1 is below the graph of y_2 when $x<-\frac{5}{7}$, which supports the original solution.

6. $-5\le 1-2x<6 \Rightarrow -6 \Rightarrow -2x<5 \Rightarrow 3\ge x>-\frac{5}{2} \Rightarrow -\frac{5}{2}<x\le 3 \Rightarrow \left(-\frac{5}{2},3\right]$

7. (a) The graphs intersect at $x=2 \Rightarrow \{2\}$

   (b) The graph of $f(x)$ intersects or is below the graph of $g(x)$ for $x\ge 2$, on $[2,\infty)$.

8. Since the triangles formed by the shadows are similar, use proportion to solve.

   $\frac{x}{27}=\frac{6}{4} \Rightarrow 4x=162 \Rightarrow x=40.5$ ft.

9. (a) Since the income from each disc is \$5.50, a function R for revenue from selling x discs is: $R(x)=5.50x.$

   (b) Since the cost of producing each disc is \$1.50 and there is a one-time equipment cost of \$800, a function C for cost of recording x discs is: $C(x)=1.50x+800.$

   (c) Solve $R(x)=C(x)$: $5.5x=1.5x+800 \Rightarrow 4x=800 \Rightarrow x=200$ discs.

10. $V=\pi r^2 h \Rightarrow h=\frac{V}{\pi r^2}$

Chapter 1 Review Exercises

1. Use the distance formula: $d=\sqrt{(-1-5)^2+(16-(-8))^2} \Rightarrow d \Rightarrow \sqrt{(-6)^2+24^2} \Rightarrow d=\sqrt{36+576} \Rightarrow$ $d=\sqrt{612}=6\sqrt{17}.$

2. Use the midpoint formula: Midpoint $=\left(\frac{-1+5}{2},\frac{16-8}{2}\right)=(2,4).$

3. Use the slope formula: $m=\frac{16-(-8)}{-1-5} \Rightarrow m=\frac{24}{-6}=-4.$

4. Use point-slope form and slope from ex. 3: $y-16=-4(x-(-1)) \Rightarrow y-16=-4x-4 \Rightarrow y=-4x+12$.

5. Change to slope-intercept form: $3x+4y=144 \Rightarrow 4y=-3x+144 \Rightarrow y=-\frac{3}{4}x+36 \Rightarrow m=-\frac{3}{4}$.

6. For the x-intercept, $y=0$. Therefore, $3x+4(0)=144 \Rightarrow 3x=144 \Rightarrow x=48$.

7. For the y-intercept, $x=0$. Therefore, $3(0)+4y=144 \Rightarrow 4y=144 \Rightarrow y=36$.

8. One possible window is: $[-10, 50]$ by $[-40, 40]$.

9. Since $f(3)=6$ and $f(-2)=1$, $(3,6)$ and $(-2,1)$ are points on the graph of the line. Using these points, find the slope: $m=\frac{6-1}{3-(-2)}=\frac{5}{5}=1$. Use point-slope form to find the function:

$f(x)-6=1(x-3) \Rightarrow f(x)-6=x-3 \Rightarrow f(x)=x+3$. Now solve for $f(8)$: $f(8)=8+3=11$.

10. The slope of the given equation is -4. A line perpendicular to this will have a slope of $\frac{1}{4}$. Using this and point-slope form produces: $y-4=\frac{1}{4}(x-(-2)) \Rightarrow y-4=\frac{1}{4}x+\frac{1}{2} \Rightarrow y=\frac{1}{4}x+\frac{9}{2}$.

11. (a) $m=\frac{-4-5}{2-(-1)} \Rightarrow m=\frac{-9}{3}=-3$

(b) Use point-slope form: $y-5=-3(x-(-1)) \Rightarrow y-5=-3x-3 \Rightarrow y=-3x+2$

(c) Midpoint $=\left(\frac{-1+2}{2},\frac{5+(-4)}{2}\right)=\left(\frac{1}{2},\frac{1}{2}\right)$ or $(0.5,0.5)$

(d) $d=\sqrt{(2-(-1))^2+(-4-5)^2} \Rightarrow d\sqrt{3^2+(-9)^2} \Rightarrow d=\sqrt{9+81}=\sqrt{90}=3\sqrt{10}$

12. (a) $m=\frac{1.5-(-3.5)}{-1-(-3)} \Rightarrow m=\frac{5}{2}=2.5$

(b) Use point-slope form: $y-1.5=2.5(x-(-1) \Rightarrow y-1.5=2.5x+2.5 \Rightarrow y=2.5x+4$

(c) Midpoint $=\left(\frac{-1+(-3)}{2},\frac{1.5+(-3.5)}{2}\right)=\left(-\frac{4}{2},-\frac{2}{2}\right)=(-2,-1)$

(d) $d=\sqrt{(-1-(-3))^2+(1.5-(-3.5))^2} \Rightarrow d=\sqrt{2^2+(5)^2} \Rightarrow d=\sqrt{4+25}=\sqrt{29}$

13. *C* most closely represents: $m<0, b<0$.

14. *F* most closely represents: $m>0, b<0$.

15. *A* most closely represents: $m<0, b>0$.

16. *B* most closely represents: $m>0, b>0$.

17. *E* most closely represents: $m=0$.

18. *D* most closely represents: $b=0$.

19. The rate of change is evaluated as $m = \frac{62.9-66.7}{2009-2001} = -\frac{3.8}{8} = -0.475$. The graph confirms that the line through the ordered pairs falls from left to right and therefore has a negative slope. Thus, the number of basic cable subscribers decreased by an average of 0.475 million (or 475,000) each year from 2001 to 2009. See Figure 19.

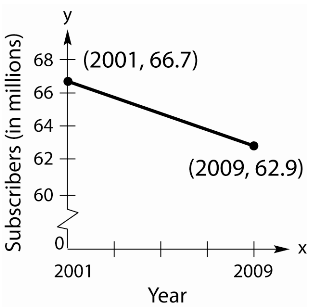


Figure 19

20. False, the slopes are different. Although the difference is small, the lines are not parallel and will intersect.

21. $f(x) = g(x)$ when the graphs intersect or when $x = -3$. I $\{-3\}$ is the best match.

22. $f(x) > g(x)$ when the graph of $f(x)$ is above the graph of $g(x)$ or when $x > -3$. K $(-3, \infty)$ is the best match.

23. $f(x) < g(x)$ when the graph of $f(x)$ is below the graph of $g(x)$ or when $x < -3$. B $(-\infty, 3)$ is the best match.

24. $g(x) \geq f(x)$ when the graph of $g(x)$ intersects or is above the graph of $f(x)$ or when $x \leq -3$. A $(-\infty, -3]$ is the best match.

25. $y_2 - y_1 = 0 \Rightarrow y_2 = y_1 \Rightarrow g(x) = f(x)$ when the graphs intersect or when $x = -3.1$. I $\{-3\}$ is the best match.

26. $f(x) < 0$ when the graph of $f(x)$ is below the x-axis or when $x < -5$. M $(-\infty, -5)$ is the best match.

27. $g(x) > 0$ when the graph of $g(x)$ is above the x-axis or when $x < -2$. O $(-\infty, -2)$ is the best match.

28. $y_2 - y_1 < 0 \Rightarrow y_2 < y_1 \Rightarrow g(x) < f(x)$ when the graph of $g(x)$ is below the graph of $f(x)$ or when $x > -3$. K $(-3, \infty)$ is the best match.

29. $5[3+2(x-6)] = 3x+1 \Rightarrow 5[2x-9] = 3x+1 \Rightarrow 10x-45 = 3x+1 \Rightarrow 7x = 46 \Rightarrow x = \frac{46}{7}.$

The graphs of $y_1 = 5[3+2(x-6)]$ and $y_2 = 3x+1$ intersect at: $\left\{\frac{46}{7}\right\}$, which supports the result.

30. $\frac{x}{4} - \frac{x+4}{3} = -2 \Rightarrow 12\left[\frac{x}{4} - \frac{x+4}{3} = -2\right] \Rightarrow 3x - 4(x+4) = -24 \Rightarrow -x-16 = -24 \Rightarrow -x = -8 \Rightarrow x = 8.$

The graphs of $y_1 = \frac{x}{4} - \frac{x+4}{3}$ and $y_2 = -2$ intersect at: $\{8\}$, which supports the result.

31. $-3x-(4x+2)=3 \Rightarrow -7x-2=3 \Rightarrow -7x=5 \Rightarrow x=-\frac{5}{7}.$ The graphs

of $y_1=-3x-(4x+2)$ and $y_2=3$ intersect at: $\left\{-\frac{5}{7}\right\},$ which supports the result.

32. $-2x+9+4x=2(x-5)-3 \Rightarrow 2x+9=2x-10 \Rightarrow 9=-10.$ This is false, therefore this is a contradiction and the solution is: $\varnothing$. The graphs of $y_1=-2x+9+4x$ and $y_2=2(x-5)-3$ are parallel and do not intersect, therefore no solution, $\varnothing$, which supports the result.

33. $0.5x+0.7(4-3x)=0.4x \Rightarrow 0.5x+2.8-2.1x=0.4x \Rightarrow 5x+28-21x=4x \Rightarrow -20x=-28 \Rightarrow$

$x=\frac{7}{5}.$ The graphs of $y_1=.5x+.7(4-3x)$ and $y_2=.4x$ intersect at: $\left\{\frac{7}{5}\right\},$ which supports the result.

34. $\frac{x}{4}-\frac{5x-3}{6}=2-\frac{7x+18}{12} \Rightarrow 12\left[\frac{x}{4}-\frac{5x-3}{6}=2-\frac{7x+18}{12}\right] \Rightarrow 3x-2(5x-3)=$

$24-(7x+18) \Rightarrow -7x+6=-7x+6 \Rightarrow 6=6.$ This is true, therefore an identity and the solution is:

$(-\infty,\infty).$ The graphs of $y_1=\frac{x}{4}-\frac{5x-3}{6}$ and $y_2=2-\frac{7x+18}{12}$ are the same line; the solution is $(-\infty,\infty)$, which supports the result.

35. $x-8<1-2x \Rightarrow 3x<9 \Rightarrow x<3.$ The graph of $y_1=x-8$ is below the graph of $y_2=1-2x$ for the interval: $(-\infty,3),$ which supports the result.

36. $\frac{4x-1}{3} \ge \frac{x}{5}-1 \Rightarrow 15\left[\frac{4x-1}{3} \ge \frac{x}{5}-1\right] \Rightarrow 5(4x-1) \ge 3x-15 \Rightarrow 20x-5 \ge 3x-15 \Rightarrow$

$17x \ge -10 \Rightarrow x \ge -\frac{10}{17}.$ The graph of $y_1=\frac{4x-1}{3}$ intersects or is above the graph of $y_2=\frac{x}{5}-1$

for the interval: $\left[-\frac{10}{17},\infty\right),$ which supports the result.

37. $-6 \le \frac{4-3x}{7}<2 \Rightarrow -42 \le 4-3x<14 \Rightarrow -46 \le -3x<10 \Rightarrow \frac{46}{3} \ge x>-\frac{10}{3} \Rightarrow -\frac{10}{3}<x \le \frac{46}{3}$ or

for the interval: $\left(-\frac{10}{3},\frac{46}{3}\right].$

38. (a) Graph $y_1=5\pi+(\sqrt{3})x-6.24(x-8.1)+(\sqrt[3]{9})x.$ See Figure 38. Find the x- intercept: $x \approx \{-3.81\}$.

(b) $f(x)<0$ when the graph of $f(x)$ is below the x-axis. This happens for the interval: $(-\infty,-3.81)$.

(c) $f(x) \ge 0$ when the graph of $f(x)$ intersects or is above the x-axis. This happens for the interval: $[-3.81,\infty)$.

[-10,10] by [-10,10]
Xscl = 1 Yscl = 1

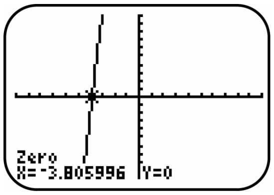


Figure 38

39. It costs \$30 to produce each CD and there is a one-time advertisement cost, therefore: $C(x) = 30x + 150$.

40. Each tape is sold for \$37.50, therefore: $R(x) = 37.50x$.

41. $C(x) = R(x)$ when $30x + 150 = 37.50x \Rightarrow 150 = 7.50x \Rightarrow x = 20$.

42. When the graph of $R(x)$ is below $C(x)$ the company is losing money, when $R(x)$ intersects $C(x)$ the company breaks even, and when $R(x)$ is above $C(x)$ the company makes money. This happens as follows: losing money when $x < 20$, breaking even when $x = 20$, and making money when $x > 20$.

43. $A = \dfrac{24f}{B(p+1)} \Rightarrow AB(p+1) = 24f \Rightarrow f = \dfrac{AB(p+1)}{24}$.

44. $A = \dfrac{24f}{B(p+1)} \Rightarrow AB(p+1) = 24f \Rightarrow B = \dfrac{24f}{A(p+1)}$.

45. (a) $f(x) = -3.52(5) + 58.6 \Rightarrow f(x) = -17.6 + 58.6 = 41^\circ$ F.

(b) $-15 = -3.52x + 58.6 \Rightarrow -73.6 = -3.52x \Rightarrow x \approx 20.9$ or about 21,000 feet.

(c) Graph $y_1 = -3.52x + 58.6$. Find the coordinates of the point where $x = 5$ to support the answer in (a). Find the coordinates of the point where $y = -15$ to support the answer in (b).

46. (a) Linear regression gives the model: $f(x) \approx 0.12331x - 244.75$. Answers may vary.

(b) $f(1990) \approx 0.12331x - 244.75 = \$0.63$ million The cost of a 30 second Super Bowl ad in 1990 was approximately \$0.63 million. This value is within about 0.17 million of the actual cost.

(c) $4 \approx 0.12331x - 244.75 \Rightarrow x \approx 2017$ Thus, the cost for a 30 second Super Bowl ad could reach \$4 million 2017.

47. Let x = bat speed and y = ball travel distance; then (50, 320) and (80, 440) are two points on the graph of the function. Use the points to find slope: $m = \dfrac{440 - 320}{80 - 50} \Rightarrow m = \dfrac{120}{30} = 4$. Now use point-slope form to find the equation for the model: $y - 320 = 4(x - 50) \Rightarrow y - 320 = 4x - 200 \Rightarrow y = 4x + 120$. Because the slope is 4, the ball will travel 4 feet further for each additional 1 mph in bat speed.

48. Since surface area is: $A = 2(lw) + 2(lh) + 2(wh)$ we can solve $496 = 2(18)(8) + 2(18)h + 2(8)h \Rightarrow 496 = 288 + 36h + 16h \Rightarrow 208 = 52h \Rightarrow h = 4$. The height of the box is 4 feet.

49. Since there are 5280 feet in a mile, there are $5280 \times 26.2 = 138,336$ feet in a marathon. Since there are 3.281 feet in a meter, there are $100 \times 3.281 = 328.1$ feet in a 100 meter dash. Now use a proportion to solve: $\frac{9.58}{328.1} = \frac{x}{138,336} \Rightarrow 328.1x = 1325258.88 \Rightarrow x \approx 4039.19$ seconds to run a marathon. Divide by 60 to get minutes run: $4039.19 \div 60 = 67.32$ minutes run or 1 hour 7 minutes and 19 seconds.

50. $C = \frac{5}{9}(864 - 32) \Rightarrow C = \frac{5}{9}(832) \Rightarrow C = \frac{4160}{9} \Rightarrow 462\frac{2}{9}\,^\circ$C.

51. Find the constant of variation: $4k = 3000 \Rightarrow k = 750.$ Use this to find the pressure: $10(750) = 7500$ kg / m^2.

52. (a) Use any two points to find slope: $m = \frac{1.8 - 3}{1 - 0} \Rightarrow m = \frac{-1.2}{1} = -1.2$ Now use point-slope form to find the equation: $y - 3 = -1.2(x - 0) \Rightarrow y = -1.2x + 3.$

(b) $y = -1.2(-1.5) + 3 \Rightarrow y = 1.8 + 3 \Rightarrow y = 4.8$ when $x = -1.5.$

$y = -1.2(3.5) + 3 \Rightarrow y = -4.2 + 3 \Rightarrow y = -1.2$ when $x = 3.5.$

53. (a) Enter the years in L_1 and enter test scores in L_2. The regression equation is: $f(x) = 1.2x - 1886.4$

(b) $y = 1.2(2012) - 1886.4 \Rightarrow y = 2414.4 - 1886.4 \Rightarrow y = 528.$

(c) Over time data can change its pattern or character. Answers may vary.

54. Let $x =$ the amount of 5% solution to be added, then solve:
$120(.20) + x(.05) = (120 + x)(.10) \Rightarrow 24 + .05x = 12 + .10x \Rightarrow 12 = .05x \Rightarrow x = 240$ mL of 5% solution needs to be added.

55. The company will at least break even when $R(x) \ge C(x)$, therefore solve:
$8x \ge 3x + 1500 \Rightarrow 5x \ge 1500 \Rightarrow x \ge 300$ or for the interval: $[300, \infty)$. 300 or more DVD's need to be sold to at least break even.

56. Let m = mental age and c = chronological age, then $IQ = \frac{100m}{c}$.

(a) $130 = \frac{100m}{7} \Rightarrow 910 = 100m \Rightarrow m = 9.1$ years.

(b) $IQ = \frac{100(20)}{16} \Rightarrow IQ = \frac{2000}{16} \Rightarrow IQ = 125$ years.

57. (a) Enter the heights in L_1 and enter weights in L_2. The regression equation is: $y \approx 4.512x - 154.4$

(b) $y = 4.51(75) - 154.4 \Rightarrow y = 338.25 - 154.4 \Rightarrow y \approx 184.$

58. (a) Enter the heights in L_1 and enter weights in L_2. The regression equation is: $y \approx 4.465x - 133.3$

(b) $y = 4.465(80) - 133.3 \Rightarrow y = 357.2 - 133.3 \Rightarrow y \approx 224.$

Chapter 1 Test

1. (a) The number $\frac{4}{2} = 2$ is a natural number, integer, rational number, and real number.

   (b) The number π is a real number.

   (c) The number $\sqrt{2}$ is a real number.

   (d) The number $0.25 = \frac{1}{4}$ is a rational number and real number.

2. Use technology to approximate the following.

   (a) $\sqrt{5} \approx 2.236$

   (b) $\sqrt[3]{7} \approx 1.913$

   (c) $3^{1/4} \approx 1.316$

   (d) $\frac{1-1.1^2}{2+\pi^2} \approx -0.018$

3. $d = \sqrt{(-2-4)^2 + (4-(-3))^2} = \sqrt{6^2 + 7^2} = \sqrt{36+49} = \sqrt{85}$, $M = \left(\frac{-2+4}{2}, \frac{4+(-3)}{2}\right) = \left(\frac{2}{2}, \frac{1}{2}\right) = \left(1, \frac{1}{2}\right)$

4. (a) $f(-2) = 4 - 7(-2) = 4 + 14 = 18$

   (b) $f(b) = 4 - 7b$

   (c) $f(a+h) = 4 - 7(a+h) = 4 - 7a - 7h$

5. The set of ordered pairs $\{(3,4), (2,-5), (1,0), (4,-5)\}$ represents a function since each x-coordinate corresponds to only one y-coordinate.

6. (a) $m = \frac{4-1}{1-(-5)} = \frac{3}{6} = \frac{1}{2}$

   (b) $m = \frac{9-3}{4-4} = \frac{6}{0} \Rightarrow$ undefined

   (c) $m = \frac{5-5}{1.7-1.2} = \frac{0}{0.5} = 0$

7. (a) Domain: $(-\infty, \infty)$, Range: $[2, \infty)$, x-intercept: none, y-intercept: (0, 3)

   (b) Domain: $(-\infty, \infty)$, Range: $(-\infty, 0]$, x-intercept: (3,0), y-intercept: $(0, -3)$

   (c) Domain: $[-4, \infty)$, Range: $[0, \infty)$, x-intercept: $(-4, 0)$, y-intercept: $(0, 2)$

8. (a) $f(x) = g(x)$ when the graph of $f(x)$ intersects the graph of $g(x)$ therefore $\{-4\}$.

   (b) $f(x) < g(x)$ when the graph of $f(x)$is below the graph of $g(x)$, for the interval: $(-\infty, -4)$.

   (c) $f(x) \geq g(x)$ when the graph of $f(x)$intersects or is above the graph of $g(x)$, for the interval: $[-4, \infty)$.

   (d) $f(y_2 - y_1) = 0 \Rightarrow y_2 = y_1 \Rightarrow g(x) = f(x)$ when the graph of $g(x)$ intersects the graph of $f(x)$, therefore $\{-4\}$.

9. (a) $y_1 = 0$ when the graph of $f(x)$ intersects the x-axis, therefore $\{5.5\}$.

(b) $y_1 < 0$ when the graph of $f(x)$ is below the x-axis, for the interval $(-\infty, 5.5]$.

(c) $y_1 > 0$ when the graph of $f(x)$ is above the x-axis, for the interval $(5.5, \infty)$.

(d) $y_1 \le 0$ when the graph of $f(x)$ intersects or is below the x-axis, for the interval $(-\infty, 5.5]$.

10. (a) $3(x-4)-2(x-5) = -2(x+1)-3 \Rightarrow 3x-12-2x+10 = -2x-2-3 \Rightarrow x-2 = -2x-5$

$\Rightarrow 3x = -3 \Rightarrow x = -1$. Check: $3(-1-4)-2(-1-5) = -2(-1+1)-3 \Rightarrow$

$3(-5)-2(-6) = -2(0)-3 \Rightarrow -15+12 = 0-3 \Rightarrow -3 = -3$

(b) Graph $y_1 = 3(x-4)-2(x-5)$ and $y_2 = -2(x+1)-3$. See Figure 10. $f(x) > g(x)$ for the interval: $(-1, \infty)$ because the graph of $y_1 = f(x)$ is above the graph of $y_2 = g(x)$ for domain values greater than -1.

(c) See Figure 10. $f(x) < g(x)$ for the interval $(-\infty, -1)$ because the graph of $y_1 = f(x)$ is below the graph of $y_2 = g(x)$ for domain values less than -1.

11. (a) $-\frac{1}{2}(8x+4)+3(x-2) = 0 \Rightarrow -4x-2+3x-6 = 0 \Rightarrow -x-8 = 0 \Rightarrow x = -8$ or $\{-8\}$. (b)

$-\frac{1}{2}(8x+4)+3(x-2) \le 0 \Rightarrow -4x-2+3x-6 \le 0 \Rightarrow -x-8 \le 0 \Rightarrow x \ge -8$ or for the interval: $[-8, \infty)$.

(c) Graph $y_1 - \frac{1}{2}(8x+4)+3(x-2)$. See Figure 11. The x-intercept is -8 supporting the result in part (a). The graph of the linear function lies below or on the x-axis for domain values greater than or equal to -8, supporting the results in part (b).

[-10,10] by [-10,10]
Xscl = 1 Yscl = 1

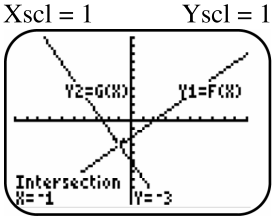


Figure 10

[-15,5] by [-10,10]
Xscl = 1 Yscl = 1

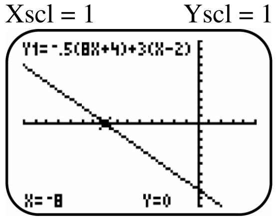


Figure 11

12. (a) Since x represents the number of years since 2007, we will use the points $(0, 13837)$ and $(5, 15082)$ find the slope: $a = \frac{15{,}082 - 13{,}837}{5-0} = \frac{1245}{5} = 249$. The y-intercept is the point (0, 13837) thus the value of b is 13837. The linear function is $f(x) = 249x + 13{,}837$.

(b) The number of stations increased, on average , by 249 per year.

(c) Since x represents the number of years since 2007 we will let $x = 7$.

$f(7) = 249(7) + 13{,}837 = 15{,}580$. The number of radio stations in 2014 is about 15,580.

13. (a) Since the given line has a slope of -2 and parallel lines have equal slopes, our new line has a slope of -2. Now use point-slope form: $y - 5 = -2(x - (-3)) \Rightarrow y - 5 = -2x - 6 \Rightarrow y = -2x - 1$.

(b) The equation: $-2x + y = 0 \Rightarrow y = 2x$ has a slope of 2. Since perpendicular lines have slopes whose product equals -1, our new line has a slope of $-\frac{1}{2}$. Now use point-slope form:

$y - 5 = -\frac{1}{2}(x - (-3)) \Rightarrow \; y - 5 = -\frac{1}{2}x - \frac{3}{2} \Rightarrow y = -\frac{1}{2}x + \frac{7}{2}$.

14. For the x-intercept $y = 0$, therefore: $3x - 4(0) = 6 \Rightarrow 3x = 6 \Rightarrow x = 2$. The x-intercept is $(2,0)$. For the y-intercept $x = 0$, therefore: $3(0) - 4y = 6 \Rightarrow -4y = 6 \Rightarrow y = -\frac{6}{4} = -\frac{3}{2}$. The y-intercept is: $\left(0, -\frac{3}{2}\right)$. Using the intercepts: $\left(0, -\frac{3}{2}\right)$ and $(2,0)$, the slope is $m = \dfrac{0 - \left(-\frac{3}{2}\right)}{2 - 0} = \dfrac{\frac{3}{2}}{2} \Rightarrow m = \frac{3}{4}$.

15. The equation of the horizontal line passing through $(-3,7)$ is $y = 7$. The equation of the vertical line passing through $(-3,7)$ is $x = -3$.

16. (a) Enter the wind speed in L_1 and enter degrees in L_2. The regression equation is: $Y \approx -.246x + 35.7$ and the correlation coefficient is: $r \approx -.96$.

(b) $y \approx -.246(40) + 35.7 \Rightarrow y \approx -9.84 + 35.7 \Rightarrow y \approx 25.9\ ^\circ F$.

17. Let x be the number of hours the car traveled at 60 mph and then $4 - x$ will be the number of hours the car traveled at 74 mph. Using the formula D = RT, we know the distance traveled at 60 mph is $60x$, and the distance traveled at 74 mph is $74(4 - x)$. Since the total distance traveled is 275 miles we have the equation $60x + 74(4 - x) = 275 \Rightarrow 60x + 296 - 74x = 275 \Rightarrow -14x = -21 \Rightarrow x = 1.5$ and $4 - x = 2.5$. Therefore, the car traveled for 1.5 hours at 60 mph and 2.5 hours at 74 mph.

18. Since the load is directly proportional to the width we have $y = kx$, where y is the number of pounds that can be supported and x is the width in inches. Then, $510 = k(2.25) \Rightarrow k = \frac{510}{2.25} = 226\frac{2}{3}$ and

$y = \left(226\frac{2}{3}\right)(3.1) = 702\frac{2}{3}$ pounds