

Chapter 1

Review Exercises

1–4 Find the domain and range of the given relation and determine whether the relation is a function.

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

2. $3x - 4y = 17$

3. $x = y^2 - 6$

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

5–8 Identify the domain, codomain, and range of the given function.

5. $f: \mathbb{N} \rightarrow \mathbb{R}, f(x) = \frac{3x}{4}$

6. $g: \mathbb{R} \rightarrow \mathbb{R}, g(x) = 5x + 1$

7. $h: \mathbb{R} \rightarrow \mathbb{R}, h(x) = \frac{1}{x^2 + 1}$

8. $k: \mathbb{N} \rightarrow \mathbb{R}, k(x) = 2 + \sqrt{x - 1}$

9–12 Find the value of the given function for **a.** $f(x - 1)$, **b.** $f(x^2)$, and **c.** $\frac{f(x + h) - f(x)}{h}$.

9. $f(x) = (x + 5)(2x)$ 10. $f(x) = \sqrt[3]{x} + 6(x + 4)$

11. $f(x) = \frac{3}{x + 2}$ 12. $f(x) = \sin 2x$

13–14 Find all open intervals of monotonicity (intervals where the function is increasing or decreasing) for the given function.

13. $f(x) = (x - 2)^4 - 6$

14. $R(x) = \begin{cases} (x + 2)^2 & \text{if } x < -1 \\ -x & \text{if } x \geq -1 \end{cases}$

15–18 Determine if the function is even, odd, or neither and then graph it.

15. $f(x) = \frac{1}{3}x^3$ 16. $f(x) = \sqrt{x}$

17. $f(x) = -2\sin x$ 18. $g(x) = -2\sin^2 x$

19–20 Discuss the symmetry of the given equation and then graph it.

19. $y = |5x|$ 20. $x^2 + y^2 = 25$

21–34 Graph the given function. Locate the x - and y -intercepts, if any.

21. $f(x) = 7x - 2$ 22. $f(x) = \frac{2x - 6}{3}$

23. $f(x) = (x - 1)^2 - 1$ 24. $f(x) = -x^2 - 6x - 11$

25. $f(x) = 4x^3$ 26. $f(x) = -\frac{2}{x^2}$

27. $f(x) = \frac{-x^3 + 7x + 6}{2}$ 28. $f(x) = \frac{x + 1}{x^2 - 4}$

29. $f(x) = \frac{\sqrt[3]{x}}{2}$ 30. $f(x) = 5|-x|$

31. $f(x) = \left\lfloor \frac{2x}{3} \right\rfloor$ 32. $f(x) = \begin{cases} x^2 & \text{if } x < 1 \\ \frac{1}{x} & \text{if } x \geq 1 \end{cases}$

33. $f(x) = -\cot x$ 34. $f(x) = \log_{1/2} x$

35–36 Sketch the graph of the given function by first identifying the more basic function that has been shifted, reflected, stretched, or compressed. Then determine the domain and range of the function.

35. $f(x) = (x - 1)^3 + 2$ 36. $f(x) = 4|x + 3|$

37–38 Write an equation for the function described.

37. Use the function $f(x) = 1/x$. Move the function 2 units to the right and 3 units up.

38. Use the function $f(x) = \sqrt[3]{x}$. Move the function 1 unit to the left and reflect across the y -axis.

39–40 Find the formula and domain for **a.** $f + g$ and **b.** f/g .

39. $f(x) = x^2$; $g(x) = \sqrt{x}$

40. $f(x) = \frac{1}{x - 2}$; $g(x) = \sqrt[3]{x}$

41–42 Use the information given to determine **a.** $(f \circ g)(x)$, **b.** $(g \circ f)(x)$, and **c.** $(f \circ g)(3)$.

41. $f(x) = -x + 1$; $g(x) = -x - 1$

42. $f(x) = \frac{x^{-1}}{18} - 3$; $g(x) = \frac{x - 4}{x^3}$

43–44 Write the given function as a composition of two functions. (Answers will vary.)

$$43. f(x) = \frac{\sqrt{x+3} + 2}{x^2 + 6x + 9}$$

$$44. f(x) = |x+2| + x^2 + 4x + 4$$

45–46 Graph the inverse of the given relation, and state its domain and range.

$$45. R = \{(-3, 5), (2, 1), (0, -5), (-1, -2)\}$$

$$46. y = \frac{1}{3}x^2$$

47–50 Find the inverse of the given function.

$$47. f(x) = \frac{2}{7x-1}$$

$$48. f(x) = \frac{4x-3}{x}$$

$$49. f(x) = x^{1/5} - 6$$

$$50. f(x) = \frac{6x-7}{2-x}$$

51. Show that $f^{-1}(f(x)) = x$ and that $f(f^{-1}(x)) = x$ for the functions given in Exercises 49 and 50.

52–53 Rewrite the given function as a purely algebraic function.

$$52. \cos(\sin^{-1} x) \quad 53. \tan\left(\sec^{-1} \frac{x}{2}\right)$$

54–55 Use the properties of logarithms to expand the given expression as much as possible; that is, decompose the expression into sums or differences of the simplest possible terms.

$$54. \ln \frac{x^2 y - xz}{5y^3} \quad 55. \log_3 \sqrt{\frac{yz^2}{x^4}}$$

56. If a pebble is shot upward with an initial (vertical) velocity of 56 ft/s, how high does it go? (**Hint:** Use the height function $h(t) = -16t^2 + 56t$.)

57. The half-life of actinium-225 is 10 days. Assuming that A_0 is the mass at time $t = 0$, find the function $A(t)$ that gives the mass remaining after t days. What percentage of the original mass of a sample of Ac-225 remains after 25 days?

58. Prove that the product of an odd function and an even function is odd.

59. Among all the pairs of numbers with a sum of 15, find the pair whose product is maximum.

60. The January 2010 Haiti earthquake was initially reported as a 7.2-magnitude quake on the Richter scale, while the March 2011 earthquake off the eastern shores of Japan was magnitude 9.0. According to these numbers, about how many times more intense was the Japanese earthquake? (**Hint:** See the directions preceding Exercise 138 in Section 1.4.)

61–62 Determine if the given complex number is in the Mandelbrot set. (**Hint:** See the directions preceding Exercises 101–108 in Section 1.3.)

$$61. c = -i$$

$$62. c = 2$$

Concept Check

63–76 Determine whether the given statement is true or false. In case of a false statement, explain or provide a counterexample.

63. The graph of any function can always be represented by a curve that passes the vertical line test.

64. Any linear function whose graph is a line with negative slope always has an inverse.

65. If f is a function, and $f(a) = f(b)$, then $a = b$.

66. If $(2, 5)$ is a point on the graph of an odd function, then $(-2, -5)$ is also on the graph.

67. The graph of a quadratic function is a parabola, so quadratic functions are even functions.

68. In general, $(f \circ g)(x) = (g \circ f)(x)$ holds for all x if both compositions can be formed.

69. If a function can be decomposed into three functions, it can only be done in one way.

70. The graph of $f(x) + a$ is that of $f(x)$ translated vertically by $|a|$ units.

71. If $c \in \mathbb{R}$ is a constant, and f is any function, then the graphs of $f(cx)$ and $cf(x)$ are identical.

72. When the graph of any function $f(x)$ is reflected about the line $y = x$, the graph of the inverse is obtained.

73. The graph of any function must pass the horizontal line test.

74. If (a, b) is a point on the graph of an invertible function $f(x)$, then (b, a) is on the graph of its inverse.

75. The common logarithm and $y = 10^x$ are inverses.

76. The function $f(x) = \tan^{-1} x$ has no asymptotes.

Chapter 1

Technology Exercises

77–79 Mentally sketch the graph of the given function by identifying the basic shape that has been shifted, reflected, stretched, or compressed. Then use a graphing utility to graph the function and check your reasoning.

77. $f(x) = \ln(x+1) + 2$

78. $f(x) = -\frac{2}{x-3} + 1$

79. $f(x) = \sin \pi x - 1$

80. The annual expenditures (in millions of dollars) for a corporation are given in the table below.

Annual Expenditures						
Year	2017	2018	2019	2020	2021	2022
Expenditures (in millions)	\$16.2	\$17.1	\$18.8	\$19.6	\$21.1	\$22.9

- Find the least-squares line of best fit for the data. (Let $x = 0$ correspond to the year 2017.)
- Estimate the expenditures for 2023.

81–82 Use a graphing utility to approximate the solution(s) of the given equation, rounded to four decimal places. (**Hint:** Zoom in on the x -intercepts or points of intersection as appropriate for each equation.)

81. $x^5 - x^3 - 3 = 0$

82. $x^2 + 6 = 2^{x+1}$

83–84 Use a graphing utility to graph the given function, and describe the characteristics of the graph as c varies. Use different viewing windows.

83. $u(x) = \frac{1 - e^{c/x}}{1 + e^{c/x}}$

84. $v(x) = \frac{x}{c^2} \sqrt[4]{c^4 - x^4}$