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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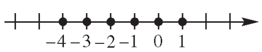
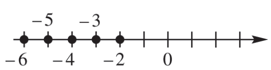
Contents

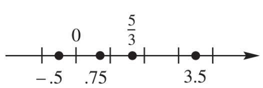
Chapter 1: Linear Functions, Equations, and Inequalities

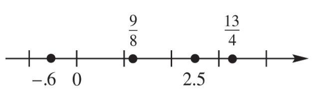
1.1: Real Numbers and the Rectangular Coordinate System

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 $-6, -\frac{12}{4}(\text{or } -3), -\frac{5}{8}, 0, .31, .\overline{3},$ 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 6π.
   (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.

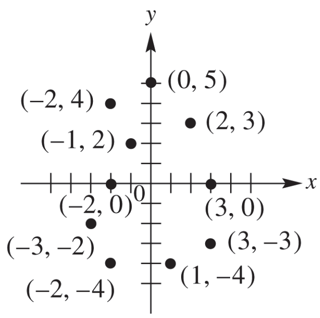


Figure 25-34

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

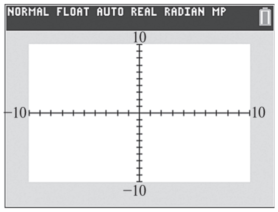


Figure 47

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

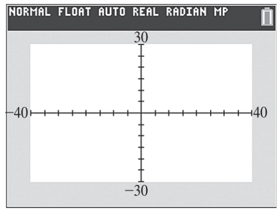


Figure 48

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

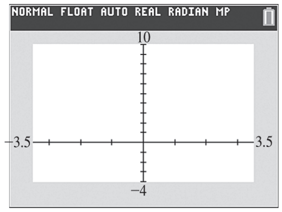


Figure 49

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

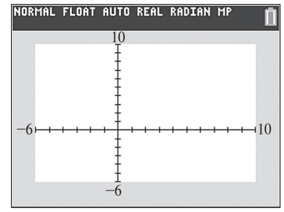


Figure 50

51. See Figure 51.

52. See Figure 52.

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

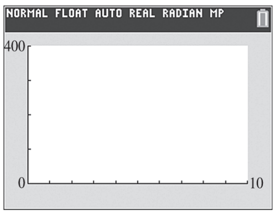


Figure 51

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

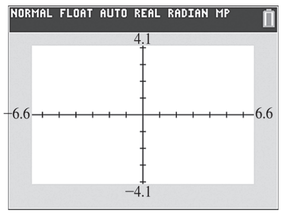


Figure 52

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:

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

$x_2=13.42.$ $\dfrac{8.55+y_2}{2}=-2.75\Rightarrow 8.55+y_2=-5.50\Rightarrow y_2=-14.05.$ 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 $d_1+d_2=2d_2=2\left(\frac{1}{2}\sqrt{(x_2-x_1)^2+(y_2-y_1)^2}\right)=\sqrt{(x_2-x_1)^2+(y_2-y_1)^2}.$

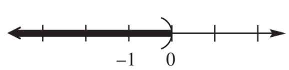
That is, the sum is equal to the distance between *P* and Q.

1.2: Introduction to Relations and Functions

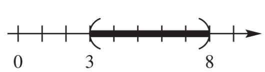
1. The interval is $(-1,4)$.

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

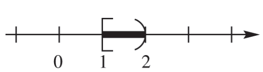
3. The interval is $(-\infty,0)$.



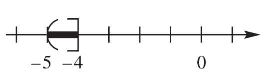
4. The interval is $(3, 8)$.



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



6. The interval is



$(-5,-4]$.

7. $(-4,3)\Rightarrow\{x\,|\,-4<x<3\}$

8. $[2,7)\Rightarrow\{x\,|\,2\le x<7\}$

9. $(-\infty,-1]\Rightarrow\{x\,|\,x\le-1\}$

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

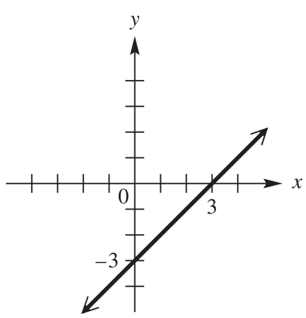


Figure 17

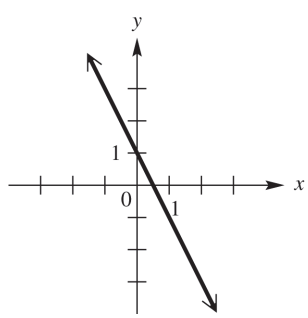


Figure 18

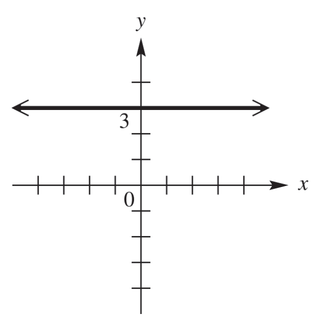


Figure 19

20. See Figure 20

21. See Figure 21

22. See Figure 22

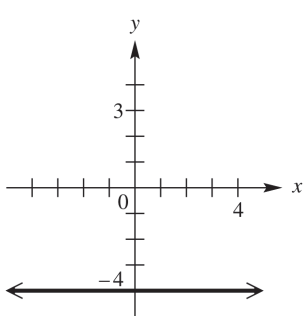


Figure 20

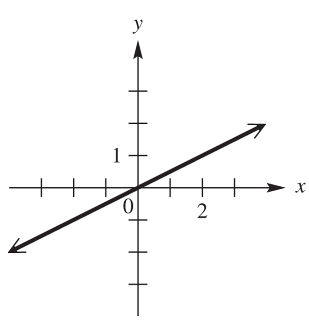


Figure 21

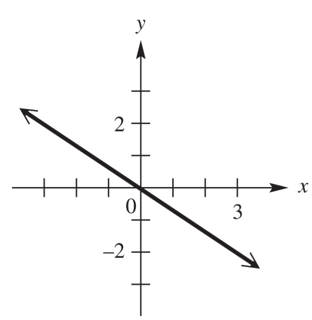


Figure 22

23. See Figure 23

24. See Figure 24

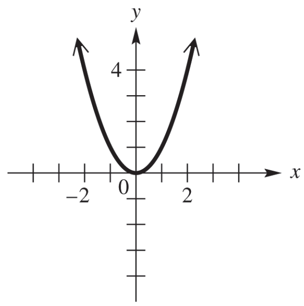


Figure 23

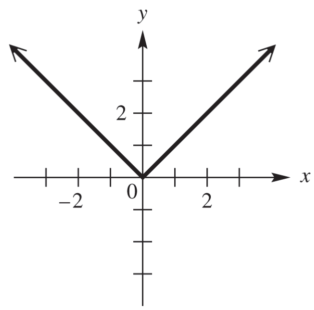


Figure 24

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: $\{\sqrt{2}, \sqrt{3}, \sqrt{5}, \sqrt{6}, \sqrt{7}\}$.

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 $f(b+1)=2(b+1)^2+4=2(b^2+2b+1)+4=$

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