4.1 EXERCISES

PRACTICE

For each of the following relations, determine the domain and range. See Example 1.

1. $R = \{(-2, 5), (-2, 3), (-2, 0), (-2, -9)\}$

2. $S = \{(0, 0), (-5, 2), (3, 3), (5, 3)\}$

3. $A = \{(\pi, 2), (-2\pi, 4), (3, 0), (1, 7)\}$

4. $B = \{(3, 3), (-4, 3), (3, 8), (3, -2)\}$

5. $T = \{(x, y) \mid x \in \mathbb{Z} \text{ and } y = 2x\}$

6. $U = \{(\pi, y) \mid y \in \mathbb{Q}\}$

7. $C = \{(x, 3x + 4) \mid x \in \mathbb{Z}\}$

8. $D = \{(5x, 3y) \mid x \in \mathbb{Z} \text{ and } y \in \mathbb{Z}\}$

9. $3x - 4y = 17$

10. $x + y = 0$

11. $x = |y|$

12. $y = x^2$

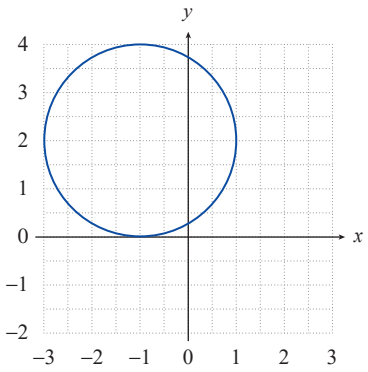
13. $y = -1$

14. $x = 3$

15. $x = 4x$

16. $y = 7\pi^2$

17.



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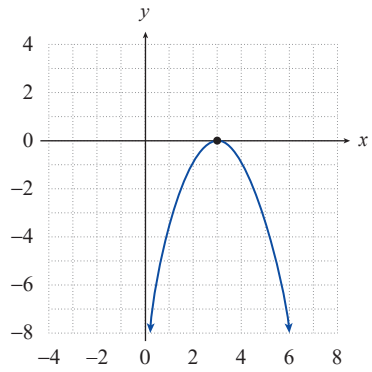

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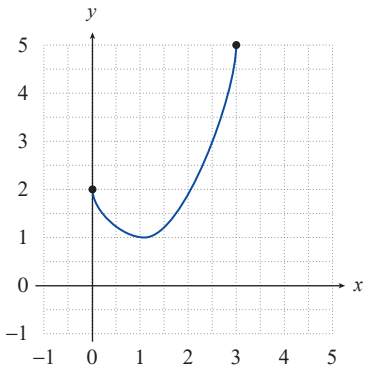

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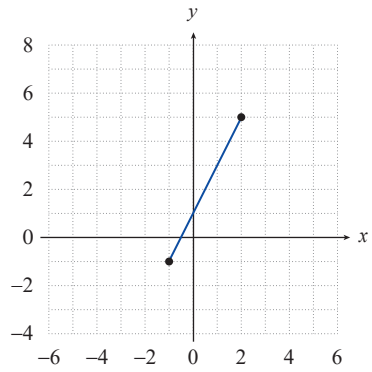

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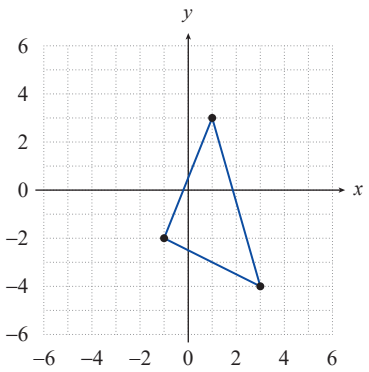

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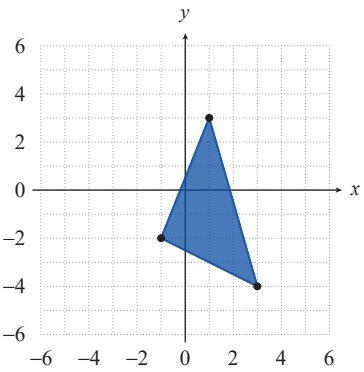


23. $V = \{(x, y) \mid x \text{ is the brother of } y\}$

24. $W = \{(x, y) \mid y \text{ is the daughter of } x\}$

Determine which of the following relations is a function. For those that are not functions, identify two ordered pairs with the same first coordinate. See Examples 2 and 3.

25. $R = \{(-2, 5), (2, 4), (-2, 3), (3, -9)\}$

26. $S = \{(3, -2), (4, -2)\}$

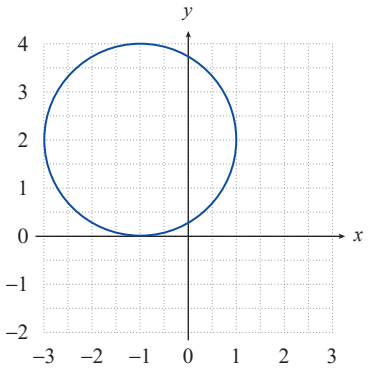
27. $T = \{(-1, 2), (1, 1), (2, -1), (-3, 1)\}$

28. $U = \{(4, 5), (2, -3), (-2, 1), (4, -1)\}$

29. $V = \{(6, -1), (3, 2), (6, 4), (-1, 5)\}$

30. $W = \{(2, -3), (-2, 4), (-3, 2), (4, -2)\}$

31.



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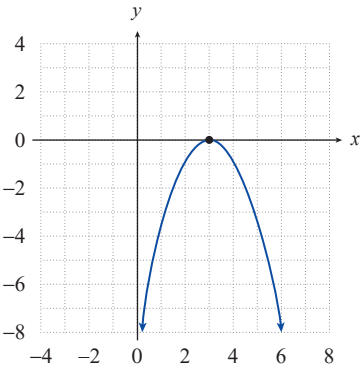

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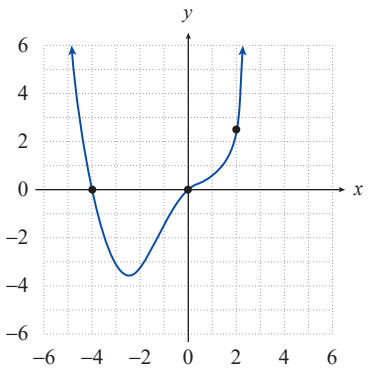

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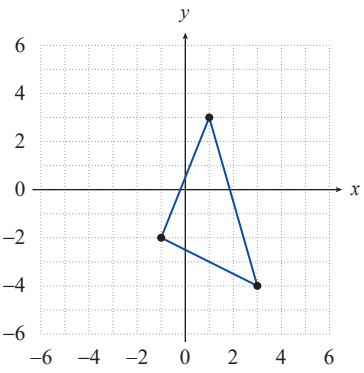

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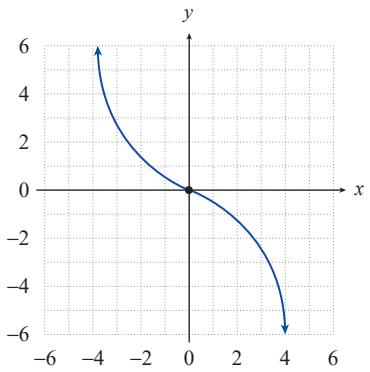

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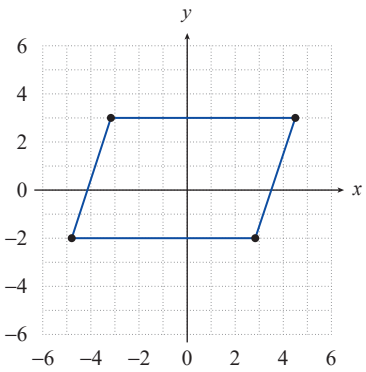


Identify which of the following relations is a function by determining whether there is a unique *y*-value related to every *x*-value in the relation's domain. For those that are not functions, identify two ordered pairs with the same first coordinate.

37. $y = \dfrac{1}{x}$

38. $x = y^2 - 1$

39. $x + y^2 = 0$

40. $y = 2x^2 - 4$

41. $y = \dfrac{x-1}{x+2}$

42. $x^2 + y^2 = 1$

43. $y = |x - 2|$

44. $y = x^3$

45. $y^2 - x^2 = 3$

46. $y = \sqrt{x} - 4$

Rewrite each of the following relations as a function of *x*. Then evaluate the function at $x = -1$. See Example 4.

47. $6x^2 - x + 3y = x + 2y$

48. $2y - \sqrt[3]{x} = x - (x-1)^2$

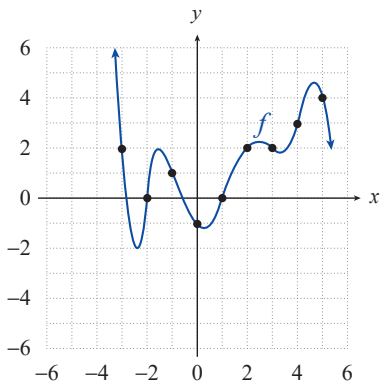
49. $\dfrac{x+3y}{5} = 2$

50. $x^2 + y = 3 - 4x^2 + 2y$

51. $y - 2x^2 = -2(x + x^2 + 5)$

52. $\dfrac{9y+2}{6} = \dfrac{3x-1}{2}$

Use the graph below of a function *f* to answer the following questions. See Example 5.



53. What is the value of $f(-1)$?

54. What is the value of $f(0)$?

55. What is the value of $f(4)$?

56. For what integer value(s) of x is $f(x)=4$?

57. For what integer value(s) of x is $f(x)=2$?

58. For what integer value(s) of x is $f(x)=0$?

For each of the following functions, determine **a.** $f(2)$, **b.** $f(x-1)$, **c.** $f(x+a)-f(x)$, and **d.** $f(x^2)$. See Example 6.

59. $f(x)=x^2+3x$

60. $f(x)=\sqrt{x}$

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

62. $f(x)=-x^2-7$

63. $f(x)=2(5-3x)$

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

65. $f(x)=\sqrt{1-x}-3$

66. $f(x)=\dfrac{-\sqrt{1-x}+5}{2}$

Determine $\dfrac{f(x+h)-f(x)}{h}$ for each of the following functions. See Example 6c.

67. $f(x)=x^2-5x$

68. $f(x)=x^3+2$

69. $f(x)=\dfrac{1}{x+2}$

70. $f(x)=6x^2-7x+3$

71. $f(x)=5x^2$

72. $f(x)=(x+3)^2$

73. $f(x)=2x-7$

74. $f(x)=\sqrt{x}$

75. $f(x)=x^{\frac{1}{2}}-4$

76. $f(x)=\dfrac{3}{x}$

Identify the domain, the codomain, and the range of each of the following functions. See Example 7.

77. $f:\mathbb{R}\to\mathbb{R}$ by $f(x)=3x$

78. $g:\mathbb{Z}\to\mathbb{Z}$ by $g(x)=3x$

79. $f:\mathbb{Z}\to\mathbb{Z}$ by $f(x)=x+5$

80. $g:[0,\infty)\to\mathbb{R}$ by $g(x)=\sqrt{x}$

81. $h:\mathbb{N}\to\mathbb{N}$ by $h(x)=x+5$

82. $h:\mathbb{N}\to\mathbb{R}$ by $h(x)=\dfrac{x}{2}$

Determine the implied domain of each of the following functions. See Example 8.

83. $f(x)=\sqrt{x-1}$

84. $g(x)=\sqrt[5]{x+3}-2$

85. $h(x)=\dfrac{3x}{x^2-x-6}$

86. $f(x)=(2x+6)^{\frac{1}{2}}$

87. $g(x)=\sqrt[4]{2x^2+3}$

88. $h(x)=\dfrac{3x^2-6x}{x^2-6x+9}$

89. $s(x)=\dfrac{2x}{1-3x}$

90. $f(x)=(x^2-5x+6)^3$

91. $c(x)=\dfrac{x-1}{2-x}$

92. $g(x)=\dfrac{5}{\sqrt{3-x^2}}$

93. $f(x)=\sqrt{x+6}+1$

94. $g(x)=-5x^2-4x$

95. $h(x)=\dfrac{-3(-5+5x)}{x}$

96. $h(x)=\sqrt{3-x}$

WRITING & THINKING

97. Justify why the following statement is true: All functions are relations, but not all relations are functions.

TECHNOLOGY

Use a graphing utility to evaluate each of the following functions at the specified values of x.

98. $f(x)=\dfrac{7x^{\frac{5}{3}}-2x^{\frac{1}{3}}}{x^{\frac{1}{2}}}$; find $f(8)$ and $f(12)$

99. $g(x)=\sqrt{x^3-4x^2+2x+31}$; find $g(2)$ and $g(3)$

100. $f(x)=\dfrac{2x^5-9x^3+12}{4x^3-7x+6}$; find $f(-3)$ and $f(2)$

101. $g(x)=\left(5x^2-7x+1\right)^3$; find $g(-19)$ and $g(12)$

102. $f(x)=\dfrac{\sqrt{x^4+6x^3-4x+13}}{4x^3+2x^2-12}$; find $f(-4)$ and $f(6)$

103. $g(x)=\dfrac{\left(3x^3-2x+9\right)^4}{\left(7x^2-5x\right)^2}$; find $g(-5)$ and $g(4)$