INSTRUCTOR'S SOLUTIONS MANUAL

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A GRAPHICAL APPROACH TO PRECALCULUS WITH LIMITS

A UNIT CIRCLE APPROACH

SEVENTH EDITION

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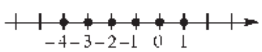
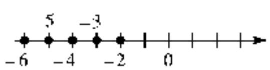
Contents

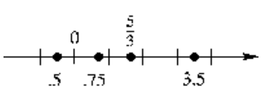
Chapter 1: Linear Functions, Equations, and Inequalities

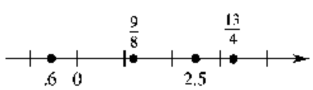
1.1: Real Numbers and the Rectangular Coordinate System

1. (a) The only natural number is 10.
   (b) The whole numbers are 0 and 10.
   (c) The integers are $-6, -\frac{12}{4}\,(\text{or } -3), 0, 10.$
   (d) The rational numbers are $-6, -\frac{12}{4}\,(\text{or } -3), -\frac{5}{8}, 0, .31, .\overline{3}, \text{ and } 10.$
   (e) The irrational numbers are $-\sqrt{3},\ 2\pi$ and $\sqrt{17}.$
   (f) All of the numbers listed are real numbers.
2. (a) The natural numbers are $\frac{6}{2}(\text{or}3), 8, \text{and}\sqrt{81}(\text{or } 9).$
   (b) The whole numbers are $0, \frac{6}{2}(\text{or } 3), 8, \text{and}\sqrt{81}(\text{or } 9).$
   (c) The integers are $-8, -\frac{14}{7}(\text{or } -2), 0, \frac{6}{2}(\text{or } 3), 8, \text{and}\sqrt{81}(\text{or } 9).$
   (d) The rational numbers are $-8, -\frac{14}{7}(\text{or } -2), -.245, \frac{6}{2}(\text{or } 3), 8, \text{and}\sqrt{81}(\text{or } 9).$
   (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 $-\sqrt{100}(\text{or } -10)\,\text{and} -1.$
   (d) The rational numbers are $-\sqrt{100}\,(\text{or } -10), -\frac{13}{6}, -1, 5.23, 9.\overline{14}, 3.14,$ 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 $-\sqrt{49}(\text{or } -7), 3, 18, \text{and } 56.$
   (d) The rational numbers are $-\sqrt{49}(\text{or } -7), -.405, -.\overline{3}, .1, 3, 18, \text{and } 56.$
   (e) The only irrational number is $6\pi.$
   (f) All of the numbers listed are real numbers.
5. The number 19,900,037,000,000 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 -24 is an integer, rational, and real number.

8. The number 17 is an integer, rational number, and real number
9. The number $-71,060$ is an integer, rational number and real number.
10. The number -12.5 is a rational number and real number.
11. The number $7\sqrt{2}$ 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 I. See Figure 25-34.
27. The point $(-3,2)$ is in Quadrant II. See Figure 25-34.
28. The point $(-4,3)$ is in Quadrant II. See Figure 25-34.
29. The point $(-5,-2)$ is in Quadrant III. See Figure 25-34.
30. The point $(-2,-4)$ is in Quadrant III. See Figure 25-34.
31. The point $(2,-2)$ is in Quadrant IV. See Figure 25-34.

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

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

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

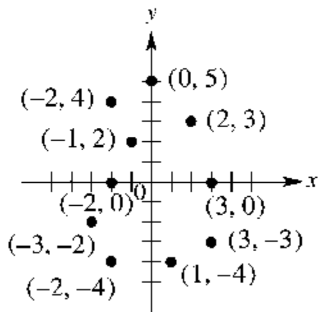


Figure 25-34

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

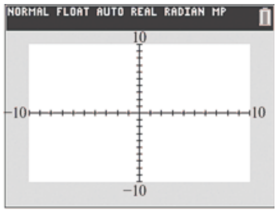


Figure 47

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

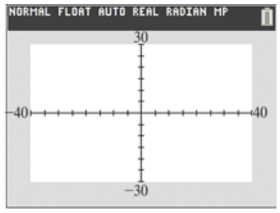


Figure 48

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

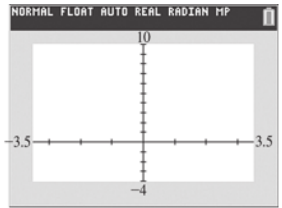


Figure 49

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

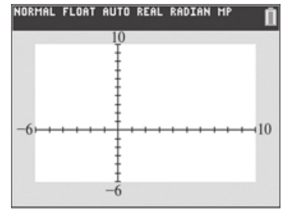


Figure 50

51. See Figure 51.

52. See Figure 52.

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

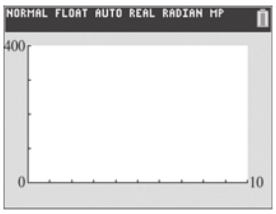


Figure 51

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

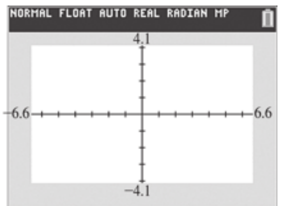


Figure 52

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. $M=\left(\frac{2011+2015}{2},\frac{36.53+67.39}{2}\right)=\left(\frac{4026}{2},\frac{103.92}{2}\right)=(2013,51.96)$; the revenue was about \$51.96 billion.

102. $M=\left(\frac{2006+2012}{2},\frac{7505+3335}{2}\right)=\left(\frac{4018}{2},\frac{10840}{2}\right)=(2009,5420)$; the revenue was about \$5420 million.

The result is quite a bit higher than the actual figure.

103. In 2012 , $M=\left(\frac{2011+2013}{2},\frac{22,350+23,550}{2}\right)=\left(\frac{4024}{2},\frac{45,900}{2}\right)=(2012,22,950)$; poverty level was approximately \$22,950. In 2014, $M=\left(\frac{2013+2015}{2},\frac{23,350+24,250}{2}\right)=\left(\frac{4028}{2},\frac{47,800}{2}\right)=$ $(2014,23,900)$; poverty level was approximately \$23,900.

104. For 2017, $M=\left(\frac{2016+2018}{2},\frac{7194+7500}{2}\right)=\left(\frac{4034}{2},\frac{14,694}{2}\right)=(2017,7347)$; enrollment was 7347 thousand. For 2019, $M=\left(\frac{2018+2020}{2},\frac{7500+7706}{2}\right)=\left(\frac{4038}{2},\frac{15,206}{2}\right)=(2019,7603)$;

Enrollment was about 7603 thousand.

105. (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.

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

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

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

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

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

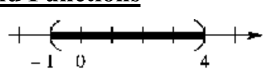
Since $(x_1-x_2)^2 = (x_2-x_1)^2$ and $(y_1-y_2)^2 = (y_2-y_1)^2$, the distances are the same.

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

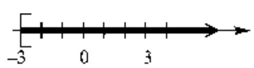
That is, the sum is equal to the distance between *P* and Q.

1.2: Introduction to Relations and Functions

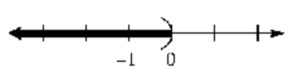
1. The interval is $(-1,4)$.



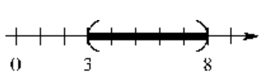
2. The interval is $[-3,\infty)$.



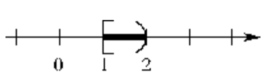
3. The interval is $(-\infty,0)$.



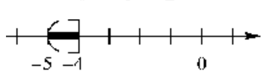
4. The interval is $(3, 8)$.



5. The interval is $\left[1,2\right)$.



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

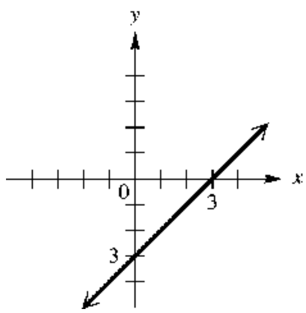


Figure 17

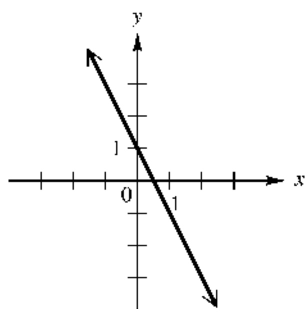


Figure 18

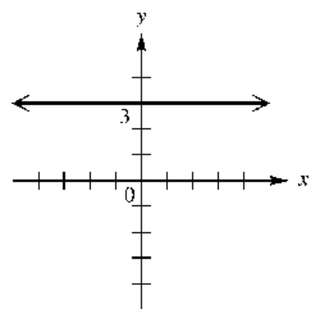


Figure 19

20. See Figure 20

21. See Figure 21

22. See Figure 22

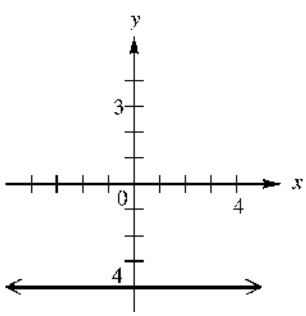


Figure 20

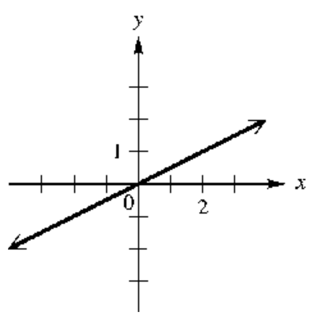


Figure 21

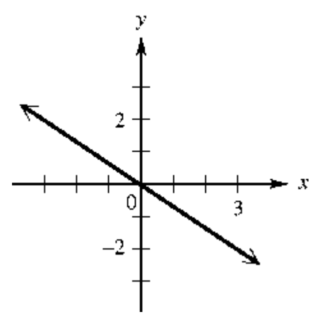


Figure 22

23. See Figure 23

24. See Figure 24

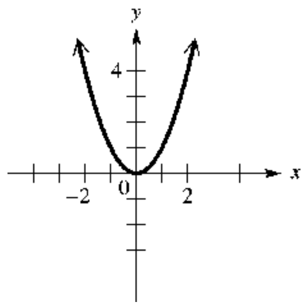


Figure 23

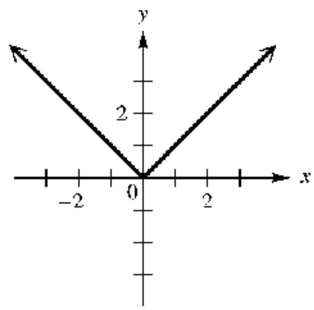


Figure 24

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. $f(8)=\sqrt[3]{8^2}=\sqrt[3]{64}=4$

64. $f(-8)=\sqrt[3]{(-8)^2}=\sqrt[3]{64}=4$

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. (a) Given that $f(x)=2x^2+4$, then $f(a)=2a^2+4$

(b) Given that $f(x)=2x^2+4$, then $f(b+1)=2(b+1)^2+4=2(b^2+2b+1)+4=$

$2b^2+2b+2+4=2b^2+2b+6$

(c) Given that $f(x) = 2x^2 + 4$, then $f(3x) = 2(3x)^2 + 4 = 2(9x^2) + 4 = 18x^2 + 4$

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) $A = \{(\text{Apple, } 216), (\text{Alphabet, } 90), (\text{Google, } 89), (\text{Microsoft, } 85)\}$, The U.S. total revenue in 2011 for Apple was \$216,000,000 dollars.

(b) See Figure 81.

(c) $D = \{\text{Apple, Alphabet, Google, Microsoft}\}$, $R = \{216, 90, 89, 85\}$

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

(b) See Figure 80

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

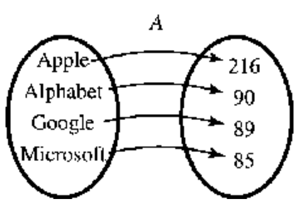


Figure 79

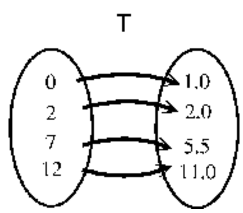


Figure 80

81. (a) See Figure 81.

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

(c) Domain: $\{1990, 2000, 2005, 2012, 2015\}$, Range: $\{10.8, 12.8, 13.5, 15.1, 16.4\}$.

82. (a) See Figure 82.

(b) $f(20012) = 2366$ In 2012, there were \$2366 billion spent on personal health care.

(c) $D: \{2010, 2011, 2012, 2013, 2014, 2015\}$ R : $\{2195, 2273, 2366, 2436, 2563, 2717\}$

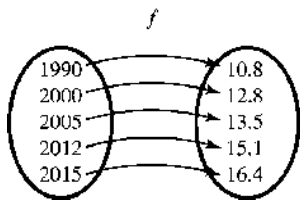


Figure 81

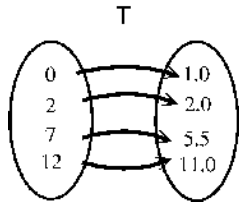


Figure 82

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 $f(-1) = -3$.

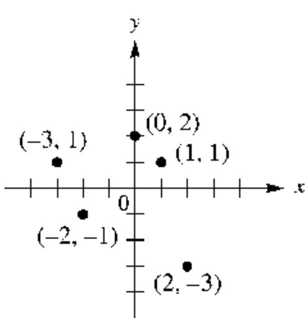


Figure 1

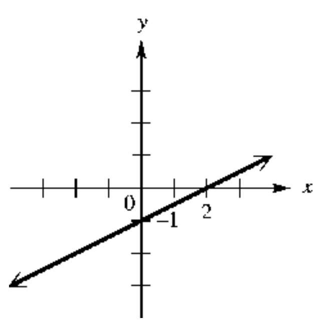


Figure 8

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 $m = 3$.

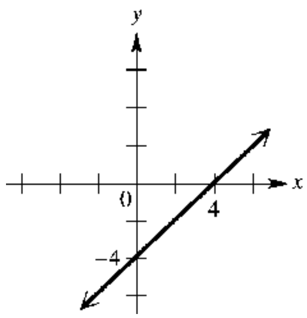


Figure 1

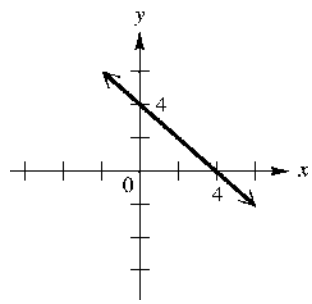


Figure 2

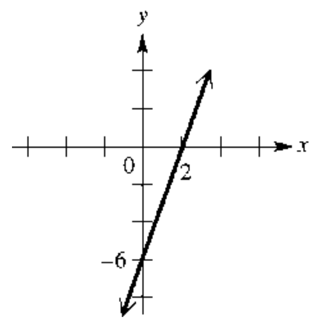


Figure 3

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 $m = \frac{4}{3}$.

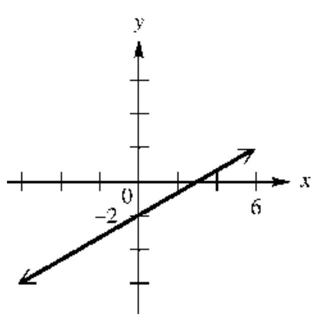


Figure 4

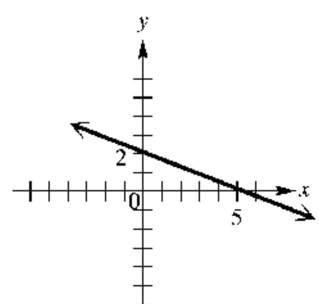


Figure 5

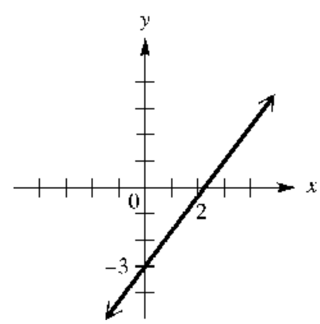


Figure 6

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 $m = -.5$.

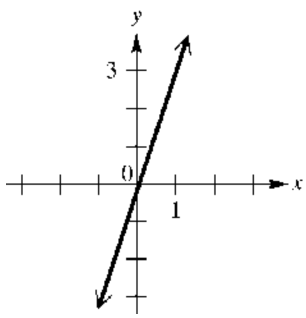


Figure 7

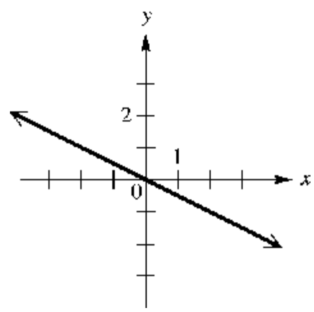


Figure 8

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

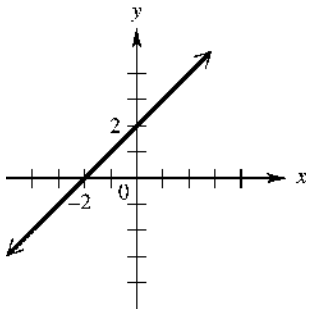


Figure 9

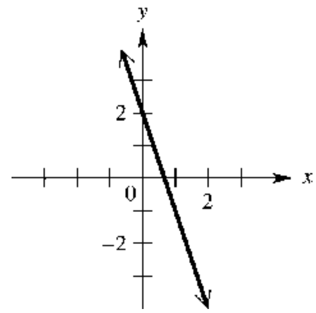


Figure 10

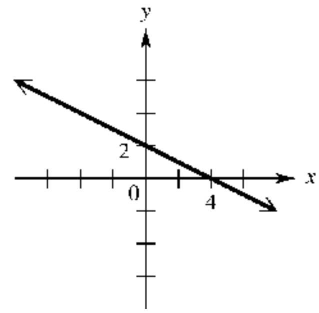


Figure 11

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

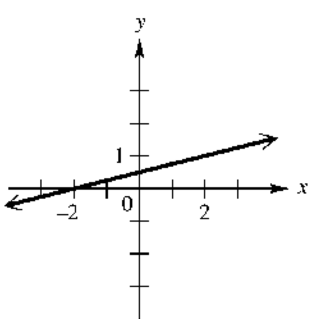


Figure 12

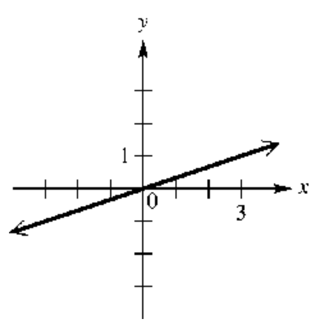


Figure 13

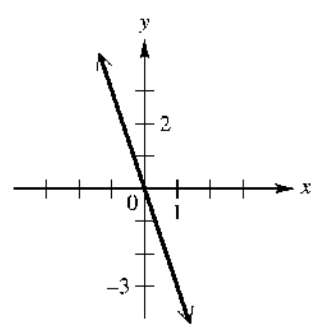


Figure 14

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) $f(-2)=\dfrac{2-(-2)}{4}=1$ and $f(4)=\dfrac{2-(4)}{4}=-\dfrac{1}{2}$

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

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

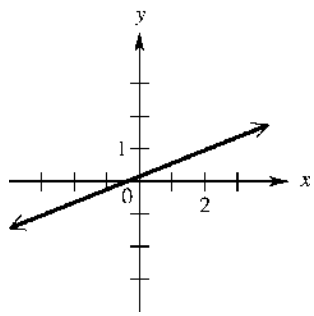


Figure 15

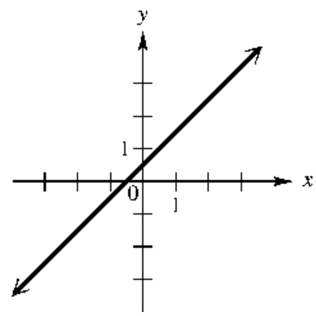


Figure 16

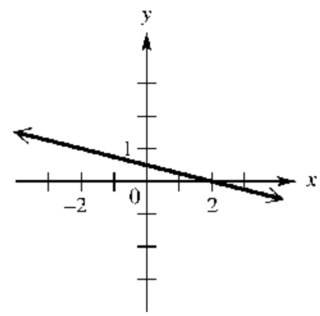


Figure 17

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

(b) The x-intercept is (–5,0) and corresponds to the zero of f. See Figure 19

(c) $\dfrac{1}{15}x+\dfrac{1}{3}=0 \Rightarrow x+5=0 \Rightarrow x=-5$

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

(b) The x-intercept is (4,0) and corresponds to the zero of f. See Figure 20.

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

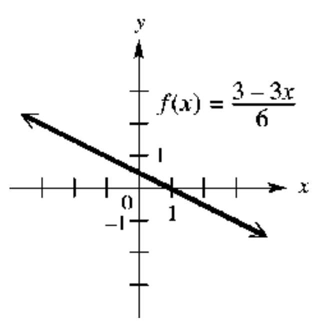


Figure 18

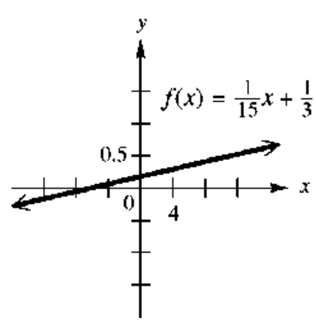


Figure 19

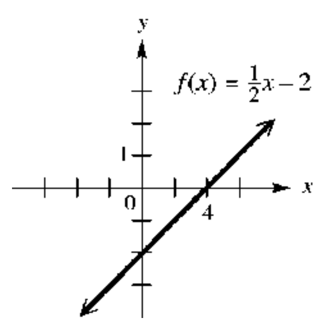


Figure 20

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

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

23. The graph is shown in Figure 23.

(a) x-intercept: none (b) y-intercept: $(0, -3)$ (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: $(0,5)$ (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: none (b) y-intercept: $(0, 2.5)$ (c) Domain: $(-\infty, \infty)$ (d) Range: $\{2.5\}$

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

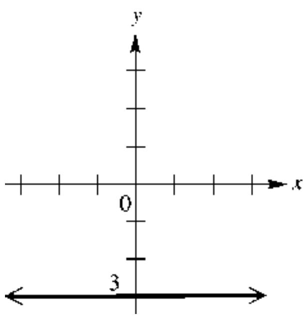


Figure 23

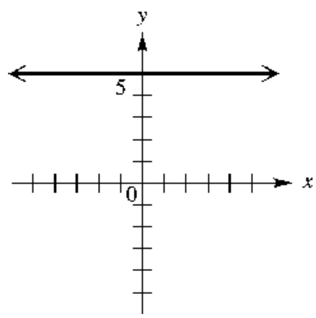


Figure 24

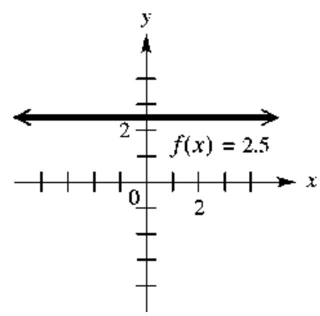


Figure 25

26. The graph is shown in Figure 26.

(a) x-intercept: none (b) y-intercept: $(0, 1.25)$ (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.

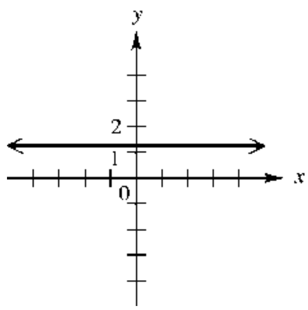


Figure 26

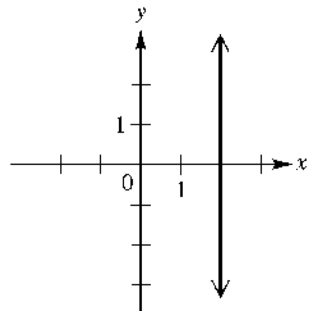


Figure 27

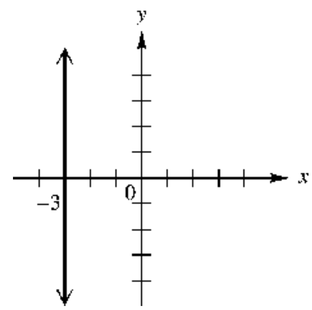


Figure 28

29. This is a horizontal line graph, therefore $y = 3$.
30. This is a horizontal line graph on the x-axis, therefore $y = 0$.
31. This is a vertical line graph on the y-axis, therefore $x = 0$.
32. This is a vertical line graph, therefore $x = 4$.
33. (a) The equation of the x-axis is $y = 0$.
    (b) The equation of the y-axis is $x = 0$.
34. To find the x-intercept , let $y = 0$ and solve for x. To find the y-intercept, let $x = 0$ and solve for y.
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

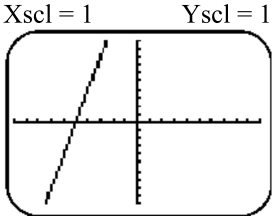


Figure 35a

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

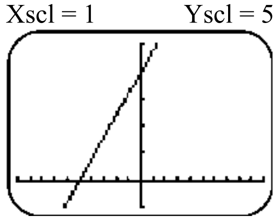


Figure 35b

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

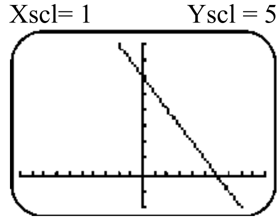


Figure 36a

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

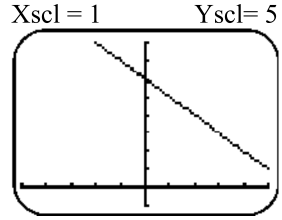


Figure 36b

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

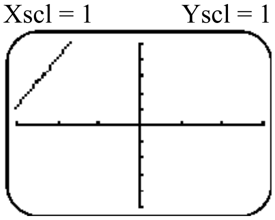


Figure 37a

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

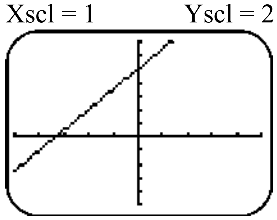


Figure 37b

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

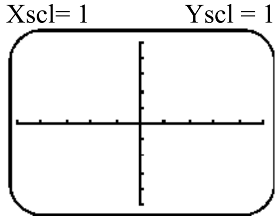


Figure 38a

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

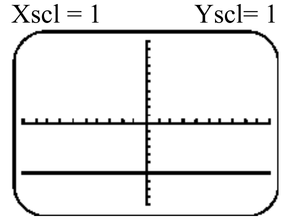


Figure 38b

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

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

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

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

52. Since the graph falls from left to right, then the slope must be less than zero. Since the graph crosses the y-axis below the origin, then the value of the y-intercept must be less than zero. The result is answer D.

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) $\Rightarrow$ $m = \dfrac{-1-1}{1-0} = \dfrac{-2}{1} = -2$. The y-intercept is $(0,1)$ and the x-intercept is $\left(\dfrac{1}{2},0\right)$.

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

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

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

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

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

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), $m = \dfrac{-4-(-4)}{50-0} = \dfrac{0}{50} = 0$. 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.

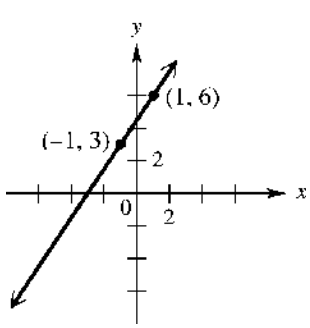


Figure 75

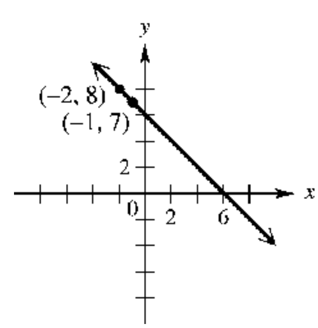


Figure 76

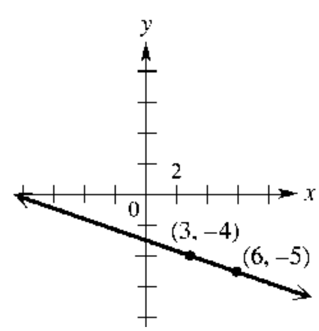


Figure 77

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.

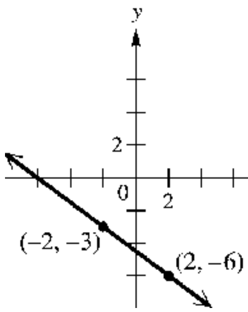


Figure 78

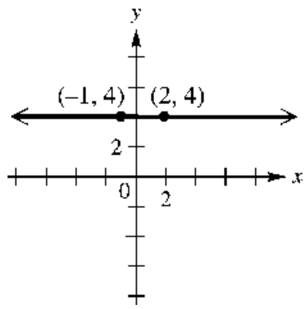


Figure 79

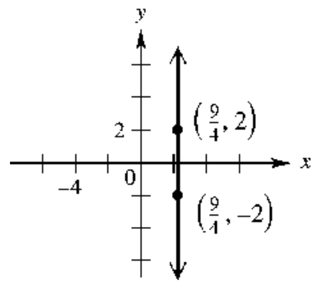


Figure 80

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.

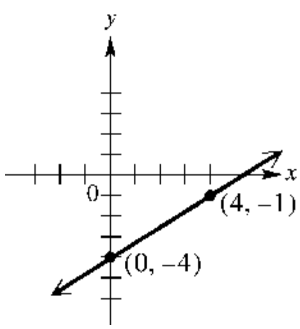


Figure 81

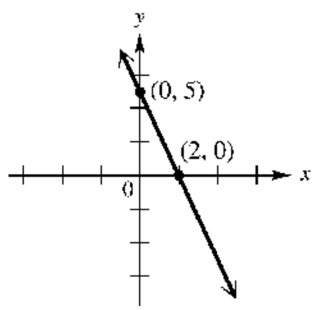


Figure 82

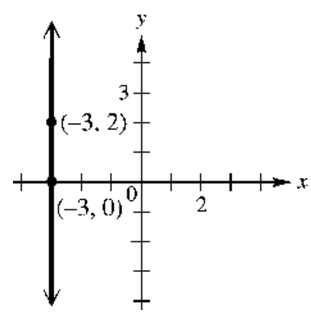


Figure 83

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

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.

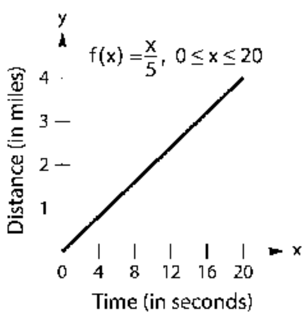


Figure 89

90. (a) $f = \{(N,493), (H,678), (B,1137), (M,1341)\}$

(b) $D = \{N, H, B, M\}$; $R = \{493, 678, 1137, 1341\}$

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

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

92. 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 $f(x) = 192x + 275$. $f(11) = 192(11) + 275 = \$2387$

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.

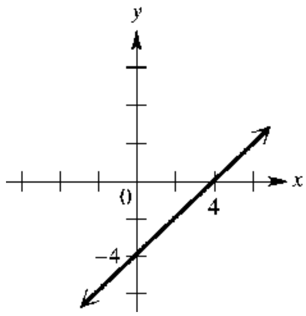


Figure 27

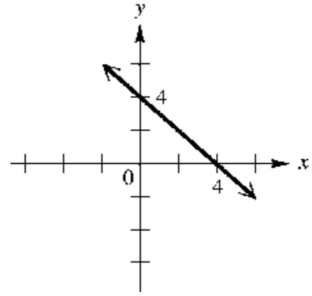


Figure 28

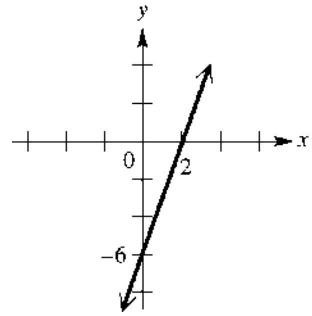


Figure 29

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.

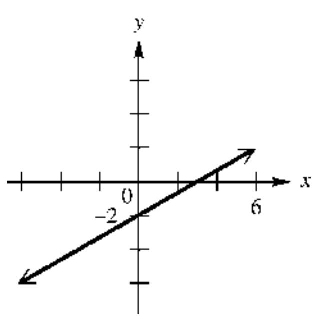


Figure 30

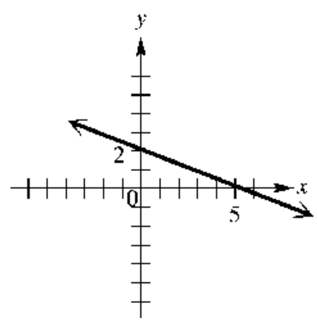


Figure 31

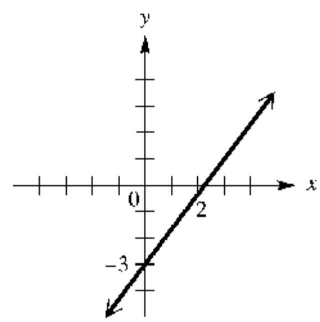


Figure 32

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.

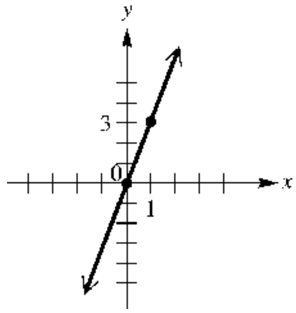


Figure 33

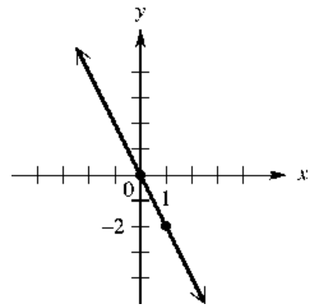


Figure 34

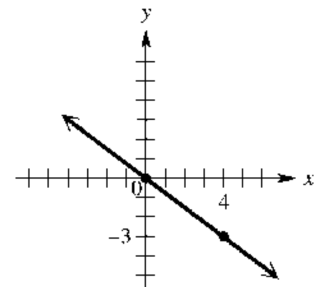


Figure 35

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.

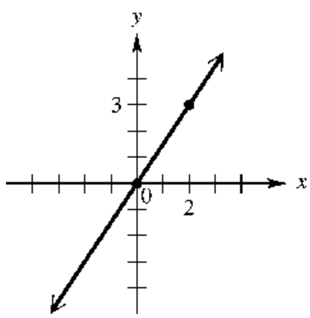


Figure 36

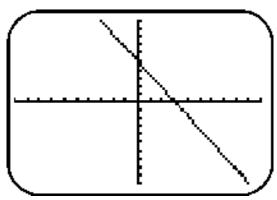


Figure 37

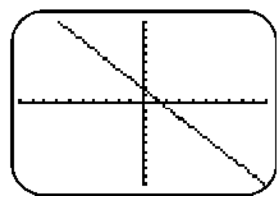


Figure 38

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

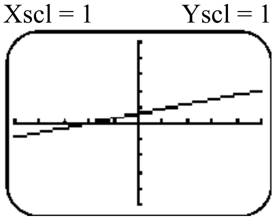


Figure 39

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

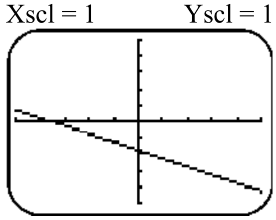


Figure 40

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

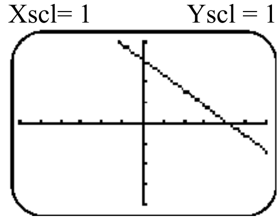


Figure 41

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

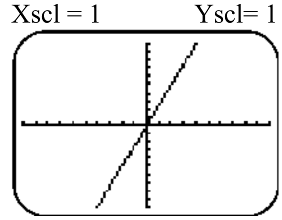


Figure 42

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 $(2012, 147)$, $(2015, 183)$ to find slope, then $m=\frac{183-147}{2015-2012}=\frac{36}{3}\Rightarrow m=12$.

Now use point-slope form to find the equation:

$y-147=12(x-2012)\Rightarrow y-147=12x-24{,}144\Rightarrow y=12x-23{,}997$.

(b) y = 12(2014) – 23,997 =171. There was approximately \$171 billion in betting revenue in 2014.

64. (a) First find the slope: $m=\frac{9.16-7.66}{2017-1990}=\frac{1.5}{27}\approx 0.056$, now use point-slope form to find the equation.

$y-7.66=0.056(x-1990)$

(b) The hourly wage increased at a rate of approximately \$0.056 per year between 1990 and 2017.

(c) At $x = 2009$, $y=0.056(2009-1990)+7.66\Rightarrow y=0.056(19)+7.66\Rightarrow y\approx 8.72$, which is higher thant the actual value of \$8.27.

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) $C(88)=\frac{5}{9}(86-32)=30°C$

66. (a) The slope is $\frac{16.4-13.2}{2013-2007}=\frac{3.2}{6}=\frac{8}{15}$:. Using point-slope form produces the equation:

$y-13.2=\frac{8}{15}(x-2007)$.

(b) At $x = 2014$, $y-13.2=\frac{8}{15}(2014-2007)\Rightarrow y-13.2=\frac{8}{15}(7)\Rightarrow y\approx 16.9$ million

67. (a) The slope is $\frac{79-28}{2016-2010}=\frac{51}{6}=8.5$:. Using point-slope form produces the equation:

$y-28=8.5(x-2010)$.

(b) Every year from 2010 to 2016, Google advertising revenue increased by about \$8.5 billion on average.

(c) 2012 Revenue: $y-28=8.5(2012-2010)\Rightarrow y=8.5(2)+28\Rightarrow y=45$ billion

2014 Revenue: $y-28=8.5(2014-2010)\Rightarrow y=8.5(4)+28\Rightarrow y=62$ billion

The calculated values are a little higher than the actual values given in the table.

68. (a) The slope is $\dfrac{25-16}{2009-2014}=\dfrac{9}{-5}=-1.8$:. Using point-slope form produces the equation:

$y-25=-1.8(x-2009)$.

(b) Every year from 2009 to 2014, newspaper ad revenue decreased by \$1.8 billion on average.

(c) $y-25=-1.8(2012-2009)\Rightarrow y-25=-1.8(3)\Rightarrow y=19.6$ The result is about \$20 billion.

69. (a) Enter the years in L_1 and enter tuition and fees in L_2. The regression equation is:

$y\approx 635.83x-1{,}242{,}735$.

(b) See Figure 69.

(c) At $x=2005, y\approx 635.83(2005)-1{,}242{,}735\approx 32{,}104$ this is greater than 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:

$y\approx 284.79x-557{,}950$

(b) See Figure 70.

(c) At $x=2009, y\approx 284.79(2009)-557{,}950\approx 14{,}193$

(d) At $x=2019, y\approx 284.79(2019)-557{,}950\approx 17{,}041$

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

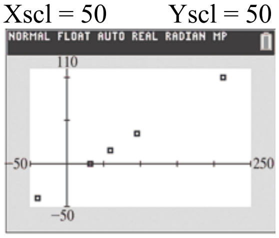


Figure 65

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

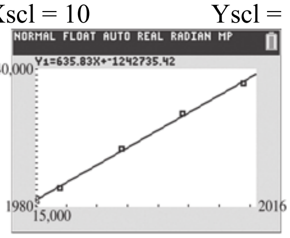


Figure 69

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

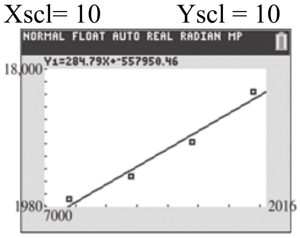


Figure 70

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: $(-\infty, \infty)$

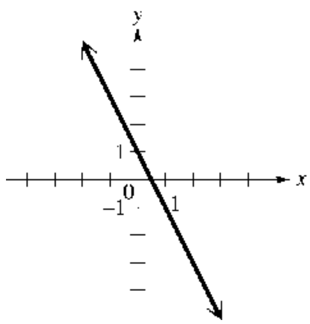


Figure 2

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. 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: $y = 2x - 3$.

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

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

7. 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:

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

8. (a) See Figure 8.

(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.

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

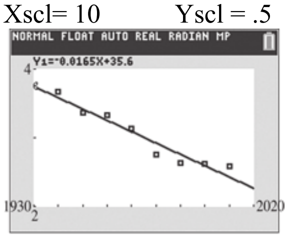


Figure 8

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

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

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

Check: $-\left[7-\left(4\left(7\right)+2\right)\right]=2+\left(2\left(7\right)+7\right)\Rightarrow -\left[7-30\right]=2+21\Rightarrow 23=23$ 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

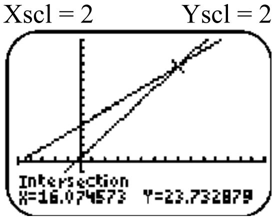


Figure 43

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

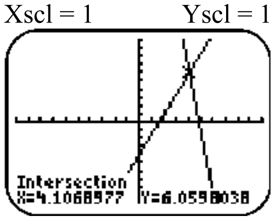


Figure 44

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

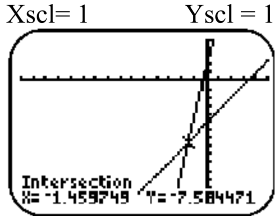


Figure 45

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 $Y_1=0.23\left(\sqrt{3}+4x\right)-0.82\left(\pi x+2.3\right)$ 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 $Y_1=-0.15\left(6+\sqrt{2}x\right)+1.4\left(2\pi x-6.1\right)$ 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

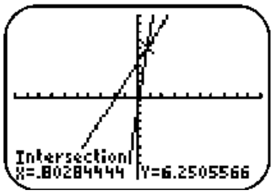


Figure 46

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

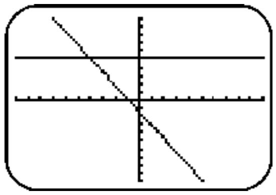


Figure 47

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

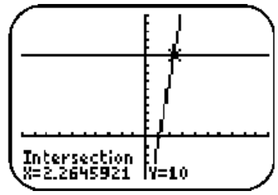


Figure 48

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. $6(2x+1)=4x+8\left(x+\dfrac{3}{4}\right) \Rightarrow 12x+6=4x+8x+6 \Rightarrow 12x+6=12x+6 \Rightarrow 6=6 \Rightarrow$ Identity. The solution set is $(-\infty,\infty)$ The table of $Y_1=6(2x+1)$ and $Y_2=4x+8\left(x+\dfrac{3}{4}\right)$ 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. $5[1-(3-x)]=3(5x+2)-7 \Rightarrow 5[-2+x]=15x+6-7 \Rightarrow -10+5x=15x-1 \Rightarrow$
$-10x=9 \Rightarrow x=-\dfrac{9}{10} \Rightarrow$ Conditional.
The solution set is $-\dfrac{9}{10}$. The table of $Y_1 = 5[1-(3-x)]$ and $Y_2 = 3(5x+2)-7$ shows that the answers are the same when x = $-\dfrac{9}{10}$.

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) $1 - 2x \geq 0 \Rightarrow -2x \geq -1 \Rightarrow x \leq \frac{1}{2},$ 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) $4 - 3x \leq 0 \Rightarrow -3x \leq -4 \Rightarrow x \geq \frac{4}{3},$ Interval Notation : $\left[\frac{4}{3}, \infty\right)$

(c) $4 - 3x \geq 0 \Rightarrow -3x \geq -4 \Rightarrow x \leq \frac{4}{3},$ 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. $\dfrac{1}{3}x-\dfrac{1}{5}x\le 2 \Rightarrow \left[\dfrac{1}{3}x-\dfrac{1}{5}x\le 2\right] \Rightarrow 5x-3x\le 30 \Rightarrow 2x\le 30 \Rightarrow x\le 15 \Rightarrow (-\infty,15]$. The graph of $y_1=\dfrac{1}{3}x-\dfrac{1}{5}x$ intersects or is below the graph of $y_2=2$ for the interval $(-\infty,15]$.

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

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

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

$x-18>-24 \Rightarrow x>-6 \Rightarrow (-6,\infty)$. The graph of $y_1=\dfrac{x-2}{2}-\dfrac{x+6}{3}$ is above the graph of

$y_2=5$ for the interval: $(-6,\infty)$.

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

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

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

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

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

98. $\dfrac{3}{4}x-.2x-6 \le 0 \Rightarrow 20\left[\dfrac{3}{4}x-.2x-6 \le 0\right] \Rightarrow 15x-4x-120 \le 0 \Rightarrow 11x \le 120 \Rightarrow x \le \dfrac{120}{11} \Rightarrow \left(-\infty,\dfrac{120}{11}\right]$. The

graph of $y_1=\dfrac{3}{4}x-.2x-6$ intersects or is below the graph of $y_2=0$ for the interval $\left(-\infty,\dfrac{120}{11}\right]$.

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].